AGRICULTURAL PESTICIDE SUPPLEMENT

PROFESSIONAL DEVELOPMENT CONTINUING EDUCATION COURSE

Technical Learning College

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New Worker Protection Standard 2017

The Worker Protection Standard (WPS) applies to farm, forest, nursery and, greenhouse operations that produce agricultural plants. The WPS is designed to protect agricultural workers from pesticide exposure.

Revisions to the WPS, made by the United States Environmental Protection Agency (EPA), were signed into law in 2016. Farm, forest, nursery, and greenhouse operations must comply with most of these revisions beginning **January 2, 2017**.

The three revisions that will not be required until January 1, 2018 are 1) Training workers and handlers in WPS content, 2) Pesticide safety information display, and 3) Handler application suspension rules.

However, the existing WPS requirements must be continued, with revisions required by the 2017 and 2018 January implementation dates.

Course Description

Agricultural Pesticide Supplement CE Training Course

This supplemental CE course is intended to provide five hours of pesticide applicator education in the following categories: Aerial, Laws & Rules and Other. This course will serve as a source of basic information needed to implement an integrated aerial pest management program and provide continuing education for aerial pesticide applicators, agricultural advisers and agricultural applicators. This course will review basic pesticide safety training information and aerial application methods. This course will cover aerial pesticide usage, various pesticides, and the National Environmental Policy Act (NEPA). This course is general in nature and not state specific. You will not need any other materials for this course.

General Objectives
The course's general objectives are in the following three categories:

Aerial Section 1 hour of credit
1) The student will be able to describe and explain Ground Crew duties, from Buffer Zones, Personal Protection Equipment, Notifying Beekeepers, Identifying Hazard Areas to Boundary Flag Placement. 2) The student will be able to understand and describe pilot duties associated with the following; Pretreatment Reconnaissance, Aircraft Facilities, Spray Tank components, Bleeding Lines, Chemical in Hoppers, Operation Boom Pressure, Computing Aircraft Loads, Kytoons, Ultra Low Volume Formulations, Dye Card Samplers to Decontamination of Equipment.

Course Procedures for Registration and Support:
All of Technical Learning College's correspondence courses have complete registration and support services offered. Delivery of services will include, e-mail, web site, telephone, fax and mail support. TLC will attempt immediate and prompt service.

When a student registers for a distance or correspondence course, he/she is assigned a start date and an end date. It is the student's responsibility to note dates for assignments and keep up with the course work.

If a student falls behind, he/she must contact TLC and request an end date extension in order to complete the course. It is the prerogative of TLC to decide whether to grant the request. All students will be tracked a unique number assigned to the student.

Instructions for Written Assignments
The Agricultural Pesticide Supplement distance training course uses a multiple choice style answer key. You can write your answers in this manual or type out your own answer key. TLC would prefer that you type out and e-mail the examination to TLC, but it is not required.

Feedback Mechanism (examination procedures)
Each student will receive a feedback form as part of his or her study packet. You will be able to find this form in the rear of the assignment.

Security and Integrity
All students are required to do their own work. All lesson sheets and final exams are not returned to the student to discourage sharing of answers. Any fraud or deceit and the student will forfeit all fees and the appropriate agency will be notified.

Grading Criteria
TLC will offer the student either pass/fail or a standard letter grading assignment. If TLC is not notified, you will only receive a pass/fail notice.

Required Texts
The course will not require any other materials. This course comes complete.

Environmental Terms, Abbreviations, and Acronyms
TLC provides a glossary that defines, in non-technical language, commonly used environmental terms appearing in publications and materials. It also explains abbreviations and acronyms used throughout the EPA and other governmental agencies. You can find the glossary in the rear of this manual.

Recordkeeping and Reporting Practices
TLC will keep all student records for a minimum of five years. It is the student's responsibility to give the completion certificate to the appropriate agencies.

ADA Compliance
TLC will make reasonable accommodations for persons with documented disabilities. Students should notify TLC and their instructors of any special needs. Course content may vary from this outline to meet the needs of this particular group.

Note to students: Final course grades are based on the total number of possible points. The grading scale is administered equally to all students in the course. Do not expect to receive a grade higher than that merited by your total points. No point adjustments will be made for class participation or other subjective factors.

Note to students: Keep a copy of everything that you submit. If your work is lost you can submit your copy for grading. If you do not receive your certificate of completion or other results within two or three weeks after submitting it, please contact your instructor.

We expect every student to produce his/her original, independent work. Any student whose work indicates a violation of the Academic Misconduct Policy (cheating, plagiarism) can expect penalties as specified in the Student Handbook, which is available through Student Services; contact them at (928) 468-0665.

A student who registers for a Distance Learning course is assigned a **"start date"** and an **"end date."** It is the student's responsibility to note due dates for assignments and to keep up with the course work.

If a student falls behind, she/he must contact the instructor and request an extension of her/his ***end date*** in order to complete the course. It is the prerogative of the instructor to decide whether to grant the request.

You will have 90 days from receipt of this manual to complete in order to receive your Continuing Education Units (**CEs**).

A score of 70% or better is necessary to pass this course. If you should need any assistance, please email all concerns or call us. If possible e-mail the final test to info@tlch2o.com or fax (928)468-0675.

Educational Mission

The educational mission of TLC is:

To provide TLC students with comprehensive and ongoing training in the theory and skills needed for the pesticide application field,

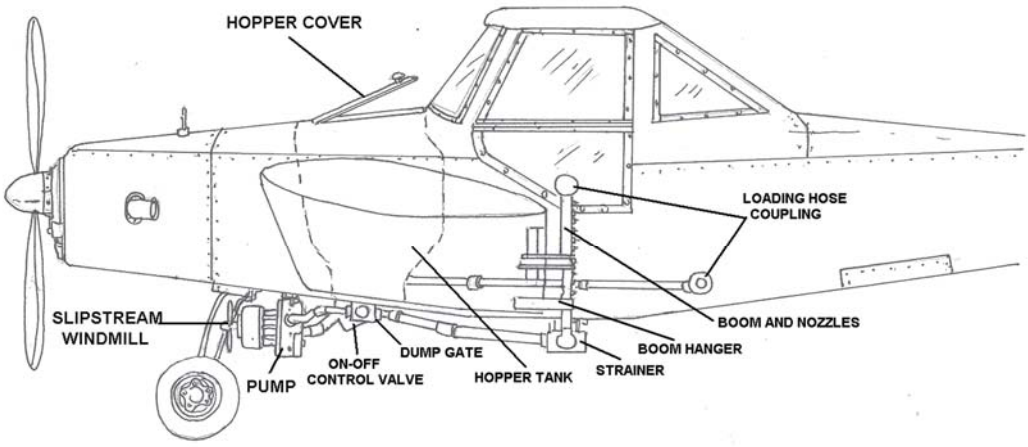
To provide TLC students with opportunities to apply and understand the theory and skills needed for pesticide application certification,

To provide opportunities for TLC students to learn and practice pesticide application skills with members of the community for the purpose of sharing diverse perspectives and experience,

To provide a forum in which students can exchange experiences and ideas related to pesticide application education,

To provide a forum for the collection and dissemination of current information related to pesticide application education, and to maintain an environment that nurtures academic and personal growth.

TLC
P.O. Box 3060
Chino Valley, AZ 86323



CROP DUSTER COMPONENTS

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed.

In late 2015 the Environmental Protection Agency issued the long awaited revision to the Worker Protection Standard (WPS). This law it is now technically active and it will be enforced. Please keep in mind that the WPS covers both restricted use AND general use pesticides. This course is not for worker and/or handler training. Always follow the label and your State Pesticide Agency rules.

Table of Contents

PILOT DOING PRE-FLIGHT CHECKS ON NOZZLES

Agricultural Pesticide Components

Pest control is at least as old as agriculture, as there has always been a need to keep crops free from pests. In order to maximize food production, it is advantageous to protect crops from competing species of plants, as well as from herbivores competing with humans.

The conventional approach was probably the first to be employed, since it is comparatively easy to destroy weeds by burning them or plowing them under, and to kill larger competing herbivores, such as crows and other birds eating seeds. Techniques such as crop rotation, companion planting (also known as intercropping or mixed cropping), and the selective breeding of pest-resistant cultivars have a long history.

All pesticides sold or distributed in the United States must be registered by EPA, based on scientific studies showing that they can be used without posing unreasonable risks to people or the environment. Because of advances in scientific knowledge, the law requires that pesticides which were first registered before November 1, 1984, be reregistered to ensure that they meet today's more stringent standards.

In evaluating pesticides for reregistration, EPA obtains and reviews a complete set of studies from pesticide producers, describing the human health and environmental effects of each pesticide. The Agency develops any mitigation measures or regulatory controls needed to effectively reduce each pesticide's risks. EPA then reregisters pesticides that can be used without posing unreasonable risks to human health or the environment. When a pesticide is eligible for reregistration, EPA explains the basis for its decision in a Reregistration Eligibility Decision (RED) document.

Chemical Pesticides
Some examples of chemically-related pesticides follow. Other examples are available in sources such as Recognition and Management of Pesticide Poisonings.

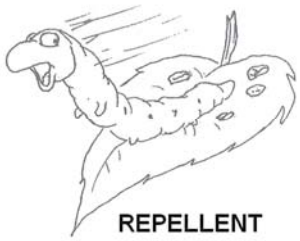
Organophosphate Pesticides - These pesticides affect the nervous system by disrupting the enzyme that regulates acetylcholine, a neurotransmitter. Most organophosphates are insecticides. They were developed during the early 19th century, but their effects on insects, which are similar to their effects on humans, were discovered in 1932. Some are very poisonous (they were used in World War II as nerve agents). However, they usually are not persistent in the environment.

Carbamate Pesticides affect the nervous system by disrupting an enzyme that regulates acetylcholine, a neurotransmitter. The enzyme effects are usually reversible. There are several subgroups within the carbamates.

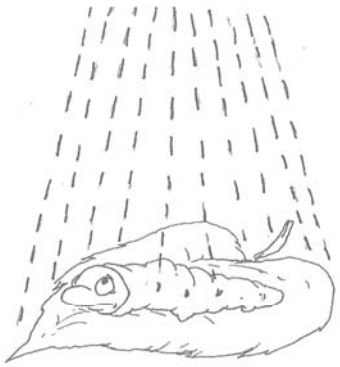
Organochlorine Insecticides were commonly used in the past, but many have been removed from the market due to their health and environmental effects and their persistence (e.g. DDT and chlordane).

Pyrethroid Pesticides were developed as a synthetic version of the naturally occurring pesticide pyrethrin, which is found in chrysanthemums. They have been modified to increase their stability in the environment. Some synthetic pyrethroids are toxic to the nervous system.

INGESTED



REPELLENT



DIRECT CONTACT

SECONDARY CONTACT

LURE AND KILL

FUMIGANT

Pesticide Adsorption

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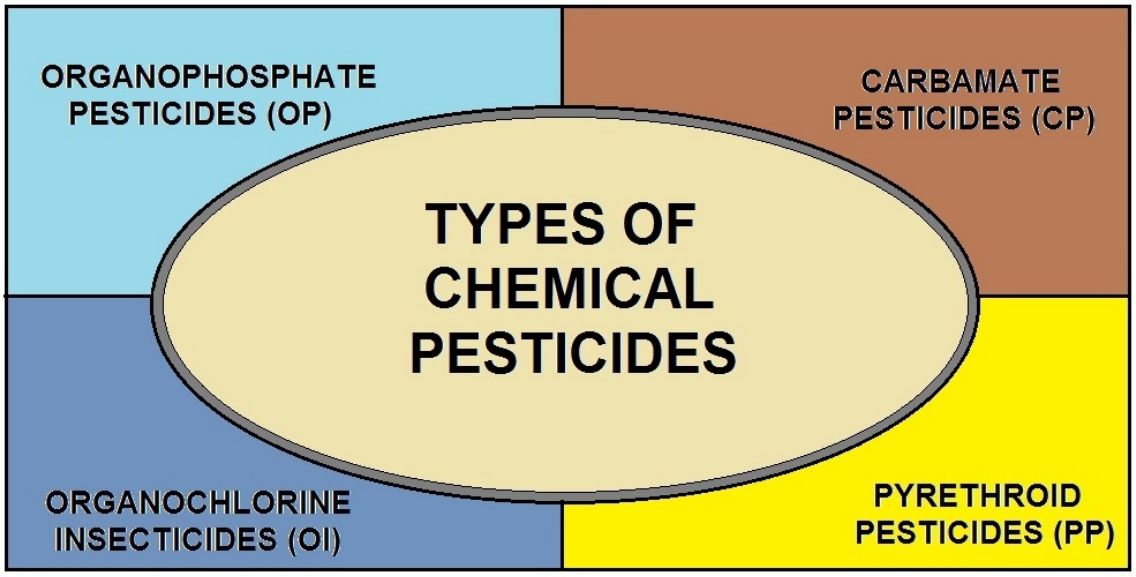


TYPES OF PESTICIDES

Adsorption Process

The adsorption process binds pesticides to soil particles, similar to iron filings or paper clips sticking to a magnet. Adsorption often occurs because of the attraction between a chemical and soil particles. Positively charged pesticide molecules, for example, are attracted to and can bind to negatively charged clay particles. Many soil factors influence pesticide adsorption.

Soils high in organic matter or clay are more adsorptive than coarse, sandy soils, in part because a clay or organic soil has more particle surface area, or more sites onto which pesticides can bind. Moisture also affects adsorption. Wet soils tend to adsorb less pesticide than dry soils because water molecules compete with the pesticide for the binding sites.

Pesticides vary in their adsorption to soil particles. Some pesticides such as paraquat and glyphosate bind very tightly, while others bind only weakly and are readily desorbed or released back into the soil solution.

As soon as the pesticide is applied into the environment it is affected by a number of physical, chemical or biological processes which then affect how persistent it might be or whether or not the pesticide moves. These processes are generally beneficial. On occasions some practices might be perceived as detrimental. For example, the watering in of a surface applied herbicide makes it work better because the herbicide is root absorbed. Therefore, there is little or no runoff or leaching. In addition, the degradation of a soil applied pesticide occurs through several mechanisms which reduce the toxicity over time.

As we then look at those processes that impact the pesticide, once introduced into the environment, we can divide them in to three major categories:

- **Adsorption**
- **Transfer**
- **Degradation**

Adsorption
Adsorption is the binding of the pesticide to the mineral components of the soil or organic matter, which is abundant in turf. In turf, organic matter includes, in many circumstances, a thatch layer. In other pesticide application circumstances there is not a thatch layer like we have in a turf system. This layer makes the turf system quite unique with regard to the buffering capacity of the system to those materials introduced into it.

There's also a transfer process (where pesticides can actually move in the environment) and, finally, a degradation process that removes pesticides (through degradation). Adsorption as a process is pretty straight forward and occurs when a chemical binds to organic or mineral matter in a way that it cannot be dislodged by water.

Transfer processes include such things as volatilization, runoff, leaching, up-take by various flora and fauna (including the turf), and removal of the treated vegetation. With turfgrass, we commonly look at the transfer process in terms of removal (movement of pesticides) from the turf due to the mowing process (the collection of clippings and their transfer to some other location).

In some circumstances detrimental effects can occur. For example, if herbicides are applied to turf and then the clippings are removed soon after application and are applied to garden plants as a mulch, the herbicide may volatilize from those clippings and certain sensitive plants could be injured.

Common sense should dictate that garden vegetables like tomatoes, peppers, and other vulnerable vegetables should not be mulched with grass clippings taken where herbicides have recently been applied.

Paraquat

Paraquat is the trade name of one of the most widely used herbicides in the world. Paraquat, a viologen, is quick-acting and non-selective, killing green plant tissue on contact. It is also toxic to human beings and animals, and is linked to the development of Parkinson's disease.

Paraquat is used as a quaternary ammonium herbicide, one of the most widely used herbicides in the world. It is quick-acting, non-selective, and kills green plant tissue on contact. It is redistributed within the plant, but does not harm mature bark. Being a herbicide, paraquat protects crops by controlling a wide range of annual and certain perennial weeds that reduce crop yield and quality by competing with the crop for water, nutrients, and light.

The key characteristics that distinguish the non-selective contact herbicide paraquat from other active ingredients used in plant protection products are:

- It is non-selective, which means it kills a wide range of annual grasses and broad-leaved weeds and the tops of established perennial weeds.
- It is very fast-acting.
- It is rain-fast within minutes of application.
- It becomes biologically inactive upon contact with soil.

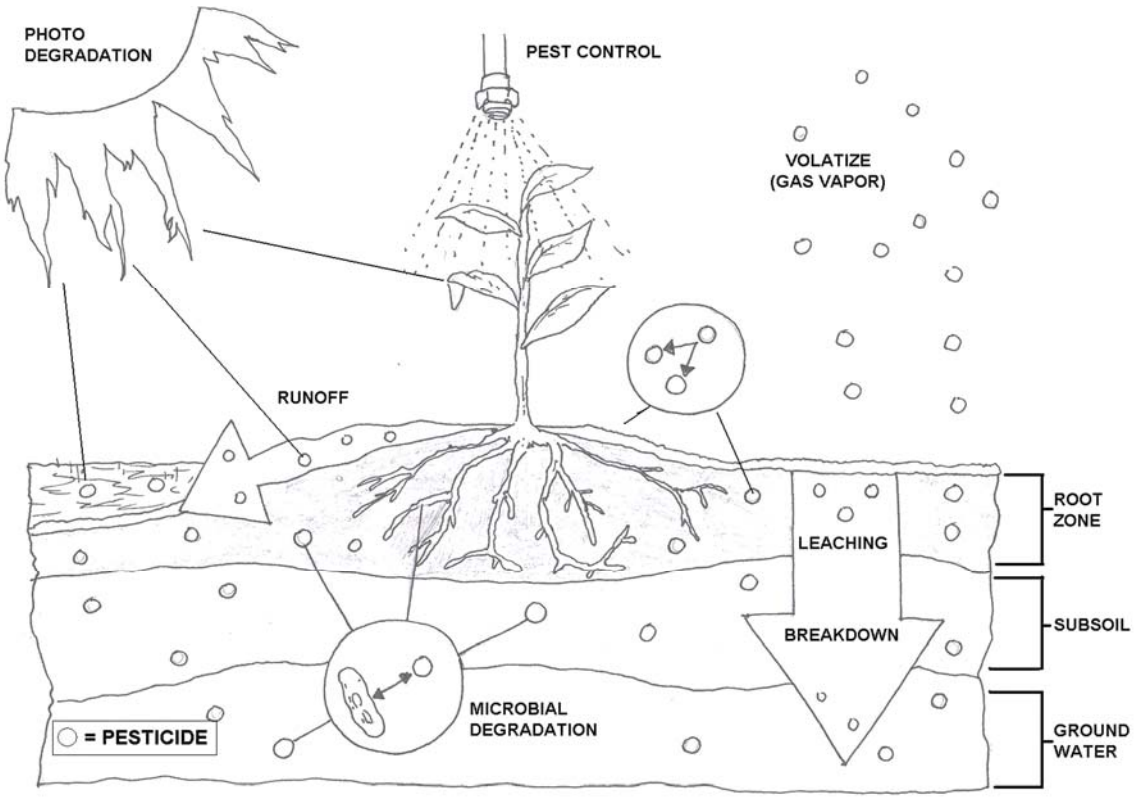
In the United States, paraquat is available primarily as a liquid in various strengths. It is classified as "restricted use," which means that it can be used only by licensed applicators. As with many chemicals, caution must be exercised during use. In the European Union, paraquat has been forbidden since July 11, 2007

Glyphosate

Glyphosate (N-(phosphonomethyl)glycine) is a broad-spectrum systemic herbicide used to kill weeds, especially annual broadleaf weeds and grasses known to compete with crops grown widely across the Midwest of the United States. Initially patented and sold by Monsanto Company in the 1970s under the tradename Roundup, its U.S. patent expired in 2000. Glyphosate is the most used herbicide in the USA, where every year, 5–8 million pounds (2,300–3,600 tons) are used on lawns and yards and another 85–90 million pounds (39,000–41,000 t) are used in agriculture.

Glyphosate's mode of action is to inhibit an enzyme involved in the synthesis of the aromatic amino acids: tyrosine, tryptophan and phenylalanine. It is absorbed through foliage and translocated to growing points. Because of this mode of action, it is only effective on actively growing plants; it is not effective as a pre-emergence herbicide.

Some crops have been genetically engineered to be resistant to it (i.e. Roundup Ready, also created by Monsanto Company). Such crops allow farmers to use glyphosate as a post-emergence herbicide against both broadleaf and cereal weeds, but the development of similar resistance in some weed species is emerging as a costly problem. Soy was the first Roundup Ready crop.



SOIL DEGRADATION FROM PESTICIDES

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed.

Check with your state environmental/pesticide agency for more information.

Environmental Effects

Effects on Non-target Species

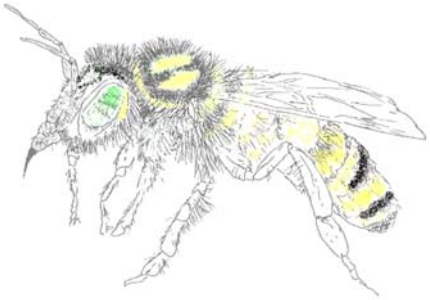
Some insecticides kill or harm other creatures in addition to those they are intended to kill. For example, birds may be poisoned when they eat food that was recently sprayed with insecticides or when they mistake insecticide granules on the ground for food and eat it. Sprayed insecticides may drift from the area to which it is applied and into wildlife areas, especially when it is sprayed aerially. A number of the organochlorine pesticides have been banned from most uses worldwide, and globally they are controlled via the Stockholm Convention on persistent organic pollutants. **These include: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene.**

DDT

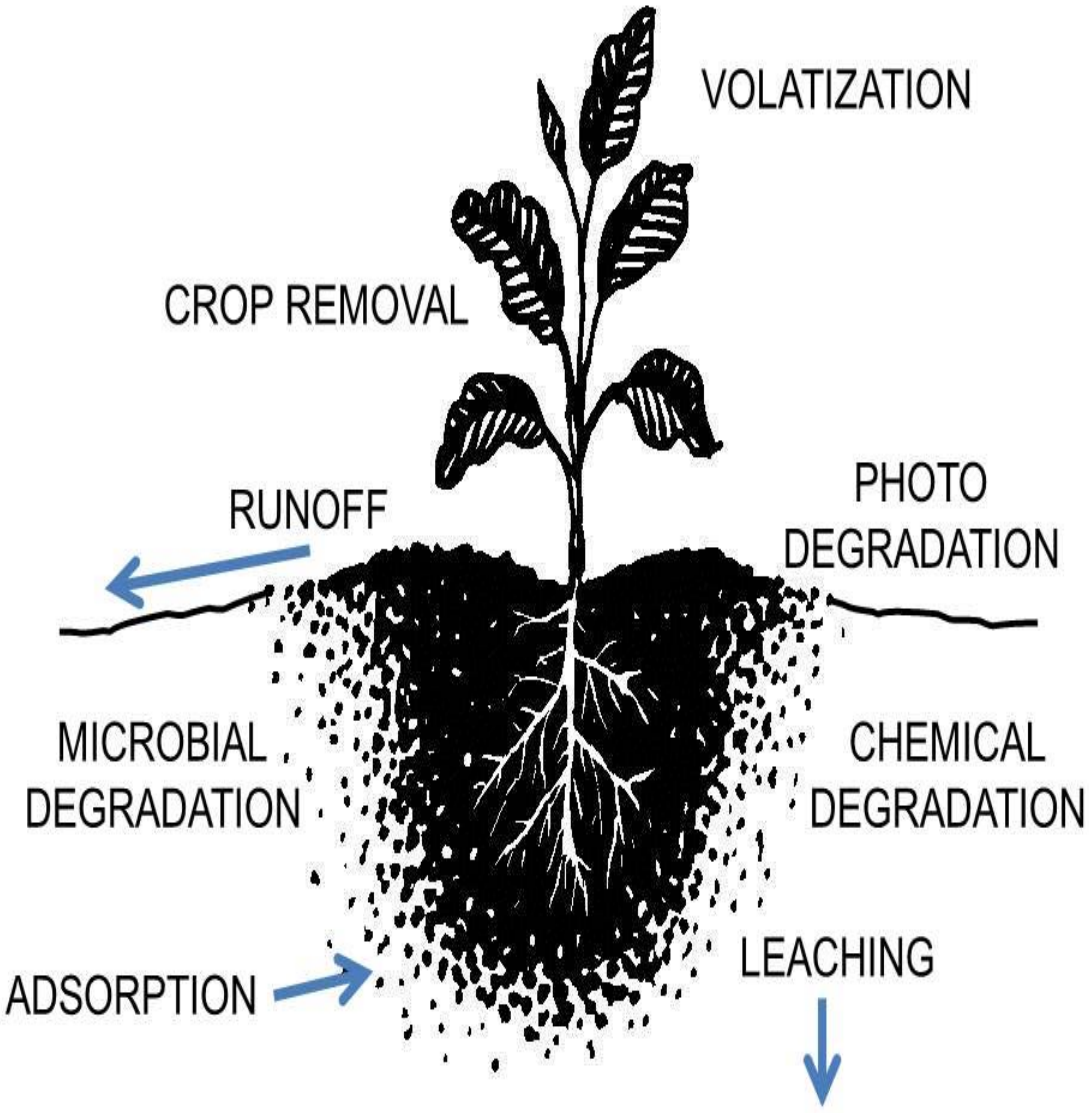
One of the bigger drivers in the development of new insecticides has been the desire to replace toxic and irksome insecticides. DDT was introduced as a safer alternative to the lead and arsenic compounds. Some insecticides have been banned due to the fact that they are persistent toxins which have adverse effects on animals and/or humans. An oft-quoted case is that of DDT, an example of a widely used (and maybe misused) pesticide, which was brought to public attention by Rachel Carson's book, Silent Spring. One of the better known impacts of DDT is to reduce the thickness of the egg shells on predatory birds. The shells sometimes become too thin to be viable, causing reductions in bird populations. This occurs with DDT and a number of related compounds due to the process of bioaccumulation, wherein the chemical, due to its stability and fat solubility, accumulates in organisms' fatty tissues. Also, DDT may biomagnify, which causes progressively higher concentrations in the body fat of animals farther up the food chain. The near-worldwide ban on agricultural use of DDT and related chemicals has allowed some of these birds, such as the peregrine falcon, to recover in recent years.

Pollinator Decline

Insecticides can kill bees and may be a cause of pollinator decline, the loss of bees that pollinate plants, and colony collapse disorder (CCD), in which worker bees from a beehive or Western honey bee colony abruptly disappear. Loss of pollinators will mean a reduction in crop yields. Sublethal doses of insecticides (i.e. imidacloprid and other neonicotinoids) affect foraging behavior of bees. However, research into the causes of CCD was inconclusive as of June 2007.



Orchid Bee


VOLATIZATION
CROP REMOVAL
RUNOFF
PHOTO
DEGRADATION
MICROBIAL
DEGRADATION
CHEMICAL
DEGRADATION
ADSORPTION
LEACHING

Reduced Pest Control

One problem resulting from pesticide adsorption is reduced pest control. For example, weeds may not be controlled if a herbicide is held tightly to soil particles and cannot be taken up by the roots of the target weeds. Some pesticide labels recommend higher application rates when the chemical is applied to adsorptive soils.

Plant injury can be another problem resulting from adsorption of pesticides to soil particles. Injury can result when a pesticide used for one crop is later released from the soil particles in amounts great enough to cause injury to a sensitive rotational crop. This pesticide "carry-over" can also lead to the presence of illegal residues on rotational food or feed crops. Adsorption is particularly important because it influences whether other processes are able to affect pesticides.

The Fate Processes
Pesticide Adsorption
The adsorption process binds pesticides to soil particles and/or plant parts, similar to iron filings or paper clips sticking to a magnet. Adsorption often occurs because of the attraction between a chemical and soil or organic particles. For example, positively charged pesticide molecules are attracted to and can bind to negatively charged clay particles and plant debris.

Many soil factors influence pesticide adsorption. Soils high in organic matter or clay are more adsorptive than coarse sandy soils. This occurs, in part, because a clay or organic soil has a greater particle surface area or number of sites onto which pesticides can bind. Soil moisture also influences adsorption. Wet soils tend to adsorb less pesticide than dry soils because water molecules compete with the pesticide for the binding sites on soil particles. Pesticides may adsorb onto plant materials such as litter in no-till or minimum-till fields, the bark of trees, or thatch in turf. These organic layers may prohibit pesticide movement to target areas deeper in the soil.

Pesticides vary in their tendency to adsorb to soil particles. Some pesticides, such as paraquat and glyphosate, bind very tightly, while others bind only weakly and are readily desorbed or released back into the soil solution. Adsorption is particularly important because it influences whether other processes can affect pesticides.

Pre-emergence Herbicides
Pre-emergence herbicides can be useful chemical tools for you as you attempt to manage weeds before they can compete for valuable space in your turf. Unfortunately, the level of control you desire does not always happen. There are a host of possible reasons for not getting the control that you want; but, by far and away, the most probable reason is improper timing of application — usually that they are not applied soon enough.

Chemical Barrier
You should have your pre-emergence herbicides on the ground and activated prior to the initiation of weed seed germination. Activation is important because you want to have an "active" chemical barrier present in the soil solution when the target weed seeds imbibe water. You can insure activation easily by irrigating immediately after herbicide activation. Be sure to irrigate at least equivalent to a half inch of rainfall.

Actually, if you plan to use sprayed formulations of pre-emergence herbicides, a good way to insure activation is to apply them when it is raining. In circumstances where irrigation is not available and you must depend on rainfall for activation, you should apply pre-emergence herbicides earlier than you might when you could irrigate, to insure there is ample time for rainfall to occur

A variety of factors affect the performance of preemergence herbicides. These include timing of application in relation to weed seed germination, soil type, environmental conditions (primarily temperature and rainfall), target weed species and biotype. Ideally, preemergence herbicides should be applied just before weed seed germination begins. Applying too early may result in reduced control or no control due to leaching and/or normal herbicide degradation.

However, there is a good deal of research that indicates preemergence summer annual grass control applications may be made as early as January. The reason this works is that during cool weather the rate of herbicide degradation is slow and most of the preemergence grass herbicides do not leach readily. Preemergence herbicides must be in place and activated before weed seed germination begins. Activation of preemergence herbicides requires 0.25 to 0.5 inch of rainfall or irrigation. For optimum performance, rainfall or irrigation should occur within 24 hours of application to move the herbicides into the upper layer of the soil. The critical period between application and activation by rainfall or irrigation varies with herbicide, rate, and environmental conditions.

Crabgrass germinates in the spring (late March-April) when soil temperature at the 4-inch depth reaches 53 degrees Fahrenheit. Alternating wet and dry conditions at the soil surface as well as light encourage crabgrass germination.

Sequential or Repeat Applications of Preemergence Herbicides
In warm weather, herbicides begin to degrade soon after application eventually reaching a level at which weed seed germination can occur. Preemergence herbicides will degrade to the point of ineffectiveness from 6 to 16 weeks after application. For this reason, repeat or sequential applications are needed for full season control. Make sequential applications 60 days after the initial treatment.

Pesticide Transfer
Pesticide transfer is sometimes essential for pest control. For example, for certain pre-emergence herbicides to be effective, they must move within the soil to reach the germinating seeds. Too much movement, however, can move a pesticide away from the target pest. This can lead to reduced pest control, contamination of surface water and groundwater, and injury of non-target species, including humans. Five ways that pesticides can be transferred are through volatilization, runoff, leaching, absorption and crop removal.

Volatilization
Volatilization is the conversion of a solid or liquid into a gas. Once volatilized, a pesticide can move in air currents away from the treated surface. Vapor pressure is an important factor in determining whether a pesticide will volatilize. The higher the vapor pressure, the more volatile the pesticide. Volatilization occurs when a pesticide partitions from the solid or aqueous phase to the gas phase. Once volatilized, a pesticide may diffuse into the atmosphere and either be destroyed or continue as an environmental risk.

When mixing disturbs a soil contaminated by a pesticide or other organic compound, a 30 percent or greater loss of the soil contaminant through volatilization is not unusual.

Thermophilic Temperatures
Volatilization of a pesticide is highly temperature dependent; thermophilic temperatures typically increase pesticide losses. The tendency for a pesticide to volatilize also depends upon its size, structure, and function. Moisture also affects volatilization rates. Water may physically impede the flow of a gas phase pesticide by obstructing the pores through which gases travel. Water may also promote volatilization by liberating weakly adsorbed pesticides.

Environmental factors tend to increase volatilization. They include high temperature, low relative humidity, and air movement. A pesticide tightly adsorbed to soil particles is less likely to volatilize; soil conditions such as texture, organic matter content, and moisture can thus influence pesticide volatilization.

Volatilization can result in reduced control of the target pest because less pesticide remains at the target site. Vapor drift, the movement of pesticide vapors or gases in the atmosphere, can lead to injury of nontarget species. Herbicide vapors in particular can injure non-target plants.

To reduce pesticide volatilization, avoid applying volatile pesticides when conditions are unfavorable, such as very hot, dry days or when the soils are wet. Labels often provide warnings if there is a volatility hazard under certain conditions. Labels for volatile pesticides may suggest adding the pesticide to the soil by tillage or irrigation during or shortly after application. This helps to reduce volatilization by reducing the amount of exposed pesticide on the soil surface. Low-volatile formulations are also available for some pesticides.

Runoff
Runoff is movement of water over a sloping surface. Runoff occurs when water is applied faster than it can enter the soil. Pesticides can be carried in the water itself or bound to eroding soil particles. The severity of pesticide runoff depends on the slope or grade of an area; the erodibility, texture and moisture content of the soil; and the amount and timing of rainfall and irrigation. Pesticide runoff usually is greatest when a heavy or sustained rain follows soon after an application. Over-irrigation can lead to excess surface water; it also can lead to pesticide runoff, especially when an irrigation system is used to apply a pesticide.

Vegetation or crop residue tends to slow the movement of runoff water. Certain physical and chemical properties of the pesticide, such as how quickly it is absorbed by plants or how tightly it is bound to plant tissue or soil, are also important.

Herbicide runoff can cause direct injury to nontarget plants. Insecticide and nematicide runoff into surface waters such as streams and ponds can be particularly harmful to aquatic organisms. Pesticide runoff also can lead to groundwater contamination and can cause injury to crops, livestock or humans if the contaminated water is used downstream.

Practices to reduce pesticide runoff include monitoring of weather conditions, careful application of irrigation water, using a spray mix additive to enhance pesticide retention on foliage, and incorporating the pesticide into the soil.

Reduced-tillage cropping systems and surface grading, in addition to contour planting and strip cropping of untreated vegetation, can slow the movement of runoff water and help keep it out of wells, sinkholes, water bodies and other sensitive areas.

Leaching

Leaching is the movement of pesticides through the soil rather than over the surface. Leaching depends, in part, on the pesticide's chemical and physical properties. For example, a pesticide held strongly to soil particles by adsorption is less likely to leach. Another factor is solubility. A pesticide that dissolves in water can move with water in the soil. The persistence, or longevity, of a pesticide also influences the likelihood of leaching. A pesticide that is rapidly broken down by a degradation process is less likely to leach because it may remain in the soil only a short time.

Water-soluble pesticides have a tendency to be “rinsed away” through a process called leaching, that is, the movement of a chemical within percolating water. Typically, leaching is of concern when the pesticide moves into groundwater or another location, posing an increased risk to humans and/or the environment. Many pesticides are not highly soluble in water, readily adsorbing onto the organic matter fraction. For this reason, use of composts in agricultural soils tends to reduce the threat of pesticide leaching losses.

Soil factors that influence leaching include texture and organic matter, in part because of their effect on pesticide adsorption. Soil permeability (how readily water moves through the soil) is also important. The more permeable a soil, the greater potential for pesticide leaching. A sandy soil is much more permeable than a clay.

The method and rate of application, the use of tillage systems that modify soil conditions, and the amount and timing of water a treated area receives after application can also influence pesticide leaching. Typically, the closer the time of application to a heavy or sustained rainfall, the greater the likelihood that some pesticide leaching will occur.

A certain amount of pesticide leaching may be essential for control of a target pest. Too much leaching, however, can lead to reduced pest control, injury of nontarget species and groundwater contamination.

Monitoring weather conditions and the amount and timing of irrigation can help minimize pesticide leaching. Careful pesticide selection is important because those pesticides that are not readily adsorbed, not rapidly degraded, and highly water soluble are the most likely to leach. Labels must be read carefully for instructions on the rates, timing and methods of application. The label may also advise against using the pesticide when certain soil, geologic or climatic conditions are present.

Pesticides can leach through the soil to groundwater from storage, mixing, equipment cleaning and disposal areas. Under certain conditions, some pesticides can leach to groundwater from normal applications. The section "Pesticides and water quality" provides further discussion on groundwater and safe handling practices to prevent contamination.

Absorption or Uptake

Absorption or uptake is the movement of pesticides into plants and animals. Absorption of pesticides by target and nontarget organisms is influenced by environmental conditions and by the chemical and physical properties of the pesticide and the soil.

Once absorbed by plants, pesticides may be broken down or they may remain in the plant until tissue decay or harvest.

Crop Removal
Crop removal transfers pesticides and their breakdown products from the treatment site. Most harvested food commodities are subjected to washing and processing procedures that remove or degrade much of the remaining pesticide residue. While we typically associate harvesting with food and feed products, it is easy to forget that pesticides potentially can be transferred during such operations as tree and shrub pruning and turfgrass mowing.

Pesticide Degradation
Pesticide degradation, or the breakdown of pesticides, usually is beneficial. Pesticide-destroying reactions change most pesticide residues in the environment to nontoxic or harmless compounds. However, degradation is detrimental when a pesticide is destroyed before the target pest has been controlled.

Biological Degradation
Microorganisms have developed many enzymes that can break down natural compounds. Modern scientists, though, have created pesticides with chemical structures not found in nature. These unique structures are often responsible for a pesticide's effectiveness and also explain why pesticides can persist in the environment. A pesticide's environmental persistence largely depends on its chemical structure and on the presence of unusual functional groups, which are large sub-structures within the pesticide molecule. The chemical structure helps determine its water solubility and consequently, its bioavailability, since microbes more readily assimilate water-soluble compounds.

When a pesticide’s functional groups are attached with weak or labile bonds, it can degrade more rapidly. Many modern pesticides have such bonds designed into them to avoid problems of extended persistence. Adding water may break many labile bonds. This process is called hydrolysis and the enzymes that promote hydrolysis are termed hydrolytic. Malathion is an example of an insecticide containing many such labile bonds that may be broken using hydrolytic enzymes (for example, esterase and phosphatase).

Hydrolytic Degradation
Other pesticides capable of hydrolytic degradation are: carbamate pesticides, urea derivatives, pyrethroids, diazinon, dicamba, dichloropicolinic acid, dimethoate, phenylalkanoic ester, dimethoate, phenylalkanoic pyrazon, atrazine, linuron, propanil, chlorpyrifos, and 2,4-D. Two other classes of enzymes, mono- and di-oxygenases, are also commonly associated with pesticide degradation. These enzymes introduce one or two oxygen atoms, respectively, into the structure of a pesticide. This oxidation process often makes the pesticide more amenable to further degradation by increasing its water solubility, thereby increasing its bioavailability. Degradation may begin at the extracellular level and then proceed further at the intracellular level.

Extracellular Decomposition
Many of the same enzymes microorganisms use to break down cellulose, hemicellulose, and lignin—the primary natural compounds in most plant material—may also degrade pesticides during composting. The large polymeric structure of these natural compounds prevents their passage into the microorganism for consumption.

To deal with this problem, microorganisms begin breaking down chemicals outside their "body," or extracellularly. They excrete enzymes out of their cells that react with the bonds in cellulose, hemicellulose, and/or lignin, breaking them down into smaller components. The shortened polymers can then be subjected to further degradation.

