AERIAL APPLICATION

PROFESSIONAL DEVELOPMENT
CONTINUING EDUCATION COURSE

Technical Learning College

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State Approval Listing URL…
http://www.abctlc.com/downloads/PDF/CEU%20State%20Approvals.pdf

You can obtain a printed version from TLC for an additional $189.95 plus shipping charges.

All downloads are electronically tracked and monitored for security purposes.

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.

Precept-Based Training Course

This training course is based upon a form of induction training, made of topical and technical precepts. The training topics are made up of “micro-content” or “precepts”– or small chunks of information that can be easily digested. These bite-size pieces of technical information are considered to be one of the most effective ways of teaching people new information because it helps the mind retain knowledge easier.

Micro-learning or precept-based training doesn’t rely on the student to process a large amount of information before breaking it down. Our method includes short modules with clearly defined learning goals for each section. This method allows a student to hone in on a particular skill, then given the opportunity to exhibit their knowledge in the final assessment.

Many States and employers require the final exam to be proctored.

Acknowledgement

Most of the course information will come from the *EPA manual How to Comply with the 2015 Revised Worker Protection Standard for agricultural Pesticides. What owner and Employers Need to Know.*

EPA 735-B-16-001 Publication date: September 2016

Pesticide Educational Resources Collaborative pesticideresources.org
epa.gov/pesticides
UC Davis Extension
1333 Research Park Dr
Davis, CA 95618

U.S. Environmental Protection Agency epa.gov/pesticides
Office of Pesticide Programs (MC 7506C)
1200 Pennsylvania Ave, NW
Washington, DC 20460

EPA Notice

The EPA determined that the 1974 regulations did not adequately protect agricultural workers and pesticide handlers who were occupationally exposed to pesticides. In order to correct these inadequacies, the EPA issued new regulations designed to reduce exposure to pesticides, mitigate exposure, and inform workers about pesticides. Reducing overall exposure to pesticides will be accomplished by prohibiting handlers from exposing workers during application, excluding workers from areas being treated and areas under a REI (some activities are allowed during a REI if workers are properly trained and protected), and notifying workers about treated areas.

Other Federal Laws and Regulations

In addition to the Federal Insecticide, Fungicide, and Rodenticide Act and the Federal Food, Drug, and Cosmetic Act, a number of other federal laws regulate the use, storage, disposal and transportation of pesticides. The Occupational Safety and Health Act mandates that employers, including farmers and ranchers, protect their employees from hazards in the work place. With respect to pesticides, the law covers workers in pesticide manufacturing plants and also farmworkers applying pesticides to crops.

Hazard communication standards developed by the Occupational Safety and Health Administration require employers to have a written hazard communication plan, possess a material safety data sheet (SDS) for each hazardous chemical, and provide training for employees on protective measures. A SDS must contain detailed information on the chemical, its hazards, and procedures to be followed in the event of an emergency.

Pesticide use is regulated by several federal laws designed to protect the environment. The Federal Endangered Species Act makes it unlawful to harm any plant or animal listed by the Fish and Wildlife Service (FWS) as *endangered* or *threatened*. The EPA, in cooperation with the USDA and the FWS, developed an Endangered Species Protection Program to protect listed species from harmful effects of pesticides. Under the program, pesticide use is restricted in areas where endangered species are likely to be exposed.

Product labels instruct users to consult county bulletins specifying locations within the county where use of the products is restricted. The Clean Water Act protects the nation's waterways from both point and non-point sources of pollution. Discharges of waste products (point source pollution) are controlled by the EPA through a permit system.

Amendments to the Clean Water Act in 1987 allow for restrictions on non-point source pollutants, such as runoff of agricultural chemicals. The EPA is presently requiring states to submit management plans for the control of nonpoint source pollution. Pesticides in drinking water falls under the jurisdiction of the Safe Drinking Water Act. This law authorizes the EPA to set maximum contaminant levels for pesticides in drinking water.

Technical Learning College’s Scope and Function

Welcome to the Program,

Technical Learning College (TLC) offers affordable continuing education for today’s working professionals who need to maintain licenses or certifications. TLC holds several different governmental agency approvals for granting of continuing education credit.

TLC’s delivery method of continuing education can include traditional types of classroom lectures and distance-based courses or independent study. TLC’s distance based or independent study courses are offered in a print- based format and you are welcome to examine this material on your computer with no obligation. We will beat any other training competitor’s price for the same CEU material or classroom training.

Our courses are designed to be flexible and for you do finish the material on your leisure. Students can also receive course materials through the mail. The CEU course or e-manual will contain all your lessons, activities and assignments. All of TLC’s CEU courses allow students to submit assignments using e-mail or fax, or by postal mail. (See the course description for more information.)

Students have direct contact with their instructor—primarily by e-mail or telephone. TLC’s CEU courses may use such technologies as the World Wide Web, e-mail, CD-ROMs, videotapes and hard copies. (See the course description.) Make sure you have access to the necessary equipment before enrolling, i.e., printer, Microsoft Word and/or Adobe Acrobat Reader. Some courses may require proctored closed-book exams depending upon your state or employer requirements.

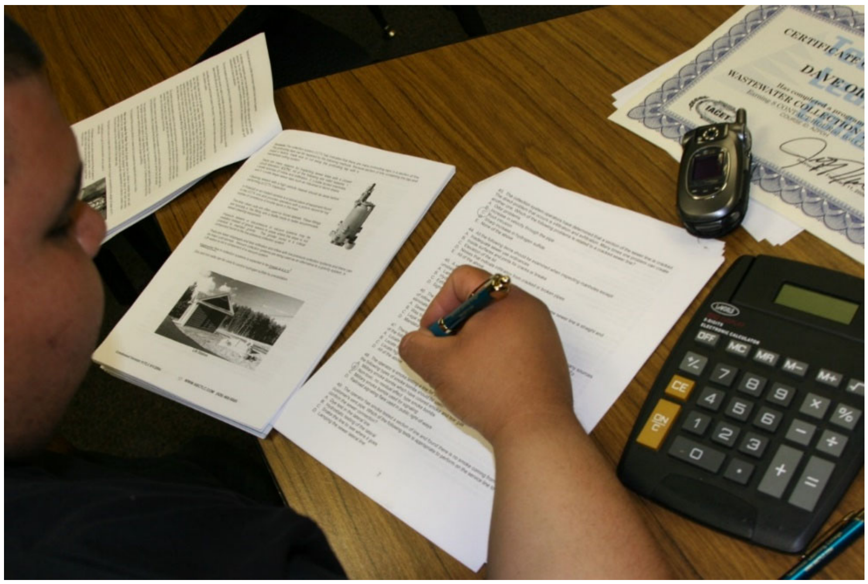
Flexible Learning
At TLC, there are no scheduled online sessions or passwords you need contend with, nor are you required to participate in learning teams or groups designed for the "typical" younger campus based student. You will work at your own pace, completing assignments in time frames that work best for you. TLC's method of flexible individualized instruction is designed to provide each student the guidance and support needed for successful course completion.

Course Structure
TLC's online courses combine the best of online delivery and traditional university textbooks. You can easily find the course syllabus, course content, assignments, and the post-exam (Assignment). This student friendly course design allows you the most flexibility in choosing when and where you will study.

Classroom of One
TLC offers you the best of both worlds. You learn on your own terms, on your own time, but you are never on your own. Once enrolled, you will be assigned a personal Student Service Representative who works with you on an individualized basis throughout your program of study. Course specific faculty members are assigned at the beginning of each course providing the academic support you need to successfully complete each course.

No Data Mining Policy
Unlike most online training providers, we do not use passwords or will upload intrusive data mining software onto your computer. We do not use any type of artificial intelligence in our program. Nor will we sell you any other product or sell your data to others as with many of our competitors. Unlike our training competitors, we have a telephone and we humanly answer.

Satisfaction Guaranteed
We have many years of experience, dealing with thousands of students. We assure you, our customer satisfaction is second to none. This is one reason we have taught more than 20,000 students.



We welcome you to do the electronic version of the assignment and submit the answer key and registration to us either by fax or e-mail. If you need this assignment graded and a certificate of completion within a 48-hour turn around, prepare to pay an additional rush charge of $50.

We welcome you to complete the assignment in Word.

Once we grade it, we will mail a certificate of completion to you. Call us if you need any help.

Contact Numbers
Fax (928) 468-0675
Email Info@tlch2o.com
Telephone (866) 557-1746

Course Description

Aerial Application CEU Training Course

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.

This course is intended to serve as a source of continuing education for the aerial pesticide applicators for license renewal.

