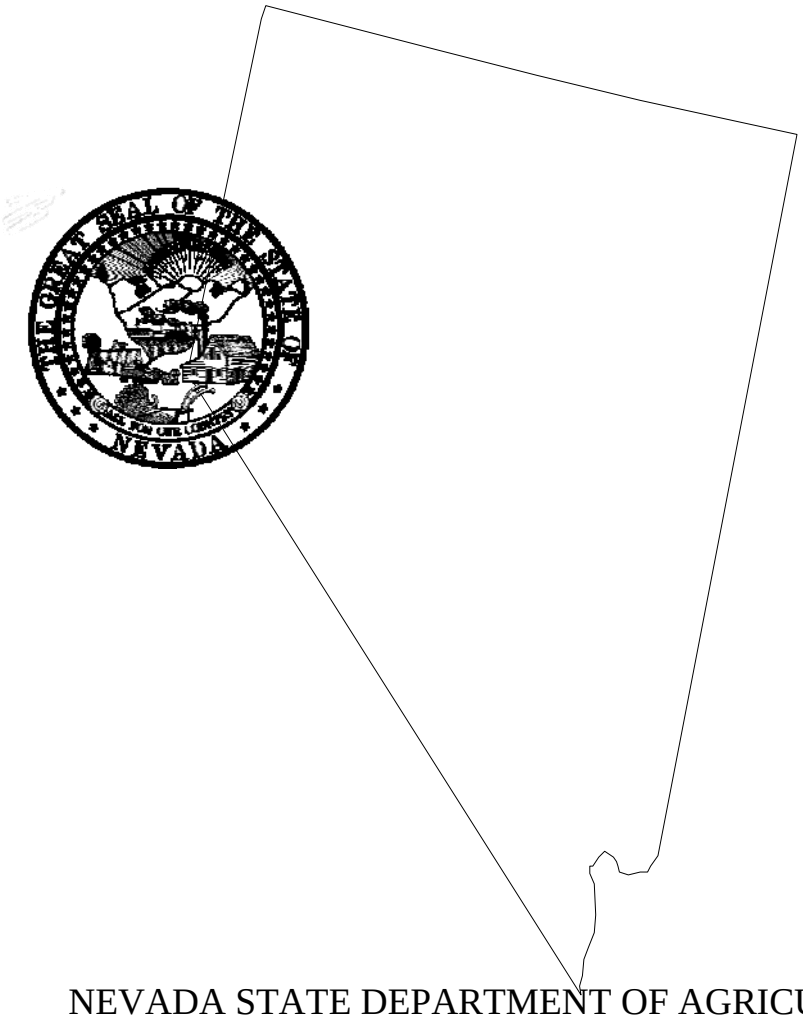
PESTICIDE APPLICATOR CORE STUDY GUIDE

Volume I

(2014 version)



NEVADA STATE DEPARTMENT OF AGRICULTURE

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PESTICIDE APPLICATOR CORE STUDY GUIDE

Volume I

Preface and Acknowledgments

This manual was prepared as a Core study guide for pest control technicians. The enclosed sections deal with federal and state pesticide laws and regulations, pesticides, pesticides and human health, Personal Protective Equipment (PPE), calculations, safety, formulations, pesticide labels, pesticides and the environment, application equipment, and basic insect identification.

Information contained herein is not intended to substitute for any pesticide label information, direction or requirement. In addition, information contained herein is furnished with the understanding that no discrimination is intended, and any reference to a commercially known product does NOT imply an endorsement by the Nevada Department of Agriculture. No endorsement, guarantee, warrantee or assumed liability of any kind, expressed or implied, is made with respect to the information contained herein. It is the pest control licensee's responsibility to follow all pesticide label directions and regulations pertaining to the control of pests.

Sample labels are used in this manual only as an instructional tool. The use of these labels implies no endorsement by the State of Nevada or the Nevada Department of Agriculture.

Due to on going pesticide and regulation changes, The Nevada Department of Agriculture assumes no liability for suggested pesticide use, control techniques, or regulation changes.

For Nevada's most current pest control NAC regulations go to:

http://www.leg.state.nv.us/NAC/NAC-555.html

For the most current NRS regulations go to:

http://www.leg.state.nv.us/NRS/NRS-555.html

Contributing authors to this study guide are Scott D. Cichowlaz - Pest Control Licensing & Continuing Education, Nevada Department of Agriculture; Lee Lawrence - Pest Control Licensing & Enforcement, Nevada Department of Agriculture; Charles Moses – Environmental Scientist, Nevada Department of Agriculture; and Wayne Johnson Ph.D., University of Nevada Cooperative Extension. Special recognition goes to the Nevada Pest Control Advisory Workgroup for their review of previous draft materials.

For a more in-depth understanding of the pest control industry the Department would urge an operator to read pertinent sections of the *Handbook of Pest Control*, A. Mallis, Editorial Director S. Hedges, 2011 (10th edition), and *Truman's Scientific Guide To Pest Management Operations*, G. Bennett, J. Owens, R. Corrigan, editors, 2012 (7th edition). Pest Control Technology (PCT) also publishes several soft cover field guides which can prove invaluable to an applicator in the day to day operations of the business. Several of these PCT field guides are: *Field Guide For The Management Of Structure Infesting Ants, Field Guide For The Management Of Urban Spiders,* a two volume edition of *PCT Field Guide For The Management Of Structure Infesting Beetles* and *PCT Field Guide For The Management Of Structure-Infesting Flies*.

Revised 8/2014

POISON CONTROL CENTER

The American Association of Poison Control Centers (AAPCC) supports our nation's 57 Poison Control Call Centers through a single toll-free phone number. All local poison control centers in the United States use this national number although calls are routed through different centers depending on geographic location. Nevada calls are routed through the **Rocky Mountain Poison Control Center** which also services calls from Hawaii and Montana. This national hotline number will let you talk to experts in poisoning.

National Poison Control

1-800-222-1222

IMPORTANT!
PRIMARY PRINCIPAL APPLICANTS
READ BEFORE PROCEEDING

INFORMATION ON FINGERPRINT CARDS AND FINGERPRINTING SERVICES FOR PRIMARY PRINCIPAL LICENSE APPLICANTS ONLY.

Nevada Revised Statute § NRS 555.345 - After January 1, 2008, each applicant for a **Primary Principal** license will be required to, "**....submit with his application a complete set of his fingerprints and written permission authorizing the Department to forward the fingerprints to the Central Repository for Nevada Records of Criminal History for submission to the Federal Bureau of Investigation for its report.**"

IF YOU ARE APPLYING FOR A PRIMARY PRINCIPAL TEST OR LICENSE, YOU MUST CONTACT THE NEVADA DEPARTMENT OF AGRICULTURE'S SPARKS OFFICE IMMEDIATELY TO RECEIVE INFORMATION ABOUT FINGERPRINT PROCEDURES AND NECESSARY DOCUMENTS. CONTACT MARY HOSSAY AT 775-353-3712.

IMPORTANT!

THIS PAGE IS INTENDED FOR NEW PRIMARY PRINCIPAL APPLICANTS ONLY.

NEW PRIMARY PRINCIPAL CRIMINAL HISTORY CHECK-

Please note, all NEW Primary Principal applicants are subject to FBI and State criminal history checks. NEW Primary Principal applicants are required to submit two sets of fingerprints on a fingerprint card SUPPLIED BY THE NEVADA DEPARTMENT OF AGRICULTURE.

Primary Principal applicants who have been convicted of a felony, or have committed a crime of moral turpitude (molestation, rape, drug trafficking, etc.) are required to provide information about their conviction on a Criminal Conviction Disclosure form supplied by the Nevada Department of Agriculture. Information presented on the form will be subject to review by the Nevada Department of Agriculture. Applicants with prior convictions MAY be subject to license denial.

DUE TO THE TIME IT TAKES TO COMPLETE THE FINGERPRINTING PROCESS AND NECESSARY PAPERWORK, EACH NEW PRIMARY PRINCIPAL APPLICANT IS ADVISED TO CONTACT THE NEVADA DEPARTMENT OF AGRICULTURE OFFICE IN SPARKS, NEVADA, AS SOON AS POSSIBLE TO RECEIVE A FINGERPRINT CARD AND THE REQUIRED FORMS AND OTHER INFORMATION. IN ADDITION, ALL QUESTIONS RELATING TO CRIMINAL HISTORY CHECKS, COMPLETION OF THE FORMS, ETC., ARE TO BE DIRECTED TO THE NEVADA DEPARTMENT OF AGRICULTURE'S HEADQUARTERS OFFICE IN SPARKS, NEVADA.

In addition to submitting fingerprints and a Criminal Conviction Disclosure form, new Primary Principal applicants will also be required to provide information about their pest control license history. Primary Principal applicants who have held a pest control license in another state must state whether they have ever had their pest control license, or permit to conduct pest control, denied, revoked, or suspended, and if so, the reason(s) for the denial, revocation or suspension.

FOR ALL REQUESTS ABOUT THE FINGERPRINT CARDS, FORMS, CRIMINAL HISTORY CHECKS, ETC., CONTACT MARY HOSSAY, AT (775) 353-3712.

NEVADA DEPARTMENT OF AGRICULTURE
EXAMINATIONS

1) All Pest Control Examinations are monitored and/or video and audio taped.

2) Anyone who cheats on an examination will be excluded from taking any pest control examination for a minimum of 6 months (NAC 555.340.7).

3) No cell phones, pagers or other electronic device may be taken into the examination area or used at any time during an examination.

4) No unapproved study materials, notes or other aids may be taken into the examination area or used during an examination.

5) Tests must be paid for prior to examination.

6) Examinees should bring a sharp pencil, eraser, and simple non-programmable calculator.

7) Any examinee who writes, marks on or otherwise damages an exam booklet, will be charged a $5.00 replacement fee. The exam will not be graded until the fee is paid.

NEVADA DEPARTMENT OF AGRICULTURE
EXAMINATION FEES AND SCHEDULING

All Operator examinations must be scheduled and paid for in advance. All fees are **NON-REFUNDABLE** regardless of whether the exam is taken, cancelled, or failed. Exams may be re-scheduled with a minimum of 48 hours notice.

Individuals who "no show" for a *Principal* exam or do not cancel a scheduled *Principal* exam with 48 hours notice, must pre-pay for all future exams.

Table of Contents

About Pesticides

State and Federal Laws

The State of Nevada defines a “pesticide” (NRS 555.267) as:

1. “any substance or mixture of substances, including any living organisms or any product derived therefrom, or any fungicide, herbicide, insecticide, nematicide or rodenticide, intended to prevent, destroy, control, repel, attract or mitigate any insect, rodent, nematode, snail, slug, fungus and weed and any other form of plant or animal life or virus, except virus on or in living man or other animals, which is normally considered to be a pest or which the Director declares to be a pest.”

2. “any substance or mixture of substances intended to be used as a plant regulator, defoliant, or desiccant, and any other substances intended for that use as are named by the Director by regulation.”

Each pesticide is different and must be judged on the basis of its chemical composition and its label content and do not include any “new animal drugs.”

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was passed in 1972, and amended in 1974, 1978, and in 1988. In 1996, the Food Quality Protection Act was signed into law. FIFRA regulates the registration, manufacturing, transportation, distribution and use of pesticides. The United States Environmental Protection Agency (EPA) administers FIFRA.

Definitions:

1) Certified Applicator: any individual who is authorized (trained and/or tested for competency in the safe and effective handling and use of pesticides) to use or supervise the use of any pesticide that is classified as restricted use.

2) “Under the Direct Supervision of a Certified Applicator”: unless otherwise prescribed by its labeling, a restricted use pesticide may be applied by a competent person acting under the instructions and control of a certified applicator who is available if and when needed, even though such certified applicator may not be physically present at the time and place the pesticide is applied.

3) “Immediate supervision” supervision by a licensed applicator who is present and responsible for a person applying a pesticide for pest control.

4) Label: the written, printed, or graphic matter on, or attached to, the pesticide, container, device or wrapper.

5) “To Use Any Registered Pesticide in a Manner Inconsistent with its Labeling”: to use any pesticide in a manner not permitted by the labeling, provided that the term shall not include:

a) Applying a pesticide at any dosage, concentration or frequency less than that listed on the labeling.

b) Applying a pesticide against any target pest not on the labeling if the application is to a crop, animal, or site that is listed.

c) Use any equipment or method of application that is not prohibited by the labeling.

d) Mix a pesticide or pesticides with a fertilizer, if the labeling does not prohibit the mixture.

6) General Use Pesticide: a pesticide, when applied in accordance with its directions for use, warnings and cautions and for the uses for which it is registered, which will not generally cause unreasonable adverse effects on the environment.

7) Restricted Use Pesticide: a pesticide, when applied in accordance with its directions for use, warnings and cautions and for the uses for which it is registered, may generally cause, without additional regulatory restrictions, unreasonable adverse effects on the environment, including injury to the applicator. Restricted Use pesticide packaging and labels are clearly distinguishable from general use pesticides by a text box stating “Restricted Use” displayed prominently on the front panel.

8) “Pest control”: means publicly holding oneself out as being in the business of detecting, preventing, controlling or exterminating pests or otherwise engaging in, advertising or soliciting for:

a) The use for hire of pesticides or mechanical devices for the extermination, control or prevention of infestations of pests.

b) The inspection for hire of households or other structures and the submission of reports of inspection, estimates or bids, written or oral, for the inspection, extermination, control or prevention of wood-destroying pests.

9) “Primary principal”: a principal who has been designated by a pest control business as the person responsible for the daily supervision of each category of pest control.

10) “Principal”: an owner, officer, partner, member or technician of a pest control business who has qualified by examination in one or more categories of pest control.

11) “Location Principal”: the primary principal at a business location of a pest control business or a principal who has been designated by a primary principal as the person responsible for the daily supervision of the category or categories of pest control performed at a business location of the pest control business.

12) “Operator”: a person who:

a) Is licensed pursuant to NAC 555.360; and

b) Applies a pesticide without the immediate supervision of a principal.

13) “Agent”: any person who solicits business on behalf of a custom pest control licensee.

The Federal Worker Protection Standard:

EPA has revised its regulations governing worker protection from agricultural pesticides. The scope of standards includes farm/ranch, forest, nursery and greenhouse workers. This proposal expands requirements for training, warnings about applications, personal protective equipment and re-entry restrictions and adds new provisions for decontamination, emergency medical duties, and training.

The WPS reference statement will appear on agricultural pesticide products that require employers to provide pesticide handlers and agricultural workers with all WPS protections. These protections include:

- Personal Protective Equipment (PPE) (handlers only).
- Display and exchange of information; emergency assistance.
- Notification of handlers and workers about pesticide applications.
- Providing a decontamination site for workers and handlers.
- Pesticide safety training for agricultural workers and handlers.

For the full text of the Code of Federal Regulations (CFR) TITLE 40 - Protection of Environment; CHAPTER I – Environmental Protection Agency; SUBCHAPTER E – Pesticide Programs; PART 170 – Worker Protection Standard, go to:

http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr170_main_02.tpl

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment, notification of workers, and restricted-entry intervals.

Commercial Applicator Information Exchange - Pesticide application information must be shared between the commercial applicator and the client/grower within twenty-four (24) hours prior to the pesticide application. Information to be shared includes: date and time of the application, specific location, Restricted Entry Interval (REI), notification method (posting or oral warning), EPA registration number and active ingredient of pesticide(s) to be applied.

The grower, in turn, must provide the commercial applicator information regarding any REIs that are in effect within ¼ mile of the scheduled pesticide application target site, (pertains only to grower's establishment).

If it is necessary for you to meet the requirements of the WPS, you will need to obtain a copy of the WPS "How to Comply" Manual, http://www.epa.gov/agriculture/htc.html

Types and Kinds of Nevada Pest Control Licenses:

Fields of pest control are:

(a) **Aerial**—The use of aircraft for the application of pesticides on standing or running water, agricultural crops, rangeland, forest, idle cropland and noncropland associated with the production of agricultural crops.

(b) **Agricultural ground**—The use of ground equipment for the application of pesticides on livestock, rangeland, agricultural crops, idle cropland and noncropland associated with the production of agricultural crops.

(c) **Urban structural**—The use of ground equipment for the application of pesticides in urban areas and in, on or around structures.

Categories of Licenses are:

(a) **Aerial**:

(1) **Insect pests**—The application of insecticides, miticides and acaricides.

(2) **Weeds**—The application of herbicides and plant regulators.

(3) **Desiccants and defoliants**—The application of desiccants and defoliants.

(4) **Fungi pests**—The application of fungicides, bactericides and nematicides.

(b) **Agricultural ground**:

(1) **Insect pests**—The application of insecticides, miticides and acaricides.

(2) **Weeds**—The application of herbicides and plant regulators.

(3) **Desiccants and defoliants**—The application of desiccants and defoliants.

(4) **Fungi pests**—The application of fungicides, bactericides and nematicides.

(5) **Vertebrate pests**--The application of various substances on agricultural ground for the control of vertebrate pests, including, without limitation, the use of fumigants for burrowing rodents. This category does not include the control of vertebrate pests in, on or around industrial complexes, institutional complexes, dwelling units or other structures designed for use by humans, or on ornamentals or turf in, on or around such structures.

(c) **Urban and structural**:

(1) **Limited landscape**—The control of insect pests, vertebrate pests and plant diseases and the use of plant regulators on ornamentals and turf in urban areas, including, without limitation, fruit trees in urban areas if the fruit trees are not used for commercial purposes.

(2) **Industrial and institutional**—The control of insect pests and vertebrate pests in, on or around industrial complexes, institutional complexes and dwelling units.

(3) **Structural**—The control of wood-destroying pests, inspection for wood-destroying pests and inspection for conditions conducive to infestations of wood-destroying pests.

(4) **Fumigation**—The use of poisonous and lethal fumigants.
(5) **Aquatic**—The control of insect pests, weeds and vertebrate pests in aquatic areas that are used or are intended for use in and around industrial complexes, institutional complexes and dwelling units.
(6) **Weeds**—The control of weeds in the maintenance of landscapes, turf and rights-of-way, including, without limitation, public roads, power lines, pipelines and railway rights-of-way. This category does not include the control of aquatic weeds.
(7) **Preservation of wood**—The application of pesticides directly to wood or wood products that are not a part of a habitable structure to prevent or control the degradation of the wood or wood product by a wood-destroying organism, including, without limitation, a fungus or bacterium.

Pesticide Record Keeping Requirement:

Licensed Pesticide Applicators: Whereas certified applicators are only required to keep records of restricted use pesticides (RUP), licensed pesticide applicators are required to keep accurate and legible written records of each pesticide application. NAC 555.410 states:

1. Keep accurate and legible records for 2 years of each property treated, showing:

(a) If the person is licensed in the aerial or agricultural ground field:

(1) The date of the treatment.
(2) The full name of the person for whom and the county where the treatment was conducted.
(3) The full name of the pilot or applicator doing the treating.
(4) The crop or site treated or, in the case of a spot treatment, the term “spot treatment” must be noted, followed by a description of the treatment area and the spot or spots treated.
(5) The number of units treated, including, without limitation, the number of acres or miles or fraction thereof.
(6) The number, name or site identification of the field.
(7) The brand name or generic name of the pesticide that was applied, the registration number assigned to the pesticide by the Environmental Protection Agency and the dosage applied.
(8) The purpose for which the crop, site or spot was treated.
(9) The time the treatment was started and the time the treatment was finished.
(10) The temperature at the start and finish of the treatment.
(11) The wind velocity and wind direction at the start and finish of the treatment.

(b) If the person is licensed in the urban and structural field:

(1) The date of the treatment.
(2) The address where the treatment was conducted.
(3) The full name of the applicator.
(4) The site treated, including, without limitation, the kitchen, the crawlspace beneath the structure, and the yard or area surrounding the structure. In the case of a spot treatment, the term “spot

treatment" must be followed by a description of the treatment area and the spot or spots treated.
(5) The brand name or generic name of the pesticide that was applied and the registration number assigned to the pesticide by the Environmental Protection Agency.
(6) The total amount of any diluted pesticide and the concentration of the pesticide that was applied.
(7) If the treatment is conducted in the categories of limited landscape, weeds, aquatic or fumigation:

(I) The temperature at the start and finish of the treatment.

(II) The wind velocity and direction at the start and finish of the treatment.

(III) The area of any turf or ground treated.

(IV) The purpose for which the pesticide was applied.

(V) The area or volume fumigated.

(VI) The times at which fumigation started and finished.

Your personal protection is not the only reason for keeping pesticide application records. Many herbicides can be used safely on certain sites or crops, but may be fatal to others. Without written records, it is difficult to know what pesticides have been used on a site during the previous few years. More detailed information about record keeping requirements can be obtained from the Nevada Department of Agriculture.

Types of Pesticides

Two common ways of grouping pesticides are according to what pests they control and how the pesticide works to control them. The following is a listing of various pesticide classes.

- **Insecticides** are chemicals used to control insects and other related organisms, such as ticks, spiders, centipedes and mites. Often the word "insecticide" is confused with the word "pesticide"; however, it is just one of many types of pesticides.
- **Herbicides** are chemicals used to control unwanted plants (i.e. weeds).
- **Fungicides** are chemicals used to kill or inhibit fungi that cause rot, leaf spotting, blights, mildews and rusts on plants, or wood rot.
- **Nematicides** are chemicals used to control nematodes that cause certain plant diseases.
- **Bactericides** are chemicals used to kill bacteria. Some bacteria cause plant disease.
- **Rodenticides** are chemicals used to control rats, mice, and other rodents.
- **Fumigants** are gases designed to kill insects and other organisms in confined spaces. They are hazardous and require special precautions. Those who apply fumigants must be licensed in the fumigation category (category C4).

Although not usually thought of as pesticides, the following three classes of chemicals are also regulated as pesticides under both federal and state laws.

- **Defoliants** are chemicals that cause leaves or foliage to drop from plants.
- **Desiccants** are chemicals that promote drying or loss of moisture from plant tissue.
- **Growth regulators** are substances that alter the normal or expected growth of insects or plants, and/or alter insect or plant reproduction

How Pesticides Work

Pesticides can also be grouped according to how they control pests. Read the label to find out what each pesticide will do.

- **Selective pesticides** are effective against a limited group of pests (for example, ants), as opposed to non-selective pesticides which control all related pests. For example, a non-selective insecticide will destroy all insects it contacts.
- **Residual or persistent** pesticides actively kill pests for at least a week, and in some cases several weeks or even years (usually herbicides) after application. Conversely, **non-residual or non-persistent pesticides** breakdown rapidly after application.
- **Contact pesticides** control the pest on contact. Contact pesticides are applied to the surface of an animal, plant, or structure. The pest is killed upon coming in contact with the pesticide.
- **Systemic or translocated pesticides** are absorbed by plants or animals, and move from the site of absorption to other tissues. For example, a **systemic** insecticide like Merit® is absorbed by the plant and moved throughout its tissues, killing insects that feed on it.

The Pesticide Label

The pesticide label is the information printed on the container, including any additional information included with the product. The label represents the best single source of information available to the applicator. The label is a “legal document”. Its importance to the buyer or user can not be overstated. It is the source of facts on how the pesticide is to be legally handled and used.

Pesticide Properties:

Information contained on the pesticide label is based on scientific research conducted to register the pesticide. Information on the pesticide’s properties and its human health and environmental hazards must be submitted to the Environmental Protection Agency (EPA) for review and approval. If the pesticide is not approved, its registration application will be rejected.

Physical and Chemical Properties

Pesticide properties include solubility (the ability to dissolve) in water, volatility (the tendency to vaporize/evaporate), stability to heat and light, and factors that affect how the material will act in the environment. These properties help experts estimate whether the pesticide can accumulate in the fat tissues of humans and animals (as DDT once did), whether it is susceptible to vaporization after application, whether it will be tied up in the soil after application, and whether it will leach through certain soils.

Toxicological Profile

Toxicity tests must be performed on rats and rabbits and certain fish and birds. The tests determine pesticide toxicity to various species, and whether it produces reproductive or birth defects, mutagenic (the ability to produce genetic change), and oncogenic effects (the ability to produce tumors).

Residue Analysis

The amount of a pesticide remaining in a plant at harvest, in an animal at slaughter, or left on a surface is called residue. Because pesticides degrade at different rates in different tissues, studies must be conducted on each plant part or animal product intended for consumption. These tests determine how much, if any, of a pesticide's residue remains on or in a crop or animal over time.

From this data, scientists can determine the proper number of days between the last pesticide application and a safe harvest, known as a "pre-harvest interval"; or re-application of a pesticide to a particular site or location, known as a "re-treatment interval". The restricted-entry interval (REI) is the time immediately after a pesticide application when entry into the treated area is restricted. Some pesticides have one REI, such as 12 hours, for all crops and uses. Other pesticides have different REIs depending on the crop, method of application, or the post-application activity to be performed. When two or more pesticides are applied at the same time and have different REIs, the longer REI must be followed. The REI is listed on the pesticide labeling under the heading "Agricultural Use Requirements" in the "Directions for Use" section of the pesticide labeling, or next to the crop or application method to which it applies.

Affects on Wildlife and the Environment

Tests must be performed to determine the affects of field (including large turf areas such as golf courses) applications of pesticides on wildlife and the environment. Any potential harmful affects on wildlife and the environment that are recognized during these studies must be included in the pesticide application package or otherwise submitted to the EPA for review.

Parts of the Label:

Pesticide labels conform to a set of standards established by federal law. For the applicator, the label provides guidelines for correct application and pesticide usage. The label identifies the classification of the pesticide as either general or restricted use, and specific sites intended for application.

By law, a pesticide can only be applied to a site identified on the label, even though specific pests may or may not be listed. A site can be a crop, animal or location the product is applied or intended to protect.

The manufacturer is required to furnish certain information on the label. The information includes the brand name or trade name of the product, the ingredient statement, the percentage or amount of active ingredient(s) by weight, the net contents of the container, and the name and address of the manufacturer. Other required parts of the label are the registration and establishment numbers, signal words and symbol, precautionary statements, bee advisory box, first aid, environmental hazard statement, classification statement, directions for use, storage and disposal statement, re-entry statements and harvest or grazing restrictions as necessary. The following are details on each of the aforementioned parts of the label.

Brand, Trade or Product Name

A single pesticide active ingredient may be marketed at the same time under several trade names. Each label may designate a different use of the product. A specific brand name, usually registered as a trademark, will identify a product as produced by a particular manufacturer. Usually, the brand name shows up plainly on the front panel of the label and is the most identifiable name of the product.

Many pesticides have complex **chemical names**. Some have been given trade names to make them easier to identify. For instance, “Sevin” is a brand name for “carbaryl” which is the **common name** for 1-naphthyl N-methylcarbamate. A pesticide made by more than one company will be sold under several brand names, but the same common name or chemical name should be on all of them.

Ingredient Statement

Every pesticide label must list what is in the product. The ingredient information is written so that the product’s **active ingredient** can be found quickly. Active ingredients are the chemicals in the pesticide product that actually control the pest. The amounts (percentage by weight or pounds per gallon) of the ingredients are also printed on the label. Often, the chemical name of the active ingredient is stated. If an approved common name of the active ingredient exists, it may be listed and may be followed by a chemical name (e.g. carbaryl....1-naphthyl N-methylcarbamate). Actual labels can be viewed in this study manual. Other ingredients called **other ingredients** are often added to products making them safer, easier to handle and apply. The name of the other ingredient is usually not stated, but each label must indicate its percentage of the total product content.

Net Weight or Measure of Contents

The net contents are displayed prominently on the front of the label. Net weight is often expressed as fluid ounces, pints, quarts or gallons for liquid formulations. Liquid formulations may also list pounds of active ingredient per volume (e.g. gallons) of product. If the formulation is a dry, semi-solid, viscous, pressurized, or a mixture of solids and liquids, the contents are expressed in ounces and/or pounds. Net contents may be expressed in metric units.

Type of Formulation

The mixture of active and other ingredients is called a pesticide **formulation**. On some pesticide products the manufacture will specifically identify the formulation of the product (e.g. HERBICIDE 5-G; the "G" stands for "granular"), while others will not. Where it is not clearly identified, it is sometimes possible to determine the formulation by reading the directions for use. More detail is discussed in the formulations section.

Manufacturer

The name and address of the manufacturer, registrant or formulator who makes the product must be printed on the label. In some cases this information will be found on the back panel of the label. If the registrant's name appears on the label and the registrant is not the manufacturer, it must be qualified by appropriate wording such as "packed for...", "distributed by...", or "sold by...".

EPA Registration Number

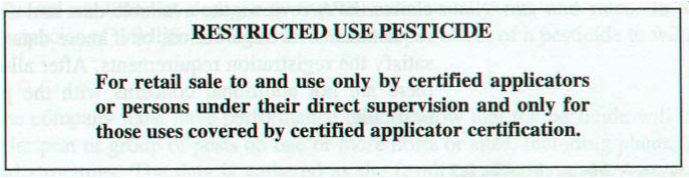
An EPA registration number must be on every pesticide label showing the product has been registered with, and the label approved by, the U.S. EPA before being marketed. In most cases it will be written as in this example, "EPA Registration No. 1234-56". In cases of a "special local need registration", a pesticide product may be approved in a specific state for additional usage not specified on the label. As in this example, this type of registration number is designated as "EPA SLN No. NV1234" and means the product is registered for additional uses as a special local need pesticide in Nevada.

EPA Establishment Number

An establishment number identifies the specific facility that produced the product. The establishment number can be used to trace a pesticide to its manufacturing plant. The information is beneficial if problems occur with the product or if it has been tampered with or adulterated.

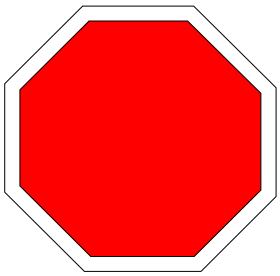
Statement of Use Classification

Every pesticide is classified as either "General Use" or "Restricted Use." EPA places every pesticide product into one of these two classes. The classification is based on the hazard of poisoning and its affect on the environment. A pesticide classified as "General Use" won't actually say "General Use". However, those classified as "Restricted Use" will be labeled as such on the top, center of the label.



- **General Use**. General use pesticides are less likely to harm the applicator or the environment when used according to label directions.
- **Restricted Use**. A restricted use pesticide is one that could cause some human injury or cause environmental damage even when used as directed on the label. The label of a restricted use pesticide will have a statement on the top of the front panel that reads: "*Restricted use pesticide for retail sale to and use by certified applicators or persons under their direct supervision* ....." In Nevada, "certification" is required for an applicator to purchase, apply or supervise the application of a restricted use pesticide. (This manual is not intended to explain the process or necessity of restricted use pesticide certification. For more information, please contact a Nevada Department of Agriculture representative.)

Directions for Use



The instructions about applying a pesticide are considered as one of the most important parts of the label. Carefully reading and understanding the label are the best ways to find out how to correctly apply a product. These directions provide the following information:

- The pests controlled (labels use common names for pests; knowing these names will help when choosing the proper pesticide and in finding control information);
- The site (crop, animal, location, etc.) the product is intended to protect, or on which it can be used;
- Rates and methods of application;
- Times and/or frequency of application;
- Mixing directions;
- Any necessary application equipment;
- Any preharvest interval (in days) may be listed.

An applicator may deviate from the label directions only in the following circumstances:

- Pesticides can be applied at less than the labeled rate (excluding pre-treatment applications for termite control);
- Pesticides can be applied against any pest not listed on the label providing the crop, animal, or site is listed on the label (unless otherwise stated);
- Any equipment or method of application that is not prohibited may be used;
- A pesticide can be mixed with another pesticide (or fertilizer) if the mixture is not prohibited by the label.

Misuse Statement

The misuse statement reminds the user that it is a violation of federal law to use a product in a manner inconsistent with its label directions. Do not use a pesticide on a crop, animal or other site not listed on the label. Do not use a pesticide at more than the recommended strength or rate of application.

Before a pesticide is registered with the EPA, the manufacturer is required to conduct many tests to insure the label directions are accurate. Following the directions exactly will give the best results.

Remember, the label is the law, and by not following the label directions users are breaking the law! Always read, understand and follow the label directions, it's the law!

Signal Word and Symbol

To do their job, pesticides must control the target pest. By nature, pesticides are toxic and must be handled with extreme care. The toxicity of a product can be told by reading its "**signal word**" and looking at the "**symbol**" on its label. Each label will display a prominent signal word that indicates the relative toxicity of the active ingredient to humans. The hazard categories have been determined by considering the acute toxic effects of when a pesticide is swallowed, inhaled, or spilled on the skin. Affects on the eyes and external injury to the skin are also considered. The three signal words, in order of increasing toxicity, are **caution**, **warning** and **danger**. The signal word must appear on the front panel of each pesticide label.

DANGER

WARNING

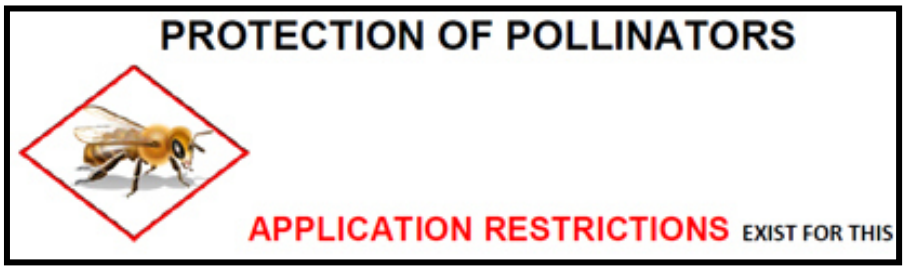
CAUTION

- **Caution** is the signal word required on the label of all pesticide products considered to be slightly toxic to relatively nontoxic when taken into the body orally, dermally or by inhalation; or that cause slight eye and skin irritation. A product with the signal word **caution** would require ingestion of an ounce or more to a pint to kill the average adult. A pesticide with a **caution** signal word can also be classified as a restricted use pesticide because of environmental concerns.
- **Warning** is the signal word required on the label of all pesticide products considered moderately toxic when taken into the body orally, dermally, or by inhalation, or that cause moderate eye and skin irritation. A pesticide with the signal word **warning** would generally require ingestion of one (1) teaspoon (0.16 of an ounce) to one (1) ounce to kill the average adult.
- **Danger/Poison**, **Peligro** and the **skull-and-crossbones** symbol must appear on the labels of all pesticides that are highly toxic when taken into the body orally, dermally, or by inhalation. They may cause severe eye and skin irritation. A product with the signal word **danger** would generally require ingestion of as little as a taste to no more than one (1) teaspoon (0.16 of an ounce) to kill the average adult.

Precautionary Statements

These statements guide the applicator in taking proper precautions to protect humans and animals that could be exposed to the pesticide.

- **Hazards to Humans and Domestic Animals** explains the ways in which the pesticide may be poisonous to humans and animals. It also tells of special precautions to take to avoid poisoning, such as protective clothing or other personal protective equipment (PPE). For example, the precautionary statements may direct the applicator to use rubber gloves, an approved respirator, and/or goggles when working with a pesticide.
- **Environmental Hazards**. Pesticides are useful tools but when applied incorrectly or carelessly can cause serious environmental harm. To help prevent this, the label contains environmental precautions that must be read and followed. For example, a label may contain one of the following statements:
    - *"This product is highly toxic to bees."*
    - *"Do not contaminate water when cleaning equipment or when disposing of wastes."*
    - *"Do not apply where runoff is likely to occur."*
    - Protection of Pollinators – Bee advisory box and iconwith information on routes of exposure and spray drift precautions. Today's announcement affects products containing the neonicotinoids imidacloprid, dinotefuran, clothianidin and thiamethoxam.



Pesticide labels may also contain broader warnings against harming birds, fish, and other wildlife.

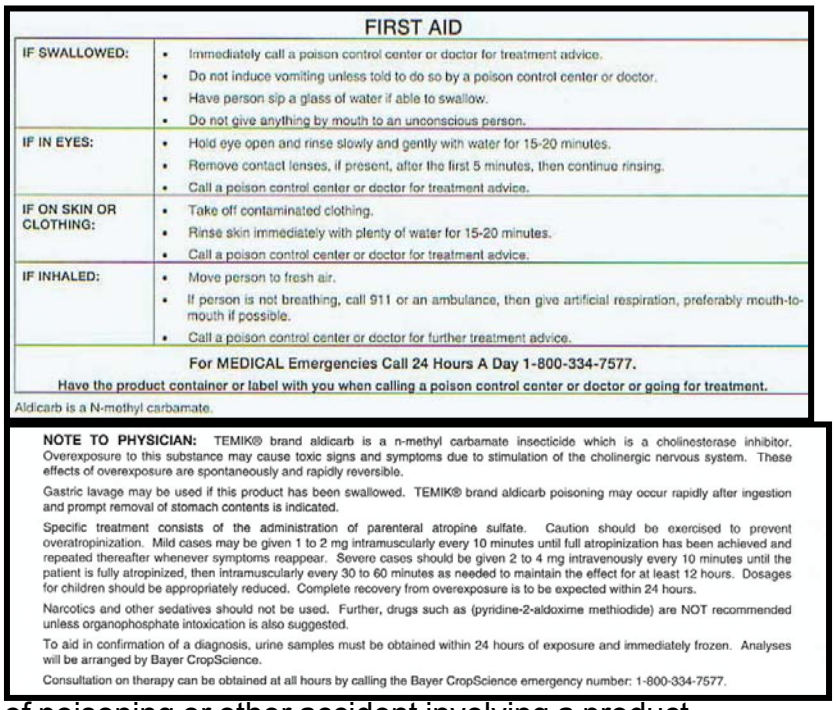
- **Physical and Chemical Hazards** tell the applicator of any special fire, explosion, or chemical hazards that the pesticide may pose. For example, a label may contain one of the following statements:
    - "*Keep away from heat or open flame*."

Every pesticide label must include the statement "**Keep out of reach of children**" on the front panel. This warning must be followed.

First Aid

First aid treatment guidelines are recommended in this statement in case of over-exposure. These guidelines are very concise.

This information should be read before the product is purchased or used, and again in case of emergency. For example, a statement may read "*In case of contact with skin, wash immediately with plenty of soap and water.*" The label also contains a "Note to Physicians" describing the appropriate medical procedure for poisoning cases, and may indicate an antidote. The pesticide label is the most important information to take to the physician when someone has been exposed. Most labels list a phone number which can be used in the event of poisoning or other accident involving a product.



FIRST AID

IF SWALLOWED:	• Immediately call a poison control center or doctor for treatment advice. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Have person sip a glass of water if able to swallow. • Do not give anything by mouth to an unconscious person.
IF IN EYES:	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. • Call a poison control center or doctor for treatment advice.
IF ON SKIN OR CLOTHING:	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
IF INHALED:	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call a poison control center or doctor for further treatment advice.

For MEDICAL Emergencies Call 24 Hours A Day 1-800-334-7577.

Have the product container or label with you when calling a poison control center or doctor or going for treatment.

Aldicarb is a N-methyl carbamate.

NOTE TO PHYSICIAN: TEMIK® brand aldicarb is a n-methyl carbamate insecticide which is a cholinesterase inhibitor. Overexposure to this substance may cause toxic signs and symptoms due to stimulation of the cholinergic nervous system. These effects of overexposure are spontaneously and rapidly reversible.

Gastric lavage may be used if this product has been swallowed. TEMIK® brand aldicarb poisoning may occur rapidly after ingestion and prompt removal of stomach contents is indicated.

Specific treatment consists of the administration of parenteral atropine sulfate. Caution should be exercised to prevent overatropinization. Mild cases may be given 1 to 2 mg intramuscularly every 10 minutes until full atropinization has been achieved and repeated thereafter whenever symptoms reappear. Severe cases should be given 2 to 4 mg intravenously every 10 minutes until the patient is fully atropinized, then intramuscularly every 30 to 60 minutes as needed to maintain the effect for at least 12 hours. Dosages for children should be appropriately reduced. Complete recovery from overexposure is to be expected within 24 hours.

Narcotics and other sedatives should not be used. Further, drugs such as (pyridine-2-aldoxime methiodide) are NOT recommended unless organophosphate intoxication is also suggested.

To aid in confirmation of a diagnosis, urine samples must be obtained within 24 hours of exposure and immediately frozen. Analyses will be arranged by Bayer CropScience.

Consultation on therapy can be obtained at all hours by calling the Bayer CropScience emergency number: 1-800-334-7577.

Re-entry Statement

If it is required, some labels may contain a precaution to protect people after a pesticide application. This statement indicates how much time must pass before an area treated with a pesticide can safely be reentered by persons not wearing protective clothing or equipment. If no reentry statement appears on the label then no one must reenter the treated area until any spray has dried or dusts have settled. That is the minimum legal reentry interval.

Storage and Disposal Directions

Upon purchase, the storage of the pesticide, the disposal of unused product and the disposal of empty containers is an important responsibility. This section of the label informs the applicator of how to store and dispose of unused pesticides and dispose of empty containers. The storage and disposal section of a label may have instructions on how to dispose of pesticide rinsate and return the container for refilling (for sale or distribution) if it can be reused Typical statements include the following:

- "*Store away from fertilizers, herbicides and fungicides.*"
- "*Store at temperatures above 32°F (0°C).*"
- "*Do not reuse container.*"
- *"Do not contaminate water, food, or feed by storage of disposal."*
- "*Triple rinse and offer this container for recycling or reconditioning, or dispose in an approved landfill or bury in a safe place.*"

These statements may appear in a special section of the label titled **Storage and Disposal**, or under headings such as "Important", "Note", or "General Instructions." Pesticide inventories should be stored securely, preferably under lock and key, and separated from food and feed products.

Summary:

The federal Environmental Protection Agency (EPA) administers the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). FIFRA requires all pesticides produced in this country, or imported, to be registered by the EPA and properly labeled.

The label is the basic legal document that controls the use of a pesticide. It is attached or printed on the pesticide container and must remain with the product throughout its life. All pesticide labels must be registered with the EPA, and all pesticides sold in Nevada must also be registered with the Nevada Department of Agriculture. All registered pesticide labels must have an "EPA Registration Number" and an "Establishment Number". The Establishment Number tells which factory made the product. The Establishment Number may be on the label or on each container.

Labeling includes the label on the container and all brochures, flyers and other product information distributed with the product or by the pesticide dealer.

Extensive scientific data is used to determine the "efficacy", or killing potential, of a pesticide. Knowing the efficacy of a pesticide is one of the prerequisites for registering a pesticide with the EPA. This data enables the pesticide producer to supply users with information about acute and chronic toxicity and possible hazards associated with the use of the product. Hazards may include possible injury to applicators or persons entering treated areas, unintended crop injury, injury to livestock, bees, fish, wildlife, etc.

The applicator must have the label, any supplemental labels (Nevada SLN registered pesticides), and any special use permits in their possession during the application to comply with state and federal laws.

READ, UNDERSTAND, AND FOLLOW ALL LABEL DIRECTIONS. IT'S THE LAW!

Pesticide Formulations and Packaging

Pesticides are available in a wide variety of formulations. It is not uncommon to find some active ingredients formulated in at least a half dozen different ways. Formulation of a pesticide is the mixing of an active ingredient with some type of carrier or diluent, either a liquid or solid material (water is the most common diluent). This is done to make the chemical suitable for application with modern equipment or, in some cases, attractive to a pest (e.g. bait). Only rarely are undiluted active ingredients used to control pests. The pesticide formulation is usually listed on the label. It is often abbreviated and may be included in the product's trade name. For example, the herbicide Casoron G-4 indicates to the applicator that it is a granular formulation ("G") with 4% active ingredient. However, on many labels it is not as simple to identify the type of formulation.

Pesticides are available as aerosols, baits, dusts, emulsifiable concentrates, flowables, fumigants, granules, soluble powders, solutions, water dispersible granules, and wettable powders. The following is a brief description of pesticide formulations.

Aerosols (A)

These pesticide formulations are liquids that contain the active ingredient in solution, packaged in a pressurized container. "Total Release Aerosols" contain a small amount of active ingredient mixed with a propellant that forces the contents from the can into a spray or mist. The size of aerosol cans intended for home-garden and general household use usually range from 12 to 16-ounces. The aerosol cylinders designed for commercial use are generally available in sizes from 4 to 10 pounds.

Aerosols are convenient to use since no measuring or mixing of ingredients is required. They are ready to use as purchased and are easy to store. However, caution is necessary when handling aerosols. Never attempt to puncture or burn aerosol cans because they can explode.