Extracellular Enzymes

Extracellular enzymes can have very low "specificity," working like a key that fits different locks. They can, therefore, react with many different chemicals. If the enzyme finds a pesticide before reaching its "intended" substrate (for example, cellulose, hemicellulose, lignin), it may react with it, changing the pesticide into a possibly less toxic and less hazardous form. Such co-metabolism appears to play a significant role in degrading pesticides found in compost and soil. Fungi are the source of most extracellular enzymes. Some fungi often associated with compost and soil organic matter are in the genera Trichoderma, Gliocladium, Penicillium, and Phanerochaete. Fungi grow through the development of hyphae (long strings of cells) that extend throughout compost or soil organic matter.

The hyphae release extracellular enzymes, which break down the pesticide and allow it to pass into the cells. This allows the production of additional hyphae and/or energy. Although fungi are present in compost feedstock, they contribute more to composting in its later stages. As bacteria exhaust the easily degraded organic matter from the feedstock, fungi then begin to degrade the more recalcitrant polymeric organic matter.

Intracellular Decomposition

After extracellular enzymes begin breaking down a pesticide or if it is otherwise bioavailable, a pesticide may enter the cell of a microorganism. To pass into a cell efficiently, the pesticide must be dissolved in water. Generally, pesticides containing more oxygen, nitrogen, and sulfur tend to be more water soluble due to hydrogen bonding. Once inside a cell, a pesticide may undergo varying degrees of degradation. Mineralization reduces the pesticide to carbon dioxide, water, and other inorganic components. Typically, it accounts for only a small portion of the "disappearance" of a pesticide through composting.

Adsorption

Water-insoluble pesticides tend to adsorb onto and within organic matter, making them even less bioavailable. The chemistry of the functional groups in the pesticide and the organic matter dictates the strength of this pesticide-organic matter interaction. Adsorbed pesticides are generally much more resistant to breakdown than water-soluble pesticides. This is because the latter have a much greater chance of contact with pesticide-degrading microorganisms as described above. Consequently, highly adsorbed pesticides are not considered bioavailable, enabling them to persist for months or even years. However, when a pesticide is adsorbed to organic matter that eventually decomposes, it may once again become bioavailable.

Additional factors can make adsorption a likely outcome for even water-soluble pesticides. For example, many pesticides contain acidic and nitrogen-containing functional groups that can adsorb due to the presence of a negative or positive charge, respectively. A negatively charged pesticide will adsorb to positively charged functional groups on organic matter, while positively charged pesticides will adsorb to negatively charged functional groups on organic matter and clays.

Three types of pesticide degradation are microbial, chemical, and photodegradation.

Microbial Degradation
Microbial degradation is the breakdown of pesticides by fungi, bacteria, and other microorganisms that use pesticides as a food source. Most microbial degradation of pesticides occurs in the soil. Soil conditions such as moisture, temperature, aeration, pH, and the amount of organic matter affect the rate of microbial degradation because of their direct influence on microbial growth and activity.

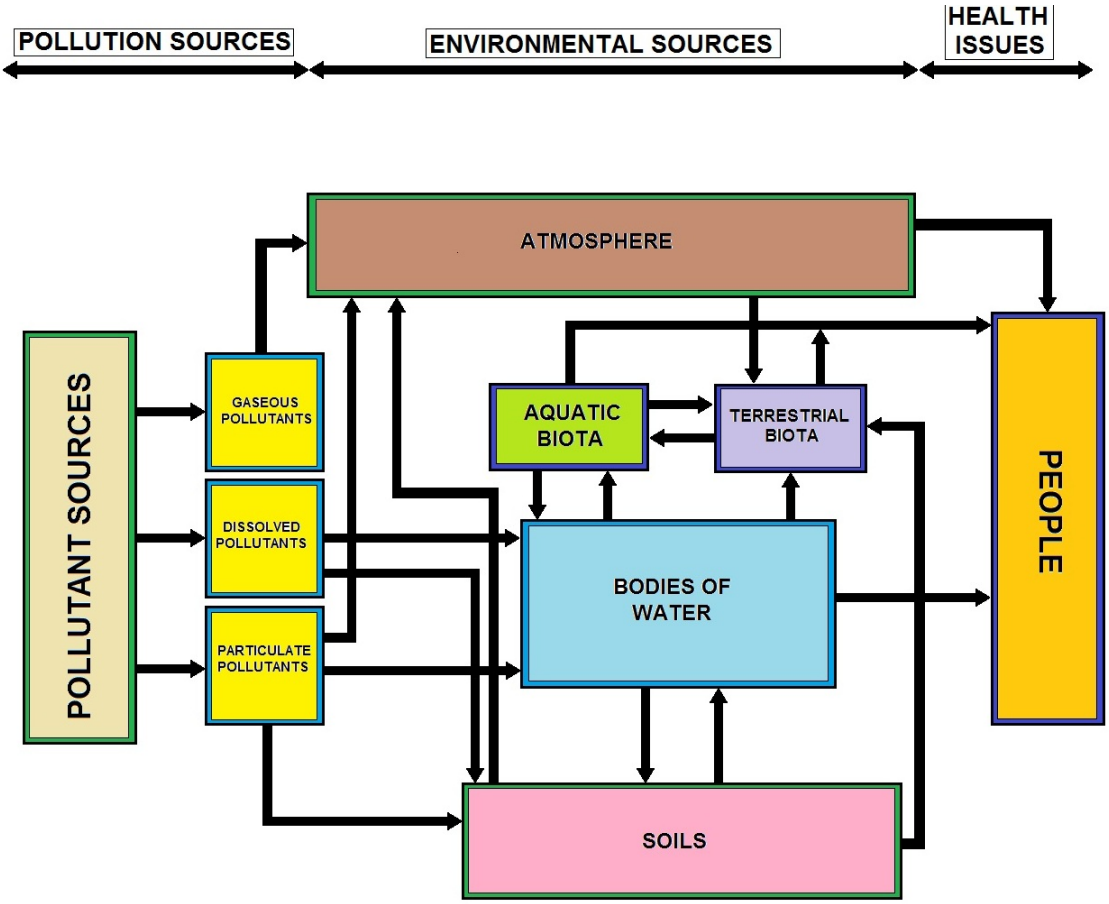
The frequency of pesticide application also is a factor that can influence microbial degradation. Rapid microbial degradation is more likely when the same pesticide is used repeatedly in a field. Repeated applications can actually stimulate the buildup of organisms that are effective in degrading the chemical. As the population of these organisms increases, degradation accelerates and the amount of pesticide available to control the pest is reduced. In extreme cases, accelerated microbial degradation has led to certain products being removed from the marketplace. Microorganisms greatly reduce the effectiveness of these chemicals soon after application.

The possibility of very rapid pesticide breakdown is reduced by using pesticides only when necessary and by avoiding repeated applications of the same chemical. Alternating between different classes, groups or formulations of pesticides can minimize the potential for microbial degradation problems as well as pest resistance.

Chemical Degradation
Chemical degradation is the breakdown of pesticides by processes that do not involve living organisms. Temperature, moisture, pH and adsorption, in addition to the chemical and physical properties of the pesticide, determine which chemical reactions take place and how quickly they occur. One of the most common pesticide degradation reactions is hydrolysis, a breakdown process in which the pesticide reacts with water. Many organophosphate and carbamate insecticides are particularly susceptible to hydrolysis under alkaline conditions. Some are actually broken down within a matter of hours when mixed with alkaline water.

Product labels may warn against mixing a pesticide with certain fertilizers, other pesticides or water with specific characteristics. Following these precautions can help prevent pesticide degradation and potential incompatibility problems. In some situations, buffers or other additives may be available to modify spray mix conditions and prevent or reduce degradation. Pesticide degradation and possible corrosion of application equipment can be avoided by not allowing a spray mix to remain in a tank for a long period of time.

Photodegradation
Photodegradation is the breakdown of pesticides by light, particularly sunlight. Photodegradation can destroy pesticides on foliage, on the surface of the soil, and even in the air. Factors that influence pesticide photodegradation include the intensity of the sunlight, properties of the application site, the application method and the properties of the pesticide. Pesticide losses from photodegradation can be reduced by adding the pesticide to the soil during or immediately after application.



WATER QUALITY INDICATORS

This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

Pesticides and Water Quality

Insecticides and herbicides (sometimes referred to as pesticides) are widely used in agriculture, industry, leisure facilities and gardens to control weeds and insect pests and may enter the water cycle in many ways. The Federal Insecticide, Fungicide, and Rodenticide Act, which authorizes EPA to control the availability of pesticides that have the ability to leach into ground water.

Agricultural activities (pesticide application) can make significant contributions to ground-water contamination with the millions of tons of fertilizers and pesticides spread on the ground and from the storage and disposal of livestock wastes. Homeowners, too, can contribute to this type of ground-water pollution with the chemicals they apply to their lawns, rosebushes, tomato plants, and other garden plants.

Groundwater
Groundwater originates as precipitation that sinks into the ground. Some of this water percolates down to the water table (shallowest surface of the groundwater) and recharges the aquifer. For shallow wells (i.e., less than 50-75 feet) the recharge area is often the immediate vicinity around the well or "wellhead." Some wells are recharged in areas that may be a great distance from the well itself. If the downward percolating precipitation encounters any source of contamination, at the surface or below it, the water may dissolve some of that contaminant and carry it to the aquifer. Groundwater moves from areas where the water table is high to where the water table is low.

Consequently, a contaminant may enter the aquifer some distance upgradient from you and still move towards your well. When a well is pumping, it lowers the water table in the immediate vicinity of the well, increasing the tendency for water to move towards the well. Contaminants can be lumped into three categories: microorganisms (bacteria, viruses, Giardia, etc.), inorganic chemicals (nitrate, arsenic, metals, etc.) and organic chemicals (solvents, fuels, pesticides, etc.).

Although it is common practice to associate contamination with highly visible features such as landfills, gas stations, industry or agriculture, potential contaminants are widespread and often come from common everyday activities as well, such as septic systems, lawn and garden chemicals, pesticides applied to highway right-of-ways, stormwater runoff, auto repair shops, beauty shops, dry cleaners, medical institutions, photo processing labs, etc. Importantly, it takes only a very small amount of some chemicals in drinking water to raise health concerns. For example, one gallon of pure trichloroethylene, a common solvent, will contaminate approximately 292 million gallons of water.

Wellhead Protection
Wellhead protection refers to programs designed to maintain the quality of groundwater used as public drinking water sources by managing the land uses around the wellfield. The theory is that management of land use around the well, and over water moving (underground) toward the well, will help to minimize damage to subsurface water supplies by spills or improper use of chemicals. The concept usually includes several stages. Until the 1970s, ground water was believed to be naturally protected from contamination. The layers of soil and particles of sand, gravel, crushed rocks, and larger rocks were thought to act as filters, trapping contaminants before they could reach the ground water. Since then, however, every state in the nation has reported cases of contaminated ground water, with some instances receiving widespread publicity.

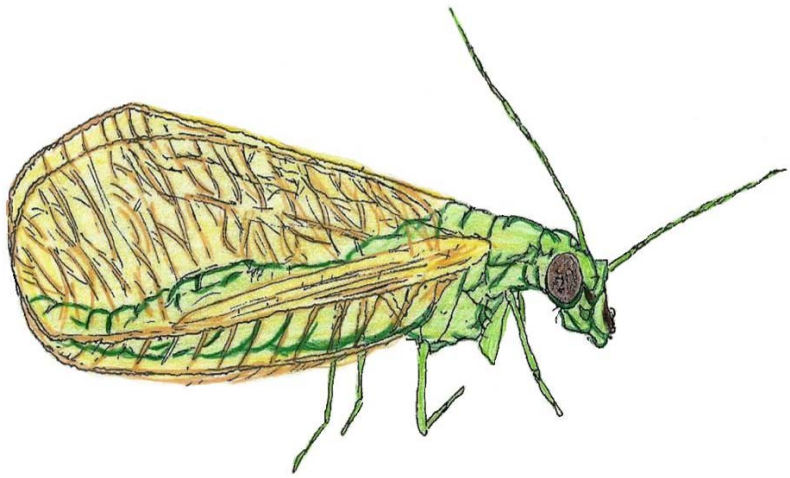
We now know that some contaminants can pass through all of these filtering layers into the saturated zone to contaminate ground water.

Between 1971 and 1985, 245 ground-water related disease outbreaks, with 52,181 associated illnesses, were reported. Most of these diseases were short-term digestive disorders. About 10 percent of all ground-water public water supply systems are in violation of drinking water standards for biological contamination. In addition, approximately 74 pesticides, a number of which are known carcinogens, have been detected in the ground water of 38 states.

Although various estimates have been made about the extent of ground-water contamination, these estimates are difficult to verify given the nature of the resource and the difficulty of monitoring its quality.

Checklist for protecting water from pesticides

- Always check pesticide labels to learn irrigation practices, rates and application methods.
- Be aware of the geology and the relative depth of the groundwater in your area.
- Build dikes around your bulk tanks to prevent off-site movement of pesticides.
- Clean your pesticide application equipment in a way that makes it easy to collect rinsates.
- Delay pesticide applications if rain is forecast.
- Ensure that any abandoned well near a pesticide handling or application site is properly closed.
- Grade the area around your well to divert surface runoff.
- Install a check-valve on your water hose to prevent back-siphoning.
- Know which pesticides you use have a potential for leaching.
- Leave a border of untreated vegetation between treated and sensitive areas.
- Store pesticides in their original containers in a cool, well-ventilated building with a concrete floor.
- Use pesticides only when necessary and then at the lowest rate needed to control a pest.



Green Lacewing, a beneficial insect.

IPM Methods (Types of Pest Control)

Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

The IPM approach can be applied to both agricultural and non-agricultural settings, such as the home, garden, and workplace. IPM takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides. In contrast, organic food production applies many of the same concepts as IPM but limits the use of pesticides to those that are produced from natural sources, as opposed to synthetic chemicals.

IPM is not a single pest control method but, rather, a series of pest management evaluations, decisions and controls. In practicing IPM, growers who are aware of the potential for pest infestation follow a four-tiered approach.

The four steps include:
Set Action Thresholds
Before taking any pest control action, IPM first sets an action threshold, a point at which pest populations or environmental conditions indicate that pest control action must be taken. Sighting a single pest does not always mean control is needed. The level at which pests will either become an economic threat is critical to guide future pest control decisions.

Monitor and Identify Pests
Not all insects, weeds, and other living organisms require control. Many organisms are innocuous, and some are even beneficial. IPM programs work to monitor for pests and identify them accurately, so that appropriate control decisions can be made in conjunction with action thresholds. This monitoring and identification removes the possibility that pesticides will be used when they are not really needed or that the wrong kind of pesticide will be used.

Prevention
As a first line of pest control, IPM programs work to manage the crop, lawn, or indoor space to prevent pests from becoming a threat. In an agricultural crop, this may mean using cultural methods, such as rotating between different crops, selecting pest-resistant varieties, and planting pest-free rootstock. These control methods can be very effective and cost-efficient and present little to no risk to people or the environment.

Control
Once monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, IPM programs then evaluate the proper control method both for effectiveness and risk. Effective, less risky pest controls are chosen first, including highly targeted chemicals, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding. If further monitoring, identifications and action thresholds indicate that less risky controls are not working, then

additional pest control methods would be employed, such as targeted spraying of pesticides. Broadcast spraying of non-specific pesticides is a last resort.

Six Basic Components

An IPM system is designed around six basic components: The US Environmental Protection Agency has a useful set of IPM principles.

1. Acceptable pest levels: The emphasis is on control, not eradication. IPM holds that wiping out an entire pest population is often impossible, and the attempt can be economically expensive, environmentally unsafe, and frequently unachievable. IPM programs first work to establish acceptable pest levels, called action thresholds, and apply controls if those thresholds are crossed. These thresholds are pest and site specific, meaning that it may be acceptable at one site to have a weed such as white clover, but at another site it may not be acceptable. By allowing a pest population to survive at a reasonable threshold, selection pressure is reduced. This stops the pest gaining resistance to chemicals produced by the plant or applied to the crops. If many of the pests are killed then any that have resistance to the chemical will form the genetic basis of the future, more resistant, population. By not killing all the pests there are some un-resistant pests left that will dilute any resistant genes that appear.

2. Preventive cultural practices: Selecting varieties best for local growing conditions, and maintaining healthy crops, is the first line of defense, together with plant quarantine and 'cultural techniques' such as crop sanitation (e.g. removal of diseased plants to prevent spread of infection).

3. Monitoring: Regular observation is the cornerstone of IPM. Observation is broken into two steps, first; inspection and second; identification. Visual inspection, insect and spore traps, and other measurement methods and monitoring tools are used to monitor pest levels. Accurate pest identification is critical to a successful IPM program. Record-keeping is essential, as is a thorough knowledge of the behavior and reproductive cycles of target pests. Since insects are cold-blooded, their physical development is dependent on the temperature of their environment. Many insects have had their development cycles modeled in terms of degree days. Monitor the degree days of an environment to determine when is the optimal time for a specific insect's outbreak.

4. Mechanical controls: Should a pest reach an unacceptable level; mechanical methods are the first options to consider. They include simple hand-picking, erecting insect barriers, using traps, vacuuming, and tillage to disrupt breeding.

5. Biological controls: Natural biological processes and materials can provide control, with minimal environmental impact, and often at low cost. The main focus here is on promoting beneficial insects that eat target pests. Biological insecticides, derived from naturally occurring microorganisms (e.g.: Bt, entomopathogenic fungi and entomopathogenic nematodes), also fit in this category.

6. Responsible Pesticide Use: Synthetic pesticides are generally only used as required and often only at specific times in a pests' life cycle. Many of the newer pesticide groups are derived from plants or naturally occurring substances (e.g.: nicotine, pyrethrum and insect juvenile hormone analogues), but the toxophore or active component may be altered to provide increased biological activity or stability. Further 'biology-based' or 'ecological' techniques are under evaluation.

Main Focus of IPM Programs
An IPM regime can be quite simple or sophisticated. Historically, the main focus of IPM programs was on agricultural insect pests. Although originally developed for agricultural pest management, IPM programs are now developed to encompass diseases, weeds, and other pests that interfere with the management objectives of sites such as residential and commercial structures, lawn and turf areas, and home and community gardens.

IPM is applicable to all types of agriculture and sites such as residential and commercial structures, lawn and turf areas, and home and community gardens.

Reliance on knowledge, experience, observation, and integration of multiple techniques makes IPM a perfect fit for organic farming (sans artificial pesticide application). For large-scale, chemical-based farms, IPM can reduce human and environmental exposure to hazardous chemicals, and potentially lower overall costs of pesticide application material and labor.

1. Proper identification of pest - What is it?
Cases of mistaken identity may result in ineffective actions. If plant damage due to over-watering are mistaken for fungal infection, spray costs can be incurred, and the plant is no better off.

2. **Learn pest and host life cycle and biology.**
At the time you see a pest, it may be too late to do much about it except maybe spray with a pesticide. Often, there is another stage of the life cycle that is susceptible to preventative actions. For example, weeds reproducing from last year's seed can be prevented with mulches. Also, learning what a pest needs to survive allows you to remove these.

3. Monitor or sample environment for pest population - How many are here?
Preventative actions must be taken at the correct time if they are to be effective. For this reason, once the pest is correctly identified, monitoring must begin before it becomes a problem. For example, in school cafeterias where roaches may be expected to appear, sticky traps are set out before school starts. Traps are checked at regular intervals so populations can be monitored and controlled before they get out of hand. Some factors to consider and monitor include: Is the pest present/absent? What is the distribution - all over or only in certain spots? Is the pest population increasing or decreasing?

4. Establish action threshold (economic, health or aesthetic) - How many are too many?
In some cases, a certain number of pests can be tolerated. Soybeans are quite tolerant of defoliation, so if there are a few caterpillars in the field and their population is not increasing dramatically, there is not necessarily any action necessary. Conversely, there is a point at which action must be taken to control cost. For the farmer, that point is the one at which the cost of damage by the pest is more than the cost of control. This is an economic threshold. Tolerance of pests varies also by whether or not they are a health hazard (low tolerance) or merely a cosmetic damage (high tolerance in a non-commercial situation).

Different sites may also have varying requirements based on specific areas. White clover may be perfectly acceptable on the sides of a tee box on a golf course, but unacceptable in the fairway where it could cause confusion in the field of play.

5**. Choose an appropriate combination of management tactics**
For any pest situation, there will be several options to consider. Options include mechanical or physical control, cultural controls, biological controls and chemical controls. Mechanical or physical controls include picking pests off plants, or using netting or other material to exclude pests such as birds from grapes or rodents from structures. Cultural controls include keeping an area free of conducive conditions by removing or storing waste properly, removing diseased areas of plants properly. Biological controls can be support either through conservation of natural predators or augmentation of natural predators.

Augmentative control includes the introduction of naturally occurring predators at either an inundative or inoculative level.

An inundative release would be one that seeks to inundate a site with a pest's predator to impact the pest population. An inoculative release would be a smaller number of pest predators to supplement the natural population and provide ongoing control.

Chemical controls would include horticultural oils or the application of pesticides such as insecticides and herbicides. A Green Pest Management IPM program would use pesticides derived from plants, such as botanicals, or other naturally occurring materials.

6. Evaluate results - How did it work?
Evaluation is often one of the most important steps. This is the process to review an IPM program and the results it generated. Asking the following questions is useful: Did actions have the desired effect?

Was the pest prevented or managed to farmer satisfaction?

Was the method itself satisfactory?

Were there any unintended side effects?

What can be done in the future for this pest situation?

Understanding the effectiveness of the IPM program allows the site manager to make modifications to the IPM plan prior to pests reaching the action threshold and requiring action again.

Insecticides

An insecticide is a pesticide used against insects. They include ovicides and larvicides used against the eggs and larvae of insects respectively. The use of insecticides is believed to be one of the major factors behind the increase in agricultural productivity in the 20th century. Nearly all insecticides have the potential to significantly alter ecosystems; many are toxic to humans; and others are concentrated in the food chain. This course contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Evaluating Pesticides EPA
All pesticides sold or distributed in the United States must be registered by EPA, based on scientific studies showing that they can be used without posing unreasonable risks to people or the environment.

Because of advances in scientific knowledge, the law requires that pesticides which were first registered before November 1, 1984, be reregistered to ensure that they meet today's more stringent standards.

In evaluating pesticides for reregistration, EPA obtains and reviews a complete set of studies from pesticide producers, describing the human health and environmental effects of each pesticide. The Agency develops any mitigation measures or regulatory controls needed to effectively reduce each pesticide's risks. EPA then reregisters pesticides that can be used without posing unreasonable risks to human health or the environment. When a pesticide is eligible for reregistration, EPA explains the basis for its decision in a Reregistration Eligibility Decision (RED) document.

Classes of Agricultural Insecticides

The classification of insecticides is done in several different ways:

- Contact insecticides are toxic to insects brought into direct contact. Efficacy is often related to the quality of pesticide application, with small droplets (such as aerosols) often improving performance.
- Inorganic insecticides are manufactured with metals and include arsenates, copper compounds and fluorine compounds, which are now seldom used, and sulfur, which is commonly used.
- Mode of action—how the pesticide kills or inactivates a pest—is another way of classifying insecticides. Mode of action is important in predicting whether an insecticide will be toxic to unrelated species, such as fish, birds and mammals.
- Natural insecticides, such as nicotine, pyrethrum and neem extracts are made by plants as defenses against insects. Nicotine based insecticides have been barred in the U.S. since 2001 to prevent residues from contaminating foods.

- Organic insecticides are synthetic chemicals which comprise the largest numbers of pesticides available for use today.
- Plant-Incorporated Protectants (PIP) are insecticidal substances produced by plants after genetic modification. For instance, a gene that codes for a specific Baccilus thuringiensis biocidal protein is introduced into a crop plant's genetic material. Then, the plant manufactures the protein. Since the biocide is incorporated into the plant, additional applications at least of the same compound are not required.
- Systemic insecticides are incorporated by treated plants. Insects ingest the insecticide while feeding on the plants.
- Heavy metals, e.g. arsenic have been used as insecticides; they are poisonous and very rarely used now by farmers.

Organochlorine Compounds

The insecticidal properties of the best known representative of this class of insecticides, DDT, was made by the Swiss Scientist Paul Müller. For this discovery, he was awarded the Nobel Prize for Physiology or Medicine in 1948. DDT was introduced on the market in 1944. With the rise of the modern chemical industry, it was possible to make chlorinated hydrocarbons. DDT works by opening the sodium channels in the nerve cells of the insect. A number of the organochlorine pesticides have been banned from most uses worldwide, and globally they are controlled via the Stockholm Convention on persistent organic pollutants. These include: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene.

Penta or Pentachlorophenol

Penta or Pentachlorophenol (PCP) is an organochlorine compound used as a pesticide and a disinfectant. First produced in the 1930s, it is marketed under many trade names. It can be found in two forms: PCP itself or as the sodium salt of PCP, which dissolves easily in water.

In the past, PCP has been used as an herbicide, insecticide, fungicide, algaecide, disinfectant and as an ingredient in antifouling paint. Some applications were in agricultural seeds (for nonfood uses), leather, masonry, wood preservation, cooling tower water, rope and paper mill system. Its use has been significantly declined due to the high toxicity of PCP and its slow biodegradation. There are two general methods for preserving wood. The pressure process method involves placing wood in a pressure-treating vessel where it is immersed in PCP and then subjected to applied pressure. In the non-pressure process method, PCP is applied by spraying, brushing, dipping, and soaking. Utility companies save millions of dollars in replacement poles, because the life of these poles increases from approximately 7 years for an untreated pole to about 35 years for a preservative-treated pole.

PCP has been detected in surface waters and sediments, rainwater, drinking water, aquatic organisms, soil, and food, as well as in human milk, adipose tissue, and urine. As PCP is generally used for its properties as a biocidal agent, there is considerable concern about adverse ecosystem effects in areas of PCP contamination.

Releases to the environment are decreasing as a result of declining consumption and changing use methods.

However, PCP is still released to surface waters from the atmosphere by wet deposition, from soil by run off and leaching, and from manufacturing and processing facilities. PCP is released directly into the atmosphere via volatilization from treated wood products and during production. Finally, releases to the soil can be by leaching from treated wood products, atmospheric deposition in precipitation (such as rain and snow), spills at industrial facilities and at hazardous waste sites.

Since the early 1980s, the purchase and use of PCP in the U.S has not been available to the general public. Nowadays most of the PCP used in the U.S is restricted to the treatment of utility poles and railroad ties. In the United States, any drinking water supply with a PCP concentration exceeding the MCL, 1 ppb, must be notified by the water supplier to the public. Disposal of PCP and PCP contaminated substances are regulated under RCRA as a F-listed hazardous waste.

Organophosphates

The next large class developed was the organophosphates, which bind to acetylcholinesterase and other cholinesterases. This results in disruption of nerve impulses, killing the insect or interfering with its ability to carry on normal functions. Organophosphate insecticides and chemical warfare nerve agents (such as sarin, tabun, soman and VX) work in the same way. Organophosphates have an accumulative toxic effect to wildlife, so multiple exposures to the chemicals amplify the toxicity.

Carbamates

Carbamate insecticides have similar toxic mechanisms to organophosphates, but have a much shorter duration of action and are thus somewhat less toxic.

Organophosphates and Carbamates Pesticides

Organophosphates are phosphoric acid esters or thiophosphoric acid esters. When developed in the 1930s and 1940s, their original compounds were highly toxic to mammals. Organophosphates manufactured since then are less toxic to mammals but toxic to target organisms, such as insects. Malathion, dibrom, chlorpyrifos, temephos, diazinon and terbufos are organophosphates. Carbamates are esters of N-methyl carbamic acid. Aldicarb, carbaryl, propoxur, oxamyl and terbucarb are carbamates.

Although these pesticides differ chemically, they act similarly. When applied to crops or directly to the soil as systemic insecticides, organophosphates and carbamates generally persist from only a few hours to several months. However, they have been fatal to large numbers of birds on turf and in agriculture, and negatively impacted breeding success in birds. Many organophosphates are highly toxic to aquatic organisms.

These are two very large families of insecticides. Indeed, they have been the primary insecticides for the past 25 to 30 years. They range in toxicity from slightly to highly toxic. They are formulated in all kinds of ways from highly concentrated emulsifiable concentrates (ECs) to very dilute granular (G) formulations.

These insecticide families are similar in their modes of action—they are all nervous system poisons. Insects and all other animals, including humans, have nervous systems that are susceptible. Both insecticide families are efficiently absorbed by inhalation, ingestion, and skin penetration. To a degree, the extent of poisoning depends on the rate at which the pesticide is absorbed.

Organophosphates break down chiefly by hydrolysis in the liver; rates of hydrolysis vary widely from one compound to another. With certain organophosphates whose breakdown is relatively slow, significant amounts may be temporarily stored in body fat. The organophosphates and carbamates replaced the chlorinated hydrocarbons (e.g., chlordane, aldrin, and heptachlor) for all uses, including termite control. Examples of organophosphates are chlorpyrifos for termite control and diazinon for other household pests. An example of a carbamate is carbaryl, also used for household and lawn pests.

How can people be exposed to organophosphate and carbamate pesticides?
People can be exposed to organophosphates and carbamates pesticides through accidental exposure during use. People can accidentally inhale the pesticides if they are in an area where they were recently applied. The chemicals can be ingested with food or drinks that are contaminated.

How can these pesticides exhaust affect my health?
Acetylcholinesterase is an enzyme found in the nervous system, red blood cells and blood plasma. These pesticides damage nerve function by acting as acetylcholinesterase inhibitors in the nervous system.

Breathing - Short-term exposure can produce muscle twitching, headache, nausea, dizziness, loss of memory, weakness, tremor, diarrhea, sweating, salivation, tearing, constriction of pupils, and slowed heartbeat.

Long-term exposure can produce delayed neurotoxicity, such as tingling and burning in the extremities. This delayed neurotoxicity can progress to paralysis and is seldom reversible. Damage to the liver, kidney, immune system and bone marrow may occur. Some carbamates are also suspected carcinogens.

What should I do if exposed to these pesticides?
If you think you were exposed to these pesticides, contact your doctor.

Is there a medical test to show whether I was exposed to these pesticides?

The level of cholinesterase activity in red blood cells or plasma helps physicians determine exposure to these pesticides. However, other chemicals or disease states can alter acetylcholinesterase activity. Urine or blood tests only apply if a person was exposed to a large quantity. Persons who will use these pesticides regularly should ask their physician to establish a baseline value prior to prolonged use, followed by monthly monitoring.

Pyrroles

Chlorfenapyr is the only termiticide from the pyrrole family of chemistry and is active primarily as a stomach poison with some contact activity. It is also non-repellent to termites. Chlorfenapyr is registered as a termiticide under the tradename Phantom®. Chlorfenapyr acts on the mitochondria of cells and uncouples or inhibits oxidative phosphorylation, preventing the formation of the crucial energy molecule adenosine triphosphate (ATP). As a result, energy production in the cells shuts down, resulting in cellular and, ultimately, termite death.

Fiproles (or Phenylpyrazoles)

Fipronil is the only insecticide in this new class, introduced in 1990 and registered in the U.S. in 1996. It is marketed as a termiticide under the tradename Termidor®. This termiticide is a non-repellent material with contact and stomach activity. Fipronil works by blocking the gamma-aminobutyric acid (GABA) regulated chloride channel in neurons, thus disrupting the activity of the insect's central nervous system.

Pyrethroids

To mimic the insecticidal activity of the natural compound pyrethrum another class of pesticides, pyrethroid pesticides, has been developed. These are non-persistent, which is a sodium channel modulators, and are much less acutely toxic than organophosphates and carbamates. Compounds in this group are often applied against household pests.

The pyrethroids are a large family of modern synthetic insecticides similar to the naturally derived botanical pyrethrins. They are highly repellent to MOST INSECTS AND ESPECIALLY termites, which may contribute to the effectiveness of the termiticide barrier. They have been modified to increase their stability in the natural environment. They are widely used in agriculture, homes, and gardens. Some examples are bifenthrin, cyfluthrin, cypermethrin, deltamethrin, and permethrin. They may be applied alone or in combination with other insecticides. Pyrethroids are formulated as emusifiable concentrates (EC), wettable powders (WP), granulars (G), and aerosols. Certain pyrethroids exhibit striking neurotoxicity in laboratory animals when administered by intravenous injection, and some are toxic by the oral route.

Systemic toxicity by inhalation and dermal absorption are low, however—there have been very few systemic poisonings of humans by pyrethroids. Though limited absorption may account for the low toxicity of some pyrethroids, rapid biodegradation by mammalian liver enzymes (ester hydrolysis and oxidation) is probably the major factor responsible. This course contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them.

If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Most pyrethroid metabolites are promptly excreted, at least in part, by the kidney. In response to dermal exposure, some persons may experience a skin sensitivity called paresthesia. The symptoms are similar to sunburn sensation of the face and especially the eyelids. Sweating, exposure to sun or heat, and application of water aggravate the disagreeable sensations. This is a temporary effect that dissipates within 24 hours. For first aid, wash with soap and water to remove as much residue as possible, and then apply a vitamin E oil preparation or cream to the affected area. Paresthesia is caused more by pyrethroids whose chemical makeup includes cyano- groups: fenvalerate, cypermethrin, and fluvalinate. In addition to protecting themselves from future exposure, persons who have experienced paresthesia should choose a pyrethroid with a different active ingredient, as well as a wettable powder or microencapsulated formulation.

About These Pesticides
Pyrethrins and pyrethroids are insecticides included in over 3,500 registered products, many of which are used widely in and around households, including on pets, in mosquito control, and in agriculture. The use of pyrethrins and pyrethroids has increased during the past decade with the declining use of organophosphate pesticides, which are more acutely toxic to birds and mammals than the pyrethroids. This change to less acutely toxic pesticides, while generally beneficial, has introduced certain new issues. For example, residential uses of pyrethrins and pyrethroids may result in urban runoff, potentially exposing aquatic life to harmful levels in water and sediment.

Pyrethrins are botanical insecticides derived from chrysanthemum flowers most commonly found in Australia and Africa. They work by altering nerve function, which causes paralysis in target insect pests, eventually resulting in death.

Pyrethroids are synthetic chemical insecticides whose chemical structures are adapted from the chemical structures of the pyrethrins and act in a similar manner to pyrethrins. Pyrethroids are modified to increase their stability in sunlight.
Most pyrethrins and some pyrethroid products are formulated with synergists, such as piperonyl butoxide and MGK-264, to enhance the pesticidal properties of the product. These synergists have no pesticidal effects of their own but enhance the effectiveness of other chemicals.
* Pyrethrins, a single pesticide active ingredient, contain six components that have insecticidal activity:

pyrethrin 1, pyrethrin 2, cinerin 1, cinerin 2, jasmolin 1, and jasmolin 2

Pyrethroids include:
Allethrin stereoisomers, Bifenthrin, Beta-Cyfluthrin, Cyfluthrin, Cypermethrin, Cyphenothrin, Deltamethrin, Esfenvalerate, Fenpropathrin, Tau-Fluvalinate, Lambda-Cyhalothrin, Gamma Cyhalothrin, Imiprothrin, 1RS cis-Permethrin, Permethrin, Prallethrin, Resmethrin, Sumithrin (d-phenothrin), Tefluthrin, Tetramethrin, Tralomethrin, and Zeta-Cypermethrin

Synergists include:
MGK-264 and Piperonyl butoxide

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Permethrin

General Information
Permethrin is a broad-spectrum pyrethroid insecticide. It is available in dusts, emulsifiable concentrates, smokes, ULV concentrates, and wettable-powder formulations.

The historical development of the synthetic pesticides called pyrethroids is based on the pyrethrins, which are derived from chrysanthemums. Pyrethrins are a "natural" environmental product that is of low toxicity to mammals. They are highly photolabile and degrade quickly in sunlight, and the cost of reapplying them has limited their widespread agricultural use. Pyrethroids have been synthesized to be similar to pyrethrins yet more stable in the environment. Evidence suggests that they have a very large margin of safety when used as directed by the label (Aldridge, 1990; Chen et al., 1991; Snodgrass, 1992).

Commercial pyrethroid products commonly use petroleum distillates as carriers. Some commercial products also contain OP or carbamate insecticides because the rapid paralytic effect of pyrethrins on insects ("quick knockdown") is not always lethal (Cheremisinoff and King, 1994). Pyrethroids are formulated as emulsifiable concentrates, wettable powders, granules, and concentrates for ULV application.

Borates

"Borate" is a generic term for compounds containing the elements boron and oxygen. Boron never occurs alone naturally but as calcium and sodium borate ores in several places in the world.

Borax and other sodium borates are used in numerous products such as laundry additives, eye drops, fertilizers, and insecticides. Though the mechanisms of toxicity are not fully understood, boron is very toxic to insects and decay fungi that commonly damage wood in structures. At low levels, however, boron is only minimally toxic, and perhaps beneficial, to humans, other mammals, and growing plants. Use of borate-treated wood for construction of homes and their wood-based contents appears to offer many advantages to today's environmentally sensitive world.

Unlike most other wood preservatives and organic insecticides that penetrate best in dry wood, borates are diffusible chemicals—they penetrate unseasoned wood by diffusion, a natural process. Wood moisture content and method and length of storage are the primary factors affecting penetration by diffusion. Properly done, diffusion treatments permit deep penetration of large timbers and refractory (difficult-to-treat) wood species that cannot be treated well by pressure.

The diffusible property of borates can be manipulated in many ways; suitable application methods range from complex automated industrial processes to simple brush or injection treatments.

Application methods include momentary immersion by bulk dipping; pressure or combination pressure/diffusion treatment; treatment of composite boards and laminated products by treatment of the wood finish; hot and cold dip treatments and long soaking periods; spray or brush-on treatments with borate slurries or pastes; and placement of fused borate rods in holes drilled in wood already in use. This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Technical Learning College (TLC) assume no liability resulting from the use of these recommendations.

Neonicotinoids

Neonicotinoids are synthetic analogues of the natural insecticide nicotine (with a much lower acute mammalian toxicity and greater field persistence). These chemicals are nicotinic acetylcholine receptor agonists. Broad-spectrum—systemic insecticides, they have a rapid action (minutes-hours). They are applied as sprays, drenches, seed and soil treatments—often as substitutes for organophosphates and carbamates. Treated insects exhibit leg tremors, rapid wing motion, stylet withdrawal (aphids), disoriented movement, paralysis and death.

Biological Insecticides

Recent efforts to reduce broad spectrum toxins added to the environment have brought biological insecticides back into vogue. An example is the development and increase in use of Bacillus thuringiensis, a bacterial disease of Lepidopterans and some other insects. Toxins produced by different strains of this bacterium are used as a larvicide against caterpillars, beetles, and mosquitoes. Because it has little effect on other organisms, it is considered more environmentally friendly than synthetic pesticides. The toxin from B. thuringiensis (Bt toxin) has been incorporated directly into plants through the use of genetic engineering. Other biological insecticides include products based on entomopathogenic fungi (e.g. Beauveria bassiana, Metarhizium anisopliae), nematodes (e.g. Steinernema feltiae) and viruses (e.g. Cydia pomonella granulovirus).

Anti-feedants

Many plants have evolved substances, like polygodial, which prevent insects from eating, but do not kill them directly. The insect often remains nearby, where it dies of starvation. Since anti-feedants are nontoxic, they would be ideal as insecticides in agriculture. Much agrochemical research is devoted to make them cheap enough for commercial use.

Polygodial is an active constituent of Dorrigo Pepper, Mountain Pepper, Horopito, Canelo, Paracress and Water-pepper. It elicits a warm and pungent flavor.

The biological activity of polygodial has been reported in the scientific literature to include antifungal and antimicrobial activities, antihyperalgesia, potent attachment-inhibitory activity, insect antifeedant activity, antinociception, vasorelaxation action in vessels of rabbit and guinea pig, anti-inflammatory and anti-allergic activities.

Polygodial's primary antifungal action is as a nonionic surfactant, disrupting the lipid-protein interface of integral proteins nonspecifically, denaturing their functional conformation. It is also likely that polygodial permeates by passive diffusion across the plasma membrane, and once inside the cells may react with a variety of intracellular compounds. It is also used as an insecticide for its antifeedant property, which causes insects to starve.