This course will review basic pesticide safety training information and aerial application methods. This course will cover aerial pesticide usage, various crop insects, PPE and the Federal Pesticide Rules. This course is general in nature and not state specific. You will not need any other materials for this course.

General Objectives
The general objectives are to: 1) provide students with a general understanding of the chemistry and mode of action (toxicology), and uses of the common pesticides, 2) to provide students with information on aerial pesticide application techniques, including selection, use, and calibration of various types of equipment, and 3) to provide students with an appreciation for the hazards, environmental concerns, and governmental regulations which are associated with the use of pesticides.

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, they 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 by an unique number assigned to the student.

Instructions for Written Assignments
The Aerial Application distance training course uses a multiple choice and a True/False 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. You can find the assignment on the website under Assignments.

Feedback Mechanism (Examination Procedures)
Each student will receive a feedback form as part of their study packet. You will be able to find this form in the assignment packet.

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 (**CEUs**) or Professional Development Hours (**PDHs**). 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

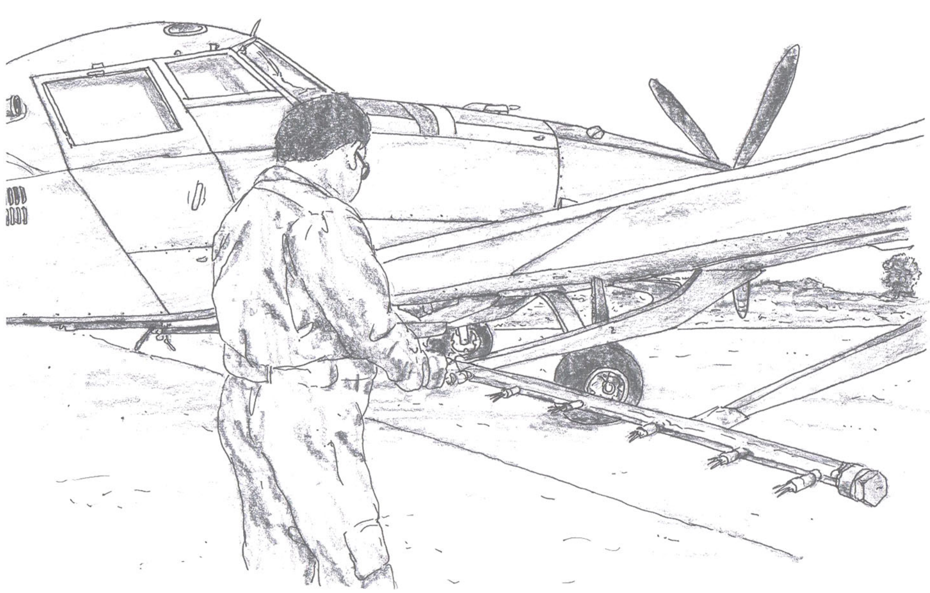
The educational mission of TLC is:
To provide TLC students with comprehensive and ongoing training in the theory and skills needed for the pesticide application field,

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.



PILOT PERFORMING PRE-FLIGHT CHECKS ON SPRAY NOZZLES

Important Information about this Manual

This CEU course manual has been prepared to educate pesticide applicators and operators in general safety awareness of dealing with the often complex and various pesticide treatment devices, methods, and applications. This manual covers general laws, regulations, required procedures, and accepted policies relating to the use of pesticides. It should be noted, however, that the regulation of pesticides and hazardous materials is an ongoing process and subject to change over time. For this reason, a list of resources is provided to assist in obtaining the most up-to-date information on various subjects.

This manual is not a guidance document for applicators or operators who are involved with pesticides. It is not designed to meet the requirements of the United States Environmental Protection Agency or your local State environmental protection agency or health department.

This CEU course manual provides general pesticide safety awareness and should not be used as a basis for pesticide treatment method/device guidance. This document is not a detailed pesticide information resource or a source or remedy for poison control.

Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in the original labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, pets, and livestock. Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits and/or vegetables. Dispose of empty containers carefully. Follow label instructions for disposal. Never reuse containers. Make sure empty containers are not accessible to children or animals.

Never dispose of containers where they may contaminate water supplies or natural waterways. Do not pour down sink or toilet. Consult your county agricultural commissioner for correct ways of disposing of excess pesticides. Never burn pesticide containers. Individuals who are responsible for pesticide storage, mixing, and application should obtain and comply with the most recent federal, state, and local regulations relevant to these sites and are urged to consult with the EPA and other appropriate federal, state, and local agencies.

Copyright Notice

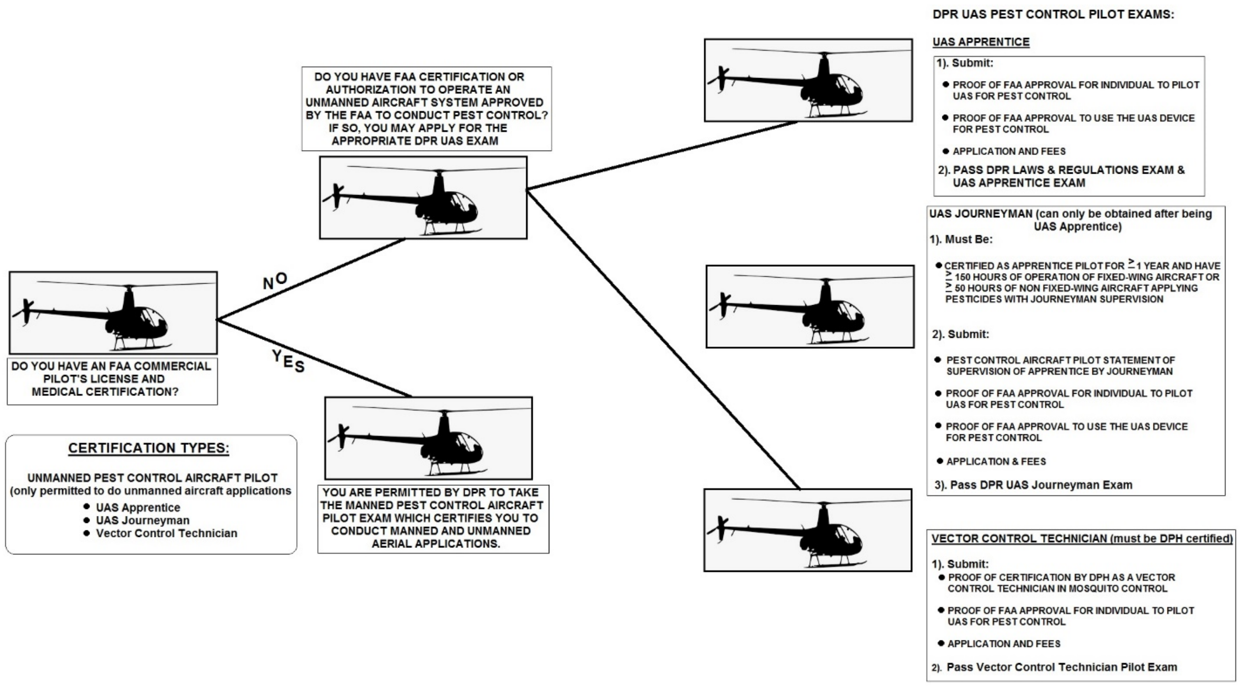
TLC
P.O. Box 3060
Chino Valley, AZ 86323-3060

Table of Contents

Topic 1 - Aerial Application Introduction

Section Focus: You will learn the basics of aerial pesticide application. At the end of this section, you will be able to describe aerial applications and safety procedures. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Aerial application, commonly called crop dusting, involves spraying crops with fertilizers, pesticides, and fungicides from an agricultural aircraft including drones. 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 or are specifically designed as pesticide spraying drones. Helicopters are sometimes used, and some aircraft serve double duty as water bombers in areas prone to wildfires.



FAA CERTIFICATION FOR AERIAL APPLICATION LICENSES

Aerial spraying can be used to treat large areas quickly and, unlike ground spraying, can be carried out when field conditions prevent wheeled vehicle access, which enables the timing of spray treatments to be improved and soil compaction reduced. There are however, certain disadvantages associated with aircraft spraying.