Baits (B)

Poisonous baits are composed of an edible substance or some other attractant mixed with an active ingredient. Baits either attract pests or are placed in locations where pests will find them. Pests must consume enough of the bait to be killed.

Baits may be used to control certain insects, snails, slugs, rodents, other pest mammals and pest birds. Most bait formulations contain a low percentage of active ingredient, usually less than 5%. Baits are often used in gardens, granaries, kitchens, other food-storage and food-processing facilities, and refuse disposal areas. A major advantage is that baits can be placed exactly where and only when needed, and can be removed after use.

Disadvantages are that baits may be attractive to children, pets and other non-target species. Domestic animals and wildlife can be killed by poorly placed or monitored baits. At times, poison baits may not control target pests, especially when other more attractive food sources are available.

An example of a bait is Amdro® Fire Ant Bait.

Dusts (D)

These formulations are ready to use as purchased without additional mixing. Dusts contain an active ingredient plus a finely ground inert substance such as talc, clay, nut hulls, or volcanic ash. The amount of active ingredient usually ranges from 1 to 10 percent.

The major advantage of dust formulations is their ease of handling with low-cost application equipment. However, dusts are generally not as economical to purchase as other formulations. They are relatively expensive for the amount of active ingredient in the total formulation. Furthermore there are often problems with drift; they may be more irritating to the applicator than sprays; often little active material reaches the target pest; rain and wind can easily remove dusts from treated surfaces. Dusts are recommended mainly for use around the home and garden but not for large scale farm use.

Dust concentrates are available for further dilution with dry inert ingredients, however this is rare. Herbicides are not formulated as dusts because of the extreme drift hazard that would result.

An example of an insecticidal dust would be Delta Dust®. This dust formulation contains 0.05% percent of the active ingredient Deltamethrin.

Emulsifiable Concentrates (EC, E)

These are liquid formulations with the active ingredient dissolved in one or more petroleum solvents. Active ingredients that are formulated as EC's are insoluble in water. An emulsifier is added so the material will mix readily with water. The emulsifier in the EC formulation allows the product to form an emulsion when mixed with water. Emulsifiable formulations usually contain between 2 and 8 pounds of active ingredient per gallon. EC formulations will not settle out or separate when agitated.

EC formulations are easy to measure and mix. They are not abrasive and will not plug screens and nozzles. There are, however, several shortcomings associated with the use of these materials. Because of the high concentration of active ingredient(s) in EC formulations, there may be considerable hazard to the applicator and other persons if the product is accidentally spilled on the skin or ingested. They should never be stored in areas subject to excessively high temperatures or where liquids can freeze. Most of these formulations are highly flammable because of the petroleum solvent they contain. Compatibility and phytotoxicity (toxicity to plants) of EC materials may occasionally be a problem. This is often the reason why EC formulations are not registered for use on certain sites, crops and plants, while a wettable powder or dust formulation containing the same active ingredient can be used on these sites. Most liquid concentrates of this type can cause rubber hoses, gaskets, and pump parts to deteriorate, and some formulations are detrimental to painted surfaces.

An example of an EC would be Cynoff ®EC Insecticide.

Flowables (F, L)

Flowables are formulations made up of active ingredients that will not dissolve in water or other commonly used carriers. These formulations consist of finely ground solid particles (usually clay) suspended in a liquid carrier. The solid in a flowable is similar to the active ingredient in a wettable powder, except that the solid is formulated to stay in suspension in liquid. The result is a formulation that looks like a thick paste or cream. Normally, flowables contain 4 or more pounds of active ingredient per gallon. Flowables must be shaken prior to pouring. Shaking the container re-mixes the formulation. Flowables can be mixed readily with water and usually do not clog nozzles. They need moderate agitation to remain in suspension because the formulation settles out quickly. The principal disadvantage of flowables is the hazard associated with handling and storing undiluted concentrated materials. The same precautions should be observed with flowables as with emulsifiable concentrates.

An example of a flowable would be Admire® 2 Flowable. This formulation contains 2 pounds of active ingredient per gallon of formulation.

Fumigants (LG)

These are pesticides in the form of poisonous gases. Many fumigants are formulated as liquids under pressure (liquefied gases) and become gases only when released. Their use is generally limited to soil and closed structures such as buildings, granaries, and special types of greenhouses. A single fumigant may kill insects, weed seeds, nematodes, rodents, fungi, and other pests. Fumigants are nonselective in their action and can penetrate into any area that is not airtight.

Fumigants are the most hazardous of all pesticide formulations. Extreme care must be taken when using these products. Protective equipment, including adequate respiratory protection devices, must be used at all times. Often fumigants are formulated with some type of warning gas, but this gas can also be highly toxic. Since some fumigants can severely irritate or burn the skin, fumigants are not recommended for use by homeowners.

An example of a fumigant is Vikane® Gas Fumigant

Granules and Pellets (G)

Granular formulations are dry, ready-to-use materials normally containing from 1 to 15 percent active ingredient. Most granules are produced by applying a liquid active ingredient to a coarse, porous, solid material such as clay, walnut shells, sand or ground corn cobs.

The active ingredient is absorbed by and/or adheres to the porous material.

Granules and pellets are ready to use as purchased and require no mixing. Since the particles are relatively heavy, granules do not normally present a drift hazard and are thus less likely to drift than other formulations. They can be applied with relatively inexpensive equipment such as seeders and fertilizer spreaders. Granules are applied either directly to soil or over plants.

Although granules are more expensive to use than many other formulations, the ease of application more than offsets the added cost. Granular formulations, with few exceptions, cannot be used for treating foliage because they will not stick to plant surfaces.

An example of a granular pesticide would be Treflan TR-10®. The granular formulation of this herbicide contains 10 percent active ingredient.

Solutions (S)

A solution is a mixture of one or more substances in which all ingredients are completely dissolved. Many of these formulations are designed to be used without further dilution, or can be diluted with specially refined oil or other petroleum solvents. Solutions can also be applied as ultra low volume (ULV) applications. Some materials in this category can be mixed with water to form true solutions. High-concentrate formulations contain 8 or more pounds of active ingredient per gallon, while low concentrates usually contain less than 2 pounds active ingredient per gallon. Many are formulated with chemicals that function as spreaders and stickers.

An example of a solution would be Riptide® Insecticide Waterbased Pyrethrin ULV … 30% Active Ingredients.

Water Dispersible Granules (DF - Dry Flowables)

These formulations are dry, granular materials designed to be mixed with water. Upon contact with water the granules disperse or break apart. The resulting preparation has all the characteristics of a flowable formulation or a finely dispersed wettable powder, except the active ingredient is prepared as granule-sized particles.

The major advantage of a water-dispersible granule is the ease of handling. Water-dispersible granules have replaced many wettable powders and flowables since they eliminate dust like particles, hence reducing the respiratory hazard often associated with wettable and soluble powder formulations and they do not need to be shaken like flowables. The formulation requires constant agitation to keep it suspended in water. However, since many water-dispersible granules have a fairly high ingredient percentage, the same precautions as observed with flowables should be taken.

An example of water-dispersible granules of dry flowable formulation is Spike® 80DF herbicide. It contains 80 percent active ingredient.

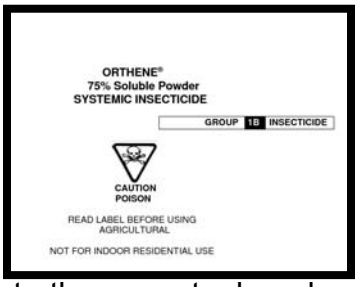
Wettable Powders (WP, W)

Wettable powders are dry, finely ground or powdered formulations that look like dust. In the formulation process, active ingredients are combined with a dry inert carrier or diluents such as clay or talc and a wetting and/or dispersing agent to keep suspended particles uniformly dispersed. Wettable powders usually contain from 15 to 95 percent active ingredient. Wettable powders are mixed with water to produce suspensions but do not dissolve in water. Before adding a wettable powder to a mix tank, a slurry should be formed. Wettable powders settle out quickly unless constant agitation is used to keep them suspended.

As a rule, wettable powders are safer to use on foliage and usually are not absorbed through the skin as quickly as liquid formulations. They are generally easy to handle, transport, store, mix and are relatively reasonable in cost. Wettable powders frequently cause sprayer screens and nozzles to clog. They are also very abrasive to spray nozzles and pumps. Very hard or alkaline water can cause wettable powders to mix poorly.

An example of a wettable powder would be Demon® WP. This wettable powder formulation contains 40 percent of the active ingredient cypermethrin.

Soluble Powders (SP)



A soluble powder is similar to a wettable powder except that the active and other ingredients completely dissolve in water and form a true solution. Some agitation in the spray tank may be needed to dissolve the product into solution; once dissolved, however, no further agitation is needed. The amount of active ingredient in a soluble powder is usually above 50 percent.

A limited number of wettable and soluble powders are now being sold in water soluble bags; the inner bag is placed directly into the spray tank and subsequently dissolves. This type of packaging eliminates the need for measuring and greatly minimizes risk of exposure to the applicator.

An example of a soluble powder is the insecticide Lannate® SP.

Water-Soluble Concentrates (WS)

A few pesticide active ingredients dissolve readily in water. When mixed with water, they form a solution that will not settle out or separate. Banvel® and the amine formulations of 2,4-D are examples of soluble formulations.

Microencapsulated

Microencapsulated formulations are particles of pesticides (either liquid or dry) encased in a polymer coating (inert material) causing a slow, sustained release of the pesticide over time. The formulated product is mixed with water and applied as a spray. Once applied, the capsule slowly releases the pesticide. The encapsulation process can prolong the active life of the pesticide by providing a timed release of the active ingredient. Constant agitation is necessary to prevent these pesticides from settling out.

An example of a microencapsulated pesticide would be Onslaught®. This product is comprised of petroleum distillates and contains 6.40% active ingredient.

Packaging

Pesticides are packaged in a variety of containers from pint containers for the home owner, gardener, and pest control operator to 55-gallon drums, and in bulk fiberglass containers holding upwards of 1,000 gallons for large commercial use. Dusts, wettable and soluble powders, granules, and other solid formulations are packaged in everything from water-soluble bags, small cellophane-wrapped bait packs, lined paper bags, to cardboard and plastic containers and drums. Liquids are packaged in plastic, glass, or metal containers; the choice of container is often dictated by the reactivity or corrosiveness of the liquid materials. Aerosols usually come in reinforced metal containers and cylinders. The variety of packaging materials, shapes and sizes is practically endless.

Non-Pesticidal Formulations

In some pesticide formulations, compounds, which are not pesticides themselves, may increase the effectiveness of the active ingredient. Adjuvans may work in this way. A solvent is the liquid in which the active ingredient dissolves to form a solution. Most pesticides require organic solvents. In addition to dissolving the active ingredient, organic solvents may enhance the active ingredient's toxicity. In some cases this is because the solvent increases the active ingredient's absorption into the organism. Some solvents are very toxic when inhaled or ingested. None are very toxic when absorbed by the skin but may dissolve the skin’s natural oils and cause dermatitis and pigment change.

Synergists are compounds which are added to pesticides to increase their effectiveness (toxicity). Some synergists act by promoting absorption of the pesticide, others by modifying the speed the pesticide is metabolized. Synergists that modify the rate pesticides are metabolized may also modify the rate other materials are metabolized, including drugs. Because of this, the same care should be taken when handling these compounds. Finally, different pesticides may react differently with each other to increase the toxicity of one or both of them. Indiscriminate mixing of pesticides should be avoided since the unexpected mixture may be less effective or highly toxic.

Understanding Pesticide Labels

The pesticide label gives the information necessary for each product's safe, effective, and lawful use. Remember, the label is the law. Failure to read and follow the label directions is a violation that may result in fines or legal action against the pest control company and/or the applicator. It makes good sense to follow the label; by doing so, risk to the applicator, others and the environment is greatly reduced or eliminated! Supplemental label information is often attached to the product or available from the dealer to explain specific product requirements and geographic prohibitions (e.g. endangered species and additional county use restrictions). It is very important to be able to read and interpret pesticide label information. Knowing how toxic a product is and understanding the ways a person can be exposed to it, allows the applicator to lower the risk of exposure and damage to the environment. The toxicity of a pesticide can not be changed, but understanding label directions, wearing proper PPE and following all precautionary statements will greatly reduce the risk of misusing a pesticide.

Several pesticide labels have been provided on the following pages. From the information previously presented and from the following labels, answer the sample questions beginning on page 27.

Globally Harmonized System (GHS) for Classification and Labelling of Chemicals

GHS Pictograms that would be most commonly used on pesticide labels.

The Globally Harmonized System (GHS) of Classification and Labelling of Chemicals is a worldwide initiative to promote standard criteria for classifying chemicals according to their health, physical and environmental hazards. It uses pictograms, hazard statements, and the signal words "Danger" and "Warning" to communicate hazard information on product labels and safety data sheets in a logical and comprehensive way. The primary goal of GHS is better protection of human health and the environment by providing chemical users and handlers with enhanced and consistent information on chemical hazards.

FIFRA SECTION 24(c) SUPPLEMENTAL LABELING
FOR DISTRIBUTION AND USE ONLY WITHIN THE STATE OF NEVADA

RESTRICTED USE PESTICIDE

Due to toxicity to aquatic invertebrate animals.
For retail sale to and use only by Certified Applicators, or persons under their direct supervision, and only for those uses covered by the Certified Applicator's certification.

Chemtura

Dimilin® 25W

INSECT GROWTH REGULATOR
EPA REG. NO. 400-465

Active Ingredients: (% by weight)	
N-[[(4-Chlorophenyl)amino]carbonyl]-2,6-difluorobenzamide	25.0%
Inert Ingredients	75.0%
TOTAL:	100.0%

KEEP OUT OF REACH OF CHILDREN

CAUTION

THIS LABEL IS SUPPLEMENTAL TO THE STANDARD FEDERAL LABEL PRINTED ON THE CONTAINER

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Do not apply this product through any type of irrigation system.

CROP/SITE: For use only in the following aquatic sites where there is low risk to populations of crabs, shrimp and other non-target arthropods through direct application, runoff or drift.
Street gutters, rubber tires stockpiled for processing or frost protection; storm water drains, ditches and retention/detention/seepage ponds; sewage effluent and disposal spray fields and oxidation ponds; grassy swales; phosphate pits, tailing canals and slime ponds; wastewater biological filter beds; industrial waste tertiary ponds and irrigation disposal fields; livestock, swine and poultry waste lagoons; man made ponds, channels and percolation basins developed exclusively for decorative and landscape purposes; and junkyards.
Do not apply when conditions favor drift or runoff to adjacent aquatic sites.

TARGET PESTS: Mosquitoes and Midges

DOSAGE/APPLICATION:
Apply 3.25 oz. of DIMILIN 25W (0.05 lbs. a.i.) per acre in sufficient spray mixture to provide uniform coverage. If granular formulation is used, refer to the table below. Repeat as needed to maintain control. Application may be made by either ground or aerial application equipment.
For use by mosquito control agencies, a 0.25 or a 0.5% granule may be prepared and applied according to the following directions:

	0.25% Granule	0.50% Granule
DIMILIN 25W Insect Growth Regulator	30 lbs.	60 lbs.
Coarse Sand (20/30 mesh)	2957 lbs.	2927 lbs.
Oil	10 lbs.	10 lbs.
Hysil 233	3 lbs.	3 lbs.
Total:	3000 lbs.	3000 lbs.
Rate of Use	20 lbs./A	10 lbs./A

Thoroughly mix sand and oil for 10 minutes. Add DIMILIN 25W and Hysil and mix an additional 30 minutes. A typical batch should take 30 minutes to mix and 30 minutes to empty. Use granules promptly after mixing.
Application may be made by either ground or aerial application equipment. It is essential that application be uniform over the treated area. When inspections indicate an increase in the density of larvae, repeat applications at a minimum of 10 day intervals.
Do not make hay or feed to livestock from treated areas. Growers must be informed that the grass is not to be cut for hay.
Treated water may not be used for irrigation or human consumption.
Do not plant food or feed crops in treated areas within 6 months following the last application, unless DIMILIN is authorized for use on these crops.

Follow all applicable directions, restrictions, and precautions on the EPA registered label.
This label must be in the possession of the user at the time of the pesticide application. 004

24c (SLN) REGISTRANT:
Chemtura Corporation
199 Benson Road
Middlebury, CT 06749

EPA SLN. NO. NV-940003

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

READ THIS LABEL: Read this entire label and follow all use directions and use precautions.

IMPORTANT: Do not expose children, pets, or nontarget animals to rodenticides. To help to prevent accidents:

1. Store unused product out of reach of children and pets.
2. Apply bait in locations out of reach of children, pets, domestic animals and nontarget wildlife, or in tamper-resistant bait stations. These stations must be resistant to destruction by dogs and by children under six years of age, and must be used in a manner that prevents such children from reaching into bait compartments and obtaining bait. If bait can be shaken from bait stations when they are lifted, units must be secured or otherwise immobilized. Stronger bait stations are needed in areas open to hoofed livestock, raccoons, bears, or other potentially destructive animals, or in areas prone to vandalism.
3. Dispose of product container and unused, spoiled, or unconsumed bait as specified on this label.

USE RESTRICTIONS: For control of Norway rats, roof rats and house mice. Do not place bait in areas where there is a possibility of contaminating food or surfaces that come in direct contact with food. When used in USDA-inspected facilities, this product must be applied in tamper-resistant bait stations. Do not broadcast bait.

Urban Areas: This product may be used in and around the periphery of homes, industrial, commercial, and public buildings. May also be used in transport vehicles (ships, trains, aircraft) and in and around related port or terminal buildings. May also be used in alleys.

Non-Urban Areas: This product may be used in and around homes and agricultural buildings.

SELECTION OF TREATMENT AREAS: Determine areas where rats or mice will most likely find and consume the bait. Generally, these areas are along walls, by gnawed openings, in or beside burrows, in corners and concealed places, between floors and walls, or in locations where rodents or their signs have been seen. Protect bait from rain and snow. Remove as much alternative food as possible.

APPLICATION DIRECTIONS:

Each bait block in this container weighs nearly 3/4 oz. (20 g).

RATS: Place 5 to 22 blocks (usually at intervals of 15 to 30 feet) per placement. Maintain an uninterrupted supply of fresh bait for at least 10 days or until signs of rat activity cease.

FINAL®

All-Weather Blox

Mold Resistant Moisture Resistant

KILLS RATS AND MICE

KILLS WARFARIN RESISTANT NORWAY RATS AND HOUSE MICE

Norway rats and house mice may consume a lethal dose in one night's feeding with first dead rodents appearing four or five days after feeding begins.

ACTIVE INGREDIENT:	
Brodifacoum (CAS #56073-10-0):	.....0.005%
INERT INGREDIENTS*:	99.995%
	100.000%

*Contains Denatonium Benzoate

KEEP OUT OF REACH OF CHILDREN

CAUTION

FIRST AID

HAVE LABEL WITH YOU WHEN OBTAINING TREATMENT ADVICE

IF SWALLOWED:

- Call a poison control center, doctor, or 1-877-854-2494 immediately for treatment advice.
- Have person sip a glass of water if able to swallow.
- Do not induce vomiting unless told to do so by the poison control center or doctor.

IF ON SKIN:

- Wash with plenty of soap and water.

NOTE TO PHYSICIAN OR VETERINARIAN

If swallowed, this material may reduce the clotting ability of the blood and cause bleeding. If ingested, administer Vitamin K_1 intramuscularly or orally as indicated in bishydroxycoumarin overdoses. Repeat as necessary based on monitoring of prothrombin times.

NET WEIGHT: 9 lbs. (4.1 Kg)

Manufactured by:

Bell Laboratories, Inc.
Madison, WI 53704

EPA REG. NO. 12455-89 EPA EST. NO. 12455-WI-1

DIRECTIONS FOR USE (Continued from other panel)
APPLICATION DIRECTIONS (Continued from other panel)

For use in sewers, thread wire through block and securely attach to a stationary structure such as the bottom step of a manhole ladder or a sewer grate. Allow just enough wire for the block to rest on manhole benching. If benching is not present, suspend block a few inches above the high water mark or secure block on a board supported by opposing steps of the ladder. Securing block in this manner will prevent removal by rats or water. Use at least 15 blocks per manhole. Maintain an uninterrupted supply of fresh bait for at least 10 days or until signs of rat activity cease.

MICE: Place 1 block per placement. Space placements at 8 to 12 foot intervals. Two blocks may be needed at points of very high mouse activity. Maintain an uninterrupted supply of fresh bait for at least 15 days or until signs of mouse activity cease.

FOLLOW-UP: Replace contaminated or spoiled bait immediately. Collect and dispose of all dead, exposed animals and leftover bait. To prevent reinfestation, limit sources of rodent food, water, and harborage as much as possible. If reinfestation does occur, repeat treatment. Where a continuous source of infestation is present, establish permanent bait stations and replenish as needed.

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION: Harmful if swallowed. Wash thoroughly with soap and water after handling.

ENVIRONMENTAL HAZARDS

This product is toxic to fish, birds and other wildlife. Do not apply this product directly to water or to areas where surface water is present or to intertidal areas below the mean high water mark.

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

Storage: Store only in original container in a cool, dry place inaccessible to children and pets. Keep containers closed and away from other chemicals.

Pesticide Disposal: Wastes resulting from the use of this product may be placed in trash or delivered to an approved waste disposal facility.

Pesticide Container: Do not reuse empty container. Dispose of empty container by placing in trash, at an approved waste disposal facility or by incineration or, if allowed by state and local authorities, by burning. If burned stay out of smoke. Call your Local Waste Agency for any questions on proper disposal.

WARRANTY: Seller makes no warranty, expressed or implied, concerning the use of this product other than indicated on the label. Buyer assumes all risk of use and/or handling of this material when such use and/or handling is contrary to label instructions.

101504

38L34-3263CBR-9-Rev. 2/06 (PNT 2/06)

PRECAUTIONARY STATEMENTS
Hazards to Humans & Domestic Animals
CAUTION

Harmful if absorbed through the skin, eyes, or clothing. Wash thoroughly with soap and water after handling.
Do not contaminate food or feed. Do not apply directly to food. Do not apply to classrooms when in use. Do not apply this product in occupied patient rooms or in any rooms while occupied by the elderly or infirm.

FIRST AID

If Swallowed: Immediately call a poison control center or doctor. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give any liquid to the person. Do not give anything by mouth to an unconscious person. **If Inhaled:** Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice. **If on Skin or Clothing:** Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice. **If In Eyes:** Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice. HOT LINE NUMBER – Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For emergency information, call (985) 878-6751, Monday through Friday, 8:00 am to 4:30 pm CST. After 4:30pm call your poison control center. For product information call (203) 597-1812, Monday-Friday, 8:00 am to 5:00 pm EST. **NOTE TO PHYSICIAN** – Contains petroleum distillate - vomiting may cause aspiration pneumonia.

PHYSICAL OR CHEMICAL HAZARDS

Flammable. Contents under pressure. Keep away from fire, sparks, and heated surfaces. Do not puncture or incinerate container. Exposure to temperatures above 130°F may cause bursting. Do not use in the vicinity of open flame or pilot lights.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labelling.
Do Not Use As A Space Spray. Spray on surfaces only. Hold container upright while spraying. Direct nozzle approximately 12 inches from surface to be treated. Spray away from self and other persons. Do not allow children in treated area until spray has dried. Do not use in aircraft cabins.

PERMITTED AREAS OF USE INCLUDE, BUT ARE NOT LIMITED TO:

RESIDUAL PEST CONTROL: Homes, apartment buildings, laboratories, restaurants, kitchens, cafeterias, dairies, dairy products processing plants, milk storage rooms, supermarkets, hospitals (nonoccupied patient areas), nursing homes (nonoccupied patient areas), egg processing plants, bakeries, bottling plants, wineries and similar structures, breweries, institutions, hotels, motels, kennels, stables, schools, nurseries, stores, warehouses, manufacturing canneries, frozen food plants, cereal processing and manufacturing plants, pickle factories, grain mills, granaries, spice plants, food manufacturing, processing and servicing establishments: **Transportation –** Aircraft (except aircraft cabins), buses, trucks, marine vessels, railcars; **Storage –** Commercial, industrial, apartment, office and storage buildings.

CRACK AND CREVICE AND SPOT APPLICATION: Cockroaches, Spiders, Crickets, Silverfish, Firebrats. Do not spray directly on plastic, painted, varnished surfaces or into any electronic equipment such as radios, televisions, computers, etc. **For Crack and Crevice –** Use injector tip, releasing approximately 1 second spray per spot. For serious infestations, spray spots approximately 12 inches apart; for light infestations, spray approximately 3 feet apart. Spray into hiding places such as cracks, crevices, moist areas, openings around pipes and sinks, under refrigerators, behind baseboards, coffee makers, meter boxes, and manholes. **For Spot Spray –** Apply directly on insects in these locations when possible. Repeat as necessary. Spot treatments may also be made to areas including, but not limited to, storage areas, closets, around water pipes, doors and windows, behind and under refrigerators, cabinets, sinks, stoves and other equipment, the underside of shelves, drawers and similar areas.

CRAWLING INSECTS: Sowbugs, Pillbugs, Millipedes, Centipedes, Bedbugs, Earwigs and Ticks – Apply around doors and windows and other places where these pests may be found or where they may enter premises. Spray baseboards, storage areas and other locations. Spray around foundations and porches. Repeat as necessary.

FLYING INSECTS: Wasps, Bees, Yellow Jackets and Hornets – Application to nests should be made late in the evening when insects are at rest. Apply directly. Thoroughly spray nest, entrance and surrounding areas where insects may land or rest.
Flies, Mosquitoes, Gnats, Flying and Cloths Moths: Use as a surface spray only. Apply directly to walls, ceilings, window screens, and other flying insect resting areas as a residual surface treatment. May be used inside residential buildings, as well as, in and around carports, garages, and storage sheds.
Ants: Apply to ant trails, around doors and windows and other places where ants may be found.

PANTRY PESTS: Carpet, Confused, Red Flour, Drugstore, Cigarette, Sawtoothed and Merchant Grain Beetles and Lesser Grain Borers – Contact as many insects as possible when treating infested areas such as cracks and crevices in wall voids, around windows and door frames, under siding, in machinery and in dark secluded areas. Repeat as necessary.
For long lasting residual action allow residue to remain undisturbed as this product will keep on killing for weeks.

APPLICATIONS WITHIN FOOD AREAS AND NON-FOOD AREAS OF FOOD HANDLING ESTABLISHMENTS

FOOD HANDLING ESTABLISHMENTS

Places other than private residences in which food or feed is held, processed, prepared, or served.

1. FOOD AREAS (INCLUDING SOME SERVING AREAS)

Includes areas for receiving, storage, packing (canning, bottling, wrapping, boxing), preparing edible waste storage and enclosed processing systems (mills, dairies, edible oils, syrups). Also includes some SERVING AREAS.

FOOD SERVING AREAS: SERVING AREAS are facilities where food is served, such as dining rooms, but not where food is prepared or held. These areas are considered FOOD AREAS when food is exposed and the facility is in operation.
Follow application directions in this section. If food is not exposed and facility is not in operation, follow application directions under NONFOOD SERVING AREAS below.

Use Restriction: FOOD AREA application is limited to CRACK AND CREVICE TREATMENT ONLY. Application to other areas are not permitted.

Application Directions: Apply in small amounts directly into cracks and crevices using void injector directly into cracks and crevices, in points between elements of construction, between equipment and floor openings leading to voids and hollow spaces in walls, equipment legs and bases, conduits, motor housing and electrical switch boxes where insects hide. Care should be taken to avoid depositing the product onto exposed surfaces or introducing the material into the air. Avoid contamination of food or food processing surfaces. Do not apply directly to food. Reapplications may be made at 10-day intervals.

2. NONFOOD AREAS (INCLUDING SOME SERVING AREAS)

Includes garbage rooms, lavatories, floor drains (to sewer), entries and vestibules, offices, locker rooms, machine rooms, boiler rooms, garages, mop closets and storage (after canning or boiling). Also includes some SERVING AREAS.

NONFOOD SERVING AREAS:

SERVING AREAS are facilities where food is served, such as dining rooms, but not where food is prepared or held. These areas are considered NONFOOD AREAS when food is not exposed and the facility is not in operation.
Follow application directions in this section. If food is exposed and the facility is in operation, follow application directions under FOOD SERVING AREAS.

Application Directions: Apply as a spot treatment to selective surfaces such as baseboards, under elements of constructions into cracks and crevices. Avoid treating surfaces likely to be contacted by food. In the home, cover all food handling surfaces and cover or remove all food and cooking utensils, or wash thoroughly after treatment.

OTHER NONFOOD AREAS

Application Directions: Apply to baseboard areas, around water pipes, surfaces behind and beneath sinks, lockers, tables, pallets and similar areas where insects hide or through which they may enter.
Authorized by USDA for use in Federally Inspected Meat and Poultry Plants

STORAGE & DISPOSAL

Do not contaminate water, food or feed by storage or disposal. **Storage:** Do not store near heat or open flame. Store in cool dry area away from children.
Disposal: Do not Puncture or Incinerate! **If empty:** Place in trash or offer for recycling if available.
If partly filled: Call your local solid waste agency or 1-800-CLEANUP for disposal instructions.

STEEL

Manufactured by
WATERBURY COMPANIES, INC.
P.O. Box 1812 • Waterbury, CT 06722 • Made in U.S.A.
800-845-3495 • www.CBProProducts.com

0 43725 32631 4

CB RESIDUALS

Intruder® HPX

RESIDUAL WITH CYFLUTHRIN

15% VOC Formulation

- Provides Rapid Control of Residential and Industrial Pests
- Quick Knockdown
- Solvent System

KILLS: CRAWLING INSECTS– Cockroaches, Ants, Spiders, Crickets, Silverfish, Sowbugs, Pillbugs, Millipedes, Centipedes, Firebrats, Earwigs, and Bedbugs; **FLYING INSECTS–** Wasps, Bees, Flies, Yellowjackets, Hornets, Gnats, Mosquitoes, Flying and Clothes Moths; **PANTRY PESTS–** Carpet, Confused, Red Flour, Drugstore, Cigarette, Sawtoothed and Merchant Grain Beetles and Lesser Grain Borers

PERMITTED AREAS OF USE INCLUDE, BUT ARE NOT LIMITED TO: Homes, Apartment Buildings, Laboratories, Hospitals (non-occupied patient areas), Nursing Homes (non-occupied patient areas), Institutions, Hotels, Motels, Kennels, Stables, Schools, Nurseries, Stores, Warehouses, Aircraft (except Aircraft Cabins), Buses, Trucks, Trailers, Marine Vessels, Railcars; Commercial, Industrial, Apartment, Office, Storage Buildings, Restaurants, Kitchens, Cafeterias, Dairies, Dairy Product Processing Plants, Milk Storage Rooms, Supermarkets, Egg Processing Plants, Bakeries, Bottling Plants, Wineries and Similar Structures, Breweries, Manufacturing Canneries, Frozen Food Plants, Cereal Processing and Manufacturing Plants, Pickle Factories, Grain Mills, Granaries, Spice Plants, Food Manufacturing, Processing and Servicing Establishments

ACTIVE INGREDIENT:

Cyano (4-fluoro-3-phenoxphenyl) methyl 3-(2,2-dichloroethenyl)-2,2-dimethyl-cyclopropanecarboxylate	0.10%
Pyrethrins	0.05%
*Piperonyl Butoxide, technical	1.00%
INERT INGREDIENTS	98.85%
	100.00%

*Equivalent to 0.80% (butylcarbityl) (6-propylpiperonyl) ether and 0.20% of related compounds.
Contains Petroleum Distillates

Contains no CFCs or Other Ozone Depleting Substances. Federal Regulations Prohibit CFC Propellants in Aerosols.

KEEP OUT OF REACH OF CHILDREN

CAUTION

See Back Panel for Additional Precautionary Statements.
EPA Reg. No. 9444-183 • EPA Est. No. 9444-LA-1

NET WEIGHT 14 oz / 397 g

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS & DOMESTIC ANIMALS

CAUTION: Harmful if swallowed. May cause irritation. Avoid contact with eyes or clothing. Wash thoroughly with soap and water after handling.

ENVIRONMENTAL HAZARDS

Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark.

This pesticide is toxic to birds and fish. Wildlife feeding on treated bait may be killed. Do not contaminate water by cleaning equipment or disposal of waste Do not feed to livestock or poultry. Do not mix with grain for livestock or poultry feed.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

USE RESTRICTIONS

Do not apply to food or feed crops. Do not use where stored food or feed (such as grain or meat) might become contaminated.

Avitrol must not be exposed in any manner that may endanger desirable and protected bird species. If there is a question of such hazard, consult local, state and federal game authorities before undertaking bird management with Avitrol.

Investigate local laws that may prohibit the use of any toxic chemical in bird control.

Applicators shall wear gloves and use a scoop when mixing, applying and broadcasting this product.

STORAGE & DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

Storage: Store only in original container in a cool, dry location inaccessible to children and pets. Store apart from food or animal feed and protect against rodent penetration of the carton. Store apart from other pesticides, fertilizers, food or feed that may cause cross- contamination of odor or insect infestation.

Pesticide Disposal: Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

Container Disposal: Fiber Drums with Liners: Completely empty liner by shaking and tapping sides and bottom to loosen clinging particles. Empty residue into application equipment. Then dispose of liner in sanitary landfill or by incineration if allowed by State and local authorities. If drum is contaminated and cannot be reused, dispose of in the same manner.

RESTRICTED USE PESTICIDE
DUE TO ACUTE AVIAN TOXICITY

For sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's Certification.

Avitrol®

MIXED GRAINS

Active Ingredient: 4-Aminopyridine	0.5%
Inert Ingredients:	99.5%
Total	100.0%

Avitrol is a poison with flock alarming properties used for the control of Pigeons, House Sparrows, Red-Winged, Yellow-Headed, Brewer's and Rusty Blackbirds, Grackles, Cowbirds and Starlings in, on or in the area of structures, nesting, feeding, loafing and roosting sites, in such a way that a part of the flock may react and frighten the rest away. Birds that react and alarm a flock usually die.

NOT FOR USE IN NEW YORK STATE WITHOUT NEW YORK STATE TECHNICAL BULLETIN, AVITROL #2 FOR AVITROL MIXED GRAINS.

KEEP OUT OF REACH OF CHILDREN
CAUTION

FIRST AID

Have label with you when obtaining treatment advice.

If swallowed	- Call a poison control center, doctor or 1-800-424-9300 immediately for treatment advice. - Have person sip a glass of water if able to swallow. - Do not induce vomiting unless told to do so by the poison control center or doctor.
In Eyes	- Hold eye open and rinse slowly and gently with water for 15-20 minutes. - Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. - Call a poison control center, doctor or 1-800-424-9300 immediately for treatment advice.

Manufactured By
AVITROL CORPORATION
7644 East 46th Street
Tulsa, Oklahoma 74145-6370
(918) 622-7763 * (800) 633-5069
EPA Reg. No. 11649-4
EPA est. 11649-OK-1

SPECIMEN LABEL

PREBAITING DIRECTIONS

This product must not be applied where non-target birds are feeding. Careful observations of the birds' feeding habits must therefore be made to establish proper feeding locations and to determine that no non-target birds are feeding on the prebait. Prebaiting with untreated grains of the same composition as the Avitrol carrier is usually essential to the effective deterrence of birds with Avitrol. The target species are primarily ground feeders and should be prebaited on the ground when possible. Pigeons will feed from roof tops as well as from the ground. Inside structures, prebaiting may be performed on elevated flat surfaces, perching and loafing areas and ledges. Bait trays may be used but feeding acceptance will normally require more time.

DILUTION DIRECTIONS

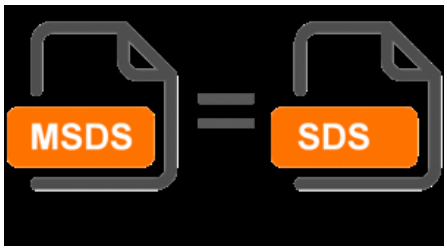
Avitrol treated grain should be thoroughly mixed with untreated grain of the same composition as the Avitrol carrier at the dilution ratios indicated below. For the control of Pigeons, Blackbirds, Grackles, Starlings and Cowbirds with Avitrol, no dilution ratio less than one part treated to nine parts untreated is recommended. House Sparrows, however, usually operate within limited areas, with feeding and nesting sites relatively close to one another. Thus, while ratios of one part treated to nine (or more) untreated parts have given good control in many instances, particularly stubborn cases may require a ratio of one part treated to five parts untreated. Greater numbers of birds may be killed, however, as toxic bait is made less dilute.

BAITING DIRECTIONS

To obtain minimal mortality, the distribution of Avitrol should be limited to scattered spot placements that will provide feeding opportunities only for the necessary number of target birds. After the birds' feeding pattern has been established through prebaiting, replace untreated bait with diluted treated bait only at sites where the target birds are actively feeding. Do not apply treated bait to inactive feeding sites. Where uneaten bait may be a hazard to other birds or animals, it should be picked up at the end of each day. Pick up and dispose of dead birds by burial. This product must not be applied where nontarget bird species are feeding. During the first few days, baiting with Avitrol may require successive applications until control is obtained. Note that retreatment may also be necessary after rainfall.

Notice: Buyer and/or user assumes all risks of use and/or handling of these materials contrary to label instructions.

6/15/2005



MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT & COMPANY IDENTIFICATION

Rozol® Tracking Powder
EPA Reg. No. 7173-113, Restricted Use Pesticide

Rozol® Blue Tracking Powder
EPA Reg. No. 7173-172, Restricted Use Pesticide

Other Designation: Anticoagulant rodenticide with Chlorophacinone
Manufacturer: **Liphatech, Inc.**
3600 W. Elm Street, Milwaukee, WI 53209
Emergency Phone: 414-351-1476 Monday-Friday, 8:00 am-4:30 pm CST
After Hours: Call CHEMTREC at 1-800-424-9300

SECTION 2 INGREDIENT INFORMATION

Hazardous Ingredient:	CAS Number:	OSHA PEL:	ACGIH TLV:	ACGIH STEL:
Chlorophacinone	3691-35-8	Not assigned	Not assigned	Not assigned
cristalline silica	14808-60-7	(see regulations at 29 CFR 1910.1000)		

SECTION 3 HAZARDS IDENTIFICATION

Emergency Overview: May be fatal if swallowed or absorbed through the skin, because it may reduce the clotting ability of blood and cause bleeding.

Primary Entry Routes: Oral, dermal (absorption through skin), inhalation.

Acute Effects (Signs and Symptoms of Overexposure):
- Eyes: May cause temporary eye irritation.
- Skin: May be harmful or fatal if absorbed by skin. Symptoms of toxicity include lethargy, loss of appetite, reduced blood clotting ability, bleeding.
- Inhalation: May be fatal if absorbed inhaled. Symptoms of toxicity include lethargy, loss of appetite, reduced blood clotting ability, and bleeding.
- Ingestion: May be fatal if swallowed. Symptoms of toxicity include lethargy, loss of appetite, reduced clotting ability of blood, and bleeding.

Chronic Effects: Prolonged and/or repeated exposure to small amounts of product can produce cumulative toxicity. Symptoms of toxicity include lethargy, loss of appetite, reduced clotting ability of blood, and bleeding.

Medical Conditions Aggravated by Exposure: Bleeding disorders
Target Organs: Blood
Carcinogenicity: Crystalline silica classified as carcinogen by NTP, IARC
HMIS: Health – 3, Flammability – 0, Reactivity – 0

SECTION 4 FIRST AID MEASURES

Eyes: Flush with water. Get medical attention if irritation persists.
Skin: Wash with soap and water. Get medical attention if irritation persists.
Inhalation: If inhaled, remove person to fresh air and Get medical attention.
Ingestion: Call a physician or poison control center immediately. Have the product label available for medical personnel to read.

Induce vomiting under the direction of medical personnel. Drink 1 or 2 glasses of water and induce vomiting by touching the back of throat with finger. If syrup of ipecac is available, give 1 tablespoon (15 ml) followed by 1 or 2 glasses of water. If vomiting does not occur within 20 minutes, repeat this dosage once. Do not induce vomiting or give anything by mouth to an unconscious person.

Note to Physician: This rodenticide contains an anticoagulant ingredient. If ingested, administer vitamin K_1 intramuscularly or orally, as indicated in bishydroxycoumarin overdoses. Repeat as necessary based on monitoring of prothrombin times.

For information on this pesticide product (including health concerns, medical emergencies, or pesticide incidents) call the National Pesticide Information Center at 1-800-858-7378.

SECTION 5 FIRE FIGHTING MEASURES

NFPA

Flash Point: None
Autoignition Temp.: None - noncumbustible
Explosive Limits: LEL: Not applicable
UEL: Not applicable
Extinguishing Media: Use media suitable for the surrounding fire
Unusual Fire or Explosion Hazards: None known
Fire Fighting Instructions: Firefighters should wear self-contained breathing apparatus (full facepiece) and full protective clothing. Contain runoff to prevent pollution.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Large Spill/Leak Procedures: Isolate and contain spill. Limit access to the spill area to necessary personnel. Do not allow spilled material to enter sewers, streams or other waters. Wear all required safety equipment (see Section 8). Scoop up spilled material and place in a closed, labeled container for use or disposal.

Small Spills: Scoop up material for use according to label instructions.

SECTION 7 STORAGE AND HANDLING

Storage Requirements: Store in original container in a cool, dry area out of reach of children, pets and domestic animals. Do not contaminate water, food or feed. Keep container tightly closed. Do not remove or destroy the product label.

Handling Precautions: Read the entire product label before using this rodenticide. Carefully follow all cautions, directions and use restrictions on the label. Avoid contact with eyes, skin or clothing.

SECTION 8 EXPOSURE CONTROLS/ PERSONAL PROTECTION

Ventilation: Special ventilation is not required for the normal handling and use of this product when following the label instructions.
Protective Clothing/Equipment: Wear gloves.
Respirator: Wear a NIOSH/MSHA approved dust/mist (N95) respirator.
Contaminated Equipment: Damaged or unwanted bait stations and bait holders should be wrapped in paper and discarded in trash.
Comments: Never eat, drink or smoke in work areas. Practice good personal hygiene after using this product. Wash arms, hands and face with soap and water after handling this product, and before eating and smoking. Launder contaminated clothing separate from street clothes.

SECTION 9 PHYSICAL & CHEMICAL PROPERTIES

Physical State:	Powder	**Water Solubility:**	Negligible
Color:	Light brown or Blue	**% Volatile (Volume):**	Not applicable
Odor:	Raw grain odor	**Specific Gravity:**	2.6 g/cc (approx.)
Melting Point:	Not available	**Vapor Pressure:**	Not applicable
Boiling Point:	Not applicable	**Vapor Density:**	Not applicable
Freezing Point:	Not applicable	**pH:**	Not applicable

SECTION 10 STABILITY AND REACTIVITY

Stability: Stable
Conditions to Avoid: None
Hazardous Polymerization: Will not occur
Chemical Incompatibilities: None
Hazardous Products of Decomposition: Oxides of carbon

SECTION 11 TOXICOLOGICAL INFORMATION

Eye Effects/Eye Irritation:	Mild, transient irritant
Acute Oral Effects:	LD_{50} (oral-rat): >5000 mg/kg
Acute Inhalation Effects:	LC_{50} (inh-rat, 4 hour) >2.1 mg/ iter
Acute Dermal Effects:	LD_{50} (dermal-rabbit): >2000 mg/kg
Skin Irritation:	Non-irritating
Skin Sensitization:	Not a skin sensitizer

SECTION 12 ECOLOGICAL INFORMATION

This product is toxic to fish and wildlife. Do not apply this product directly to water, where surface water is present or to intertidal areas below the mean high water mark. Carefully follow label cautions and instructions to reduce hazards to children, pets and non-target wildlife.

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal: Wastes resulting from the use of this product according to the label instructions must be disposed of as specified on the product label.
RCRA Waste Status: This product is not regulated as a hazardous waste under RCRA. State and local regulation may affect the disposal of this product. Consult your state or local environmental agency for disposal of waste generated other than by use according to label instructions.