Rotenone

Rotenone is an odorless chemical that is used as a broad-spectrum insecticide, piscicide, and pesticide. It occurs naturally in the roots and stems of several plants such as the jicama vine plant. In mammals, including humans, it is linked to the development of Parkinson's disease.

Rotenone is used in solution as a pesticide and insecticide, or in emulsified liquid form as a piscicide. People catch fish by extracting rotenone from plants and releasing it into water. Poisoned fish come to the surface and are easily caught. This method was first practiced by various indigenous tribes who smashed the roots. Fish caught this way can be eaten because rotenone is very poorly absorbed by the gastrointestinal tract of humans, whereas it is lethal to fish because it readily enters the blood stream of the fish through the gills.

Small-scale sampling with rotenone is used by fish researchers studying the biodiversity of marine fishes to collect cryptic, or hidden, fishes, which represent an important component of shoreline fish communities. Rotenone is the most effective tool available because only small quantities are necessary. It has only minor and transient environmental side-effects.

Rotenone is also used in powdered form to reduce parasitic mites on chickens and other fowl. In the United States and in Canada, all uses of rotenone except as a piscicide (fish killer) are being phased out.

Rotenone is sold as an organic pesticide dust for the garden. Unselective in action, it kills potato beetles, cucumber beetles, flea beetles, cabbage worms, raspberry bugs, and asparagus bugs, as well as most other arthropods. Rotenone rapidly bio-degrades under warm conditions so there is minimal harmful residue. A light dusting on the leaves of plants will control insects for several days. It is not known to be harmful to humans when used properly. However, a recent report from the National Institutes of Health finds statistically significant associations between use of either rotenone or paraquat with Parkinson's disease.

Rotenone is produced by extraction from the roots and stems of several tropical and subtropical plant species, especially those belonging to the genus Lonchocarpus or Derris.

Some of the plants containing rotenone:

- Hoary Pea or Goat's Rue (Tephrosia virginiana) – North America
- Jícama (Pachyrhizus erosus) – North America
- Cubé Plant or Lancepod (Lonchocarpus utilis) – South America
- The root extract is referred to as Cubé resin
- Barbasco (Lonchocarpus urucu) – South America
- The root extract is referred to as Cubé resin

- Tuba Plant (Derris elliptica) – southeast Asia & southwest Pacific islands

The root extract is referred to as Derris or Derris root

- Jewel Vine (Derris involuta) – southeast Asia & southwest Pacific islands

Among the Mizo tribes of India (Derris walchii/D. thyrsiflora) the tender root is eaten as vegetable. The root extract is referred to as Derris or Derris root

- Duboisia – This shrub grows in Australia and bears white clusters of flowers and berry like fruit. The crushed plants were used by the Aboriginals for poisoning fish for food.
- Verbascum Thapsus
- Cork-Bush (Mundulea sericea) – southern Africa
- Florida fishpoison tree (Piscidia piscipula) – southern Florida, Caribbean

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This course contains EPA's federal rule requirements. Please be aware that each state implements pesticide regulations that may be more stringent than EPA's regulations and these frequently are changed. Check with your state environmental/pesticide agency for more information.

Insect Growth Regulators

An insect growth regulator (IGR) is a synthetic chemical that mimics insect hormones. Hormones regulate a wide array of body and growth (physiological) functions. IGRs may interfere with molting, pupal emergence, or body wall formation. IGRs are often specific for an insect species or a group of very closely related species. They often have delayed effects because they are taken into the insect and stored until the insect reaches the right growth stage. This may range from days to weeks or even months. For example, if the IGR stops the insect from molting and a given insect is exposed just after a molt, it would continue to function normally until the next molt before dying.

Reduced Risk
Many IGRs are labeled "reduced risk" by the Environmental Protection Agency, meaning that they target juvenile harmful insect populations while causing less detrimental effects to beneficial insects. Unlike classic insecticides, IGRs do not affect an insect's nervous system and are thus more worker-friendly within closed environments. IGRs are also more compatible with pest management systems that use biological controls. In addition, while insects can become resistant to insecticides, they are less likely to become resistant to IGRs.

Hormonal IGRs
Hormonal IGRs typically work by mimicking or inhibiting the juvenile hormone (JH), one of the two major hormones involved in insect molting. IGRs can also inhibit the other hormone, ecdysone, large peaks of which trigger the insect to molt.

If JH is present at the time of molting, the insect molts into a larger larval form; if absent, it molts into a pupa or adult. IGRs that mimic JH can produce premature molting of young immature stages, disrupting larval development. They can also act on eggs, causing sterilization, disrupting behavior or disrupting diapause, the process that causes an insect to become dormant before winter. IGRs that inhibit JH production can cause insects to prematurely molt into a nonfunctional adult. IGRs that inhibit ecdysone can cause pupal mortality by interrupting the transformation of larval tissues into adult tissues during the pupal stage.

Chitin Synthesis Inhibitors
Chitin synthesis inhibitors work by preventing the formation of chitin, a carbohydrate needed to form the insect's exoskeleton. With these inhibitors, an insect grows normally until it molts. The inhibitors prevent the new exoskeleton from forming properly, causing the insect to die. Death may be quick, or take up to several days depending on the insect. Chitin synthesis inhibitors can also kill eggs by disrupting normal embryonic development. Chitin synthesis inhibitors affect insects for longer periods of time than hormonal IGRs. These are also quicker acting but can affect predaceous insects, arthropods and even fish.

In the case of termite control, the slow action of the IGR allows the chemical to be widely spread throughout the colony as the termite workers feed and groom one another. IGRs are, in general, environmentally safe and have very low mammalian toxicity. Some examples are hexaflumuron, diflubenzuron, pyriproxyfen, and methoprene.

Hexaflumuron

Hexaflumuron (hexaflumeron) is an insect growth regulator that interferes with insects' chitin synthesis. It was registered in 1994 — the first active ingredient to be registered as a "reduced risk pesticide" through the U.S. Environmental Protection Agency's (EPA's) reduced risk program, which waives tests for new pesticides that are thought to pose fewer hazards than existing pesticides. It is registered for use on termites, and is the active ingredient in the Sentricon™ bait system. It functions by inhibiting the synthesis of chitin, the material that makes up the exoskeleton of insects (Cox, 1997).

Hexaflumuron is a benzoyl-phenylurea termiticide registered for use to control Eastern and Formosan subterranean termites. It is registered for use in above- and below-ground termite bait station systems in food and nonfood areas. Treatment sites may include interior and exterior surfaces of buildings and crawl spaces, fences, utility poles, decking, landscape decorations, trees, and other features which could be damaged by termite foraging and feeding activity.

Hexaflumuron is not approved for use in indoor residences. While it is not a restricted use product, hexaflumuron is sold in conjunction with a service provided by pest-control operators licensed by the state to apply termiticides. As hexaflumuron was first registered in 1994, it was not subject to the reregistration process as required by FIFRA.

The Agency anticipates conducting an ecological risk assessment for hexaflumuron, including an endangered species assessment. For human health, risk assessments may be required if there are changes in current use patterns. Below is a summary of the issues relevant to the registration review process of hexaflumuron.

Environmental Fate and Ecological Risk:

• The application method for hexaflumuron (i.e., bait stations), is viewed by the Agency as a “closed system” with minimal likelihood of environmental exposure. No previous ecological risk assessments or drinking water exposure assessments have been conducted for hexaflumuron.

• The Agency has not conducted a risk assessment that supports a complete endangered species determination. The ecological risk assessment planned during registration review will allow the Agency to determine whether hexaflumuron use has “no effect” or “may affect” federally listed threatened or endangered species (listed species) or their designated critical habitats. When an assessment concludes that a pesticide’s use “may affect” a listed species or its designated critical habitat, the Agency will consult with the U.S. Fish and Wildlife Service and/or National Marine Fisheries Service (the Services), as appropriate.

• Considering the environmental fate properties of hexaflumuron and the method of application (i.e., bait stations), hexaflumuron has the potential to enter into the environment via termites eating the bait and then transporting it away from the bait station. Once in the termite, hexaflumuron could be transferred to termite predators, such as birds and mammals. Based on the fate properties of hexaflumuron, it has the potential to bioaccumulate in food webs. Another possible route of exposure where uncertainty exists is the ability of non-target terrestrial invertebrates, such as native ground-dwelling pollinators, to enter the hexaflumuron bait stations. Therefore, future ecological risk assessments of hexaflumuron will include assessing risks associated with exposures of terrestrial animals to hexaflumuron through consumption of contaminated termites and non-target terrestrial invertebrates that may enter bait stations.

• Hexaflumuron's mode of action, fate and transport properties, and toxicity to non-target terrestrial species create the potential for hexaflumuron to reduce survival, reproduction, and/or growth in non-target terrestrial animals including birds, mammals, amphibians, reptiles and terrestrial insects when used in accordance with the current label. These non-target organisms include federally listed threatened and endangered species as well as non-listed species.
• Based on the application methods (i.e., above- and below-ground bait stations) and the environmental fate properties for hexaflumuron, the potential for hexaflumuron to migrate to the soil and to further migrate to surface water and/or groundwater sources is considered minimal. Therefore, ecological risk to aquatic organisms is expected to be low. In addition, unless the use patterns for hexaflumuron change, a drinking water exposure assessment will not be required to support registration review.

Human Health Risk
• Because of the low toxicity of hexaflumuron, and the low-exposure scenarios associated with hexaflumuron products, a human health risk assessment has not been previously conducted.
• Given the current uses, the Agency does not anticipate conducting a human health risk assessment for hexaflumuron to support registration review. However, if in the future new uses or use patterns emerge, human health risk assessments that examine the dietary, residential, aggregate, or occupational risks of hexaflumuron may be required.
• Based on the Agency's review of the available human health toxicity and exposure data for hexaflumuron, no additional data are expected to be required to support registration review.

Diflubenzuron

Diflubenzuron is an insecticide of the benzamide class. It is used in forest management and on field crops to selectively control insect pests. The mechanism of action of diflubenzuron involves inhibiting the production of chitin which is used by an insect to build its exoskeleton. Diflubenzuron is an acaricide/insecticide (insect growth regulator) used to control many leaf eating larvae of insects feeding on agricultural, forest and ornamental plants (e.g. gypsy moths, mosquito larvae, rust mites). Diflubenzuron is used primarily on cattle, citrus, cotton, mushrooms, ornamentals, standing water, forestry trees and in programs to control mosquito larvae and gypsy moth populations. Formulations include a soluble concentrate, flowable concentrate, wettable powder and a pelleted/tableted. Diflubenzuron is applied by airblast, aircraft and hydraulic sprayers.

Regulatory History
Diflubenzuron was first registered as a pesticide in the U.S. in 1976. EPA issued a Registration Standard for diflubenzuron in September 1985 (PB86-176500). A November 1991 Data Call-In (DCI) required additional residue chemistry and ecological effects data. Currently, 29 diflubenzuron products are registered.

Human Health
Assessment Toxicity
In studies using laboratory animals, diflubenzuron generally has been shown to be slightly toxic on an acute basis. It is absorbed by the dermal route and has been placed in Toxicity Category III (the second lowest of four categories). It has also been placed in Toxicity Category IV (the lowest of four categories) for ingestion by the oral and inhalation routes.

Occupational and Residential Exposure
Based on current use patterns, handlers (mixers, loaders, and applicators) may be exposed to diflubenzuron during and after normal use of applications in agricultural and other settings. The Agency is establishing a short-term (1 to 7 days) toxicological endpoint of sulfhemoglobinemia and intermediate-term (1 week to several months) toxicological endpoint of methemoglobinemia.

Human Risk Assessment
Diflubenzuron generally is of low acute toxicity, but affects the hemoglobin of animal in studies. Although the Agency has determined that there is no evidence of carcinogenicity for iflubenzuron per se (Group E); p-chloroaniline (PCA), a metabolite of diflubenzuron, is a probable human carcinogen (Group B2). The Agency has also determined that pchlorophenylurea (CPU), a metabolite of diflubenzuron that is closely related to PCA but has no adequate carcinogenicity data, is considered as having the same carcinogenicity potential (Q1*) as PCA. The total cancer risk estimate for PCA and related metabolites for the overall U.S. population is 1 X 10-6. The Rfd is 0.02 mg/kg/day, based on the NOEL of 2.0 mg/kg/day in the 52-week chronic oral study in dogs with a safety factor of 100 to account for interspecies extrapolation and intraspecies variability.

Occupational Exposure
Of greater concern is the risk posed to diflubenzuron handlers, particularly mixers/loaders/applicators. The risk for short-term occupational exposure is acceptable for handlers wearing long-sleeved shirts, long pants and chemical-resistant gloves. The risk for intermediate term occupational exposure is also acceptable, provided dust/mist respirators (TC-21C) are required for mixers, loaders and applicators when working with diflubenzuron for certain higher risk application methods.

Restricted Entry Interval
Post-application re-entry workers will be required to observe a 12-hour Restricted Entry Interval, as set by the WPS. Under the Food Quality Protection Act of 1996, the Agency has determined that there is a reasonable certainty that no harm will result to infants and children from aggregate exposure to diflubenzuron. The total dietary cancer risk for the published tolerances for the overall U.S. population is approximately 1 x 10-6. Since there are no detections of diflubenzuron in ground water, dietary risk from drinking water are expected to be negligible. Based on very low residues detected in forestry dissipation studies, a low dermal absorption rate, and extremely low dermal and inhalation toxicity, occupational uses of diflubenzuron in residential locations, parks, or forests treated with diflubenzuron are expected to result in insignificant risk.

Ecological Effects
Diflubenzuron is practically non-toxic to avian species, small mammals, freshwater fish and marine/estuarine fish on an acute oral dietary basis, while it is slightly toxic to avian species on a subacute dietary basis.

Diflubenzuron is non-toxic to bees. The results indicate that diflubenzuron is very highly toxic to freshwater aquatic invertebrates, including marine/estuarine crustacea, while it is highly toxic to marine/estuarine mollusks. The results indicate that diflubenzuron affects reproduction, growth and survival in freshwater invertebrates as well as reproduction in marine/estuarine invertebrates.

Pyriproxyfen

Pyriproxyfen is a pyridine based pesticide which is found to be effective against a variety of arthropoda. It was introduced to the US in 1996 to protect cotton crops against whitefly. It has also found useful for protecting other crops. It is also being used as a prevention for fleas on household pets.

Pyriproxyfen is a juvenile hormone analogue, preventing larvae from developing into adulthood and thus rendering them unable to reproduce. In the US pyriproxyfen is often marketed under the trade name Nylar. In Europe pyriproxyfen is known under the brand names Cyclio (Virbac) and Exil Flea Free TwinSpot (Emax).

Methoprene

Methoprene is a juvenile hormone (JH) analog which can be used as an insecticide that acts as a growth regulator. Methoprene is an amber-colored liquid with a faint fruity odor which is essentially nontoxic to humans when ingested or inhaled. It is used in drinking water cisterns to control mosquitoes which spread malaria.

Methoprene is an insect growth regulator (IGR) with activity against a variety of insect species including horn flies, mosquitoes, beetles, tobacco moths, sciarid flies, fleas (eggs and larvae), fire ants, pharoah ants, midge flies and Indian meal moths. Controlling some of these insects, methoprene is used in the production of a number of foods including meat, milk, mushrooms, peanuts, rice and cereals. It also has several uses on domestic animals (pets) for controlling fleas.

Methoprene products are sold under a number of trade names including Altosid, Precor, Kaba, Pharorid, Dianex, Apex, Fleatrol, Ovitrol, Extinguish and Diacon. Methoprene is considered a biochemical pesticide because rather than controlling target pests through direct toxicity, Methoprene interferes with an insect's life cycle and prevents it from reaching maturity or reproducing.

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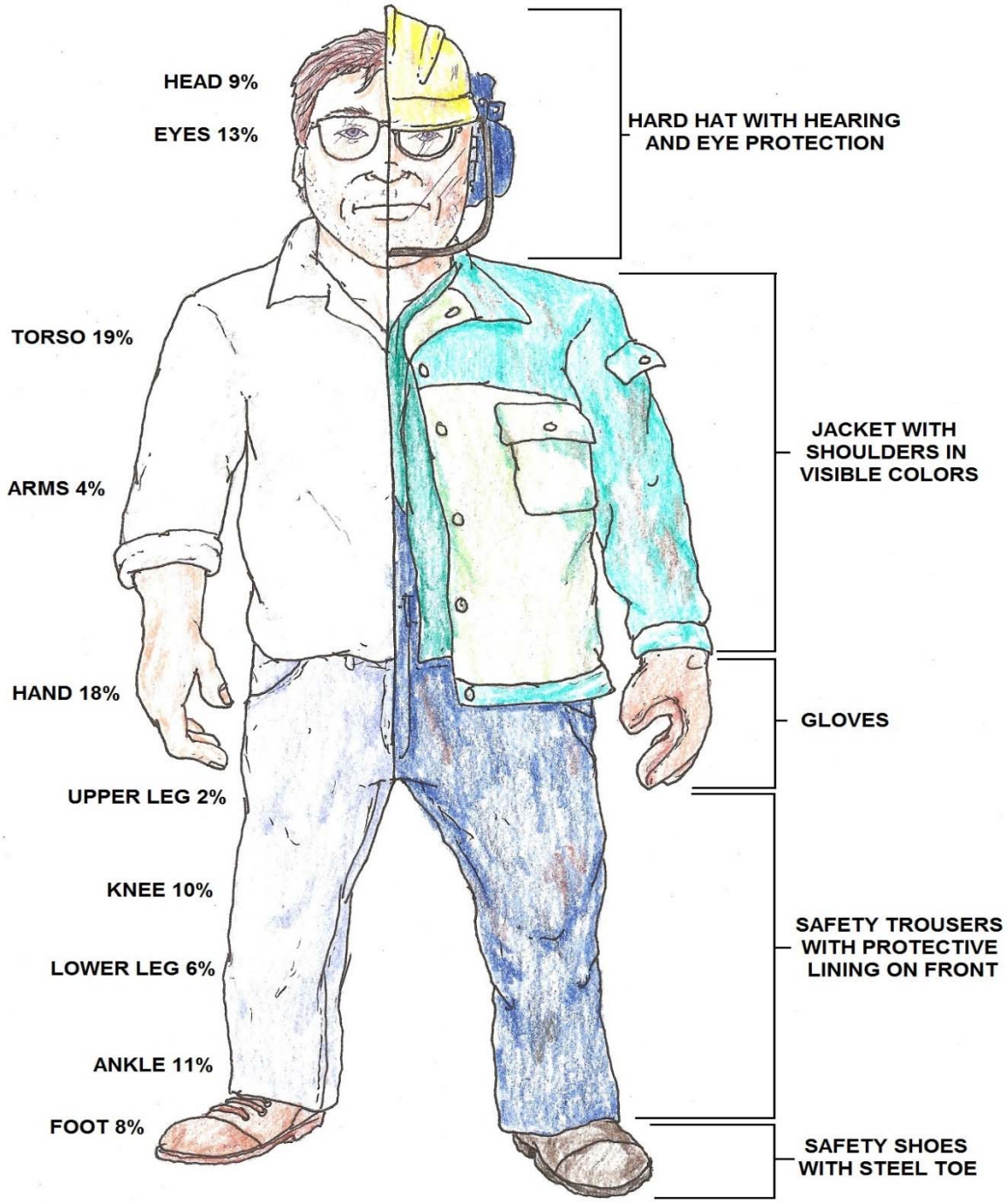

PERSONAL PROTECTIVE EQUIPMENT

Agricultural Pesticide Components Post Quiz

Mode of Action Section

1. Some pesticides have one REI, such as 12 hours, for all crops and uses. Other products have different REIs, depending on the crop or _____.

A. Restricted-entry interval
B. Training
C. Method of application
D. Pesticide
E. None of the Above

2. When two or more pesticides are applied at the same time and have different REIs, the longer interval must be followed. There is a no-entry period for 4 hours for all products with _____ labeling; this means no early entry.

A. Restricted-entry interval
B. Agricultural Use Requirements
C. Worker Protection Standard
D. Worker Notification
E. None of the Above

3. Employers must _____about pesticide applications on the agricultural establishment if they will be on or within a quarter (1/4) mile of the treated area.

A. Provide a clean-up area
B. Provide Agricultural Use Requirements
C. Provide PPE
D. Notify Workers
E. None of the Above

4. In most cases, employers may choose between oral warnings or posted warning signs, but they must _____which warning method is in effect. All applications must be additionally recorded and displayed at the central location.

A. Provide PPE and training about
B. Notify Workers Or Tell workers
C. Provide Agricultural Use Requirements
D. Provide a copy of the Worker Protection Standard
E. None of the Above

5. Most products allow worker notification either orally or by posting a field warning sign, one or the other is acceptable as long as workers are informed of which method is being used. However, you must provide double notification if the pesticide label has this statement in the "Directions for Use" section under the heading "_____":

A. Restricted-entry interval
B. Worker Notification
C. Agricultural Use Requirements
D. Worker Protection Standard
E. None of the Above

Notify workers of the application by warning them orally AND by posting warning signs at entrances to treated areas.

6. If double notification is suspected because pesticide workers have been orally notified about REIs and treated fields must be physically posted with warning signs during the REI.
A. TRUE
B. FALSE

Warning signs must be:

7. Posted 24 days or less before application.
A. TRUE
B. FALSE

8. Removed within three (3) days after the end of the harvest.
A. TRUE
B. FALSE

9. Posted so they can be seen at all normal entrances to treated areas, including borders adjacent to labor but not prison camps.
A. TRUE
B. FALSE

10. If no employees were involved with flying the aircraft, or the employees do not come within a quarter (1/4) mile to a shooting range, no posting is required.
A. TRUE
B. FALSE

11. Oral warnings must be delivered in a manner understood by workers, using an interpreter if necessary.
A. TRUE
B. FALSE

12. Oral warnings must contain the following information:
Location and description of the treated area, the length of the REI, specific directions not to enter during the REI.
A. TRUE
B. FALSE

13. The WPS requirement that information be posted (displayed) at a central location is cited by the EPA as one of the most commonly violated provisions.
A. TRUE
B. FALSE

14. The Worker Protection Standard (WPS) is a regulation issued by the U.S. Environmental Protection Agency. It covers pesticides that are used in the _____ on farms, forests, nurseries, and greenhouses.
A. Access to specific information or Access to specific labeling information
B. Production of agricultural plants
C. Prohibition of handlers from applying a pesticide
D. Reduction the risk of pesticide-related illness
E. None of the Above

15. The WPS requires you to take steps to _____and injury if you (1) use such pesticides, or (2) employ workers or pesticide handlers who are exposed to such pesticides.
A. Gain access to specific information or Access to specific labeling information
B. Provide proper pesticide safety training or Pesticide safety poster
C. Prohibit handlers from applying a pesticide
D. Reduce the risk of pesticide-related illness
E. None of the Above

16. If you are an agricultural pesticide user and/or an employer of agricultural workers or pesticide handlers, the WPS requires you to provide to your employees and, in some cases, to yourself and to others: information about exposure to pesticides, _____, and ways to mitigate exposures to pesticides.
A. Access to specific information or Access to specific labeling information
B. Protections against exposures to pesticides
C. Prohibiting handlers from applying a pesticide
D. Reducing the risk of pesticide-related illness
E. None of the Above

Answers
1.C, 2.C, 3.D, 4.B, 5.C, 6.B, 7.B, 8.B,9.B, 10.B, 11.A, 12.A, 13.A, 15.D, 16.B

Agricultural Application Section

Credit and parts of this section "Applicator Training Manual for AERIAL APPLICATION OF PESTICIDES Douglas G. Overhults, Extension Agricultural Engineer University of Kentucky"

Aerial application, commonly called **crop dusting**, involves spraying crops with fertilizers, pesticides, and fungicides from an agricultural aircraft. The specific spreading of fertilizer is also known as *aerial topdressing*.

Agricultural aircraft are often purpose-built, though many have been converted from existing airframes. Helicopters are sometimes used, and some aircraft serve double duty as water bombers in areas prone to wildfires.

Adherence to local requirements must be the starting point for all those involved in aerial spray application. Training is required for ground support staff as well as for the pilot. The local FAA Aviation Authority will normally administer the pilot's flying license and a permit to apply pesticides; however, additional training in the techniques of spraying is usually required to qualify for agricultural work. Whilst a private pilot's license can usually be obtained locally, training for agricultural work may have to be undertaken elsewhere at a recognized training facility.

A pilot must prove competence in the use of pesticides related to:

a) Appropriateness of the pesticide and formulation
b) The correct dose rate, application technique and procedures
c) Awareness of the hazards associated with the use of the product
d) First aid procedures in the event of an accident

In some states spray contractors work to agreed company guidelines which are regularly checked and updated by the FAA Aviation, EPA and /or other authorities, who issue applicator, worker or handler licenses and register individual spray aircraft as airworthy and compliant with the specifications for spray operation.

Ground support staff (mixers, loaders and flagmen) must be adequately trained to ensure that they are fully protected and the spray operation is as safe as possible. Ground-based functions cover two distinct operations:

a) Mixers and loaders.
b) Crop Advisors, Workers Handlers, and flagmen.
c) The mixer/loaders.

These staff must be fully conversant with their company procedures, operating manuals and practices so that products are safely mixed and loaded into the aircraft hopper in the correct amounts at the recommended dilutions.

Protecting the mixer/loader is a high priority as exposure potential is high when handling concentrated pesticides. Where many aircraft sorties are flown from each airstrip this results in extended periods of exposure of the ground crews and increased risk. Engineering controls such as closed chemical transfer devices, returnable containers and pre-measured chemical dose packs should be used to reduce the risk to ground staff.

Training must therefore cover the safe and correct use of chemical loading and transfer systems and the use of personal protective equipment (PPE).

Understanding the Dangers of Drift

Spray or dust drift is one of the greatest hazards of aerial application in terms of pesticide misuse. The amount of drift depends upon three factors. They are: (1) the size of the droplets or particles; (2) the wind velocity; and (3) the height above the ground from which the pesticide is released. Droplet size depends primarily upon the spray pressure, nozzle design and orientation, and the surface tension of the spray solution. The size of granular materials depends upon the particular formulation and can be controlled to some extent by screening. In the case of sprays, droplet size is generally increased by reducing pressures or increasing nozzle size. The use of surfactants tends to lower the surface tension of a spray solution and usually results in a smaller droplet size than when the same formulation is used without a surfactant.

High wind velocities obviously increase the drift hazard as they carry the small droplets and particles away from their intended target. In many cases the distance can run into several miles. Winds tend to be least turbulent just before sunrise or just after sunset. The most gusts usually occur between 2 and 4 p.m. A 3 mile per hour wind is usually the maximum wind velocity which is recommended for aerial applications.

The height from which a pesticide is released is important because it effects the time required for the droplet or particle to reach the ground. The longer the time required, the more opportunity there is for the pesticide to move away from its intended target. It is also true that the wind velocity is lower close to the ground than at higher elevations. Therefore, the wind problem can also be minimized by holding the discharge height to a minimum. Every possible effort should be made to control pesticide drift. The distances can be surprising. Table 1 shows the effect of particle size on pesticide drift. In general, the ideal size of particles for aerial pesticide application is 500 to 1000 microns. This will permit adequate coverage with minimum drift problems.

Table 1: Effect of Particle Size on Pesticide Drift

Droplet or Dust Particle Diameter (microns)	Distance of Drift*
0.5	388 miles
2	21 miles
5 (Fog)	3 miles
10	1 mile
100 (Mist)	409 feet
500 (1/50 inch) (Light Rain)	7 feet
1000 (1/25 inch) (Moderate Rain)	4.7 feet

**Pesticide released 10 feet above ground in a 3mph wind*

More on Drift Hazards

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2,4-D, Cotton, and Pesticide Drift
The three leading causes of 2,4-D injury are: volatilization (or vapor drift), spray drift, and sprayer contamination. The potential for injury from each of these causes can be greatly reduced by adhering to best management practices as described in the following paragraphs.

Spray Drift
Another way in which 2,4-D injury can occur is by spray drift. Spray drift means physical movement of spray droplets by wind. As opposed to vapor drift, spray drift can occur with any formulation of 2,4-D (or any herbicide). Spraying during windy conditions and using nozzles and pressures that result in the creation of fine spray droplets increase the risk of spray drift.

Except in extreme cases, such as spraying in very windy conditions and using nozzles and pressures that create very fine droplets, spray drift normally is observed only over short distances. A buffer of 200 feet or more between the area being sprayed and the susceptible crop usually is adequate to prevent injury from spray droplet drift unless it is very windy. If there is no wind or if the wind is blowing away from the cotton field, a shorter buffer is acceptable.

Vapor Drift (Volatilization)
Most cases of 2,4-D injury to cotton result from vapor drift of an ester-containing formulation of 2,4-D. Vapor drift injury results when the herbicide volatilizes and the vapors move to a susceptible crop such as cotton. Injury from vapor drift can occur at rather long distances from the sprayed area.

Hot temperatures, moist soils, and temperature inversions all increase the potential for vapor drift. Vapor drift is not movement of material caused by wind. In fact, calm or no wind may lead to inversions that could result in vapor drift. Vapor drift can be avoided by simply refraining from the use of ester-containing formulations of 2,4-D.

Ester formulations of 2,4-D should not be used within a mile of any cotton field during the months that cotton is in the field. Most commercially available ester formulations are considered "*low volatile*."

These formulations are still volatile, and their use can lead to cotton injury. Formulations containing a mixture of 2,4-D ester and 2,4-D acid, i.e., Weedone 638, should also be avoided in cotton-producing areas. Vapor drift is not a problem with amine formulations of 2,4-D.

Ester and ester-acid formulations of 2,4-D are popular because they mix well with liquid nitrogen. Amine formulations also can be mixed with liquid nitrogen if the 2,4-D is premixed with water before adding it to the liquid nitrogen. The type of spray nozzles that a farmer uses does not reduce the potential of vapor drift.

New Drift Reduction Requirements
The EPA began using new drift reduction requirements on the new Guthion® Solupak 50% label (8/31/03). The same or similar drift reduction statements will appear on new labels of other pesticides.

How to Avoid Problems When Treating around Fish Ponds, Fish-bearing Streams and Estuarine Areas
Use maximum gallonage (3 gallons spray or more by air or 6 gallons/acre with ground equipment) per acre and low pressure (max 25 PSI for aircraft and 40 PSI for ground sprayers).

- Delay treatments near fish ponds, etc., until wind is blowing away from sensitive area.

- Use the chemical less toxic to fish if the choice is available. Apply IPM principles such as scouting, etc., and treat only when necessary and with minimum rate to obtain control.

- Advise farmers, where practical, to plant crops near ponds and fish-bearing waters that will require a minimum of insect control (soybeans rather than cotton, for example).

- Check application equipment daily to ensure there are no leaks in hoses and fittings.

- Aerial applicators, whether equipment is loaded or empty, should not fly over fish ponds or fish-bearing waters if it can possibly be avoided. Avoid the use of LV or ULV sprayers in the vicinity of fish ponds or fish-bearing waters.

- Check to ensure that chemicals are mixed adequately before initiating spray operations (for example, premix chemical before loading sprayers). Aerial applicators should check calibration and follow all practices which enhance accurate delivery of pesticides. See Application section of handbook for tips on calibration, etc.

How to Reduce Drift (Aerial Applications)
Try to get good field-end coverage on initial spray runs; crossing the ends of fields which are bordered by trees or other obstacles usually means flying higher and increasing the chance of drift.

- ***Fly slow. Fly low***. Slow speeds are combined with lower pump pressures to produce larger droplets. Herbicides should be applied at a lower height than other pesticides.

- For fixed wing aircraft, don't use a whirl-plate, rather, use a 1/16 to 1/18 inch diameter orifice plate directed straight back.

- Be sure the positive shut-off is working properly, and ***use it!***

- Nozzle orientation affects wind shear across the nozzle face, and subsequently droplet size. Use a nozzle orientation that will give the desired droplet size.

- Boom length should be no more than 75% of the wingspan of fixed wing craft, or of the rotor diameter on helicopters to reduce drift caused by wingtip and rotor vortices.

- Use Microfoil boom, Tru-Value boom or an equivalent drift control system. See the pesticide label.

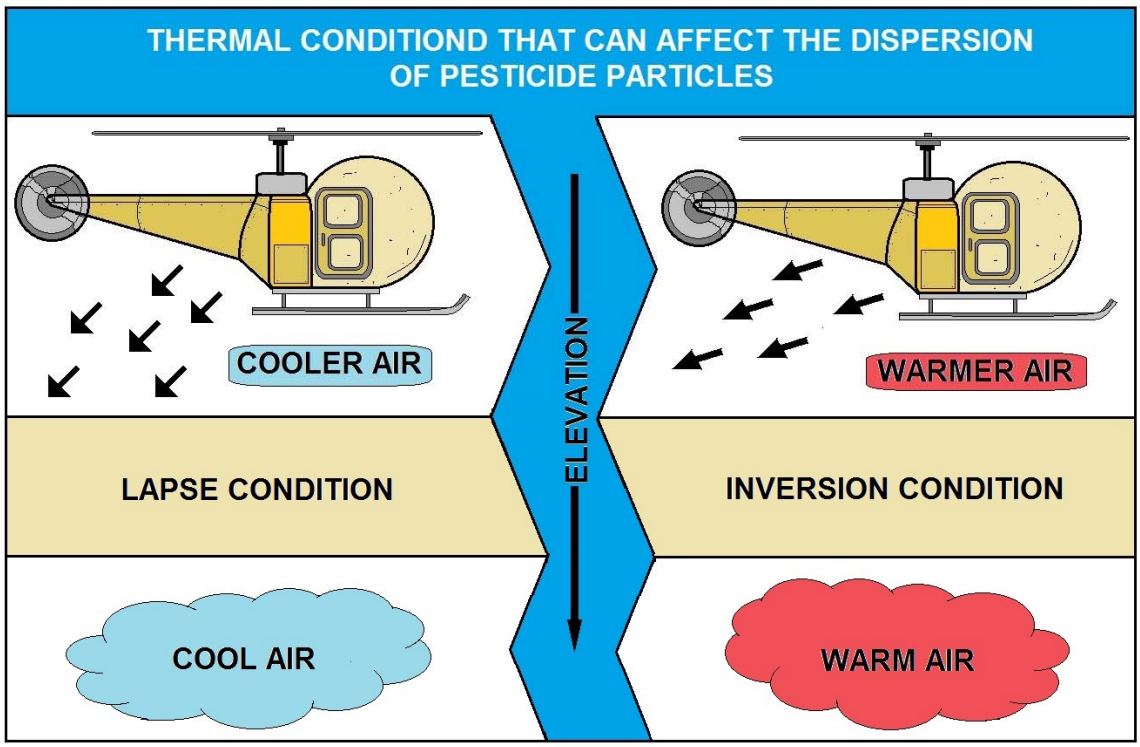
- When there is *any* possibility or concern of drift, use a drift retardant as a standard part of your spraying service. Using drift retardants can promote a positive environmental concern and help eliminate legal problems.

Spray Calibration and Vortex

Fixed-wing aircraft and helicopters exhibit similar flight characteristics (wingtip vortex and main rotor vortex). Since the airflow patterns around and in the wake of each aircraft are sufficiently different, each type and series of aircraft needs testing. If the horsepower of the engine is changed, the type of propeller or wingtip shape will change the distribution pattern.

Generalizations can be used to guide the operator on nozzle placement or granular disseminator adjustment. However, pattern testing is needed to check the effect of each feature added to the aircraft.

Pattern tests should be made in calm air to avoid cross-wind distortion. If wind is unavoidable, the tests should be made in a direction parallel to the wind. Testing should be carried out in winds less than 3 MPH at all times. The best time for this is in the early morning before the sun heats up the ground, creating eddies and inversions.



THERMAL CONDITIONS EFFECT ON PESTICIDE APPLICATION

The tests must duplicate the use for which the application is required in terms of airspeed, height of flight, nozzle pressure or gate setting for granulars, nozzle angle and placement or disseminator adjustment, etc. It is better to test with the same materials to be applied if at all possible.

Substitute materials do not always act in quite the same manner as the chemicals. This is evident with granulars, where minor changes in the surface characteristics of the granulars (shape, surface finish, fineness or grind, etc.) alter the discharge rate.

Spray Testing Section

The nozzle type and pressure should be selected for the material being used and the atomization required for the job. Machines should be calibrated often to compensate for wear. The application rate (gallons per acre) will be set by the chemical being applied and the crop being treated as listed on the manufacturer's label. Because each aircraft exhibits its own normal or effective swath width, this value should be used with the following tables to determine the acres per minute being treated.

Knowing the gallons per minute required, the number of nozzles can be calculated based on the manufacturer's data for that nozzle type and pressure. The pressure and the air speed are now fixed for the tests and the application.

Computation of Acreage and Materials

Formula:

$$\text{Acres covered} = \frac{\text{Length of Swath (miles) X Width of Swath (ft.)}}{8.25}$$

The number of acres in a swath of given width and length can be determined from the acreage chart below.

EXAMPLE: An aircraft with a 40-foot effective swath treats a strip 1 mile long. To find the number of acres, look at the chart and follow the 40-foot vertical column down until it intersects the l-mile line. The answer, to the nearest tenth, is 4.8 acres. For swath widths other than those shown, interpolate or use combinations of the figures shown. To determine the amount of chemical required, multiply the acres by the desired rate of application.

ACREAGE CHART

	Width in Feet							
Swath Length	30	35	40	45	50	75	100	200
1/4	.9	1.1	1.2	1.4	1.5	2.3	3.0	6.1
1/2	1.8	2.1	2.4	2.7	3.0	4.5	6.1	12.1
3/4	2.7	3.2	3.6	4.1	4.6	6.8	9.1	18.2
1	3.6	4.2	4.8	5.5	6.1	9.1	12.1	24.2
2	7.2	8.4	9.8	10.9	12.1	18.2	24.2	48.5
3	10.8	12.6	14.5	16.4	18.2	27.3	36.4	72.7
4	14.4	16.8	19.4	21.8	24.2	36.4	48.5	97.0
5	18.0	21.0	24.2	27.3	30.3	45.5	60.6	121.1

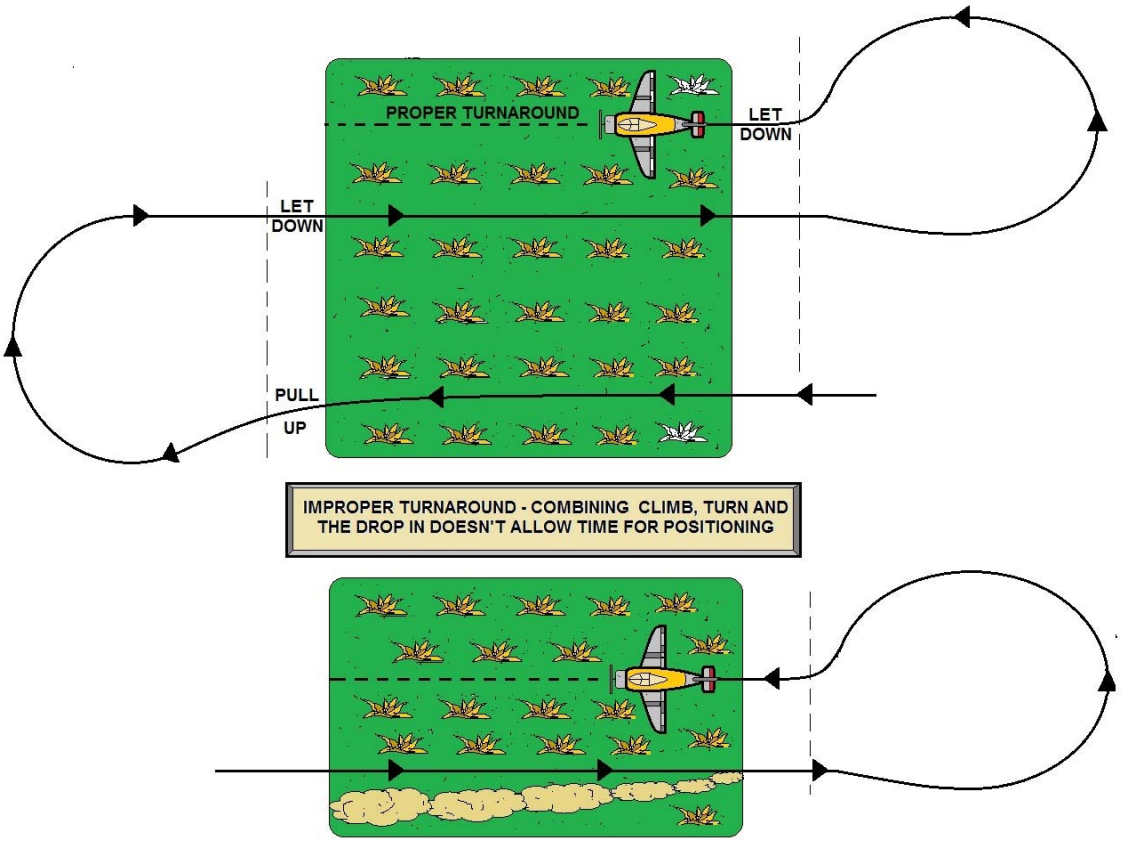
Aircraft Calibration

Formula:

$$\text{Acres per minute} = \frac{\text{2 X Swath Width X Miles Per Hour}}{1{,}000}$$

The following acres-per-minute chart shows the rate at which spray or dry material can be applied when the swath width and speed of aircraft are known. For swath widths or aircraft speeds other than those shown, interpolate or use combinations of the figures shown. To find the rate of flow in gallons per minute or pounds per minute, multiply the acres per minute by the number of gallons or pounds per acre to be applied.