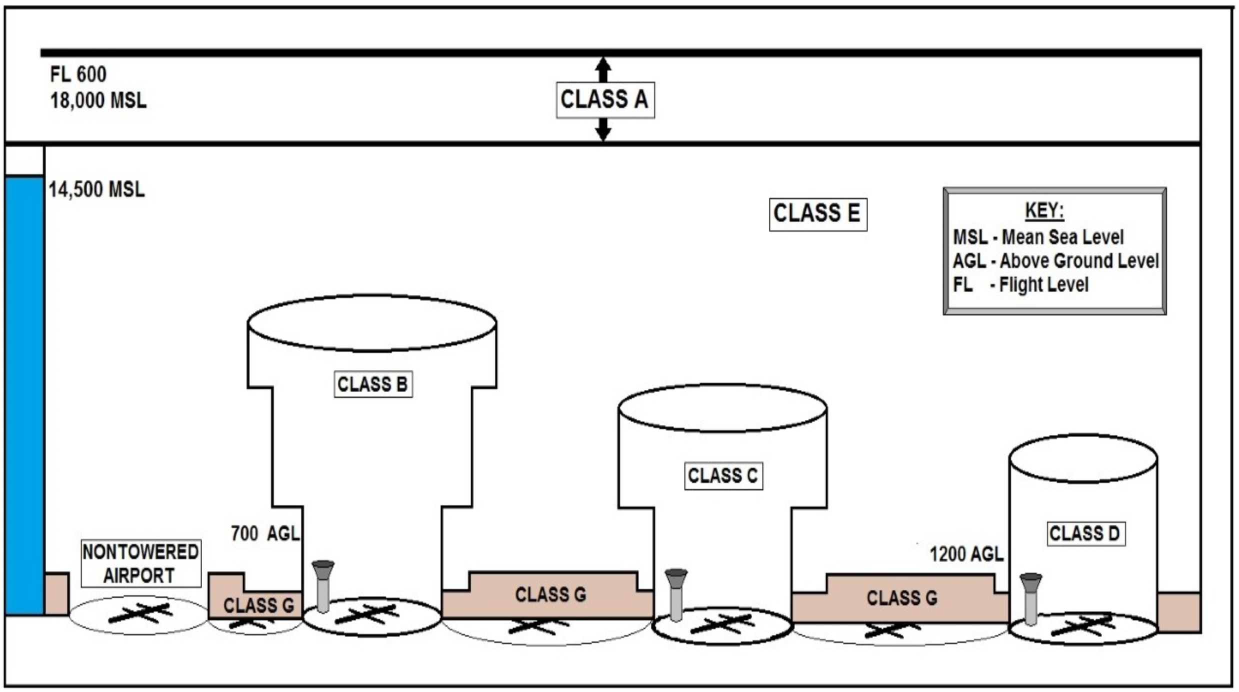
High wind speed and temperature inversion may limit treatment application whilst trees, waterways, environmental considerations and overhead power lines may also prevent some fields from being treated.

Accurate deposition in dense crop canopies can also be more difficult to achieve with aircraft. Volatility and spray drift can be a problem with aerial spraying and environmental contamination can be significant if spraying is incorrectly executed.

Certain factors limit the utility of aerial application/spraying.
These include:

- inclement weather,
- the presence of fixed obstacles,
- target site size and shape limitations,
- the intrinsic chemical properties of certain pesticidal active ingredients,
- ferry distance (i.e., the distance between the application site and place where the aircraft is refilled and serviced), and
- the general public's misconceptions about aerial application of any pesticide.

Intrinsically, aircraft operation allows very little room for error — in either pilot or machine. The same can be said for application of pesticide. Combining the two (flight and pesticide application) compounds risk, which, in turn, underscores the importance of a knowledgeable and competent pilot safely operating a properly configured aircraft.



AIRCRAFT CATEGORIES

The conditions and regulations outlined in the fixed-wing aircraft section also apply to helicopters and drones. 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.

History of Aerial Application

Aerial Seed Sowing 1906
The first known aerial application of agricultural materials was by John Chaytor, who in 1906 spread seed over a swamped valley floor in Wairoa, New Zealand, using a hot air balloon with mobile tethers. Aerial sowing of seed has continued on a small scale.

Crop Dusting 1921
The first known use of a heavier-than-air machine occurred on 3 August 1921. Crop dusting was developed under the joint efforts of the U.S. Agriculture Department, and the U.S. Army Signal Corps' research station at McCook Field in Dayton, Ohio. Under the direction of McCook engineer Etienne Dormoy, a United States Army Air Service Curtiss JN4 Jenny piloted by John A. Macready was modified at McCook Field to spread lead arsenate to kill catalpa sphinx caterpillars at a Catalapa farm near Troy, Ohio in the United States. The first test was considered highly successful. The first commercial operations were begun in 1924, by Huff-Daland Crop Dusting, which was co-founded by McCook Field test pilot Lt. Harold R. Harris. Use of insecticide and fungicide for crop dusting slowly spread in the Americas and to a lesser extent other nations in the 1930s and 1940s.

Top Dressing 1939-1946
Aerial topdressing, the spread of fertilizers such as superphosphate, was developed in New Zealand in the 1940s by members of the Ministry of Public Works and RNZAF, led by Alan Pritchard and Doug Campbell - unofficial experiments by individuals within the government led to funded research. Initially fertilizer and seed were dropped together (1939), using a window mounted chute on a Miles Whitney Straight, but by the end of the 1940s different mixtures of fertilizer were being distributed from hoppers installed in war surplus Grumman Avengers and C-47 Dakotas, as well as some privately operated de Havilland Tiger Moths in New Zealand, and the practice was being adopted experimentally in Australia and the United Kingdom. Crop dusting poisons enjoyed a boom after World War II until the environmental impact of widespread use became clear, particularly after the publishing of Rachel Carson's Silent Spring.

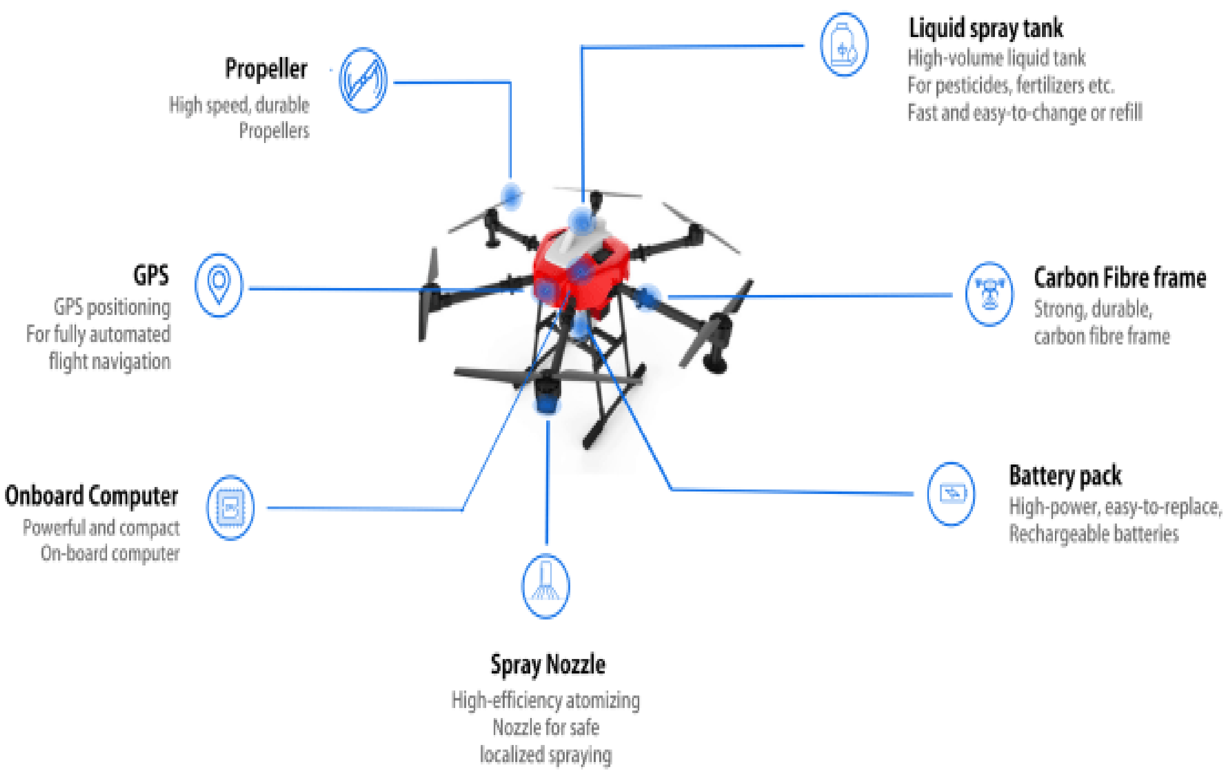
Water Bombing 1952
Aerial firefighting, or water bombing, was tested experimentally by Art Seller's Skyways air services in Canada in 1952 (dropping a mix of water, fertilizer and seed), and established in California in the mid-1950s.