SECTION 14 TRANSPORT INFORMATION

Transportation Data (49 CFR): This product is not regulated as a hazardous material for all modes of transportation within the U.S.
Hazard Class: Not applicable **ID No.:** Not applicable

SECTION 15 REGULATORY INFORMATION

TSCA: All components of this product are listed on the TSCA inventory.
SARA Section 313: Contains no reportable components.
OSHA Hazard Classification: Acute and chronic health hazard.
Proposition 65: Contains no components subject to warning requirement.

SECTION 16 OTHER INFORMATION

Prepared by: T. Schmit **Date:** 12/1/2005
Information presented on this Material Safety Data Sheet is believed to be accurate at the time of publication. No warranty, expressed or implied, is made with regard to this information. This information may not be adequate for every application, and the user must determine the suitability of this information due to the manner/conditions of use, storage or local regulation.

Sample Label Questions:

* Note: To answer the following questions, read entire labels on previous pages.

I. **Final® Rodenticide All-Weather Blox** (Page 23)

A. What is the active ingredient in Final®?

B. True or False: This product may be used in sewers.

C. An uninterrupted supply of fresh bait should be maintained for_____ days or until house mouse activity decreases.

a. 10
b. 12
c. 15
d. 18
e. 20

D. What is the EPA registration number for Final®?

E. What type of formulation is this product?

II. Intruder® HPX Residual with Cyfluthrin (Page 24)

A. True or False: This product may be used as a space spray in food serving areas.

B. True or False: This product can be used to control bedbugs.

C. How many ounces (per 1,000 cubic feet) of Intruder® HPX Residual with Cyfluthrin should be used for flying insect control?

a. 0 (not allowed as a space spray)
b. 2
c. 5
d. 8
e. 10

D. What is the signal word associated with this product?

III. ROZOL Tracking Powder Material Safety Data Sheet (Page 26)

A. What is the acute Rat Oral LD50?

IV. Dimilin® 25W (Page 22)

A. True or False: This product is intended for use by the general public.

B. What is the maximum application rate (oz / per acre) of non-granular DIMILIN® 25W?

a. 0.25
b. 0.50
c. 3.25
d. 10.0
e. 20.0

C. What is the Nevada SLN number for DIMILIN® 25W?

D. What is the signal word on this label?

a. CAUTION
b. DANGER
c. WARNING
d. HAZARD
e. TOXIC

V. Avitrol® Mixed Grain (Page 25)

A. Avitrol® Mixed Grains can be used to control the following birds except for:

a. Mourning Doves
b. Blackbirds
c. Pigeons
d. Starlings
e. House Sparrows

B. True or False: This product is intended for use by the general public.

C. True or False: This product is intended for as a flocking alarm.

D. Which the following statements are true; according to the label:

a. Pre-baiting is not required if controlling Pigeons with Avitrol® Mixed Grains.
b. Avitrol® Mixed Grains can be stored with other pesticides.
c. Avitrol® Mixed Grains can be broadcast on vacant ground.
d. Pick up and dispose of dead birds by burial.
e. The label does not specify any PPE.

ANSWERS TO SAMPLE LABEL QUESTIONS

I. A. Brodifacoum
B. True
C. c
D. 12455-89
E. Bait

II. A. False (crack-and-crevice only)
B. True
C. 0 (not allowed as a space spray)
D. CAUTION

MSDS Question
III A. >5,000 mg/kg
(grater than 5,000 milligrams per kilogram of body weight)

IV. A. False
B. c
C. NV-940003
D. a

V. A. a
B. False (it is a Restricted Use Pesticide)
C. True (however, some mortality will occur especially at higher use rates (1:9)
D. d

Pesticides and Human Health

Pesticides are toxic. A person's health risk depends on the toxicity of a pesticide and their exposure time to it. The longer the exposure, the greater the risk.

RISK = TOXICITY x EXPOSURE

Exposure to pesticides can produce a range of different symptoms, depending on how the exposure occurred, the duration of exposure, and what type of pesticide was involved.

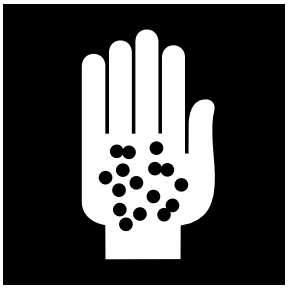
The way pesticides are applied also influences the potential for exposure. For example, applying chemicals in enclosed areas may subject a person to higher levels of exposure than applying them outdoors.

How Pesticides Enter the Body

Despite all the precautions taken and safety equipment worn, applicators may still be subject to exposure. Pesticides may enter the body through contact with the skin (dermal exposure), and through the mouth, lungs, and eyes.

Dermal Route:

For most exposure situations, the skin is the most common entry route for pesticides to enter the body. Evidence indicates that absorption through the skin accounts for about 97 percent of all exposures to pesticides. Sometimes skin contamination can occur without the applicator noticing. Absorption may occur as a result of a splash or spill when mixing, loading or disposing of a pesticide, or by drift during application. It may also result from exposure to large amounts of residue when cleaning or repairing contaminated equipment. Skin irritations, cuts, and exposure during perspiration can increase the likelihood of dermal absorption. With some pesticides, skin contact alone is enough to cause death.



Some pesticides are more readily absorbed through the skin than others. Liquid oil-based formulations such as emulsifiable concentrates are very easily absorbed. Pesticides highly soluble in oil pass through the skin faster than pesticides highly soluble in water. Wettable powders, dusts, and granular pesticide formulations are much less likely to be absorbed through the skin.

Rates of absorption through the skin are different for different parts of the body. Given an adsorption rate of "1.0" for forearms, the groin areas absorbs materials more than 11 times faster with an absorption rate of "11.8". Absorption through the skin in the groin area is rapid enough to approximate the affect of injecting the pesticide directly into the bloodstream. At this rate, the absorption of pesticide is more dangerous than swallowing it. The face, scalp, groin and neck absorb substances more rapidly than do the palms of the hands and soles of the feet.

Applicators should also be aware that it is not only active ingredients in pesticides that are dangerous. The other ingredients may be dangerous as well. For example, some pesticide formulations are oil based. If sufficient quantities of these oils get into the bloodstream, the result could be fatal. Remember, always use soap and water when washing skin contaminated by oil-based pesticides.

Effects of Dermal Exposure:

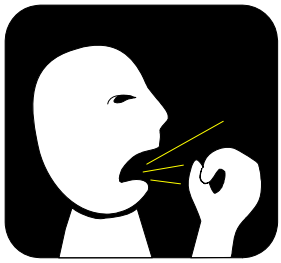
Dermatitis, or inflammation of the skin, is generally accepted as the most commonly reported affect associated with pesticide exposure. Individuals vary greatly in their susceptibility to dermatological affects.

Many chemicals cause dermatitis on contact. Irritation caused by **one** contact is usually Primary Irritation Dermatitis (PID). Symptoms range from a slight redness of the skin to blisters or ulcerated lesions.

There is a second type of dermatitis called Allergic Contact Dermatitis (ACD). The symptoms are similar. However, ACD occurs after repeated **chronic** exposure to a chemical, when the allergenic substance comes into contact with previously sensitized skin. An example of ACD is an applicator being exposed to a pesticide allergen for years before becoming sensitized and showing symptoms of dermatitis.

Treatment for dermal exposure involves the removal of contaminated clothing, washing the skin, changing into clean clothing and avoiding contact with the allergen. Always wear protective clothing when handling pesticides. If pesticide is splashed or spilled onto anyone, the exposed area should be washed immediately. It is also important to wash hands thoroughly before smoking, eating, or using the bathroom.

Oral Route:



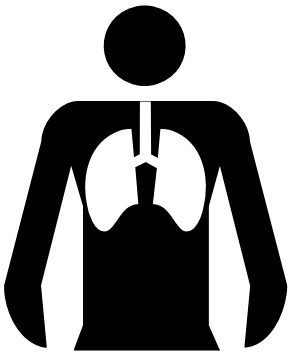
If a pesticide is swallowed, it may result in serious illness, severe injury, or even death. Pesticides may be consumed by accident, through carelessness, or they may be consumed intentionally. The most serious oral exposure occurs when liquid concentrates splash into the mouth during mixing. A certain amount of chemical may be swallowed when contaminated hands are used for eating, drinking, smoking; or rubbing mouth on contaminated clothing, or even licking of the lips. Since the intestinal tract rapidly and completely absorbs many pesticides, it is sound advice to wash hands and face thoroughly before eating, drinking or smoking.

The most frequent cases of accidental oral exposure occur when pesticide concentrates have been removed from their original labeled container and put into an unlabeled bottle or food container. This is not only dangerous, but it is a violation of State and Federal law! **Children under the age of 10 years of age are the victims of at least half of the accidental pesticide deaths in the US.** If pesticides were always cared for correctly, children would never have the opportunity to touch them.

To avoid oral exposure to pesticides, observe the following rules:

- Always store a pesticide in its original labeled container.
- Never use the mouth to clear a spray line or nozzle, or to siphon a pesticide.
- Never eat, drink, or smoke until after leaving the work area and washing thoroughly.

Inhalation Route:



Respiratory exposure is particularly hazardous because pesticides can be absorbed by the lungs where they are rapidly absorbed into the bloodstream. Particularly dangerous are toxic dusts, vapors, gases (fumigants) or very small particles. In addition, pesticides can be inhaled in sufficient amounts to cause serious damage to nose, throat, and lung tissue. Vapors and extremely fine particles pose the most serious risk. When pesticides enter through the respiratory tract, it is usually the result of breathing in the pesticide or smoking a contaminated cigarette.

Lungs may be exposed to pesticides by the inhalation of powders, airborne droplets and vapors. Working with wettable powders can be hazardous because the concentrated pesticide powders may be inhaled during the mixing operation.

The hazard from inhalation of pesticide spray droplets is fairly low when dilute sprays are being applied with conventional low pressure application equipment. This is because most droplets are too large to remain airborne and inhaled. However, when high pressure, ULV, or fogging equipment is used, the potential for respiratory exposure is increased. The droplets produced during these operations are in the mist or fog-sized range and can be carried on air currents for long distances.

Airborne particles of five microns or larger are mostly deposited in the nose or throat and either swallowed or expelled. Smaller particles of two to five microns are more likely to be deposited in the throat and swallowed. Particles of one micron or less reach the lungs, where they are rapidly absorbed into the bloodstream.

Cartridge or canister-type respirators can provide respiratory protection for most types of outdoor applications. When fumigants or highly toxic pesticides are used in confined areas, it may be necessary to use a respirator with a self-contained air supply.

Other Routes:

There are several other routes of entry that are generally not as important as the dermal, inhalation, and oral routes. However, under certain conditions and with certain pesticides, absorption through the eyes or through skin abrasions can be significant and particularly hazardous. Eyes are very sensitive to many pesticides and considering their size are able to absorb a surprisingly large amount. The eyes and any open wounds should be protected when handling pesticides.

Fate of Pesticide in the Body:

Once a pesticide has been absorbed, it eventually enters the bloodstream and can be circulated to the body's organs. Once in the body, a pesticide will be dealt with in one of three ways: metabolism, excretion, or accumulation.

- **Metabolism** is the general process of breaking down or building up compounds in the body. The body's breakdown of chemical is called **detoxification**. The liver is especially important in detoxifying pesticides.

- **Excretion**. Most pesticides currently used in the US, are excreted (eliminated) from the body in urine, feces, exhaled air, or perspiration. The amount of time necessary for complete elimination of a pesticide from the body varies from a few hours to months.
- **Accumulation**. Some pesticides are not eliminated from the body. Instead, they are deposited in certain tissues, especially fat, where they may accumulate. DDT is an example of a pesticide that was banned due to its tendency to concentrate in the fatty tissues of mammals. It also caused the egg shells of birds to become too thin to support the weight of adults during incubation.

Half-Life:

The combination of all three of these processes determines the **half-life** of any particular chemical in the body. So what is a half-life? Chemical degradation is measured as "half-life"; that is, how long it takes a chemical to break down to ½ of its initial amount or activity. In humans, the half-life is defined as the amount of time it takes to eliminate 50 percent or half of the chemical from the body. Half-life's are also used to determine the environmental fate of pesticides (i.e. how long it takes a herbicide to break down to ½ of its applied active ingredient strength).

Toxicity of Pesticides:

Knowing the toxicity of a pesticide means knowing how poisonous it is. All pesticides must be toxic to the pest they are intended to control. But because pesticides are a poison, they are potentially hazardous to people and animals. Since pesticide toxicity varies widely, it is very important for persons who use pesticides, or those who regularly come in contact with pesticides, to have at least a general knowledge of the relative toxicity of the products they are using. Pesticide toxicity is measured in more than one way. Many pesticides are dangerous after one large dose, this is called **acute toxicity**. Some pesticides, however, become dangerous after small repeated doses, this is called **chronic toxicity**.

Determining the toxicity of a pesticide to humans is not easy. Obviously humans can not serve as test animals. Other animals, such as rats, mice, rabbits, and dogs are often used for testing. Toxicity study results are only used as guidelines. They are used to estimate how poisonous a pesticide is. Remember, the active ingredient is that portion of a pesticide formulation that is toxic to the pest.

Acute Toxicity:

Acute toxicity is a measure of how poisonous a pesticide is to an animal or human after a single exposure. A pesticide with a high acute toxicity is deadly even if a small amount is absorbed. Acute toxicity may be measured as acute oral toxicity, acute dermal toxicity, or acute inhalation toxicity.

Toxicity is usually expressed as **LD_{50}** (lethal dose 50) and **LC_{50}** (lethal concentration 50) these terms will be discussed in greater detail below.

LD_{50} = Lethal Dose for 50 Percent of Test Population

LD_{50} is a standard toxicological term that means a single lethal dose that kills 50 percent of a test population of animals under a standard set of conditions. Toxicity values of pesticides, based on a single dosage, are recorded in milligrams (mg) of pesticide per kilogram (kg) of body weight of the test animal (expressed mg/kg), or in parts per million (ppm). Consequently, it would take twice as much pesticide to kill a human weighing a 150 pounds (68 kg) than one weighing 75 pounds (34 kg). LD_{50} values are useful in comparing the toxicity of different active ingredients as well as different formulations of the same active ingredient. The lower the LD_{50} of a pesticide product, the greater the toxicity of the material to people and animals. Pesticides with high LD_{50} values are the least toxic to humans when used according to product label directions. LD_{50} values are calculated for both dermal and oral exposure. A pesticide's active ingredient will have an oral and dermal LD_{50}. For example, a pesticide may have an oral LD_{50} of 100 mg/kg and a dermal LD_{50} of 1,500 mg/kg.

LC_{50} = Lethal Concentration for 50 Percent of Test Population

In addition to oral and dermal exposure, an individual may be exposed through inhalation of a pesticide. The concentration of a pesticide in the total volume of air that kills 50 percent of a test population is referred to as the LC_{50}. An LC_{50} is expressed as "parts per million" (ppm) when a gas or vapor, and in micrograms per liter (µg/L) when a dust or mist.

LD_{50} or LC_{50} values are usually derived from tests using only the active ingredient of a pesticide. Usually, however, not always, a formulated pesticide product which contains both active and other ingredients would be less toxic and have a higher LD_{50} than the LD_{50} of just the active ingredient itself. For example, the oral LD_{50} of the active ingredient carbofuran is 8, while the oral LD_{50} of the formulated pesticide Furadan 10 G is 167.

There are several important characteristics to note about LD_{50} and LC_{50} values:

- the smaller the LD_{50} or LC_{50} value, the greater the toxicity;
- they are based on a single dose (LD_{50}) or short exposure (LC_{50});
- they do not indicate cumulative affects of small doses;
- they are an indicator of the amount of chemical required to kill or severely injure animals, and do not indicate the amount of chemical causing less severe toxic effects.

In the testing for LD_{50} and LC_{50} values, scientists rely on the use of a dose response curve showing the noticeable effects of pesticides at increasing doses. The highest dose at which no toxic effect occurs is called the **No Observable Effect Level** or the **NOEL**. The lowest dose which will cause death in one test animal is called the **threshold of toxicity**. The LD_{50} and LC_{50} levels will be at even higher more concentrated doses.

Toxicological research has shown that the susceptibility of test animals to pesticides varies with species, age, sex and nutritional state. Therefore data on the toxicity of pesticides to test animals can only serve as a guide to the probable toxicity of a pesticide to a single person. The LD_{50} values of some pesticides for rats and dogs could be quite inaccurate for predicting the lethal dose for birds or humans. However, LD_{50} values are very useful in classifying pesticides based on their toxicity to one or more test group, and indicate how carefully some pesticides must be handled.

Pesticides are assigned a “toxicity category” based on their highest measured toxicity, be it oral, dermal, or inhalation. Effects on the eyes and external injury to the skin are also considered. Those pesticides that are classified as highly toxic on the basis of either oral, dermal, or inhalation toxicity must have the signal words DANGER and POISON (in red letters) and a skull and crossbones prominently displayed on the package label, as well as the Spanish equivalent for DANGER, “PELIGRO”. As little as a few drops of these highly toxic products taken orally could be fatal to a 150-pound person. Acute oral LD_{50} values for pesticide products in this group range from a trace to 50 mg/kg (i.e. 50 milligrams of poison per 1 kilogram of body weight).

Pesticide products considered moderately toxic must have the signal word WARNING (“AVISO” in Spanish) displayed on the product label. Acute oral LD_{50} values range from 50 to 500 mg/kg. 1 teaspoon to 1 ounce of this material could be fatal to a 150-pound person.

Pesticide products classified as either slightly toxic or relatively nontoxic are required to have the signal word CAUTION on the pesticide label. Acute oral LD_{50} values are greater than 500 mg/kg.

Pesticides formulated in petroleum solvents or other combustible liquids must also include the precautionary word FLAMMABLE on the product label.

Signal Words and Hazards

Signal Word	Toxicity	Oral LD_{50}	Approx. Oral Lethal Dose for a 150 pound Person
Danger-Poison	Highly Toxic	0 - 50	A few drops to 1 teaspoon
Warning	Moderately Toxic	50 - 500	1 teaspoon to 1 ounce
Caution	Slightly Toxic	Over 500	1 ounce to 1 pint or pound

Chronic Toxicity:

Chronic toxicity refers to the harmful effects that occur from small, repeated pesticide exposures over a period of time. It is not possible to assess the chronic toxicity of a pesticide in the same way the LD_{50} or LC_{50} are used to determine acute toxicity. Unlike acute poisoning, symptoms of chronic poisoning may not become evident for weeks, months, or even years. When the symptoms finally develop, it may be difficult to prove a direct link between the symptoms and exposure that may have happened some time ago.

After repeated use of a pesticide, symptoms of chronic toxicity may occur as a slowly progressive detrimental condition, such as, increased breathing difficulty or skin sensitization (allergy). Sometimes chronic toxicity may show itself in the form of a disease such as cancer.

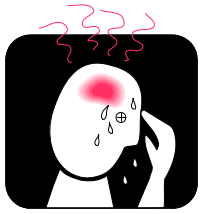
Individuals who run the greatest risk of developing a chronic disease condition are workers involved in industries which use carcinogenic materials or are exposed to them over time. Applicators that do not follow label directions and fail to wear protective equipment increase their risk of developing a chronic health condition.

Special Populations: In comparison to healthy adults, infants, children and infirm adults may be at a greater risk from pesticide exposure due to many different factors. Children have growth and developmental factors which must be considered; while the elderly and infirm adults have many health related problems (reduced physical activities, breathing difficulties, compromised immune systems, etc.) to consider when making pesticide applications in living and working environments.

Crop residues should also be considered when making applications to edible crops. No one wants pesticide residue in a crop at harvest time.

When researching a pesticide's chronic effects, scientists evaluate laboratory animals for the presence of a number of abnormalities. These effects include the following:

- **Oncogenicity** - the ability of a substance to cause tumors. **Carcinogenicity** - the ability to cause malignant tumors (cancer). **Mutagenicity** - the ability to cause changes in the genetic composition of a cell. If this occurs in an egg or sperm cell, the change, or defect, may be passed on to offspring.
- **Neurotoxicity** - the ability to cause toxic effects to the nervous system. Such damage might result in memory or coordination loss, headaches or muscular weakness.



- **Reproductive effects** - the ability to cause birth defects; to cause changes in the amount of sperm activity; and to cause toxic effects to the fetus, such as spontaneous abortions (miscarriages) or babies of low birth weight.

Despite the fact that some pesticide products are considered to be only slightly toxic or relatively nontoxic, all pesticides can be hazardous to man, non-target animals, and the environment if used inconsistently with the instructions on the product label. Use the pesticide only as recommended by the manufacturer. As the applicator, you are legally responsible if a pesticide is misused in any way.

Chemical Sensitivity:

In the population, some individuals may have an extreme sensitivity to chemicals, including pesticides. Exposure to a very small amount of pesticide may create symptoms of pesticide poisoning. This unusual reaction may be a genetically determined response to a substance or a hypersensitivity developed over time. Since there are different chemical classes of pesticides, an individual may show extreme reactions to one class of pesticide and no observable reaction to another class of pesticide.

Symptoms of Pesticide Poisoning

Recognizing the symptoms of pesticide poisoning is of vital importance to a pesticide applicator. By recognizing these symptoms quickly, a pesticide applicator can act to decrease exposure and seek treatment sooner.

Get medical advice quickly if unusual or unexplained symptoms appear at work or later the same day. A person who may have been poisoned should not be left alone. Do not let anyone get dangerously sick before calling a physician or going to a hospital. It is better to be too cautious than too late. Take the container (or the label) of the pesticide to the physician.

The different classes of pesticides have distinct poisoning symptoms. Applicators should always be aware of the class of pesticide they are using and the symptoms associated with exposure.

Classes of Pesticides and Their Poisoning Symptoms:

Organophosphates: (Examples are malathion, dimethoate, acephate)

Organophosphates interfere with the activity of an enzyme known as cholinesterase which is necessary for proper nerve function. When the cholinesterase enzyme is unable to perform its normal function, the nerves in the body send impulses to the muscles continuously.

The level of organophosphate poisoning is indicated by certain symptoms. These symptoms are:

- **Mild Poisoning**: fatigue, headache, dizziness, blurred vision, excessive sweating, salivation, nausea, vomiting, stomach cramps and diarrhea.
- **Moderate Poisoning**: inability to walk, weakness, chest discomfort, muscle twitches and eye pupil constriction. As time passes, symptoms which become evident early on may become more severe.
- **Severe Poisoning**: unconsciousness, severe eye pupil constriction, muscle twitches, secretions from mouth and nose, and breathing difficulty. Death if not treated.

Illness may occur quickly or be delayed a few hours. But if signs or symptoms start more than 12 hours after exposure to the pesticide, it is probably some other illness. Check with a physician to be sure. Organophosphates all contain carbon, hydrogen and phosphorus, which usually degrade within 72 hours after application.

Organochlorines (also know as Chlorinated Hydrocarbons): most of the pesticides in this class have been phased out or their uses severely restricted. Examples include chlordane, heptachlor, aldrin, lindane, endosulfan.

All organochlorines contain hydrogen and chlorine, which resist breakdown in the environment. All are contact or ingestion type poisons and are persistent in the environment. They generally do not penetrate the skin, however in the past, Endrin and Chlordane would.

Not many organochlorines have caused acute poisoning of applicators. Early signs and symptoms of poisoning include headache, nausea, vomiting, general discomfort, and dizziness.

With more severe poisoning, convulsions follow. They may even appear without the warning symptoms. Coma may follow convulsions. The victim may also be unusually excited or irritable.

Carbamates (N-Methyl Carbamate): (Examples: carbaryl, bendiocarb, propoxur)

The only carbamates likely to affect you act similarly to organophosphates - producing the same signs and symptoms. Carbamates also inhibit the cholinesterase enzyme; however their action is quickly reversed by the body. The illness caused by carbamates is usually not as severe or as long lasting as that caused by organophosphates. Carbamates all contain carbon, hydrogen, nitrogen and sulfur. They do not accumulate in the environment and are rapidly inactivated under alkaline conditions. They are slightly more persistent than the organophosphates.

Biologicals and Insecticides of Biological Origin: (Examples: pyrethrins, rotenone, *Bacillus thuringiensis*)

The most common pesticide of biological origin is pyrethrin which is extracted from the flower of the chrysanthemum plant. Synthetic pyrethroids, which are chemically similar to pyrethrins, are manufactured in pesticide laboratories. Both of these insecticides are highly toxic to insects and fish but less toxic to humans than most other insecticides. Pyrethrins and synthetic pyrethroids affect the central nervous system. An extremely high exposure can result in convulsions and lack of coordination. However, because of their low level of toxicity, pyrethrins and synthetic pyrethroids usually cause only irritation to the skin and eyes. Some rotenone dusts irritate the respiratory tract. Nicotine is a fast-acting nerve poison with paralysis and vascular collapse being prominent in acute poisoning, but death is often due to respiratory paralysis. A side note to nicotine: the half-life of nicotine in smokers is about one hour and can be up to two hours in non-smokers. Some other plant-derived pesticides are strychnine, azadirachtin, streptomycin. As a general rule, most pesticides from biological origins are not persistent in the environment.

Arsenicals: most of the pesticides in this class have been phased out (Examples - common names: Chemonite, Paris Green, DSMA).

Many arsenicals have been discontinued in the US as a result of government regulations. Ingestion is the route of intake for most acute poisoning by the arsenicals. Stomach pain, vomiting and diarrhea are the primary symptoms of acute poisoning. Symptoms are sometimes delayed for hours. A garlic odor to the breath and feces helps to identify the poisoning agent.

At low levels of exposure the symptoms of poisoning are chronic headache, stomach pain, and low grade fever.

Cyanide

Cyanide is one of the fastest-acting poisons. Massive doses result in unconsciousness and death without warning. Smaller doses may result in the odor of bitter almonds on the breath, salivation, nausea, anxiety, confusion, and dizziness. Illness may last one or more hours, terminating with unconsciousness, convulsions, and death from respiratory failure.

Anticoagulants: (Examples: brodifacoum, warfarin, diphacinone)

Anticoagulant pesticides are the 2nd most commonly ingested pesticide after pyrethrins and pyrethroids in the US, with over 16,000 exposures reported in 2004 (Annual Report of the American Association of Poison Control Centers Toxic Exposure Surveillance System). Intestinal absorption of these toxicants is efficient. The injurious effects of anticoagulants are due to loss of blood, mainly into the body tissues. For example, the initial symptoms in chronic warfarin poisoning are back pain and abdominal pain due to a buildup of blood in these areas.

Bipyridilium: (Example: Gramoxone)

Bipyridilium herbicides may be harmful if inhaled or absorbed through the skin, and may be fatal if swallowed. Severe irreversible lung damage can develop if they are swallowed or inhaled. The symptoms of injury may be delayed. Prolonged skin contact causes severe irritation.

Nitrophenols and Pentachlorophenol:

Almost all US registrations have been canceled or severely restricted. Pentochlorophenol (PCP) is currently registered in the US only as a restricted use pesticide for use as a wood preservative.

The signs and symptoms of skin exposure to these compounds include redness, burning, and blisters.

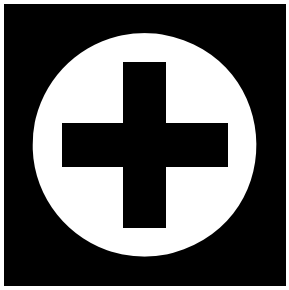
The signs and symptoms of poisoning include headache, nausea, gastric disease, restlessness, hot feeling, flushed skin, sweating, deep and fast breathing, fast beating of the heart, fever, ashen color, collapse, and coma. Severe poisoning usually runs a rapid course. Those affected usually either die or are almost well within 24 to 48 hours.

Fumigants: (Examples: chloropicrin, methyl bromide, phosphine)

Fumigants are easily absorbed in the lungs, gut, and skin. Too much exposure to these compounds may make a person seem drunk. The signs and symptoms of exposure or poisoning are highly variable and are based on the fumigant agent. However, some general signs are poor coordination, slurring of words, confusion, sleepiness.

Repeated exposure to the fumigant methyl bromide has caused permanent internal injury without early signs or symptoms. A fatal does can be absorbed before symptoms appear. Most fumigants will contain some kind of a "**warning agent**". Chloropicrin, having a strong odor and irritant effect, is often added as a "warning agent" to other liquid fumigants.

First Aid Procedures:



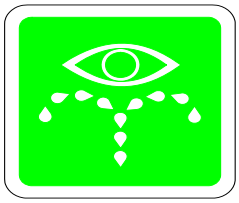
First aid information is found in the “First Aid” section on each pesticide label. The information and instructions stated in this section can save the life of someone suffering from a pesticide incident.

Always follow label directions and call the Poison Control Center. The following is a general guideline for first aid procedures when exposed to a pesticide.

For pesticide on skin:

- act quickly. Remove all contaminated clothing ;
- promptly wash contaminated skin with water;
- do not forget hair and fingernails;
- solutions of pesticides in petroleum oil or other solvents can only be thoroughly removed using soap or detergent and water. **Detergents work best**. Do not use a brush of any kind.

For pesticide in eye:



- hold eyelid open, wash eye immediately with a gentle stream of clean warm water. Use large amounts of water. Immediate action can decrease the chance of eye injury;
- continue washing for 15 minutes or more;
- do not use medications or drugs in wash water;

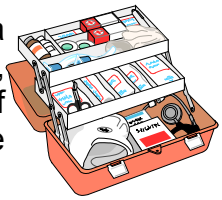
For inhaled pesticide:

- call a doctor or the poison control center immediately;
- seek fresh air or remove affected person to fresh air immediately. Seek medical treatment right away;
- loosen tight clothing;
- in fresh air, apply artificial respiration if breathing has stopped or if the victim's skin is blue;
- never attempt to rescue a victim from an enclosed area without proper protective equipment. If equipment is unavailable, call for emergency personnel
- do not give alcohol in any form.

For ingested pesticide:

- call a doctor or the poison control center immediately;
- rinse mouth with plenty of water;
- remove person from area of exposure and get them to fresh air;
- get to a physician immediately;
- it is sometimes dangerous to cause vomiting; review and follow label directions;
- if patient is vomiting, do not allow patient to lie on back because the vomitus could enter the lungs and do additional damage.

First Aid Kit



A well-equipped, readily available first aid kit can be important in a pesticide emergency. Always keep a first aid kit nearby when mixing, loading, or applying pesticides. It is vitally important to have a supply of clean water. A first aid kit for field and on-the-job use should include the following items:

- A small plastic bottle of common detergent to quickly wash pesticide off skin;
- A container of clean water. If there is no clean water in an emergency, use any pond or stream water available;
- Simple Band-Aids, bandages, and tape. All cuts and scrapes should be covered to prevent pesticide from easily entering the body;
- Cell phones should have the numbers of the nearest poison control center and hospital saved in them.

Cholinesterase and Cholinesterase Testing

Organophosphate pesticides have been involved in more cases of occupational poisoning and death than any other single group of pesticide. This occurs as a result of the suppression of a chemical in the body that regulates the transmission of signals between nerve cells called acetycholinesterase, or **cholinesterase** for short. Pesticide applicators using organophosphate and carbamate pesticides on a regular basis should consider having their blood tested to find their normal or **base level** of **cholinesterase**. Base level tests should be done before ever handling an organophosphate or carbamate, or during the "off-season". There are wide differences in cholinesterase levels among individuals. The normal level for each person must be individually established.

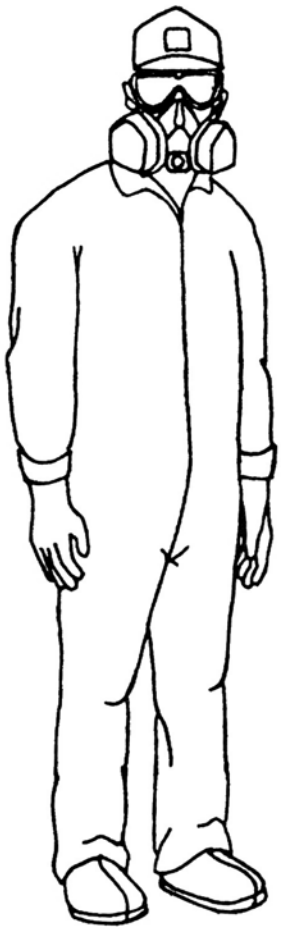
Once a pesticide applicator's base level of cholinesterase has been determined by a doctor, a blood test after pesticide use will show if there has been overexposure to either an organophosphate or carbamate pesticide. If so, further contact with these pesticides should be avoided until the cholinesterase level returns to normal. In severe cases, antidotes must be given. In the absence of additional exposure, blood cholinesterase enzymes will regenerate in about 120 days from very low to normal levels in the case of organophosphate poisoning and more rapidly for carbamate poisoning. For carbamate insecticides, cholinesterase testing must be done immediately following exposure to be of much value.

Approximately one percent of the population has abnormally low levels of cholinesterase. Individuals with this abnormality are at extreme risk. For safety's sake, individuals should have their base cholinesterase level determined before applying any organophosphate or carbamate insecticide.

Medical Antidotes

By law, highly toxic pesticides must have instructions for physicians on the labels in case of poisoning. Such instructions will include information on medical antidotes if applicable. Remember that medical antidotes can be very dangerous if misused. They should never be used as a preventive treatment and should be prescribed and given only by a qualified physician. In cases where instructions for the physician are not given on the pesticide label, a poison control center or poison treatment center should be contacted.

Protective Clothing and Personal Protective Equipment



Personal Protective Equipment (PPE)

The type of protective clothing and equipment needed depends on the job being done and the type of chemical being used. **READ THE LABEL** on the pesticide container carefully and follow all directions concerning necessary protective clothing and equipment. Many highly toxic pesticides require full protection, including a respirator, while mixing, applying and disposing of the pesticide. In some cases, special equipment may be required, such as a self-contained air system when using fumigants. In most cases, the handler is required to wear a chemical-resistant apron while mixing, loading, or disposing of a product, in addition to the required personal protective equipment (PPE) designated for the applicator.

Recommended Clothing:

The minimum protective clothing recommended by the United States Department of Agriculture (USDA), the National Agricultural Chemical Dealers Association (NACA), and the Environmental Protection Agency (EPA) when handling **dilute** (mixed) pesticides includes a long-sleeved shirt, long pants, underwear, chemically resistant gloves, socks, and shoes (boots). When handling **concentrates**, particularly pesticides with DANGER or WARNING labels, a face shield, goggles, or respirator (full face and eye protection), chemical resistant apron, and chemical resistant boots are necessary. Each pesticide label will identify the required PPE that must be worn during each stage of handling and using the pesticide (mixing, loading, applying, repairing, clean-up, disposal). **Read the label**.

- **Coveralls** Cotton coveralls over regular work clothing are helpful protection when applying and/or handling pesticides. Sleeves should reach the wrist and the pant legs should reach the ankle. Coveralls should be closed (e.g. buttoned or zipped) in the front. They must be laundered after every wearing and should be replaced annually to prevent pesticide carry-over in the clothing from one season to the next. When wearing gloves and boots with coveralls, the garments are to be worn outside (over) the gloves and boots. This prevents pesticides from getting into the gloves or boots. Disposable coveralls, such as regular Tyvek® or Polylaminated Tyvek® (polyethylene coated), are suitable for handling granular or powdered formulations and less toxic liquid pesticides. They also can be worn over other work clothing, and offer protection similar to cotton coveralls, but are

water resistant. Tyvek® coated with Saranex 23P® offers better protection for handling undiluted and highly toxic pesticides, but does not "breathe." In some weather conditions, they must be used with discretion to avoid heat exhaustion.

Disposable coveralls are relatively inexpensive, so for many situations they are a good safety investment. Disposable coveralls are durable, but cannot be effectively decontaminated and should be disposed of in the same way as empty pesticide containers or hazardous waste.

If coveralls are not warn, long-sleeved shirts and long pants made of a closely woven fabric are a must when handling pesticides. The sleeves should reach the wrist and the pant legs should reach the ankle. The shirt should be closed (e.g. buttoned or zipped) in the front. If a shirt is worn outside the pants, it should reach below the top of the pants. Both the shirt and pants should be cleaned daily and should not have any holes in them. Same as with coveralls, when wearing gloves and boots with long-sleeved shirts and long pants, the garments are to be worn outside (over) the gloves and the boots preventing pesticides from getting into the gloves and boots.

- **Aprons** When handling pesticide concentrates a liquid proof chemical resistant apron should be worn. Aprons should cover the body from the chest to the boots. Read the label to see if a chemical resistant apron is required.

- **Gloves** Gloves have been shown to reduce pesticide contamination of skin if properly maintained and replaced frequently. Hands should always be protected when working with pesticides. A USDA study showed that applicators handling concentrated pesticides received 85 percent of their pesticide exposure on their hands. When handling concentrated or highly toxic pesticides, wear gloves made of **neoprene**, **nitrile** or **butyl rubber**. For most pesticides, nitrile gloves or natural rubber gloves provide the best protection. All gloves should be long enough to protect the wrist, or at least 12 inches long. Latex gloves (used in dishwashing) should only be used when working with diluted (mixed) pesticides. Neoprene readily absorbs some fumigants and therefore should not be used in these applications. The label may require a specific kind of glove to be worn.

  Gloves should not be lined with a fabric. The lining is hard to clean if a chemical gets on it. Do not wear cotton or leather gloves. They absorb the pesticide, which provide a continuous source of exposure, and can be more hazardous than wearing no gloves at all. Gloves with a “wristband” should never be worn.

  Gloves can get contaminated on the inside, and the moist warm conditions there may foster pesticide absorption into the skin. To avoid this problem, discard or clean gloves often.

  Before removing gloves, rinse them with water and detergent to prevent contaminating hands.

- **Hat** Wear something to protect the head. A wide-brimmed, waterproof hat will protect neck, eyes, mouth, and face. It should not have a cloth or leather sweatband, or other porous materials that may absorb pesticides; these sweatbands are

hard to clean if chemicals get on them. Webbed, mesh, baseball caps, or similar headgear should not be used. One of the best hats is the plastic "hard hat" with a plastic sweatband.

- **Boots** As stated above in the gloves section, it is a good idea to wear unlined rubber or neoprene boots. Leather and canvas shoes/boots absorb and hold pesticides which in turn provide a constant source of skin exposure. Wash boots daily and dry thoroughly inside and outside to remove any pesticide residue. Pants or overalls should be worn outside of boots to prevent pesticides from getting inside them.

- **Goggles or Face Shield (eye protection)** Wear goggles or a face shield when there is any chance of getting pesticides in the eyes. These should completely cover the eyes. Exposure is likely when handling mists, dusts, liquid concentrates, or pressurized equipment. Tight fitting goggles with anti-fog lenses and indirect venting are best. Many goggles have headbands that are made of materials that readily absorb chemicals. It is recommended that these headbands be replaced with ones made of nonabsorbent materials (see section on hats for recommendations). Wash goggles or face shield with detergent and water at least once a day. Store in a plastic bag away from pesticides to avoid contamination. Glasses and sunglasses with or without side guards should never be used as eye protection against pesticides.

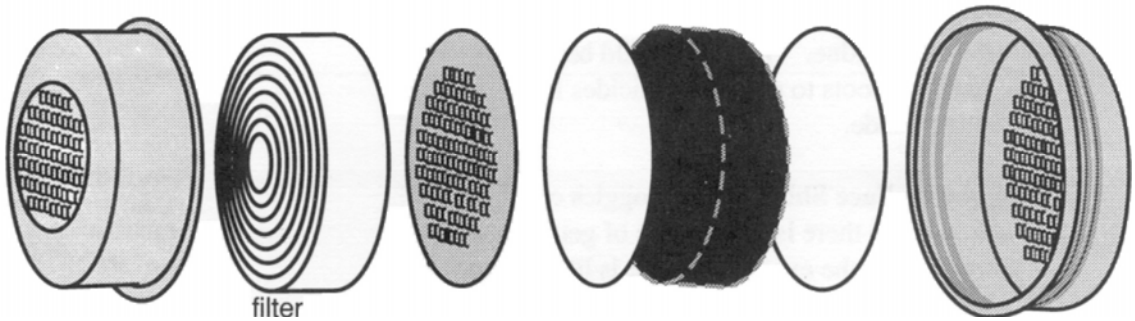
Respiratory Protective Devices:

Respirators provide protection against inhalation exposure. Pesticides can be inhaled either as mists, dusts, or vapors. The respiratory tract rapidly and completely absorbs pesticides, and should be protected. Wear an approved respiratory device when directed by the label. Follow the label instructions on respiratory protection. An applicator needs a respirator if exposed to a pesticide for a long time, if the pesticide used is highly toxic, or if working in an enclosed area.

OSHA requirements are constantly changing with respect to respirators used in general industries, which includes the occupation of pest control. A pest control operator is advised to contact OSHA periodically to obtain the most recent requirements on respirators, or periodically consult and read the Code of Federal Regulations (CFR) Chapter 29 Part 1910.134. Depending on respirator usage and company policies on respirator usage, applicators may want to consult a physician before using a respirator. In some cases where respirator usage is mandatory, a medical evaluation may be necessary because some individuals may have physical problems that may be aggravated by restricted airflow associated with respirator usage. If respirator usage is required, the company will have a written Respirator Protection Program with required work site-specific procedures and elements.

Commonly Used Respirators:

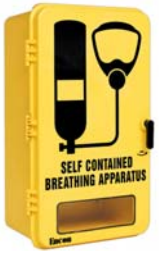
- **Dust and Mist Respirators** Dust and mist respirators are physical filters which only protect against pesticide dusts and larger spray droplets. They are not effective against fumigants and the many pesticides which emit vapors.
- **Chemical Cartridge Respirator** Chemical cartridge respirators are usually designed as a half-face mask which cover the nose and mouth but not the eyes; therefore, eye protection is required when using them. They have one or two cartridges attached to the face piece. In the cartridge, the inhaled air comes through both a filter pad and an absorbing material such as activated charcoal which removes most of the pesticide vapors, gases and particles. These respirators come in two types; non-disposable respirators with inter-changeable cartridges, or the ever more popular disposable dual cartridge respirators. Full-face chemical cartridge respirators are available which provide eye protection. Chemical cartridge respirators are recommended for short term outdoor use and low concentrations of pesticides. They should not be used with fumigant gases or in areas with deficient oxygen levels.



- **Chemical Canister Respirator (Gas Mask)** Gas masks are normally designed to cover the eyes, nose and mouth. The canister is either attached directly to the face piece or is worn on a belt and is connected to the face piece by a flexible hose.

  These respirators are to be worn when applicators are exposed to a continuous concentration of a toxic pesticide. Normally, the canister has longer lasting absorbent material and filters compared to a cartridge respirator. Gas masks usually protect the face better than cartridge types, but neither kind provides protection when the oxygen supply is low. Gas masks should not be used where oxygen deficiency or high gas concentrations may occur, such as in a structure undergoing a fumigation.

- **Supplied Air Respirators and Positive-pressure Self Contained Breathing Apparatus (SCBA)** Supplied Air Respirators and SCBA (not SCUBA) respirators, such as those manufactured by Survivair, Ranger, Scott, or MSA, are used primarily in fumigation or where the oxygen supply is low. Both of these respirator types have full face masks and do not require additional eye protection.



Selection of Respirators:

Specific types of cartridges and canisters protect against specific chemical gases and vapors. Be sure to choose one to protect against the pesticide being used. Use only those approved by the National Institute for Occupational Safety and Health (NIOSH), or the Mine Safety and Health Administration (MSHA). An example or an organic vapor respirator for pesticide use would be a "NIOSH-MSHA Approval No. TC-23C-860 issued to 3M, St. Paul, Minnesota, USA." All respirators, even dust masks, have these approvals. Read the pesticide label and the respirator for appropriate NIOSH-MSHA approval before using a pesticide which requires the use of a respirator.

A respirator or mask should be fitted properly to the face. Long sideburns, beard, or glasses may prevent a good seal. Adjust headbands tightly enough to obtain a good seal. Before using, read the manufacturer's instructions on the use and care of the respirator and its parts. The manufacturer's instructions will suggest procedures to test for a proper seal. This may be similar to the following inhalation/exhalation test.

- **Inhalation Test** Place the palm of the hands over the cartridge assemblies or inhalation points and inhale. If no air enters and the face-piece collapses slightly, the respirator is properly fitted and the exhalation valve is closing property.
- **Exhalation Test** Place the palm of the hand or thumb over the exhalation valve guard and press lightly. Exhale to cause a slight pressure inside the face-piece. If no air escapes, the face-piece is properly fitted and the inhalation valves are closing correctly. If air escapes, readjust the headbands.