Example
A 100 mile per hour aircraft has a 40-foot effective swath. On the acres-per-minute chart, follow the vertical 40-foot column down until the number opposite 100 miles per hour is intersected. The aircraft would cover 8.0 acres per minute. If 1 gallon of spray is to be applied per acre, the aircraft should be calibrated to disperse liquid at the rate of 1 X 8.0 or 8.0 gallons per minute. (If 10 pounds of dry material is to be applied per acre, the aircraft should be calibrated to disperse material at the rate of 10 X 8.0 or 80 pounds per minute.)



PESTICIDE APPLICATION
(FIELD FLIGHT PATTERN & PROPER TURN AROUND)

ACRES-PER-MINUTE CHART

	Acres Per Minute Covered for a Given Swath Width							
Speed (M.P.H)	30	35	40	45	50	75	100	200
40	2.4	2.8	3.2	3.6	4.0	6.0	8.0	16.0
50	3.0	3.5	4.0	4.5	5.0	7.5	10.0	20.0
60	3.6	4.2	4.8	5.4	6.0	9.0	12.0	24.0
70	4.2	4.9	5.6	6.3	7.0	10.5	14.0	28.0
80	4.8	5.6	6.4	7.2	8.0	12.0	16.0	32.0
90	5.4	6.3	7.2	8.1	9.0	13.5	18.0	36.0
100	6.0	7.0	8.0	9.0	10.0	15.0	20.0	40.0
110	6.6	7.7	8.8	9.9	11.0	16.5	22.0	44.0
120	7.2	8.4	9.6	10.8	12.0	18.0	24.0	48.0

To determine gallons (or pounds per acre) discharged from the aircraft, divide the gallons (or pounds) per minute discharged by the acres per minute that the aircraft covers in a swath.

Discharge Calibration

Having installed the desired type, size and number of nozzles, the output of the system should be checked to see that the correct discharge in gallons per minute is taking place. If the pump can be run at operating speed with the aircraft stationary, nozzle discharge can be checked with a measuring container and stop watch. Boom pressure must remain constant.

If this stationary test cannot be done, the aircraft should be parked and the tank(s) filled with water to a suitable mark. The aircraft can then be flown and the spray system run for a timed period (30, 60, 90 or 120 seconds). The aircraft should then be brought back to the same point used previously and the amount of water determined by reading the tank scale(s) or refilling to the first mark using measuring devices.

Swath Pattern Tests: With the application rate now established, the swath pattern should be checked to see that the distribution across the swath is as uniform as possible. The best method of spray pattern testing consists of adding a tracer (dye, fluorescent material, etc.) to water in the tank(s) of the aircraft. The aircraft is then flown at the chosen air speed and height and the spraying system is operated at the chosen pressure. One pass is made over a row of target plates or cards laid out every 2 to 3 ft. at right angles to the direction of flight.

The aircraft flies over the center of the target line that is 100 to 150 feet wide. The targets are collected and the spray deposit on each target is measured by the quantity of tracer. From the results, the distribution pattern of the swath can be determined. Corrections to the nozzle location can be made and the results checked by further testing.

A less satisfactory method is to lay out a roll of paper tape (adding machine tape) and visually inspect the resultant pattern. Interpretation of the spray pattern using this method is at best only a rough estimate of the uniformity of the deposit pattern.

Granular Material Testing
Disseminators are sensitive to adjust and the differences between granular materials have a pronounced effect on the rate of delivery and the pattern. Some disseminators are restricted as to quantity or type of materials being handled. These limitations should be checked before testing.

Discharge Calibration
Several runs should be made with the disseminating equipment installed to determine the quantity of material metered out for a given gate setting. If the disseminating equipment can be run with the aircraft on the ground, the material can be caught in large linen or paper bags and weighed.

Ram-air Disseminators
Ram-air disseminators require flight tests to get true discharge rates because the air currents and the engine vibration in flight affect the metering gate discharge rate. After running the disseminator for a given time (30, 60, 90, 1~0 seconds) the collected material is weighed. If flight tests are used, the quantity needed to refill the hopper is weighed.

Where flight is needed to calibrate the system, use blank granulars (the granular carrier, without the pesticide, of the same type used to carry the chemical). Test for three gate settings to determine the gate setting that will give the required discharge in pounds per minute of granular material. Use the figures in Tables I and II to convert pounds per minute discharged to pounds per acre applied.

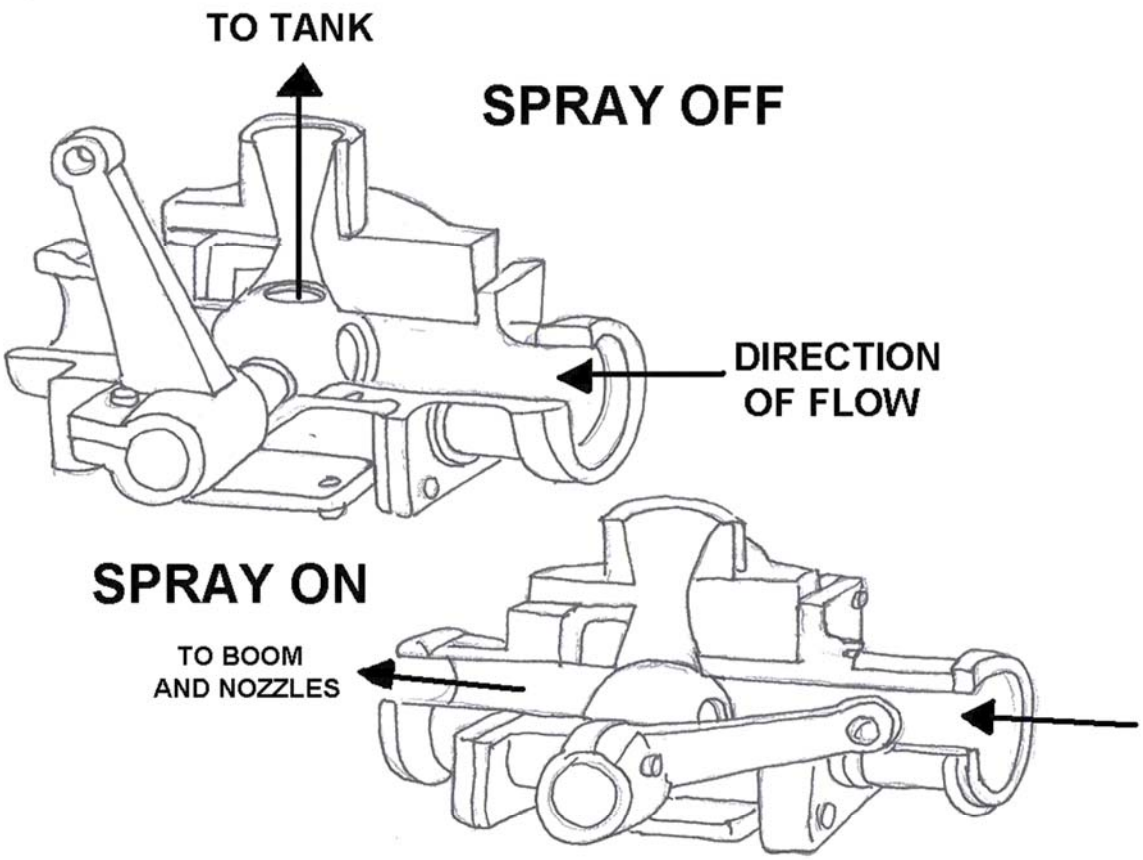
Swath Pattern Tests
These tests are similar to the spray pattern tests except that the targets are replaced with containers (large buckets or 5-gallon grease pails). Use containers that have the same area of opening. The quantity caught in each container is measured with a sensitive balance, or the volume is determined in a narrow, graduated tube. From these readings and the spacing of the containers, the swath pattern can be drawn. Adjustments to rate and pattern are made and the tests are repeated to check the adjustments.

Operation Section
General
When an aircraft has been calibrated, the air speed, spraying pressure (or gate setting for granules), height of flight and effective swath width are fixed. Applications must be made at the same settings. The ferrying height between the airstrip and the field should be a minimum of 500 feet, loaded or empty. Avoid flying over farm buildings, feedlots or residential areas to avoid noise and accidental leakage problems. Courtesy to your neighbor costs so little and pays real dividends.

Tank Filling
The spray loader is at the highest risk when handling the concentrate pesticide and his exposure time will increase on airstrips handling more than one aircraft for multiple sorties. In such cases, the use of a closed chemical transfer system will reduce the risk to both the applicator, worker or handler and environment. Aircraft hoppers can be top-loaded (solids), but most liquids are loaded via a self-filler valve located on the fuselage. These valves must be of the dry-break type and large enough to facilitate rapid filling. The valve must be positive in action to eliminate spillage.

The tank filling procedure must follow label recommendations for product introduction into the hopper, however, as agitation of the spray solution is limited during filling and "ferrying", the use of a pre-mix facility is recommended.

- ✓ The above point becomes more important in the case of a helicopter fitted with pannier tanks and an intermittent electric drive pump, which is only used when actually spraying.
- ✓ Aircraft payload may need to be reduced to compensate for airstrip conditions or the effect of atmospheric conditions on engine performance, which in turn will determine how much spray liquid, can be loaded.



POSITIVE CUT-OFF SPRAY VALVE

Prior Warnings

Notify Beekeepers
Notify beekeepers about the meetings. Program operational guidelines, environmental impact statements, environmental assessments (EA), State laws, and/or pesticide labels may also require that beekeepers in the area be notified of control programs. Members of the public, not directly involved with the spray operation, may also be affected by an aerial pesticide application so the contractor/farmer may have a mandatory obligation to issue “prior warnings” to any person or organization that might be affected or concerned. Warnings must be given in ample time to beekeepers, owners of adjacent crops, livestock owners and those responsible for nearby environmentally sensitive sites. Where particularly toxic materials are to be used, it may be necessary to warn the emergency services, and the local environment and water authorities. The product label should give precise advice on prior warning and who to contact.

Field Application
Adequate pre-preparation will make sure that the actual spraying is carried out under the safest conditions and accurate spray timing will help ensure that the product is used to optimum effect. Employers and applicator, worker or handler s must make sure that all safety equipment, clothing and aircraft loading equipment is clean and in a good state of repair.

Field Survey
The possible environmental effect of the selected product will have already been considered when the decision to use it is made. The pilot accepts the responsibility for treating a particular field and the decision to spray will be made following a preliminary inspection flight to note boundary locations and determine the method of ground marking. The pilot will also note the position of trees, overhead wires, habitations, waterways, livestock which might be frightened by low flying aircraft, and field undulations, which may affect aircraft performance and the number and position of the flagmen required. Adjacent crops must be noted and roads and railways observed, particularly where they are raised on embankments, which may restrict aircraft maneuvering. Spray pilots must observe national legislation regarding the dimension of mandatory “no-spray” (buffer) boundaries. The product label will stipulate the buffer widths where appropriate. In some states organizations are available to advice on field headland and boundary management and they can assist with local environmental risk assessment when a pesticide is to be used.

Meteorological Considerations
Spray deposit efficiency is greatly influenced by local meteorological conditions at crop height. Wind velocity and direction, temperature, relative humidity and the likelihood of rain all influence spray deposit. The distance a spray droplet travels depends on the droplet size and downward velocity, the release height and the ambient conditions. Vortices created by the aircraft passage will also influence spray distribution efficiency.

Wind
Aircraft spraying is normally carried out when the surface wind speed is less than 20F/S, which is a safe speed for aircraft handling and safety. However, in areas of exceptional turbulence the above figures may have to be reduced. Reference to local rules and guidelines may indicate the cut-off wind speed for aerial spraying; however, it is inadvisable to spray when wind speeds exceed 8m/s under most circumstances.

Wind speed and direction will also influence flying height. When the wind speed is less than 3m/s, a boom height of between 3 and 4 m above the crop will ensure good lateral movement of the spray but flying height must be reduced if the wind speed exceeds 3m/s. Spraying must be carried out taking into account the crosswind to ensure that the flying speed and the application rate remain the same for both flight directions. The distance that the spray moves will vary according to wind strength and aircraft altitude.

Temperature
In conventional (water-based) spraying, high temperature, combined with low relative humidity will reduce droplet size through evaporation, which will increase the risk of drift. As temperature increases so atmospheric turbulence rises. Spraying must not be carried out where there is upward air movement or where a temperature inversion prevents the spray cloud settling within the treated area.

For ULV spraying, conditions of mild turbulence, similar to those recommended for conventional spraying, are preferable. The relative humidity can be calculated from tables, by determining the difference between the wet and dry bulb thermometers (hygrometer). When the difference between the wet and dry bulbs exceeds 8°, aqueous spray suspensions should not be sprayed.

Treatment Timing
The optimum timing to spray will depend on the pest, weed and disease development stages. Treatment timing will also be governed by meteorological conditions, which may affect losses from drift and from volatile spray. Temperature, relative humidity, wind direction, wind velocity and rainfall can all influence spray deposit efficiency. The product label will indicate the period of time the treatment can be applied before rain and may also indicate the required dose rates for top-up application if the original spray is diluted by unexpected rain shortly after spraying.

If application timing is accurate, fewer spray treatments may be needed. The use of suitable computer modeling to predict spray timing may help to reduce the number of treatments required and accurate pest forecasting can be useful. The time of day a treatment is applied can be important. The optimum spray timing for efficacy may coincide with the foraging time of beneficial insects. It is therefore important to know and understand crop, insect and disease development and the status of beneficial organisms to determine when to spray. An understanding of product mode of action in relation to crop development will also be advantageous.

Airstrip Operation
The site should be as close as possible to the work area and must have good vehicle access. Aviation fuel and pesticide must not be stored together and the latter should be shaded from direct sunlight. A hard apron for loading and washing down aircraft is preferable for permanent airstrips where spills and washings should be retained and drained into a holding tank for processing.

Emergency and first aid equipment must be kept in good condition and clearly marked and sited. Facilities for washing and for storing PPE must also be available.

Applicator, worker or handler and environment contamination may be reduced if products are handled and loaded using closed-transfer systems working with returnable containers.

When spraying with aqueous solutions the aircraft hopper should be half filled with water before adding the formulation. As spray tank agitation is usually limited, wettable powders must be pre-mixed before loading. The use of a separate, ground-based mixing tank will speed up the transfer operation and enable the spray mixture to be fully agitated before loading.

Pilots should not be in contact with the pesticide during the loading the pesticide solution into the aircraft, which is the responsibility of the ground staff who should be familiar with the products they are handling and the accident procedures in the event of a spill or a contamination incident. The ground staff members are also responsible for cleaning up any spills onto the aircraft itself during filling and for keeping the cockpit windscreen splash free and clean.

Field Operation

Local regulations relating to aircraft operation must always be strictly followed. Crop Advisors, Workers Handlers, and members are responsible for on-the-ground site management. Field marking is carried out following a reconnaissance flight made by the pilot prior to the operation commencing.

Swath matching (lane separation) can be affected by various methods. The use of natural markers provide an inexpensive marking system but fixed markers can only be considered if the crop is to be treated many times and the wind direction remains consistent. Balloons and kytoons have been used to mark aircraft passes over tall crops but the most common method of field marking is still human flagmen, who must be fully protected at all times and remain visible to the pilot during the spray operation.

To reduce contact with the spray cloud flagmen must be positioned at least 100 yards away from the field edge and should move upwind when the aircraft comes out of the turn and levels in preparation for the spray run. The distance between spray runs should be measured, using a fixed length of rope.

Wherever possible, the use of a GPS system is strongly recommended to eliminate the use of human flagmen. Crop Advisors, Workers, and Handlers should never enter the treated area.

Accurate Aerial Spraying
Accurate aerial spraying over undulating rangelands and forest tracts is more difficult to achieve than when treating smaller crop areas and in these circumstances electronic track guidance may be financially justified. Both the self-contained Inertial Navigation System (INS) and the Doppler System require no external reference input during flight, but the size and complexity of these units confines their use to large aircraft. These systems are not precise enough for smaller-scale agricultural spraying.

Systems working with external references are also available. Positional information is received from a series of transmitting stations around the world, which produce hyperbolic lines of constant phase, which can be converted onboard into navigational guidance. Such systems eliminate the need for human flagmen, and constantly monitor and evaluate the spray process.

Sprayer Field Settings
During a flight, spray pressure, output and aircraft height above the crop can be adjusted if necessary however, as the pilot has to concentrate on flying the aircraft he may only occasionally check the spraying system.

The use of artificial targets within the treated crop is strongly recommended to check and evaluate spray deposit efficiency as well as confirm the lane separation distances. This is where the ground staff can report back to the pilot, via the radio, any problems with the spraying system such as blocked nozzles or incorrectly operating atomizers.

Chemical Handling
To help keep sprayer-applicator, worker or handler exposure to a minimum, wherever possible preference must be given to using pesticide packs handled via closed transfer systems.

Handling and loading chemical products must only be carried out by fully trained and protected staff. Only approved PPE must be used. Absorbent material to contain chemical spills must be available at the filling site. Chemical stores must be kept secure at all times and must have a secure section for storing clean, empty chemical containers prior to their collection for disposal.

Chemical Container Handling
All applicator, worker or handler s must be trained to handle chemical containers, remove seals, measure and weigh dry formulations and pour liquid formulations and to correctly rinse empty containers.

Where mechanized container rinsing is not available, triple manual rinsing with clean water will remove chemical residues leaving the container ready for disposal. (Use 20% of the container volume in clean water for the three individual rinses). Containers must be rinsed immediately after use and the washing liquid (rinsate) emptied back into the spray or mixing tank.

Handling the concentrate material presents the applicator, worker or handler with the highest exposure risk so correct safety equipment and clothing must be available and applicator, worker or handler s trained to use and maintain it properly.

Engineering controls, closed transfer systems, returnable containers, water dispersible sachets etc., should be used where possible.

Chemicals must be stored in their original containers and part-full product containers must be re-sealed and returned to the store.

EMPTY CONTAINERS MUST NOT BE RE-USED

Post-Treatment Warnings
Immediately after the spray has been applied warning notices must be posted around the treated area in accordance with any label recommendations. Recipients of warnings such as beekeepers can be informed that the application has been completed. The field notice should inform people of the treatment and the re-entry period. Notices should be removed when they are no longer required. Livestock must be kept out of the treated area for the period stipulated on the product label.

Post-Application
Safety for the applicator, worker or handler and the environment remain a prime consideration after spraying when cleaning or repairing spray and loading equipment. Such operations may be carried out by aircraft-maintenance staff who are not familiar with the protection required when handling contaminated equipment. They must be fully protected when cleaning or repairing the aircraft or the spray equipment.

Refer to the aircraft and sprayer manufacturer instruction literature for the correct maintenance procedures. Aircraft maintenance will be the subject of local FAA Aviation rules but no work should be started before the equipment has been thoroughly cleaned (“decontaminated”).

Dry-Material Spreaders
Venturi-type and rotary-slinger spreaders are used to distribute dry formulations of herbicides, fertilizers, and seed. Fixed-wing aircraft use venturi spreaders while helicopters use rotary spreaders. Venturi spreaders clamp to the gate box at the base of the hopper. Gate boxes are 25-, 38-, or 41-inches wide.

Agitators and positive metering systems are available. Rotor spreaders are self-contained units that hang below the helicopter. A recent approach for helicopters is to use saddle tanks with an auger and forced-air boom.

Swath Pattern Application
Vanes in the spreader can be adjusted to control the, and the pattern should be tested for even distribution of materials upon initial spreader installation. Agitators are available to assist the flow of material from the hopper.

Positive metering systems are valuable for metering pelleted herbicides or hard slick grass seed in fixed-wing aircraft. Chaffy grass seed can be especially difficult to meter and applicator, worker or handler “know-how” is valuable.

Cleaning (“Decontamination”) of Equipment and PPE

Following spraying, the aircraft and spray equipment must be washed internally and externally in the field and the rinse liquid sprayed onto a crop for which the product is registered, making sure that the recommended dose rate is not exceeded by over-spraying a treated area. Following a conventional spray application the spraying system should be rinsed three to four times with small amounts of water rather than once with a full tank. Particular care must be taken after working with wettable powders as residues can accumulate in the spray lines and filter housing.

Oil-based, ULV formulations cannot be washed out with water. An appropriate, recommended solvent must be used to rinse the spraying system. Tank washings can be sprayed out onto waste land provided there is no likely environmental effect, or alternatively can be collected, treated and incinerated. If cleaning /decontamination is incomplete, product deposits may build up in un-purged areas or on rotary atomizers throwing them out of balance. Vegetable oil used as a spray carrier can be fully removed by washing with water and a detergent solution immediately after spraying is completed.

Complete spray system rinsing and draining is important as some aircraft plumbing can retain as much as 15 gallons of spray solution or ULV product when they are considered “empty”.

Personal Protective Equipment must be thoroughly cleaned after use, dried and stored in a well- ventilated store away from other materials.

Disposal of Surplus Spray
Pesticide waste can be divided into surplus diluted spray solution and surplus concentrate material. Contaminated safety equipment, protective clothing, cockpit filter elements and material used to absorb spills all have to be correctly disposed of. Pre-planning the spray operation should help to ensure that surplus spray solution is kept to a minimum and only enough product for the area to be treated is purchased and prepared. This may be difficult where product demand is high and the objective of the management is to keep aircraft working when conditions are right. Good stock control will keep surplus concentrates to a minimum.

In some cases, unused chemicals can be returned to the retailer otherwise an approved contractor will have to be used to dispose of the unwanted product. Where this service is used the waste chemicals must be securely packed and clearly labeled when transported.

Unused dilute spray and tank washings can cause serious problems, particularly where many aircraft use the same airstrip and many different chemicals are washed from the aircraft at the end of work periods. In such cases, installing a dedicated effluent plant to deal with such washings is likely to be the only practical solution.

Disposal of Empty Chemical Containers
Before final disposal, empty chemical containers must be thoroughly cleaned (“decontaminated”) either by using an approved rinsing nozzle or by the triple manual rinse technique. Wherever possible, the rinsing must be done immediately after the containers are emptied so that the washings can be added to the spray tank in the field.

When this is not possible, the rinse water can be collected, clearly labeled and stored for future use as a spray diluent when the same product is used again.

EPA is required by the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) to promulgate regulations prescribing procedures and standards for container design and the removal of pesticides from containers prior to disposal. Information on this page will help registrants, refillers, retailers, commercial applicators and custom blenders to comply with the requirements of this rule.

EPA's final regulations, "Standards for Pesticide Containers and Containment" were published in October 29, 2008, EPA published a final rule that amended the pesticide container and containment regulations to provide a one-year extension of the labeling compliance date; to make some other changes to the label requirements; and to correct typographical and other minor errors.

The pesticide container and containment regulations include five sections, which are described below.

1. **Non-refillable Containers:** This section addresses "one-way" or disposable containers and applies to pesticide registrants. The purpose of these standards is to ensure that containers are strong and durable, minimize human exposure during container handling and facilitate container disposal and recycling.
2. **Refillable Containers:** This section applies to containers that are intended to be refilled and reused more than once and applies to pesticide registrants. The purpose of these standards is to ensure that containers are strong and durable, minimize cross-contamination of pesticides distributed in refillable containers, and encourage the use of refillable containers to reduce container disposal problems.
3. **Repackaging:** This section, which describes procedures and other safeguards for repackaging pesticide into refillable containers, applies to pesticide registrants and anyone who refills pesticide containers for sale (registrants, formulators, distributors and dealers). These regulations are intended to minimize cross-contamination of pesticides distributed in refillable containers, codify safe refilling management practices and encourage the use of refillable containers to reduce container disposal problems.
4. **Labeling:** The labeling segment includes instructions for how to properly clean pesticide containers and a statement identifying the container as non-refillable or refillable. Pesticide registrants are required to ensure that labels include the specified information. Pesticide users are required to comply with the instructions on the labels.
5. **Containment Structures:** This section establishes standards for secondary containment structures at certain bulk storage sites and for containment pads at certain pesticide dispensing operations. Pesticide dealers who repackage pesticides, commercial applicators and custom blenders have to comply with the requirements. The purpose of these standards is to protect the environment from leaks and spills at bulk storage areas and from contamination due to pesticide dispensing operations.

Concentrated pesticide residues that leak from unrinsed, discarded containers can cause significant environmental contamination. Up to 3 ounces of pesticide may be left inside a 5-gallon container after normal emptying.

Depending on the cost of the product, the money saved in pesticide costs alone through proper container rinsing could be significant. Containers should be rinsed immediately after they are emptied because residue can dry and become more difficult to remove.

As a commercial hazardous material, a container cannot legally be placed in a landfill, recycled or burned except in hazardous waste facilities. This could become a tremendous financial and logistic problem for farmers. But there is an option! If properly prepared before disposal, the containers are considered to be non-hazardous by the U.S. Environmental Protection Agency.

Proper preparation means either proper triple rinsing or proper pressure rinsing. In laboratory studies, both processes resulted in less than 1 part per million (ppm) of residual in the water from the containers. At this level, it is safe to place the containers into disposal systems.

Managing Empty Pesticide Containers

1. Remove the cap. Rinse the cap into the spray tank.
2. Dispose of the cap separately.
3. Rinse the container immediately after emptying.
4. Drain rinsate into the spray tank.
5. Store the rinsed containers in a dry area.
6. Deliver rinsed containers to a recycling or a collection disposal facility.

How to Properly Rinse Containers

Proper preparation of the used agricultural chemical containers is the first step, no matter what the second step might be! Whether you deliver the container to a landfill or to a recycling program the environment is protected if the containers are properly prepared.

If there is any doubt about proper preparation of the containers a disposal site can refuse the containers. The only real options available are landfills and recycling programs. Take the necessary few minutes to properly rinse your containers so they are no longer considered hazardous and acceptable to the receiver of the containers.

Two types of procedures are recommended for rinsing pesticide containers: triple rinsing and pressure rinsing. Here are the steps involved in each method.

Triple Rinsing

Triple rinsing is the most commonly used procedure and involves the following steps:

1. When emptying a liquid pesticide from a container, the flow will normally reduce to drops as the container becomes empty. Continue draining for 30 minutes after drops start.
2. Add the correct amount of rinse solution (water or the designated spray carrier) as follows:
    - Containers up to 5 gallon in size require rinse solution equal in amount to at least one quarter of their volume.
    - Thirty- and 55-gallon containers require a minimum of 5 gallons of rinse solution.
3. Secure the lid on the container.
4. Shake small containers, or roll and tumble large containers to get rinse on all interior surfaces.

5. Remove the lid from the container. Drain the rinsate from the container into the spray tank. Continue draining 30 seconds after drops start.
6. Repeat steps 2 through 5 two more times.
7. Put the lid back on the container and dispose of according to the label directions.

Pressure Rinsing
By using a high pressure nozzle designed specifically for rinsing pesticide containers you can take care of the rinsing process while emptying the pesticides into the spray tank. Special nozzles that attach to a garden hose are used to puncture plastic and metal containers.

When turned on the nozzle produces a forceful spray inside the empty container. Hold the container over the opening of the spray tank or holding tank while rinsing to capture the rinse water as it drains from the container spout. Follow the steps below to rinse using a pressure nozzle.

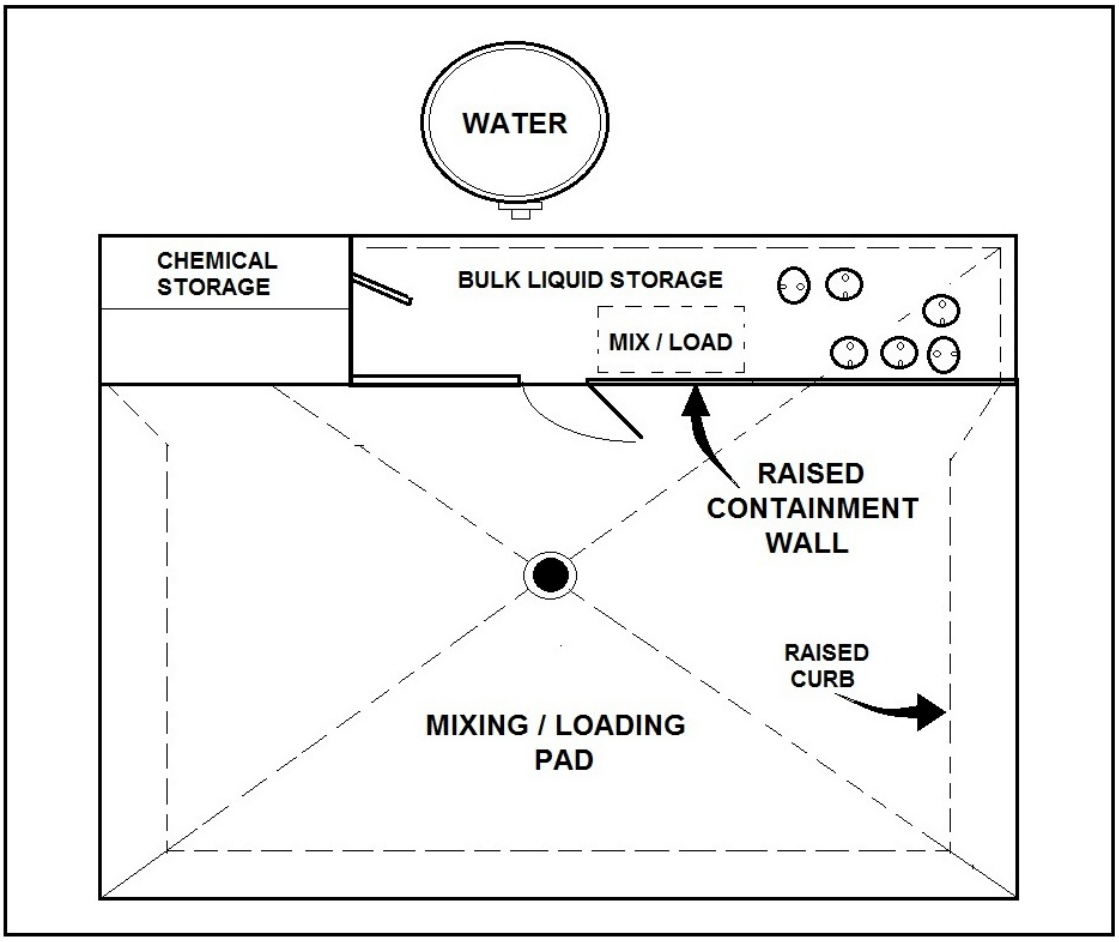
1. Remove cover from the container. Empty the pesticide into the spray tank and let the container drain for 30 seconds after drops start.
2. Insert the pressure rinse nozzle by puncturing through the lower side of the pesticide container.
3. Hold the container upside down over the sprayer tank opening so rinsate will run into the sprayer tank.
4. Turn the nozzle on and rinse for the length of time recommended by the manufacturer (generally 30 seconds or more). Wiggle nozzle to rinse all interior surfaces.
5. Rinse the container lid separately in a bucket of water and pour this rinse water into the spray tank.
6. Put the lid back on the container and dispose of according to the label directions.

Equipment Maintenance and Repair
When spraying has been completed, equipment must be prepared for storage. Both inside the spray hopper and the outer surfaces of the aircraft must be thoroughly washed and the liquid spray system fully rinsed through to ensure that all piping and hoses are clean. Washing the aircraft fabric is particularly important to avoid damage to the aircraft components. All the surfaces of the aircraft controls must be cleaned and lubricated as appropriate.

The spraying system should be operated at a higher than the normal operating pressure to fully test the system to indicate leaks from worn or damaged hoses and or component parts. Pump drive systems, electrical, hydraulic or ancillary engine, must be maintained in accordance with the manufacturer’s instructions and the spray circuit pipe system fully drained before storage. All hydraulic nozzles should be removed for storage and all check-valve diaphragms inspected for damage and wear. The spray pressure gauge must be checked at zero when the spraying system is not in use.

Rotary atomizers must be thoroughly cleaned and cages checked for damage and balance. Seals must be inspected and spring-loaded working parts (cut-off valves/liquid restrictor valves) must be working correctly. Brakes used to stop the spray pump and atomizers rotating during ferrying must be clean and free from contamination from oil and grease.

All electrical components of the spraying system should be checked and couplings sealed for storage when units such as navigation aids and spray monitoring equipment are removed for storage. When new components are fitted to the spray system or existing ones repaired, work carried out must be recorded in the aircraft maintenance log.



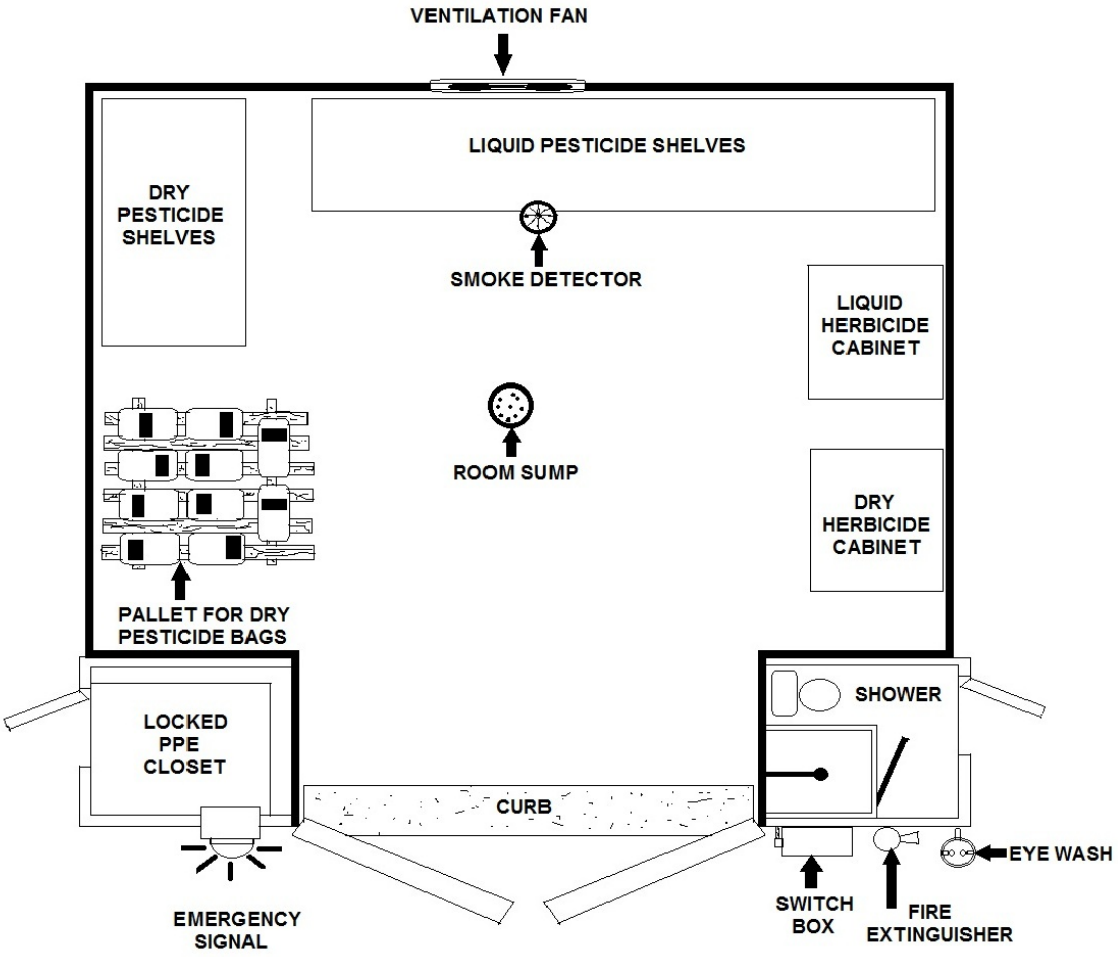
PESTICIDE STORING AND MIXING AREA

Equipment Storage
Refer to the relevant applicator, worker or handler instruction manuals for both the spray equipment and the aircraft. Aircraft mounted spray equipment is often removed after spraying to release the aircraft for other duties. Both the spray equipment and the aircraft must be thoroughly cleaned (“decontaminated”) and dried, before being stored. Aircraft storage will depend on local regulations but the aircraft should be stored under cover and be fully secure.

Pesticide Storage
Unused pesticide must be returned to store. Distressed or damaged containers must be emptied into clean replacement containers, which are fully labeled. Store stock control must ensure that existing chemicals are used first before recently purchased similar new products. Good stock control and accurate planning will mean that waste concentrate and diluted spray are kept to a minimum.

However, where old or obsolete chemical products have to be disposed of, an approved contractor must be used. Chemicals for disposal must be secure in their original containers wherever possible and fully labeled. The responsible use of pesticides in agriculture must include a properly designed pesticide storage shed, which in turn will help prevent injury to people and livestock.

A storage shed that is properly constructed will also prevent unauthorized and perhaps unqualified persons from handling and removing pesticides. Pesticides should be shielded from direct exposure to the environment, e.g., light, temperature extremes, and humidity. Such conditions may cause chemical decomposition and thus decrease the effectiveness of the pesticide. Improperly stored pesticides are more hazardous to handle and may violate federal regulations. Another concern of the applicator is the possibility of being sued or held liable for pesticide contamination of surface or groundwater due to improper storage.



PESTICIDE STORAGE BUILDING

Use of Existing Structures
Small quantities of pesticides may be stored in a separate enclosure within an existing building, constructed of fire resistant material and having a smooth-finished concrete floor. It is recommended this enclosure be on the first floor. All pesticides must be stored away from food, animal feed, seed, fertilizer or other materials that might become contaminated. Also, workers rest and lunch areas must not be near the pesticide enclosure.

A properly designed ventilation system will prevent the buildup of toxic vapors and dust in the storage enclosure. The exhaust from the ventilation system must be vented outside and into a restricted area to minimize the contamination of people and livestock. The enclosure is to be kept secured at all times, never left open when unattended and properly identified as a place of pesticide storage.

Site Selection
The quantity and type of pesticides stored and the availability of suitable existing structures will determine the need to construct a separate storage shed. Site selection is an important consideration when building the structure. Locating the shed at a distance downwind and downhill from sensitive areas such as houses, play areas, wells, feedlots, animal shelters, gardens and ponds will minimize pesticide exposure, especially in the event of a fire. Selecting an area where flooding is unlikely will reduce the possibility of contaminating surface and groundwaters. Place the shed with its front entrance in the direction of the prevailing winds to facilitate ventilation.