Night Aerial Application 1973-present
Crop dusting at night is mostly liquid spray and is conducted in the Southwest U.S. deserts. The rising cost of pesticides and increasing immunity built up by continuous spraying reduced the effectiveness of spraying in daytime. In high temperature areas, the insects would travel down in plants in daytime and return to the top at night. The aircraft — both fixed wing and helicopters — were equipped with lights, usually three sets: Work lights were high power and aimed or adjustable from the cockpit; wire lights were angled down for taxiing and wire or obstruction illumination; and turn lights were only turned on in the direction of the turn to allow safe operation on moonless nights where angle of entry or exit needed to be illuminated.

These aircraft were equipped with pumps, booms, and nozzles for spray application. Some aircraft were equipped with an elongated metal wing called a spreader, with inbuilt channels to direct the flow of dust such as sulfur, used on melons as a pesticide and soil amendment. Very little pesticide dust was used day or night in comparison to spray, because of the difficulty in drift control. Workers on the ground, called "flaggers", would use flashlights aimed at the aircraft to mark the swaths on the ground; later, GPS units replaced the flaggers due to new laws restricting use of human flaggers with some pesticides.

Unmanned Drones 2015- Present

In recent years, due to the increasing costs of labor caused by the shortage of agricultural workers, as well as reduced operating efficiency, and due to geographical conditions, manual-work spraying of pesticides destroyed the seedling rate is too high, the spraying effect is not ideal. Therefore, the use of agricultural unmanned aerial vehicles is to solve this series of problems.



DRONE DIAGRAM

Conventional methods of pesticide spray application leads to excessive application of chemicals, lower spray uniformity, deposition, and coverage; resulting higher cost of pesticide as well as water and soil pollution. Apart from these, there will be increased drudgery in field application and reduced area coverage, leading to increased cost of inputs as well as reduced effectiveness in controlling the pests and diseases.

Keeping in view of these facts, a drone mounted sprayer was developed for application of pesticide sprays on to crops which improves coverage, boosts chemical effectiveness and makes spraying job easier and faster.

Relevant Aerial Spraying Factors and Terms

Alphabetical Order

Wireless Spraying Drone

Drones- Control Loop and Wireless Sensor Network
The application of herbicides and fertilizers in agricultural areas is of prime importance for crop yields. The use of drone is becoming increasingly common in carrying out this task mainly because of its speed and effectiveness in the spraying operation system. However, some factors may reduce the crop yields, or even cause damage because of climate condition, wind intensity and direction, and pesticide deposition while spraying. The process of applying the pesticides and fertilizers is controlled by means of the feedback obtained from the wireless sensor network (WSN) deployed on the crop field monitoring. The function is to support short delays in the control loop so that the spraying UAV can analyze and process the information from WSN to further route. The pesticide operator or applicator can evaluate an algorithm to adjust the UAV route under changes in wind speed and direction.

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 handlers must make sure that all safety equipment, clothing and aircraft loading equipment are 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 advise 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.

Pesticide Application
Pesticide application refers to the practical way in which pesticides; (including herbicides, fungicides, insecticides, or nematode control agents) are delivered to their biological targets (e.g., pest organism, crop or other plant). Public concern about the use of pesticides has high-lighted the need to make this process as efficient as possible, in order to minimize their release into the environment and human exposure (including operators, bystanders and consumers of produce). The practice of pest management by the rational application of pesticides is supremely multi-disciplinary, combining many aspects of biology and chemistry with: agronomy, engineering, meteorology, socio-economics and public health, together with newer disciplines such as biotechnology and information science.

Pilot in Command
No person may act as pilot in command of an aircraft unless they hold a pilot certificate and rating prescribed by Sec. 137.19 (b) or (c), as appropriate to the type of operation conducted. In addition, the pilot must demonstrate to the holder of the Agricultural Aircraft Operator Certificate conducting the operation that the pilot has met the knowledge and skill requirements of Sec.137.19(e). If the holder of that certificate has designated a person under Sec. 137.19(e) to supervise their agricultural aircraft operations the demonstration must be made to the person so designated. However, a demonstration of the knowledge and skill requirement is not necessary for any pilot in command who
(1) Is, at the time of the filing of an application by an agricultural aircraft operator, working as a pilot in command for that operator; and
(2) Has a record of operation under that applicant that does not disclose any question regarding the safety of their flight operations or their competence in dispensing agricultural materials or chemicals.

137.43 Airport traffic areas and control zones
(a) Except for flights to and from a dispensing area, no person may operate an aircraft within the lateral boundaries of the surface area of Class D airspace designated for an airport unless authorization for that operation has been obtained from the ATC facility having jurisdiction over that area.

(b) No person may operate an aircraft in weather conditions below VFR minimums within the lateral boundaries of a Class E airspace area that extends upward from the surface unless authorization for that operation has been obtained from the ATC facility having jurisdiction over that area.
(c) Notwithstanding Sec. 91.157(a)(2) of this chapter, an aircraft may be operated under the special VFR weather minimums without meeting the requirements prescribed therein.

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.

Ultra-Low Volume (ULV)
The term Ultra-Low Volume (ULV) (spraying) is used in the context of pesticide application. Ultra-low volume application of pesticides has been defined as spraying at a Volume Application Rate (VAR) of less than 2.5 gallons/ 2.5 acres (5 L/ha) for field crops or less than 13 gallons/ 2.5 acres (50 L/ha) for tree/bush crops. Always follow the label for specific instructions.

VARs of 1 cup/2.5 acre (0.25 / 2 l/ha) are typical for aerial ULV application to forest or migratory pests. ULV spraying is a well-established spraying technique and remains the standard method for locust control with pesticides and is also widely used by cotton farmers in central-southern and western Africa.

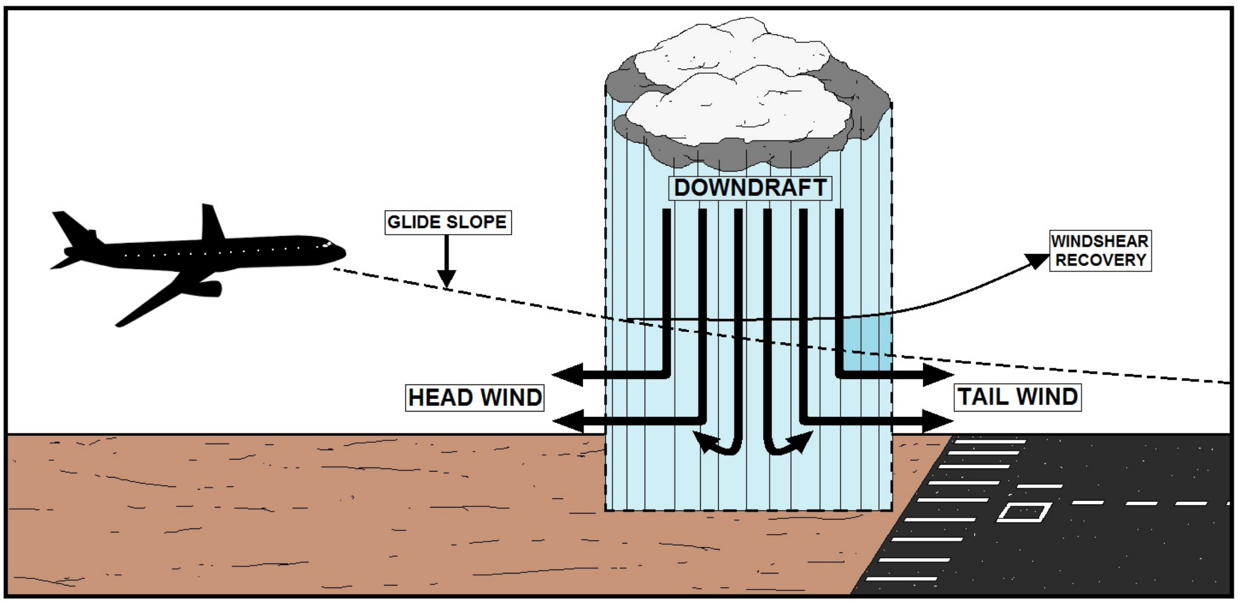
It has also been used in massive aerial spraying campaigns against disease vectors such as the tsetse fly. A major benefit of ULV application is high work rate (i.e., hectares can be treated in one day). It is a good option if all (or some) of these conditions apply:

* large area of land to treat

* rapid response required
* little or no water for making pesticide tank mixtures
* logistical problems for supplies
* difficult terrain: poor access to target site

Wind

Aircraft spraying is normally carried out when the surface wind speed is less than 20 F/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. 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.



DOWNDRAFT EFFECTS

Winged Aircraft Agricultural Spraying Equipment Sub-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.