Maintenance of Respirators:

During heavy spraying, the filters in chemical cartridge respirators should be changed at least two times a day - more often if breathing becomes difficult. Cartridges should be changed after eight hours use, or when the manufacturer recommends replacement. If the applicator detects pesticide odor or feels nose or throat irritation, the applicator should leave the work area immediately and change the canister or cartridge. Filters and cartridges should be removed after each use. Remember, once cartridges have been removed from their original wrapping they lose their absorptive capacity rapidly. If disposable respirators are used, follow directions on the package. Filters/cartridges on disposable respirators are not replaceable. Use a new respirator as needed or recommended by the manufacturer.

The face piece on all types of respirators (including disposable respirators) should be washed with soap and water, rinsed, dried with a clean cloth, and stored in a clean, dry place away from pesticides after every use. A tightly closed plastic bag works well for storage. The useful life of a cartridge or canister depends on the amount of absorbent material, the concentration of contaminants in the air, the breathing rate of the wearer, and the temperature and humidity. As a general rule, a canister, cartridge, or disposable respirator should never be reused even if used for just a few minutes. These filters are easily replaced, but lungs are not. Remember— a disposable respirator or cartridges should be changed:

- When the manufacturer recommends;
- If breathing is troublesome;
- If pesticide odors can be smelled;
- If the last time it was used is unknown.

Avoiding Heat Stress

Now that PPE has been discussed, it is time to examine heat stress and its relation to PPE. Heat stress is an illness that occurs when the body builds up more heat than it can cope with. Heat stress is not caused by exposure to pesticides, but may affect pesticide handlers who are working in hot conditions. Wearing PPE, clothing and devices that protect the body from contact with pesticides can increase the risk of heat stress by limiting the body's ability to naturally cool itself.

Several factors work together to cause heat stress. Before beginning a pesticide handling task, think about whether any of these factors are likely to be a problem. Consider making adjustments in the task itself or in the workplace conditions, including:

- heat factors - temperature, humidity, air movement, and sunlight;
- workload - the amount of effort a task takes;
- personal protective equipment (PPE);
- water drinking, and scheduling.

Heat and Workload: High temperatures, high humidity, and sunlight increase the likelihood of heat stress. Air movement, from wind or fans, should provide cooling. Because physical work causes the body to produce more heat, a person is more likely to develop heat stress while working upright, such as lifting or carrying heavy containers, than someone sitting while driving a vehicle or flying an aircraft.

Cooling Systems and Shade: When indoors use fans or ventilation system, and shade whenever possible outdoors. A work area or vehicle can sometimes be shaded with a tarp, canopy, awning, or provided with fans or air conditioners. Consider wearing cooling vests - garments with ice or frozen gel inserts that help keep the body cool.

Allow Time to Adjust - Allow time to adjust to the heat and workload. People who have become used to working in the heat are less likely to be affected by heat stress. To adjust to a hot working environment, allow two hours of light duty per day in the heat for several days in a row; then gradually increase the work period and the workload for the next several days. An adjustment period of at least seven days is recommended. If warm weather occurs gradually, handlers may adjust naturally by working in the increasing temperatures.

Level of PPE:

Select a level of PPE that is appropriate for the pesticide being used. The pesticide label will indicate the minimum PPE to be used. Use personal experience and PPE selection guides to help decide whether more protection is needed. Do not over-protect if heat stress is a concern, but wear at least the minimum required PPE. Generally, the more protective the equipment, the more it adds to the heat load.

- **Select Coolest Possible PPE** - Choose PPE that is designed to be as cool as possible or that provides a cooling effect, such as a powered air-purifying respirator or, when appropriate, back-vented coveralls. Whenever practical, choose coveralls

that allow air to pass through them. Woven fabrics (cotton, or cotton-polyester blends) allow air to pass through fairly easily. Rubber or plastic fabrics and fabric with chemical-resistant barrier layers allow almost no air to pass through. Non-woven polyolefin (Tyvek®) fabrics allow little air to pass through. Depending on how they are constructed, non-woven polypropylene and polyester/wood pulp fabrics vary in their resistance to airflow.

Drinking Water Intake:

Evaporation of sweat cools the body. Under the conditions that lead to heat stress, the body produces a large amount of sweat. To help maintain a normal body temperature, the water lost in sweat must be replaced.

- **Drink Enough Water** – During periods of high temperature, drink plenty of water before, during, and after work. Do not rely on thirst. A person can lose a dangerous amount of water before feeling thirsty, and the feeling of thirst may stop long before fluids are replaced.
- **Maintain Weight** - Be sure to keep body weight fairly constant. All weight lost due to perspiration should be regained every day. People working in heat stress conditions should weigh themselves before work every day and keep weight constant by drinking plenty of water.

Scheduling:

When the combination of temperature, sunlight, humidity, workload, and PPE is likely to lead to overheating, use scheduling to avoid heat stress.

- **Work During the Coolest Times** - Schedule tasks requiring the heaviest workload or the most PPE during the coolest part of the day.
- **Use work/rest cycles** – When the possibility of heat stress is high, schedule frequent breaks to allow the body to cool. Consider using a work/rest cycle guide to decide how long to work before taking a break.

Remember that people differ in their ability to work in hot conditions. Most work/rest cycle guides are based on an average of many people who are adjusted to the heat and the workload. Workers who have not had time to adjust should work less time than the guide indicates.

When using recommended work/rest cycles, continue to be alert for possible heat stress problems. Anyone who gets dangerously hot should stop work immediately and cool down. If necessary, shorten the time between breaks.

Signs and Symptoms of Heat Stress:

Heat stress, even in mild forms, makes people feel ill and impairs their ability to work effectively. They may get tired quickly, feel weak, be less alert, and be less able to use good judgment. Severe heat stress (heat stroke) is a serious illness. Unless victims are cooled quickly, they can die. Severe heat stress is fatal to more than 10 percent of its victims, even young, healthy adults. Victims may remain sensitive to heat for months and be unable to return to the same work.

Learn the signs and symptoms of heat stress and take immediate action to cool down if they appear. Signs and symptoms may include:

- fatigue (exhaustion, muscle weakness);
- headache, nausea, and chills;
- dizziness and fainting;
- loss of coordination;
- severe thirst and dry mouth;
- altered behavior (confusion, slurred speech, quarrelsome or irrational attitude).

Heat cramps can be painful. These are muscle spasms in the legs, arms, and stomach caused by loss of body salts through heavy sweating. To relieve cramps, drink cool water or sports drinks. Stretching or massaging muscles may temporarily relieve cramps. If there is a chance that stomach cramps are being caused by pesticides rather than the bodies loss of salt, get medical help right away.

First Aid for Heat Stress:

It is not easy to tell the difference between illness brought on by heat stress and that of pesticide poisoning. The signs and symptoms are similar. **Don't waste time trying to decide what's causing the illness**. Get medical help right away.

First aid:

- Get the victim into a shaded or cool area;
- Cool victim as rapidly as possible by sponging or splashing skin, especially face, neck, hands, and forearms, with cool water or, when possible, immersing in cool water;
- Carefully remove all PPE and any other clothing that may be making the victim hot;
- If the victim is conscious have them drink as much cool water as possible;
- Keep the victim quiet until help arrives.

Severe heat stress (heat stroke) is a medical emergency! Cool victim immediately! Brain Damage and death can result if treatment is delayed.

Multiple Chemical Sensitivity (MCS)

Multiple Chemical Sensitivity (MCS) is one of several names used by some to explain the wide array of physical and psychological symptoms expresses by those who are, or claim to be, adversely affected by chemicals. These symptoms are extremely diverse and include headaches, fatigue, difficulty concentrating and depression. A few other terms used to describe these symptoms include:

- environmental illness;
- total allergy syndrome ;
- 20^{th} century disease.

Often, those who believe they have MCS say their symptoms are caused by exposure to certain foods and chemicals, including low levels of household chemicals and pesticides.

However, decades of medical and scientific study have failed to find evidence that MCS exists. In fact, the American Medical Association Council on Scientific Affairs, the American College of Physicians, and the American Academy of Allergy, Asthma and Immunology all reject MCS as a clinical disease and discourage its use as a diagnosis.

The symptoms ascribed to MCS can be caused by a number of diverse medical problems. People may have medical problems not yet diagnosed, suffer from allergies, experience a psychological reaction to an unpleasant odor, or have stress-related problems.

People who believe they have MCS may truly be suffering from some other physical or psychological ailment. It is understandable that people seek an explanation or name to describe their condition. As a result, the concept of MCS has spread within the popular culture, despite overwhelming medical evidence that MCS is not a clinical disease.

Indoor Air Quality

All applicators should have an awareness of indoor air pollution. Indoor air quality is a relatively new environmental issue. Today most Americans spend up to 90% of their time indoors, that is inside their home, office, stores, and other spaces.

Indoor air pollutants can cause long and short term health effects, especially when concentrations build up over time.

There are many potential sources of indoor air pollution in any home, apartment, office building, warehouse, restaurant, store, etc.; and yes, pesticide application and storage are on the list. Applicators should be aware that what they spray in a house, apartment, office building, warehouse, restaurant, store, etc., can affect indoor air quality.

One reason for indoor air problems is inadequate ventilation. If too little outdoor air enters a home, apartment, office building, store, etc., pollutants can build up causing discomfort or health problems. New home building techniques compound this problem because they are built "leak-free", that is they are designed for energy efficiency and minimize the amount of outside air that can "leak" in.

A number of well identified illnesses, such as Legionnaire's disease, asthma, hypersensitivity pneumonitis, and humidifier fever, have been directly traced to specific building problems. These are called building-related illnesses. Most of these diseases can be treated; nevertheless some can pose serious risk to sensitive individuals.

What can pest control operators do to alleviate indoor air problems from pest control? There are two basic strategies; they are Source Control and Ventilation.

- **Source Control** - This is usually the most effective way to improve indoor air quality. **Be Aware of Your Surroundings**. If indoor air is a concern in a home, apartment, office building, warehouses, restaurant, store, etc., an applicator should limit the amount of indoor spraying. Baits, monitoring traps, gels, etc., should be relied upon more in these situations.
- **Ventilation** - This is another approach to lowering the concentrations of indoor air pollutants. The idea is to increase the amount of outside air entering the structure. One way of accomplishing this while conducting pest control is to open windows and doors, and by turning on bathroom and kitchen exhaust fans if they are vented to the outside. In both cases they will lower indoor air pollution by removing pesticide contaminants from the air.

It is particularly important to take as many precautions as possible when doing pest control. Pest control is a short-term activity that can generate high levels of "pollution" in a short period of time. Again, know the environment, take into consideration children's rooms, the elderly, people with allergies, etc. These people may be more sensitive to pesticides and pesticide odors. Talk with clients and look around and behind objects before spraying; and notice if the house is closed-up tight. Be observant and use senses (eyes, ears, noise) when examining a particular place.

Laundering Pesticide Contaminated Clothing

Clothing acts as a barrier to prevent skin absorption of pesticides. Researchers agree that clothing worn for pesticide application needs to be washed after every wearing. Research on the laundering of clothes indicates that it is extremely difficult to remove all traces of pesticides from test fabrics. Therefore, protective apparel like a rubber apron or laminated Tyvek® suit may be useful (or even required) when mixing or handling pesticides. If clothing gets soaked with concentrated pesticide, dispose of it properly.

Laundry Hints:

Follow these laundering suggestions for care of pesticide-soiled clothing:

- Collect and keep pesticide soiled clothing separate from other dirty laundry. Line a cardboard box with a garbage bag and use it as a disposable hamper. Discard box and liner at the end of the pesticide application season.
- Wear rubber gloves when handling pesticide soiled clothing. Dispose of gloves with hamper at the end of the pesticide application season.
- Wash clothing as soon as possible after each day's soiling to avoid pesticide residue build-up in fabric.
- Pre-rinse pesticide-soiled clothes in one of these ways:
    - Spray or hose them outdoors
    - Soak them in a tub or bucket. Throw the dirty water on/in an approved labeled site
    - Use the presoak cycle
- Wash pesticide soiled clothes separately from family laundry. Pesticides can be transferred from one garment to another in wash water. Use hot water setting (140 degrees F.).
- Wash only a few items at a time.
- Use full water level.
- Use the normal 12-14 minute wash cycle (not a shorter knit cycle) and a double rinse if possible
- Use heavy-duty detergent.
- Repeat laundering if evidence of pesticide odor, staining, or other color difference remains in clothing after laundering. If repeated laundering does not remove these traces, discard clothing
- Line-dry clothes to avoid possible contamination of dryer and other family clothes (Ultra violet rays from the sun help to breakdown pesticide residue.)
- After removing clothing, rinse empty washing machine with a full load of hot water and detergent.
- Do not attempt to wash clothing that is saturated with full strength concentrate; instead, discard clothing.

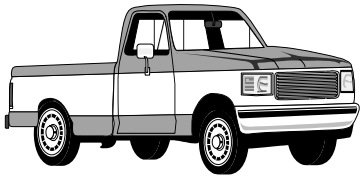
Mixing, Handling, and Disposing of Pesticides

Many aspects of pesticide application involve some risk of injury when:

- hauling pesticides;
- mixing, loading, and applying pesticides
- cleaning pesticide application equipment;
- cleaning up pesticide spills;
- storing or disposing of pesticides.

To prevent harm from pesticides, follow safety precautions and use common sense. The following paragraphs cover basic safety steps when handling pesticides. **Always start by reading the label.**

Transporting Pesticides Safely



Transporting concentrated pesticides to and from the distributor and/or storage area carries risk of accidental poisoning and environmental contamination.

The safest way to carry pesticides is in the back of a truck. Never transport pesticides inside the passenger compartment or trunk area of any vehicle. No one should be permitted to ride near pesticides. The placement of a pesticide inside a vehicle may subject the driver and any passenger to pesticide fumes or leaks. In an accident, a pesticide spill might result in injury or even death to an occupant.

To prevent spillage and breakage, fasten pesticides in the truck bed so they cannot roll or slide around. Never transport food, seed, fertilizer or livestock feed with a pesticide. The danger of contamination is too great. It is a good practice to transport herbicides separately from all other pesticides, since a spill could lead to cross contamination.

Never leave a truck or trailer unattended when transporting a pesticide in an open bed. Drivers are legally responsible if curious children or careless adults are accidentally poisoned from pesticides left unattended and exposed in the vehicle. All Commercial Pest Control Operators who transport or store pesticides on their service vehicle are required to keep them secure in a locked compartment.

If a spill occurs, clean it up immediately. When cleaning up a spill, always follow label instructions regarding the use of PPE and proper disposal of the waste material. Spills and clean up will be discussed in greater detail later.

Enforcement: The Transportation Act of 1974 authorized the U.S. Department of Transportation (DOT) to declare, issue and enforce hazardous material regulations for all modes of transportation. These regulations (contained in Title 49 of the Code of Federal Regulations (CFR)), cover the safety aspect of transporting hazardous materials including the packaging, repackaging, handling, describing, labeling, marking, placarding and routing of such materials.

The commercial transportation of small quantities of some materials is subject to fewer regulations due to a lower risk hazard. These lower volumes are commonly transported by pest control businesses and farmers. The DOT rules for transporting chemicals can be found in 49 CFR part 173.6, and requires drivers to have knowledge of this regulation including the quantity limitations that apply, packaging, marking, and labeling requirements.

If transporting any (1) Hazardous material that requires placarding or, (2) More than one liter of a "material extremely toxic by inhalation", the material must be registered with the Nevada Department of Motor Vehicles. Hazardous material training is required for transporters of "reportable quantities" of these materials.

The Nevada Department of Agriculture does not enforce DOT requirements. Questions regarding the procedures and regulations for transporting and handling pesticides and about shipping documents, manifest and reportable quantities (as they vary by active ingredient), should be directed to the U.S. DOT, Nevada DOT, Nevada Highway Patrol or chemical supplier. Remember, it is the driver's responsibility to become familiar with these transportation regulations!

Mixing Pesticides Safely

The greatest chance of pesticide poisoning occurs when pesticide concentrates are being mixed and loaded. The concentrated form of many pesticides is relatively poisonous, even through simple absorption through the skin. Before handling a pesticide container, always read the pesticide label first to double check the PPE requirements. Then put on the correct protective clothing and other necessary equipment. Rubber gloves and eye protection should always be worn when mixing any form of pesticide concentrate. For very toxic materials, a respirator and face shield should be worn to prevent inhalation of the material and to prevent it from splashing onto the face. Each time a pesticide is to be used, carefully read the label directions before removing the material from the container or mixing it.

As a general rule, when mixing pesticides, fill the spray tank halfway, add chemical and then add remainder of needed water. This will aid in mixing the material. Be sure to accurately measure the proper amount of chemical according to the label instructions. All measuring utensils (spoons, cups, etc.) should be kept in the area where pesticides are stored and must be incrementally calibrated to match the measurements used on the label. In other words, for example, only use a measurement device with grams to measure the amount of grams needed, not the amount of ounces needed. These are two different units of measure and will result in an improper dilution ratio. These utensils should be thoroughly washed after each use and should never be used for other purposes.

To help prevent splashing onto the head, you should always keep your head well above the tank's fill hole. Do not spill or splash when filling the tank. Carefully fill the spray tank with the correct amount of water. Make sure the water hose does not contact the spray dilution when preparing it. This prevents contamination of the hose and avoids the possibility of back siphoning the dilution into the water source.

Some pesticides can be mixed together and applied as a single application. Charts are available that show the compatibility of different pesticides. Only those materials that

are fully compatible should be mixed together. Applicators should never mix herbicides with other types of pesticides.

In addition to following the label directions, follow the precautions outlined below whenever mixing or loading a pesticide:

- It is recommended that nitrile or similar gloves, a chemical resistant apron, goggles, and a respirator be worn when handling moderately toxic materials, even if the label does not specifically recommend their use.
- Work outdoors. Choose a place with good light and ventilation. If mixing or loading indoors, work in an area where there is good light and air circulation.
- When mixing or loading make certain any breezes blow fumes or dust away from you. Stand in the crosswind.
- When taking a pesticide out of its container, keep the container and pesticide below eye level. This will help prevent a splash or spill onto goggles or protective clothing. Do the same thing when adding or pouring any pesticide.
- Keep pets and people out of mixing and loading area. Although working alone is not advised when highly toxic materials are involved, especially at night.
- Do not tear open paper containers. Use a sharp knife to open them. Clean the knife afterwards, and do not use it for other purposes.
- Select an area for mixing and loading that will not contaminate any water supply. Be aware that some properties have wells. As a general rule to protect groundwater, mixing and loading operations should not occur within 150 feet of a well.
- Always keep an air gap between the fill hose and water in the spray tank to prevent back siphoning.
- Never leave a spray tank unattended while filling.
- If a pesticide is splashed or spilled on clothing while mixing or loading, stop work and remove contaminated clothing immediately. Wash affected skin thoroughly with soap and water and put on clean clothing.

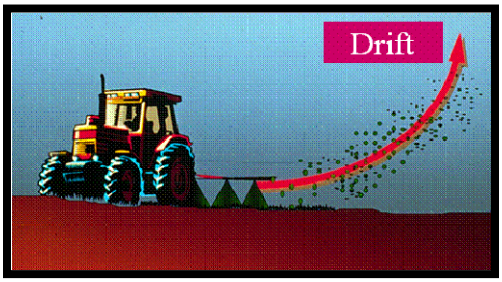
Applying Pesticides Safely

The most important safety “tool” is your head! Before applying any pesticide always **read the label** carefully. Become familiar with the potential dangers of the product to be used. Be sure any pest to be treated has been properly identified (e.g. insect, weed, disease, etc.). Make sure the site where the pesticide is to be applied (e.g. indoor, lawn, soil, right-of-way, etc.) or host plant or animal is listed on the label. Pesticides should not be applied unless they are actually needed.

Do not permit an irresponsible or careless person to handle, mix or apply any pesticide. They may cause harm to themselves or others. Some workers may not understand the instructions on labels; others may not care. **Ability and attitude are of equal importance in the safe and effective use of any chemical**. Again, it is strongly advised that applicators work in pairs when a highly toxic pesticide is being applied. Immediate assistance is then available if one of them becomes ill.

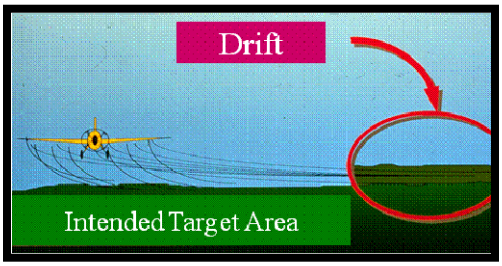
If two or more products are equally effective, select the least toxic material if possible. A county extension agent, university specialist, chemical manufacture representative, or chemical supplier can assist in selecting the proper pesticide product for a particular pest control need.

Wear clean clothing and use PPE as needed. Never eat, drink, or smoke when applying pesticides; do not even carry food or smoking items. Service vehicles are required to have some safety items on them. Carry fresh water, soap, and paper towels in a sealed container and keep container away from pesticide spray. These items can be used if chemical is accidentally spilled or drifted onto the skin.



Guard against drift from sprays or dusts. Drift can be reduced or controlled when applications are made when there is very little wind. Some chemicals (specifically fog and ULV applications) are capable of drifting for miles under certain conditions, the most important factors being wind velocity and direction.

People and animals can be severely injured or killed if directions are not followed. Cover all food, food preparation areas, dishes, and utensils when treating kitchens. Do not apply pesticides too close to ornamental ponds, especially ones with fish, or ponds used by wildlife. Where ponds are used for domestic water supply, be especially careful not to contaminate them.



Consider the safety of wildlife as well as humans, domestic animals, and plants when applying pesticides. When handled properly, pesticides can be used without endangering wildlife. Understand hazards associated with applying pesticides and their unintended affects on non-target organisms. Certain pesticides are not allowed to be applied to specific areas (e.g. some insecticides in granular form can not be applied to golf courses, because geese may eat them). Always read pesticide labels closely and obey any restrictions. Pay attention to your surroundings. Do not spray or let pesticides drift onto beds, clothing, electronics, children's toys, etc. When outdoors do not spray or let pesticides drift onto cloths lines, swamp coolers, vehicles, furniture, play areas, etc. By using the correct application equipment, keeping it in good condition and operating properly, unnecessary hazards to the applicator, crop, site, etc., can be avoided.

Fixing or adjusting equipment during application puts the applicator at greater risk of exposure. Always use the correct type of application equipment. For example, a powder intended to be dissolved in water should never be applied as a dust in a dust applicator. The label will explain what types of applications are permissible. **Herbicides should always be applied through separate application equipment! Some herbicide labels require it!** As an example of not following this rule, if a container contains enough leftover herbicide residue, and the container is used to hold an insecticide that is applied to a yard, the herbicide residue may be strong enough to cause serious damage to tress and shrubs. If the same equipment is used to apply different types of pesticides other than herbicides, the possibility of accidental injury to plants still exists. This risk can be reduced if the equipment is thoroughly cleaned with an approved product. The steps to clean spray equipment are:

- Clean the sprayer thoroughly by draining the tank, pump, hoses, and nozzles and flushing with water.
- Fill the tank with a mixture of water and household ammonia and let stand overnight. (Use 2 cups of ammonia for each 10 gallons of water.)
- Drain and flush with clean water.

Immediately following application and cleaning of equipment, applicators should wash thoroughly and change in to clean clothing. Any residue must be removed from the skin. Applicators that delay bathing and changing into clean clothing can become extremely ill from toxic residues on the skin or clothing. Because many EC's are petroleum based, always use a detergent when washing hands and clothing.

Safety Precautions - A review:

Recognizing the potential hazards of some pesticides, the responsible applicator will take every precaution to avoid adverse health or environmental affects. Keeping personal and environmental exposure levels to a minimum is a key part of reducing risk.

Since pesticides can be absorbed through the skin, it is important to shower at the end of each work day. Wash hands before eating, drinking, smoking, chewing tobacco or gum. Take care not to rub eyes or mouth during application, and because pesticides are absorbed very easily if they contact the genitals, wash hands before using the bathroom.

Never eat or store food in areas where pesticides are being applied or stored; the food could be contaminated.

Pesticide Spills

Even when proper procedures are followed, pesticide spills can occur. Knowing what steps to take in the event of a pesticide spill will allow for a quick and proper response. Remember: Always be sure to wear proper protective clothing when dealing with pesticide spills and to clean equipment and clothing when finished.

- **Control the spill:**

  Immediately after a spill, make sure the source of the spill has been identified and controlled to prevent further spillage.

  If a small container is leaking, it can be placed in a larger, empty, water tight container.

  Keep people and animals at least 30 feet upwind from spill. Avoid coming into contact with any fumes. As soon as possible call authorities for help and information on controlling the spill.

- **Contain the spill:**

  Contain the spill with a dike of soil, sand, or other absorbent material. It is particularly important to not allow chemicals to get into water, including storm drains, sewers, ditches, etc. Never hose down spills, as this will only spread the chemical.

- **Clean up the spill**:
  Use an absorbent material such as dirt, sand, clay, kitty litter or other commercially available absorbent material to soak up the spill. Shovel all contaminated material into a leak-proof container for proper disposal. A "spill kit" is required to be carried on each pest control service vehicle in Nevada.

NAC 555.425.2. Each service vehicle that is used in the custom application of pesticides must be equipped with:

(a) Clothing and equipment designed to provide protection against any pesticide carried on or in the vehicle;

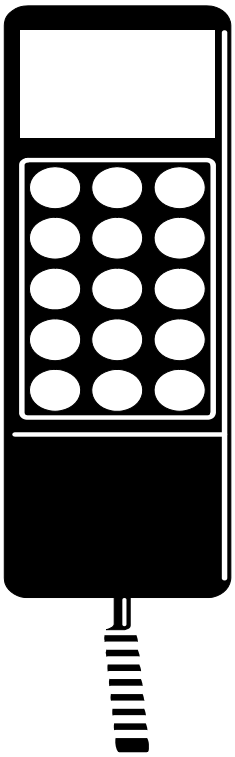
(b) Absorbent material capable of absorbing and containing more than 1 gallon of pesticide that has been spilled;

(c) Equipment designed to store safely materials contaminated with pesticide; and

(d) A sufficient quantity of potable water to wash skin exposed to pesticide.

Once the spill has been cleaned up, it may be necessary to decontaminate the area. Common household bleach is often an effective decontaminate. However, always read the label for specific decontamination directions.
For example, the directions for cleaning up spills on many synthetic pyrethroid labels state not to use bleach. Additional information about cleaning up spills can be found by contacting the pesticide manufacturer, dialing the emergency telephone number on the label, or by calling CHEMTREC at, 1-800-424-9300.

- **Call the authorities**:
  Pesticide spills or emergency dumps must be reported by telephone to the Nevada Department of Agriculture. In Northern Nevada spills can be reported at, 775-353-3716; in Southern Nevada report them to, 702-668-4570 (after hours leave a message).



NAC 555.410.2, & .3

Report by telephone within 24 hours to the Director or his or her designee:

(a) Any emergency dumps of pesticides by aircraft, and accidents of aircraft loaded with pesticides or ground equipment involving the spillage of pesticides; or

(b) The accidental spillage at sites of operations of more than 1 gallon of liquid or 4 pounds of dry weight of unmixed pesticides that are detrimental to persons, wildlife, domestic animals or crops.

Report by telephone to the Director or his or her designee within 48 hours any cases of apparent pesticide poisoning requiring medical treatment.

Spills involving large quantities of concentrated pesticides or pesticides mixed with oil or other hazardous materials should also be reported to the Nevada Division of Environmental Protection (NDEP), especially if there is a threat to human health or environmental contamination. To report spills to NDEP's Waste Management Division, call 775-687-4670. Also dial 911, and notify Nevada's Division of Emergency Management at 775-687-0300, and the Nevada Department of Agriculture in Northern Nevada at 775-353-3716, or in Southern Nevada at 702-668-4570 (after hours leave a message). CHEMTREC may be of some assistance in the event authorities are not reachable. They can be reached at 800-424-9300.

Federal law requires immediate notification of the appropriate agency of the U.S. government when oil or hazardous substances are discharged. Anyone who fails to notify an agency immediately of a discharge shall, upon conviction, be fined not more than $10,000 or imprisoned for not more than one year or both. Spills can be reported to the EPA's Western Region Headquarters. The telephone number to call in California, Nevada, Hawaii, and Arizona is 1-800-424-8802. Spills must also be reported to the National Response Center at 1-800-424-8802. When reporting a spill the following information should be given:

- name, address, and telephone number of person reporting;
- exact location of spill;
- name and address of company involved;
- specific pesticide or mixture spilled;
- estimated quantity of pesticide spilled;
- source of spill;
- cause of spill;
- name of body of water if involved, or nearest body of water to the spill area; and,
- action taken to contain and cleanup spill.

Storing Pesticides Safely

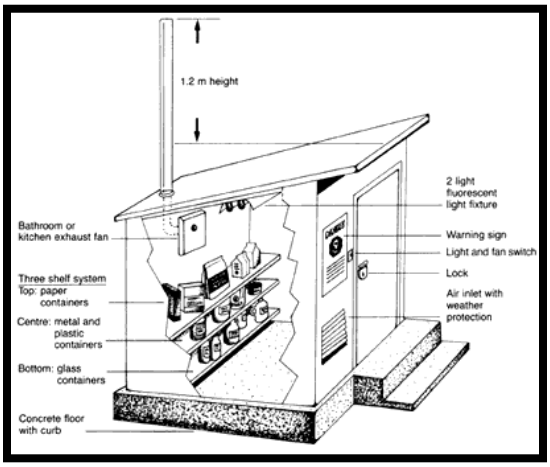
As soon as a pesticide is transported or delivered to a place of business, move it to a locked and posted storage area where children and untrained people cannot access it. Pesticides should never be stored in a garage, basement or home. Read the label for correct storage procedures.

If storing certain flammable, explosive, or extremely toxic pesticides (e.g. methyl bromide, anhydrous ammonia) that are above the **reportable quantity level**, to find out about placarding and additional storage requirements, the local fire department's hazardous materials division should be contacted. Often chemical fires cannot be extinguished by ordinary means and their smoke can be extremely toxic. The fire department must be properly prepared in the event of a fire involving a pesticide.

Site Selection:

When selecting a pesticide storage area several things should be considered. The site should be in an area where flooding is unlikely. It should be downwind and downhill from sensitive areas such as houses, schools, parks, and bodies of water. Also, the site should be located so that any accidental runoff or drainage will not contaminate any water source. Storage facilities should be located away from homes and livestock areas in case there is a fire or other problem.

Storage Area:



Store pesticides and pesticide containers in a separate building, room, or other secure enclosure where they can be kept cool, dry, and out of direct sunlight. Protect pesticides from extreme heat and cold which can cause excessive pressure and containers to break and leak, and contents to separate or breakdown.

To avoid cross contamination, herbicides should not be stored with other pesticides. This is especially true with the "broadleaf herbicides" or the chlorophenoxy herbicides (e.g. 2,4-D).

Sacks, cartons, and fiber boxes should be stored off the floor on wooden pallets or on shelves. The storage area should be securely locked. Weatherproof signs stating "Danger - Pesticides, Keep Out!", or similar warning should be hung over every door and window. In addition, the fire department may have specific posting/placarding requirements — Check with the fire department's hazardous materials division for specific requirements.

Storage areas need to have adequate ventilation to prevent the buildup of fumes. If possible, store pesticides in an area with a concrete floor free from drains. An adequate supply of detergent or soap, hand cleanser, and water are essential in the storage area. Water can be a quick first aid in a poisoning emergency.

A pesticide storage area should be used only for pesticides and pesticide equipment. Do not store pesticides near food, feed, fertilizers, seeds, veterinary medicines, or other stored products.

Always store pesticides and other chemicals in their original container with their label attached and lid closed tightly. Using food or drink containers (e.g. soda-pop bottles, milk jugs, fruit jars, or other types of non-pesticide containers) can have serious consequences. Small children as well as most adults associate the shape of a container with its contents. Consequently, a child or adult may be seriously poisoned or even killed if they drink a pesticide from an unmarked, secondary container.

Heavy or difficult to handle pesticide containers should be stored on or near the floor to prevent them from being dropped or falling. Extremely heavy containers should always be placed on floors, never on shelves. Containers should not extend beyond the edge of shelves or cabinets where they can be bumped, knocked off, or broke open.

Check containers frequently for cracks and leaks. If a crack or leak is found, transfer the contents to an empty container that originally held the same material. Otherwise, dispose of the contents in the manner prescribed on the product's label. Clean up spilled pesticide promptly and thoroughly using proper safety equipment during the cleanup procedure. Dispose of the pesticide waste in a proper manner.

Be sure that corrosive materials are stored and handled in containers designed for them. A corrosive material in the wrong type of container may corrode it and cause serious damage.

Pesticides in glass bottles should not be stored near heat. Glass containers can break or explode spreading their contents over a large area. Glass containers should be stored in cool, dry areas. It is also necessary to protect them from freezing. Always check the label carefully for proper storage information. Remember to consult the product label for specific storage information.

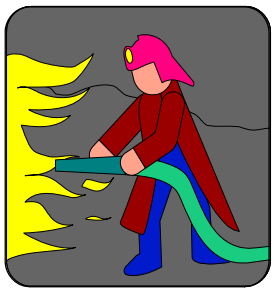
To insure container labels remain in good condition for long periods of time, protect them with transparent tape, or laminate them and reattached them to the container. Remember, the label is the most important item for using a pesticide safely. **Do not let it become damaged or destroyed**.

Keep an inventory of all pesticides and mark each container with the date of purchase. If a product has a specific **shelf life** recorded on its label, and the purchase date is written on it, the exact expiration date will be known. Using all of a product before its expiration date will keep it from expiring and prevent the need for disposing of leftover pesticides.

Do not buy more pesticide than needed. Remove only the amount needed for one day's operation, and be sure to reseal and return any unused pesticide and empty containers to the storage area at the end of each day. Do not leave empty containers in accessible areas. Keep all empty containers in a locked storage area until they can be disposed of properly.

Emergency information including phone numbers for the poison control center, nearest hospital, fire department, personal physician, etc., should be posted in a prominent location in the storage facility.

Pesticide Fires:



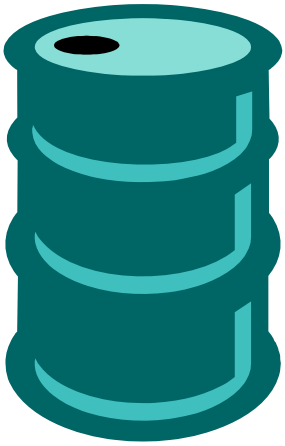
In the event of a fire, call the fire department and make it clear that pesticides are involved and provide information about them. Evacuate all personnel to a safe area upwind from the smoke and fumes. If a fire does occur and the amount of pesticide is small, it may be best to let it burn (this may be a very difficult judgment call that goes beyond the scope of this manual). To fight fires involving chemicals requires the use of a self-contained breathing apparatus because the smoke is often more toxic than the burning pesticide. A decision to fight a fire involving chemicals should be made with extreme caution. Bottles, drums, and aerosol cans are not vented and can explode. Use as little water as possible and contain runoff. Contaminated runoff can result in the most serious problem. Environmentally it may make more sense to let a fire burn instead of creating large amounts of contaminated runoff (again, this goes beyond the scope of this manual). If a water source is contaminated, inform the Nevada Division of Environmental Protection immediately.

Disposing of Pesticides Safely

Pesticide waste may include pesticide concentrate, leftover diluted pesticide, the empty pesticide container and rinsate from rinsing out equipment. A good way to dispose of leftover pesticide, pesticide concentrate, and rinsate is to simply apply it to a site approved by the label according to label directions. Unfortunately, if not applied it becomes waste. Disposal of pesticide waste is regulated by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Another federal law, Resource Conservation and Recovery Act (RCRA) regulates the disposal of "hazardous" pesticide waste. In Nevada, hazardous waste and disposal are regulated by the Nevada Department of Conservation and Natural Resources and Nevada Division of Environmental Protection.

Empty pesticide containers, discarded improperly, are potentially very hazardous. A number of deaths and illnesses, particularly among children, have resulted from contact with improperly discarded pesticide containers. An empty can or drum can attract a curious child or animal and should never be left where they can access them.

Disposal of Pesticide Concentrate:



There are only a few environmentally safe ways to dispose of leftover, unwanted or cancelled pesticides. Federal guidelines recommend highly sophisticated disposal techniques, or disposal in a federally approved hazardous waste landfill. Unfortunately, these recommended disposal techniques are not currently available in Nevada.

Avoid disposal problems associated with excess pesticides by purchasing only the amount needed for one season. Preventing a surplus of pesticides is the best way to avoid the future problem of disposing them — DO NOT STOCKPILE THEM; registrations are cancelled and changed, and new chemicals may be preferred over old ones. Mix only the amount of pesticide needed for a particular application. If too much is mixed, it can

be applied in the recommended manner to another site listed on the label. Unfortunately, it is sometimes not possible to avoid having unusable, damaged, or canceled pesticides in storage. It may be possible to use them by applying them according to label directions. However, if use of the product has been cancelled, it may have to be properly disposed of.

A pesticide in its original container can usually be returned to the manufacturer. Before returning any stored or cancelled pesticide contact the manufacturer to make sure they will take it back. If the manufacturer will not take it back, or it can not be disposed of properly, store it according to the label directions.

Some pesticides are classified as hazardous waste by the EPA. Pesticides classified as acutely hazardous wastes, or as toxic wastes are subject to strict EPA regulations.

A pesticide becomes a hazardous waste when it is no longer usable or is destined for disposal. An empty pesticide container destined for disposal is also considered a hazardous waste until it is triple or pressure rinsed. After which it can be disposed of as regular trash. Cleanup from spills, un-rinsed containers, unused rinsate, damaged products (separated or solidified emulsions, caked or hardened wettable powders, etc.) are all considered hazardous waste.

Waste Pesticide Collection Days:

The Nevada Department of Agriculture's (NDA) pesticide waste disposal program gives pesticide users the opportunity to properly discard unwanted pesticide products. This is a safe way to protect the environment from pesticide pollution and surface or groundwater contamination. Small quantities of unusable, unwanted and banned pesticides are collected by the NDA from homeowners, ranchers, farmers and commercial pest control operations. This is an excellent opportunity to dispose of unwanted or excess pesticides.

Acceptable products consist of insecticides, fungicides, herbicides, rodent baits or other pesticides. Fertilizers, batteries, motor oil, antifreeze, paint and any other "non-pesticide" product can be disposed of through the State of Nevada Recycling hotline: 1-800-597-5865. Call your local NDA office to make an appointment for pesticide drop-off.

Household Hazardous Waste collections are sponsored periodically by local disposal services. An example is Republic Services in Southern Nevada sponsors “Household Hazardous Waste Drop-Off Days.” At their North Las Vegas and Henderson waste collection centers. They accept up to 15 gallons of liquid or 40 pounds of hazardous wastes, per customer, during their drop off event. For more information view their website at www.republicservicesvegas.com.

Side note: Homeowners are allowed to dispose of up to 1 gallon of most liquid pesticides and up to 10 pounds of dry formulation through their regular trash service. To do this, the pesticide label (in the Storage and Disposal section) must not have any restrictions against it; the lid must be secured; and several layers of newspaper must be tie around the container. If empty containers are not properly rinsed, homeowners should handle them in a similar way.

Disposal of Dilute Rinsate Solutions:

Waste solutions from washing equipment, rinsing tanks and booms, surplus tank mixtures, and spilled pesticides must be disposed with minimal impact to the environment.

Follow these guidelines to minimize the amount of pesticide waste solution:

- Mix only enough pesticide for the acreage or site to be treated.
- If too much pesticide is mixed, try to find other label approved sites with the same pest problem and use up any extra tank mix or rinse water on these areas. Small amounts of surplus mixtures can be diluted and reapplied to the treated area. Be sure that the total application rate does not exceed the maximum rate for which the pesticide is labeled (this is usually not a factor when using up small amounts).
- Properly calibrate sprayer before filling with pesticide dilution.
- When triple rinsing containers, pour the rinsate into the spray tank.
- Before combining two or more pesticides, read the product labels carefully. Some pesticides are incompatible. If uncertain, perform a small-jar comparability test with the pesticide products you intend to mix.
- To avoid being faced with the disposal of a tank full of incorrect pesticide, double check the label and the job to be performed before selecting a pesticide.

Disposal of Pesticide Containers:

Pesticide labels normally provide some information on container disposal. Always comply with the label directions, as well as state and federal regulations. Regardless of the disposal method, all empty pesticide containers (except paper bags and sealed returnable containers) must be triple rinsed or pressure rinsed prior to disposal. Containers should be rinsed and punctured immediately after they are emptied (do not puncture or break glass containers or pressurized cans). Empty containers should never be stored for rinsing and puncturing at a later date. The pesticide will dry on the inside of the container, making it difficult to properly rinse the container. In addition, un-rinsed pesticide containers pose a threat to the environment. Studies have shown that up to 6½ ounces of some pesticide formulations (particularly flowables) can remain in an un-rinsed 5-gallon container despite the best efforts to empty it thoroughly.

Triple rinse all containers in the following manner:

- Empty the container in the spray tank and let it drain for 30 seconds.
- Fill the container one-fifth to one-fourth full of water.
- Close the lid and rotate the container. Overturn the container so the rinse reaches all sides and surfaces.
- Drain the rinse water from the container into the spray tank and let drain 30 seconds.
- Repeat the procedure at least two more times.
- Puncture plastic or metal containers to make them unusable.

Another option for large pest control operations is to pressure rinse empty containers. Pressure rinsing requires the use of a special nozzle that directs high pressure spray into the interior of the container. Using the rinsing nozzle, the applicator punctures the side of the container and rinses the container for 30 seconds, allowing the rinse water to drain into the spray tank. Pressure rinsing is much faster than triple rinsing and is more

effective. Studies have shown that pressure rinsing is 300 percent more effective than triple rinsing at removing residue.

Remember, rinsing containers immediately after they are emptied is important for two reasons: first, it keeps the product from drying on the inside of the container; second, it allows the rinsate to be placed in the spray tank.

Triple or pressure rinsing is impractical for paper containers. However, the bags may be cleaned out by vigorously shaking the paper container until it is completely empty.

Never reuse a pesticide container once it has been rinsed. Even rinsed containers will still contain some pesticide residue. Do not improperly dispose of empty containers, or allow them to accumulate in an easily accessible area.

Returnable containers are becoming ever more popular. These containers are sealed and once empty are to be returned to the dealer for refilling and reuse. Information about recycling them can be found of the product's label. Labels may contain special instructions on how to handle, store, and return empty containers.

The Pesticide Container Recycling Program:

Plastic from pesticide containers is a valuable resource that can be recycled and used as pesticide containers, pallets, waste drums, and other items. It is illegal to burn pesticide containers: *The open burning of any combustible refuse, waste, garbage or oil, or for any salvage operations, except as specifically exempted, is prohibited (NRS 445B.210).*

The agriculture industry in Nevada, including applicators and pesticide dealers, has expressed interest in developing a recycling program for Nevada.

The Nevada Department of Agriculture in cooperation with Interstate Ag Plastics (IAP) and the state's pesticide users came together to implement a convenient and effective container recycling pilot program.

Eligible containers consist of high density polyethylene (HDPE) 55 gallons and smaller, containers that held EPA registered pesticides, and containers that held surfactant and adjuvants.

For more information regarding the pesticide container recycling program, please contact the NDA at (775) 353-3715, or access the fact sheet at: http://agri.nv.gov/uploadedFiles/agrinvgov/Content/Resources/Fact_Sheets/2014-04-Pesticide%20Containers.pdf

Pesticide Use and the Environment

Although pesticides provide efficient control of insects, weeds, and diseases, they can also damage the environment under certain conditions. Anyone who applies pesticides should be aware of potential environmental risks and act to prevent problems. Pesticides can cause problems when they move off target through drift, move by soil runoff or erosion, run off into surface water, or leach through soil into groundwater.

Pesticides can also contaminate the environment as a result of improper storage and disposal. Careful management of pesticides must be a concern for all pesticide applicators and the public in order to prevent environmental contamination.