Shed Construction
It is important that the pesticide storage shed be constructed on a 4-inch thick, smooth-finished concrete slab to resist chemical action and facilitate decontamination in the event of a pesticide accident. Floor drains will be needed for washing and decontaminating the storage shed therefore, the concrete slab must have a 1/4" per foot slope to the drains to prevent water from puddling. The placement and number of drains will depend on the layout and size of the storage shed (see sample USDA Pesticide Storage Building Plans).

Both cost reduction and improvement in security are achieved by constructing a windowless structure which could prevent some pesticides from being broken down when exposed to sunlight. Having doors on opposite ends of the shed will provide easy access and an escape route in case of an emergency. Standard exit locking hardware (which automatically looks from the outside when closing) for each door is required to ensure that the shed is secured when left unattended.

Ceiling-hung light fixtures should meet National Electronic Code (NEC) provisions. Light switches should also meet NEC ratings and be placed just inside each door. These switches are wired so that either switch may be used to control the lights. Minimizing toxic or flammable vapors and dust buildup can be accomplished by using a forced-air ventilation system. Louvers are installed near the ceiling just above the front entrance to the shed. A two-speed electrically shielded centrifugal fan is placed above the back entrance. The system will provide approximately six air changes per hour at all times. When the interior lights are switched on, it is important that the fan speed up to give approximately 20 air changes per hour, thus assuring a safe working environment. Keep the area immediately beneath the vent outlet restricted to avoid exposing people and livestock to the hazardous exhaust.

Whenever large quantities of pesticides are stored, a fire detection system should be installed. An automatic sprinkler system hung from the ceiling of the shed will give additional protection in the event of fire. It is recommended that floor plane, records, location and nature of pesticides be kept on file at the police and fire departments and the Department of Agriculture. Place a Type ABC fire extinguisher of 10 pound capacity near each door.

In localities where lightning is common, the electrical wiring system will be protected against high voltage surges by following NEC requirements. This is especially important where electrical power supplied to the storage shed is delivered by overhead power lines.

Posting of weather-proof pesticide warning signs stating Danger Pesticides Keep Out! or similarly worded signs on the doors and outside walls are required. No Smoking signs are also required when any of the pesticides are labeled as flammable. The lettering on the signs must be large enough so they may be read from a distance of at least 50 feet. Warning signs in a language other than English may also be advisable.

Wash Down Area
A concrete slab, six inches thick and sloped 1/4" per foot to a drain is attached to the back wall of the shed. It will be used as an area to complete the preparation of the pesticide spray mixes and for washing equipment used in the spray operation. Its size will depend on the needs and type of equipment used by the farmer. Spray rigs and other pesticide application equipment should be washed down in the area (field) where the application was made.

A stainless steel wash basin and drain board should be located within the shed, near the back door and beneath an exhaust fan. This area should be used for initial mixing of pesticides and for washing utensils. Install a deluge shower and eye wash fountain near the back door for emergency use. Always maintain access to the safety equipment by keeping its surroundings clear at all times.

Vacuum breakers must be installed on sink faucets and water lines to prevent pesticides from being siphoned into the water system. This may occur when the hose to the spray tank is partially submerged after there is a break in water pressure. (It is recommended that the hose never be submerged in the pesticide mix.) The vacuum breakers are installed on the downstream side of any shut-off valve and above the level to which an outside water hose may be elevated.

Handling the Pesticide Wastes
Incorporate a waste system to collect all materials from the interior sink, the floor drains and the exterior wash area. A waste system collection tank (of up to 1000 gallons capacity) is used to store pesticide solutions generated as a result of washing application and safety equipment. However, it should not be used for storing excess pesticide tank mix will be left. At present, there are no legal means permitting the disposal of the diluted liquid waste pesticides collected in the storage tank.

The Federal Resource Conservation and Recovery Act (RCRA) addresses the problem related to storage and disposal of hazardous wastes including pesticides. Special anti-leak precautions for storage tanks must be followed if more than 10% of their volume is buried.

Keeping pesticide storage tanks and pipes above ground is a simple way to allow constant inspection of the tank for leaks and eliminates the regulation of FCRA requirements. It is highly recommended to install a cement slab to collect leakage that might occur from or above the ground tank. The Hazardous Waste Program should be contacted for any questions dealing with pesticide waste storage tanks.

Farmers and other pesticide applicators who have unused pesticides in their spray tanks, unusable pesticides in their storage shed, or who in other ways generate hazardous waste must consider how they are to manage and legally dispose of them.

Some Final Thoughts
Proper rinsing of pesticide containers is easy to do, saves money and reduces the risk of contaminating the environment. It takes a few minutes to properly triple rinse a container while it takes less than a minute to pressure rinse. The amount of rinsate generated is generally reduced by the pressure rinsing method. Several manufacturers are selling pressure rinse nozzles. Contact your county Extension office for the most up-to-date list. It is always a good idea to check with your local recycling center for any specific preparation requirements. Remember to read and follow all label instructions. Wear appropriate protective gear when working with pesticides. Dispose of all pesticide containers properly. Do all mixing and loading of pesticides and rinsing of pesticide containers at least 150 feet away from all wells, preferably on specially constructed concrete pads.

Record-Keeping
Keeping records of pesticide use and application is good management. Good records can be referred to in the event of off-target contamination or if a complaint arises from poor field performance. Records can assist pesticide stock control as well as provide a useful reference guide to product performance for future decision making.

Where record keeping is mandatory, local enforcement officers are empowered to refer to records, sometimes up to three years after the actual application has been completed. Where applicator, worker or handler health monitoring is mandatory, the records may have to be retained for considerably longer. Records should cover both details of the actual application and any applicator, worker or handler health observations carried out.

Aircraft use and maintenance recording should be carried out, usually in accordance with the local FAA Aviation Authority and the appropriate department of the pesticide agency.

Field Spray Records
An accurate and comprehensive recording system must cover all relevant information and be simple to complete. An investigation into unsatisfactory product performance or an off-target contamination incident will begin with a check on the job-card or work sheet, which should be completed on the day of application.

The job-card should include the following information:
- Field number, size and location (map reference)
- Hectares sprayed
- Target pest and growth stage
- Total amount of product used
- Application date and time
- Adjacent crops

- Crop, growth stage
- Tank-mix information
- Product and dose rate
- Adjuvants used
- Water volume used
- Pilots name
- Aircraft type and registration
- Start and finish time
- "No-spray" barrier information
- Field marking method
- Meteorological conditions at application
- Aircraft loading information
- Lost time information
- Applicator, worker or handler exposure times
- PPE used and applicator, worker or handler monitoring

Equipment Repairs and Maintenance

- ✓ Repairs to spray equipment must be logged and changes in spray technique and calibration during the season must be listed for future reference.

- ✓ Information on aircraft maintenance should be recorded in accordance with the local FAA requirements.

- ✓ Repairs to spray equipment repairs must be promptly carried out following which the aircraft must be re-calibrated and the swath width re-checked. This is normally required to comply with local legislation.

- ✓ Spare nozzles, anti-drip diaphragms, atomizer blades, valve springs etc., should all be kept in stock throughout the spraying season.

Applicator, Worker or Handler Health Surveillance
Where label recommendations demand applicator, worker or handler health surveillance, a separate record must be prepared for each individual applicator, worker or handler to cover name health details and previous health history.

Exposure periods must be listed to include the date of the initial exposure to a particular product, together with any recommendations coming from the clinical practitioner responsible for the monitoring program.

Applicator, worker or handler contact with other chemical products during the monitoring period must also be recorded. All staff involved with the spray operation should be submitted for health checks on a regular basis.

Personal Protective Equipment
PPE is only as good as its use and maintenance and must be provided and used on a strictly individual basis. To make sure that safety equipment gives maximum protection, applicator, worker or handler training is important.

Wearing protective clothing does not guarantee applicator, worker or handler protection. When chemical loading or handling equipment becomes defective through wear or damage regular visual checks must be carried out. Specialist equipment such as respirators must be checked according to the manufacturer's recommendation. Checks must be more frequent when working conditions are severe. Faults must be recorded and corrected before further use.

Local Emergency Contacts

In the event of an aircraft accident, chemical spillage or an environmental contamination incident, an accessible list of local emergency contacts must be available to cover appropriate medical facilities with access to poisons information. The local chemical product manufacturer and or supplier must be listed as a source of up to date product information and accident procedure.

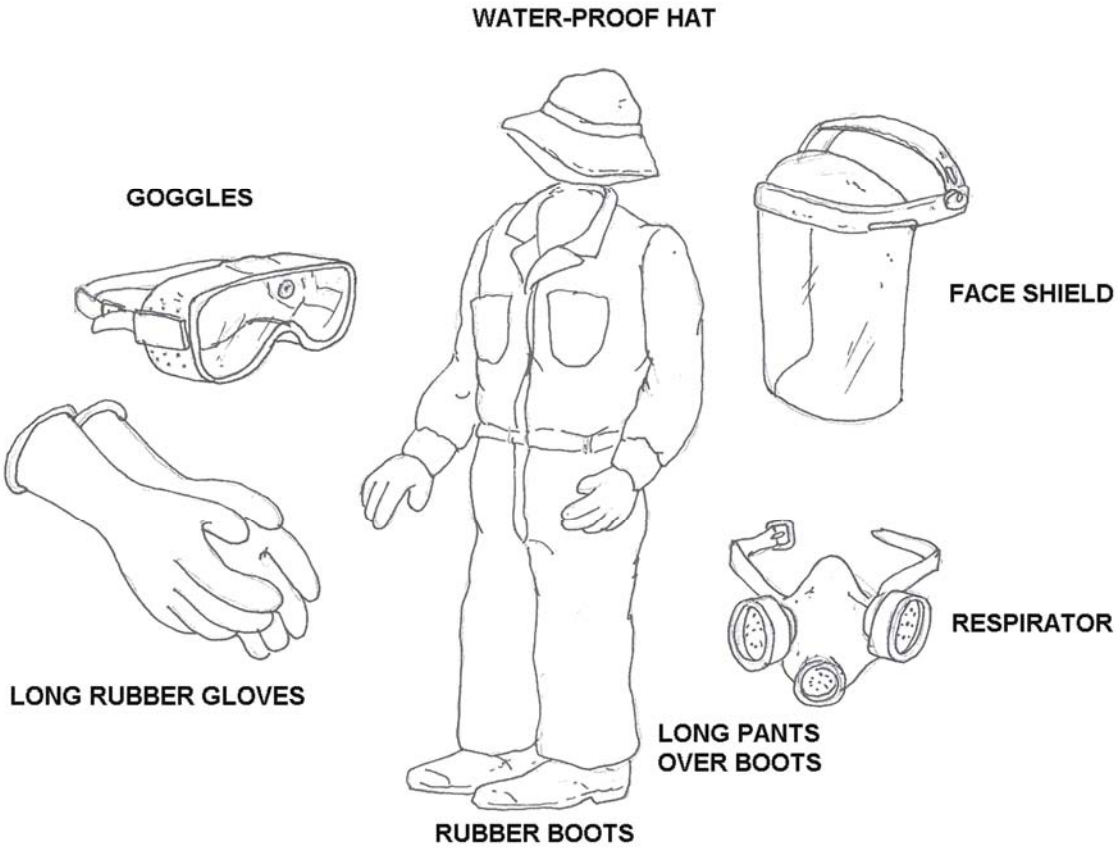
Contacts, such as the FAA, water authority, environmental and pollution control agency and the emergency services should all be listed, and a trained local first-aid practitioner appointed. The first-aid worker should be conversant with the chemical products in use and the emergency procedures in the event of an accident.

He/she must have up-to-date product label information and access to a good supply of appropriate antidotes for the products in use.

Pesticide poisonings are usually acute resulting from dermal contact. It is therefore essential that first-aid workers can recognize the different poisoning symptoms for the products in current use.

Symptoms vary for different chemical products and may be mistaken for other illnesses, notably those resulting from heat exposure.

PESTICIDE PROTECTIVE EQUIPMENT



Personal Safety Section

Pilot
Pilots should never be involved in loading aircraft with pesticides. It is difficult, even with normal protective clothing and equipment, to load without some exposure. Accumulated exposures may bring on mild pesticide symptoms, including dizziness and fixed contraction of the pupils (miosis) of the eye.

The latter symptom has been reported to have diminished visual acuity, especially at night. While these mild symptoms may not be serious to ground applicators, or the ground crew, they are potentially fatal to a pilot, especially in a night application. If pilots are exposed when dispensing pesticides and also during loading operations, this may accumulate enough dosage to trigger symptoms. When crosswinds occur, application should start on the downwind side of the field to avoid flying through the previous swath.

There is evidence that accidental direct eye contamination by organophosphates may cause contraction of the pupils from 7-10 days without any other symptoms. There have been several reports of fatally injured agricultural pilots who were using organophosphates and who had definite miosis discovered following the crash.

While it is very difficult to assign "*pilot error*" crashes to pesticide exposure, present evidence suggests pesticide exposure should be kept to a minimum. Where symptoms characteristic of pesticide poisoning occur, the pilot should not fly until they are gone. Remember, your body will tolerate small amounts of most pesticides. You can accumulate doses of pesticide from various operations--flying, loading mixing, cleaning, etc., but when you reach a certain level, symptoms will begin.

There have been a number of air crashes where the pilot was drenched with pesticide from a ruptured spray tank. Many pesticides are rapidly absorbed through the skin in addition to entry through the respiratory route. It is essential that contaminated clothing be removed as soon as possible and the pilot "*streak*" for the nearest water for washing--ditch, creek, pond, hose, etc. This is not the time for modesty.

The California Department of Health has reported one pilot who was not critically injured in a crash but was splashed with TEPP and Phosdrin and died of organophosphate poisoning 20 minutes later. Similar poisonings can also occur with Paraquat or Parathion.

Chemical Spill
A filter or canister type respirator appropriate for the chemical being applied should be used. If one is needed for extended periods during hot weather, use a respirator and crash-helmet combination that is ventilated with fresh air.

Flagman
It is essential that the flagman wear adequate protective clothing when exposed to pesticides. Pilots should not spray or dust over flagmen.

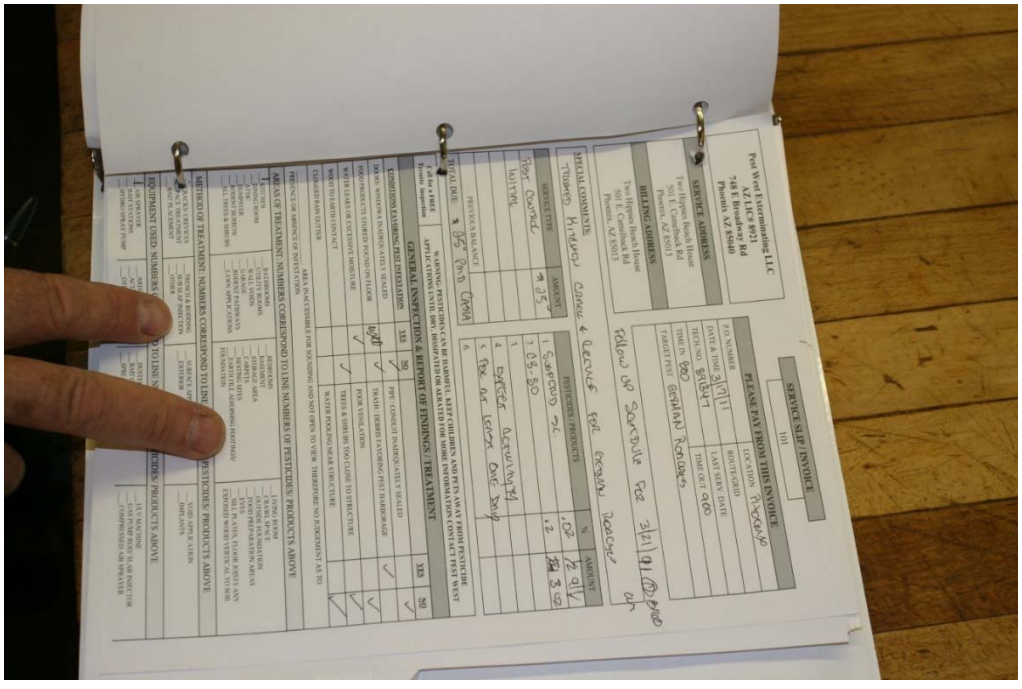
Permanent markers are being used in increasing amounts by aerial applicators. These markers eliminate the possibility of exposure by flagmen.

Loading Crew
The handling of very toxic pesticides, sometimes in concentrated forms, necessitates the wearing of proper protective clothing. Puddles of pesticide spilled in the mixing or loading area can penetrate improper footwear. Only liquid-proof or rubber boots should be worn.

Aerial Application Check List
It is suggested that pilots and crew, including flagmen, review a check list at least weekly. It is easy to become complacent and careless.

Pilot Check List: The pilot should do the following ***BEFORE, DURING*** and ***AFTER*** any application:

1. The pilot should not load or handle highly toxic pesticides during any operation, especially hazardous formulations.
2. Engines should be shut off during loading operations.
3. Hard helmets with pesticide respirators should be worn in flight.
4. Check the field and surrounding area prior to application and make sure there are no animals, humans, crops, waterways, streams and ponds that would be injured or contaminated either from direct application or drift.
5. Do not fly through the drift of an application.
6. Stop treatments if winds rise and create a drift hazard.
7. Do not turn on dispersal equipment or check the flow rate except in the area to be treated.
8. Refuse to fly if the customer does not read and understand the flagman check list. Also refuse if he insists on having pesticide applied in a manner and time which may create a hazard to crops, humans, animals, and surrounding environment.
9. Read the label yourself and know the hazardous characteristics of the pesticide.
10. Know how far and in what direction the chemical will drift.
11. Do not spray or dust over flagmen.
12. After completing the job, do not dump remnants on the field but carry them to the loading area and have the crew dispose of remnants in a safe manner.



Ground Crew Check List

The ground crew should do the following ***BEFORE, DURING*** and ***AFTER*** any application. Also, the ground crew should be familiar with the pilot's check list.

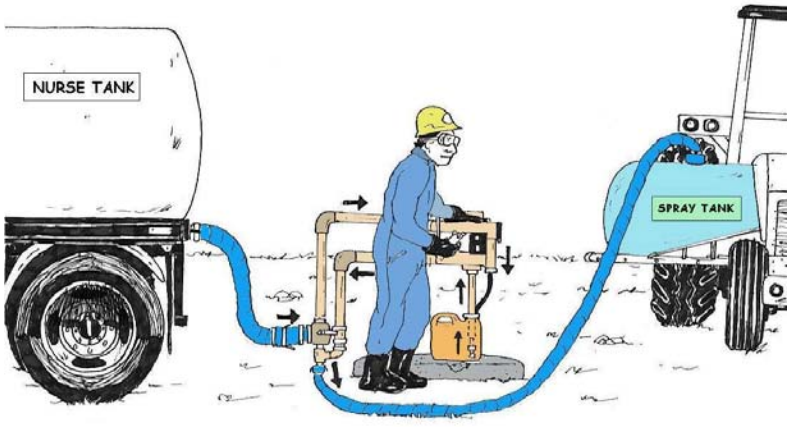
1. The aircraft, especially the cockpit, should be cleaned frequently.
2. Tanks and hoppers should be tightly sealed so chemicals will not blow back over pilot.
3. Cover the hopper as soon as loading is completed.
4. Remove any chemical spilled near the fill opening.
5. When cleaning aircraft or other equipment, use extreme care and wear protective clothing.
6. Do not stand in or allow runoff water to splash on you.

Change clothing after washing aircraft and contaminated equipment.

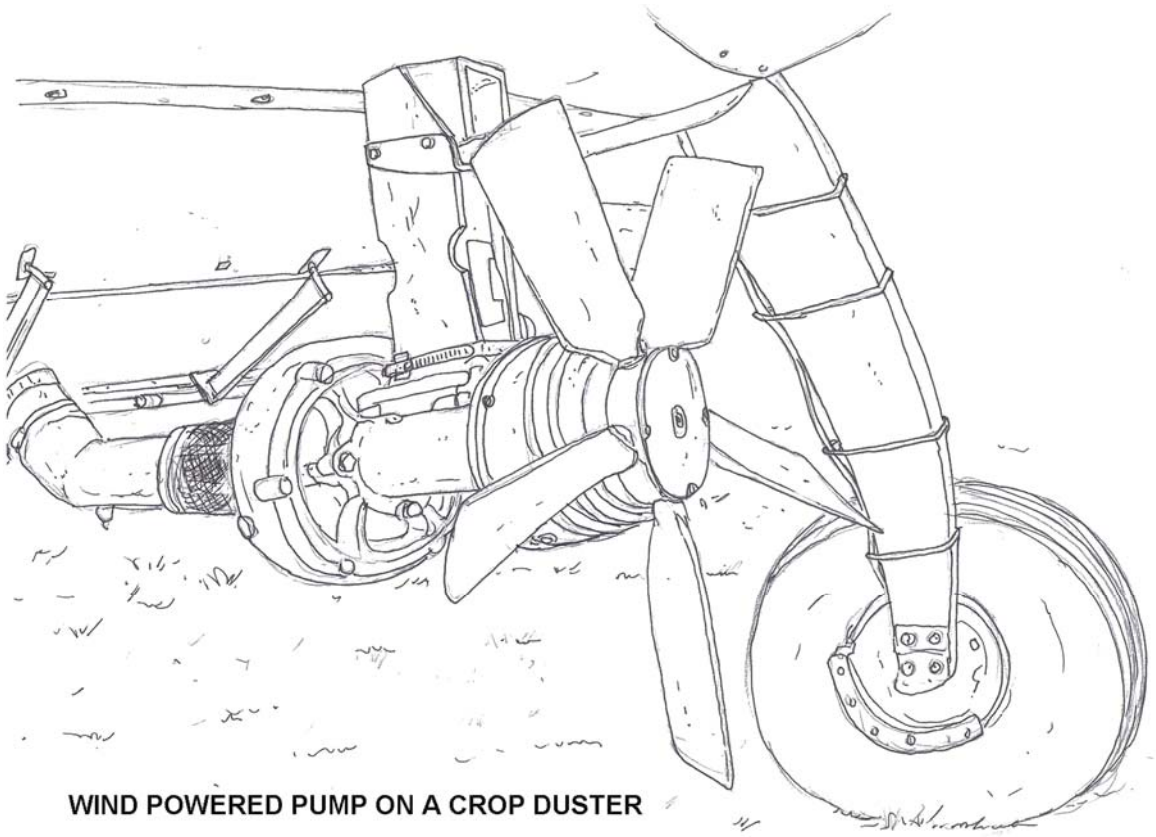
Flagman Check List

Where flagmen are used, they should do the following ***BEFORE, DURING*** and ***AFTER*** any application. A flagman should also be familiar with the pilot's check list. If the farmer is to assist the flagman, be sure he is familiar with this check list.

1. When the flagman arrives at the field to be treated, he should warn all people in the immediate area that an aircraft is going to treat a certain area. Ask these people to stay out of the area and avoid drift.
2. Avoid as much spray or dust as possible.
3. Wear the appropriate protective equipment for the pesticide being applied.
4. As soon as the aircraft is lined up with you for a pass, move over to the next position, but ***DO NOT TURN YOUR BACK ON AN APPROACHING AIRPLANE***.
5. Stay at the field until the pilot has completed the job. If there is an accident, you may be able to help the pilot.
6. Carry a card or have printed on the work order, a copy of which you should have, the chemical being applied and any emergency instructions for the doctor in case someone is exposed to a toxic dose of the chemical.
7. Have a radio-equipped vehicle nearby so that you may contact your office for changes in instructions or emergency procedures.



Never allow a stand-in to perform your job without a thorough knowledge of this check list and the job he is to do.



WIND POWERED PUMP ON A CROP DUSTER

Buffer Zones

A buffer zone is an untreated area wide enough to capture drift fallout adjacent to the sprayed area. Nozzle type, droplet size, product dose, dilution and spray technique should be considered when this unsprayed barrier (buffer) width is determined. For aircraft spraying the buffer zone needs to be wider than for ground spraying as it is more difficult to make a precise spray cut-off with an aircraft operating at speed. The width of a buffer zone is also influenced by the pesticide product type and by the presence of adjacent waterways. For example, a buffer zone of 5,000 meters is recommended for certain organochlorine insecticides. This distance is considered adequate to capture sedimenting spray droplets following the completion of a spray run.

Some pesticides are highly toxic to aquatic life so that spray drift fallout over water should be carefully avoided with products with this classification. The product label should provide application details, which should include nozzle selection, volume applied, and application timing. When ULV applications are to be made using rotary atomizers, liquid flow regulation and atomizer rotational speed should also be stated on the label.

The label usually carries first aid information to assist a doctor in the event of accidental contamination. Information on cleaning (“decontamination”) and disposal of empty containers is also usually included on the label.

Tank Mixing
Applying more than one product at the same time (tank-mixing) can improve the logistics and cost of spraying provided the respective treatment timings coincide and the formulations are chemically and physically compatible. Only approved mixtures should be used.

Risks associated with tank mixing may include a reduction in biological activity due to product antagonism. This may be present as crop scorch, which although it may be only transient, can often reduce final yield.

The most common limitation, however, is physical incompatibility, which can result in nozzle and filter blockage as well as phase separation in the spray tank where agitation is inadequate. This is common when during flights to the spray area (ferry flights) the spray pump is secured or turned off in the case of an electrically driven pump. This means that there is no circulation of the spray liquid back to the tank.

Where aircraft are refilled from a ground (“nurse”) tank, frequent re-circulation of the contents will ensure that there is no phase separation within the nurse tank. Product labels should give advice on tank mixing and approved mixture partners, information on the sequence of introducing the products into the tank and the need for agitation. Water temperature, quality and pH can also influence chemical stability of tank mixes.

Safety Section
The overall safety of crop protection chemicals must be the objective of all users and those engaged in the storage, distribution and retailing of agrochemicals.

Applicator, Worker or Handler Health Surveillance

The health of applicator, worker or handler's exposed to pesticide must be monitored. The surveillance should cover health records and medical checks, which can alert medical authorities of any health changes, which might be related to exposure during work with pesticides. Health surveillance should also help determine whether safety practices and the selection and use of PPE are adequate for the products being used.

PPE

Each worker is instructed how to put on, use, and remove the personal protective equipment and is informed about the importance of washing thoroughly after removing personal protective equipment.
(x) Each worker is instructed in the prevention, recognition, and first aid treatment of heat-related illness.
(xi) Workers have a clean place(s) away from pesticide-storage and pesticide-use areas for storing personal clothing not in use; putting on personal protective equipment at the start of any exposure period; and removing personal protective equipment at the end of any exposure period.
(xii) When personal protective equipment is required by the labeling of any pesticide for early entry, the agricultural employer shall assure that no worker is allowed or directed to perform the early-entry activity without implementing, when appropriate, measures to prevent heat-related illness.

Product Transport and Storage
Transporting pesticides by road is usually controlled within respective State or federal regulations for the movement of dangerous goods, where emergency procedures in the event of a road accident are already in place. All pesticide manufacturers issue “Transport Emergency Cards (“Labels or Placards”), to vehicle drivers transporting hazardous goods, which may include pesticides.

As well as the journey from the retailer to the end user, pesticide containers will also be moved in and out of store and to the airstrip on the farm. Containers must be checked for leaks and damage and must always remain fully and clearly labeled. This is particularly important for aircraft spraying where large drums are stored outside and are exposed to the vagaries of the weather.

PESTICIDES MUST ONLY BE TRANSPORTED AND STORED IN THEIR ORIGINAL TRANSPORT CONTAINERS AND PACKAGES

It is usual for large quantities of pesticide to be stored and handled at permanent airstrips. Such stores must be secure, as they may be remote and not always attended. Shade must be provided for chemical stocks, particularly when they are packed in 55 gallon drums. Ground support staff must be fully conversant with procedures in the event of accidental spillage or applicator, worker or handler contamination at airstrips, which must have fully maintained first-aid kits, an emergency shower unit and adequate quantities of absorbent materials to deal with spillage.

Pesticide Storage Areas
Pesticide storage areas must be accessible in the case of an emergency. Storing pesticides on the farm may be covered by local legislation. Correct and safe storage is essential to maintain a safe working environment, to maximize product shelf life and to minimize the risk of fire and spillage. Pesticides must be kept in a dedicated store, which is accessible in case of emergency and can be locked when not in use. When considering erecting a pesticide store, guidelines relating to construction materials, design, location, emergency procedures etc. can usually be obtained from national regulatory authorities. Under no circumstances must pesticides be stored near foodstuffs.

Product Handling
The product label is usually the first reference for guidance on handling formulated pesticide products. It will usually describe the requirements for the use of Personal Protective Equipment (PPE) both for handling the undiluted (concentrate) product and for diluted spray solution. Applicator, worker or handler exposure and environmental contamination can be substantially reduced when closed filling systems are used to extract the product from its shipping container and deliver it either directly to the spray tank or via a metering system to a separate mixing tank. This avoids contact with the loading crew and accidental spillage.

Chemical Container Management
On no account must empty chemical containers be reused. Empty containers must be thoroughly washed and rendered unusable before disposal. Empty containers can be effectively cleaned by manual methods or by a closed transfer system that collects the washing water (rinsate). Empty containers must be collected and securely stored prior to disposal and should not be left unsecured at the mixing site.

Some states allow controlled burial for empty and thoroughly cleaned containers whilst high-temperature incineration is permitted in other cases. Local environmental pollution control regulations must be consulted.

Chemical container management can be facilitated where products are purchased in returnable containers. In this case sealed containers are returned to the manufacturer for re-filling; a process, which often can be repeated several times during the life of a container. An approved, compatible extraction system to both measure and extract the chemical for use is required and systems must be capable of handling products of different viscosities and containers of different closure sizes.

Accident Procedures
If spillage occurs during transport or handling a pesticide, this may result in a fire, injury to humans, property damage or environmental contamination. Rapid action must follow the accident to contain and minimize any adverse effects. Pesticide transporters and users must be familiar with label recommendations and procedures to be followed. In the event of an accident, the appropriate authorities (Environment, Water, Police etc.) must be notified. Records must be kept of all incidents and remedial action taken. Only vehicles correctly equipped to carry pesticides must be used to transport product to the airstrip.

Agricultural Application Post Quiz

Disposal of Surplus Spray

1. _____can be divided into surplus diluted spray solution and surplus concentrate material.

2. _____ can cause serious problems, particularly where many aircraft use the same airstrip and many different chemicals are washed from the aircraft at the end of work periods. In such cases, installing a dedicated effluent plant to deal with such washings is likely to be the only practical solution.

Disposal of Empty Chemical Containers

3. Before final disposal, empty chemical containers must be thoroughly cleaned ("decontaminated") either by using an approved rinsing nozzle or by the_____. Wherever possible, the rinsing must be done immediately after the containers are emptied so that the washings can be added to the spray tank in the field.

How to Properly Rinse Containers

4. _____of the used agricultural chemical containers is the first step, no matter what the second step might be! Whether you deliver the container to a landfill or to a recycling program the environment is protected if the containers are properly prepared.

Equipment Maintenance and Repair

5. _____must be thoroughly cleaned and cages checked for damage and balance. Seals must be inspected and spring-loaded working parts (cut-off valves/liquid restrictor valves) must be working correctly.

Pesticide Storage

6. Good stock control and accurate planning will mean that waste concentrate and diluted spray are kept to a_____.

Use of Existing Structures

7. A properly designed ventilation system will prevent the buildup of toxic vapors and dust in the storage enclosure. The exhaust from the ventilation system must be vented outside and into a restricted area to minimize the contamination of people and livestock. The enclosure is to be kept secured at all times, never left open when _____and properly identified as a place of pesticide storage.

Site Selection

8. Selecting an area where flooding is unlikely will reduce the possibility of contaminating surface and groundwaters. Place the shed with its front entrance in the direction of the prevailing winds to facilitate_____.

Wash Down Area
9. Install a deluge shower and eye wash fountain near the _____for emergency use. Always maintain access to the safety equipment by keeping its surroundings clear at all times.

Record-Keeping
10. Records should cover both details of the actual application and any applicator, worker or handler _____carried out.

Field Spray Records
11. An accurate and comprehensive recording system must cover all relevant information and be simple to complete. An investigation into unsatisfactory product performance or _____will begin with a check on the job-card or work sheet, which should be completed on the day of application.

Applicator, Worker or Handler Health Surveillance
12. Exposure periods must be listed to include the _____to a particular product, together with any recommendations coming from the clinical practitioner responsible for the monitoring program.

Pilot
13. There is evidence that accidental direct eye contamination by organophosphates may cause contraction of the pupils from 7-10 days_____. There have been several reports of fatally injured agricultural pilots who were using organophosphates and who had definite miosis discovered following the crash.

Chemical Spill
14. A filter or canister type respirator appropriate for the chemical being applied should be used. If one is needed for extended periods during hot weather, use a respirator and crash-helmet combination that is ventilated with_____.

Loading Crew
15. The handling of very toxic pesticides, sometimes in concentrated forms, necessitates the wearing of proper protective clothing. Puddles of pesticide spilled in the mixing or loading area can penetrate improper footwear. Only _____ should be worn.

Buffer Zones
16. The label usually carries first aid information to assist a _____in the event of accidental contamination. Information on cleaning (“decontamination”) and disposal of empty containers is also usually included on the label.

Tank Mixing
17. Applying more than one product at the same time (tank-mixing) can improve the logistics and cost of spraying provided the respective treatment timings coincide and the formulations are _____compatible. Only approved mixtures should be used.

Product Transport and Storage
18. All pesticide manufacturers issue_____, to vehicle drivers transporting hazardous goods, which may include pesticides.

Pesticide Storage Areas
19. Under no circumstances must pesticides be stored near_____.

Accident Procedures
20. If spillage occurs during transport or handling a pesticide, this may result in a fire, injury to humans, property damage or environmental contamination. _____ must follow the accident to contain and minimize any adverse effects.

Answers
1. Pesticide waste
2. Unused dilute spray and tank washings
3. Triple manual rinse technique
4. Proper preparation
5. Rotary atomizers
6. Minimum
7. Unattended
8. Ventilation
9. Back door
10. Health observations
11. An off-target contamination incident
12. Date of the initial exposure
13. Without any other symptoms
14. Fresh air
15. Liquid-proof or rubber boots
16. Doctor
17. Chemically and physically
18. “Transport Emergency Cards (“Labels or Placards”)
19. Foodstuffs
20. Rapid action

Aerial Application Section

Most of this information is credited to the University of State of Kentucky Agriculture Program
The conditions and regulations outlined in the fixed-wing aircraft section also apply to helicopters. Applications must follow the chemical's Product Label, and the applicator must be certified by the state. Batch trucks which carry clean water and chemical mixing tanks for helicopters usually have landing pads atop the truck for convenience and safety in servicing. Ground personnel must always be alert to the helicopter's moving rotors during servicing.

Helicopters are more expensive to operate than fixed-wing aircraft, but they have the advantage of operating where fixed-wing aircraft cannot. Helicopters do not need landing strips and are adapted to remote rugged terrain and irregular shaped sites. GPS/GIS units negate the need for flagmen in these remote sites and can record flight patterns.

Agricultural Aircraft Equipment Section
Equipment for aerial pesticide application is limited to either fixed or rotary wing aircraft. Regardless of the choice, there are at least a few general features which should be considered.

These are as follows:

1. **Pilot's fresh air supply**--Filtered air for the pilot to breathe is necessary because it is nearly impossible for the pilot to avoid flying back through some of the swath of previous flight passes. If a filtered-air helmet is not available, the pilot should at least wear an approved respirator.
2. **Fuselage features**--Enclosed fuselages should be fitted with cleanout panels for the regular removal of corrosive sprays and dusts. Spray pumps, filters, and control valves should be easily accessible for maintenance and repair.
3. **Maintenance**--The seasonal use of agricultural aircraft might suggest a pattern of inspection and repair during the idle, off-season periods. However, the critical demands of agricultural flying call for all the regular maintenance checks at all required intervals to ensure that the aircraft is in first class order at all times.

Two of the more important advantages of fixed wing aircraft are a high speed of application and a large payload capacity per dollar invested. Maneuverability is adequate, though not equal to the rotary wing aircraft. One of the limitations of fixed wing equipment is the necessity of a designated landing area, which may not always be in close proximity to the application area.

Rotary wing aircraft offers the advantages of extreme maneuverability and speed variation, and may be operated in almost any local area. Pilots of these crafts must also be competent, alert, and have knowledge of the area and the limitations of their crafts. Rotary wing flying puts a special demand on the pilot to perform application with minimum time loss in turns, hovering and loading, since this type aircraft is more expensive to operate per unit of flying time than fixed wing aircraft.

Guidelines
The following guidelines have been drawn up to cover the application of both conventional aqueous undiluted sprays and ultra-low volume (ULV) formulations. They provide information and advice on safe practices.

For adequate aerial spray operation the following considerations must be addressed:

a) Close co-operation between the grower, the spray contractor and the pilot.
b) Adequate pre-planning before spraying.
c) Awareness and understanding of local environmental considerations.
d) Consideration of the safety of people, animals and non-target crops.
e) Accurate selection of approved products.
f) Use of appropriate spray technology and well maintained equipment.
g) Competent and well trained management and support staff.
h) Pilot awareness.

Application

Spraying equipment and techniques are designed to minimize drift while applying spray droplets of efficacious size to the plant canopy. Aerial sprays are normally applied when wind speed is between 2 and 10 mph and air temperatures are not above 90^{O} F.

Droplet micron size is determined by the specific nozzle used first and foremost. In general, the larger the orifice tube, the larger the micron size of the droplet produced. The second factor in determining droplet size is the aircraft speed.

The range of micron sizes produced by each nozzle are listed below as tested by Helicopter at speeds of 30 to 40 MPH (Fixed wing speeds of 125 to 135 MPH will produce a micron size approximately half of the sizes listed below.)