137.3 Definition of Terms
For the purpose of this part — Agricultural aircraft operation means the operation of an aircraft for the purpose of
(1) dispensing any economic poison,
(2) dispensing any other substance intended for plant nourishment, soil treatment, propagation of plant life, or pest control, or
(3) engaging in dispensing activities directly affecting agriculture, horticulture, or forest preservation, but not including the dispensing of live insects.

Economic poison means
(1) any substance or mixture of substances in-tended for preventing, destroying, repelling, or mitigating any insects, rodents, nematodes, fungi, weeds, and other forms of plant or animal life or viruses, except viruses on or in living man or other animals, which the Secretary of Agriculture shall declare to be a pest, and
(2) any substance or mixture of substances intended for use as a plant regulator, defoliant or desiccant.

The basics of an Agricultural Aircraft 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.

Enclosed Cabs

Enclosed cabs must have a nonporous barrier that totally surrounds the occupants and prevents contact with pesticides outside of the cab.

Enclosed cabs that provide respiratory protection must have a properly functioning ventilation system that is used and maintained according to the manufacturer's written operating instructions. The cab must be declared in writing by the manufacturer or by a governmental agency to provide at least as much respiratory protection as the type of respirator listed on the pesticide labeling.

Examples:
Some enclosed-cab systems provide respiratory protection equivalent to a dust/mist filtering respirator and could, therefore, be used as a substitute when that type of respirator is specified on the product labeling. Other enclosed-cab systems are equipped to remove organic vapors as well as dusts and mists and could be used as a substitute when either the dust/mist filtering respirator or an organic-vapor-removing respirator is specified on the product labeling.

1. Enclosed cabs that do not provide respiratory protection — In an enclosed cab that does not provide respiratory protection, handlers need not wear all the PPE listed on the pesticide labeling, but must wear at least:

- long-sleeved shirt and long pants,
- shoes and socks, and
- any respirator required for the handling task.

2. Enclosed cabs that provide respiratory protection — In an enclosed cab that provides respiratory protection equal to the labeling-required respirator, handlers need not wear all the PPE listed on the pesticide labeling, but must wear at least:

- long-sleeved shirt and long pants, and
- shoes and socks.

3. In any enclosed cab where reduced PPE is worn — Handlers must:

- keep immediately available all PPE listed on the labeling for the type of task being performed,
- store the PPE in a chemical resistant container (such as a plastic bag),
- wear the PPE if it is necessary to leave the cab and contact pesticide-treated surfaces in the treated area, and
- take off PPE that was worn in the treated area before reentering the cab in order to prevent contamination of the inside of the cab.

Note: If the PPE that was worn in the treated area needs to be stored inside the enclosed cab, it must be stored in such a way that will prevent contaminating the inside of the cab. One way to achieve this would be to store the contaminated PPE in a chemical-resistant container, such as a plastic bag.

Cockpits

1. Gloves when entering or leaving an aircraft — Handlers have the option of whether to wear chemical-resistant gloves when entering or leaving an aircraft used to apply pesticides, *unless* the pesticide product labeling requires chemical-resistant gloves to be worn for these activities. If gloves are worn for such a use, then if they are brought inside the cockpit, handlers must store the used gloves in an enclosed container, such as a plastic bag, to prevent contamination of the inside of the cockpit.

2. Open cockpits — In an open cockpit, handlers must wear any gloves, respirator, and body protection listed on the pesticide labeling for application tasks. However, they may wear:

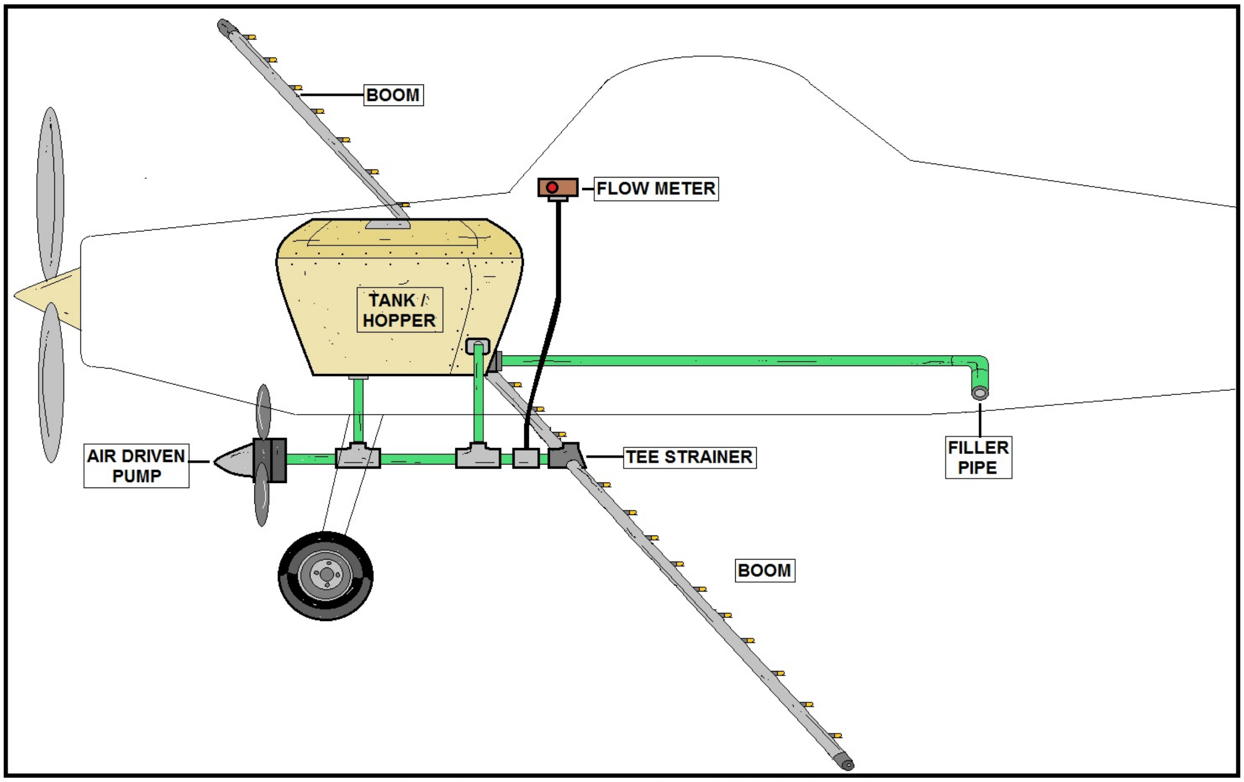
- shoes and socks instead of chemical-resistant footwear,
- a helmet instead of a chemical-resistant hat or hood, and
- a visor instead of protective eyewear.

3. Enclosed cockpits — In an enclosed cockpit, handlers need not wear all the PPE listed on the pesticide labeling, but must wear at least:

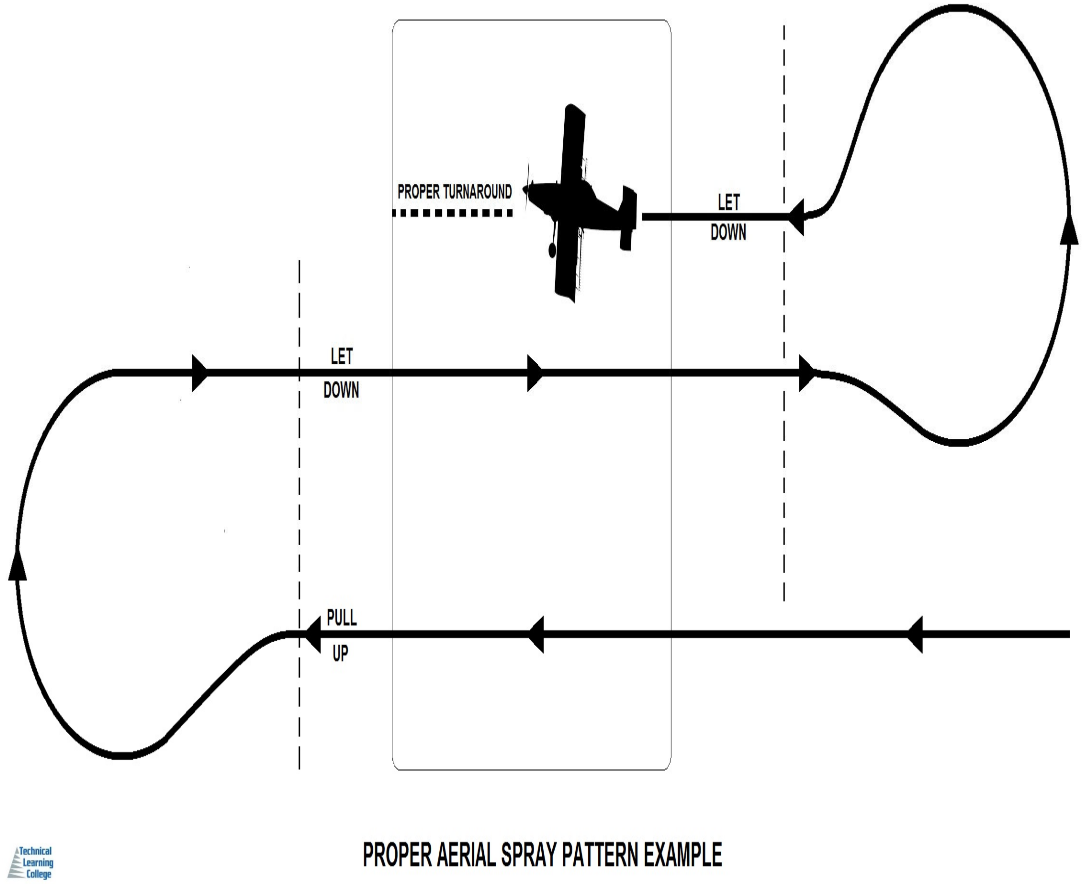
- long-sleeved shirt and long pants, and
- shoes and socks.