Pesticide Properties

A pesticide can move from the source of application in a variety of ways. How a pesticide moves, and what happens to it, depends on the properties of each individual pesticide. Some pesticides are absorbed by and held, or bind, to soil particles more tightly than others. Pesticide properties and soil characteristics, such as organic matter and clay content in the soil, influence the extent of adsorption.

Pesticides also differ in their ability to dissolve in water...or water **solubility**. In general, as water solubility increases, so does the likelihood of a chemical being moved by surface water runoff or leaching through the soil.

Some pesticides are more **persistent** than others; that is, they remain present and active in their original form for a long period of time before breaking down and degrading. The rate of **degradation**, or chemical breakdown, differs with each pesticide.

In some situations, a persistent pesticide may be desirable to provide long-term control (e.g. herbicide soil sterilant). However, with today's environmental concerns, pesticides which readily breakdown into harmless components are usually more desirable. A pesticide's persistence beyond the time it is needed is often undesirable and is usually referred to as **residue**.

An example of an undesirable effect of a persistent herbicide would be the unexpected long term control of weeds in someone's yard. After a year the homeowner prepares the soil to plant grass. However, there was carryover (i.e. residue) in the soil that prevented the newly planted grass from growing. The herbicide worked, but probably too well. That is, it did not degrade to a point where new grass could grow. If the applicator knew the homeowner was planning to plant grass in the treated area the following year, a lower application rate could have been used to achieve the desired weed control with no harmful residue left in the soil. The key to avoiding these problems is to read the label, communicate with the customer to find out their future intentions and to look for evidence of persistence before replanting a treated area. Sometimes long-term control is desired, in this case it would not be.

Pesticide Breakdown

When pesticides remain in the soil they often change in form and do not retain the same chemical composition they had when they were applied. Pesticides usually breakdown or degrade into different chemical components (especially soil applied pesticides).

The three major pathways for pesticide degradation are:

- **hydrolysis** (chemical reactions with water);
- **photolysis** (breakdown caused by exposure to sunlight); and,
- **microbial degradation** (breakdown through microbial action).

Pesticide Drift:

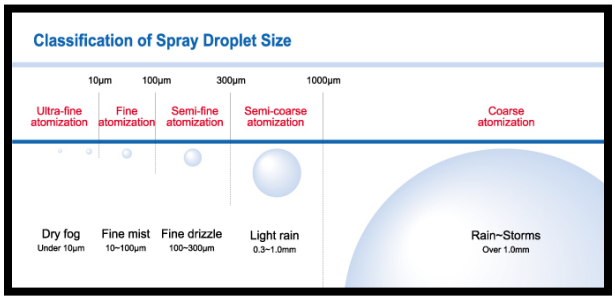
Studies have shown that a significant percentage of pesticides never reach the intended site of application because of misapplication, drift, or volatility (pesticide evaporation). It is impossible to totally eliminate particle drift or volatility, but it is possible to reduce them to acceptable levels.

Where significant drift does occur, it can damage sensitive plants (crops), pose health hazards, contaminate soil and water, and cause considerable friction between neighbors. Applicators are legally responsible for damages resulting from off-target pesticide movement.

Drift can be defined simply as the movement of a pesticide through the air to a non-target area. There are two types of drift: Particle Drift and Vapor Drift.

- **Particle Drift** refers to small spray droplets carried by air movement from the target area during application. Any pesticide applied with a sprayer is susceptible to particle drift.
- **Vapor Drift** refers to the movement of pesticide vapors from the target area. Some pesticides are "volatile" and can change from a solid or liquid form into a gas. As a gas or vapor, the pesticide may drift farther and for a longer period of time than spray droplets. Pesticides with a high volatility are most susceptible to vapor drift.

Factors Affecting Particle Drift:



The many factors that influence the amount of drift are discussed in the following sections. Of primary concern are **spray droplet size** and **wind velocity**. Although there are several other factors that can affect the off-target movement of a pesticide, most of the problems associated with drift can be avoided by paying close attention to the droplet size being produced by the sprayer and the velocity and direction of the wind.

Spray Droplet Size

The size of the spray droplets influences how fast they fall to the ground and how far they drift. Small, lightweight droplets fall very slowly and consequently will drift farther away from the target site. The diameter of a spray droplet is measured in microns; a micron is 1/1000 of a millimeter (The diameter of a human hair is approximately 50 microns.)

It has been shown that drops smaller than 150 microns are highly susceptible to drift under normal conditions and that the ideal range for general ground spray application is greater than150 microns (www.pesticidestewardship.org). See the pesticide label for drift management recommendations. The fall rate and lateral drift of different spray droplets is presented in Table 1.

As droplet size increases, the potential for drift decreases. Because of this, it is desirable to operate a sprayer so it produces the largest droplets while providing adequate coverage of the target area.

However, as droplet size increases, the volume of water required to give the same degree of coverage also increases. Most non-agricultural commercial applicators apply their pesticide dilutions from tanks with capacities less than 50 gallons. While large scale agricultural applicators use tanks of a thousand gallons or more. Smaller tanks minimize the amount of water that has to be transported.

In order to achieve adequate coverage of the target area with reduced volumes, especially with post emergence herbicides, it is necessary to equip a sprayer with nozzles that produce fairly small droplet sizes. These types of nozzles unfortunately increase the potential for drift, and illustrate one of the reasons it is critical to pay attention to factors affecting the amount of off-target pesticide movement.

Vapor Drift:

Pesticide formulations with high volatility have the ability to volatilize off treated areas and drift as vapors. Two major chemical formulations of 2,4-D, one of the oldest and most widely used herbicides, are **amine salts** and **esters**. The ester formulations of broadleaf herbicides containing 2,4-D may produce vapors that damage nearby non-target plants. Broadleaf herbicide amine formulations are essentially non-volatile and therefore pose very little risk of volatilization.

Temperature also influences the volatility of pesticides. The higher the temperature, the faster they volatilize. Research indicates that vapors from a highly volatile ester formulation of 2,4-D nearly tripled with a temperature increase from 60°F to 80°F. In addition, there was a corresponding increase in plant damage from the vapors as temperatures increased.

Drift may occur as particles during application or as a vapor as the pesticide evaporates. Some products must be applied as an “incorporated treatment” (mixed into the soil) with a drift retardant or “adjuvant” in order to reduce the risk of vapor drift. Labels often list plant species that are sensitive to drift and provide information on how to prevent drift.

Areas adjacent to the target site being treated with volatile compounds should be checked for sensitive plants and animals. The applicator should be aware of any open windows, overhead trees, fish ponds, clothes lines, play areas, swamp coolers, etc., near the application site. The applicator should also be aware of sensitive people near the area where a potentially volatile pesticide is to be applied and take precautions to avoid negatively impacting them and desirable plants and animals in the area. Inform them of the possible outcomes of the treatment, and if possible to stay 100 feet away from the application. This may require the use of a buffer zone.

Wind Velocity and Direction:

Wind speed is the major weather condition affecting drift. The greater the wind speed, the greater the drift. In general, wind speeds below five miles per hour (mph) pose very little drift hazard. In fact some pesticide labels require a minimum wind speed to avoid temperature inversions. Nearly all the spray particles will have a chance to deposit on the site before moving too far off. When wind speed increases above 5 mph, drift does become an important factor and must be considered. Generally, wind over 10 mph will control and carry virtually all smaller particles and will affect medium and large particles.

In general, winds are usually less just before sunrise and just after sunset. Air is usually the most turbulent during mid afternoon. Pesticides should not be applied when wind movement is toward an adjoining property. Buffer zones should be increased as winds increase.

Other factors that Affect Drift:

Several other minor factors influence the potential for drift. These factors should be considered when operating under conditions favorable for drift.

- **Physical properties of liquids** - The viscosity of a liquid is a measure of its resistance to flow. For example, mayonnaise is more viscous than water. As the viscosity of the liquid is increased, the droplet size of the spray increases. Thickening agents can be added to the spray to increase droplet size, thereby reducing the time a droplet is suspended in the air, thereby reducing the chances of it drifting.

  In addition to thickeners, a number of drift control agents are now available that reduce the potential for drift. They include foam additives, invert emulsions, and others. Research with ground sprayers indicated that the addition of a spray thickener reduced spray drift by 66 to 90 percent. However, some post-emergence herbicides require small droplets for optimum performance, so techniques that increase the droplet size of an herbicide, may reduce weed control. Always follow the label directions regarding the use of any spray additive.
- **Air stability** - Air turbulence is influenced by the temperature at ground level and the temperature of the air above it. When the air near the soil surface is warmer than the air above it, the warm air rises and the cool air settles, resulting in a gentle mixing of the air. This condition occurs early in the morning and in the early evening and these are the best times to apply pesticides since any pesticide released into the atmosphere will disperse slowly and more predictably.

  As the temperature near the soil increases, the hot air rises faster and mixes more rapidly with the cooler air above. This rapid movement of air can cause windy conditions. These conditions can occur during mid-day causing wind speeds to exceed 10 mph.

  A temperature inversion is the “abnormal” situation where cool air is trapped near the surface under a layer of warm air. Temperature inversions often occur early in the morning. A temperature inversion allows very little vertical mixing of the air. Damage from spray drift is most severe with temperature inversions since small spray droplets and vapors

will remain suspended in the cool air for prolonged periods and move laterally away from the application site where they finally come to settle-off site.

- **Humidity and Temperature** - Low relative humidity and/or high temperature, increases the evaporation rate of water-spray droplets thereby shrinking them before they settle. Evaporation reduces the size of the spray droplets, thereby making the smaller droplets more susceptible to drift. Droplets greater than 150 microns are not significantly affected by evaporation.
- **Method of Application** - Spray drift is usually greater from aerial applications than from ground applications. Low-pressure ground sprayers usually produce larger spray droplets that are released closer to the target than aerial sprays. Irregular air movements around the fixed wing of airplanes or the rotary blades of helicopters also increase the potential for spray drift.

Table 1. Influence of Droplet Size on Potential Distance of Drift (droplet falling 10ft in 3 mph wind)

Type of Droplet	Diameter (in microns)	Time required for droplets to fall 10 ft.	Lateral distance traveled by droplets[1]
Fog	5	66 minutes	3 miles
Very fine spray	20	4.2 minutes	1,110 feet
Fine spray	100	10 seconds	44 feet
Medium spray	240	6 seconds	28 feet
Coarse spray	400	2 seconds	8.5 feet
Fine rain	1,000	1 second	4.7 feet

For ground application equipment with boom sprayers, keep booms mounted as low as possible to diminish effects from the wind. Do not adjust the boom lower than the recommended height for the nozzle type being used. Flat fan tips are available in several nozzle angles. Using a wide-angle tip allows the boom to be placed closer to the ground, therefore reducing the potential for drift. (Nozzle types will be examined in greater detail beginning on page 99.)

The two major factors that influence spray droplet size are **nozzle type** and **spray pressure**.

The type of nozzle used will determine the size of the spray droplet at various pressures. The “flood nozzle” tends to produce slightly larger droplets than the “flat fan”, while the flat fan produces slightly larger droplets than “hollow cone” types.

In a given nozzle type, a nozzle with a smaller output rating will produce a greater number of smaller droplets when operated at equivalent pressures than a nozzle with a higher output rating. Drift potential can be decreased by using nozzles which produce larger droplets, but this will require higher spray volumes (i.e. more gallons of spray dilution).

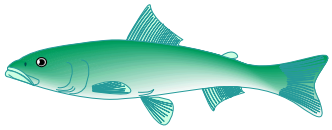
Spray pressure influences the size of droplets formed by the spray nozzle. Increasing spray pressure will cause nozzles to increase the production of smaller droplets that are more susceptible to drift. Inversely, decreasing spray pressure will cause nozzles to produce larger droplets that are less susceptible to drift. It is important to use pressures within the guidelines of a particular nozzle type. Operating outside of the suggested

pressure range may not only produce the wrong droplet size, but may also distort the spray pattern, resulting in non-uniform coverage. Table 2 shows the affect of spray pressure on droplet size produced by several types of nozzles.

Table 2. Influence of nozzle type and spray pressure on droplet size (diameter in microns, "µ")

Nozzle type	Spray Pressure (pounds per square inch, "psi") 15psi	30psi	40psi
Flat fan	239µ	194µ	178µ
Flood	289µ	210µ	185µ
Hollow cone	228µ	185µ	170µ
Whirl chamber	195µ	158µ	145µ
Raindrop	506µ	358µ	310µ

Pesticide Effects on Wildlife



Since the 1800's, the landscape of Nevada has changed dramatically. Fish and wildlife have suffered as their natural habitats disappeared and the quality of their environment declined.

Nevada's wildlife find shelter and food around the many lakes, streams, forests, ravines, and meadows across the state.

The fate of wildlife should concern everyone. As native American Indian Chief Seattle stated in 1854: "*What is man without the beasts? If all the beasts were gone, man would die from a great loneliness of the spirit. For whatever happens to the beasts, happens to man*". In effect, wildlife is an "environmental barometer". Their presence or absence tells us about the quality of our environment.

Pesticides can affect wildlife in many ways. Some chemicals are toxic enough to directly kill wildlife. Others may weaken animals to the point they become more susceptible to disease, exposure to harsh weather, or predation. Herbicides can affect available habitat by killing vegetation and insecticides can reduce the amount of food needed by insectivores.

Birds appear to be more sensitive to commonly used pesticides than mammals. The increased use of agricultural chemicals near wetlands and on golf courses has been blamed for declines in waterfowl populations in some of these areas.

Fish are also affected by agricultural chemicals. In Nevada, some of the most sensitive fish include the Woundfin and Virgin River Chub, both are found in Clark County.

Chemical Hazards:

Insecticides are generally more toxic than herbicides to wildlife. Few acute or chronic effects on wildlife are currently known to be connected with herbicide use. The organophosphate, carbamate and synthetic pyrethroids are the most commonly applied types of insecticides. The organophosphate and carbamate pesticides kill insects by damaging their nervous system, and can kill wildlife in the same way. The synthetic pyrethroids also affect the nervous system. However, the pyrethroids have low to medium toxic effects on birds and mammals, but are extremely toxic to fish.

Wildlife can be exposed to chemicals by eating contaminated food, drinking contaminated water, breathing them in, absorbing them through their skin, or by swallowing them while grooming. Young birds can die from insecticides by eating or being fed insects that have been treated. If an animal, including a bird, dies from an exposure, this is called a **lethal effect**.

Insecticides can also damage the central nervous system of wildlife in such a way that the animal does not die, but shows abnormal behavior affecting its ability to survive or reproduce. This are called a **sub-lethal effect**.

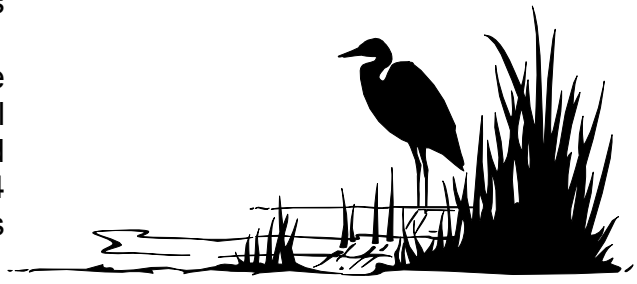
Insecticides can also affect wildlife indirectly by killing the insects wildlife feed on. Insects are very high in protein. Protein is necessary for young birds to grow. The growth of young birds, such as ducklings, can be stunted in areas where insecticides are heavily used.

Fish also feed on insects, as well as very tiny aquatic animals called zooplankton. Some scientists believe that fish may also show signs of stunted growth in areas with heavy insecticide use because of reductions in both aquatic insects and zooplankton. This reduction in food supply can affect fish reproduction because the number of eggs a fish produces is directly related to its size and health.

Some pesticides breakdown slowly and may persistent in the environment for long periods of time. Over time these pesticides can build up to toxic levels in the bodies of organisms that consume them over time. This process is referred to as **bioaccumulation** or **bioconcentration**. Many of the chlorinated hydrocarbons (DDT, heptachlor, chlordane) are both persistent and accumulative; these combined properties account for environmental problems associated with their use. As a result, many years ago EPA canceled the use of most chlorinated hydrocarbons.

Pesticides and the their breakdown products can build up in the food chain. A **food chain** describes the sequence whereby an animal feeds on a particular food source and is in turn eaten by another animal and so on as we go up the food chain. Food chains emphasize levels of feeding by describing a pattern through which energy is transmitted from producers (e.g. plants) to primary consumers (e.g. grazers and browsers) to secondary consumers (e.g. predators) to decomposers (e.g. bacterial). At each succeeding level, an animal normally eats a number of individuals from a “lower level”. In an ecosystem single food chains never occur. Instead, a **food web** more accurately describes how different organisms feed at many different levels on many different types of food. In any ecosystem many food chains are linked together and intersect each other to form a complex network called a food web. An accumulation of pesticides and their breakdown products can, therefore, become increasingly concentrated as they move up the food chain; this process is referred to as **biomagnification or bioaccumulation**.

For example, a study of DDT residue in the soil showed concentrations of 10 ppm. After the soil was consumed by earthworms the level increased to 141 ppm in the worms and then increased to 444 ppm in robins that ate the worms. (DDT was banned by the EPA in the 1970's.)



Application Hazards:

Any application method or farming practice that allows considerable drift or runoff is potentially harmful to wildlife. Insecticides aerially applied near wetlands will contaminate them to some degree. In 1987, an aerial application of ethyl parathion, an organophosphate insecticide, to sunflower fields adjacent to wetlands in North Dakota led to the death of 96 percent of the mallard ducklings in the wetlands. When the pilot was instructed to avoid these areas, no deaths occurred.

Granular insecticides left on the surface of a treated area (such as a golf course) may be attractive to birds. Some birds can die from swallowing even a single granule of some insecticides.

By following the best management practices outlined in this study guide and the pesticide label use directions, pesticide impacts on wildlife can be minimized. If applying pesticides near ornamental ponds, wetland, or other wildlife habitat, consider the following strategies:

- Avoid contaminating ornamental ponds and wetland areas when treating. Instruct applicators to avoid treating these areas or other natural areas if they do not need to be treated.
- When considering what type of pesticides to use, choose those that pose the least hazard to wildlife. When applying pesticides near ornamental ponds, avoid using pyrethroids where there may be runoff into the water. Pyrethroids are a good alternative in upland areas away from water because they have low toxicity to birds and mammals.

Pesticide Effects on Non-target Organisms:

The effects of pesticides on non-target organisms may involve direct and immediate injury, or may be due to the consequences of prolonged environmental pollution. The effects of pesticides on non-target plants, livestock, bees and other wildlife will be discussed in the next section.

Effects on Non-target Plants:

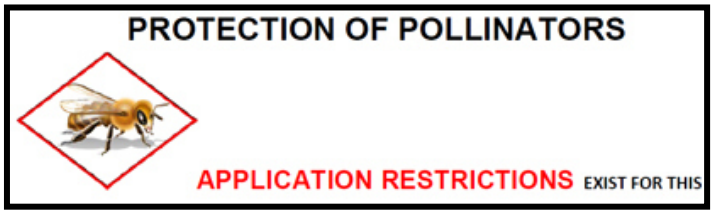
Nearly all pesticides can cause plant injury, particularly if they are applied at concentrations or rates that are too high, applied at the wrong time or under unfavorable environmental conditions. **Phytotoxicity** is simply defined as plant injury caused by exposure to a chemical; phytotoxic injury can occur on any part of a plant, such as roots, stems, leaves, flowers, or fruits.

Many injuries caused by phytotoxicity are due to herbicides that persist in the soil. These residues can remain from one year to the next at concentrations high enough to damage succeeding crops. Damage to plants in adjacent spray areas is primarily due to drift, although it may sometimes be a consequence of surface runoff, particularly from sloping areas.

Effects on Bees:

Because bees are important pollinators of flowers and many fruit, vegetable and field crops, applicators need to be aware of bee activity when applying insecticides (and in some cases herbicides). Preventing bee loss is the shared responsibility of the applicator, farmer, and beekeeper. Before applying pesticides that are toxic to bees, notify commercial beekeepers in the vicinity not more than 72 hours and not less than 24 hours before the application. This will allow beekeepers time to protect or move their bee colonies. Applicators applying pesticides labeled as toxic to bees must follow the "Nevada Bee Rule". See the laws and regulations section at the back of this manual for more information on protecting bees. The unintended poisoning of bees can be minimized by being aware of and practicing these principals:

- Read the label and follow label recommendations.
- Determine if bees are foraging in the target area so that protective measures can be taken.
- Apply chemicals in the evening after they have finished foraging for the day, or during early morning hours well before they begin foraging. Evening applications are generally safer than morning applications. If unusually warm evening temperatures cause bees to forage later than usual, delay the insecticide application until they are done foraging.
- Do not treat flowers, fruit trees, vegetables or other crops in bloom except when absolutely necessary.
- Whenever possible, use insecticides that are relatively non-toxic to bees.
- Choose the least hazardous pesticide formulation. Emulsifiable concentrates are safer than wettable powders; granules are the safest and least likely to harm bees.
- Minimize drift of pesticide products on to beehives or to off-site pollinator active habitat.
- Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewarship web site at:
  http://www.epa.gov/opp00001/ecosystem/pollinator/index.html
- Pesticide incidents should immediately be reported to the Nevada Department of Agriculture. Bee kills should also be reported to the National Pesticide Information Center at: www.npic.orst.edu.



Effects on Beneficial Insects:

Beneficial insects, other than bees, can also be harmed by pesticides. Despite the fact that some insects are valuable allies in keeping pest populations below damaging levels, their importance is often overlooked. When pesticides are applied, beneficial insect populations are often reduced along with pest populations.

Effects on Livestock:

The most frequent cause of livestock poisoning by pesticides is contamination of feed, forage and drinking water. This is often the result of simple carelessness. Great care must be exercised when applying in and around dairy barns, corrals, feed lots, etc. Do not contaminate any feed by spraying or drifting onto it, or placing poison baits in it. Make sure the pesticide is labeled for application in and around livestock areas.

Potential effects on livestock are numerous and usually result from improper transportation, storage, handling, application, disposal, and a simple lack of attention by the applicator.

Protecting Wildlife and Endangered Species:

The Endangered Species Preservation Act was passed by Congress in 1966 and amended to the Endangered Species Act (ESA) in 1982. The U.S. Fish and Wildlife Service and the National Marine Fisheries Service are the designated federal agencies that are responsible for administering the law.

The ultimate goal of the ESA is to maintain the natural diversity of plants and animals and the ecosystems upon which they depend. As of 2010, the U.S. Fish and Wildlife Service endangered species list contained more than 1,060 species of plants and animals. An additional 317 species of plants and animals are listed as threatened. Of these, 40 species of plants and animals are federally listed as endangered or threatened in Nevada.

Once listed as endangered or threatened, a species has full legal protection under the Endangered Species Act. All Federal agencies are required to undertake programs for the conservation of endangered and threatened species. They are prohibited from authorizing, funding, or carrying out any action that would jeopardize a listed species or destroy or modify its "critical habitat:" the limited area where an endangered species lives.

The ESA program is concerned about the impact pesticide use limitations or restrictions have on the people who use pesticides. To minimize these impacts, the EPA emphasizes lower pesticide application rates rather than complete prohibition of use in areas where endangered or threatened species and their habitats could be affected by pesticides. The use of lower rates reduces the exposure of endangered and threatened species to potentially harmful pesticides.

The program requires some pesticide manufacturers to place a generic statement on the label. This statement instructs the pesticide's users to determine if any use limitations exist by visiting the U.S. Environmental Protection Agency's Endangered Species "Bulletins Live" website, http://epa.gov/espp/. If use limitations are listed, the user is required to understand the information and adhere to its restrictions. The bulletins contain habitat location maps, which pinpoint species habitat locations. The maps can help pesticide users determine if a pesticide application has the potential to impact a threatened or endangered species. The EPA is working with U.S. Fish and Wildlife Service, U.S. Department of Agriculture, the Natural Heritage Program and state agencies to ensure the accuracy of the maps. Contact the Environmental Protection Agency's Endangered Species Hotline, 1-800-447-3813, to find out which counties nationwide are currently included in the program.

Because EPA's Endangered Species Protection Program is constantly changing, check regularly with the Nevada Department of Agriculture for changes in pesticide use

restrictions and to learn which bulletins are available. **Remember, if you use pesticides, you are responsible for knowing if an endangered or threatened species or their habitat may be affected by pesticide use in your area.** Read each pesticide label carefully, get the additional information you need, and then observe any necessary limitations that apply to endangered species or their habitats. When you fulfill your responsibilities as a pesticide applicator, you help ensure that the benefits of pesticide use outweigh the risks.

The Nevada Natural Heritage website, http://heritage.nv.gov, lists all the endangered and threatened species in Nevada. Check the website regularly for updates. Endangered and threatened species are also protected in Nevada by the Nevada Revised Statutes (NRS) 501 Fauna (animals), NRS 527 Flora (plants) and the Cactus and Yucca Law (with the exception of the Warner sucker in Washoe County, which is not listed by the state of Nevada).

Protecting Groundwater

Groundwater is the source for well and spring water. Water is present at some depth beneath every point of the earth's surface. Below the land surface, water occurs in one of two general regions, the unsaturated zone above, and the saturated zone below the water table. The dividing line between the saturated zone and overlying unsaturated zone is called the **water table**. Ground water is usually defined as the water within the saturated zone. The geologic formation through which groundwater flows is called an aquifer. An aquifer can be defined as groundwater flowing through a layer of sand, gravel, or other soil materials, or a section of bedrock with fractures that can transmit significant quantities of water under natural hydraulic pressure.

Why Groundwater is Important:

Groundwater is widely used for household and other water supplies. Approximately half of the population in the United States relies on groundwater for drinking water, and more than 90 percent of rural residents obtain their water from groundwater through wells or springs.

There are good economic reasons for this widespread dependence on groundwater. In its natural state, the quality of groundwater is usually excellent and can be used with no costly treatment or purification. It can be inexpensively tapped where it is needed, thereby saving the cost of piping it long distances. In addition, costly storage facilities such as water tanks and towers are not needed. Surface water on the other hand usually requires storage, transport and treatment. This can not be achieved without expensive and sometimes difficult to manage technical resources. For rural residents who rely on individual wells, groundwater is often the only available water supply, and for many communities it is by far the least expensive option for public water.

Consumption of groundwater is increasing at twice the rate of surface water. This trend is expected to continue as future demands for water increase. Replenishment of aquifers and groundwater, or **recharge**, may be a very long term process but abstraction of water from these important resources can happen very quickly. When the volume of water removed from aquifers and groundwater exceeds the rate at which they can recharge the process becomes unsustainable. The recharge rate for some aquifers is generally so long that the water is considered to be a nonrenewable resource with respect to current rates of

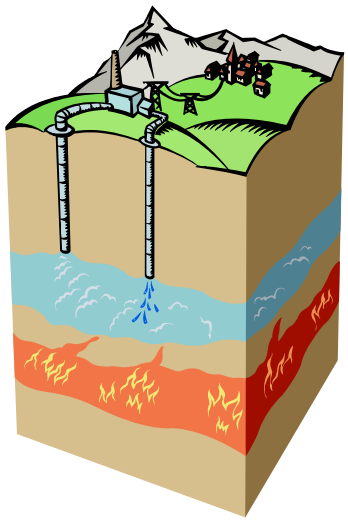
human utilization. Protecting the quality of existing and potential future groundwater supplies is of vital importance to the continued existence of all terrestrial populations, especially human populations. Aquifers are generally being depleted by the human population and fresh-water aquifers with limited recharge can be easily over-exploited or contaminated.

Traditionally, groundwater has been assumed to be a relatively pristine source of water, cleaner and better protected than surface water supplies. Although nitrate and bacterial contamination were known to occur in some locations, groundwater was thought to be immune from more serious forms of pollution such as industrial discharges, hazardous waste dumps, or leaching of pesticides from urban and agricultural areas. Within the past decade however, a variety of pesticides and other synthetic and organic compounds have been discovered in our nation's groundwater; often at concentrations far exceeding those in surface water supplies. Such discoveries have led to a new understanding of the link between what we do on the land and what we find in groundwater. Pesticides and agrochemicals like fertilizers used, spilled or improperly disposed of by farmers and homeowners, and poorly constructed septic systems are examples of how chemicals can impact groundwater quality.

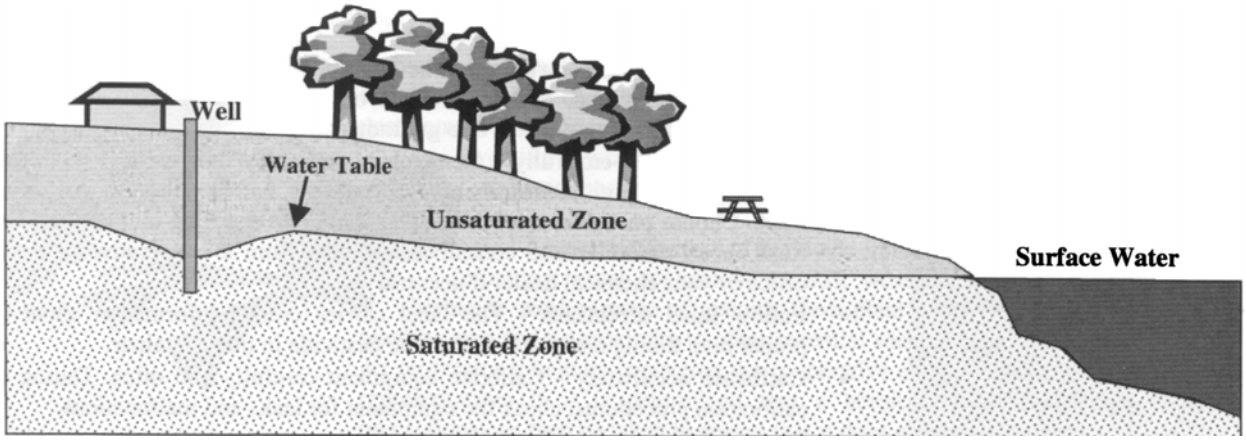
Where Groundwater Comes From:

If water on the surface is not taken up by plants, evaporated, or held tightly in soil pores it will gradually enter the soil by percolating through it. This percolation will continue until the water reaches the groundwater. In drier areas this process can take decades. Water accumulation in large confined aquifers is the product of thousands of years of accumulation. The process of water percolating through soil down to groundwater and accumulation in the water table is called **recharge**. Recharge water passes downward through the root zone and unsaturated zone until it reaches the water table. Effective programs for protecting groundwater focus primarily on the recharge processes since this controls both the quantity and quality of water reaching the saturated zone. Water is far easier and less expensive to manage on the surface than it is underground.

The rate of recharge in any particular location depends on the amount of precipitation, irrigation, soil type, topography, geology, and human impact. Seasonal fluctuations and human impact can greatly affect the rate of recharge, which in turn affect water table depth. In wetter areas in the winter and early spring, when plants are not yet using much water, the water table may be close to or at the ground surface. Evidence of this includes wet basements and saturated agricultural fields that can not be cultivated. As the summer progresses, the water table commonly drops, because evaporation and plant uptake exceeds recharge. During dry periods this drop may cause water shortages in shallow wells, as well as the drying up of some springs, wetlands, and streams.



Both the quantity and quality of groundwater depend on recharge water that continually filters down through the soil to the saturated zone. Any chemicals on the ground surface or introduced into the soil can become groundwater contaminants if they are carried downward by recharge water.



How Groundwater Moves:

Groundwater does not typically consist of large underground lakes, rivers or streams. Rather, it is water that moves slowly through irregular spaces within rock fractures or between particles of sand, gravel, or clay. Whereas water in a stream may move several feet per second, groundwater may move only a few feet per month or even per year. The major exception to this general rule is in limestone areas, where groundwater may flow rapidly through large underground channels and caverns.

The geologic formation through which groundwater moves is called an **aquifer**. This can be a layer of sand, gravel, or other soil materials, or a section of bedrock with fractures through which water flows. Randomly drilling a hole into the ground in many parts of the country will yield some water. Only major aquifers will have sufficient flow to maintain community water systems or large irrigation wells. The quantity and quality of recharge received by aquifers depends on their depth from the ground surface, geology of overlying materials, climate, land uses, and water and chemical management practices in recharge areas.

Recharge water moves downward through the soil until it reaches the water table. Once in the aquifer, it then travels in a more horizontal direction, at which time it flows into wells. Eventually, groundwater resurfaces, producing springs, streams, wetlands, or other surface water bodies. Groundwater becomes contaminated when recharge water carries pollutants downward to the water table. Once in the saturated zone, these chemicals move with the groundwater, forming a region of contaminated water called a **plume**.

Leaching:

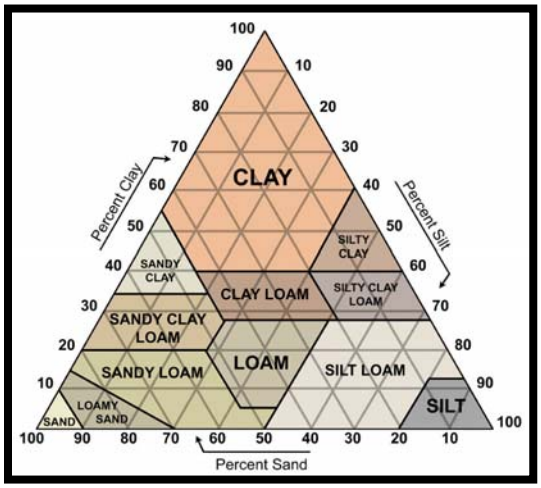
We now know that some pesticides do reach groundwater by moving through the soil. For a pesticide to leach into groundwater, it must move down through the soil and resist breakdown to nontoxic compounds. Pesticide movement into groundwater is generally not a common occurrence. Three factors determine whether a pesticide is likely to reach groundwater:

- pesticide characteristics,
- soil properties,
- environmental conditions.

Pesticide Characteristics:

- **Solubility:** As water moves downward through the soil, it carries with it water soluble chemicals. This process is called leaching. In general, highly soluble pesticides have the ability to leach through the soil to become groundwater contaminants.
- **Adsorption:** Weak attraction of a pesticide to the outside of soil particles may allow it to move through the soil. (In other words, if the bond between a pesticide and a soil particle is weak, it will allow the pesticide to be pulled off the soil particle and moved downward with the water into the water table.)
- **Persistence:** The longer a pesticide persists, the greater the chance it will leach into the groundwater.
- **Volatilization:** If a pesticide is highly volatile, the greater the chances it will evaporate into the atmosphere rather than being available to leach through the soil.

Soil characteristics:



- **Texture and structure:** Soil texture is determined by the relative proportions of sand, silt, and clay. In sandy soils, percolating water moves faster and there are fewer binding sites available for adsorption of dissolved chemicals. Although pesticide movement is more likely in sandy soils, leaching may still occur in clay soils. Small amounts of pesticides may move through natural cracks, worm holes, and root channels. These are referred to as **macropores**.
- **Organic Matter:** Soil organic matter influences how much water a soil can hold, and how well it adsorbs pesticides. Increasing the soil organic content, increases the soil's ability to hold both water and dissolved pesticides in the root zone where they will be available to plants.
- **Depth to groundwater:** The shallower the depth to groundwater, the less soil there is to act as a filter. With fewer “filters” there are fewer opportunities for pesticide degradation or adsorption. Extra precautions need to be taken to protect groundwater in areas where it is near the surface.

- **Geology:** In addition to the depth to groundwater, it is important to look at the permeability of the geologic layers between the soil and the groundwater. Highly permeable areas, such as gravel deposits, allow water and dissolved pesticides to freely percolate downward to groundwater. On the other hand, layers of clay are much less permeable and thus inhibit the downward movement of water.

Consequences of Groundwater Contamination:

Once groundwater is contaminated, fixing the problem is difficult or not possible and may be prohibitively expensive. For example, in 1979 the pesticide aldicarb was found in Long Island's groundwater. Since then over $3 million has been spent measuring Aldicarb concentrations in Long Island wells. Carbon filtration units had to be installed in over 2500 affected households, and plans are being made to replace individual wells with expensive community water supply systems. These huge expenses simply treat the water supply, but do nothing to correct the groundwater contamination problem.

Another unfortunate consequence of groundwater contamination is restrictions placed on pesticides found in groundwater, or their outright cancellation. This can be a major inconvenience to those who rely on certain pesticides. For example, Aldicarb can no longer be used on Long Island or in parts of California, Florida, Massachusetts, New Jersey, and Wisconsin. Other compounds, such as DBCP and EDB, have been removed completely from agricultural use after their discovery in groundwater. Due to groundwater contamination in several parts of Nevada (Reno and Las Vegas metropolitan areas) use restrictions on pesticides containing atrazine, simazine, alachlor, diuron, prometon tebuthiuron, and metolachlor may occur due to their detection in groundwater.

Cleaning pesticide contaminated groundwater is often impossible. Water may remain contaminated for many years. Pesticide degradation in groundwater tends to be quite slow because of cold temperatures and low microbial activity. The slow movement of groundwater means that it may take many years for the contaminate water plume to flow past affected wells. Even determining what wells will be affected and for how long is difficult necessitating the need for long-term monitoring to insure drinking water safety. Clearly, the best solution is to keep pesticides and other contaminants out of groundwater through careful planning, use, storage, and disposal practices.

Pesticide Contamination of Groundwater:

Between 1950 and 1980, production of synthetic organic pesticides more than tripled in the United States, from about 400 million pounds in 1950 to over 1.4 billion pounds in 1980. Although not much testing for pesticides in groundwater has been done, recent tests have shown a few pesticides to be significant contaminants. At least 25 pesticides have been detected in groundwater, and up to 80 have the potential to leach into it.

Most rural families and those in farming communities rely on individual wells that are untreated, unmonitored, and often located near fields where pesticides are applied. Water leached through these fields may contain pesticides that end up in a drinking water supply. Fortunately not all pesticides leach through soil; and certainly not all wells on farms are contaminated. An understanding of what causes these differences is crucial in protecting the quality of rural groundwater supplies.

What pesticides will leach, and in what quantities, depends in part on the amount applied (usually measured in rate per acre per year), the solubility of the compound (how

strongly it is held by the soil), and how quickly it breaks down in the root zone. Before the 1940s most pesticides were compounds derived from arsenic, mercury, copper or lead. Although some of these compounds may have made their way into drinking water, they were not highly soluble. Residues ingested in contaminated fruits and vegetables were of far greater concern. Synthetic organic pesticides were introduced during World War II and were thought to be far safer and more effective. These included chlorinated hydrocarbons such as DDT, aldrin, dieldrin, chlordane, heptachlor, lindane, endrin, and toxaphene. Because of their low solubility in water and their strong tendency to chemically attach to soil particles, these compounds have rarely contaminated groundwater. Although when introduced, they were thought to be safe for humans and the environment, it was later discovered that they accumulated in the environment in toxic concentrations. Use of most chlorinated hydrocarbon pesticides were canceled many years ago.

One group of insecticides that have replaced the chlorinated hydrocarbons is organophosphorus compounds. One example is malathion; others include diazinon and chlorpyriphos. Although some organophosphorus compounds are highly toxic to humans, they generally breakdown rapidly in the environment and rarely have been found in groundwater. Another group that has replaced the chlorinated hydrocarbons is the carbamate pesticides. The carbamate group includes the insecticides sevin, oxamyl (a Restricted Use Pesticide) and carbofuran (a Restricted Use Pesticide). These compounds tend to be soluble in water and weakly adsorbed to soil particles. Consequently, if not degraded in the upper soil layers, they have a tendency to migrate to groundwater. The most significant occurrences of groundwater contamination in the U.S. have been with the carbamate pesticides.

After a pesticide is applied to a target site, it may meet a variety of fates. Some may be lost to the atmosphere through volatilization (evaporation), carried away with surface water runoff, or broken down by sunlight (photodegradation). Pesticides that enter the soil may be taken up by plants, degraded into other chemical forms by biological organisms (biodegradation), or leached downward, possibly to groundwater. The remainder is retained in the soil and continues to undergo degradation. How much and how fast degradation occurs depends on several factors, including:

- properties of the pesticide,
- properties of the soil,
- conditions of the site, and
- management practices.

Monitoring for Pesticides in Groundwater:

Water monitoring and data collection are vital tools used for tracking trends of pesticide contaminants in water. Monitoring data is used to determine the extent of and possibly the source of contamination. Appropriate management actions will be selected based on water monitoring data.

The Nevada Department of Agriculture is responsible for managing a water monitoring and sampling program. Objectives of sampling are to assess the occurrence of pesticides in shallow groundwater to provide decision makers with information needed to evaluate and manage pesticide application practices designed to protect drinking water resources, especially deep, potable groundwater. A network of pesticide sampling sites in urban and agricultural areas across the state is a critical element of the Nevada Department of

Agriculture pesticide management plan and is essential to help detect contamination in its early stages.

Water samples are collected from selected sites biannually. When a pesticide is detected during routine sampling events, confirmation samples will be collected during subsequent sampling events. Identifying the source of contamination is critical in order to select the appropriate response action and to identify contamination sources the Nevada Department of Agriculture works with agricultural producers, applicators, local organizations, land managers, and others knowledgeable of local pesticide use.

Preventing Groundwater Contamination - The Applicator's Responsibility:

Prevention is the best way to minimize groundwater contamination. Following proper application practices can make pesticide use more efficient and prevent groundwater contamination. The need, method and frequency of chemical control should be evaluated in the context of potential groundwater contamination.

Pesticides should only be used when and where necessary and only in amounts adequate to control pests. Using pesticides only when necessary and using only the minimum amount necessary for effective pest management will help to minimize potential groundwater contamination.

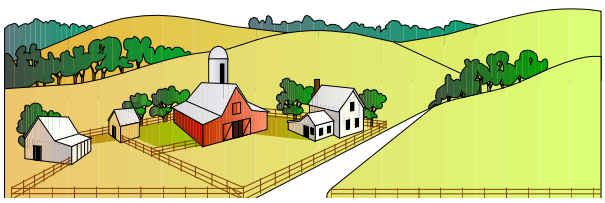
Multiple applications of the same pesticide to the same site have caused groundwater contamination in several locations in the U.S. Reducing the number of applications, reducing the amount applied, changing to a pesticide that is less likely to move through the soil, or using alternative methods of pest control can help minimize groundwater contamination. The susceptibility of the particular soil type to leaching should be determined prior to using pesticides with the potential to contaminate groundwater.

As previously explained, pesticides can reach groundwater by moving through the soil. Some pesticides move readily through soils that are well-drained, sandy, or low in organic matter. Sandy soils have low water holding capacity, support smaller populations of microorganisms that can break down pesticides, and lack clay and organic matter to bind with and hold the chemicals. Because of these factors, the possibility of groundwater contamination is greater when pesticides are applied to sandy soil than to any other soil type.

Pesticides should not be applied where they can reach ground or surface water sources. The closer the water table is to the surface of the soil, the greater the possibility of contamination. As an example, land near a marsh, stream, or pond has a water table near the surface.

Water table depth in Nevada's valleys range from less than a foot from land surface (LS) to well over 500 feet deep. The following are measured static water levels in Reno and Las Vegas during the Spring of 2000:

- Las Vegas (Boulder Hwy / Sahara) = 7.1 feet from LS. Water levels in Las Vegas area range from 22 feet from LS in the Northwest to 6.5 feet from LS at Boulder Hwy / Flamingo.



- Reno (Huffaker Park) = 10.08 feet LS. Water levels in the Reno area range from 51 feet from LS in the South end of the valley (near Mira Loma / SR 341) to 4.9 feet from LS at Reed High School, and shallower water levels at the UNR Ag Station (1.6 feet from LS).

To summarize, the most significant cases of groundwater contamination have involved carbamate pesticides. These compounds tend to be soluble in water and weakly adsorbed to soil particles. Carbamates have the ability to migrate to groundwater if they are not degraded in the upper soil levels. Another pesticide group, the organophosphates, generally breakdown rapidly in the environment and are rarely found in groundwater. Whenever possible, the pesticide applicator should select a pesticide that is less likely to leach into groundwater. To avoid run-off and the potential of pesticides entering groundwater, do not apply leachable pesticides to slopes, and be careful of clay soils which help to prevent pesticides from leaching through them, but not from pesticides running off the surface of them.