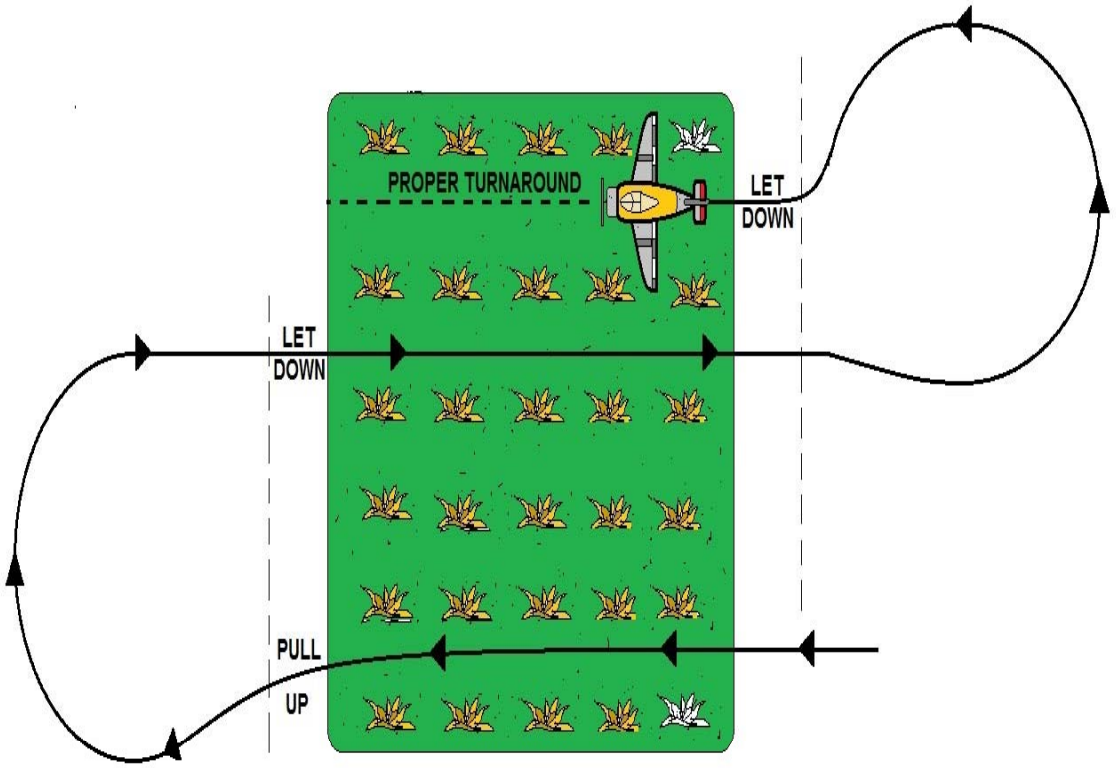
Nozzle Orifice Size = Range in Micron Size

.016 = 500-700
.020 = 600-800
.028 = 800-1000
.047 = 1400-1500
.063 = 2500-3000
.085 = 4000-4500

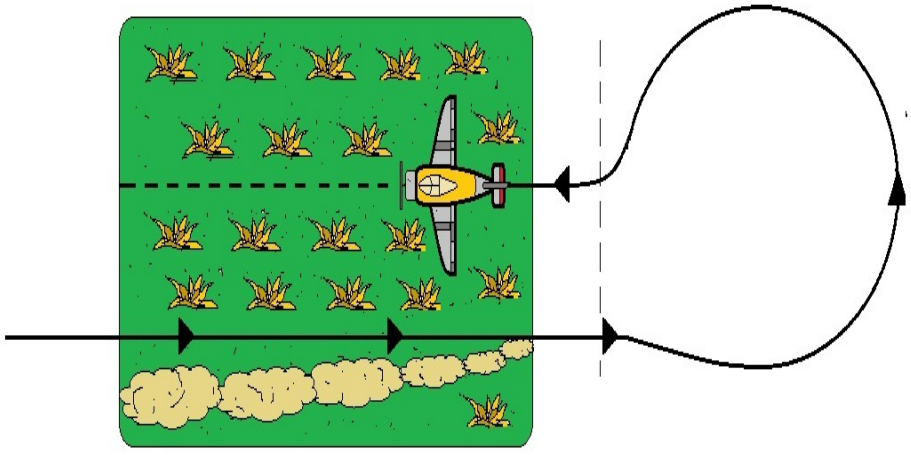
Spraying should not be conducted in no-wind conditions because of inversions (warm air over cold air) or potential shifts in wind direction. Federal (EPA) and state regulatory agencies have strict regulations for aerial spraying, and applications must follow the specifications on the chemical's Product Label.

Fixed-wing aircraft are cost effective because they can spray large areas quickly and effectively. They have larger payload capacities and greater airspeeds than helicopters. Airstrips are required for landing, servicing, and takeoff. Excessive ferrying distances are wasteful and costly. GPS/GIS units negate the use of flagmen and can record flight patterns. Fixed-wing planes are not suited for spraying highly irregular shaped sites or mountainous areas.

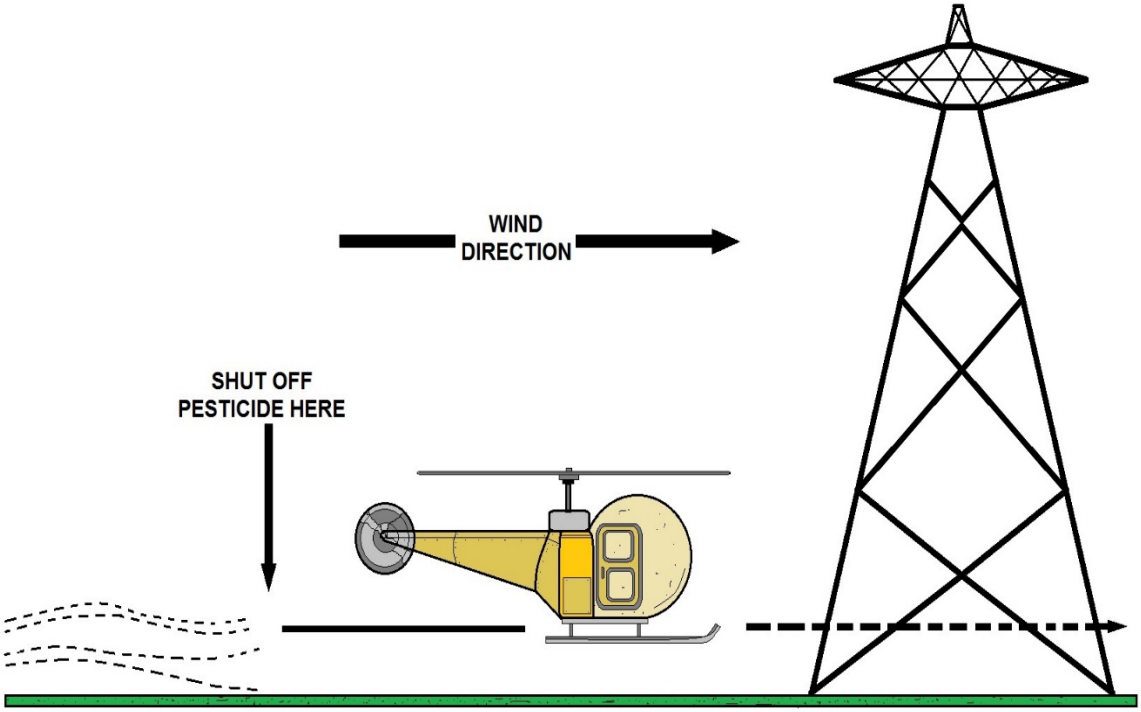
Many over-the-counter pesticides for household and garden use are sold in a form ready for application. Solid products are often spread simply by sprinkling from the boxes in which they are furnished, and some liquid products can be sprayed from simple, small pressurized equipment. Several pesticides used for vector control are available in granular forms that can be applied by hand or through commonly available equipment like fertilizer spreaders or horn seeders. Other pesticides used in vector control require specialized equipment for their application.



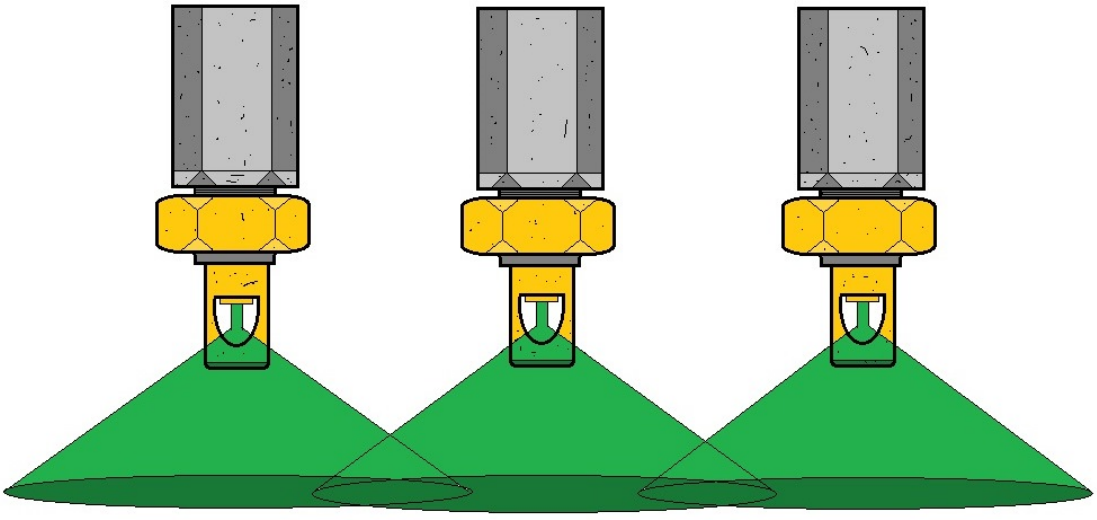
IMPROPER TURNAROUND - COMBINING CLIMB, TURN AND THE DROP IN DOESN'T ALLOW TIME FOR POSITIONING



PESTICIDE APPLICATION
(FIELD FLIGHT PATTERN & PROPER TURN AROUND)



PESTICIDE APPLICATION
(Adjusting for specific conditions: wind - objects - drift distance)



FLAT FAN NOZZLE WITH PROPER PATTERN OVERLAP
(Pesticide Application)

The aerial application of pesticides has several advantages for the modern agricultural producer. When properly managed, aerial application offers speed of dispersal, accessibility to crops on which ground equipment cannot operate, and reasonable cost. In many cases, the advantages also include more timely applications and, therefore, better utilization of pesticide materials.

You can cover large areas quickly. You can treat crops or areas (such as mid-season corn or forest stands) for which ground equipment isn't suitable; and the application cost per acre is comparatively low. Before applying pesticides by aircraft, you must have a valid pilot's certificate, and you or your employer must have a valid agricultural aircraft operator's certificate.

The full advantages of aerial application are more likely to be realized when its use is preplanned. Development of a planned aerial application program will require good cooperation between pilot and grower.
It should be based upon the grower's specific problems and the overall scope of his operation. Any plan must also recognize the potential dangers to people, other crops and the environment. After a plan has been developed, it is essential that it be followed as closely as possible in order to return maximum benefits to both the producer and the applicator.

Notify Beekeepers
Many of the pesticides used in aerial treatments are highly toxic to bees. Notify beekeepers about the meetings. Program operational guidelines, environmental impact statements, environmental assessments (EA), State laws, and/or pesticide labels may also require that beekeepers in the area be notified of control programs.

Members of the public, not directly involved with the spray operation, may also be affected by an aerial pesticide application so the contractor/farmer may have a mandatory obligation to issue "prior warnings" to any person or organization that might be affected or concerned.

Warnings must be given in ample time to beekeepers, owners of adjacent crops, livestock owners and those responsible for nearby environmentally sensitive sites. Where particularly toxic materials are to be used, it may be necessary to warn the emergency services, and the local environment and water authorities. The product label should give precise advice on prior warning and who to contact.

Notify Organic Producers
Program operational guidelines, environmental impact statements, environmental assessments (EA), State laws, and/or pesticide labels may also require that organic producers in the area be notified of control programs.

Notify Public Meeting Attendees
Contact should be made with the following groups and individuals to notify them of upcoming public meetings:

- Beekeepers
- County and city government
- Environmental organizations

- Federal land managers or land managing agency (for Federal land managers involved in the area)
- Federal land user or recreation associations (trail riders, mountain bikers, hikers, 4x4 clubs, etc.)
- Landowner and industry groups (grower associations, grazing associations)
- Organic producers
- School superintendents and principals (if schools are located or involved in the project area)
- State and Federal representatives of appropriate regulatory agencies (Federal Aviation Administration (FAA) Flight Standards District Office (FSDO), pesticide regulatory, etc.)
- State land managers
- State and Federal wildlife management agencies (State game and fish departments; U.S. Fish and Wildlife Service (USFWS))

Other agencies, groups and persons that may be appropriate to contact about the meetings are as follows:

- Airport manager
- County Extension Agent
- Fire department (responsible for covering the airport and treatment blocks)
- Grazing associations
- Hospital
- Law enforcement (highway patrol, sheriff)
- Native American Tribal Group or representative (if any Native American or Tribal land is involved or if any other areas are used by Native Americans)
- Public
- Representative for private landowners (for private land involved)

Complete Environmental Documentation

Environmental documentation may be required in order to comply with the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA). NEPA and ESA ensure that any selected control method used will **not** significantly affect the quality of the human environment or jeopardize the survival of threatened or endangered species.

In compliance with ESA and NEPA, the following documents may be developed in order to meet the requirements of these two Acts, as well as to provide direction and policy for anticipated programs:

- Biological assessments (BA)
- Biological opinions (may be developed by FWS or NMFS)
- Final Environmental Impact Statement (FEIS) and Record of Decision
- Programmatic Environmental Assessments (EA)
- Site-specific Environmental Assessments (EA)
- Finding of **No** Significant Impact (FONSI)

Documentation and processes are different depending on the program.

Further information and guidance regarding environmental documentation can be obtained from:

USDA-APHIS-PPD
Environmental Services
4700 River Road, Unit 149
Riverdale, MD 20737-1237
Phone: 301-734-8565
FAX: 301-734-3640

Other Materials and Resources
Consider having the following materials accessible in local libraries and at meetings:

- Environmental assessments (EA)
- Environmental impact statements (EIS)
- Material Safety Data Sheets (MSDS)
- Pesticide labels
- Program background information
- Program objectives

Draft Treatment Boundaries
Draft treatment boundaries on master program maps. Obtain Cooperative Agreements from States and

Non-Federal Cooperators
For voluntary cooperative programs, APHIS is responsible for cooperating with States, ranchers, land managers, grower groups, or other landowners in planning and implementing control activities. A cooperative agreement is a written agreement used to establish arrangements with non-federal entities for APHIS to provide technical assistance, goods or services; and may be on a full cost-recovery or cost-share basis.

Cooperative Agreement
A cooperative agreement for an aerial application for pest control may be established between APHIS and ranchers, States, and Native American Tribal Councils upon request from the cooperator and dependent on availability of funds. Some pest management programs are initiated by the voluntary activities of States, ranchers, land managers, grower groups, and other private landowners who **must** request assistance from APHIS and/or the State and commit to share program costs before a control program is planned or initiated.

Individual pest program or regional office administrative procedures **must** also be followed when developing cooperative agreements. When preparing a cooperative agreement with a State or other cooperator, the language may be changed or language may be added to the agreement to meet special needs and circumstances. Changes are subject to regional approval. Work with your Regional Cooperative Agreements section staff to properly accomplish this process.

Obtain Memorandum of Understanding (MOU) from Federal Agencies
Federal land managers are required to request in writing that their land be treated (such as for grasshopper control). Although a letter of request may originate as a telephone call, a written letter of request is required for the expenditure of program funds. When cooperative pest management programs (such as grasshopper control) are administered by APHIS, a Memorandum of Understanding (MOU) is established with each Federal agency that manages the land. MOUs are put in place and signed at the Headquarters

level. MOUs or cooperative agreements (that detail responsibilities) may also be developed at the local level.

The Program Manager or Contracting Officer's Representative (COR) should identify which Federally-managed lands are present in each State, and then review the related MOUs to better understand the agreed responsibilities to conduct a pest management program.

Native American Trust Land
A national Memorandum of Understanding (MOU) with the BIA currently exists. Obtain a written request from the BIA and the Tribal Council, and approval from the Tribal Council. Many States have land that is held in trust for Native American tribes, Communications with both tribal authorities and the BIA are a **must**. This trust land is considered federally-administered and may be directly administered by the Bureau of Indian Affairs (BIA). Equally important is land allotted to individuals within a tribe. In some cases, a single allotment may be divided throughout generations among a large number of tribal members. Each tribe or Nation is independent and relations with PPQ are on a Nation-to-Nation basis. Obtain *APHIS Aerial Application Prospectus* and Chemical Contracts Information.

Gather Documents and Information
The following documents and information are needed to complete ***PPQ Form 136, Detailed Work Plan***, and ***Work Checklist (accompanies PPQ Form 136, Detailed Work Plan)***:

- *APHIS Aerial Application Prospectus*
- Control option
- Cooperative agreements
- Environmental documentation (completed)
- Letters of Request
- Memorandums of Understanding
- Map showing landownership
- Proof of cooperator cost on deposit (escrow account)

After all the above information has been collected (figures from past programs are also helpful), then prepare ***PPQ Form 136, Detailed Work Plan*** and a ***Work Checklist (accompanies PPQ Form 136, Detailed Work Plan)***.

Prepare a Detailed Work Plan and Work Checklist

As part of the planning process and as far in advance of the scheduled treatment as possible, prepare ***PPQ Form 136, Detailed Work Plan,*** (DWP), and ***Work Checklist (accompanies PPQ Form 136, Detailed Work Plan)*** for pretreatment planning. PPQ Form 136 **must** be prepared quickly and accurately.

The completed Detailed Work Plan contains a broad estimate of various costs and is sent to the Region Office for approval, pending funding.

The accompanying Work Checklist contains a broad estimate of various costs, and is a good aid to help ensure that all necessary activities are completed.

Criteria for Selecting Program Maps
Maps are an essential tool for conducting an aerial application program, and are essential to the success of each program. Maps are frequently referred to and updated during each project. Accurate and up-to-date information must be recorded on each map used to help prevent potential problems that Program Managers (PM) and Contracting Officers Representatives (CORs) and routinely face. In general, the size of the project will determine the scale of the map to use. Topographic maps, surface management maps, and other maps with similar detail are excellent maps to use for smaller block treatment. Large area treatments require appropriate map scales to make each map easier to handle, depending on the location of where the map will be used.

Several types and scales of maps may be useful for the same project. Seven and one-half (7.5) minute maps provide excellent detail and information necessary for master program maps. Smaller scale maps are more appropriate for the pilot to use in an aircraft cockpit.

Map Scale
Map scales are listed from smaller size blocks to larger size blocks. Program managers and CORs should select a map scale that is a compromise between the amount of detail required and convenience of use.

Commonly used map scales follow:
- 2-5/8 inch to the mile (1:24,000)
- 1 inch to the mile (1:62,500)
- 5/8 inch to the mile (1:100,000)
- 1/2 inch to the mile (1:125,000)
- 1/4 inch or less (State highway maps)

In addition, the following minute series maps are commonly used:
- 30 minute
- 15 minute
- 7.5 minute

Geographical Information Systems (GIS) Maps
Programs with Geological Information Systems (GIS) mapping capability have an advantage over those using traditional methods. With GPS, Program Managers can produce maps at any desired scale or zoom in on a particular section of the treatment area. Various data layers can also be added or omitted from the program map.

Depending on availability for a particular area, data layers include county boundaries, section lines, ownership, land use, roads, and waterways. GIS technology has been interfaced with Global Positioning System (GPS) aircraft guidance. Together, these systems can provide accurate records of aircraft flights, treated or non-treated areas, and other necessary program documentation.

Information to Record on the Master Program Map
Determine the information to record on an each map by working with cooperators and experienced surveyors. Some standard information to identify in the treatment area is listed below.

Map Legend
Record the following items on the treatment map:

- Contract number
- Contractor/ pilot name
- Date started and finished
- Hazard areas
- Sensitive sites and exclusion areas
- Total acres treated (at completion)
- Total gallons sprayed

Hazard Areas
When near or within the treatment area, the areas listed below are hazardous for aerial application:

- Airports (nearby)
- Bridges
- Bluffs
- Canyons
- Cliffs
- Mountains
- Other aircraft (potential for inside the treatment area)
- Power lines
- Tall buildings
- Telephone poles
- Towers (communications, electric, microwave, radio, water, etc.)
- Windmills

Landownership
Within the treatment block, determine the following land and landownership and identify these areas on the map:

- Federal land
- Native American or Tribal land

Program Planning: Program Maps
Information to Record on the Master Program Map

- Private (rangeland, cropland, associated idle land)
- State land
- Trust lands

Sensitive Areas
Request information about existing sensitive and restricted areas from cooperators, private, State, and Federal land managers, and Fish and Wildlife Services (FWS).

Buffer Zones
Include appropriate mitigating buffer zones on the map around the following sites, as applicable:

- Areas identified by informal, field-level consultation
- Beehive locations and appropriate bee buffers
- Biological control release sites, insectary sites, experimental sites
- Bodies of water (e.g., lakes, ponds, small streams, rivers)
- Endangered and sensitive species buffers (as negotiated with Federal and State Fish and Wildlife Agencies, and land managers)
- Military areas
- Military training routes and areas
- Organically grown crops and livestock
- Populated areas (such as towns, villages, housing developments, colonies)
- Poultry farms
- Prearranged emergency jettison sites
- Private property that is **not** involved in the control program
- Prohibited areas
- Sacred Tribal areas
- Restricted areas
- Schools, parks, hospitals, and recreational areas
- Unregistered crops or animals
- Warning areas
- Wetlands

Special Use Airspace Areas
Special use airspace confines certain flight activities and restricts entry, or cautions other aircraft about operating within specific boundaries. These areas are depicted on visual aeronautical charts and include prohibited areas, restricted areas, military operating areas, and military training routes. Be sure to record any special use airspace areas on the master program maps.

- For information and assistance during program planning, contact Aircraft and Equipment Operations (AEO) listed below:

USDA-APHIS-PPQ
Aircraft and Equipment Operations
22675 N. Moorefield Road, Bldg. #6415
Edinburg, TX 78541-9398
Phone: 956-580-7270
FAX: 956-580-7276

Treatment Boundaries
In the absence of, or in addition to global positioning system (GPS) coordinates and guidance equipment in the aircraft, use landmarks to mark boundaries of the treatment area (especially for aerial applications). If there are **no** landmarks at the boundaries of the treatment area, then indicate on the program map the flagged corners of the area.

Typical landmarks to indicate on maps are as follows:

- ✓ Brush patches
- ✓ Buildings (barns, sheds, windmills)
- ✓ Events (such as accidents, drift, etc.)
- ✓ Fence lines
- ✓ Fixed objects (fire breaks, pipelines)
- ✓ Highways
- ✓ Railroads
- ✓ Ridges, mountains, mesas, hills, and buttes
- ✓ Rivers
- ✓ Roads
- ✓ Standpipes
- ✓ Telephone and power lines
- ✓ Trees

Distribution of the Master Program Map

Provide a master program map draft to each of the following co-operators:

- ✓ Airport manager
- ✓ Chairperson of rancher committee
- ✓ Federal cooperator
- ✓ Fire Department
- ✓ Private cooperator
- ✓ State cooperator
- ✓ Law Enforcement (Police Department, Sheriff's Department, etc.)

Co-operator Review

Have all the cooperators review the master program map draft for accuracy of the drafted treatment boundaries. If corrections are received from the cooperators, then make the necessary adjustments and inform each cooperator. This should ensure that each cooperator has an accurate copy of the master program map.

Program Manager and Contracting Officer's Representative

The Program Manager and Contracting Officer's Representative (COR) can adjust the treatment boundaries to provide a more flyable block. Immediately inform all cooperators when such an adjustment is made, so that the correct update can be made to each cooperator's copy of the master program map.

Some program guidelines may require that all adjustments to treatment block boundaries be made before the environmental assessments can be finalized. Each cooperator may have to sign the final map, attesting to the map's accuracy. Be sure to document in the Daily Log, the treatment block boundaries, and any changes made to master program maps and treatment boundaries.

Pretreatment Reconnaissance

Flight for Map Confirmation
Prior to distribution of the master program map and final program maps, take a pretreatment reconnaissance flight with the pilot(s) and confirm that everything is recorded on the master program maps.

Each pilot **must** have a clear understanding of where the buffer zones, sensitive areas, and spray block boundaries of the treatment area are located. After the pretreatment reconnaissance flight is successfully completed, jointly sign and date the master program map.

Pilots
Maps given to pilots can be at a scale of 1/4-inch or less to the mile, since larger maps are difficult to work with in the cockpit.

Aerial Contractor
If the control program is being conducted by aerial application under APHIS contract, then provide copies of the master program map to the aerial contractor/ pilot.

Updates to Other Program Maps
In addition to the master program maps, the Program Manager (PM) and Contracting Officer's Representative (COR) should advise all other persons who have draft maps of any changes. These changes should immediately be noted on the program maps to ensure program map accuracy.

Aircraft Selection
To facilitate the planning of PPQ programs, aircraft have been divided into categories based on size, speed, capacity, and expected performance. When selecting aircraft for a specific aerial application program, consider the following:

Aircraft size
Small aircraft may be more appropriate on blocks that are less than 2 or 3 miles (3 to 5 kilometers); operating fast aircraft on blocks that are less than 2 or 3 miles is impractical

Large, high-capacity aircraft may be more appropriate for long ferry distances or larger treatment blocks; using small aircraft when the number of aircraft required for treatment or long ferry distances would congest the airstrip is impractical.

- ✓ Available airstrips
- ✓ Ferry distances
- ✓ Individual block size
- ✓ Number of personnel available to properly manage the operation
- ✓ Terrain type
- ✓ Time allotted for completion
- ✓ Total area to be treated

Aircraft Categories and Assigned Swath Spacing
Aircraft categories have been established to facilitate program planning for desired aircraft based on the pest's or insect's life cycle, timing of application, support personnel, adequate airport space, required aircraft performance, length and strength of runways, taxiways and ramps, and the elevation and type of terrain to be treated.

The swath spacings were determined from past experience or past performance and should be the maximum allowed. If there is reason to believe the swath is **not** as wide as shown, or may **not** provide uniform coverage, or may **not** be acceptable for other reasons, then provision is made for swath checking to redefine the operational swath width.

Before changing specifications outlined consult:

Aircraft and Equipment Operations (AEO) as listed below:
USDA-APHIS-PPQ
Aircraft and Equipment Operations
22675 N. Moorefield Road, Bldg. 6415
Edinburg, TX 78541-9398
Phone: 956-580-7270
FAX: 956-580-7276

Adjustments for Special Conditions
Aircraft will **not** treat as much per week under the following conditions and adjustments should be made accordingly:

- Application rates and ferry distances are greater than those shown
- Block contains sizable areas that are **not** to be treated (exclusion areas)
- Loads **must** be lifted to higher elevations
- Rain or wind (weather conditions) may be encountered during the program (a rainy and windy season may reduce the flyable hours considerably)
- Rugged terrain (requires additional maneuvering or one-way application flights)

Aircraft may treat more per week under the following condition and adjustments should be made accordingly:

Aircraft Category D
Mid-summer weather (may provide somewhat longer flyable hours than those shown)

Application Aircraft
Requests for aircraft should be made by specifying the minimum number of aircraft required in a given category. If necessary to limit the total number of aircraft that can be used due to a lack of personnel, a crowded airstrip, or other reasons, then the request for aircraft may be stated as a minimum of X and a maximum of X category XX aircraft. If more than one category of aircraft is acceptable, then the request may be stated as a minimum of X and a maximum of X category XX or XXX aircraft.

If due to limited guidance or monitoring capability, operating two or more aircraft of the same category in formation is necessary, and then request matched aircraft. The request should be specific, (i.e., matched pairs, matched triplets, all matched within a given Category, etc.). If there is **no** need for formation flying, then **do not** request matched aircraft, since this could unnecessarily increase the contractor/pilot's expenses. When the

area to be treated contains rough and rugged terrain, and is at high elevations, then include a statement in the bid solicitation with the approximate percentage of such terrain.

Observation Aircraft
If use of four-place observation aircraft is required, then include four-place observation aircraft in the bid contract. Such aircraft is valuable for showing contract pilots the boundaries of the blocks assigned and for transportation of a PPQ employee for aerial observation of the operation. A portable PPQ radio should be installed in the observation aircraft for communication with ground personnel. Observation aircraft with a minimum speed of 160 mph (139 knots) should be specified for use with Category A and Category B aircraft; 150 mph for Category C aircraft; and 130 mph for Category D aircraft and helicopters.

A record of the number of hours the observation aircraft is flown at the request of the Government representative **must** be maintained on *PPQ Form 802, Daily Aircraft Record*. (See ***PPQ Form 802, Daily Aircraft Record*** detailed instructions.) The Government pays an hourly rate for each hour flown for official business. Most aircraft have recording tachometers or flight recorders that show operation time in hours and tenths. If the observation aircraft is **not** so equipped, then record the time of takeoff and the time of landing on PPQ Form 802.

Aircraft Facilities

Airports and Airstrips
Airports or airstrips **must** be of adequate size to handle the aircraft that may be used for the program.

Hard-surfaced runways are desirable when large multi-engine aircraft are used. The contractor/pilot **must** complete all arrangements necessary to use any airport. Although the contractor/ pilot **must** arrange for the use of any airport, the Program Manager (PM) or Contracting Officer's Representative (COR) may obtain the following information to assist in your planning:

- Is the airport or airstrip available for use by a commercial aerial applicator?
- Will there be a charge for use of the airport or airstrip? If so, how much?
- Are there load limitations? (especially important on hard-surfaced airport runways)
- Is there a traffic control tower at the airport? If so, are radios required in agricultural aircraft?
- Can aircraft be loaded near the takeoff runway to avoid excessive taxiing?
- Is there adequate space and security for pesticide storage?
- Is the storage area readily accessible to delivery trucks?
- Is other airport traffic such that there may be delays in landings and takeoffs at the time aerial applications are normally performed?
- Is aviation fuel available?
- Is there other pertinent information?

Minimum Airstrip Sizes
The airstrip lengths shown below are for runways with clear approaches and average sod conditions at an elevation of approximately 4,000 feet above sea level. At higher elevations or when fields are soft, longer airstrips will be required. Hard-surfaced runways at lower elevations may be somewhat shorter.

Suggested Minimum Airstrip Sizes for Aircraft Categories

Aircraft Category	Minimum Airstrip Length	Minimum Airstrip Width
Category A	7,000 feet	125 feet
Category B	5,000 feet	100 feet
Category C	3,000 feet	75 feet
Category D	3,000 feet	75 feet
All Others	3,000 feet	75 feet

Aerial Application Over Congested Areas

Determine if the treatment area includes congested areas. If the aerial application will be conducted over any congested area, such as a city, housing development, town, village, etc. then notice of intended operation **must** be given to the public through all news media.

Request Approval for Treatment Over Congested Areas

A request for the treatment and a congested area plan of action **must** be submitted to the appropriate authorities (local officials and the Federal Aviation Administration, Flight Standards District Office (FAA-FSDO). A congested area waiver is required to be obtained prior to the start of the application program.

Follow the procedures listed below to request and obtain approval:

Request written approval for aerial application of the treatment area from local authorities of the city, town, village, etc. Approval **must** be obtained from the appropriate officials in the area for which the operations are to be conducted prior to submitting the request to the FAA, FSDO.

Personnel, Materials, and Equipment Section

The ***Personnel, Materials, and Equipment*** section provides a detailed list of personnel, supplies, equipment, and boundary flagging instructions required to conduct the application program.

Personnel
The size of an aerial application program and the type of terrain dictate the number of people needed to satisfactorily complete the program. Staffing requirements depend on the number of programs, acres, buffer zones, treatment blocks, aircraft, type of terrain, and extent of environmental monitoring. The program manager should request the necessary personnel from the regional office.

Ground Observer
Ground observers are important for a successful treatment operation. The primary function of the ground observer is to monitor the overall job performance of both the pilot and the pilot's aircraft, and the treatment area during spray operations. Duties and responsibilities of the ground observer include the following:

- Survey and delimit areas to be treated
- Flag block boundaries (when necessary)
- Locate and mark on program maps, the areas that are **not** to be treated
- Indicate on program maps, the location of hazards to aircraft
- Determine latitude and longitude coordinates for DGPS guidance as necessary
- When practical, assist in tracking the aircraft at all times
- Observe pilot performance by checking the number of swaths applied to a field to determine effectiveness and efficiency of spraying
- Monitor flight path (such as turns over ponds, houses, or other sensitive areas)
- Monitor application aircraft height of flight
- Watch for cutoff of formulation on turns, sensitive areas, and traveling between treatment areas
- Observe trimming of fields and skips
- Report and record the location of trim work that needs to be completed by ground equipment due to obstacles such as power lines and trees
- Maintain radio contact with and report conditions and information to the COR, the aerial observer, and the airport recorder
- Place and collect dye cards to track chemical dispersal
- Observe dispersion, drift, and inversions of applied formulation
- Check for clogged or leaking nozzles
- Establish the boundaries of the areas treated each day and shade the area on the master map
- Report any skipped or missed areas so the COR/Air Ops can plan for treatment of those areas (give consideration to wind direction and velocity during original treatment and re-flights)
- Discuss work plans for the following day; include a review of light hazards and sensitive areas that may be located within or adjacent to the work areas
- Perform other duties as may be required to get a program into operation
- Contact the PPQ pilot in advance of all aerial operations

Monitor and record weather conditions

- Air temperature
- Ground temperature
- Fog
- Wind speed and direction

PPQ Pilot

When available, a PPQ pilot will be assigned to the program to assist the COR. In the event a PPQ pilot is **not** available, then the responsibilities listed below rest with the COR.

PPQ pilot duties include the following:

- Act as radio liaison when required
- Assist with the layout of block boundaries
- Calibrate the dispersal apparatus
- Check swath widths and deposit distribution and when required recommend modifications to the dispersal equipment
- Cooperate with the COR to determine daily starting and stopping times for aerial applications
- Determine whether contract pilots are qualified
- Inspect each aircraft and dispersal apparatus to determine compliance with contract specifications and FAA requirements
- Monitor the electronic guidance system (EGS) as required
    - ✓ Check EGS for accuracy and reliability
    - ✓ Check to determine whether contract pilots are using the system properly
- Observe aerial applications from the air and align guidance when required
- Review all documents relating to contract aircraft and pilots
- Train contractor pilots and PPQ personnel in the use of electronic guidance equipment (EGS) **only** when the Federal Government furnishes the equipment
- If the contractor/ pilot furnishes the equipment, then the contractor / pilot is the use of the equipment where applicable
- If the contract specifies the contractor/pilot furnishes the equipment, then the contractor is responsible for training contractor personnel and PPQ personnel in the use of the system where applicable
- Train personnel in the procedures and techniques of aerial observers

PPQ Pilots Specific Authority

When included in the contract, PPQ pilots have the following specific authority:

- ➢ Establish or verify the working swath widths for each aircraft
- ➢ Ground any aircraft or pilot for cause
- ➢ Reject any pilot who **does not** meet contract requirements
- ➢ Withhold any aircraft from operation until the aircraft complies with contract specifications

Aerial Application Observer

The aerial observer is either the Contracting Officer's Representative (COR) or another designated person within Air Ops. Aerially observing the control activities provides the Air Ops/COR with a unique view of the application and movement of the ground personnel. In many cases, the aerial observer is the practical center of communication with the COR, the contractor, the pilot, and the ground crew.

Important
The PPQ pilot will not contact the MBS Contracting Officer (CO) directly; the exception to direct contact is only when requested to do so by the Contracting Officer's Representative (COR).

- ✓ During such flights, **only** PPQ personnel, cooperators, or contractor personnel will be carried aboard
- ✓ Aerial observer will have full authority, within the limits of safe flight operations, to determine when, where, and how the aircraft shall be flown for the purpose of making observations
- ✓ Installation of a PPQ radio in the observation aircraft; a portable hand-held unit is a suitable substitute (arrange with the pilot) Keep an accurate record of flight time on *PPQ Form 802, Daily Aircraft Record*. Flight time will be the actual time shown on the flight recorder. If the aircraft **does not** have a flight recorder, then use and record clock hours and minutes from takeoff to landing. Each PPQ Form 802 shall be signed by the contractor's representative and the airport record/timekeeper.

Proficiency in aerial observation and supervision requires the ability to do the following:

- ✓ Communicate instructions effectively using radios
- ✓ Judge ground distances from the air, by reference to the size of known objects and distances (such as road width, distance between telephone poles, etc.)
- ✓ Judge swath spacing accuracy based on the application aircraft wingspan and landmarks flown over on the previous swath
- ✓ Provide information to Air Ops and/or the COR for deciding when to shutdown daily activities
- ✓ Time the application aircraft with a stopwatch to compute the dispersal rate for calibration
- ✓ View the treatment block, surrounding area, and ferry routes from the air

Important
If the external power source cable of the radio is used, then the cable should be connected to the aircraft's electrical system by the contractor's personnel only. This also includes installation of an external antenna, modifications, or other equipment.

EXAMPLE
If the sun is out, then using the application aircraft's shadow on the ground is a good method to judge spacing.

Important
The most critical daily decision in aerial application is the cooperative decision to shut down the daily activities because of developing conditions that adversely impact spray deposition. The aerial observer is responsible for communicating information to the COR for deciding when to shutdown daily activities.

Duties and responsibilities of the aerial observer include monitoring the following:

- ➢ Air speed
- ➢ Application aircraft
- ➢ Clogged/plugged nozzles (watch for)
- ➢ Coordination and communication of activities of ground observers and environmental monitors
- ➢ Drift

- Emergency jettisons
- Flight line formation
- Guidance aircraft (if used)
- Movement of ground personnel and flagging
- Drift
- Proper shutoff and turn on at boundaries and buffer zones
- Skips
- Spray pattern uniformity
- Swath displacement
- Swath spacing
- Turnarounds

Guidance Flaggers
The flaggers' primary duty is to operate markers that will enable the pilot to fly straight, equal-spaced swaths. Flaggers are needed when any of the following occur:

- ✓ Precise applications are required over areas too small for electronic guidance
- ✓ Other guidance is **not** available
- ✓ Pilots may have difficulty with uniformly spacing their swaths

Other duties may include many of the items listed for ground observers. In most cases, flaggers will be provided by the contractor, depending on how the bid description is completed. Flaggers may or may **not** be part of the required PPQ personnel.

Before going on the flag line, certain preparations should be made. A flagger **must** receive adequate briefing and/or training to know the following:

- Area to be flagged
- Direction of flight
- Direction and distance to move while flagging
- Height at which the aircraft should fly
- Proper use and care of Kytoon® aerial helium balloons (if used)
- Proper use of radio (if assigned)
- Side of the area where application will begin
- Spacing for more than one aircraft
- Swath spacing of the aircraft being guided
- Type and proper use of personal safety equipment
- Type and proper use of marker or flag
- Wind direction and pesticide drift

Flaggers **must** each have a map of the area(s) to be treated. If the flagger can visit the area(s) in advance to check on roads, open fields, or other routes to follow while flagging, then operational time can be saved. To protect from spray during application, flaggers should start on the downwind side and work upwind, since pilots prefer to spray crosswind, the aircraft will **not** fly through the spray from previous swaths.

Flagging Equipment, Supplies, and Methods
Various equipment is used for flagging aircraft. Local project circumstances determine the best method or combination of methods to use. The following techniques are used by ground flaggers. Training on the proper use of flagging equipment is important prior to use. All flaggers in the block should be coordinated and able to communicate by two-way radio.

Ground Flagging
The most effective ground flagging techniques are as follows:

- ✓ Flags on poles
- ✓ Halogen spotlights
- ✓ Kytoon® aerial helium balloons
- ✓ Measuring wheel
- ✓ Mirrors
- ✓ Rotating beacons

Boundary Flagging
On the program map, be sure to indicate the location of all boundary flagging used in the block. Global information systems technology may be available for the project that may replace the need for boundary flagging.

Boundary Flagging Material
The size of each boundary flag **must** be a minimum of 15 feet long x 3 feet wide.

Boundary flagging material types used in the program include the following:

- ✓ Orange plastic
- ✓ White or yellow cheesecloth
- ✓ White or yellow muslin
- ✓ White plastic

White flags are used for block boundaries. Orange flags are used to mark sensitive sites and buffer zones and other **no** spray or **no** treatment areas.

Boundary Flag Placement
Boundary flags should be placed as follows, and record the location on the program maps:

- ✓ Place flags 25 to 30 feet down each side from the corner of the spray block
- ✓ Place flags so they are easily visible from the air for at least one mile
- ✓ Tie flags to fence lines
- ✓ If fence line is **not** available, then either weight the flags down to the ground or attach flag to lath (strip of wood or metal) and then stake in the ground
- ✓ Place flags on high places (even when the end of the block may be just over the hill)
- ✓ Place flags along the perimeter of the spray block; place approximately every one-half mile; more flagging can be used as site-specific circumstances demand
- ✓ Place orange flags around sensitive area perimeters with (use as many flags as needed to be able to recognize the outline of the sensitive area from the air)

Object Free Areas (OFAs) and Pesticide Storage
Be aware that the Federal Aviation Administration, Flight Standards District Office (FAA-FSDO) has established regulations to prevent obstructing airport runways. There are safety zones around all airport runways called object free areas (OFAs). Check with the FAA-FSDO for the required size of the OFA at the airport, and ask if *FAA Form 7460-1, Notice of Proposed Construction or Alteration,* should be submitted for approval. The FAA has a formula to use as a guide, which includes the distance from the center line of the runway and the height of the storage tank.

If the pesticide storage area is at an airport, then **do not** place the dike and tank too close to a runway, for safety reasons and to maintain the required the object free area. Consider where aircraft can be safely loaded that will **not** obstruct other aircraft using the airport. Diking Tanks Containment dikes (berms) may be required by local or State pesticide regulators or program guidelines. Be aware that many times the diking **must** be made of a certain material or grade.