Availability of Certificate

Each holder of an agricultural aircraft operator certificate shall keep that certificate at their home base of operations and shall present it for inspection on the request of the Administrator.



SPRAY TANK AND BOOM DIAGRAM (Air Driven)



PROPER AERIAL SPRAY PATTERN EXAMPLE

How Low Can a Crop Duster Fly?
Other than on take offs and landings, agricultural aircraft must fly above 1,000 feet from the surface over congested areas.

The aircraft may, however, be operated below 500 feet over "persons, vessels, vehicles, and structures," if no hazard to people of property is created. When flying over a congested area, a crop duster must exercise "maximum safety" consistent for the purpose of the operation, and in accordance with the following: written approval public notice a submitted plan for the flight.

To decide what a congested area is, attention must be turned to the FAA. Again, though, we go back to the beginning of this article with "it depends" what a congested area is, because the FAA determines what a congested area is on a case-by-case basis.

Visual-Flight Rules (day). For VFR flight during the day, the following instruments and equipment are required:

(1) Airspeed indicator.
(2) Altimeter.
(3) Magnetic direction indicator.
(4) Tachometer for each engine.
(5) Oil pressure gauge for each engine using pressure system.
(6) Temperature gauge for each liquid-cooled engine.
(7) Oil temperature gauge for each air-cooled engine.
(8) Manifold pressure gauge for each altitude engine.
(9) Fuel gauge indicating the quantity of fuel in each tank.
(10) Landing gear position indicator, if the aircraft has a retractable landing gear.
(11) For small civil airplanes certificated after March 11, 1996, in accordance with part 23 of this chapter, an approved aviation red or aviation white anti-collision light system. In the event of failure of any light of the anti-collision light system, operation of the aircraft may continue to a location where repairs or replacement can be made.
(12) If the aircraft is operated for hire over water and beyond power-off gliding distance from shore, approved flotation gear readily available to each occupant and, unless the aircraft is operating under part 121 of this subchapter, at least one pyrotechnic signaling device. As used in this section, “shore” means that area of the land adjacent to the water which is above the high water mark and excludes land areas which are intermittently under water.
(13) An approved safety belt with an approved metal-to-metal latching device for each occupant 2 years of age or older.
(14) For small civil airplanes manufactured after July 18, 1978, an approved shoulder harness for each front seat. The shoulder harness must be designed to protect the occupant from serious head injury when the occupant experiences the ultimate inertia forces specified in §23.561(b)(2) of this chapter. Each shoulder harness installed at a flight crewmember station must permit the crewmember, when seated and with the safety belt and shoulder harness fastened, to perform all functions necessary for flight operations. For purposes of this paragraph—

> (i) The date of manufacture of an airplane is the date the inspection acceptance records reflect that the airplane is complete and meets the FAA-approved type design data; and
> (ii) A front seat is a seat located at a flight crewmember station or any seat located alongside such a seat.

(15) An emergency locator transmitter, if required by §91.207.
(16) For normal, utility, and acrobatic category airplanes with a seating configuration, excluding pilot seats, of 9 or less, manufactured after December 12, 1986, a shoulder harness for—

> (i) Each front seat that meets the requirements of §23.785 (g) and (h) of this chapter in effect on December 12, 1985;
> (ii) Each additional seat that meets the requirements of §23.785(g) of this chapter in effect on December 12, 1985.

(17) For rotorcraft manufactured after September 16, 1992, a shoulder harness for each seat that meets the requirements of §27.2 or §29.2 of this chapter in effect on September 16, 1991.

Advantages of Fixed-Wing Aircraft
Fixed-wing aircraft with spray booms mounted below the lower wing have been used effectively to apply herbicidal sprays over extensive areas to control brush and weeds since the 1950s. Today’s spray planes are designed specifically for aerial application of liquid and dry

materials and meet strict safety requirements. They use radial-piston or turbine engines with a range in horsepower from 600 to 1300. Current spray tank capacities vary from 400 to 800 gallons while older aircraft had spray tank capacities of 300 gallons or less.

§ 91.107 Use of safety belts, shoulder harnesses, and child restraint systems.

(a) Unless otherwise authorized by the Administrator—

(1) No pilot may take off a U.S.-registered civil aircraft (except a free balloon that incorporates a basket or gondola, or an airship type certificated before November 2, 1987) unless the pilot in command of that aircraft ensures that each person on board is briefed on how to fasten and unfasten that person's safety belt and, if installed, shoulder harness.

(2) No pilot may cause to be moved on the surface, take off, or land a U.S.-registered civil aircraft (except a free balloon that incorporates a basket or gondola, or an airship type certificated before November 2, 1987) unless the pilot in command of that aircraft ensures that each person on board has been notified to fasten their or her safety belt and, if installed, their or her shoulder harness.

(3) Except as provided in this paragraph, each person on board a U.S.-registered civil aircraft (except a free balloon that incorporates a basket or gondola or an airship type certificated before November 2, 1987) must occupy an approved seat or berth with a safety belt and, if installed, shoulder harness, properly secured about him or her during movement on the surface, takeoff, and landing. For seaplane and float equipped rotorcraft operations during movement on the surface, the person pushing off the seaplane or rotorcraft from the dock and the person mooring the seaplane or rotorcraft at the dock are excepted from the preceding seating and safety belt requirements. Notwithstanding the preceding requirements of this paragraph, a person may:

(i) Be held by an adult who is occupying an approved seat or berth, provided that the person being held has not reached their or her second birthday and does not occupy or use any restraining device;

(ii) Use the floor of the aircraft as a seat, provided that the person is on board for the purpose of engaging in sport parachuting; or

(iii) Notwithstanding any other requirement of this chapter, occupy an approved child restraint system furnished by the operator or one of the persons described in paragraph (a)(3)(iii)(A) of this section provided that:

(A) The child is accompanied by a parent, guardian, or attendant designated by the child's parent or guardian to attend to the safety of the child during the flight;

(B) Except as provided in paragraph (a)(3)(iii)(B)(*4*) of this action, the approved child restraint system bears one or more labels as follows:

(*1*) Seats manufactured to U.S. standards between January 1, 1981, and February 25, 1985, must bear the label: “This child restraint system conforms to all applicable Federal motor vehicle safety standards”;

(*2*) Seats manufactured to U.S. standards on or after February 26, 1985, must bear two labels:

(*i*) “This child restraint system conforms to all applicable Federal motor vehicle safety standards”; and

(*ii*) “THIS RESTRAINT IS CERTIFIED FOR USE IN MOTOR VEHICLES AND AIRCRAFT” in red lettering;

(*3*) Seats that do not qualify under paragraphs (a)(3)(iii)(B)(*1*) and (a)(3)(iii)(B)(*2*) of this section must bear a label or markings showing:

(*i*) That the seat was approved by a foreign government;

(*ii*) That the seat was manufactured under the standards of the United Nations; or

(*iii*) That the seat or child restraint device furnished by the operator was approved by the FAA through Type Certificate or Supplemental Type Certificate.