Integrated Pest Management

Understanding IPM

Integrated pest management, or as it is commonly referred to, IPM, is a comprehensive approach to pest control. IPM is considered as the "total science" of pest control. Prior to the mid 1960's, standard pest control practices consisted largely of applying pesticides during specific calendar dates to control anticipated pest outbreaks. This approach, combined with broadcast spraying, was used to perform "total pest control". Many decades of total pest control resulted in an environment which was disrupted by extensive pesticide use. Many of the pesticides used then were resistant to breakdown and persisted in non-target organisms such as birds, fish, etc. Total pest control practices also assisted in the evolution of pest populations which became resistant to the pesticides used to control them.

IPM is an informed approach to pest control which is supported by sound scientific research about insect biology, life history and ecology. It relies on combined strategies to controlling pest populations, rather than the haphazard spraying of pesticides at specific times, or randomly over the environment. The science of pest control has changed dramatically since the 1960's. Today we have a better understanding of the pests themselves, their life cycle, where they live, at what stages they cause damage, how and where they overwinter, etc. A better understanding of pest populations and the way they interact with one another and their environment aids in creating more effective and safer strategies to control them.

The "Pest Triangle"

The "pest triangle" is a model used to understand pest populations and their development. The triangle consists of three basic components: the pest, its food or host and the environment. When food resources and environmental conditions are favorable, infestations may develop (figure 1). In general, seeds of different species of plants are triggered to germinate after they are subjected to certain combinations of environmental conditions (usually light, temperature and moisture) specific to the species. For example, fungal spores which have remained dormant in turf grass all year will germinate when several calm, cool, moist nights occur in a row.

Fungi infest the host grass and continue growing and spreading until their environment or food source, or both become unfavorable. It is important to understand that if any part of the pest triangle is removed or controlled through management, the pest will be controlled or prevented from developing. Another example is cockroach control. When cockroaches are introduced into an environment that is warm, moist, with plenty of hiding places and where food is plentiful, the result will be a population explosion, but if no food is available, or they have no place to hide from predators, their numbers will not increase. This explains why many of the detrimental cockroaches found in homes and restaurants throughout Nevada do not live outdoors in our harsh climate or where predators are abundant.

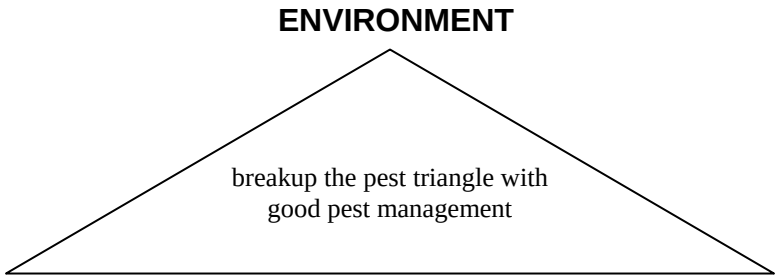


figure 1.

Identify the Pest

The first step in any IPM program is to identify the pest. If the pest is unknown it is difficult to know which approach to use to control it. For example, an insect found in damaged wood under a home could be a termite, carpenter ant, powder post beetle, or one of several other wood-destroying pests. The control practices for each of these pests are very different. Misidentifying the pest would result in an ineffective control. If the pest is not available, it may be possible to identify the pest from the damage caused, or at least to narrow it down to one or two species that may require similar controls. Once the pest has been identified control can begin.

Control Options

Once the pest has been identified the following control options may be available:

- **Prevention:** Preventing infestations from occurring should be the first strategy used. It is the most effective and least costly! For example, trees and wood boring beetles are common throughout Nevada. Not all trees are affected by the beetles due to their natural ability to vigorously defend themselves. Healthy pine trees defend themselves by exuding pitch when beetles try to bore into their bark. The pitch acts as a barrier, preventing the beetles from entering. When ample water is not available, the trees become stressed and often lose their ability to produce the necessary pitch to fight beetle attack. To compound the problem, many of the wood boring beetles can tell when a tree is stressed for water and will single out the tree for attack. Insecticides can be used to kill the beetles as they attack the tree, but this is only marginally effective, and does not change the overall stressed and weakened state of the tree. In this case, the simplest method to “control” the pest is to prevent it from infesting the tree in the first place by keeping the tree healthy and stress free, particularly for water. This generally requires “responsible watering” during drought and warm periods.

- **Exclusion:** Exclusion is simply keeping a pest out of an area. For example, a greenhouse may use fine mesh screens on its vents and high volume air blowers at its entrances to exclude flying pests from entering. Many warehouses have automatic doors that close after being opened to help exclude rodents. Regional and national quarantine laws allow for inspection stations at ports of entry and state borders to exclude pests transported on, or in products, shipping containers, vehicles, etc. Excluding a pest is less expensive than allowing it to become established, cause damage, and then trying to manage it later.

- **Cultural:** Cultural controls are the oldest pest control methods used and are still some of the most practical. Cultural methods include pulling weeds by hand, removing insect pests directly from host plants, herding large numbers of rodents into traps, etc. Cultural methods are often inexpensive but may require a great deal of human effort. We often see cultural control in the form of good sanitation practices, such as keeping kitchen areas clean, covering garbage cans, removing rotten/diseased fruits from fields, raking up leaves and other debris to remove overwintering sites for pests, proper fertilization and irrigation, etc.

  Populations of naturally or genetically altered plant and animal varieties bred for productivity may lose resistance to pests. The number of pests to which a variety or breed is susceptible can increase rapidly, resulting in vulnerability to devastating epidemics (National Research Council, 1972). Expansion of pest populations can sometimes be held in check by pockets of resistant host individuals which serve to buffer the impact of pests on susceptible organisms or environments. An example of an insect and disease resistant tree is an elm variety which is both Dutch Elm Disease resistant, as well as, Elm Leaf Beetle resistant.

- **Mechanical:** As the name implies, mechanical controls involve the use of machinery to control pest populations. In agriculture, weeds are controlled by plowing them into the soil or mowing. Birds are often dispersed from areas with loud “guns”, or deterred from roosting on ledges and rooftops where electrical shock or spike strips have been placed. “Sticky traps” can be used as insect monitors (e.g. to track cockroach populations in food preparation areas, or for trapping of exotic pests), and they can also be used as a general trap for insects and rodents. Lights are often used in restaurants to attract flying insects, and snap traps are in the arsenal of almost anyone wishing to control rodents.

- **Biological:** Many people are familiar with the use of ladybugs by organic gardeners to control aphids and the role bats play in controlling night flying insects, but what some do not realize is that biological control is one of the fastest growing areas of pest control. Since the mid 1970's, efforts to develop and market biological control agents have been stepped up significantly. *Bacillus thuringiensis*, or "BT" as it is commonly known, is a strain of bacteria that was discovered and has been further developed through genetic engineering to control a variety of different pests. The bacteria produces a toxin which is active against large groups of insects including beetles, moths and butterflies, wasps, bees and ants. The bacteria infests its insect host and multiplies within it, killing the host, and then spreading to other host. The genetic material within the bacteria that produces the toxin has been inserted into some agricultural plant populations with the result that insects feeding on the plants are poisoned and insect populations are held in check or locally eliminated. Some fungi and viruses are now commonly used in the same manner. One of the most controversial issues facing biological control is the splicing of the BT gene sequence which is toxic to insects, into crop plants to prevent the growth of insect populations within crops.

  Pheromones and chemical sex attractants are used to control and monitor some pest populations. Pheromones are chemical factors secreted by insects that elicit specific responses from other members of the same species. Sex pheromones are usually produced by females and function as attractants to males of the same species. Sex pheromones and aggregation pheromones are used in pest control to attract pests to a trap where the insect dies. Knowing when certain pests reproduce, how many reproduce, where they reproduce, etc., is an important part of many IPM programs.

- **Chemical:** Many people believe that IPM does not involve the use of pesticides. This perception is incorrect. IPM as a total pest control science depends on all aspects of control including the use of pesticides. However, in an IPM program pesticides are usually only used as a last resort, or to assist other controls being used. When using pesticides, care must be taken to target the pest with as little damage as possible to predators and other beneficial organisms. Broadcast applications of pesticides often leads to the reoccurrence of pests due to the slower recovery period required for beneficial insect predators (ladybugs, spiders, etc.)

What is “Control”?

Many people have a different understanding of what “control” is. Some feel control is the total eradication of a pest. This may be true in situations where there is a zero tolerance for a particular pest, such as a cockroach in a restaurant, but for many who maintain IPM programs, good control is keeping a pest population at or below its “**economic threshold**” .The economic threshold is that level at which the damage caused by the pest is equal to the cost of its control. For example, a farmer who has pests causing damage in a field must be able to determine if the crops which are being lost to the pest are equal to, or greater than what it would cost to control them. If the pests are going to cause more damage to the crop than the cost of controlling them, then further control measures are justified.

In ornamental landscapes, an “**aesthetic threshold**” is often more important than an economic threshold. An aesthetic threshold is the level of pest presence allowable before any damage incurred distracts from the beauty, condition or function of the landscape. Like beauty, an aesthetic threshold is in the eye of the property owner and may change with circumstance. For, example, a few aphids on a rose bush in a formal garden may not detract from the beauty of the landscape, but if the rose society is scheduled to visit the planting or the roses are cut for bouquets to be placed on the tables at a formal dinner, the aesthetic threshold changes immediately to a much higher intolerance. No one wants aphids on their dinner table, let alone in their food!

“**Emotional thresholds**” are also present in society and are often driven by fear, sentimentality, or circumstance. For example, a “bug” in a baby’s room or crib would elicit swift action, but seldom is action taken to rid a landscape of all “bugs”. A tree planted by newlyweds would have a greater sentimental value to them and thus evoke more demand to protect it from pests as well as a greater willingness to pay for its protection rather than the protection of other trees in the same landscape.

Aesthetic and emotional thresholds are difficult to quantify and may even appear irrational to outsiders, but just the same, they must be taken into account and they often drive the pest management used.

It is important to communicate with homeowners about the benefit of control versus eradication. Many are not aware that accepting a few pests may be beneficial to them, the environment, and the food web supporting wildlife, than paying for expensive home pest control services designed to kill everything in their yard or home.

Control Versus Eradication

Eradication is necessary in some instances. Pesticides are often used in eradication efforts due to their quick action. Eradication is sometimes used in grain storage facilities to eliminate pests which could, in a short period of time if left unchecked, develop into large populations. Eradication efforts are often performed in the United States on newly introduced pests from other countries, such as imported fire ants, Asian longhorned beetles, and many “noxious weed” species. Eradication schemes are intensive and costly in the short run, but very cost effective when considered against the consequences of rampant pest spread, damage and cost of management if they are not eliminated and become established.

Setting up an IPM Program

The first step in setting up an IPM program is to determine customer needs and expectations. The pest manager must understand the customer's economic, aesthetic and emotional thresholds regarding their pest situation. Every customer should understand what IPM is and its importance in pest control. To be able to follow through with a good IPM program, it is imperative that pest control professionals know as much as possible about the pest they intend to control. Knowing the pest's habits, life cycle, harborages, how and where it overwinters, when it reproduces, in what stage of its life it causes damage, where it lays its eggs, spreads its seeds or spores, etc., is necessary information when designing optimal control programs. Overlooking any of these aspects may make effective control difficult. When the biology of the pest is understood, IPM control practices can be researched and decisions can be made to determine the best practice for managing the pest.

Nevada's pest control study manuals place emphasis on being able to identify pests and being familiar with their ecology and life history. Accurate pest identification is the first step in developing a successful control program.

Calculations, Equipment, and Calibration

Applying the correct amount of pesticide is a must for responsible, effective pest control. The pesticide label and other recommendations inform applicators of how much to apply. It is their job to:

- dilute the formulation correctly;
- select the right kind of application equipment for each job;
- accurately calculate the size of the application site (if necessary); and,
- calibrate application equipment accurately.

Calculations

Unless there is the correct amount of pesticide mix in a tank, even a correctly calibrated sprayer can apply the wrong amount of pesticide to the target.

Formulations consisting of wettable and soluble powders, emulsifiable concentrates, and flowables usually are sold as concentrates and must be diluted in the spray tank. Water is the most common diluent, but kerosene, oil, and other liquids are sometimes used. Consult the labeling or other recommendations to find out what diluent to use and how much of the concentrate should be diluted.

To determine the amount of pesticide to use, some simple calculations are needed based on spray tank capacity, equipment calibration, area to treat and recommended application rate. Math formulas and examples are provided below to assist applicators in determining their chemical needs. When performing these calculations, write them out. It is easy to make a mistake. Be sure to double check answers.

Calculations for pesticide applications consist primarily of three factors:

- Pump Rate.
- Percentage or Pounds Actual Per Gallon of the pesticide active ingredient.
- Area to be treated.

These three factors will be explained separately and then in combination with each other. Sample problems for each area and combination of areas are at the end of this section. Answers to the problems and an explanation of how the answers were found are also at the end of this section.

Pump Rate:

The pump rate is the rate a liquid is discharged from a sprayer, or the speed at which the spray is coming out of the nozzle. This speed is normally expressed as gallons per minute (GPM)

- **Example**: If a sprayer can fill a 5 gallon can in one minute, then the pump rate is 5 gallons per minute, or 5 GPM. As the pump rate is expressed in gallons per minute, then a portion of a gallon, or a portion of a minute, can be converted to GPM. To do this the following items must be known.
  - One gallon = 4 quarts = 8 pints = 128 fluid ounces
  - One quart = 2 pints = 32 fluid ounces = ¼ gallon
  - One pint = 16 fluid ounces = ⅛ gallon = ½ quart
  - One fluid ounce = 2 tablespoons
  - One Hour = 60 Minutes

- One Minute = 60 Seconds
- One gallon of water weighs 8.3 Pounds

Hint: When figuring GPM, all given facts must be converted to **minutes and gallons**.

- **Problem**: It takes 30 seconds to fill a 5 gallon can. What is the pump rate in GPM?
- **Answer**: From the chart above it can be seen that there are 60 seconds in a full minute. The problem states that the time involved is 30 seconds; this converts to ½ minute (30 seconds ÷ 60 seconds = ½ minute). But the pump rate is expressed in gallons per full minute so the ½ minute must be converted to a full minute by multiplying by 2. So, as the minutes were multiplied by 2, the gallons must also be multiplied by 2, which gives 10 gallons. Therefore, if it takes 30 seconds to fill a 5 gallon can, the pump rate is 10 GPM.

Conversely, if 2 minutes had been given, divide by 2 times the expressed volume to get GPM.

Hint: 30 seconds is ½ of a minute, so multiply by 2 times the expressed volume to get GPM.

- **Problem**: It takes 15 seconds to fill a 1 pint bottle. What is the pump rate in GPM?
- **Answer**: First convert the seconds to minutes; this is done by dividing 15 seconds by 60 seconds which gives ¼ minute (15 seconds ÷ 60 seconds = ¼ minute). Next, convert the ¼ minute to a full minute by multiplying by 4 (¼ minute x 4 = 4/4 minute = 1 minute). Then convert 1 pint to gallons which is 1/8 gallon (remember the chart?). As the minutes were multiplied by 4, the gallons must also be multiplied by 4, which gives ½ gallon (⅛ gallon x 4 = 4/8 gallon = ½ gallon). Therefore, when it takes 15 seconds to fill a 1 pint bottle, the pump rate is ½ GPM.

Hint: 15 seconds is ¼ of a minute, so multiply by 4 times the expressed volume in a minute or 4 pints which is ½ gallon

Time to Empty:

Once the pump rate is known, the time it will take to discharge or empty a sprayer can be determined. This is done by dividing the number of gallons in the spray tank by the pump rate, or in the form of a formula:

$$\text{Time to Empty} = \frac{\text{Spray Tank Capacity}}{\text{Pump Rate}}$$

- **Problem**: The spray tank contains 300 gallons and your pump rate is 25 GPM. How long will it take to empty the spray tank?
  - **Answer**: Using the formula, the problem is set up:

$$\text{Time to Empty} = \frac{300 \text{ Gallons}}{25 \text{ GPM}} = 12 \text{ Minutes}$$

- **Problem**: A power spray unit takes 6 seconds to fill a 4 pint container. How long will it take to empty the entire 225 gallon spray tank?
  - Answer:
    - Convert 6 seconds to minutes (6 seconds ÷ 60 seconds = 1/10 minute)
    - Convert 1/10 minute to a minute (1/10 minute x 10 = 10/10 = 1 minute)
    - Convert 4 pint to gallons (1 pint = ⅛ gallon; 4 pints = ½ gallon)
    - Perform action for gallons for any action performed for the minutes (½ gallon x 10 = 10/2 gallons = 5 gallons).
    - Determine GPM (GPM = 5 gallons)
    - Using the formula, set up the problem:

$$\text{Time to Empty} = \frac{225 \text{ Gallons}}{5 \text{ GPM}} = 45 \text{ Minutes}$$

Area to be Treated:

The area to be treated is normally given in square feet (sq.ft). The square feet of an area is determined by multiplying the length (L) in feet by its width (W) in feet.

- **Example**: If an area is 20 feet long and 10 feet wide, then the area is 200 square feet. Additionally, some pesticides give area in acres. To do area problems the following conversions will need to be used:
  - 43,560 sq.ft. = 1 acre
  - One yard = 3 feet = 36 inches
  - One square yard = 9 sq.ft. = 1296 square inches
  - One square foot = 144 square inches
  - 5,280 feet = 1 mile

  - **Problem**: How many square feet are there in an area 60 yards long and 15 yards wide?
    - Answer:
      - Multiply the length by the width (60 yds. x 15 yds. = 900 sq. yds).
      - Multiply by 9 sq.ft. (900 sq.yds. x 9 sq.ft. = 8100 sq.ft).

Hint: When figuring areas to be treated, the length and width can only be multiplied when they are the same unit of measure. You cannot, therefore, multiply feet by inches or yards by feet.

  - **Problem**: How many acres are there in an area that is 312 feet long and 264 feet wide?
    - Answer:
      - Multiply the length by the width (312 feet x 264 feet = 82,368 sq.ft).
      - Divide 82,368 sq.ft. by 43,560 sq.ft./acre = 1.89 acres.

Volume Calculation:

In some instances an applicator is required to treat a room using an aerosol or a fog. In these instances the length, width and height of the area to be treated must be known. When these are known, then the length (L) multiplied by the width (W) multiplied by the height (H) will give the **cubic** dimensions of the area to be treated. (Cubic feet are expressed as $ft^{3)}$

Cubic Area = Volume = L x W x H

- **Example**: If a room is 20 feet long, 10 feet wide, and 8 feet high then the volume of the room is 20 ft. x 10 ft. x 8 ft. which equals 1600 cubic feet. Once the volume is known it is then possible to treat if the rate of the application is given. This rate is often expressed in the number of cans needed to treat 1000 cubic feet. To determine the number of cans required, first find the volume of the room and second divide by the number of cubic units required for each can, or in the form of a formula:

$$\text{No. of Cans Required} = \frac{\text{Volume}}{\text{Cubic Units Required}}$$

- **Problem**: How many cans of an aerosol will be required to treat a room 125 feet long, 40 feet wide, and 12 feet high, if the label states to use one 12 oz. can per 1200 cubic feet?
  - **Answer**:
    - Volume = 125 ft x 40 ft x 12 ft
    - Volume = 60,000 cubic feet (ft^3)
    - Using the formula, set up the problem:

$$\text{No. of Cans Required} = \frac{60{,}000\ ft^3}{1{,}200\ ft^3} = 50 \text{ Cans}$$

The following section is intended for:
1) Urban and Structural Principals; and
2) Aerial and Agricultural Ground Operators and Principals

Determining the amount of a pesticide:

Once the size of the area to be treated and the rate of application are known, the total amount of pesticide to be applied can be figured. To determine the amount of pesticide to be applied, divide the area to be treated by the number of square feet in the application rate and then multiply by the number of gallons in the application rate, as shown in the following formula:

$$\text{Gallons Required} = \frac{\text{Area to be Treated}}{\text{Sq. Ft. Application Rate}} \times \text{Application Rate (gallons)}$$

- **Problem**: How many gallons of pesticide are required to treat 2,400 sq. ft. at the rate of 5 gallons per 20 sq. ft.?
  - **Answer**:
    - Using the formula, set up the problem:

$$\text{Gallons Required} = \frac{\text{2,400 sq.ft.}}{\text{20 sq.ft.}} \times \text{5 Gallons}$$

    - = 120 x 5 Gallons = 600 Gallons

Number of units:

Although the rate of application is normally given in gallons per square feet, it is sometimes given in pounds of actual pesticide per square feet.

- **Example**: A label may say to apply a pesticide at the rate of 1½ lbs. actual per acre. In these cases, this type of rate is used to determine how many acres a certain number of gallons (pounds actual) will treat. To determine this, the number of pounds of actual pesticide in one gallon is divided by the rate of pounds of actual pesticide; then multiplied by the number gallons of concentrate; and finally multiplied by the rate for acres. The following is the formula:

$$\text{No. of sq.ft. Treated} = \frac{\text{No. of lbs. Actual/Gal.}}{\text{Rate of lbs. Actual}} \times \text{No. of Gal. Conc.} \times \text{Rate per sq.ft.}$$

- **Problem**: How many square feet can be treated using 6 gallons of a 2 EC concentrate (2 lbs. actual/gal.) at the rate of ¼ lb. actual per 1,000 sq. ft.?
  - **Answer**:
    - Using the formula, set up the problem:

$$\text{No. of sq.ft. Treated} = \frac{\text{2 lbs. Actual/Gal.}}{\text{¼ lbs. Actual}} \times \text{6 Gal. Conc.} \times \text{1,000 sq.ft.}$$

    - = 8 lbs. Actual/Gallon x 6 Gallons x 1,000 sq.ft.
    - = 48 x 1,000 sq.ft.
    - = 48,000 sq.ft.

Percent of active ingredient in tank:

If the recommended rate is a percentage of active ingredient (a.i.) in a tank, use the following formula:

$$\text{Gallons of formulation} = \frac{\text{Gallons in tank} \times \text{\% a.i.} \times \text{weight of water}}{\text{Pounds a.i. per gallon} \times 100}$$

- To do these kinds of problems you must know:
  - One gallon of water = 8.3 pounds
  - 16 ounces = 1 pound

- **Problem**: You want to make 25 gallons of a 1.0% spray, using water as the diluent. You have a 2.5 gallon jug of a 2 EC formulation (2 pounds a.i. per gallon). How much of the 2 EC should you add to the 25 gallons of water in the tank?
  - **Answer**:
    - Using the formula, set up the problem:

$$\text{Gallons of formulation} = \frac{\text{25 gallons} \times 1 \times \text{8.3 lbs per gallon}}{\text{2 lbs. a.i.} \times 100}$$

    - 207.5 ÷ 200 = 1.04 gallons (or 1 gallon and 5 ounces) of formulation to add.

    Note: to convert .04 gallons to ounces = 128 x .04 = 5

(Note: The % in the formula is expressed as a whole number not a fraction or decimal. For example 2% is expressed as “2”, not “0.02”)

Concentrate per 100 gallons:

Finally, in some instances the label will state to add a certain number of units of pesticide to a certain number of units of water. In most cases the number of units of water stated on the label will not be used and consequently the number of units of pesticide to be used must be reduced. To determine the correct amount of pesticide to add to the reduced water, multiply the required units of concentrate by the number of units of water to be used and then divide this by the units of required water. Use the following formula:

$$\text{Concentrate Needed} = \frac{\text{Required Units of Conc.} \times \text{Units of Water Wanted}}{\text{Units Water Required}}$$

- **Problem**: The label states "add 5 gallons of insecticide to 100 gallons of water" and your sprayer only holds 30 gallons of water. How much insecticide should be added to your sprayer?
  - **Answer**:
    - Using the formula, set up the problem:

$$\text{Concentrate Needed} = \frac{\text{5 Gals. of Conc.} \times \text{30 Gals. of Water}}{\text{100 Gals. Water Required}}$$

    - 5 x 30 ÷ 100 = 1.5 gallons of concentrate is needed

Hint: Since your tank hold about ⅓ of the 100 gallons, you will need about ⅓ of the 5 gallon rate.

Test Your Knowledge

Q1. The discharge rate of a sprayer is 96 pints per minute. How many minutes will it take to empty a 240 gallon spray tank?

Q2. It takes 5 seconds for a sprayer to fill a 3 qt. container. At that rate how long will it take to empty a 300 gallon sprayer?

Q3. How many gallons of pesticide are needed to treat a 6000 sq.ft. area at the rate of 1½ gallons per 24 sq.ft.?

Q4. How many gallons of a 1% pesticide spray solution are required to treat an area 350 yds. in length and 120 yds. in width at the rate of 3 gallons per 250 sq.ft.?

Q5. How many square feet will 7 gallons of a 4 EC pesticide (4 lbs. actual/gallon) treat if your application rate is 1/4 lb. actual per 500 sq.ft.

Q6. How many square feet will 2 gallons of a flowable pesticide (8 lbs. actual/gallon) treat if the application rate is ⅔ lb. actual per 300 sq.ft.

Q7. The label directions on an aerosol container state, "use one 20 oz. can per 260 cubic feet." To treat a room 13 feet long, 10 feet high and 8 feet wide, how many cans are needed?

Q8. The label directions on an aerosol container state, "use one 12 oz. can per 700 cubic feet." How many cans are required to treat a warehouse 70 feet long, 25 feet wide and 14 feet high?

Q9. The label directions state, "add 3 gallons of pesticide to 100 gallons of water." The pesticide concentrate is a 2 EC (2 lbs. actual/gallon) and the sprayer capacity is 50 gallons. Only 25 gallons of water are needed, how many gallons of concentrate are needed?

Q10. The label directions state, "add 3 pints of insecticide to 45 gallons of water." The insecticide is a flowable (8 lbs. actual/gallon) and only 30 gallons of water are needed for the job. How much concentrate should be added?

Answers and Solutions to Sample Problems:

A1. **20 Minutes**

■ **Solution**

Convert 96 Pints to Gallons

$$8 \text{ Pints} = 1 \text{ Gallon; therefore } \frac{96 \text{ Pints}}{8 \text{ Pints}} = 12 \text{ Gallons}$$

96 Pints Per Minute = 12 gallons Per Minute = 12 GPM

Use the formula:

$$\text{Time to Empty} = \frac{\text{Spray Tank Capacity}}{\text{Pump Rate}}$$

$$\text{Time to Empty} = \frac{240 \text{ Gallons}}{12 \text{ GPM}} = 20 \text{ Minutes}$$

Time to Empty = 20 Minutes

A2. **33 Minutes 20 Seconds**

■ **Solution**

Convert 5 seconds to 1 minute

5 seconds ÷ 60 seconds = 1/12 minute

1/12 minute x 12 = 1 minute

Convert 3 Qts. to gallons

1 qt. = ¼ gallon; therefore, 3 qts. = ¾ gallon

As the time was multiplied by 12, the gallons are multiplied by 12:

¾ gallon x 12 = 36/4 gallons = 9 gallons = 9 GPM pump rate

Use the formula:

$$\text{Time to Empty} = \frac{\text{Spray Tank Capacity}}{\text{Pump Rate}}$$

$$\text{Time to Empty} = \frac{300 \text{ Gallons}}{9 \text{ GPM}} = 33\tfrac{1}{3} \text{ Minutes}$$

Convert ⅓ minute to seconds by multiplying by 60 seconds:

⅓ minute x 60 seconds = 20 seconds

the answer is 33 minutes 20 seconds

A3. **375 gallons**

Use the formula:

$$\text{Gallons Required} = \frac{\text{Area to be Treated}}{\text{Sq.Ft. Application Rate}} \times \text{Application Rate (gals.)}$$

$$\text{Gallons Required} = \frac{6{,}000 \text{ sq.ft.}}{24 \text{ sq.ft.}} \times 1\frac{1}{2} \text{ gallons}$$

Gallons Required = 250 x 1½
Gallons Required = 375

A4. **4,536 Gallons**

Find the square area

Square area = L x W

Square area = 350 yds. x 120 yds.
Square area = 42,000 sq.yds.

Convert sq.yds. to sq.ft.

1 Square yard = 9 sq.ft.
42,000 sq.ft. x 9 sq.ft. = 378,000 sq.ft.

Use the formula:

$$\text{Gallons Required} = \frac{\text{Area to be Treated}}{\text{Sq.Ft. Application Rate}} \times \text{Application Rate (gals)}$$

$$\text{Gallons Required} = \frac{378{,}000 \text{ sq.ft.}}{250 \text{ sq.ft}} \times 3 \text{ gallons}$$

Gallons Required = 1512 x 3 gallons

Gallons Required = 4536 gallons

A5. **56,000 sq.ft.**

Use the Formula: No. of lbs. actual/gal.
No. of sq.ft. Treated = ---------- x Gal. Conc. x Rate per sq.ft.
Rate of lbs. Actual

4 lbs. Actual/Gal.
No. of sq.ft. Treated = ---------- x 7 Gal. Conc. x 500 sq.ft.
¼ lbs. Actual

No. of sq.ft. Treated = 16 Gals. x 7 Gals. x 500 sq.ft.

No. of sq.ft. Treated = 112 x 500 sq.ft.
No. of sq.ft. Treated = 56,000 sq.ft.

A6. **7,200 sq.ft.**

Use the Formula: No. of lbs. actual/gal.
No. of sq.ft. Treated = ---------- x Gal. Conc. x Rate per sq.ft.
Rate of lbs. Actual

8 lbs. Actual/Gal.
No. of sq.ft. Treated = ---------- x 2 Gal. Conc. x 300 sq.ft.
⅔ lbs. Actual

No. of sq.ft. Treated = 12 Gals. x 2 Gals. x 300 sq.ft.

No. of sq.ft. Treated = 24 x 300 sq.ft.
No. of sq.ft. Treated = 7,200 sq.ft.

A7. **4 Cans**

Find the cubic area (ft^3):

Cubic area = L x W x H

Cubic area = 13 ft. x 10 ft. x 8 ft.

Cubic area = 1,040 ft^3.

Use the formula:

$$\text{No. of Cans Required} = \frac{\text{Volume}}{\text{Cubic Units Required}}$$

$$\text{No. of Cans Required} = \frac{1{,}040\ ft^3}{260\ ft^3} = 4$$

No. of Cans Required = 4 cans

A8. **35 Cans**

Find the cubic area (ft^3):

Cubic area = L x W x H

Cubic area = 70 ft. x 25 ft. x 14 ft.

Cubic area = 24,500 ft^3

Use the formula:

$$\text{No. of Cans Required} = \frac{\text{Volume}}{\text{Cubic Units Required}}$$

$$\text{No. of Cans Required} = \frac{24{,}500\ ft^3}{700\ ft^3} = 35$$

No. of Cans Required = 35 Cans

A9. **¾ gallon**

Use the formula:

$$\text{Concentrate Needed} = \frac{\text{Required Units of Conc. x Units of Water Wanted}}{\text{Units Water Required}}$$

$$\text{Concentrate Needed} = \frac{\text{3 Gals .Conc. x 25 Gals. of Water}}{\text{100 Gals. of Water}}$$

Concentrate needed = 75 gallons ÷ 100 gallons = .75 gallons
Concentrate needed = 3/4 gallons

A10. **2 Pints**

Use the formula:

$$\text{Concentrate Needed} = \frac{\text{Required Units of Conc. x Units of Water Wanted}}{\text{Units Water Required}}$$

$$\text{Concentrate Needed} = \frac{\text{3 Pints x 30 Gals. of Water}}{\text{45 Gals. of Water}}$$

Concentrate Needed = 90 pints/gallon ÷ 45 gallons = 2 pints
Concentrate Needed = 2 pints

Application Equipment

The purpose of application equipment is to allow uniform application of pesticides to designated target sites while minimizing exposure of the applicator to the pesticide. Skill and accuracy during application is determined by the applicator and equipment being used.

Pesticide application equipment varies according to application sites and pest problems. Advanced equipment is placed in the following categories:

- sprayers;
- mist machines;
- Ultra Low Volume (ULV) devices;
- fog generators;
- granule applicators;
- dusters;
- foaming devices.

Each piece of equipment is designed for a specific application. The applicator should know what each piece of equipment is designed for and use it only for its intended purpose.

Pest control professionals in Nevada who operate in the Urban-Structural pest control field primarily use sprayers, dusters, and fog generators.

Sprayers and Their Major Uses:

- residential;
- gardens (a*gricultural commodities);*
- nurseries and green houses;
- golf courses;
- parks and public grounds;
- buildings;
- commercial grounds;
- water ways, lakes, ditches and rivers.

Sprayers are the most diverse type of application equipment. They are generally classified as manually operated or power driven sprayers.

Manually Operated Sprayers:

Five major types:

- aerosol;
- trigger pump;
- hand pump;
- compressed air;
- garden hose sprayer.

Advantages

Advantages of manually operated sprayers:

- used in restrictive areas;
- economical;
- simple design, easy to use, clean and store.

Disadvantages

Limitations of manually operated sprayers:

- limited capacity;
- lack good agitation, and screening for wettable powders.

Pressurized can (aerosol sprayer)

This type of sprayer consists of a sealed container of compressed gas and pesticide. The pesticide is driven through an aerosol-producing nozzle when the valve is activated. Pressurized cans usually have a capacity of less than 1 quart and are not reusable. Larger reusable cylinders are available for some specialty agricultural uses.

Trigger pump sprayer

With trigger pump sprayers, the pesticide is not packaged under pressure. Instead, the pesticide and diluent are forced through the nozzle by pressure created when the trigger is squeezed. The capacity of trigger pump sprayers ranges from 1 pint to 1 gallon.

Hose-end sprayer

This device causes a fixed rate of pesticide to mix with the water flowing through the hose to which it is attached. The mixture is dispensed through a high volume nozzle. These sprayers usually hold no more than 1 quart of concentrated pesticide, but because the concentrate mixes with the water, they may deliver 20 gallons or more of finished spray solution per fill.

Push-pull hand pump sprayer

This type of sprayer depends on a hand operated plunger that forces air out of a cylinder, creating a vacuum at the top of a siphon tube. The suction draws pesticide from a small tank and forces it out with the air flow. Capacity is usually 1 quart or less.

Compressed air sprayers

This is usually a hand carried sprayer that operates under pressure created by a self contained manual pump. The air in the tank is compressed by the pump. The compressed air forces liquid pesticide through the hose and nozzle whenever the control valve is opened. A few types of these sprayers use carbon dioxide cartridges instead of a hand pump for providing pressure. Capacity is usually ½ to 3 gallons.

Backpack (knapsack) sprayer

One type of backpack sprayer is a compressed air sprayer with a harness that allows it to be carried on the operator's back.
Another type of backpack sprayer has a hand operated hydraulic pump that forces liquid pesticide through a hose and one or more nozzles. The pump is usually activated by moving a lever. A mechanical agitator plate

may be attached to the pump plunger. Some of these sprayers can generate pressures of 100 pounds per square inch (psi) or more. Capacity of both these types of backpack sprayers is usually 5 gallons or less. (The amount is limited by the number of gallons an individual can safely carry on their back.)

Sprayer Parts:

This subsection introduces various parts of a sprayer. However, it does not address the detailed aspects of sprayers since each "owners manual" is specific to each individual sprayer. Applicators should carefully read their owners manuals before using their equipment.

Types of Power Operated Pumps

- piston pump (reciprocating pump);
- roller impeller pump;
- flexible impeller pump;
- gear pump;
- diaphragm pump;
- centrifugal pump.

Pumps must be able to supply the necessary spray pressure (psi) and flow (volume) and:

- supply all nozzles;
- provide hydraulic agitation when needed;
- have ample pressure reserve to allow for pressure loss due to wear.

Power Operated Sprayers:

Lower pressure sprayers

These sprayers are designed to distribute liquid pesticide dilutions over large areas. They deliver a low to moderate volume of spray (10 to 60 gallons/acre) at a working pressure ranging from 15 to 50 psi.

These sprayers are usually mounted on a vehicle (or sometimes boats). These sprayers have varying capacities (25 to 1,000 gallons) and usually are hydraulically agitated.

- **Advantages**
  - medium to large tanks;
  - low cost;
  - light weight and versatile.
- **Disadvantages**
  - low gallon output which limits their use when high volume is required;
  - low pressure limits pesticide penetration into dense foliage and limited agitation may interfere with pesticide use.

High pressure sprayers are also called Hydraulic sprayers.

These are not widely used in urban structural pest control. They are used mainly in agricultural settings where pesticide sprays need to penetrate into dense foliage. They are designed to deliver large volumes at high pressure ranging from 20 to 800 psi.

- **Advantages**
  - well built;
  - mechanical agitation;
  - long lasting, even when using wettable powders;
  - with proper pressure regulator can be used at low pressure.
- **Disadvantages**
  - expensive;
  - large amounts of water, power, and fuel are needed;
  - The high pressure produced by these sprayers makes spray drift more likely.

Ultra Low Volume (ULV) Sprayers:

Although they are not discussed in detail, operators should be aware of Ultra Low Volume sprayers (ULV) and Air Blast sprayers. ULV sprayers deliver undiluted pesticide concentrate from the air, on the ground, or in buildings. Air Blast sprayers by their very nature move pesticide by creating wind.

- **Advantages**
  - ULV sprayers need no water (less volume to apply and no mixing);
  - equal control with "less" pesticide.
- **Disadvantages**
  - ULV does not provide thorough wetting;
  - hazards of using pesticide concentrates;
  - chance of overdosing;
  - small number of pesticides to chose from.

Tanks:

Tanks vary in size, shape and material; but the most important consideration when choosing a tank is its durability. Tanks should have large openings for easy filling and cleaning. At the fill opening they should have a strainer; and have some form of mechanical or hydraulic agitation. The tank should be made of corrosion-resistant materials such as stainless steel or fiberglass. If made of mild steel, it should have a protective plastic lining or coating. The tank should have a good drain. The outlets should be sized according to the pump's capacity. If dual tanks are used, make sure plumbing allows for agitation and adequate withdrawal rates in both tanks. All tanks should have a gauge to show the liquid level.

Materials:

- Mild steel - will flake unless it is lined;
- Galvanized steel - can rust if chipped;
- Fiberglass - visible liquid level;
- Plastic - usually adequate but subject to UV-sunlight breakdown, visible liquid level;
- Stainless steel - is considered to be the best.

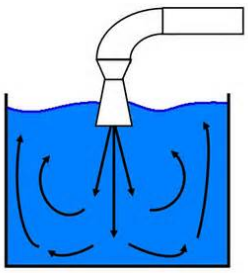
Flush out tank, pump lines, and nozzles after each day's use and each separate pesticide use. If switching to another pesticide where contamination must be prevented, wash out with detergent and water, or a neutralizing agent two or three times and then flush with water. Phenoxy herbicides such as 2,4-D are hard to remove. After using them, either follow the special cleaning procedures noted on the pesticide label or avoid using the same tank for any other product*. Keep the tank clean inside and out. Tighten or repair any leaky tank seal or fitting. Make sure sight gauges can be read.

* As a general rule it is best to use separate tanks for herbicides and all other pesticides, because tiny amounts of herbicide residue can do serious harm to crops and landscape plants.

Agitators:

All power operated sprayers must have agitation to keep the spray material uniformly mixed. If there is too little agitation, the pesticide dilution will not be thoroughly mixed and it will be applied at uneven concentrations. If there is too much agitation, some pesticides will foam causing interference with pump and nozzle operation. The type of agitation usually depends on the pesticide formulation. Generally, power operated sprayers use 10% of their total power for agitation.

- **Mechanical**: Mechanical agitators usually consist of flat blade paddles or propellers mounted on a shaft. This type of agitator keeps the materials well mixed but can cause foaming if operated at high rpm's. Foaming should be avoided since it causes issues which result in uneven pesticide application.
- **Jet action**: Jet action or hydraulic agitation pressurizes the spray mix and forces it through jet nozzles into the tank. A pump 10 to 20 percent larger or an additional pump may be required to produce the pressure required for jet agitation. Jet action is recommended for wettable powders and flowable formulations in small tanks.



  - The pump and tank capacity and operating pressure determine the minimum number of jets
    - 55 gallons = 1 or more jets
    - 100 - 150 gallons = 3 or more jets
    - 200 gallon and larger = 5 or more jets
- **Return flow**: Return Flow agitation is common for small sprayer systems. Return Flow is usually accomplished through a by pass line from the regulator to the tank. This type of agitation is generally recommended for use with highly soluble mixes, such as soluble powders and liquid formulations such as solutions and emulsifiable concentrates that do not require much agitation. Return flow bypass agitation is not recommended for wettable powders or tanks larger than 55 gallons.

Control Valves:

Control valves should be located between the pressure regulator and the nozzles to provide positive on/off action. The valves should be rated for the pressure being used. The valves should be large enough so they do not restrict flow when fully open. All valves should be readily accessible.

Screens (filters):

To prevent plugging and excessive nozzle wear, always use screens to remove large particles from the spray mixture. Proper filtering of the pesticide protects the working parts of the sprayers, and avoids time loss and misapplication due to clogged nozzle tips.

The proper screen mesh size to use is determined by the size of the nozzle orifice opening. Filtering should be **progressive** with the largest mesh screen in the suction line between the tank and the pump. A smaller mesh screen should be placed in the high pressure line between the pump and the pressure regulator, and then a fine mesh screen should be used near the nozzles. As a general rule, nozzles with low outputs should be used with a 100 mesh screen whereas a 50 mesh screen can be used on larger nozzles. The screen opening sizes should be less than the size of the nozzle opening but never larger than the nozzle opening. Do not use a screen in the suction line of a centrifugal pump.

Clean strainers after each use, especially when spraying wettable powders, flowables, or water dispersible granules. Replace them if they show signs of deterioration. Strainers are the best defense against excessive nozzle and pump wear and nozzle clogging.

Hoses:

Hoses should be made of high quality synthetic rubber, neoprene, or plastic that have the following characteristics:

- bursting strength greater than the peak operating pressure;
- resistant to oils and solvents present in pesticides;
- weather resistant (light, heat, cold, etc.).

Suction hoses should be reinforced to resist collapse. They should be larger than pressure hoses, with an inside diameter equal to or larger than the inlet part of the pump. All fittings on suction lines should be as large as, or larger than, the line itself.

Hoses should be kept from kinking or rubbing. To prolong their life rinse them often, inside and out. Remove and store hoses during the off season, or at least store the spray unit out of the sun. Replace the hoses at the first sign of surface deterioration.

Pressure Gauges:

Pressure gauges aid in monitoring spray applications. They must be accurate and indicate only the operating range needed during use. For example, a 0-60 psi gauge with 2-pound gradations would be enough for most low pressure sprayers.

Check pressure gauge accuracy frequently against an accurate gauge. Do not use gauges under too much pressure, as excessive pressure will destroy them. Keep glass faces clean and intact. Use gauge protectors to protect against corrosive pesticides and pressure surges.

Pressure Regulators:

The pressure regulator controls the pressure and, indirectly, the quantity of spray material delivered by the nozzles and also serves as a system relief valve. Pressure regulators protect pump seals, hoses and other sprayer parts from damage caused by excessive pressure. Pressure is regulated by adjusting the flow in the bypass line. A decrease in flow to the bypass increases pressure to the nozzles. Increased flow to the bypass line decreases nozzle pressure.

Nozzles:

The proper selection of nozzle type and size are two of the most important considerations when setting up a sprayer for pesticide application. The nozzle helps control the rate and pattern of pesticide distribution. Several types of nozzle tips that produce a variety of spray patterns may be interchanged on a single nozzle body made by the same manufacturer. The cap, used to secure the strainer and the tip to the body, should not be over tightened. The nozzle strainer is placed in the nozzle body to screen out debris that may clog the nozzle opening. The type of nozzle strainer needed depends on the size of the nozzle opening and the chemical being sprayed. Special nozzle screens equipped with check valves, constructed with a spring loaded ball valve, help prevent nozzle dripping. Check valves should be used in situations where a sprayer must be stopped and started frequently, such as in small target areas, near sensitive crops, indoors, or for right-of-way treatments. The operator must check the spring loaded ball valves frequently to be sure they are working properly. Nozzle tips fracture the liquid pesticide into droplets. They also distribute the spray in a predetermined pattern and are the principal element that controls the rate of application. Nozzle performance depends on:

- nozzle design or type;
- operating pressure;
- size of the opening;
- discharge angle;
- distance to target.

To minimize drift, select nozzles that give the largest droplet size, while providing adequate coverage at the desired application rate.