Dry Pesticide Formulations
Keep dry pesticide formulations dry; **do not** let them get damp or wet. A hangar, warehouse, or other suitable building at the airport, or enclosed van, truck, or trailer should be used for storage. If suitable enclosed storage facilities are **not** available at or near the loading site, then pesticide material stored outside of buildings should be stacked on pallets and protected with waterproof covers.

Pesticide Spill Kit
Every pesticide storage and loading area site should have an accessible spill kit to contain and clean up accidental leaks or spills. To create a spill kit, collect and/or order and assemble the items listed below. Use the 50-gallon garbage cans to hold the spill kit contents.

List of Spill Kit Contents Item	Quantity
50-gallon plastic garbage can with wheels	2 each
Approved respirator with approved canisters	2 sets
Bar soap	2 bars
Broom and dustpan	1 each
Emergency eyewash system	1 system
Fire extinguisher, 5 lb.	1 each
Goggles or safety glasses	2 pairs
Heavy duty plastic garbage bags	50
Kitty litter	100 pounds
Lime	50 pounds
Lime and Lye Material Safety Data Sheets (MSDS)	1 each
Liquid detergent	1 quart
Lye (sodium hydroxide - NaOH)	50 pounds
Pesticide label and MSDS	1 each
Plastic tarp (25 ft by 25 ft)	1 each
Potable water	5 gallons
Rain suits (unlined or disposable coveralls)	2 suits
Rubber boots (unlined)	2 pairs
Rubber gloves (unlined)	4 pairs
Scrub brushes	2
Shovel (spade tip)	1 each
Shovel (square tip)	1 each
Other safety gear, as appropriate	

Pesticide Spills
Contingency plans and procedures for managing spills **must** be in place in advance of storing pesticides. The contingency plan **must** also include training on equipment and protocols.

Pest Mortality Assessment Section

Introduction
The ***Pest Mortality Assessment*** section provides information about setting up official sample sites, determining the effectiveness of the treatment, documenting the results of the treatment, and informing cooperators of those results.

Procedures
Establish official mortality assessment sites in the treatment block and visit those sites before and after treatment operations. Mortality assessment may also be accomplished along with normal survey activities.

Step 1: Determine the Number of Sites
Based on the delimiting survey, select a number of survey sites to serve as the official sample sites for assessing mortality of the control program. Depending on the target pest, refer to the program requirements to determine survey methodology. The recommended number of sample sites is dependent on the following:

- Access to the area
- Available personnel
- Environmental or political sensitivity to the block
- Size of the treatment block
- Type of pest being sampled

Program Planning: Pest Mortality Assessment Procedures
As much as practical, randomly select the sample sites, which should represent a variety of terrains or habitats within the treatment area, and provide a more realistic estimate of efficacy. Mark the mortality sample sites using stakes or flags. Record the location of these sites on the program map that will be part of the program file. Some program manuals or work unit locations may have established guides for mortality assessment.

Step 2: Perform Pre-treatment Sampling
Sampling the sites in relation to treatment dates is important. Pretreatment samples should be taken as close as practical to, but before the treatment begins.

Step 3: Establish Control Group Sites
For some suppression projects, establishing sample mortality sites outside the treatment block (control group site) is recommended. Outside treatment area sample sites can provide an estimate of the natural increase or decrease of pest populations in nearby, untreated areas. If populations outside the treatment block remain static or show an increase, then this information can demonstrate to cooperators the success of the control program. The results of the outside treatment area sample sites (control group site) can be used in a formula to adjust the mortality assessment.

Step 4: Perform Post-treatment Sampling
Accuracy is important to determine the success of the treatment. Weather conditions significantly affect accuracy of pest counts. The Program Manager (PM) and Contracting Officer's Representative (COR) **must** balance treatment timing and available personnel to optimum weather. Allow adequate time for the chemical to be effective before taking post-treatment counts to increase the accuracy of mortality assessment and provide a

better estimate of program success for cooperators. When selecting the sampling dates for post-treatment counts, consider the type of pesticide that is being used.

- Chemicals such as Malathion have a fast mode of action, and post-treatment counts can possibly be taken within a few days after treatment
- Chemicals such as Carbaryl or bait type formulations have a slower mode of action and will require additional time before maximum efficacy is achieved
- Chemicals such as Difluaenzuron (Dimilin) may require a full month to reach full efficacy due to the mode of action If the rate of mortality is unknown, then several post-treatment counts may be needed to ensure accurate data.

Step 5: Interpret Results

If the untreated pest population shows a small natural decline during treatment operations, then the percent control that can be attributed to the pest control treatment also will be reduced or corrected by the formula. Conversely, if the untreated pest population increases after the pretreatment samples are taken, then the formula will show a higher percent control attributed to the treatment.

Liquid System Inspection

If a liquid application system is being used, then inspect the system following the procedures listed below.

Spray Tank Interior

Inspect the spray tank interior as follows:
1. Climb onto the aircraft wing to inspect the hopper.
    A. **Do not** step on the boom or any part of the wing that is **not** painted with nonskid material to avoid causing damage to the aircraft structure.
    B. Use available handholds to prevent injury to yourself.
2. Look inside the hopper and make sure the inside is clean and dry, and has **no** foreign matter clinging to the sidewalls.
    A. Check for residue of other chemicals dried on or caked to the sidewalls.
    B. Inspect gaskets and seals and look for bulging or loose sealant compounds that may break loose and plug the spray system.
3. If the spray tank system is clean, then check YES under *Block 42, Spray tank interior cleaned of all contamination.*
4. If the spray tank system requires cleaning, then advise the contractor, check NO under *Block 42, Spray tank interior cleaned of all contamination* and note under *Deficiencies Noted*.
    A. Using a good cleaning agent (such as non-sudsing ammonia or Top Job®), and a good scrub brush to clean with should remove most residue.
    B. If excessive residue is inside the hopper, and then you should suspect that other parts of the spray system are also contaminated.
    C. Corrosive chemicals such as Malathion will loosen most residues and cause plugging of strainers, screens, and spray tips, which result in program delays and improper application rates.

Leakproof Spray System Components
Check the condition of gate seal, hoses, and other spray system components to make sure they are leakproof. This is to prevent pesticide spills and leaks that will cause damage to the environment and loss of expensive pesticides. All leaks **must** be repaired before operations begin.

Inspect the components as follows:
1. Check the hoses for fraying and bulging.
2. Make sure hose clamps are tight.
3. Check the condition of the gate seal. Have the pilot open the gate. After the gate is open, check the seal for cuts and fraying.
4. After the system is filled with chemical, check for leaks at all connections and spray nozzles. **Do not** begin operations until all leaks are repaired.
5. Check for leaks in the system periodically during the program. If practical, check for leaks after each load.
6. Look at the underside of the fuselage and the tail wheel assembly and check for chemical. If there is any chemical, then this may indicate a severe leak at the spray pump, gate seal, or other connections while the system is under pressure; and could also be evidence that part of the load was jettisoned through the jettison (dump) gate during the flight.
7. If there is **no** evidence of leaks after inspection, then check YES in *Block 43, Leak proof-Check condition of hoses, gate seal, and other spray system components.*
8. If there is any evidence of leaks, advise the contractor, check **NO** in *Block 35, Spray tank interior cleaned of all contamination,* and list under *Deficiencies Noted.*

Aircraft Jettison (Dump) Valve
The aircraft **must** be designed specifically for aerial application and meet the requirements of FAR Part 137 (Cessna Ag-Truck, Thrush, etc.). The aircraft **must** be equipped with a jettison (dump) valve that meets Agricultural Part FAR 137.53(C)(2), to ensure that the hopper load can be jettisoned in an emergency.

Aircraft converted from passenger or cargo certification to aerial application (DC-4, Lockheed PV2, etc.), **other than** helicopters, **must** be able to jettison at least one-half of the aircraft's maximum authorized load of agricultural chemical within 45 seconds when operating over a congested area.

If the aircraft is equipped with a device for releasing the tank or hopper as a unit, then there **must** be a means to prevent inadvertent release by the pilot or other crew members.

If the aircraft is equipped with a dump valve that meets FAR 137.53(C)(2), then check YES in *Block 37, Equipped with dump valve that meets agricultural part FAR 137.53(C)(2)*.

If the aircraft is **not** equipped with a dump valve or is equipped with a dump valve that **does no**t meet FAR 137.53(C)(2), then check **NO** in *Block 37, Equipped with dump valve that meets agricultural part FAR 137.53(C)(2)*, advise the contractor, and note under *Deficiencies Noted*.

Drain Valve(s)
The drain valve(s) **must** be located at the lowest point(s) in the system to allow for complete draining of the spray system at the end of the program. The aircraft may also be used for other purposes during the course of the program which require draining the spray system before such use. Check all low points for drain valves or removable plugs that will allow draining the spray system.

On most Category C and D aircraft, expect three low points:
- ✓ Boom T or Y strainer
- ✓ Spray pump
- ✓ Spray tank

If the drain valve(s) are located at the lowest point(s) in the system, then check YES in *Block 45, Drain valve(s) located at lowest point(s) in the system.*

If the drain valve(s) are **not** located at the lowest point(s) in the system, then check **NO** under *Block 45, Drain valve(s) located at lowest point(s) in the system,* and list under *Deficiencies Noted*.

Emergency Shut-off Valve
The emergency shutoff valve should be located between the hopper and pump. The valve should be as close to the hopper as possible to prevent the loss of pesticide and damage to the environment in the event of a major spray system leak.

Inspect the emergency shut-off valve as follows:
1. Check to be sure the emergency shut-off valve is installed at the proper location.
2. Have the pilot operate the valve to ensure the valve can be **closed** from the cockpit. (The pilot does **not** have to be able to open the valve from the cockpit.)

3. Check that the valve closes completely and without difficulty on the pilot's part. If the shutoff valve is installed at the proper location, can be closed from the cockpit, and closes completely and without difficulty, then check YES in *Block 46, Emergency shut-off value located between the hopper and pump*.

If the shutoff valve in **not** properly installed, or cannot be properly closed completely from the cockpit, then check NO in *Block 46*, inform the contractor, and note under *Deficiencies Noted*.

Bleed Lines on Spray Booms
If spray booms are equipped with a boom shut-off valve located at the 3/4 position and the valve is closed, then bleed lines **do not** need to be installed.

To determine if bleed lines are required, use a tape measure to measure from the center of the fuselage to the wing tip and determine the 3/4 position of the wingspan.

- ✓ If the aircraft is equipped with a spray boom that is longer than 3/4 of the overall wingspan and/or the outermost nozzle is more than 3 inches from the end of the spray boom, then installation of a bleed line is necessary
- ✓ Entrapped air in the boom will cause the nozzles to continue to spray after closing the spray valve, until the pressure generated by the entrapped air has bled down to 7 pounds per square inch (PSI). The check valve located in the end cap of the spray nozzle will close at 7 PSI
- ✓ If bleed lines are required on spray booms, then check to make sure they are installed correctly to remove entrapped air from the end of the spray boom. (See the current *APHIS Aerial Application Prospectus* for correct installation of bleed lines).

Inspect and confirm that the bleed lines are installed as follows:

- 3/8 inch inside diameter, and constructed from copper or other chemical-resistant material
- Attached to either the end of the boom or the outermost working nozzle port, provided the nozzle port is less than 3 inches from the end of the boom
- Attached with a tee to the outermost working nozzle positioned at 3/4 or less of the wingspan
    - ✓ PPQ will accept the outmost nozzle anywhere between 60 percent to 75 percent of the wingspan
    - ✓ If the nozzle is not at the 3/4 wingspan position, then use the next available port inside the 3/4 position, provided that position is more than 60 percent of the wingspan
- Have a shut-off valve installed between the boom and the bleed line nozzle to remove air from the boom and prevent chemical from entering the nozzle without going through the bleed line
- If bleed lines are required and are properly installed, then check YES in *Block 47, Bleed lines installed on spray booms when required*.
- If bleed lines are required but are **not** properly installed, then check NO in *Block 47*, advise the contractor, and note under *Deficiencies Noted.*

Pump Capacity
A pump capacity to deliver 40 per square inch (PSI) to all spray nozzles is required to ensure the required pressure can be delivered to all spray nozzles, regardless of the chemical and the chemical level in the spray tank.

Several types of spray pumps are acceptable for PPQ spray programs, as follows.

- Category C and smaller aircraft usually have centrifugal pumps installed. Centrifugal pumps are the most common, and will pump most materials with minimum wear
- Centrifugal pumps are powered by either of the following:
  - ✓ Hydraulic motor driven by the aircraft engine
  - ✓ Wind driven (have either a fixed pitch fan with 2-to-4 blades or variable pitch fan with 2-to-6 blades
- Larger Category A and Category B aircraft may be equipped with gear or other type pumps.
  - ✓ Gear or other type pump(s) should be as connected as follows:
    - ➢ If two pumps are used, then they should be connected so that both pumps will pump the insecticide through the total span of the spray boom(s)
    - ➢ Individual pumps connected to separate booms should **not** be accepted because adjusting the pumps so that each will pump the same rate is difficult If the pump is as specified above, then check YES in *Block 48, Pump with capacity to deliver 40 PI to all spray nozzles*.
- If the pump will not deliver 40 PSI to all spray nozzles regardless of the chemical and level in the spray tank and/or is not an acceptable type, then check NO in *Block 48*, inform the contractor, and list the deficiency under *Deficiencies Noted*.

Functional Pressure Gauge
A functional pressure gauge with a minimum range of zero-to-60 PSI, but **no** greater than zero-to-100 PSI is required to ensure that the gauge covers the required operating range and that the scale is **not** so small that reading the gauge is difficult.

1. Locate the gauge mounted either in the cockpit or on the spray boom.
2. Make sure the gauge is visible from the pilot's view and within the required range, and that gauge pressure can be easily read.
3. Check that the gauge reads zero (0) when **no** pressure is in the system.
4. Check that the gauge has a functional minimum range of 0-to-60 PSI, but no greater than 0-to-100 PSI.

If the pressure gauge meets the specifications above, then check YES in *Block 49, Functional pressure gauge with a minimum range of zero to 60, but no greater than zero to 100 PSI.*

If the pressure gauge does not have a minimum range of zero-to-60 and a maximum range of zero-to-100 PSI, and does not meet the specifications above, then check NO in *Block 49*, inform the contractor, and note under *Deficiencies Noted*.

In-line Strainer Between Pump and Boom
An in-line strainer located between the pump and boom is required to prevent foreign matter from clogging nozzle strainers and spray tips.

Check as follows:
1. Locate the in-line strainer either just after the spray valve or in the T at the center of the boom.
2. Check the strainer for cleanliness.
3. Verify the mesh is as specified in the contract.
4. A 50-mesh, in-line strainer should be used for most chemicals.
    A. Most strainers are not identified as to mesh size.
    B. To determine mesh size, mark a one inch line on the strainer and use a small pointed object (such as a push pin) to count the strands within that inch. A 50 mesh strainer has 50 strands per inch.
5. Many aircraft spray systems are equipped by the manufacturer with a 40 mesh in-line strainer.
    A. Cut a 50 mesh screen slightly larger than the inside of the strainer, and insert the 50-mesh screen (with overlap) inside the existing strainer.
    B. If the system is very clean, and then use discretion in accepting the 40 mesh screen in lieu of the 50 mesh screen. If the in-line strainer is located between the pump and the boom and is as specified above, then check YES in *Block 50, In line strainer - between pump and boom*.
    If the in-line strainer is not in the proper location or does not meet the specifications above, then check NO in *Block 50*, inform the contractor, and note under *Deficiencies Noted*.

Unused Nozzle Openings
All unused nozzles **must** be removed and the openings plugged to prevent inadvertent or intentional turning on of excess nozzles. Verify that **only** the correct number of nozzles are installed for calibration.

If the unused nozzles are removed, the unused opening are properly plugged, and the correct number of nozzles are installed for calibration, then check YES in *Block 51, Unused nozzles removed and openings plugged*.

If the unused nozzles have not been removed or the openings have not been properly plugged, then check NO in *Block 51*, inform the contractor, and note under *Deficiencies Noted*.

Special Equipment
All special equipment (automatic flagman, DGPS, smoker, etc.) specified in the aerial application contract **must** be installed and operational, including ground support equipment (pumps, meters, etc.).

Locate the required special equipment and verify the equipment is installed and operational as follows:
1. Check the smoker without having the pilot fly the aircraft.
    A. Operate the smoker on the ground and listen for the sound of the pump motor.
    B. Check the smoker oil (supplied by the contractor) and verify a sufficient amount is on hand to operate the smoker.
2. Check the automatic flagman.
    A. Ask the pilot to pop a flag while on the ground.
    B. Check the flags and verify a sufficient supply of flags in on hand.

3. Check the accuracy of the differentially corrected global positioning system (DGPS), and check the pilot's knowledge and skills using the DGPS by utilizing the procedures developed for this test. This check is normally performed by a PPQ pilot when available.

If all special equipment specified in the aerial application contract is properly installed and operational, then check YES and list the specific special equipment in *Block 52, Special equipment required*.

If the special equipment is not installed properly or not operational or missing, then check NO in *Block 52*, inform the contractor, and list under *Deficiencies Noted*.

Chemical in Hopper
Accurately determine the amount of chemical remaining in the spray tank or hopper before or after flight. The aircraft will be equipped with a gauge and/or will have calibrated divisions on the tank that are small enough to accurately determine the amount of chemical remaining in the tank. If you are unable to locate the gauge or calibrated divisions on the tank, then ask the pilot to show you the location.

If you verified the method to determine the amount of chemical remaining in the spray tank or hopper before and after flight, then check YES in *Block 53, A method to determine the amount of chemical in the hopper, in flight and on the ground*.

If you were not able to verify the gauge or calibrated divisions for determining the chemical remaining, then check NO in *Block 53*, inform the contractor, and note under Deficiencies Noted.

Number of Nozzles Installed for Application
The correct number of nozzles **must** be installed for proper calibration to ensure that the spray aircraft will deliver the desired rate of pesticide per acre.

- To determine the correct number of nozzles, use the calibration formula in ***Dispersal Systems Calibration*.**
- To determine the correct spray tip size required for the aircraft and pesticide being used.
- If the correct number of nozzles are installed, then list the number of nozzles installed in *Block 54, No. of Nozzles Installed for Application*.

If the correct number of nozzles are **not** installed, then note under *Deficiencies Noted*.

Spray Tip and Strainer Size
The correct size spray tip and tip strainers, SS8002/50 mesh, constructed from approved materials **must** be correctly installed. PPQ, Aircraft and Equipment Operations (AEO), has determined (for most aircraft) the correct spray tip size for different aircraft, based on airspeed and pesticide being used.

Inspect the spray tip and strainer as follows:
1. Inspect each spray tip to verify the tips is the correct size and constructed of stainless steel (SS)
2. Inspect the orifice for evidence of tampering or altering, especially on programs where payment is by the gallon or acre. (Altering the orifice opening is not beneficial to the contractor on programs where payment is made by the flight hour.)

3. Inspect the spray tip strainers to verify that they are installed and of the correct mesh size.

- ✓ Most spray tip strainers are **not** identified by mesh size
- ✓ To determine mesh size, measure on inch on the screen and use a small pointed object (such as a push pin) to count the number of strands in one inch; the total number of strains in one inch equals the mesh size
- ✓ List the size spray tip and strainer in *Block 55, Spray Tip and Strainer Size*.

Operating Boom Pressure (psi)
The operating boom pressure per square inch (psi) **must** be documented to be used as a reference (to all involved) that the boom pressure is to be set at the psi listed. In most cases, the spray system is calibrated for the boom pressure to be set at 40 psi. However, resetting the psi to achieve the desired flow rate per minute may be necessary, especially when applying ULV applications and the calibration requires 8-1/2 nozzles rounded up to 9 nozzles installed on the aircraft. In this case, at 40 psi the flow would be too high and a lower psi setting would be in order. List the operating boom pressure per square inch in *Block 56, Operating Boom Pressure (PSI)*.

Deficiencies, Corrections, and Remarks
Deficiencies Noted
As you conduct your inspect and document the results, be sure to note any deficiencies found during the inspection under the *Deficiencies Noted* section.

Deficiencies Corrected
Once the deficiency is corrected, then note the date the corrective action was taken, and the results after re-inspection of the deficient item under the *Deficiencies Corrected* block.

Remarks
Make any other notes under *REMARKS*.

Certification
After the inspection is completed and documented on the *PPQ Form 816, Aircraft and Pilot Acceptance*, the official conducting the inspection (PPQ Pilot), and the contract pilot or contractor **must** review the completed document and then sign the form.

Loading Facilities
Proper organization and inspection of the worksite helps assure dependable facilities for rapidly loading the aircraft. Accurate rapid loading may help with program efficiency, by increasing the number of loads per day that can be applied and reducing the operational hours required to complete a project. This could mean significant savings to the associated costs of the project which could benefit landowners.

One way to reduce lost time is to give careful consideration to the position of loading stations. The station should be spaced so the aircraft can taxi up to and away from any station and be positioned so the aircraft will **not** obstruct the runway while the aircraft is being loaded.

Loading Liquid Pesticides
Load liquid pesticides into large aircraft at a minimum rate of 100 gallons per minute, and all other aircraft at a rate of 50 gallons per minute. Pumps, meters, and plumbing should be of sufficient capacity to maintain this loading rate regardless of the number of aircraft being loaded at one time. Under average conditions, there should be approximately one-third as many loading stations as there are aircraft operating from the airstrip, or one loading station for every three aircraft.

Strainers should be incorporated in the loading system so foreign material will **not** be pumped through the meters and into the aircraft. Foreign material will impair the accuracy of meters, clog nozzles, cause check valves to leak, and cause bypass valves to stick open. Loading hoses should be of sufficient length to permit loading aircraft without parking the aircraft on a specific spot. Time is lost in parking aircraft at precise locations that may be too close to obstructions.

Loading Granulated Pesticides
Several types of mechanical loading devices can be used to load granulated pesticides into aircraft.

Acceptable types are auger, belt, and hopper. Auger and chain-type loaders have been found to be unsatisfactory for clay granules. If a loader is suspected of grinding and reducing the size of the granules, then a sample of the material should be collected and submitted for size analysis.

Loading Bran, Grits, and Rolled Wheat
Mechanical loaders should be used for loading bran, grits, and rolled wheat into all large aircraft; belt, chain, and auger types are best.

Blowers should **not** be used for loading bran. When blown into a hopper, bran may pack and **not** flow uniformly. Small aircraft can be loaded by hand, provided protective measures are taken to prevent pesticide exposure of personnel and all safety standards shown on the label and provided by the EPA are followed. This is of particular importance when dealing with pesticide dust formulations.

Computing Aircraft Loads
When aircraft loads are computed, each aircraft should be loaded to equal the amount of pesticide required for a specified number of swaths, plus a small cushion or reserve. This ensures that the aircraft will **not** run out during a swath run. Quite often, pilots may **not** know where they ran out or some who may know may **not** return to that exact point to continue applications; this would leave untreated areas.

Aircraft Assignment and Control Operations

Aircraft Assignment
When assigning aircraft to treat various blocks and the choice to use faster, large-load carrying aircraft is available, then use the faster, large load carrying aircraft to treat those blocks that are farthest from the airstrips. If the terrain is rugged, then use the best performing aircraft in those blocks. Assign the more proficient pilots to areas involving rugged terrain. Assignments **must** be coordinated with the contractor's representative.

Area Division
Development of the target pest and host plants may vary within the treatment area. The boundaries of the treatment area may need to be divided according to phenological development stages of the target pest and/or host plants.

Operations can usually be managed more effectively by dividing the treatment area into units when one or more of the following conditions occur:

- ✓ Large or complex areas require use of many aircraft
- ✓ Separate geographic entities
- ✓ Large units may require separate supervision and staffing.

Kytoons®
The use of Kytoons®, light, mirrors, or electronic or DGPS guidance allows for considerable extension of the flight lines. However, there are limitations **other than** the guidance system, such as the chance of adverse weather conditions increasing somewhere along the flight line as the line is lengthened. This can cause a reduced work day or poor application over part of the block.

For boundaries in rural areas, the use of fence flagging is effective and should be posted as needed to ensure accurate application. The use of landmarks such as buildings, country roads, fence lines, highways, railroads, rivers, telephone and power lines, trees and brush patches, windmills, etc., also effectively help pilots locate spray block boundaries.

When the use of more than one aircraft is planned for treating separate blocks as part of a larger program, then the blocks **must** be arranged so that pilots can treat their assigned blocks without danger of collision. Blocks which either contain or are adjacent to sensitive areas (beehives, mink farms, poultry farms, water reservoirs, etc.) **must** be arranged so that flights and turns over sensitive areas will be avoided or held to a minimum.

Height of Ferry and Application
When dividing blocks, establish and identify the following:

- ✓ Aircraft ferry routes
- ✓ Altitude of flight during ferry trips
- ✓ Height of flight during application

Normal ferry altitude is at least 500 feet above ground level (AGL) for rural areas. Higher ferry altitude may be required in urban areas to avoid unnecessary disturbance to residents or to avoid local air traffic. Normal application height is based on the wingspan of the aircraft being used. The standard assignment to make is one and one-half of the wingspan length of the application aircraft.

Formation (Team) Flying
Operating aircraft in formation may be desirable or necessary at times. Formation flying is most likely to occur when a number of small aircraft are used or when there are more aircraft than blocks.

For aircraft flying in formation, do as follows:
- Use aircraft of similar type, swath width, flow rate, and comparable speed
- Have each aircraft carry equal loads
- If pilots have difficulty spacing themselves properly, then the pilots may be assigned to follow a formation-proficient or experienced teammate

Productivity is lower with team flying than when aircraft are working separately, because the leading aircraft **must** make wider turns to permit the trailing aircraft to complete their swath runs, and the leading aircraft usually **must** wait for the other aircraft to be loaded.

General Briefing
Hold a briefing session for all personnel, including those of the contractor, before work starts and continue to hold briefing with personnel as often as necessary during the course of the program. During briefing, describe the program, purpose, procedures to be followed, sensitive areas, obstructions or hazards within the area and en route, policy on flight over farms or residences, traffic patterns, minimum ferry altitudes (500 above ground level (AGL)), precautions for handling the pesticide, and other safety measures.

Pilot Briefing
Briefing pilots is best accomplished through the use of observation aircraft so that each pilot can be shown landmarks, block boundaries, sensitive areas, hazards, etc. Brief each pilot individually about each block assigned. To avoid confusion and depending on block size, brief the pilot on **no** more than two blocks at a time.

Flagger Briefing
If flaggers are used, they should be briefed along with the pilots. Discuss the type and number of markers to be used, the location of markers in relation to block boundaries, and other markers that may be located inside the block. Orienting flaggers by means of a reconnaissance flight may be necessary.

Spray Block, Sensitive Area, and Buffer Zone Verification
After taking a pretreatment reconnaissance flight with each pilot and confirming that everything (buffer zones, spray blocks, and sensitive areas) is recorded on a master program map, then jointly sign and date the map. When observation aircraft are **not** available, then using ground vehicles to show pilots and/or flaggers their assigned blocks may be necessary.

Pilot Experience
All pilots, especially those with minimum experience, should be observed closely during applications to determine if their work is satisfactory. If the pilot **does not** perform satisfactorily, then the pilot should be replaced regardless of the amount of experience. Experience alone **does not** necessarily determine pilot acceptability. A pilot who is **not** conscientious or **not** capable or who has an inappropriate attitude may contribute toward program difficulties.

Terrain Type
Always allow pilots to participate in flight planning and swath pattern decisions. Prior to the start of treatment, flat and rolling terrain will be divided into rectangular blocks whenever possible to enable the pilot to fly straight parallel lines. When boundaries are curved or crooked, pilots are inclined to straighten up the flight lines as treatment progresses; this causes skips which then require multiple flights (to cover the skipped areas).

When feasible, blocks should be aligned with the general direction of most fences and highways (e.g., north-south or east-west on the Great Plains), to aid the pilot in keeping direction and spacing. Try **not** to plan east-west flight lines at sunrise and sunset.

Treat Crosswind
Pilots prefer to treat crosswind, starting on the downwind side, and working upwind so they will **not** fly through the spray from previous swaths. This also protects ground personnel from the treatment formulation (spray). Pilot safety **must** always be addressed.

Flat and Rolling Terrain
When treating flat and rolling terrain where maintaining a reasonable altitude **without** deviating off-course is impossible, then the pilot should fly straight parallel lines and crosswind as practical. When spraying the treatment formulation, the pilot should begin on the downwind side of the block and move upwind on each progressive swath run to avoid flying through suspended spray from the preceding swath.

Rugged Terrain
When the terrain is too mountainous or rugged for a pilot to maintain a reasonable altitude over hills and valleys, then block boundaries will be designed to follow contours. Pilots are capable of spacing their swaths properly in curving flight lines when they can follow contours. GPS guidance can greatly assist with this.

When practical, separate rugged terrain areas for treatment from rolling or level areas. In rugged areas, wind, turbulence, and other conditions may limit the period of time that treatment can be applied effectively. In such areas, the aircraft will start treatment operations in the early morning (when wind and temperature conditions are optimal), and remain until weather conditions become unsuitable. The aircraft should then move to the flat, lower areas for treatment. If the terrain is too rugged for straight flight lines, then the pilot(s) should follow the contour of the slopes.

Hazardous and Difficult
Uphill flying in canyons and valleys is hazardous and difficult for the pilot to judge the degree of the slope. Unless the pilot is flying a powerful, high-performance aircraft capable of maintaining the required application altitude and speed, the area should be flown down slope **only**. Keep in mind that this approach will significantly increase the amount of time needed to complete each load and each plane may have to carry less material to lighten the load. These factors must be figured in when planning the overall course of a program.

Congested Areas
Although the term congested area has **not** been defined specifically by the Federal Aviation Administration (FAA), a congested area applies in general to any city, town, community, or group of buildings in which people would be subject to injury as a result of the malfunction of low-flying aircraft.

If the congested area is **not** part of the treatment area, then arrange blocks adjacent to congested areas so the aircraft will **not** fly or make turns over congested areas. To minimize the hazard in such areas, the FAA places restrictions on aircraft used for treating congested areas. If a single engine aircraft can operate in a pattern at such an altitude that the aircraft can land in an emergency **without** endangering persons or property on the surface, then the aircraft can treat where there are groups of buildings and very small towns. **Only** multi-engine aircraft and helicopters with limited loads can be approved for larger towns and cities.

Contractor Plan for Congested Areas
Requirements to treat over congested areas are listed in Federal Aviation Regulations FAR Part 137, "Treatment Over Congested Areas." The contractor/pilot is responsible for obtaining necessary waivers and complying with the regulations. The contractor/pilot **must** submit a plan for each congested area operation to the FAA Flight Standards District Office (FSDO) having jurisdiction over the area where the operation is conducted. A letter of authorization signed by the city or town authorities (for the congested area) **must** accompany each plan. The operator **must** provide additional documentary evidence relative to aircraft and pilots.

Ferrying and Turnaround Routes
Where possible, plan ferrying and turnaround routes to avoid flights over congested areas, bodies of water, and other sensitive areas that are **not** to be treated.

Racetrack Pattern
When large blocks are treated, setting up two parallel flight lines approximately 1 mile apart for aircraft operating at less than 130 mph (113 knots) may be advantageous. If possible for aircraft operation above 130 mph, the flight lines should be two miles apart. This allows a timesaving 180° turn instead of the conventional keyhole pattern necessary with formation flying. In addition, the racetrack pattern lends to a safer and less complex procedure turn. This turn reduces pilot work load and facilitates continuous visual contact with the next landmark.

Crew and Work Assignments
Supervise the crew and work assignments as follows:
1. Ensure that all aircraft, equipment, and personnel are ready.
2. Distribute equipment and radios to project personnel and provide the necessary training for their work assignments.
3. Establish a daily operational plan with input from the ground crew and the pilot(s).
4. Monitor daily work assignments of both APHIS personnel and cooperating personnel.
5. Hold meetings and briefings to identify problems, provide progress reports to personnel, adjust work assignments, and provide additional training.

Weather
Weather has an important role in aerial application. Winds may displace the pesticide formulation within the target area. High temperatures combined with low humidity may cause fine liquid pesticide formulation to evaporate or drift away **without** reaching the target. Before and during application, have trained personnel monitor weather conditions and record the following:

- Air temperature and ground temperature
- Cloud formation
- Fog

- Wind speed and direction

Weather monitors **must** be able to communicate with the pilot at all times. Weather readings are critical to effective applications and should be taken frequently for ultra-low-volume (ULV) formulations.

Weather monitoring should occur within the treatment block for more accurate readings. When applying ULV formulations, control activities should **stop** when safe and accurate placement of the spray formulation on treatment areas could be jeopardized by weather conditions.

To minimize drift and volatilization, **do not** use ULV formulations when any of the following weather conditions exist:

- ✓ Air turbulence could seriously affect the normal deposition pattern
- ✓ Fog is present or is imminent
- ✓ Heavy dew is on foliage
- ✓ Rain is falling or is imminent
- ✓ Temperature changes could cause the spray formulation to move outside of the treatment block or to non-target areas
- ✓ Wind velocity exceeds 10 miles per hour (unless a lower wind speed is required for pesticide application under State law or pesticide label requirements)

Field observers should watch for and report the following conditions that can indicate poor weather conditions for applying liquid sprays:

- Treatment formulation begins to rise instead of falling to the ground (inversions)
- Excessive drift occurs
- Soil and air temperature is incorrect

Air and Soil Temperature

Daily operation times for most projects using liquid formulation begin at first light (daybreak) and continue until the soil temperatures rise above the air temperature (usually mid-morning). Daily operation times for programs using baits and flakes are more flexible because these materials are less sensitive to temperature.

Ultra Low Volume (ULV) Formulations

When using liquid ultra- low volume (ULV) formulations, special consideration **must** be given to monitoring the air and ground temperature difference. This is one of the critical indicators of the time to quit treating for the day.

The best weather for spraying treatment is usually from dawn until mid-morning. As the morning progresses, inversions occur when the soil warms the air above; as the soil surface warms, the air above begins to rise. When the soil temperature and air temperature equalize, the upward air currents (thermals) increase and cause the fine pesticide formulation droplets to float or even begin to rise as they near the ground. If the droplets float or rise, then offsite pesticide drift and reduced efficacy due to the pesticide **not** reaching the target is more likely.

Consistent monitoring of the deposition pattern on dye cards, the air and ground temperature are the best methods of determining the effects of weather factors on application. When weather inversions occur, consider terminating application for the day.

The soil temperature should be taken by placing the thermometer probe on an unshaded site; then shade the thermometer for 3 minutes before reading. For rangeland programs, the air temperature should be taken 5 feet above the surface in the open, but with the thermometer shaded. Other programs may require taking a reading much higher above the canopy of vegetative cover. Some programs may require monitoring.

Bait Formulations
A bait formulation is an active pesticide ingredient mixed with food or another substance to attract a specific type of pest. The pest eats the bait and expires. The active pesticide ingredient in most bait formulations is generally relatively low (usually less than five percent).

In some situations (pest habits, environmental sensitivity), etc.), wheat bran bait is an effective alternative to liquid pesticides. Baits are commonly used in the Grasshopper and Mormon Cricket Control Programs.

Bait formulations (such as wheat bran) and other solid materials (such as pheromone flakes) are **not** as sensitive to air and ground temperatures. Bait formulations can be applied throughout the day, and are **not** affected by temperature inversions. Rain and high winds still affect the application of bait treatments.

Daily Start-up Procedures
At the start of each workday and prior to allowing application aircraft to load or leave the airport, contact all ground observers and the aerial observer to confirm that all personnel are in place and weather conditions are within tolerances for aerial application of the material being used. Generally, projects using liquid formulation begin at first light (daybreak) and continue until the soil temperatures rise above the air temperature (usually mid-morning). Daily operation times for programs using baits and flakes are more flexible because the materials are less sensitive to temperature.

Evening Pesticide Application
Planning pesticide application in the evening is not advisable, unless the program is an emergency. If the application is an emergency, then be sure to plan for safe evening operations, and determine the approximate time darkness will occur. Although GPS guidance now allows for night operations, safety is still a consideration and all safety factors **must** be considered. If operating aircraft **without** GPS guidance, then the pilot should **not** be permitted to take off with a load **without** the assurance of adequate time to complete the round trip before dark. There **must** be adequate daylight to do satisfactory application work. Although the airport may be lighted for safe landing after dark, this is irrelevant to having proper light on the actual treatment area.

Visual Observations
Ground and aerial observers **must** monitor or perform visual inspections of many aspects of aircraft and pesticide performance during operations. Observers should be aware of the following elements and record or report them clearly and accurately.

Pesticide Deposition
Record or report the following elements as indicated:

- Drift (movement of pesticide formulation by wind, air currents, or volatilization outside the intended area, usually as fine droplets during or shortly after application)
- Skips (areas within the control block that **did not** receive treatment due to poor aircraft guidance, pilot error, or aircraft's running out of chemical)
- Swath displacement (distance the swath deposition is offset from the center flight line due to a crosswind)
- Swath spacing when formation flying ((GPS ensures the aircraft are spaced the proper distance from each other)
- Swath for each aircraft **does not** overlap; and space or skips are left between patterns
- Uniformity of deposition pattern (pesticide formulation should be applied and deposited as evenly as possible over the width of the swath)

Application Aircraft
Record all the following, and where indicated notify the COR and airport supervisor of the specified information:

- ✓ Height of flight and identity of aircraft that are flying at **other than** the assigned height
- ✓ Jettisons
    - Report to the COR and airport supervisor immediately the accidental release, leak, or intentional jettison of pesticide formulation
    - Record, secure, and report the time and location of the jettison to the COR and airport supervisor

- ✓ Plugged nozzles (incorrect operating nozzles affect calibration and reduce efficacy; significant variance in boom readings may also indicate plugged nozzles)
    - Identify the aircraft by number
    - Notify the COR and the airport supervisor of any non-operating nozzles, nozzles that operate intermittently, or nozzles that have **only** partial output

- ✓ Proper shutoff and turn on

- Verify that aircraft are opening and closing the boom or bait spreader at the proper boundaries and over sensitive areas
- Verify that nozzles **do not** trail off or continue to operate after the boom has been shutoff (could be caused by inadequate, plugged, or improperly installed bleed lines on the boom)
- Ensure positive nozzle shutoff

✓ Turnarounds
- Verify that aircraft completes the turn prior to re-entering the treatment block and resuming treatment
- Verify that aircraft is level, on track, and is at cruising speed at the beginning of each pass

✓ Weather Conditions
- Record and clearly and accurately report weather conditions

Spray Deposition Monitoring

Dyecard Samplers
Use dyecards to monitor liquid formulation spray deposition. Dyecards are made of water- or oil-sensitive paper and are used to provide valuable information on swath width, spray droplet deposition pattern, and droplet size; and to identify leaks in the spray system. When systematically placed, dyecards can verify the non-treatment of sensitive areas and the treatment of other areas that are **not** targeted for treatment. Maintaining dye cards as part of the program file is important.

Position, recover, record, and evaluate the dyecards as listed below:
1. Position dyecards as follows:
   A. Identify each dyecard with a code or number for record keeping purposes.
   B. Place dyecards at regular intervals; spacing depends on size of block, sensitive sites, and time allowed for placement.
   C. Tack dyecards to tops of fence posts, stakes, or other devices to hold the dyecards above vegetation.
2. Recover dyecards as follows:
   A. Wait at least 15 minutes after the spray aircraft have left the area before retrieval; this should allow ample time for the pesticide formulation to reach the target area.
   B. Pick up dyecards in the same order they were placed.
   C. Use adequate card holders to prevent smearing of dyecards.
3. Record the following information on the card batch:
   A. Name and location of place pesticide was used.
   B. Target pest.
   C. Site to which dyecards were applied (i.e., cotton field).
   D. Year, month, day, and time of application.
   E. Trade name and EPA registration number of pesticide.
   F. Amount of pesticide used and its formulation (i.e., Malathion ULV concentrate, 8.0 fluid ounces per acre).
4. Evaluate the deposition pattern on the dyecards.