(*iv*) That the seat or child restraint device furnished by the operator, or one of the persons described in paragraph (a)(3)(iii)(A) of this section, was approved by the FAA in accordance with §21.8 or Technical Standard Order C–100b, or a later version.
(*4*) Except as provided in §91.107(a)(3)(iii)(B)(*3*)(*iii*) and §91.107(a)(3)(iii)(B)(*3*)(*iv*), booster-type child restraint systems (as defined in Federal Motor Vehicle Safety Standard No. 213 (49 CFR 571.213)), vest- and harness-type child restraint systems, and lap held child restraints are not approved for use in aircraft; and
(C) The operator complies with the following requirements:
(*1*) The restraint system must be properly secured to an approved forward-facing seat or berth;
(*2*) The child must be properly secured in the restraint system and must not exceed the specified weight limit for the restraint system; and
(*3*) The restraint system must bear the appropriate label(s).
(b) Unless otherwise stated, this section does not apply to operations conducted under part 121, 125, or 135 of this chapter. Paragraph (a)(3) of this section does not apply to persons subject to §91.105.

Helicopter/Rotary Winged Sub-Section - Introduction

Helicopters/rotary winged aircraft 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.

Helicopters with boom sprayers are well suited for use in mountainous areas, steep terrain, highly irregular shaped sites, or remote areas. They are highly maneuverable and apply sprays at much slower speeds than fixed-wing aircraft.

Airspeed can vary from 30 to 80 mph but is about 45 mph for brush and weed spraying. To maintain precision application rates, aircraft should be equipped with variable-rate, flow-control units to compensate for changes in airspeed. GPS/GIS systems are helpful for precision applications. Spray tanks vary in size from 90 to 230 gallons, and the spray boom should not exceed 90% of the rotor diameter. Many types and sizes of nozzles are available.

Advantages of Rotary Wing Aircraft
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.

Subpart D—Airworthiness Requirements

§ 133.41 Flight characteristics requirements.

(a) The applicant must demonstrate to the Administrator, by performing the operational flight checks prescribed in paragraphs (b), (c), and (d) of this section, as applicable, that the rotorcraft-load combination has satisfactory flight characteristics, unless these operational flight checks have been demonstrated previously and the rotorcraft-load combination flight characteristics were satisfactory. For the purposes of this demonstration, the external-load weight (including the external-load attaching means) is the maximum weight for which authorization is requested.

(b) Class A rotorcraft-load combinations: The operational flight check must consist of at least the following maneuvers:

(1) Take-off and landing.

(2) Demonstration of adequate directional control while hovering.

(3) Acceleration from a hover.

(4) Horizontal flight at airspeeds up to the maximum airspeed for which authorization is requested.

(c) *Class B and D rotorcraft-load combinations:* The operational flight check must consist of at least the following maneuvers:

(1) Pickup of the external load.

(2) Demonstration of adequate directional control while hovering.

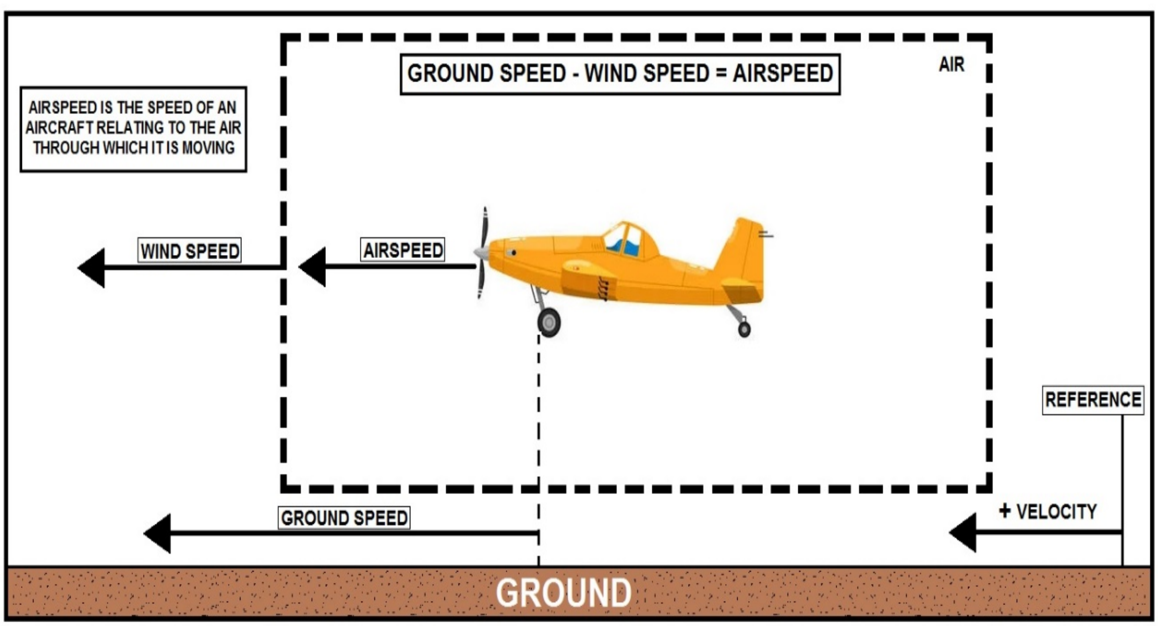
(3) Acceleration from a hover.

(4) Horizontal flight at airspeeds up to the maximum airspeed for which authorization is requested.

(5) Demonstrating appropriate lifting device operation.

(6) Maneuvering of the external load into release position and its release, under probable flight operation conditions, by means of each of the quick-release controls installed on the rotorcraft.

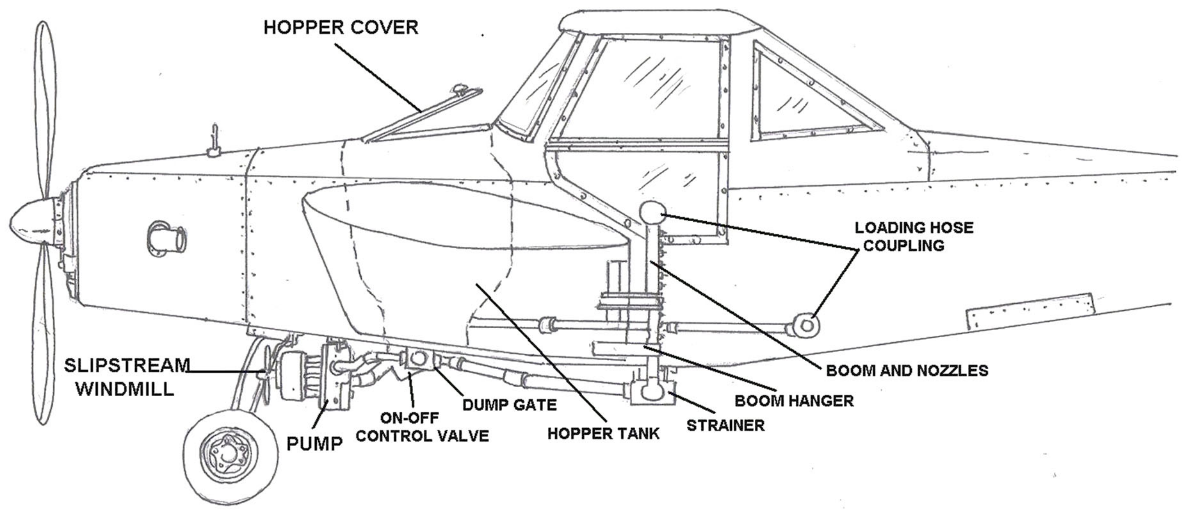
(d) Class C rotorcraft-load combinations: For Class C rotorcraft-load combinations used in wire-stringing, cable-laying, or similar operations, the operational flight check must consist of the maneuvers, as applicable, prescribed in paragraph (c) of this section.



AIRSPEED CALCULATION BASICS EXAMPLE

Aerial Pesticide Application Fundamentals - Introduction

The purpose of this sub-section is to identify some of the problems and to suggest means of addressing them. Although the number of aircraft licensed for aerial spraying has decreased recently, where large uniform areas have to be rapidly treated, aircraft application is usually considered to be more fuel-efficient than ground spraying. Aircraft are used to apply both liquid and solid materials as well as to broadcast seed when soil conditions prohibit the use of ground equipment. The regulations and any State or federal laws relating to aircraft spraying must always be observed.



COMMON AERIAL APPLICATION COMPONENTS

State Laws and Rules

Every state always has the option to write laws and rules that are more stringent than federal laws and regulations. Many states do so. Whenever this occurs, state law governs the issue. For this reason, a working knowledge of state law and rules is “essential equipment” for every aerial applicator. Copies of state-specific laws and rules governing pesticide use and applicator licensure (including aerial application of a pesticide) can usually be obtained (often without cost) by contacting the state regulatory agency (typically, the state’s Department of Agriculture) that administers the state’s pesticide applicator certification program.