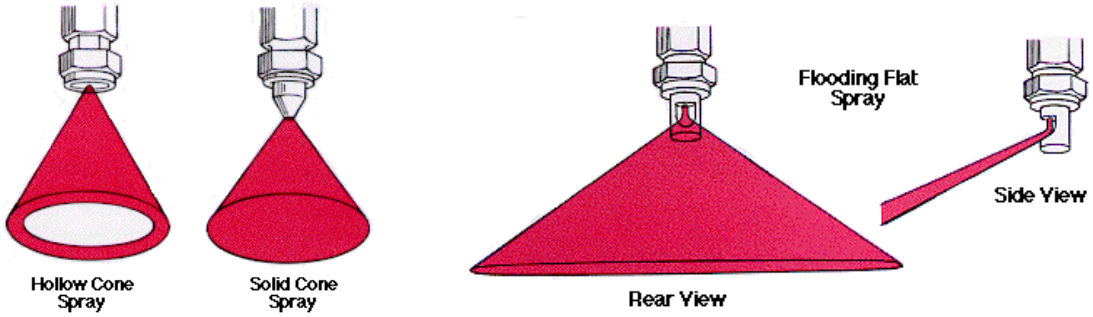
Nozzles are made up of four parts:

- nozzle body;
- screen;
- spray tip;
- nozzle cap.

Nozzle patterns

There are three basic nozzle types or patterns. They are:

- solid stream;
- fan;
- cone;



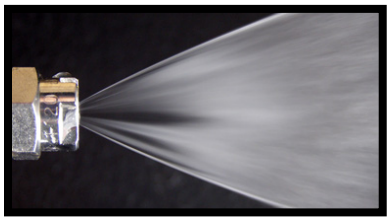
Some special purpose nozzle tips produce specific patterns for specialized applications of pesticides, these might include:

- raindrop nozzle;
- atomizing nozzle;
- broadcast nozzle;

Solid stream nozzles

These nozzles are used in handgun type sprayers to spray a distant or specific target such as the canopy of a tall tree. They are also used for crack and crevice treatments in and around buildings.

Fan pattern nozzles

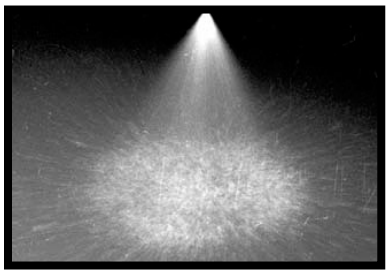


At least three types of nozzle tips have fan patterns. They are used mostly for uniform spray coverage of surfaces; for example, broadcast soil applications of herbicides or insecticides.

The **regular flat fan** nozzle makes a narrow oval pattern with tapered ends. It is used commonly for broadcast herbicide and insecticide applications outdoors at 15 to 60 psi.

The **even flat fan** nozzle makes a narrow oval pattern. Spray delivery is uniform across its width. It is used for band spraying and for treating walls and other surfaces. It is not useful for broadcast applications.

The **flooding (flat fan)** nozzle delivers a wide angle flat spray pattern. It operates at very low pressure and produces large spray droplets. Its pattern is fairly uniform across its width but not as even as the regular flat fan nozzle pattern. If used for broadcast spraying, it should be overlapped to provide double coverage. It is often used for applying liquid fertilizers or fertilizer/pesticide mixtures.



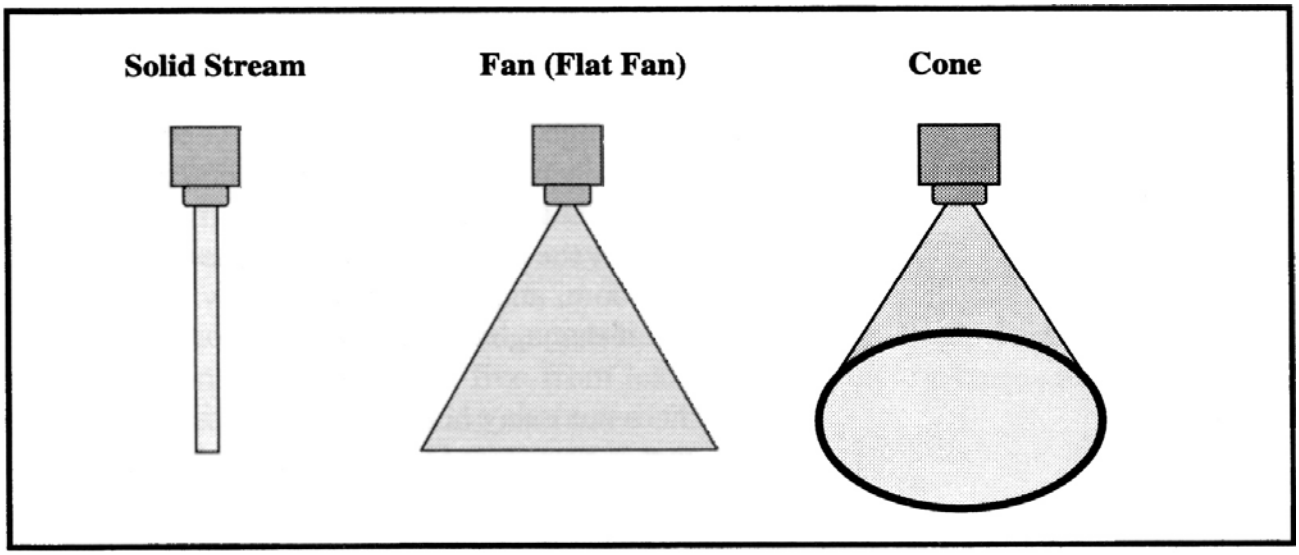
Cone pattern nozzles

Hollow and solid cone patterns are produced by several types of nozzles. These patterns are used where penetration and coverage of plant foliage or other irregular targets are desired. They are most often used to apply fungicides and insecticides to foliage, although some types are used for broadcast soil applications of herbicides.

Core-insert cone nozzles produce either a solid or hollow cone spray pattern. They operate at moderate pressures and give a finely atomized spray. They should not be used for wettable powders because their small passages clog easily and they wear rapidly due to abrasion.

Disk-core nozzles produce a cone shaped spray pattern, which may be hollow or solid. The spray angle depends on the combination of disk and core used and also, to some extent, on the pressure. Disks made of very hard materials resist abrasion well, so these nozzles are recommended for spraying wettable powders at high pressures.

Adjustable cone nozzles change their spray angle from a wide cone pattern to a solid stream when the nozzle collar is turned. Many manual sprayers are equipped with this type of nozzle. Handguns for power sprayers have adjustable nozzles that usually use an internal core to vary the spray angle.



Nozzle materials:

Most nozzle parts are available in several materials. Here are the main features of each kind:

- **Brass**:
  - resists corrosion from most pesticides;
  - wears quickly from abrasion;
  - probably the best material for general use;
  - may be corroded by liquid fertilizers.
- **Plastic**:
  - will not corrode;
  - resists abrasion better than brass;
  - may swell when exposed to some solvents;
  - useful life about equal to that of brass nozzles.
- **Stainless steel**:
  - resists abrasion, especially if hardened;
  - good corrosion resistance;
  - suited for high pressures, especially with wettable powders;
  - lasts longer than brass.
- **Aluminum**:
  - resists some corrosive materials;
  - easily corroded by some fertilizers;
  - useful life much shorter than brass.
- **Tungsten carbide and ceramic**:
  - highly resistant to abrasion and corrosion;
  - best material for high pressures and wettable powders;
  - lasts much longer than brass.

Equipment care:

Clogged screens and nozzles are the main source of problems for sprayers. Continued use and improper cleaning often results in increased pump and nozzle wear.

Proper maintenance can minimize downtime and prolong pump and sprayer life. Flush new sprayers before using to remove metal chips and manufacturing debris. Sprayers which have been idle should be flushed to remove any dirt or rust. Clean screens and nozzles regularly.

Use pesticides that are approved for the pumps and nozzles being used. Check owner's manual to see what types of pesticides are recommended. Some materials will ruin a pump and nozzle after just one application.

Always use clean water. Sand and silt can rapidly wear pumps and other parts of the sprayer system.

Keep screens in place and clean. Sprayers usually have 3 screens: A coarse screen between the tank and pump, a medium screen between the pump and pressure and a fine screen at the nozzle regulator (see screen filter section). The nozzle screen should be fine enough to filter particles that will plug the nozzle orifice. Always clean orifice in nozzle tip with a soft brush or round wooden toothpick. Never use a metal object to clean the orifice. Metallic objects can change the spray pattern and capacity of the nozzle.

Clean sprayer thoroughly after use. Flush entire system with clean water. A neutralizing agent should be used if different types of pesticides are applied by the same piece of equipment. Remove nozzle tips when flushing tank, pump, and lines. Clean all filters. Be sure to wear rubber gloves to prevent contact with remaining pesticide. Check entire sprayer for leaks, damaged or worn hoses, uneven spray patterns and condition of power and drive units. All cleaning should be in a location that is not accessible to children, pests, livestock, or wildlife. Discharge water must not contaminate water supplies, streams, crops, or other plants (see the section on disposal).

Proper maintenance and compliance with operator's manual will extend equipment life and prevent downtime for repairs.

For long term storage, chemical residues should be removed from the tank, pump, hoses, and boom. The sprayer should be thoroughly drained and dried inside and out. Some manufactures recommend that nozzles, pump, (inside and out) and any other moving part be given a light coat of oil to prevent corrosion. Lines, valves, and regulators where water may accumulate should have antifreeze added. Not only does this prevent freezing, but also helps prevent corrosion. Store equipment in a dry place out the weather.

Dusters and Granule Applicators:

In recent years the application of pesticides in dust form has decreased, while granule applications have become more popular.

Dusters: Small hand crank operated dusters, small power dusters, and smaller bulb or bellows type dusters are commonly used in the urban-structural field.

These hand dusters have the **advantages** of:

- good penetration in confined spaces;
- pesticide comes ready to apply (no mixing).

Disadvantages include:

- high cost of pesticide dusts;
- poor foliar coverage;
- dust is subject to drift.

Power dusters are simple in design, easy to maintain and inexpensive. The limitations of power dusters are similar to hand held dusters and include drift hazard, high cost of material, and poor uniform coverage.

Power dusters should give a uniform application rate as the hopper is emptied. It is important that the dusting mechanism does not contaminate the user.

Granule applicators: Granular applicators distribute granular pesticides by several methods, including:

- spinning or whirling disks;
- broadcasting;
- by drilling (mechanical incorporation into the soil)

These granular applicators have the **advantages** of:

- simple design;
- no mixing;
- minimal drift;
- low exposure hazard to applicator;
- pesticide comes ready to apply.

Disadvantages include:

- limited use against some pests;
- need to calibrate for each different formulation;
- spinning disks type applicators may not give uniform lateral distribution.

Aerosol generators and foggers:

Aerosol generators and foggers convert special formulations into very fine droplets (aerosols). Single droplets cannot be seen, but large numbers of droplets are visible as a fog or mist. Aerosol generators and foggers usually are used to completely fill a space with a pesticide. Certain foggers rely on heat to vaporize oil based pesticides into small particles. Aerosol generators and foggers are available in a large variety of sizes, from 2 ounce to 30 pounds, in disposable and refillable containers. Containers range in pressure from 25 to 200 psi. A variety of different types of pesticides are available as aerosols.

Advantages of aerosols and foggers:

- penetration into cracks and crevices;
- some indoor devices are automatic and do not require the presence of an applicator.

Disadvantages of aerosols and foggers:

- high drift potential;
- reduced residual effectiveness (they tend not to last very long);
- applications which result in less residual pesticides often require more frequent applications;
- risk of explosion in enclosed areas.

Choose an aerosol or fog generator according to whether it will be used indoors or outdoors. Be sure the pesticide used in aerosol or fog generators is registered for this use and the application is on target. Since these generators usually produce a pesticide “cloud”, steps should be taken to keep the applicator, other individuals and animals out of the treatment area.

Calibration

One of the most common problems encountered by the Nevada Department of Agriculture is applicators who fail to accurately calibrate their equipment. Calibration is simply adjusting your equipment to apply the desired amount/rate of pesticide. This does not have to be difficult. Calibration requires some simple math. Applying the correct amount/rate of pesticide is crucial to assure a proper (legal) application. Too much pesticide can be dangerous; too little can be ineffective. Only by calibrating equipment correctly can the best results be obtained.

There are many ways to calibrate equipment. The owner's manual is usually the best source of information to start with; it explains how to adjust equipment, what pressure and types of nozzles to use, etc. The instructions often contain suggestions about such things as the appropriate rate of travel (speed to be used during application, e.g. 2 mph), the range of the most efficient pump pressure, approximate settings for achieving various delivery rates, and types of nozzles that can be used.

Pesticide application equipment will not deliver the right amount of pesticide if it is not working correctly. Before calibrating equipment, check it carefully to be sure that all components are clean and in good working order. Pay particular attention to the parts that regulate the amount of pesticide being released, such as nozzles or hopper openings. If they become clogged, not enough pesticide will be released. If they become worn, too much pesticide will be released. Preferred methods differ according to the kinds of equipment used.

Figuring out the application rate:

The amount of pesticide applied, divided by the area covered, is the application rate. This can be found by making an application to a predetermined area such as "per acre" or "per 1000 linear feet". The amount applied to a given area is the application rate. This rate is often incorrect due to incorrect nozzle size, application speed, pressure, etc.

It may be impractical to test equipment over such a large area, and it is not advisable to test equipment with a pesticide dilution. For these situations, smaller sites can be tested using water or other inert material to test and calibrate equipment. How to test application rates on smaller sites is discussed next.

Small equipment, small target sites

For application equipment capable of only applying relatively small amounts (up to a few gallons of liquid or a few pounds of dry pesticide), or if the target site is relatively small (less than an acre or 1,000 linear feet), a smaller test area is needed. If the use directions use a given distance of 100 linear feet, the applicator might chose a test site of 25 linear feet. If the directions are for 1,000 square feet, or for an acre, a test site of 250 square feet (a 10- by 25-foot rectangle) may be used. Measure the amount applied to the smaller site and then multiply to find the rate:

- The amount applied to 25 linear feet, multiplied by 4, equals the rate per 100 linear feet.
- The amount applied to 250 square feet, multiplied by 4, equals the rate per 1,000 square feet.
- The amount applied to 250 square feet, multiplied by 175, equals the rate per acre.
- The amount applied to 1000 square feet, multiplied by 43.56, equals the rate per acre.

Larger equipment, larger target sites

If using application equipment capable of applying larger loads (more than a few gallons of liquid or a few pounds of dry pesticide), or if the target site is relatively large (greater than an acre or 1,000 linear feet), choose a larger test site. If the test site for these types of equipment is too small, measurements are likely to be inaccurate. For example, a multi nozzle boom sprayer being tested on a small 10 feet by 25 foot area, does not allow for proper operation when taking into consideration variations in average speed and spray pressure during operation. Trying to calibrate large equipment in such a small area often produces inaccurate application rate results.

If the label states a given amount to apply per 1,000 square feet, or per acre, use a test site of at least 1,000 square feet (for example a rectangle measuring 20' x 50'). The output that is measured will be the current application rate for 1,000 square feet. To find the current rate per acre, multiply the test output by 43.56, which is the number of square feet in one acre (43,560 sq.ft.) divided by 1,000 sq.ft. This will give the current application rate per acre; however, this amount may not be correct. If incorrect, adjustments and additional tests will have to be conducted until the desired application rate is achieved.

Check Calibration Often:

Once equipment is calibrated, do not assume that it will continue to deliver the same rate during future applications. Clogging, corrosion, and wear may change the delivery rate, or the settings may gradually go out of adjustment. Periodically checking equipment calibration will help insure the correct amount of pesticide is being applied.

Always be alert for possible calibration problems each time equipment is used. When beginning an application, pay attention to the amount of chemical being applied. If there is a concern about whether too much or too little is being applied, stop and double check calculations, equipment, travel speed, pressure, etc., only continue after the correct calibration is confirmed. Checking calibration before or at the beginning of an application will help prevent a mistake and possibly a major problem.

Calibrating Sprayers'

To calibrate spray equipment, determine the:

- appropriate pump pressure;
- spray volume to be delivered;
- type of diluent to be used (usually water);
- application speed.

Spray gun nozzles:

Spray guns are usually hand operated and used to wet surfaces thoroughly. When choosing a spray gun nozzle, the operating pressure must be known. Some guns are designed for a wide range of operating pressures (30 to 800 psi). Others are built for narrower ranges (30 to 100 psi). Other variables to consider are the spray angle from each nozzle at various pressure settings and the maximum throw at different pressures from each nozzle type.

Applicators must choose a nozzle type that offers them the best combination of appropriate angle and throw distances. The nozzle tip should be based on the gallons per

minute the pump produces and the pressure necessary to do the job. Nozzle capacities range from 0.25 gpm to 50 gpm at 30 to 800 psi, with throw distances of up to 60 feet at high pressure.

Calibration at the Application Site

The first step in calibration is to check two important factors related to the nozzles:

- pressure at the nozzles;
- nozzle flow rates.

Unless these two factors match the figures on the manufacturer's nozzle spray charts, the equipment will not deliver the specified amount of pesticide (too much or too little delivered).

The nozzle selection charts are based on pressure at the nozzles. To check nozzle pressure, mount a pressure gauge close to the nozzles. Then compare that reading with the pressure reading at the main line pressure gauge. (After the test, remove the pressure gauge near the nozzles and plug the connection).

Even new nozzles may deliver rates that vary from the manufacturer's charts; variance in delivery rates can result in underdosing or overdosing. Check nozzle flow rates by measuring the length of time needed to collect a quart of diluent from each nozzle.

Next, test the equipment at the application site to determine if it is delivering the pesticide at the desired rate. If the equipment is not delivering at a rate within 5 percent of the desired gpm, make adjustments and do another test. Minor adjustments in gallons per acre or gallons per minute can be made in one of three ways:

- Changing the pump pressure - lower pressure means less spray; higher pressure means more spray (remember - more pressure means smaller droplet size and more drift potential);
- Change spraying speed - slower speed means more spray delivered;
- Change nozzle tips - this is the preferred method for large changes in delivery rate.

Calibrating Granule Applicators:

There are many types of granule application equipment. Gravity feed application equipment may have one long hopper with a sliding gate or auger that regulates the flow to multiple outlets. Granules drop straight down to the target surface from the outlets, so the swath width is equal to the width of the hopper. Other equipment uses an air blast or whirling disks to distribute granules in a wide swath. To determine swath width, measure the actual swath on a hard surface.

Band applicators usually are a modification of the gravity feed equipment. Granules drop through tubes and are released just above the soil to form bands of a specific width. For band applicators, the swath width is the number of bands multiplied by the band width in feet.

Soil injectors are band applicators that release granules into furrows in the soil, which are then covered.

In all types of granule application equipment, the amount of granules applied per unit of area depends on the size of the adjustable opening, the speed at which the equipment travels (or the speed of the hopper agitator), how rough the application site is (except for aerial application), and the granular formulation chosen.

Different formulations have different flow rates depending on the size, weight, shape, and texture of the granules. Environmental factors such as temperature and humidity also alter granular flow rates (flow rate slows as temperature and humidity rise).

Because so many variables can affect the delivery rate, calibrate equipment for each batch of product and for each new field condition.

Granule application equipment with a wheel driven dispersal system geared to the revolutions of the wheel, deliver granules at a slower rate at low speeds and higher rate at high speeds. As a result, minor changes in equipment speed do not affect the amount of granules deposited per unit area. The most common way to change the application rate in this type of equipment is to change the feed gate opening.

Granule application equipment with a power dispersal or gravity flow dispersal system, distributes granules at a constant rate independent of ground speed travel. The application rate per acre (or other unit area) depends on both the metered opening and equipment ground speed. Minor adjustments in flow rates can be made by altering the travel rate of speed. (Faster speed means fewer granules delivered per area). Larger adjustments can be made by altering equipment settings.

Consult the manufacture's equipment manual to determine the proper application rate. If the equipment is motorized, select a speed recommended by the manufacturer while taking into consideration soil conditions. Soft, muddy, or uneven surfaces and small areas with many obstacles require slower travel speeds, which in turn may require a lower application rate.

Calibrate equipment using one of two methods described below. If the application rate differs more than 5 percent from the desired rate, adjust the equipment and re-calibrate.

Broadcast granule applications:

Run a pre-calibration check on the equipment:

- First, fill the hopper to a predetermined height or weight. Settle the material by driving a short distance or by shaking or striking the hopper; then refill.
- Set the flow rate recommended by the equipment manual.
- Select a hard and flat test area.
- Cover test area with trap. This will allow for the collection, weighing and reuse of granules used in the calibration test.
- Measure area. The dimensions of the test area must be known.
- Turn on equipment and check for uniform distribution along the swath width.
- Operate equipment over measured area to determine if equipment is metering granules at the proper rate (per acre).

To calculate the granular application rate, use the volume output method:

Volume output method

The volume output method of calibration can be done in one of two ways:

(1) Treat an acre at the speed and setting recommended by the equipment manual. To determine the rate of application, measure the amount of granules needed to refill the hopper;

OR...

(2) Treat less than an acre. Stake out a test area in the field to be treated. The total test run should be at least 1,000 square feet.

- Treat test area at the desired speed and setting;
- Measure the amount of granules needed to refill the hopper.

$$\text{Area (acres) Treated in Test} = \frac{\text{Swath Width (ft)} \times \text{Distance in Test Run (ft)}}{\text{sq.ft. in an acre (43,560)}}$$

Calculate the rate of application:

$$\text{Pounds Per Acre} = \frac{\text{Pounds Used in Test}}{\text{Area (acres) Treated in Test Run}}$$

- **Example**:
  - Swath width= 15 feet.
  - Test run = 100 feet.
  - Amount used in test run = 0.5 pounds.
  - Amount needed per acre = 15 pounds.

$$\text{Area (acres) treated in test} = \frac{15 \text{ ft.} \times 100 \text{ ft.}}{43{,}560 \text{ sq.ft.}} = 0.034$$

$$\text{Pounds Per Acre} = \frac{0.5 \text{ lbs.}}{0.034 \text{ acres}} = 14.7 \text{ lbs/acre}$$

$$\text{Pounds Per 1,000 sq.ft.} = \frac{14.7 \text{ lbs./acre}}{43.56 \text{ acre/sq.ft.}} = 0.33 \text{ lbs/1000 sq.ft.}$$

That is within 5 percent of the specified rate of 15 pounds per acre, so the equipment is correctly calibrated.

Calibrating Dust Application Equipment:

To calibrate pesticide dusters, follow the granular application directions given above.

This section is for Aerial Applicators Only.

Aerial Application

In addition to the calculations above, there are some specific application calibration techniques that are unique to aerial applications.

Navigation Methods

The ability to navigate an aircraft accurately is an essential part of the piloting process. The ability to navigate to a certain point is one of the basic skills taught to pilot trainees. An additional amount of knowledge is necessary to find and identify a certain agricultural field and crop at the site to be treated. However, it is beyond the scope of this manual to cover all means of cross-country navigation available to the pilot.

For the purpose of this section of the Core Manual is so aerial applicators understand how to direct the flight of the aircraft across the field while applying the proper amount of material in each pass. The flight path must be accurately controlled to produce consistent swaths, ensure that buffer zones are not exceeded, and to prevent skips or double coverage.

Global Positioning Systems:

One of the most accurate methods of navigation for aerial applicators is by the use of a global positioning system (GPS). The aircraft is equipped with a receiver that picks up signals from satellites that allow the pilot to know the velocity of the aircraft and its position in three dimensions. GPS equipment is, in most cases, an essential tool for aerial application. A recent study indicates that at least 92% of the agricultural pilots in the U.S. use GPS equipment.

A GPS receiver uses data sent by orbiting satellites to calculate its own current location. In order to find its exact location, the receiver must simultaneously detect the identification signals from four different GPS satellites. The time it takes signals to travel from three of the GPS satellites form the basis of the calculations performed by the GPS receiver to determine its location in three-dimensional space. The signal from the fourth satellite serves to verify time signals from the three other satellites.

Each of the GPS satellites is configured to broadcast signals over two microwave frequency channels. One channel carries a strong signal that can only be used by the military. The second satellite signal is less robust and is known as the coarse acquisition (C/A) signal. This signal is available for nonmilitary GPS use, although calculations based on this C/A signal do not provide pinpoint precision of the GPS receiver location. It typically gives a location precision of ± 30 meters (roughly 100 feet) for horizontal accuracy. For some uses, such as aerial application, this lower level of precision makes C/A-signal-based GPS data too inaccurate for ultra-precise aerial application.

To improve accuracy of the C/A signal, a technology known as **Differential GPS** (DGPS) provides greater precision. DGPS technology reduces the horizontal error down to less than a meter and rarely more than three meters. DGPS systems are the type used by aerial applicators.

Regular GPS relies on only one receiver, but DGPS technology requires two receivers. One of these remains stationary at an accurately surveyed permanent location and acts as a reference receiver. The other is mounted inside the aircraft. Both of these receivers detect the same C/A-signals from the orbiting satellites. The stationary receiver transmits data that refines the mobile receiver positioning information. Various governmental agencies and commercial providers operate stationary receiver signal transmission systems, thus enabling them to provide DGPS service to the public.

Because the location of the stationary receiver is precisely known and fixed, it can analyze the incoming timing signals from the satellites and compute a correction factor for the mobile receiver in the aircraft. Although the stationary receiver cannot determine which particular GPS satellites the mobile receiver is using, it detects all accessible satellites, computes the timing signal correction factor for each, and transmits the error corrections to the aircraft's mobile receiver, which then sorts out the data for the satellites being used.

DGPS providers transmit the correction signals from stationary GPS receivers to mobile receivers over a wide-range communication network. Two transmission methods predominate:

- FM radio tower beacon (e.g., U.S. Coast Guard Differential GPS Navigation Service; Nationwide Differential GPS Service)
- communication satellite relay (e.g., Wide Area Augmentation System (WAAS) and various commercial DGPS services)

Because GPS alone did not meet navigation requirements of the Federal Aviation Administration for accuracy, integrity, and availability, the FAA and the Department of Transportation (DOT) developed the **Wide Area Augmentation System** (WAAS) for use in precision flight approaches. WAAS corrects for GPS signal errors caused by ionospheric disturbances, timing, and satellite orbit errors, and it provides vital integrity information regarding the status of each GPS satellite.

WAAS consists of approximately 25 ground reference stations positioned across the United States, covering a very large service area. These stations are linked to form the U.S. WAAS network. Two master stations, one located on the East Coast and the other on the West Coast, collect data from the reference stations and create a GPS correction message that is transmitted to a geostationary communication satellite (GEO). The satellite broadcasts the message on the same GPS frequency to receiver's onboard aircraft that are within the broadcast coverage area of the WAAS.

The WAAS improves basic GPS accuracy to approximately 7 meters (28 feet) vertically and horizontally, improves the availability of the signals using *geostationary communication satellites,* and provides necessary integrity information about the entire GPS system.

For some users in the U.S., the position of the geostationary satellites over the equator makes it difficult to receive the signals if trees or mountains obstruct the view of the southern horizon. WAAS signal reception is ideal for open land areas and for marine applications.

The U.S. Coast Guard provides a **Maritime DGPS service** for the Harbor and Harbor Approach phase of marine navigation. The Maritime DGPS service coverage area includes the coastal United States, Great Lakes, Puerto Rico, and most of Alaska and Hawaii. It consists of two DGPS control centers and about 65 DGPS reference stations.

The reference stations transmit correction signals on U.S. Coast Guard radio beacon frequencies, and this service is available to the public.

Many GPS receivers are equipped with built-in radio receivers that accept and process GPS-satellite correction signal data. The position accuracy of the Maritime DGPS Service is within 10 meters (approximately 33 feet). If an aircraft is equipped with suitable DGPS receiving equipment, and is less than 100 miles from a reference station, its pilot may typically expect positioning accuracy of 0.75 meters (about 2.5 feet). For aircraft operating more than 100 miles away from the Maritime DGPS reference station, positioning accuracy decays at a rate of approximately 1 meter per 150 kilometers of distance (1 yard per 90 miles). Because of this distance-related decay in accuracy, aerial applicators who require accurate positioning data should obtain GPS satellite signal corrections from the closest Maritime DGPS reference station. The Maritime DGPS program is being incorporated into the Nationwide DGPS program.

A federal law, enacted in 1997, directed the U.S. Department of Transportation to work with several other government entities to develop and operate a standardized **Nationwide DGPS Service**. The goal of this service is to provide reliable local-area GPS-satellite signal correction data to the public without charge.

This program involved the U.S. Air Force, U.S. Coast Guard, U.S. Army Corps of Engineers, the National Oceanic and Atmospheric Administration, the Federal Highway Administration, and the Federal Railroad Administration. The Nationwide DGPS Service has approximately 80 DGPS radio beacon sites in place throughout the continental United States. This provides every area in the continental United States with double coverage DGPS correction data signals from two land-based radio beacon towers. The program includes all U.S. Coast Guard-operated DGPS reference stations. Each Nationwide DGPS System radio beacon site has a 300-foot tower antenna that substantially increases the effective range available for mobile DGPS user reception. The signal from each site covers a range of 250 miles with enough signal strength to provide positional accuracy of one meter (about 3 feet) or less.

Commercial DGPS services provide additional options for pilots making aerial applications in remote locations. These services fill in areas missed by the government systems. Most mobile DGPS equipment is compatible with the commercial DGPS services. Subscribing to one of these services provides pilots with a high degree of location accuracy suitable for precise aerial pesticide application.

Computers, Spray Output Controllers, and Sensors

Positioning data can enhance accuracy of aerial application work. For this reason, many DGPS equipment manufacturers also sell onboard computers (or DGPS systems combined with a computer), spray output controllers and sensors, and computer software packages tailored to link DGPS data to aerial application needs.

An onboard DGPS computer enables aerial guidance, mapping, waypoint navigation, and spray operation recordkeeping. The pilot uses the computer to select a desired application pattern, such as racetrack. The onboard computer then uses DGPS positioning data to continuously calculate and display the aircraft location with respect to the target site and application pattern. This eliminates the need for human flaggers or flagging or marking devices.

The computer system records the precise in-field location of each spray swath. For jobs requiring multiple tanks of spray, a mapping system shows the pilot where to begin application of the next load. Throughout the spray operation, the computer system collects data and constructs records for customer billing, environmental reporting, GPS data analysis, and other custom needs.

Manufacturers of DGPS computer systems also offer software programs and computer hardware interfaces that enable precision spray boom operation. An electronically regulated flow controller receives continuously updated ground speed data from the onboard DGPS computer. The computer couples this data with the swath width of the aircraft and uses the result to regulate boom output. As a result, the spray can be delivered uniformly for the duration of the job in progress even if travel speed of the aircraft varies. Feedback data from the boom flow controller is used to construct an on-site record of the output performance of the spray boom.

Calibrating Equipment

The main reason for calibration is to figure out how much pesticide to put into the tank or hopper of the aircraft to apply to a determined area. This assures that the correct amount of pesticide is applied to the target site when the aircraft is flown at a determined speed and altitude. Accurate calibration is necessary for

- assuring compliance with the requirements in labeling, law, or regulation
- effective pest control
- protecting human health, the environment, and treated crops or surfaces
- preventing waste of resources
- controlling the volume of water (for liquid applications) applied to a given area

Effective Pest Control. Manufacturers of pesticides spend millions of dollars researching ways to use their products effectively. Their research includes determining the correct amount of pesticide to apply to control target pests. Using less than the labeled amount of pesticide may result in inadequate control, wasting time and money. Inadequate amounts of pesticide may also lead to problems such as pest resistance and resurgence. Using too much pesticide may have adverse effects on natural enemies, targeted plants, and the environment, and may result in residues on crop plants that exceed the legal tolerance level. Higher than label rates are *illegal* and waste pesticides.

Human Health Concerns. Pesticides applied at higher than label rates could endanger the health of pesticide handlers, field workers, and other people working in or visiting an area where they are applied. In addition, if over-application results in illegal residues on plant surfaces, regulators have the authority to confiscate and destroy an entire crop to protect consumers.

Environmental Concerns. Pesticide concentrations higher than label recommendations may cause serious environmental problems. Calibrating equipment to maintain application rates within label instructions will help to protect beneficial insects and wildlife. It also reduces the potential for contaminating surface water, ground water, and the air.

Protecting Treated Plant Surfaces. Certain pesticides are phytotoxic (injurious to plants) and damage treated desired plant surfaces when used at higher than label-prescribed rates. Manufacturers evaluate these potential problems while testing the products so they can determine safe concentrations. Using too much pesticide increases chances of

building up excessive residues in the soil. This buildup sometimes seriously limits the types of future crops that people can grow in the treated area.

Preventing Waste of Resources. Using the improper amount of pesticide wastes time and adds unnecessary costs to the application. Pesticide materials are expensive, and the fuel, labor, and equipment wear and tear required to make extra applications are costly.

Managing the Amount of Water Applied Per Acre. For the greatest application efficiency, the amount of water used per acre of application must be the smallest amount that is legal and will still give adequate results. Specific pesticide product labels often prescribe a range for water per acre to use for aerial applications.

Legal Aspects. An applicator who applies pesticides improperly is subject to criminal and civil indictments, resulting in possible loss of his or her journeyman or apprentice pilot certificate, fines, imprisonment, and lawsuits. All applicators are legally liable for injuries or damage caused by improper pesticide application.

Equipment Calibration Methods:

Liquids: Calibration involves determining how much area each tank of spray covers when the aircraft travels at a known speed and the system operates at a known pressure. To do this, measure these four factors:

- tank capacity
- application airspeed
- flow rate
- effective spray swath width

Spray pressure is a component of the flow rate because as the pressure increases or decreases the flow rate increases or decreases as well. Spray pressure must never exceed the recommendations of the nozzle manufacturer. The spray pressure must also be the same as the pressure used for calibration and be consistent throughout the entire application operation.

Check liquid spraying equipment frequently when applying abrasive pesticides, such as wettable powders, because these materials wear out pumps and nozzles. Pump wear decreases the amount and pressure of fluid output, while nozzle wear increases the volume of output. This usually lowers the output pressure and may produce a poor spray pattern.

Tank Capacity: You need to know exactly how much liquid can be put into the tank in order to determine how much area the aircraft can spray with each load. This requires measuring the capacity of the spray tanks, usually *one time only*. If the tank is modified or if sprayer components inside the tank are removed or added, you will have to re-measure the capacity. Never rely on tank size ratings provided by the manufacturer because these may be approximate volumes, they may not take into account fittings installed inside the tank, and they do not account for the attitude of the aircraft while it is on the ground. In addition, the capacity of the spray lines, pump, and filters influences the total tank volume.

Position the fixed or rotary wing aircraft on a level surface and make sure there is no liquid in the system. Drain the system if necessary, then close any open valves to prevent water leaks and start adding measured amounts of clean water with the pump running to circulate the liquid. Using a flow meter, bring the water level to the maximum operating fill point. This is the level to which the tank will always be filled whenever applying a full load. Once the actual capacity of the tank or tanks is known, paint or engrave this amount onto a prominent place for permanent reference.

While filling the tank, also calibrate the tank sight gauge, or make marks on the tank as measured volumes of water are added. Once the sight gauge or tank is calibrated, it is easy to see how much liquid is in the tank when it is not entirely full. Always return the aircraft to a level surface when reading the sight gauge or tank marks. The sight gauge readings while the aircraft is in flight will differ from readings taken when the aircraft is on the ground due to flight attitude.

Application Speed: Measure speed under actual working conditions, with the aircraft spray tank fully loaded with water, and flying at the same altitude as an actual spray application. If the aircraft spraying system is equipped with a flow rate controller, the controller will calculate the proper flow rate and make adjustments if speed changes. For it to make these adjustments, you must enter the application rate and the size of the effective swath width into the unit.

Flow Rate: If the aircraft is not equipped with a flow rate controller, measure the actual output of the system when nozzles are new, then periodically thereafter to accommodate for nozzle wear. Manufacturers provide charts showing the estimated output of given nozzle sizes at specified spray pressures. Manufacturer charts are most accurate when using new nozzles - used nozzles may have different output rates because of wear. Even new nozzles may have slight variations in actual output. Additionally, the pressure gauge in the aircraft system may not be accurate, which further adds error to the output estimate determined from manufacturer charts. The flow rate is expressed in gallons per minute, which you can then convert to gallons per linear mile at the prescribed swath width.

Rotary Wing Aircraft.

To find out the combined flow rate for all nozzles on a helicopter spray boom, collect liquid from each nozzle over a known time (such as 30 seconds) and add together these amounts. Use a calibrated container that measures liquid ounces. Once the total amount of output is determined, convert the ounce measurement into gallons and then determine the gallons per minute output.

$$\frac{\text{Seconds of Collection Time}}{\text{Total Ounces Collected} \times 60 \text{ Seconds/Minute}} = \text{Total Ounces / Minute}$$

$$\frac{\text{Ounces / Minute}}{128 \text{ Ounces / Gallon}} = \text{Gallons / Minute}$$

$$\frac{\text{MPH}}{60 \text{ Minutes / Hour}} = \text{Miles / Minute}$$

Gallons / Minute
---------- = Gallons / Mile
Miles / Minute

Fixed Wing Aircraft.

Most fixed wing aircraft use air driven spray pumps, so the aircraft must be airborne or have the engine running at high speed while on the ground. Due to the air blast from the propeller, you cannot collect spray from the nozzles. Therefore, find the output of the sprayer over time by measuring how much water is used during several test flights. Each time you fill the tank you will make a run operating the sprayer for a timed period.

Start by moving the aircraft to a level surface and fill the tank to a known amount with clean water. Fill the tank to a level that you can duplicate when refilling. A convenient technique is to fill the tank with clean water to the point just before it begins to overflow. Use a low-volume, low-pressure water source, such as from a garden hose, for topping off the tank. Check for leaks around tank seals, hoses, and hose fittings. All nozzles must be clean and operating properly or the results will be inaccurate.

Take off and fly to an area where you can release the spray water. Operate the sprayer at its normal operating speed and pressure. Open the valve to the spray boom, starting a stopwatch at the same time. Continue to run the sprayer for several minutes, and then close the valve. Record the elapsed time, return to the ground, and park the aircraft at the same spot where the tank was filled, and refill it. For more accuracy, repeat this process two more times to get an average of sprayer output.

Attach a flow meter to a low-pressure filling hose and refill the tank to the original level. Record the gallons of water used; this volume is the amount of liquid sprayed during the timed run. Determine the gallons per minute output of the sprayer by using the calculations shown below.

A crucial step in the calibration of an aircraft liquid dispersal system involves determining the **effective swath width**. Although the actual swath width may be wider, the effective swath width includes overlaps made with each pass to achieve a more even application. The amount of overlap leading to the effective swath width produced by an aircraft is measured by pattern testing. Whenever the spray boom is altered in any way, or application height is changed, you must repeat this pattern test and recalculate the effective swath width. Application height affects the effective spray swath, so the application height used during pattern testing must be the same as the height flown during an actual application.

To determine the proper swath width when the output rate is limited, divide the gallons (or pounds) per minute by the application rate to get the acres treated per minute. Multiply this by 1,000 and divide by doubling the aircraft speed.

Acres / Minute x 1,000
------------------------------ = Swath Width
Aircraft Speed x 2

Application Height. Application height describes the distance between the nozzle tips and the target, be it the plant canopy or open ground at the target site. The effective swath width usually increases as the application height increases due to air movement. Spray drift management studies indicate that application height can affect the amount of offsite drift of the spray, depending on the spray droplet size. Therefore, in order to minimize offsite drift risk, small droplet sprays require lower application heights. The greater the application height, the more time it takes for spray droplets to reach the target and so they are subjected to evaporation and other forces that create offsite drift. With larger spray droplets, application height can increase. An application height of 8 to 10 feet is usually the maximum suitable for applying 150–200 μ spray droplets. For application heights greater than 8 to 10 feet, larger spray droplets are needed to reduce drift. Application height limits or a range of application heights for a particular product is usually given on the pesticide label. Flying too low can cause additional drift issues because of air turbulence hitting the ground (ground effect).

Arrange nozzles on the boom in such a way as to produce the desired deposition pattern with the material being applied from the application height selected. Keep application height constant during each swath run to obtain uniform coverage of the target site. Avoid adjusting application height to either change the swath width or spray pattern uniformity. Swath width and pattern uniformity are best corrected with nozzle adjustments.

Determining the Acres per Minute Treated: To calculate the number of acres treated in one minute, use the speed and the effective swath width measurements in the calculations shown here.

$$\frac{\text{MPH} \times 5{,}280 \text{ Feet / Mile}}{60 \text{ Minutes/Hour}} = \text{Feet / Minute}$$

Once the swath width and speed are known, then the acres per minute can be found by using the formula:

$$\frac{2 \times \text{Swath with (feet)} \times \text{speed (MPH)}}{1000} = \text{Acres per Minute}$$

$$\frac{\text{MPH} \times 5{,}280 \text{ Feet / Mile}}{60 \text{ Minutes / Hour}} = \text{Feet / Minute}$$

Feet / Minute x Effective Swath Width = Square Feet / Minute

$$\frac{\text{Square Feet / Minute}}{\text{43,560 Square Feet / Acre}} = \text{Acres / Minute}$$

Determining the Per Acre Application Rate: Utilizing the calculations in the above sections a per acre application rate can be determined by dividing calculated acres per minute being treated into the amount of liquid being applied per acre.

$$\frac{\text{Gallons / Minute}}{\text{Acres / Minute}} = \text{Gallons / Acre} \qquad \frac{\text{Pounds / Minute}}{\text{Acres / Minute}} = \text{Pounds / Acre}$$

Determining the Amount of Pesticide to Put into the Tank: The label or contracted job prescribes how much pesticide to apply per acre. Be sure to check that the job does not exceed the legal rate given on the label. It may be necessary to adjust nozzle output or modify the application pattern to achieve this desired rate. For example, more than one pass may be needed to apply the total number of gallons of spray or pounds of granules per acre as required by the label, job order, or recommendation application rate.

Use tank volume and the gallons per minute figure to calculate how much time it will take for the liquid in the tank to be sprayed out. Once this time is known, the total area covered with each tank of material can be calculated. The result will be the actual acres of treatment site that can be sprayed with one tank of pesticide mixture. Knowing this value and the recommended rate of application (units of pesticide per acre of treatment area) makes it possible to determine how much pesticide to put into the tank.

$$\frac{\text{Gallons / Tank}}{\text{Gallons / Minute}} = \text{Minutes / Tank}$$

To determine the amount of chemical to add to the tank, first figure the acres per tank that can be sprayed by using the formulas:

$$\frac{\text{Gallons / Tank}}{\text{Gallons / Acre}} = \text{Acres / Tank}$$

$$\text{Minutes / Tank} \times \text{Acres / Minute} = \text{Acres / Tank}$$

The amount of pesticide to add to the tank can then be determined by using the formulas:

$$\frac{\text{Pints / Acre} \times \text{Acres / Tank}}{\text{8 Pints / Gallon}} = \text{Gallons / Tank}$$

$$\text{Acres/ Tank} \times \text{Chemical (Pts., Qts., or Gallons) / Acre} = \text{Chemical / Tank}$$

Granules: The techniques for calibrating granule applicators are similar in many ways to those used for liquids. However, granules vary in size and shape from one pesticide to the next, influencing their flow rate from the applicator hopper and spreader. Temperature and humidity may also influence granule flow. Due to their lower drift potentials, pesticides formulated as granules can generally be delivered from greater application heights than those suitable for liquids. Higher application heights can also produce more uniform deposition patterns.

Before beginning to calibrate a granule applicator, be sure that it is clean and all parts are working properly. Three variables should be measured when calibrating a granule applicator:

- application speed
- output rate
- swath width

Always measure **speed** under actual working conditions with the aircraft loaded and at the altitude that a granule application will be made.

To determine the **rate of output**, follow the manufacturer's guidelines and set the ram-air spreader gate or centrifugal spreader gate to the desired rate per acre. Place a series of at least 13 collection pans at 5-feet intervals in a straight line on the ground perpendicular to the flight line. The footprint shape of the collection pans is unimportant, but the pans should be approximately 4 inches deep and have an area of **1 square foot**. All of the collection pans must be exactly the same size. Pad the bottom of each pan with a thin layer of foam to help prevent granules from bouncing out.