Environmental Monitoring
When environment monitoring is required, then ensure monitoring is set up in the proper locations and that personnel are equipped and in communication. Environmental monitoring samples **must** be drawn according to the Environmental Monitoring Plan for the specific pest program or site-specific circumstances. Environmental monitors **must** be coordinated with treatment operations in order to carry out their duties.

Pesticide Supply Monitoring
Although determining the amount of pesticide to order for the project is an important step in program planning, monitoring the pesticide supply on hand as pesticides are used during the control operations is just as important in program supervision. Consider the actual amount of pesticide being used as compared to the actual number of acres that have been treated in the block. A disparity between these two figures will indicate calibration problems or other application problems.

Pesticide Supply Adequacy to Ensure On-time Completion of Project

1. Determine the number of acres remaining in the treatment block.
Number of acres in treatment block remaining to be treated

+ Number of acres in buffer zones and sensitive no spray zones (if any)

= Total acres remaining to be treated

2. Determine the number of acres a gallon of pesticide will treat.
128.0 fluid ounces per gallon

Application rate per acre in fluid ounces (of pesticide)

= Number of acres one gallon of pesticide will treat (at given application rate)

3. Determine the number of gallons of pesticide required to complete the project.
Number of acres remaining

Acres 1 gallon will treat

= Number of gallons required to complete project

4. Determine the total amount of pesticide that has been delivered.
Initial amount delivered
+ Subsequent amounts delivered
= Total pesticide delivered

5. Determine the amount of pesticide on hand.

Total pesticide delivered

– Total amount used

= Total amount of pesticide on hand

Aerial Application Section Ground Crew Post Quiz

1. The conditions and regulations outlined in the _____ section also apply to helicopters.

A. Fixed-wing aircraft
B. Pilot
C. Ground personnel
D. Applicator
E. Rotary wing aircraft or Helicopters
F. None of the Above

2. Applications must follow the_____, and the applicator must be certified by the state.

A. Fixed-wing aircraft
B. Chemical's Product Label
C. Ground personnel
D. Applicator
E. Rotary wing aircraft or Helicopters
F. None of the Above

3. _____which carry clean water and chemical mixing tanks for helicopters usually have landing pads atop the truck for convenience and safety in servicing.

A. Fixed-wing aircraft
B. Pilot
C. Batch trucks
D. Applicator
E. Rotary wing aircraft or Helicopters
F. None of the Above

4. _____ must always be alert to the helicopter's moving rotors during servicing.

A. Fixed-wing aircraft
B. Pilot
C. Ground personnel
D. Applicator
E. Rotary wing aircraft or Helicopters
F. None of the Above

5. **Agricultural Aircraft Equipment Section**

Equipment for _____is limited to either fixed or rotary wing aircraft. Regardless of the choice, there are at least a few general features which should be considered.

These are as follows:

Pilot's fresh air supply--Filtered air for the pilot to breathe is necessary because it is nearly impossible for the pilot to avoid flying back through some of the swath of previous flight passes. If a filtered-air helmet is not available, the pilot should at least wear an approved respirator.

A. Fixed-wing aircraft
B. Pilot
C. Ground personnel
D. Applicator
E. Aerial pesticide application
F. None of the Above

6. Two of the more important advantages of fixed wing aircraft are a high speed of application and a large payload capacity per dollar invested. Maneuverability is adequate, though not equal to the rotary wing aircraft. One of the limitations of fixed wing equipment is the necessity of a_____, which may not always be in close proximity to the application area.

A. Fixed-wing aircraft
B. Pilot
C. Designated landing area
D. Applicator
E. Rotary wing aircraft or Helicopters
F. None of the Above

Chemical Container Handling

7. All applicator, worker or handlers must be trained to_____, remove seals, measure and weigh dry formulations and pour liquid formulations and to correctly rinse empty containers.

A. Handle chemical containers
B. Washing liquid (rinsate)
C. Thoroughly cleaned (“decontaminated”)
D. Re-seal and return to the store
E. Pour liquid formulations
F. None of the Above

8. Where mechanized container rinsing is not available, triple manual rinsing with clean water will remove chemical residues leaving the container ready for disposal. (Use 20% of the container volume in clean water for_____).

A. The three individual rinses
B. Handling the concentrate material
C. Notices to be removed
D. Handling and loading chemical products
E. Mechanized container rinsing
F. All of the Above

9. _____after use and the washing liquid (rinsate) emptied back into the spray or mixing tank.

A. Application has been completed
B. Washing liquid (rinsate)
C. Can is thoroughly cleaned (“decontaminated”)
D. Containers must be rinsed immediately
E. Pour liquid formulations
F. None of the Above

10. Handling the concentrate material presents the applicator, worker or handler with the highest exposure risk so correct safety equipment and clothing must be available and applicator, worker or handlers trained to use and maintain it properly._____, closed transfer systems, returnable containers, water dispersible sachets and etc., should be used where possible.

A. Engineering controls
B. Handling the concentrate material
C. Notices should not be removed
D. Loading chemical products
E. Mechanized container rinsing
F. All of the Above

11. Chemicals _____and part-full product containers must be re-sealed and returned to the store.

A. Applications
B. Must be stored in their original containers
C. Been thoroughly cleaned (“decontaminated”)
D. Re-sealed and returned to the store
E. Pour liquid formulations
F. None of the Above

Post-Treatment Warnings

12. Immediately after the spray has been applied _____ in accordance with any label recommendations.

A. Kept secure
B. Handling the concentrate material
C. Notices should be removed
D. Handling and loading chemical products
E. Mechanized container rinsing
F. All of the Above

Answers

1.E, 2.B, 3.C, 4.C, 5.E, 7.A, 8.A, 9.D, 10. A, 11. B, 12.F

Pilot Aerial Application Section Post Quiz

1. Equipment for _____is limited to either fixed or rotary wing aircraft. Regardless of the choice, there are at least a few general features which should be considered.
These are as follows:
Pilot's fresh air supply--Filtered air for the pilot to breathe is necessary because it is nearly impossible for the pilot to avoid flying back through some of the swath of previous flight passes. If a filtered-air helmet is not available, the pilot should at least wear an approved respirator.

A. Fixed-wing aircraft
B. Pilot
C. Ground personnel
D. Applicator
E. Aerial pesticide application
F. None of the Above

2. Two of the more important advantages of fixed wing aircraft are a high speed of application and a large payload capacity per dollar invested. Maneuverability is adequate, though not equal to the rotary wing aircraft. One of the limitations of fixed wing equipment is the necessity of a_____, which may not always be in close proximity to the application area.

A. Fixed-wing aircraft
B. Pilot
C. Designated landing area
D. Applicator
E. Rotary wing aircraft or Helicopters
F. None of the Above

3. Some _____come in concentrated form and must be diluted to produce what is known as a tank mix.

A. Range of micron sizes
B. Aerial sprays
C. Spray pumps, filters, and control valves
D. Some liquid products
E. Public health pesticides
F. None of the Above

4. _____that are applied as fogs or by using ultra-low volume techniques require equipment designed for these purposes.

A. Spray techniques
B. Aerial spraying
C. Aerial applications
D. Mosquito adulticides
E. Droplet size and application rates
F. None of the Above

5. Because the labels of the pesticides used in these kinds of applications carry specific restrictions on_____, it is critical that the equipment be maintained in good working order, and that the equipment is calibrated frequently to make sure the applications conform to label requirements.

A. Equipment is calibrated frequently
B. Possibility of pesticide drift
C. Properly calibrated and operated
D. Droplet size and application rates
E. Liquid spray techniques
F. None of the Above

6. Some pesticide labels say the pesticide can be applied by either fixed-wing aircraft or by helicopters. The main advantage of _____ is that it can be carried out quickly and at times when ground equipment cannot operate.

A. Spray techniques
B. Aerial spraying
C. Aerial applications
D. An aerial pesticide application
E. Droplet size and application rates
F. None of the Above

7. The main disadvantage is the increased possibility of pesticide drift onto neighboring areas and_____.

A. Equipment is calibrated frequently
B. Possibility of pesticide drift
C. Properly calibrated and operated
D. Decreased spray coverage
E. Liquid spray techniques
F. None of the Above

8. Even when properly calibrated and operated, _____are often not as thorough in applying material as ground rigs, especially to the lower surfaces of the leaves and to the lower portions of the plants when the foliage is dense.

A. Equipment is calibrated frequently
B. Aircraft sprayers
C. Properly calibrated and operated
D. Pesticide application equipment
E. Liquid spray techniques
F. None of the Above

9. _____ should not be used for small acreages or in residential areas, and should be done only by properly trained individuals who hold a valid pesticide applicators certificate. Information on aerial applicator courses and pesticide applicator certificates can be obtained from your state pesticide department.

A. Spray techniques
B. Aerial spraying
C. Aerial applications
D. An aerial pesticide application
E. Droplet size and application rates
F. All of the Above

10. When choosing the type of pesticide application equipment to be used in vector control operations select if a liquid or a solid (dust or pellets) pesticide formulation will be used. For_____, the basic choice will hinge on the spray techniques to be used.

A. Equipment is calibrated frequently
B. Possibility of pesticide drift
C. Liquid formulations
D. Pesticide application equipment
E. Liquid spray techniques
F. None of the Above

11. _____, in turn, often are classified on the basis of the spray volume used in an application.

A. Spray techniques
B. Aerial spraying
C. Aerial applications
D. An aerial pesticide application
E. Droplet size and application rates
F. None of the Above

12. The three basic types of _____ are high volume (40 gallons per acre or more), low volume (0.5–40) gallons per acre), and ultra-low volume (0.5 gallons per acre or less).

A. Equipment is calibrated frequently
B. Possibility of pesticide drift
C. Properly calibrated and operated
D. Pesticide application equipment
E. Liquid spray techniques
F. None of the Above

Pilot Section Answers
1.E, 2.C, 3.E, 4.D, 5.D, 6.B, 7.D, 8.B, 9.C, 10.C, 11.A, 12.E

National Environmental Policy Act NEPA Law Section

Introduction
The National Environmental Policy Act (NEPA) is a United States environmental law that established a U.S. national policy promoting the enhancement of the environment and also established the President's Council on Environmental Quality (CEQ).

NEPA's most significant effect was to set up procedural requirements for all federal government agencies to prepare Environmental Assessments (EAs) and Environmental Impact Statements (EISs). EAs and EISs contain statements of the environmental effects of proposed federal agency actions. NEPA's procedural requirements apply to all federal agencies in the executive branch. NEPA does not apply to the President, to Congress, or to the federal courts.

1969 Santa Barbara Oil Spill
NEPA came into existence following increased appreciation for the environment, and growing concerns about ecological and wildlife well-being; indeed, the public outcry after the 1969 Santa Barbara oil spill was perhaps the leading catalyst. An Eisenhower-era Outdoor Recreation report, a Wilderness Act, Clean Air and Clean Water Acts, along with Rachel Carson's book Silent Spring, all reflect the growing concerns, public interest group efforts, and legislative discussion involved. Another major driver for enacting NEPA were the freeway revolts that occurred in response to the bulldozing of many communities and ecosystems around the country as the Interstate Highway System was being built during the 1960s.

National Environmental Policy Act of 1969
The law has since been applied to any project, federal, state or local, that involves federal funding, work performed by the federal government, or permits issued by a federal agency. Court decisions throughout the law's history have expanded the requirement for NEPA-related environmental studies to include actions where permits from a federal agency are required, regardless of whether or not federal funds are spent implementing the action. Although enacted on January 1, 1970, its "short title" is "National Environmental Policy Act of 1969."

The Preamble Reads:
"To declare national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation..."

NEPA contains three important sections:
1. The declaration of national environmental policies and goals.
2. The establishment of action-forcing provisions for federal agencies to enforce those policies and goals.
3. The establishment of a Council on Environmental Quality (CEQ) in the Executive Office of the President.

The essential purpose of NEPA is to ensure that environmental factors are weighted equally when compared to other factors in the decision making process undertaken by federal agencies.

The act establishes the national environmental policy, including a multidisciplinary approach to considering environmental effects in federal government agency decision making. The act also established the President's Council on Environmental Quality (CEQ). The CEQ was established to advise the President in the preparation of an annual environmental quality report addressing the state of federal agencies in implementing the act, on national policies nurture and promote the improvement of the environments quality and on the state of the environment.

Environmental Impact Statement (EIS)
The effectiveness of NEPA originates in its requirement of federal agencies to prepare an environmental statement to accompany reports and recommendations for funding from Congress. This document is called an Environmental Impact Statement (EIS). NEPA is an action-forcing piece of legislation, meaning that the act itself does not carry any criminal or civil sanctions. All enforcement of NEPA was to be obtained through the process of the court system.

A major federal action has been expanded to include most things that a federal agency could prohibit or regulate. In practice, a project is required to meet NEPA guidelines when a federal agency provides any portion of the financing for the project. Sometimes, however, review of a project by a federal employee can be viewed as a federal action and would then, therefore, require NEPA-compliant analysis be performed.

NEPA covers a vast array of federal agency actions, but not all actions are necessarily covered under NEPA. The act does not apply to purely private or purely public state action. This means that there is a complete absence of government influence or funding concerning that specific action. Exemptions and exclusions are also present within NEPA's guidelines. Exemptions from NEPA include specific federal projects detailed in legislation, EPA exemptions and functional equivalent exemptions. Functional Equivalent exemptions apply where compliance with other environmental laws requires environmental analysis similar to NEPA. These other environmental laws can include but are not limited to the Clean Air Act, Resource Conservation and Recovery Act, Safe Drinking Water Act, and the Federal Insecticide, Fungicide, and Rodenticide Act.

The NEPA process consists of an evaluation of relevant environmental effects of a federal project or action undertaking, including a series of pertinent alternatives. The NEPA process begins when an agency develops a proposal to address a need to take an action. Once a determination of whether or not the proposed action is covered under NEPA there are three levels of analysis that a federal agency may undertake to comply with the law. These three levels include: preparation of a Categorical Exclusion (CE), preparation of an Environmental Assessment (EA) and Finding of No Significant Impact (FONSI); or preparation and drafting of an Environmental Impact Statement (EIS).

Preparation of a Categorical Exclusion
A CE is a category of actions that the agency has determined does not individually or cumulatively have a significant effect on the quality of the human environment (40 C.F.R. §1508.4). If a proposed action is included in the description provided for a listed CE established by the agency, the agency must check to make sure that no extraordinary circumstances exist that may cause the proposed action to have a significant effect in a particular situation. Extraordinary circumstances typically include such matters as effects to endangered species, protected cultural sites, and wetlands.

If the proposed action is not included in the description provided in the CE established by the agency, or there are extraordinary circumstances, the agency must prepare an EA or an EIS, or develop a new proposal that may qualify for application of a CE.

Preparation of an Environmental Assessment and Finding of No Significant Impact
The purpose of an EA is to determine the significance of the environmental effects and to look at alternative means to achieve the agency's objectives. The EA is intended to be a concise document that (1) briefly provides sufficient evidence and analysis for determining whether to prepare an EIS; (2) aids an agency's compliance with NEPA when no environmental impact statement is necessary; and (3) facilitates preparation of an Environmental Impact Statement when one is necessary (40 C.F.R. § 1508.9). If after investigation and drafting of the environmental assessment no substantial effects on the environment are found the agency may produce a Finding of No Significant Impact (FONSI).

Preparation of an Environmental Impact Statement
The EIS is a more detailed evaluation of the environmental impacts when compared to the content of the environmental assessment. The crafting of EIS has many components including public, outside party and other federal agency input concerning the preparation of the EIS. These groups subsequently comment on the draft EIS.

In some circumstance an agency may wish to undertake the construction of an EIS without the initial drafting of the environmental assessment. This will take place under circumstances in which the agency believes that the action will undoubtedly have adverse effects on the environment or is considered an environmentally controversial issue.

CE (Categorical Exclusion)
A CE is based on an agency's experience with a particular kind of action and its environmental effects. The agency may have studied the action in previous EAs, found no significant impact on the environment based on the analyses, and validated the lack of significant impacts after the implementation. If this is the type of action that will be repeated over time, the agency may decide to amend their implementing regulations to include the action as a CE. In these cases, the draft agency procedures are published in the Federal Register, and a public comment period is required. Participation in these comment periods is an important way to be involved in the development of a particular CE.

EA (Environmental Assessment)
An EA is a screening document used to determine if an agency will need to prepare either an EIS or construct a FONSI. EAs are concise public documents that include: a brief discussion of the need for the proposal; of alternatives and a listing of agencies and person consulted. Most agency procedures do not require public involvement prior to finalizing an EA document. Agencies advise that facilitating public comment be considered at the draft EA stage. EAs need to be of sufficient length to ensure that the underlying decision about whether to prepare an EIS is legitimate, but should not attempt to be a substitute for an EIS.

FONSI (Finding Of No Significant Impact)
A FONSI presents the reasons why an action will not have a significant effect on the human environment. It must include the EA or summary of the EA that supports the FONSI determination.

EIS (Environmental Impact Statement)
If it is determined that a proposed federal action does not fall within a designated categorical exclusion or does not qualify for a FONSI, then the responsible agency or agencies must prepare an EIS. The purpose of an EIS is to ultimately help public officials make informed decisions that are a reflection of an understanding of environmental consequences and the alternatives available.

An EIS is required to describe:
• The environmental impacts of the proposed action;
• Any adverse environmental impacts that cannot be avoided should the proposal be implemented;
• The reasonable alternatives to the proposed action;
• The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and
• Any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented.

Council on Environmental Quality (CEQ)

The CEQ was modeled after the Council of Economic Advisers created by the employment act of 1946. Shortly after the act was signed into law, President Nixon expanded the CEQ's mandate by Executive Order directing it to issue guidelines to federal agencies for the proper preparation of Environmental Impact Statements and to assemble and coordinate federal programs related to environmental quality. The Council was placed within the executive office of the President and is composed of three members. These members must be appointed by the president and subsequently confirmed by the Senate. The CEQ has some fundamental roles which include assisting and advising the President in the preparation of the annual environmental quality report on the present progress of federal agencies in implementing the act, on national policies to nurture and promote the improvement of environmental quality and on the current state of the environment.

CEQ has No Authority

The CEQ has played a key part in the development of the EIS process. Its initial guidelines were issued in 1971 and required each department and agency of the government to adopt its own guidelines consistent with the guidelines established by CEQ. These set forth guidelines did not carry the status of formal agency regulations but were often held up in the court of law as such. Eventually President Jimmy Carter authorized via an Executive Order to adopt regulations rather than simple guidelines on EIS preparation. However, the CEQ has no authority to enforce its regulations.

The CEQ regulations begin by calling for agencies to integrate NEPA regulations and requirements with other various planning requirements at the earliest possible time to ensure that all decisions are reflective of environmental values, avoid potential delays in the future and eliminate potential future conflicts. NEPA's action-forcing provision, Section 102(2)(C), stipulates that an EIS shall be "included in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment..."

The CEQ has taken strides within the past several years to prepare advisory documentation to explain the general structure of the environmental document, the nature of cumulative impacts and other advisories. The CEQ also maintains a web site that is useful for NEPA information and guidance at www.nepa.gov.

The Council on Environmental Quality

The Council on Environmental Quality (CEQ) coordinates Federal environmental efforts and works closely with agencies and other White House offices in the development of environmental policies and initiatives. CEQ was established within the Executive Office of the President by Congress as part of the National Environmental Policy Act of 1969 (NEPA) and additional responsibilities were provided by the Environmental Quality Improvement Act of 1970.

The President's Advisor

The Council's Chair, serves as the principal environmental policy adviser to the President. Chair assists and advises the President in developing environmental policies and initiatives. Through interagency working groups and coordination with other EOP components, CEQ works to advance the President’s agenda. It also balances competing positions, and encourages government-wide coordination, bringing federal agencies, state

and local governments, and other stakeholders together on matters relating to the environment, natural resources and energy.

In addition, CEQ oversees the Office of the Federal Environmental Executive. The role of the Federal Environmental Executive is to promote sustainable environmental stewardship throughout the Federal government.

Balancing Social, Economic, and Environmental Goals
In addition, CEQ oversees Federal agency implementation of the environmental impact assessment process and acts as a referee when agencies disagree over the adequacy of such assessments. In enacting NEPA, Congress recognized that nearly all Federal activities affect the environment in some way and mandated that before Federal agencies make decisions, they must consider the effects of their actions on the quality of the human environment. Under NEPA, CEQ works to balance environmental, economic, and social objectives in pursuit of NEPA's goal of "productive harmony" between humans and the human environment. 42 U.S.C. §4331(a). NEPA assigns CEQ the task of ensuring that Federal agencies meet their obligations under the Act. The challenge of harmonizing our economic, environmental and social aspirations has put NEPA and CEQ at the forefront of our nation's efforts to protect the environment.

Improve Environmental Outcomes
EPA's comments on proposed federal projects contribute to increased benefits to the environment. For example, through EPA's review of the Folsom Dam Safety and Flood Damage Reduction Project, the Bureau of Reclamation and the Corps of Engineers committed to a variety of environmentally friendly practices. These include use of the cleanest available on-road vehicles, the most recent pollution control equipment for all off-road construction equipment, and electrical power rather than diesel for all stationary equipment.

The agencies also agreed to reduce haulage miles and minimize the overlap of activities that produce pollutant emissions. These commitments will significantly reduce emissions of air pollutants from the project, reducing impacts to communities surrounding the Folsom Reservoir.

List of Acronyms
CE: Categorical Exclusion
CEQ: Council on Environmental Quality
CFR: Code of Federal Regulations
EA: Environmental Assessment
EIS: Environmental Impact Statement
EMS: Environmental Management System
EPA: The Environmental Protection Agency
FONSI: Finding of No Significant Impact
NEPA: The National Environmental Policy Act
NOI: Notice of Intent
ROD: Record of Decision

The NEPA Statute

The National Environmental Policy Act of 1969, as amended (Pub. L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pub. L. 94-52, July 3, 1975, Pub. L. 94-83, August 9, 1975, and Pub. L. 97-258, § 4(b), Sept. 13, 1982)

An Act to establish a national policy for the environment, to provide for the establishment of a Council on Environmental Quality, and for other purposes. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that this Act may be cited as the "National Environmental Policy Act of 1969."

Purpose
Sec. 2 [42 USC § 4321].
The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

TITLE I
CONGRESSIONAL DECLARATION OF NATIONAL ENVIRONMENTAL POLICY
Sec. 101 [42 USC § 4331].
(a) The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.
(b) In order to carry out the policy set forth in this Act, it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may --
1. fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
2. assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;
3. attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;
4. preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice;
5. achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and
6. enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

(c) The Congress recognizes that each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment.

Sec. 102 [42 USC § 4332].
The Congress authorizes and directs that, to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this Act, and (2) all agencies of the Federal Government shall --
(A) utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decisionmaking which may have an impact on man's environment;
(B) identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by title II of this Act, which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations;
(C) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on --
(i) the environmental impact of the proposed action,
(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,
(iii) alternatives to the proposed action,
(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.
Prior to making any detailed statement, the responsible Federal official shall consult with and obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved. Copies of such statement and the comments and views of the appropriate Federal, State, and local agencies, which are authorized to develop and enforce environmental standards, shall be made available to the President, the Council on Environmental Quality and to the public as provided by section 552 of title 5, United States Code, and shall accompany the proposal through the existing agency review processes;
(D) Any detailed statement required under subparagraph (C) after January 1, 1970, for any major Federal action funded under a program of grants to States shall not be deemed to be legally insufficient solely by reason of having been prepared by a State agency or official, if:
(i) the State agency or official has statewide jurisdiction and has the responsibility for such action,
(ii) the responsible Federal official furnishes guidance and participates in such preparation,
(iii) the responsible Federal official independently evaluates such statement prior to its approval and adoption, and
(iv) after January 1, 1976, the responsible Federal official provides early notification to, and solicits the views of, any other State or any Federal land management entity of any action or any alternative thereto which may have significant impacts upon such State or affected Federal land management entity and, if there is any disagreement on such impacts, prepares a written assessment of such impacts and views for incorporation into such detailed statement.

The procedures in this subparagraph shall not relieve the Federal official of his responsibilities for the scope, objectivity, and content of the entire statement or of any other responsibility under this Act; and further, this subparagraph does not affect the legal sufficiency of statements prepared by State agencies with less than statewide jurisdiction.
(E) study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources;
(F) recognize the worldwide and long-range character of environmental problems and, where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality of mankind's world environment;
(G) make available to States, counties, municipalities, institutions, and individuals, advice and information useful in restoring, maintaining, and enhancing the quality of the environment;
(H) initiate and utilize ecological information in the planning and development of resource-oriented projects; and
(I) assist the Council on Environmental Quality established by title II of this Act.

Sec. 103 [42 USC § 4333].
All agencies of the Federal Government shall review their present statutory authority, administrative regulations, and current policies and procedures for the purpose of determining whether there are any deficiencies or inconsistencies therein which prohibit full compliance with the purposes and provisions of this Act and shall propose to the President not later than July 1, 1971, such measures as may be necessary to bring their authority and policies into conformity with the intent, purposes, and procedures set forth in this Act.

Sec. 104 [42 USC § 4334].
Nothing in section 102 [42 USC § 4332] or 103 [42 USC § 4333] shall in any way affect the specific statutory obligations of any Federal agency (1) to comply with criteria or standards of environmental quality, (2) to coordinate or consult with any other Federal or State agency, or (3) to act, or refrain from acting contingent upon the recommendations or certification of any other Federal or State agency.

Sec. 105 [42 USC § 4335].
The policies and goals set forth in this Act are supplementary to those set forth in existing authorizations of Federal agencies.

TITLE II
COUNCIL ON ENVIRONMENTAL QUALITY
Sec. 201 [42 USC § 4341].
The President shall transmit to the Congress annually beginning July 1, 1970, an Environmental Quality Report (hereinafter referred to as the "report") which shall set forth (1) the status and condition of the major natural, manmade, or altered environmental classes of the Nation, including, but not limited to, the air, the aquatic, including marine, estuarine, and fresh water, and the terrestrial environment, including, but not limited to, the forest, dryland, wetland, range, urban, suburban an rural environment; (2) current and foreseeable trends in the quality, management and utilization of such environments and the effects of those trends on the social, economic, and other requirements of the Nation; (3) the adequacy of available natural resources for fulfilling human and economic requirements of the Nation in the light of expected population pressures; (4) a review of

the programs and activities (including regulatory activities) of the Federal Government, the State and local governments, and nongovernmental entities or individuals with particular reference to their effect on the environment and on the conservation, development and utilization of natural resources; and (5) a program for remedying the deficiencies of existing programs and activities, together with recommendations for legislation.

Sec. 202 [42 USC § 4342].
There is created in the Executive Office of the President a Council on Environmental Quality (hereinafter referred to as the "Council"). The Council shall be composed of three members who shall be appointed by the President to serve at his pleasure, by and with the advice and consent of the Senate. The President shall designate one of the members of the Council to serve as Chairman. Each member shall be a person who, as a result of his training, experience, and attainments, is exceptionally well qualified to analyze and interpret environmental trends and information of all kinds; to appraise programs and activities of the Federal Government in the light of the policy set forth in title I of this Act; to be conscious of and responsive to the scientific, economic, social, aesthetic, and cultural needs and interests of the Nation; and to formulate and recommend national policies to promote the improvement of the quality of the environment.

Sec. 203 [42 USC § 4343].
(a) The Council may employ such officers and employees as may be necessary to carry out its functions under this Act. In addition, the Council may employ and fix the compensation of such experts and consultants as may be necessary for the carrying out of its functions under this Act, in accordance with section 3109 of title 5, United States Code (but without regard to the last sentence thereof).
(b) Notwithstanding section 1342 of Title 31, the Council may accept and employ voluntary and uncompensated services in furtherance of the purposes of the Council.

Sec. 204 [42 USC § 4344].
It shall be the duty and function of the Council --
to assist and advise the President in the preparation of the Environmental Quality Report required by section 201 [42 USC § 4341] of this title; to gather timely and authoritative information concerning the conditions and trends in the quality of the environment both current and prospective, to analyze and interpret such information for the purpose of determining whether such conditions and trends are interfering, or are likely to interfere, with the achievement of the policy set forth in title I of this Act, and to compile and submit to the President studies relating to such conditions and trends; to review and appraise the various programs and activities of the Federal Government in the light of the policy set forth in title I of this Act for the purpose of determining the extent to which such programs and activities are contributing to the achievement of such policy, and to make recommendations to the President with respect thereto; to develop and recommend to the President national policies to foster and promote the improvement of environmental quality to meet the conservation, social, economic, health, and other requirements and goals of the Nation; to conduct investigations, studies, surveys, research, and analyses relating to ecological systems and environmental quality; to document and define changes in the natural environment, including the plant and animal systems, and to accumulate necessary data and other information for a continuing analysis of these changes or trends and an interpretation of their underlying causes; to report at least once each year to the President on the state and condition of the environment; and to make and furnish such studies, reports thereon, and recommendations with respect to matters of policy and legislation as the President may request.

Sec. 205 [42 USC § 4345].
In exercising its powers, functions, and duties under this Act, the Council shall --
consult with the Citizens' Advisory Committee on Environmental Quality established by Executive Order No. 11472, dated May 29, 1969, and with such representatives of science, industry, agriculture, labor, conservation organizations, State and local governments and other groups, as it deems advisable; and utilize, to the fullest extent possible, the services, facilities and information (including statistical information) of public and private agencies and organizations, and individuals, in order that duplication of effort and expense may be avoided, thus assuring that the Council's activities will not unnecessarily overlap or conflict with similar activities authorized by law and performed by established agencies.

Sec. 206 [42 USC § 4346].
Members of the Council shall serve full time and the Chairman of the Council shall be compensated at the rate provided for Level II of the Executive Schedule Pay Rates [5 USC § 5313]. The other members of the Council shall be compensated at the rate provided for Level IV of the Executive Schedule Pay Rates [5 USC § 5315].

Sec. 207 [42 USC § 4346a].
The Council may accept reimbursements from any private nonprofit organization or from any department, agency, or instrumentality of the Federal Government, any State, or local government, for the reasonable travel expenses incurred by an officer or employee of the Council in connection with his attendance at any conference, seminar, or similar meeting conducted for the benefit of the Council.

Sec. 208 [42 USC § 4346b].
The Council may make expenditures in support of its international activities, including expenditures for: (1) international travel; (2) activities in implementation of international agreements; and (3) the support of international exchange programs in the United States and in foreign countries.

Sec. 209 [42 USC § 4347].
There are authorized to be appropriated to carry out the provisions of this chapter not to exceed $300,000 for fiscal year 1970, $700,000 for fiscal year 1971, and $1,000,000 for each fiscal year thereafter.

The Environmental Quality Improvement Act, as amended (Pub. L. No. 91- 224, Title II, April 3, 1970; Pub. L. No. 97-258, September 13, 1982; and Pub. L. No. 98-581, October 30, 1984. 42 USC § 4372.
(a) There is established in the Executive Office of the President an office to be known as the Office of Environmental Quality (hereafter in this chapter referred to as the "Office"). The Chairman of the Council on Environmental Quality established by Public Law 91-190 shall be the Director of the Office. There shall be in the Office a Deputy Director who shall be appointed by the President, by and with the advice and consent of the Senate.
(b) The compensation of the Deputy Director shall be fixed by the President at a rate not in excess of the annual rate of compensation payable to the Deputy Director of the Office of Management and Budget.
(c) The Director is authorized to employ such officers and employees (including experts and consultants) as may be necessary to enable the Office to carry out its functions ;under this chapter and Public Law 91-190, except that he may employ no more than ten

specialists and other experts without regard to the provisions of Title 5, governing appointments in the competitive service, and pay such specialists and experts without regard to the provisions of chapter 51 and subchapter III of chapter 53 of such title relating to classification and General Schedule pay rates, but no such specialist or expert shall be paid at a rate in excess of the maximum rate for GS-18 of the General Schedule under section 5332 of Title 5.
(d) In carrying out his functions the Director shall assist and advise the President on policies and programs of the Federal Government affecting environmental quality by --
providing the professional and administrative staff and support for the Council on Environmental Quality established by Public Law 91- 190;
assisting the Federal agencies and departments in appraising the effectiveness of existing and proposed facilities, programs, policies, and activities of the Federal Government, and those specific major projects designated by the President which do not require individual project authorization by Congress, which affect environmental quality;
reviewing the adequacy of existing systems for monitoring and predicting environmental changes in order to achieve effective coverage and efficient use of research facilities and other resources; promoting the advancement of scientific knowledge of the effects of actions and technology on the environment and encouraging the development of the means to prevent or reduce adverse effects that endanger the health and well-being of man; assisting in coordinating among the Federal departments and agencies those programs and activities which affect, protect, and improve environmental quality;
assisting the Federal departments and agencies in the development and interrelationship of environmental quality criteria and standards established throughout the Federal Government; collecting, collating, analyzing, and interpreting data and information on environmental quality, ecological research, and evaluation.
(e) The Director is authorized to contract with public or private agencies, institutions, and organizations and with individuals without regard to section 3324(a) and (b) of Title 31 and section 5 of Title 41 in carrying out his functions.
42 USC § 4373. Each Environmental Quality Report required by Public Law 91-190 shall, upon transmittal to Congress, be referred to each standing committee having jurisdiction over any part of the subject matter of the Report.
42 USC § 4374. There are hereby authorized to be appropriated for the operations of the Office of Environmental Quality and the Council on Environmental Quality not to exceed the following sums for the following fiscal years which sums are in addition to those contained in Public Law 91- 190:
(a) $2,126,000 for the fiscal year ending September 30, 1979.
(b) $3,000,000 for the fiscal years ending September 30, 1980, and September 30, 1981.
(c) $44,000 for the fiscal years ending September 30, 1982, 1983, and 1984.
(d) $480,000 for each of the fiscal years ending September 30, 1985 and 1986.
42 USC § 4375.
(a) There is established an Office of Environmental Quality Management Fund (hereinafter referred to as the "Fund") to receive advance payments from other agencies or accounts that may be used solely to finance --
study contracts that are jointly sponsored by the Office and one or more other Federal agencies; and Federal interagency environmental projects (including task forces) in which the Office participates.
(b) Any study contract or project that is to be financed under subsection (a) of this section may be initiated only with the approval of the Director.

NEPA Topic Post-Quiz Section

National Environmental Policy Act (NEPA)
Introduction

1. NEPA's _____was to set up procedural requirements for all federal government agencies to prepare Environmental Assessments (EAs) and Environmental Impact Statements (EISs).

A. Environmental impacts
B. Environmental factors
C. Most significant effect
D. Procedural requirements
E. Current state of the environment
F. None of the Above

The Preamble Reads:

2. "To declare national policy which will encourage productive and enjoyable harmony between man and his environment; to _____to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation..."

A. Lack of significant impacts
B. Effects to endangered species
C. State of the environment
D. Promote efforts which will prevent or eliminate damage
E. Current state of the environment
F. None of the Above

3. The essential purpose of NEPA is to ensure that environmental factors are weighted equally when compared to other factors in the decision making process undertaken by_____.

A. Environmental impacts
B. Federal agencies
C. NEPA's guidelines
D. Procedural requirements
E. Human environment
F. None of the Above

4. The CEQ was established to advise the President in the preparation of an annual environmental quality report addressing the state of federal agencies in implementing the act, on national policies nurture and promote the improvement of the _____and on the state of the environment.

A. Lack of significant impacts
B. Effects to endangered species
C. Environments quality
D. Ecological systems
E. Current state of the environment
F. None of the Above

Environmental Impact Statement (EIS)

5. NEPA covers a vast array of_____, but not all actions are necessarily covered under NEPA. The act does not apply to purely private or purely public state action. This means that there is a complete absence of government influence or funding concerning that specific action. Exemptions and exclusions are also present within NEPA's guidelines.

A. Environmental impacts
B. Environmental factors
C. Federal agency actions
D. Procedural requirements
E. Human environment
F. None of the Above

Preparation of a Categorical Exclusion

6. Extraordinary circumstances typically include such matters as effects to endangered species, protected cultural sites, and wetlands. If the proposed action is not included in the description provided in the CE established by the agency, or there are extraordinary circumstances, the agency must prepare an EA or an EIS, or develop a new proposal that may qualify for application of a_____.

A. Lack of significant impacts
B. Effects to endangered species
C. State of the environment
D. CE
E. Current state of the environment
F. None of the Above

Preparation of an Environmental Impact Statement

7. The EIS is a more detailed evaluation of the environmental impacts when compared to the content of the_____.

A. Environmental impacts
B. Environmental factors
C. NEPA's guidelines
D. Procedural requirements
E. Environmental assessment
F. None of the Above

CE (Categorical Exclusion)

8. A CE is based on an agency's experience with _____and its environmental effects. The agency may have studied the action in previous EAs, found no significant impact on the environment based on the analyses, and validated the lack of significant impacts after the implementation.

A. A particular kind of action
B. Effects to endangered species
C. State of the environment
D. Ecological systems
E. Current state of the environment
F. None of the Above

FONSI (Finding Of No Significant Impact)

9. A FONSI presents the reasons why an action will not have a significant effect on the human environment. It must include the EA or summary of the EA that supports the_____.

A. Environmental impacts
B. Environmental factors
C. NEPA's guidelines
D. Procedural requirements
E. Human environment
F. None of the Above

Answers

1. C, 2.D, 3.B, 4.C, 5.C, 6.D, 7.E, 8.A, 9.F

Council on Environmental Quality (CEQ) Post-Quiz

Council on Environmental Quality (CEQ)

1. The CEQ has some fundamental roles which include assisting and advising the President in the preparation of the annual environmental quality report on the present progress of federal agencies in implementing the act, on national policies to nurture and promote the improvement of environmental quality and on the current state of the environment.

A. Lack of significant impacts
B. FONSI determination
C. State of the environment
D. Ecological systems
E. Current state of the environment
F. None of the Above

Balancing Social, Economic, and Environmental Goals

2. In addition, CEQ oversees Federal agency implementation of the environmental impact assessment process and acts as a referee when agencies disagree over the_____.

A. Environmental impacts
B. Environmental factors
C. Adequacy of such assessments
D. Procedural requirements
E. Human environment
F. None of the Above

The NEPA Statute
Purpose
Sec. 2 [42 USC § 4321].

3. The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the _____and natural resources important to the Nation; and to establish a Council on Environmental Quality.

A. Lack of significant impacts
B. Effects to endangered species
C. State of the environment
D. Ecological systems
E. Current state of the environment
F. None of the Above

TITLE I
CONGRESSIONAL DECLARATION OF NATIONAL ENVIRONMENTAL POLICY
Sec. 101 [42 USC § 4331].

4. (b) In order to carry out the policy set forth in this Act, it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may --
_____ the responsibilities of each generation as trustee of the environment for succeeding generations;

A. Enhance
B. Assure
C. Fulfill
D. Attain
E. Preserve
F. None of the Above

5. _____for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;

A. Enhance
B. Assure
C. Fulfill
D. Attain
E. Preserve
F. None of the Above

6. _____ the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;
A. Enhance D. Attain
B. Assure E. Preserve
C. Fulfill F. None of the Above

7. _____ important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice;
A. Enhance D. Attain
B. Assure E. Preserve
C. Fulfill F. None of the Above

8. _____a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and
A. Enhance D. Achieve
B. Assure E. Preserve
C. Fulfill F. None of the Above

9. _____ the quality of renewable resources and approach the maximum attainable recycling of depletable resources.
A. Enhance D. Attain
B. Assure E. Preserve
C. Fulfill F. None of the Above

10. The Congress recognizes that each person should enjoy a _____and that each person has a responsibility to contribute to the preservation and enhancement of the environment.
A. Healthful environment D. Ecological systems
B. Effects to endangered species E. Current state of the environment
C. State of the environment F. None of the Above

Answers
1.B, 2.C, 3.D, 4.C, 5.B, 6.A, 7.E, 8.D, 9.A, 10. A

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