Fly a swath test along a centerline oriented at a right angle to the line of collection pans. If ambient wind speed is greater than a sustained 8 mph, orient the line of pans at a right angle to the prevailing wind and fly directly into the wind.

After the swath test flight, collect the granules from each pan. Use a small graduated cylinder to collect and measure the granules in each individual pan, progressing from left to right. Record the quantity of granules from each pan on a graph in the exact order of collection. Finally, combine the granules from all the pans into another container, weigh, and record this weight. Calculate the total area of the 13 pans or 13 square feet.

$$\frac{\text{Total Ounces Collected x 43,560 Square Feet / Acre}}{\text{Total Square Feet of Pans x 16 Ounces / Pound}} = \text{Pounds / Acre}$$

The distribution of granules caught in the 13 pans laid out 5-feet apart across equals a 60-foot swath. Another pass centered 30 feet to the right of the first pass would result in a 50% overlap of the swaths and produce an ideal, even distribution of granules. This would represent an **effective swath width** of 30 feet.

$$\frac{\text{Swath Width} + 50\% \text{ Swath Width}}{2} = \text{Effective Swath Width}$$

Once the effective swath width is known, the amount of granules, in pounds per acre, can be estimated. Unfortunately, it is often impossible to accurately calibrate dry materials unless the actual materials are being used. Spreading pesticide granules onto an area not designated for the application of a pesticide is dangerous and irresponsible. If possible, obtain “blank” granules (granules of the same size, shape, and weight as the pesticide product, but without the pesticide active ingredient) from the manufacturer to use for calibration. If this is not possible, the only alternative is to rely on the equipment manufacturer recommendations for setting and adjusting the ram-air spreader gate or centrifugal spreader gate to the desired rate per acre. This setting should result in accurate initial application rates. This rate can be fine-tuned to be even more precise by calculating the amount of pesticide that was applied to a known area and comparing that to the desired rate.

Test your knowledge

Sample Calibration questions

Q1. What is calibration?

Q2. Why is ground speed important when calibrating many kinds of application equipment?

Q3. List some important factors to consider when calibrating a sprayer.

Q4. List some important factors when calibrating granular application equipment.

Q5. While calibrating a handheld granular applicator to apply insect granules to control ants in a 100 foot long test area, with a 60 inch application band, it is noted that it takes ½ pound of formulation to refill the hopper. The directions on the pesticide label lists two broadcast rates of 45 pounds per acre, or 1 pound per 1000 square feet.

1) Show how to determine whether the equipment is delivering the correct amount of pesticide to the target. First, calculate the square foot area covered in the test run. Second, find the pounds per 1,000 square feet that was applied.

2) Is the answer within 5 percent of the recommended application rate?

Answers and Solutions to Sample Problems

A1. Calibration is the process of measuring and adjusting the amount of pesticide that a piece of equipment will apply to a target site.

A2. For many types of application equipment, the speed at which the equipment travels across the target site is one of the main factors in calibration. Unless the release of the pesticide is geared to the turning of the equipment's ground wheels, the speed at which the equipment moves is one factor which determines the amount of pesticide applied in a given area.

A3. Some factors that affect sprayer calibration include equipment speed, pump pressure, spray volume to be delivered and the type of diluent used (usually water).

A4. Some factors that affect the calibration of granule applicators include size of the adjustable opening, equipment speed, and roughness of the application site; the size, weight, shape, and texture of the granules in the formulation; temperature and humidity.

A5. (1) To determine the square feet of treated area (L x W), first determine total swath width of the 60 inch band in feet.

12 inches = 1 foot

60 inches ÷ 12 inches = 5 foot swath (W)

Area in Square Feet = 100 ft. Length x 5 ft. Width = 500 sq.ft.

$$\text{Actual Application Rate} = \frac{0.5 \text{ lb.}}{500 \text{ sq.ft.}} = \frac{X}{1{,}000 \text{ sq.ft.}}$$

Cross multiply & solve for X

X = 1 lb., which is the label suggested rate per 1,000 sq.ft.

(2) Label directions give two rates of application: 45 lbs/acre & 1 lb/1,000 sq.ft. Therefore, the acceptable rate of application will be an amount between these two quantities, with an acceptable 5% margin of error between these two calculations.

$$\frac{45 \text{ lbs.}}{43{,}560 \text{ sq.ft.}} \times \frac{43{,}560 \text{ sq.ft.}}{1 \text{ acre}} = \frac{45 \text{ lbs}}{\text{acre}}$$

$$\frac{45 \text{ lbs.}}{43{,}560 \text{ sq.ft.}} \times \frac{43{,}560 \text{ sq.ft.}}{1 \text{ acre}} = \frac{45 \text{ lbs.}}{\text{acre}}$$

$$\frac{1 \text{ lb}}{1{,}000 \text{ sq.ft.}} \times \frac{43{,}560 \text{ sq.ft.}}{\text{acre}} = 43.5 \text{ lbs/acre}$$

With the 5% margin of error, the acceptable application per acre range for both calculation methods would be:

45 lbs./acre + 5% = 47.25 lbs/acre (high end)

43.5lbs./acre – 5% = 41.32 lbs/acre (low end)

The acceptable application range is 47.25 lbs/acre, to, 41.32 lbs/acre

To determine if the 0.5 lb. applied to the 500 sq.ft. is within the allowable limits, calculate:

$$\frac{0.5 \text{ lb.}}{500 \text{ sq.ft.}} \times \frac{43{,}560 \text{ sq.ft.}}{\text{acre}} = \frac{43.6 \text{ lbs.}}{\text{acre}}$$

The 43.6 lbs/acre amount is within the acceptable application range.

(Note: There is an established laboratory protocol for sample analysis which sets acceptable limits depending on the percent active ingredient as directed by the label or claimed by the applicator. The 5% variation in this example is considered acceptable for this demonstration purpose, but should not be considered as an overall acceptable variation standard.)

Appendix A

Insect Identification and Biology

INSECTS

The phylum Arthropoda, the group of animals that includes, crabs, lobsters, spiders, and insects, represents the most abundant group of animals on Earth. Arthropods far outnumber all other types of animals combined, with an estimated one million known species, accounting for some 80 percent of all animals on Earth. Given that a great number of insect species probably exist which remain unknown and unidentified, the actual number of species has been estimated to be in the millions. Arthropods have survived and sometimes thrived over vast expanses of time in the face of cataclysmic, geological, climatic and biological changes because they represent such a diverse group of organisms. Their relatively fast reproductive rates generally allow populations to evolve and diversify quickly. Insects, a class within Arthropods , fill every imaginable environment from the Antarctic to the Mohave Desert with up to 25,000 species in Nevada.

Insects survive on a wide variety of hosts (food) including each other (predators and parasites) and nearly every natural product humans grow or use. Part of their ability to survive and adapt is related to their reproductive capabilities, both in sheer number of potential offspring per individual and rapid generation time.

Insects become a problem when they interfere with human activities. In their multi-faceted roles as consumers and decomposers, insects are integral parts of food webs and their interactions with other organisms and the physical environment may make them vital components of ecosystem ecology. Only about 2% - 3% of all the insect species are pests at one time or another.

When attempting to control insects, we normally only suppress the target population for a small period of time over a relatively small area of land. Insect populations are normally held in check by a variety of natural factors such as temperature, moisture, diseases, and predators & parasites. These natural controls are the primary way most insect populations are suppressed. When we see an outbreak of insects, we are observing an increase in survival between generations from 1 to 2% to 3 or 4%. Small changes in survival may amount to a very large increase in total population size especially when generation time is relatively short. Insect outbreaks often result from a change in suppression or enhancement factors in the habit such as:

1. Use of a chemical in a habitat which may disrupt the size of an insect's predators or prey populations.
2. Weather that favors a pest while suppressing its predators and parasites.
3. Planting of monocultures of host plants (typical U.S. agriculture).

All pest populations must be regularly monitored. This can be done by a variety of means. Some of these methods include traps, both active (baits, lures, pheromones, light, etc.) and passive (sweep nets and visual observations). Accurate records of pest observations can lead to prediction of future outbreaks. Monitoring may also indicate when a pest has reached its economic threshold. This threshold is the point at which, if the insect outbreak continues, it will cause enough damage to pay for the cost of treating.

Insect Identifications

Before any action is taken against a suspected pest, an accurate identification must be made. Pest control handbooks, field guides, and other references may be adequate for identification of common pests and beneficial insects. The scope of these references may be limited and they may be difficult to use. For more accurate identification of the insect, identification is available from the State Entomologist and the Nevada Department of Agriculture.

Basic Requirements for Submitting Insects for Identification

When submitting insects for identification it is crucial to provide as much information about the sample as possible. Accurate information about the sample is valuable data and can be an important part of the official record of arthropod species that occur in Nevada. Samples that are submitted may become a permanent part of the State Collection. Proper preservation of the insect is important. Below are some simple steps in taking when submitting insect for identification:

Basic Collection Information (see *Insect Specimen Submission Form*):

- Location (city, county, state)
- Date collected
- Collector - name, address, company, and phone number
- Host - scientific name preferred
- Infestation - number per leaf, tree, etc.
- Damage – extent of impact

Preserving and Submitting

- Most soft-bodied insects and arachnids should be preserved in 70% alcohol (preferably ethanol).
- Never fill the vial more than 1/2 way with specimens or materials.
- Most hard bodied insects (such as beetles, flies, bees & wasps) can be killed and sent dry in a padded envelope or box.
- Host (what the specimens were collected on or where they were collected) should always be filled in if known.
- When sending insects and arachnids, always send as many as possible (10 or more recommended).
- If present, adult insects are best. However, if several life stages are present, send all that are available.
- Unless otherwise noted, always sort specimens from material and preserve before submitting
- Remember that samples submitted on tape may get a limited identification.

Identifying Insects from other Arthropods

In most taxonomic schemes, the Animal Kingdom is broken down into smaller groups called Phyla (singular, phylum), each of which is further divided into many smaller groups called Classes. The phylum Arthropoda includes insects, millipedes, centipedes, spiders, and crustaceans. All animals in the phylum have the following characteristics:

1. Segmented bodies comprised of 2 or 3 distinct body regions
2. Paired and segmented appendages
3. External skeleton of chitin
4. Ventral nerve cord
5. Open circulatory system as opposed to a system with enclosed veins and arteries (such as our own)

Differences between insects and other classes of Arthropods:

Crustaceans
- Two body divisions (head, abdomen)
- No wings
- Five or more pairs of legs
- Two pairs of antennae
- (Examples: crabs, crayfish, shrimp, and sowbugs (pillbugs)

Millipedes (Diplopoda)
- Two body divisions
- No wings
- Two pair of legs/ body segment (many segments)
- No or 1 pair of antennae

Centipedes (Chilopoda)
- Two body divisions
- No wings
- One pair of legs/ segment
- No or 1 pair of antennae

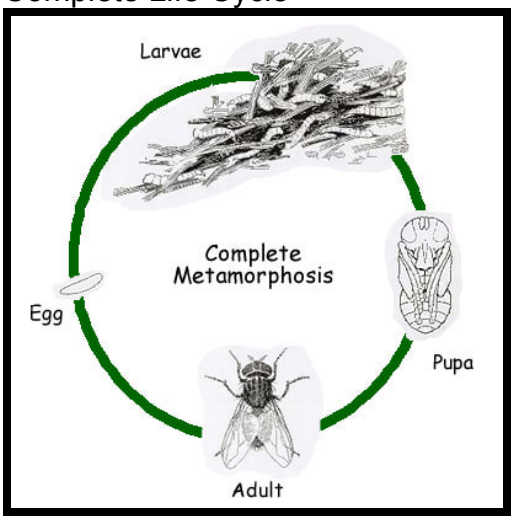
Arachnids (Spiders)
- Two body parts
- Four pairs of legs
- No antennae
- No wings

Insects
- Three body regions head, thorax, abdomen
- Three pairs of legs
- One pair antennae
- Often wings in adult stage; usually 2 pair

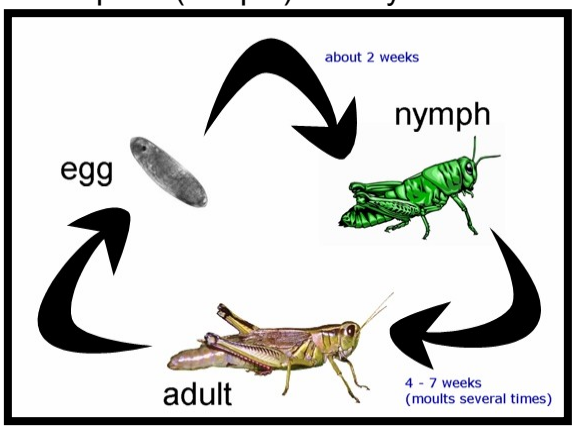
Class Insecta (all insects)

Insect life cycles: It is important to know the life cycle of an insect so that control mechanisms, when necessary, may be incorporated at the most susceptible stage. We generally refer to the life cycle of insects as **complete** or **incomplete** (also called simple). Eggs of insects that have a complete life cycle pass through larval and pupal stages before developing into adults. In an incomplete, or simple life cycle, eggs become nymphs which eventually become adults. Unlike larvae which pupate into adults, nymphs have a body form which already resemble adults. Nymphs do not pupate into adults.

Complete Life Cycle



Incomplete (Simple) Life Cycle



Many insects are only pests during certain stages of their life and often may only be effectively controlled in one or two stages of their life cycles. Knowledge of an insect species life cycle and life history is an important part of insect control. Without this knowledge, much effort and time may be wasted on control measures.

The class Insecta is a very diverse group of invertebrates within the Arthropod phylum. Although they are a very diverse group of animals, all insects have three pairs of legs, a body divided into three parts, one pair of antennae and a chitinous exoskeleton. The Insecta class is further subdivided into about 30 orders, more or less, depending on the taxonomic classification scheme used. Orders of insects are distinguished from one another by certain identifying characteristics such as types of mouthparts (chewing and sucking are the most common), presence, absence and number of wings, wing structure, type of life cycle, and presence of social forms, and other morphological and life history traits.

Important Insect Pest Orders	Mouthparts	Life Cycle	Wings (if present)
Thysanura	chewing	simple	none
Collembola	chewing	simple	none
Dermaptera	chewing	simple	none, 2pr
Blattodea*	chewing	simple	2 pr
Orthoptera	chewing	simple	2pr
Phthiraptera	chewing/sucking	simple	none
Thysanoptera	rasping	simple	2pr, none
Hemiptera	sucking	simple	2pr
Homoptera	sucking	simple	2 pr
Neuroptera	chewing/sucking	complete	2 pr
Lepidoptera	chewing/sucking	complete	2 pr
Coleoptera	chewing	complete	2 pr
Siphonaptera	sucking	complete	none
Hymenoptera	chewing	complete	2 pr
Diptera	lapping-chewing sucking-sponging	complete	1 pr

* The order Blattodea used to be only cockroaches. Today it comprises cockroaches and termites (termites were in the former order Isoptera). Ispotera is now an infraorder within Blattodea.

Basic Summary and Example Organisms of the Insect Orders

Thysanura: This order contains the silverfish and firebrats. They are very primitive, soft-bodied insects with chewing mouthparts that lack wings but have long cerci. **Length**: 0.35" - 0.50". These insects are nocturnal and can cause damage to stored books, other paper products, wallpaper and other products containing starch.

Collembola: Springtails make up this order. Small, wingless insects without compound eyes, these insects go through a simple life cycle. They get around using a tail-like structure that folds beneath their body and propels them. **Length**: 0.04" - 0.08". They inhabit moist areas and may be a nuisance in homes. Only one genus is known to feed on seedlings and mushrooms.

Dermaptera: The earwigs make up this order. They have long slender bodies with or without wings that end in pincer-like cerci. **Length**: 0.75" - 1.0". A nuisance pest in homes, they are a minor pest in vegetable gardens and ornamentals.

Blattodae: Cockroach and termite order. Cockroaches have an oval, brown to black body, two pairs of membranous wings, if present, and long antennae. Their head is bowed down and covered with a pronotum. **Length**: depending on the cockroach, their lengths range from 0.5" (brown-banded) - 2.0" (American). They can run rapidly, are generally nocturnal and flee quickly from a sudden light source (with the exception of the Asian cockroach which is attracted to light).

Blattodae: **-Cont.** Termites comprised the former order Isoptera until recent research revealed that termites are so closely related to cockroaches that contemporary taxomic schemes now place termites in the cockroach order, Blattodae, making Isoptera an “infraoder” within the Blattodae. Termites have a broad juncture at the abdomen and thorax, two pairs of similar sized and shaped, membranous wings and moniliform antennae. **Length**: depending on species and life stage, termite adult reproductives range from 0.35" - 1.0". They are pests of wood and require cellulose from wood or other plant tissue for food. They are social insects.

Orthoptera: This order contains grasshoppers, and crickets. Their life cycle is simple. They have strong chewing mouthparts. Their rear wings are membranous and are covered and protected by the front pair. Most are large insects and many are pests **Length**: depending on species and life stage, these insects adults can range from 0.6" - 2.0" for crickets and grasshoppers.

Phthiraptera: This order is subdivided into sucking lice (suborder Anoplura) and chewing lice (suborder Mallophaga). The sucking lice feed on their host’s blood while chewing lice feed on hair, feathers, or skin. Lice are small wingless ectoparasites (external parasites that live on the exterior body of their host as opposed to internally), that have a simple life cycle spent entirely on their host. The head is wider than the thorax. **Length**: 0.04" - 0.12". Most are ectoparasites on birds, domestic fowl and mammals and can transmit disease. Only the sucking lice are human parasites.

Thysanoptera: Thrips are minute insects and may be winged or wingless. If winged, there are four narrow wings with long hairs. They have a simple life cycle and feed by rasping-sucking plant juices. **Length**: 0.04" - 0.06". Most feed on flowers, buds, and leaves and injury to plants can be serious. On the other hand, a few species may be beneficial to plants because they prey on mites and scale insects and some species aid in pollination.

Hemiptera: This order, known as the true bugs can be recognized by their distinctive proboscis (mouthpart formed into a beak used to pierce plant tissue and suck plant liquids) and the “X” formed by their folded wings. This order includes both pests and beneficial insects. They have piercing-sucking mouthparts and a simple life cycle. **Length**: depending on the true bug, their lengths range from 0.2" (bed bugs) - 2.0" (giant water bugs). The order includes box elder bugs, leaf footed bugs, stink bugs, assassin bugs, big-eyed bugs, minute pirate bugs, and bed bugs.

Homoptera: In this order we find the aphids, leafhoppers, cicadas, scales and mealybugs. All are plant feeders and may be pests. They have piercing-sucking mouthparts, are winged or wingless and may have simple to near complete life cycles. **Length**: aphids 0.05" - 0.12"; leafhoppers 0.12" - 0.15"; cicadas 0.5" - 1.0"; scales 0.4" - 0.7"; mealybugs 0.12" - 0.2". Many are vectors of plant diseases, viruses and mycoplasmas.

Neuroptera: Antlions and lacewings are placed in this order. Most of the members of this order are predacious. The adults in this order have wings that have numerous veins giving them a net-like appearance. Larvae can be destructive. They have chewing mouthparts. They have complete life cycles and many are important aquatic insects. **Length**: lacewing adults 0.4" - 0.8"; antlion adult 1.5".

Lepidoptera: The major characteristic of the adults of this group are scale-covered wings. They have a long tube mouthpart for sucking/siphoning, two pairs of wings and they go through complete metamorphosis. This order contains the moths and butterflies. Many serious pests occur in this order. **Length**: butterfly and moth adults vary in length from 0.35" to over 5". Their larvae are caterpillars.

Coleoptera: This is the largest order of insects with over 300,000 species commonly referred to as beetles. Most can be easily identified by the hardened forewings, called elytra. This order contains both beneficial and injurious species of beetles. **Length**: beetle adults vary in length from 0.10" (carpet beetles) to beetles over 3" The larvae are called grubs and are economically important because this is the stage they do most of their damage.

Siphonaptera: Fleas are brown, flattened, wingless insects with jumping legs and reaching mouthparts. **Length**: 0.04" - 0.15". They have a complete life cycle and are vectors of diseases such as bubonic plague and typhus.

Hymenoptera: This order contains the ants, bees, wasps and sawflies. This order contains many beneficial insects; however the adult's ability to sting can cause problems. The sawflies are a group whose larvae are plant feeders and the adults lack the conspicuous constricted abdomen **Length**: ants 0.06" (little black ant) - 0.5" (carpenter ant); bees 0.09" (andrenid bee) - 1" (carpenter bee); wasps 0.01" (parasitic wasps) - 1.3" (tarantula hawks & mud daubers); and sawflies 0.15" (leaf miners) - 1.5" (horntails).

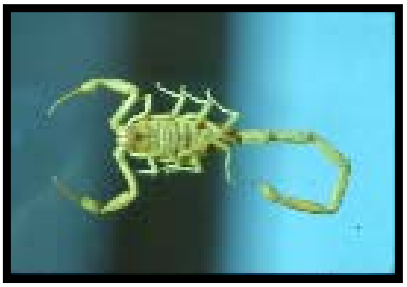
Diptera: This order contains the flies, mosquitoes, and midges. The members of this order feed on a variety of materials. They have only one pair of membranous or clear wings. **Length**: flies 0.03" (crane fly) - 1.1" (horse fly); mosquitoes 0.12" - 0.18"; and midges 0.05" - 0.3". They experience a complete life cycle.

Although other Arthropods are sometimes commonly called insects , for the purpose of pest control it is important to know that Arthropod is a larger category of animals that includes insects (class Insecta), spiders, scorpions and mites (class Arachnida), crustaceans (Malacostraca and others) and others. The following photographs show some commonly encountered "Insects" which are in fact types of Arachnida (spiders and scorpions).

Araneae (spiders).

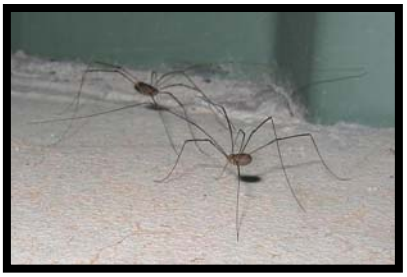
Acari (mites)

Scorpiones scorpions



Solifugae wind scorpions

Opiliones harvestmen, daddy longlegs



Nevada Department of Agriculture Insect Specimen Submission Form

Do not fill out boxes in red

Rating State # File Submit by Email Print Form

Quar Nur Agr Urb Sur Date collected

Collector1 Collector2 Collector3

County Abbreviation City

Collector's Address

email address Phone#

Owner Consignee Name

Owner address

State County Fed PCO Other

Quar shipper Quar address

Type of insect Host

Alive Dead Trapped Egg Larva Nymph Pupa Adult

Infestation:

Single specimen Leaf Stem Limb Fruit Sweep Trap

per Sq yd Linear ft Animal Other-1

Damage:

Acres Single plant Scattered All plants Heavy Medium Light None

Identification :

Please Do Not Write in The Fields Below !!

Order Family

Genus Species Subspecies

Commonname

Order2 Family2

Genus2 Species2 Subspecies

Commonname2

General Restricted New Not in New state or county record

Pest Scavenger Parasite Predator Innocuous

Notes

Determiner Processdate

Appendix B

Fact Sheet 96-18 Water pH and its Effects on Pesticide Stability

UNIVERSITY OF NEVADA •Reno

COOPERATIVE EXTENSION
Bringing the University to You

Nevada Agricultural Experiment Station

Fact Sheet FS-02-36
(Replaces Fact Sheet FS-96-18)

WATER pH AND ITS EFFECT ON PESTICIDE STABILITY

Peggy McKie, Agriculturist, Nevada Department of Agriculture
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Have you ever used a pesticide, or had someone apply one for you and it did not control the pest? You may have attributed the poor control to weather conditions, the chemical itself, applicator error, pest resistance, or maybe that you bought the wrong material. But have you ever thought to check the pH of the water used to mix the pesticide? The pH of the water that goes into your spray tank makes a difference in how effectively the pesticide works.

How does pH affect pesticides?

The characteristics of water used in a spray mix influence the effectiveness of some pesticides. One of the most important is the pH of the water: it's relative acidity or alkalinity. Water with a pH higher than 7 is alkaline. Many pesticides, particularly commonly used organophosphate and carbamate insecticides, undergo a chemical reaction in the presence of alkaline water that reduces their effectiveness. This reaction is called alkaline hydrolysis. The pesticide is hydrolyzed and rendered ineffective when it is mixed with water with a pH greater than 7. The more alkaline the water, the more rapidly the pesticide breaks down. The severity of the reaction is determined by:

- how susceptible the pesticide is to alkaline hydrolysis,
- the amount of time the pesticide is in contact with the alkaline water,
- the temperature of the diluted pesticide mixture, and
- the level of alkalinity (pH) of the water.

The hydrolysis can be very fast when the pH of the water is greater than 8 or 9. For every unit increase in pH, the rate of hydrolysis increases 10 times. Some pesticides begin to break down as soon as they are combined with alkaline water in the tank, especially when the pH of the water is very high. As a consequence, the active ingredients start to change to inactive ingredients before the pesticide ever leaves the tank! The degree of pest control may be somewhat to greatly decreased or even lost completely. If a spray tank is allowed to stand for several hours or overnight before the contents are used, as much as 50% of the active ingredient may be lost.

Do I need to worry about the pH of water in Nevada?

Many water supplies in Nevada have a pH high enough to cause hydrolysis of susceptible pesticides. Water sources may have varying degrees of alkalinity even if they are in the

same hydrologic basin. If the pH of your water is higher than 7.5, it is alkaline enough to affect some pesticides. Use a pH meter or pH test kit such as those used for testing swimming pool water to accurately determine the pH of the water. Test papers, like hydrion or litmus can be inaccurate and should not be used. Both surface and ground water pH can and do change with time. The pH may fluctuate seasonally. It is a good practice to test the pH of the water just prior to mixing up your spray solution. If your water supply is alkaline, with a pH of 7.5 or greater, you can and should lower the pH, particularly if you are using a pesticide that is sensitive to high pH. A pH of 4 to 7 is recommended for mixing most pesticides. You can adjust your spray solutions to the 4 to 7 pH range with commercially available buffering agents.

What is a buffering agent?

A buffering agent changes the pH of a spray solution to a prescribed level and keeps it there. They are often straight acidifying agents, but many are sold as combination products containing surfactants, trace elements or other fertilizers. Examples of commercially available buffering agents are Buffer-X® (Kalo, Inc.), Buffer®(Ladda Co.), Spray-Aide®(Miller Chemical), and Buffercide®(Custom Chemicals). Buffering agents prevent pesticide hydrolysis during mixing and storage in the tank, until the spray is applied and the water has evaporated away.

How will I know if a product should be buffered?

If the product label tells you to avoid alkaline water or materials, the spray mixture will benefit by adjusting the pH to 6 or slightly lower. In general, insecticides are more susceptible to hydrolysis than fungicides and herbicides. Among insecticides, the organophosphates and carbamates are decomposed by alkaline hydrolysis much more rapidly than others.

Many manufacturers provide information on the rate at which their products hydrolyze. This rate is usually expressed as 'half-life' or the time it takes for 50% of the product to breakdown (hydrolyze), Table 1. Dimethoate (Cygon) has a half-life of 1 hour at a pH of 9. This means that if the pH of your spray water is 9, and one hour elapses between the times you mix-up the dimethoate and spray it out, 50% of the active ingredient is already lost! However, if your water has a pH of 6, it is not likely that any significant loss of active ingredient will have occurred in one hour.

Are there any materials that should not be mixed with a buffering agent?

Yes! Under no circumstances should sprays containing fixed copper or lime fungicides, including Bordeaux, copper oxide, basic copper sulfate, copper hydroxide, etc. or lime sulfur be mixed with a buffering agent, or plant damage may occur, Figure 1.

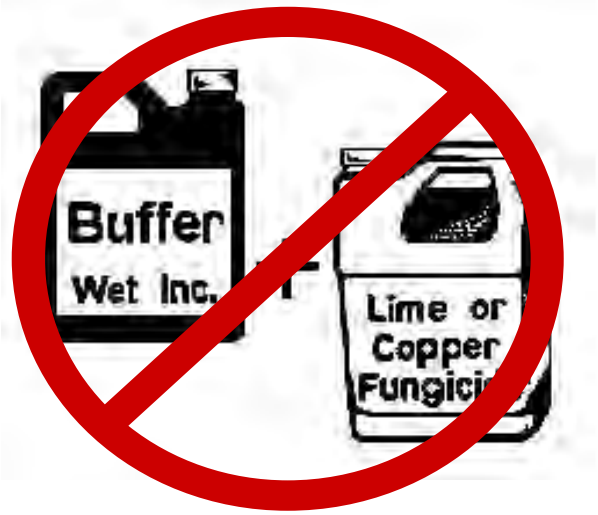

Figure 1. Do not mix buffering agents with lime sulfur or fungicides that contain lime or copper.

Table 1. The Half-life of Selected Pesticides at Different pH Values[1]

Pesticide		Half-life Time[2] at Different Solution pHs								
Common Name	Trade Name	3	4	5	6	7	8	9	10	11
acephate	Acephate Pro	65d						16d		
azin-phos methyl	Guthion			17d		10d		12h		
bendiocarb	Ficam					4d				
carbaryl	Sevin				125d	27d	2-3d	1-3d		
carbofuran	Furadan				200d	40d	5d	3d		
chlorothalonil	Daconil		Stable below pH7				38d			
diazinon	Knox-Out			31d		185d		136d		
dimethoate	Cygon				12h			1h		
disulfoton	Di-syston			60h	32h			7h		
malathion	Digon				8d	3d	19h		2h	
methomyl	Lannate				54w	38w	20w			
phosmet	Imidan		13d			12h	4h		1m	
methylparathion	Declare			690d		120d			29h	3h
trichlorfon	Dylox				4d	6h	1h			

1. These figures are generalized estimates and reflect trends, but half-life times vary considerably. Hydrolysis depends on other factors besides the pH of the solution, including temperature, the presence of other pesticides and adjuvants in the spray tank, and the formulation of the pesticide.
2. w = weeks, d = days, h = hours, m = minutes.

How much buffering agent should be used?

To determine how much buffering agent should be used in the spray tank depend on three things: 1) the pH of the water, 2) the volume of the mixture that will be made up for the application and 3) the buffering agent used—its type and effective concentration. Once the pH of the water is determined, read and closely follow the directions on the label of the buffering agent. Follow the directions in Table 2 for help.

Summary

If your water source has a pH above 7, addition of a buffering agent to the spray solution is an easy and economical way to guarantee maximum results from your pesticide application. Know the pH of water that is used with your pesticides and make the appropriate buffering adjustments. Whenever possible, use pesticides that do not hydrolyze in alkaline water. That information is available on the label.

Table 2. Testing and Adjusting the pH of Alkaline Water Used for Mixing Pesticides[1]

Measure pH with an electronic pH meter or swimming pool test kit. Test paper used for pH testing is less reliable and should not be used.

Water pH Testing Procedures:

1. Collect a sample of water from the same source that will be used to fill the spray tank. Use a clean container and rinse it several times with the same water.

2. Check the pH of the water using a pH meter or test kit. Follow the manufacturer's directions.

pH 3.5-6.0:	Satisfactory for spraying and short-term (12 to 24 hours) storage of most spray mixtures in the spray tank.
pH 6.1-7.0:	Adequate for spraying most pesticides. Do not leave the spray mixture in the tank more than 1 to 2 hours or the pesticide may lose its effectiveness.
Above pH 7.0:	Add buffer or acidifier

pH Adjustment Procedure:

1. Using a standard eyedropper, add 3 drops of buffer or acidifier to a measured pint of water.
2. Stir well with a clean glass rod or other clean, non-porous utensil.
3. As described above, check the pH and compare the results to the pH ranges given in number two.
4. If further adjustment is needed, repeat steps 1 through 3. Repeat until the pH is satisfactory. *Record how many times 3 drops were added to bring the solution to the proper pH!*

Correct pH in Spray Tank:

1. Before adding pesticides to the sprayer, fill the tank to the level required for the application.
2. For every 100 gallons of water in the spray tank, *add 2 ounces of buffer for each time 3 drops of buffer were used in the jar test above.* Add buffer or acidifier to water while the agitators are running. If the tank is not equipped with an agitator, stir or mix the solution well by hand.
3. Collect a sample of the water in the sprayer and check the pH to be certain it is correct. Add more buffer if necessary and recheck the pH.
4. Once the pH is correct, add the pesticides to the spray tank.

1. *From* The Safe and Effective Use of Pesticides, *University of California Statewide Integrated Pest Management Project.*

Appendix C

Hantavirus - An Update

HANTAVIRUS - AN UPDATE

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In May 1993, a cluster of unexplained deaths in the Four Corners area of Southwestern United States led to the discovery of a previously unrecognized disease. This disease, Hantavirus Pulmonary Syndrome (HPS), is caused by a previously unknown hantavirus, the Sin Nombre virus.

Though newly discovered in the southwest, hantaviruses are not new. During the Korean war, over 3,000 United Nations troops contracted hemorrhagic fever with renal syndrome (HFRS) a disease caused by another hantavirus. There is evidence that HFRS was known as early as 960 AD in China.

Although it was discovered in 1993, the Sin Nombre virus is not new in the United States. Some cases have been diagnosed from the saved blood of people who died from unknown causes - one died in 1959. The virus has been present long enough to differentiate into subtypes. Using RNA analysis, the Center for Disease Control has determined for example, that an Arizona resident died from HPS that he contracted in Colorado. The Navajo Indians, through oral history say that deer mice and people should not be together because deer mice cause sickness. They further say that in 1918, 1933, and 1934, rain caused large piñon nut crops that caused high populations of deer mice that resulted in deaths in young healthy Navajo.

Prior to the discovery of the Sin Nombre virus in 1993, five strains of hantavirus were recognized along with many subtypes (Table 1). The mortality rates from these diseases vary but generally are under 10%. One strain, Prospect Hill, that is known in the Eastern United States, has not been shown to cause disease in humans.

Hantaviruses are maintained in nature by a reservoir species (usually a rodent) that carries the virus but does not contract the disease (Table 1). Once infected, the reservoir species probably carries the virus for the rest of its life and sheds the virus in feces, urine, and saliva. This appears to be the case for deer mice (*Peromyscus maniculatus*), the reservoir species for the Sin Nombre hantavirus. There have been thousands of deer mice trapped and tested for hantavirus in the U.S. since the 1993 outbreak and as the age of deer mice (indicated by body weight) increases, the percent found hantavirus-positive increases. Non-reservoir species may carry the virus to a lesser extent and for shorter periods.

Other closely related viruses have since been discovered in the United States. The Black Creek Canal virus in the Southeast occurs outside of the range of the deer mouse and is reservoired by the cotton rat (*Sigmodon hispidus*). The Bayou virus in Louisiana and Texas is associated with the rice rat (*Oryzomys palustris*) and HPS cases in the Northeast are linked with the deer mouse and white footed mouse (*P. leucopus*)

Since the 1993 outbreak, the Nevada Division of Health along with other cooperating agencies, have gathered information about hantavirus in Nevada. Several hundred deer mice have been tested with around 10% -12% overall found positive for hantavirus. Occasionally, positives have been found in other species. The closely related cactus mouse (P. eremicus) is an example.

It is interesting to note that similar infection rates have been found in California deer mice. It is probably safe to assume that hantavirus can be found to some extent in deer mice throughout most of Nevada.

Fortunately, HPS is very difficult to contract. Since the disease was discovered in 1993, the Center for Disease Control has collected blood from around 10,000 people who are believed to have a higher risk of coming in contact with infected deer mice. These people include biologists, mammalogists, and animal handlers. Of these, only slightly over 1% carried antibodies to hantavirus.

Unfortunately, despite this fact, HPS unlike HFRS is often fatal. The HPS fatality rate was initially 58% in the Four Corners outbreak. The fatality rate for the cases after that date is currently 30%. Two hundred eighty-three cases have been reported in the U.S. through April 16, 2001.

This good news, bad news, makes it difficult to know the appropriate way to deal with HPS The rest of this paper will give you further information about the disease and its treatment.

Symptoms

The symptoms of HPS are not specific to HPS however, there are some characteristic patterns to look for and be aware of: fever and muscle ache of large muscle groups occur in all cases; abdominal pain is present in about half of the cases, coughing, shortness of breath, dizziness, and chills may also occur. Earaches, rashes, and sore throat are VERY UNCOMMON in HPS.

Symptoms do not appear for 1 to 3 weeks, occasionally up to 6 weeks. Shortness of breath is a symptom that appears later due to the filling of the lungs with fluid. Pneumonia is the most frequent mis-diagnosis of HPS. Abdominal pain and bilateral filling of the lungs in HPS serve to differentiate it from pneumonia.

Transmission

Sin Nombre virus is passed in the feces, urine, and saliva of infected deer mice. Breathing contaminated air is the major route of transmission to people. Being bitten by an infected deer

mouse is also a possible route of transmission, however, it is much less efficient and it is not common. However, biting, along with grooming, probably helps perpetuate the virus in deer mice. Person to person transmission has not been observed and health care workers who have cared for HPS patients have not become infected. Piñon nuts have been mentioned as a possible source of Sin Nombre virus. They are not. While they probably contribute to deer mouse population increases in some areas, piñon nuts do not carry Sin Nombre virus!

Risk Factors

There do not appear to be differences in susceptibility due to age or sex. Increased likelihood of exposure to deer mice or another reservoir species increases someone's chance of contracting the disease.

Entering tightly closed areas that have deer mouse infestations increases risk. Spring and summer are the seasons when most cases occur due to increased contact with rodents. The possibility of exposure for campers, hikers, and tourists is very low.

Prevention

Sanitation and rodent proofing are the best ways to eliminate deer mice and minimize the chances of contracting hantavirus.

To keep deer mice out of a building, seal all openings over 1/4" in size. Locations where utility lines or pipes enter a building may be entrance routes.

Use rodent proof containers for storing food and trash both inside and outside of the home. Keep pet food in sealed containers when not being used.

Remove trash, brush, and debris from around the outside.

Deer mice can be trapped using snap traps (mouse traps.) Peanut butter mixed with uncooked oatmeal makes a good bait. Trapped deer mice can be buried or placed in a bag and then thrown into the trash.

Safety Precautions

To reduce risk of contracting HPS wear rubber gloves when handling deer mice. Clean up urine and feces by spraying with a disinfectant solution and then wipe up. Do not sweep or vacuum if at all possible since stirring up dust increases the levels of airborne virus.

If dusty areas must be entered wear a respirator or dust mask with a HEPA filter to remove viruses. It is probable that the virus only remains viable for 3 or 4 days in feces and urine. Because of this, trapping deer mice from an area and waiting 3 or 4 days before cleaning will also reduce levels of virus.

Treatment

There is no specific antidote or vaccine for HPS. Treatment consists of ventilation and early aggressive treatment of the symptoms. Transfer to an Intensive Care Unit that provides detailed monitoring is extremely important. A drug, "Ribarvirin", has been given to patients and is thought to provide some benefit.

Identification of Deer mice

Deer mice and house mice (*Mus musculus*) are similar looking but have characteristics that enable them to be differentiated. Deer mice have white hair on their belly, legs, and feet. Their tail has short hair that is bicolored: dark on the top and white on the sides and bottom. The house mouse has a tail that is scaly with few hairs. The belly of a house mouse is lighter than its back and sides but a house mouse does not have a white belly, feet, and legs.

Deer mice have no odor, whereas house mice have a musty odor. Comparatively, deer mice have larger ears and eyes than house mice.

Table 1. Strains of Hantavirus

Strain	Reservoir Host	Location	Disease
Bayou	rice rat (*Oryzomys palustris*)	Louisiana, Texas	HPS[1]
Black Creek Canal	cotton ran (*Sigmodon hispidus)*	Southeastern United States	HPS
Hantaan	field mouse (*Apodemus agrarius)*	N. Asia, Eastern Europe, Far East	HFRS[2] severe
Northeatern US	deer mouse, white-footed mouse (*P. leucopus*)	Northeastern United States	HPS
Porogia	field mouse (*A. flavicollis)*	Balkans	HFRS severe
Prospect Hill	meadow vole (*Microtus pennsylvanicus)*	N.E. United States	none
Puumala	bank vole (*Cleithrionomys glareolus)*	Europe, Western Russia, Scandinavia, Balkans	HFRS
Sin Nombre	deer mouse (*Peromyscus maniculatus)*	Central Western United States	HPS

1 Hantavirus Pulmonary Syndrome
2 Hemorrhagic Fever with Renal Syndrome

Revised January 9, 2002

Hantavirus Pulmonary Syndrome

Hantavirus Pulmonary Syndrome (HPS) is a rare but severe, sometimes fatal, respiratory disease in humans caused by infection with hantavirus.

What are the symptoms of HPS?

Early Symptoms:

- Fever
- Headaches
- Muscle Aches
- Stomach Problems
- Dizziness
- Chills

Early symptoms include fatigue, fever and muscle aches, especially in the large muscle groups—thighs, hips, back, and sometimes shoulders. About half of all HPS patients also experience headaches, dizziness, chills, and abdominal problems, such as nausea, vomiting, diarrhea, and abdominal pain.

Late Symptoms:

- Lungs Fill with Fluid
- Shortness of Breath

Four to 10 days after the initial phase of illness, the late symptoms of HPS appear. These include coughing and shortness of breath, with the sensation of, as one survivor put it, a "...tight band around my chest and a pillow over my face" as the lungs fill with fluid.

How do people get HPS?

People can get HPS when they are exposed to infected rodents. Exposures may include:

- Breathing in the virus. This may happen when rodent urine and droppings containing hantavirus are stirred up into the air.
- Touching eyes, nose or mouth after touching rodent droppings, urine, or nesting materials that contain the virus.
- A bite from an infected rodent.

HPS is not spread from person to person.

Which rodents can cause humans to get HPS?

Rodents known to carry hantavirus include:

Deer Mouse

Cotton Rat

Rice Rat

White-Footed Mouse

Not all rodents carry hantavirus and there is usually no way to tell when a rodent has the virus. So, it is wise to avoid all contact with rodents when possible.

National Center for Emerging and Zoonotic Infectious Diseases
Division of High-Consequence Pathogens and Pathology

CS235473

How is HPS diagnosed?

Diagnosing HPS in an individual who has only been infected for a few days is difficult, because early symptoms such as fever, muscle aches, and fatigue are easily confused with influenza.

Experiencing all of the following would strongly suggest HPS infection:

- A history of potential rodent exposure
- Fever and fatigue
- Shortness of breath

Anyone experiencing these symptoms and having a history of recent rodent exposure should see their physician immediately and mention their potential rodent exposure.

How is HPS treated?

There is no specific treatment, cure, or vaccine for HPS.

If infected individuals are recognized early and receive medical care in an intensive care unit, they may do better. In intensive care, patients are intubated and given oxygen therapy to help them through the period of severe respiratory distress.

The earlier the patient is brought in to intensive care, the better. If a patient is experiencing full respiratory distress, it is less likely that the treatment will be effective.

How can HPS be prevented?

When people get HPS, it's usually because they've been exposed to infected rodents or their droppings. So, the best way to help prevent HPS is to eliminate or minimize contact with rodents in your home, workplace, or campsite.

There's an easy way to do this – it's known as **Seal Up! Trap Up! Clean Up!**

Seal up holes inside and outside the home to keep rodents out.

Trap rodents around the home to help reduce the population.

Clean up any food that is easy to get to.

For more information on how to Seal Up! Trap Up! Clean Up! visit www.cdc.gov/rodents.

More Information:

For More Information Contact CDC Info: 1-800-CDC-INFO (1-800-262-4636)/TTY 1-888-232-6348 or visit our website at www.cdc.gov/hantavirus

Appendix D

Nevada Laws and Regulations
Chapter 555

Pest Control Nevada Administrative Codes (NAC) Chapter 555 go to:
http://www.leg.state.nv.us/NAC/NAC-555.html

Pest Control Nevada Revised Statutes (NRS) Chapter 555 go to:
http://www.leg.state.nv.us/NRS/NRS-555.html

Pest Control NAC Regulation Changes – Nevada Register go to:
http://www.leg.state.nv.us/

Click on “law Library”

Click on “Table of Contents” under “Nevada Register”

Click on “Subject Index” under the year you want to search.

After clicking, look for “Agriculture (555)” with a subject relating to pest control. Example: For 2014 proposed regulations, look for R033-14 with the latest posting date.