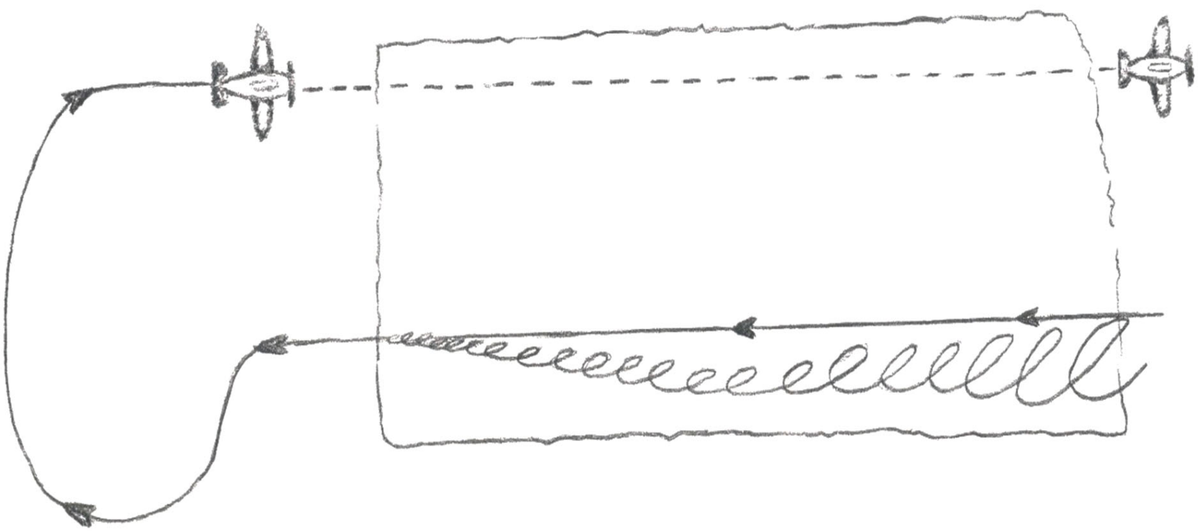
Airspeed

Airspeed can vary from 100 to 160 mph but is about 120 mph for brush and weed spraying. Spray boom length should not be more than three-fourths the length of the wingspan because the turbulent wingtip vortices cause drift. Spray pumps must have positive shut-off valves and nozzles must have check-valves to prevent continuous spraying or leakage over off-target areas. Hydraulic spray nozzles are the predominate type used on aircraft and many styles and sizes are available.

GPS/GIS systems are helpful for precision applications. When using an approved pesticide, the objective is to distribute the correct dose to a defined target with the minimum of wastage due to drift using the most appropriate spraying equipment. Acceptable spray distribution is relatively easy to achieve with most ground-based directed spraying, but spray application with fixed and rotary wing aircraft presents more complex problems.

Field Flight Patterns
With rectangular fields, the normal procedure is to fly back and forth across the field in parallel lines. Flight directions should be parallel to the long axis of the field because the number of turns is reduced.

Where crosswinds occur, treatment should start on the downwind side of the field to save the pilot flying through the previous swath, as shown in the diagram below.



CROSS-WINDS SPRAYING EXAMPLE DIAGRAM

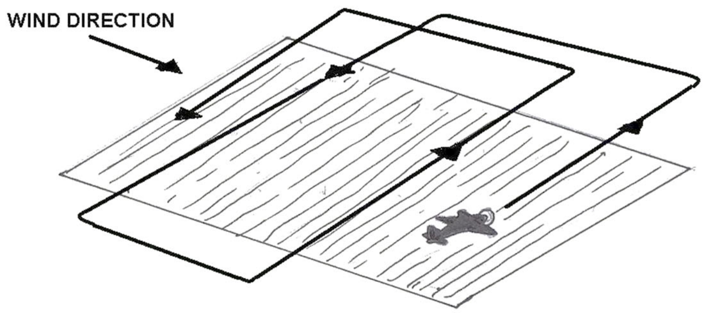
When this fits in with crop rows, the pilot can line up the aircraft with a crop row. If the area is too rugged or steep for these patterns, flight lines should follow along the contours of the slopes.

Where spot areas are too steep for contour work (mountainous terrain), make all treatments down slope. Avoid flying parallel to a stream or large lake if there is a tendency for drift toward the stream or lake.

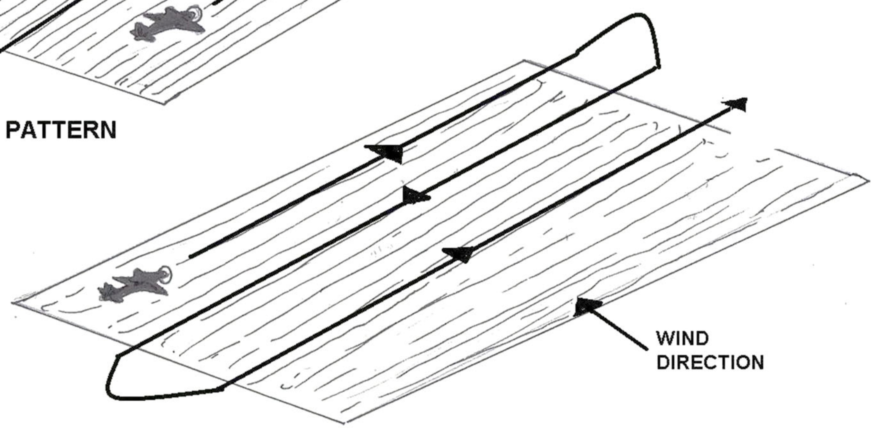
Swath Marking
Swaths can be marked with flags set above the height of the crop to guide the pilot. This method is useful if the field is going to be treated several times in a season. Two flagmen can be used to aid the pilot to line up across the field. When the pilot has lined up on their swath, the nearer flagman starts pacing off (or counting crop rows) to the next swath.

Flagmen should avoid being directly sprayed on and they should ***NEVER*** turn their backs toward an oncoming aircraft.

Federal orders prohibit using youths under 16 years of age as flagmen. Where the aircraft is flown parallel to a row crop, one flagman can be used to identify the swath row to the pilot. Automatic flagmen (a swath marking device) are in common use now. These devices, attached to the aircraft and controlled by the pilot, release weighted streamers. These streamers give the pilot a visible mark to help him judge the next swath. Permanent markers in the fields are also in common use.



RACE TRACK PATTERN



BACK AND FORTH PATTERN

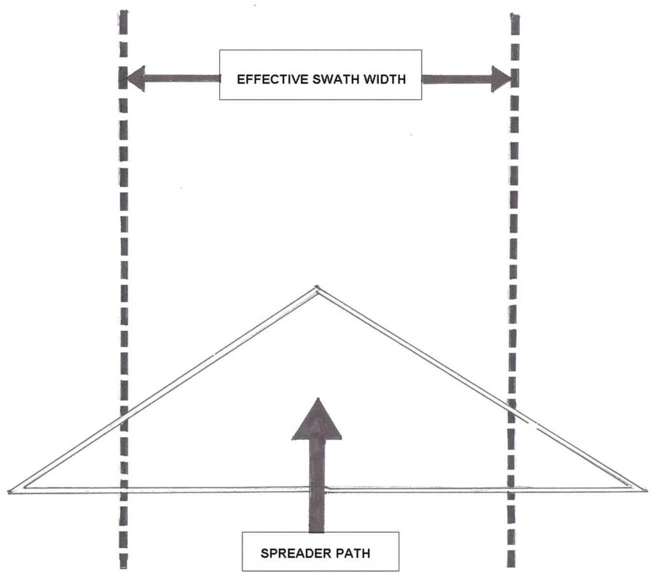
Turnaround
At the end of each swath the pilot should stop the disseminator and pull up out of the field before beginning their turn. The turn should be completed before dropping into the field again. The polit should fly far enough beyond the field for their turn to permit slight course corrections before dropping into the field again for the next swath, as shown in the following diagram.

Sprayer Field Settings
During a flight, spray pressure, output and aircraft height above the crop can be adjusted if necessary, however, as the pilot must concentrate on flying the aircraft, the pilot 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.

Obstructions
If obstructions occur (trees, power and telephone lines or buildings) at the beginning or end of the swath, it is preferable to turn the equipment on late or shut if off early. Then, when the field is completed, fly one or two swaths crosswise (parallel to the obstruction) to finish out the field. Do not run the disseminator when dropping in or pulling out of the field, since the pattern will be distorted. Obstructions inside the field should be treated in the same way. Skip the treatment as you avoid the obstruction, then, at the finish, come back and spot treat the skipped part, flying at right angles to the rest of the job.



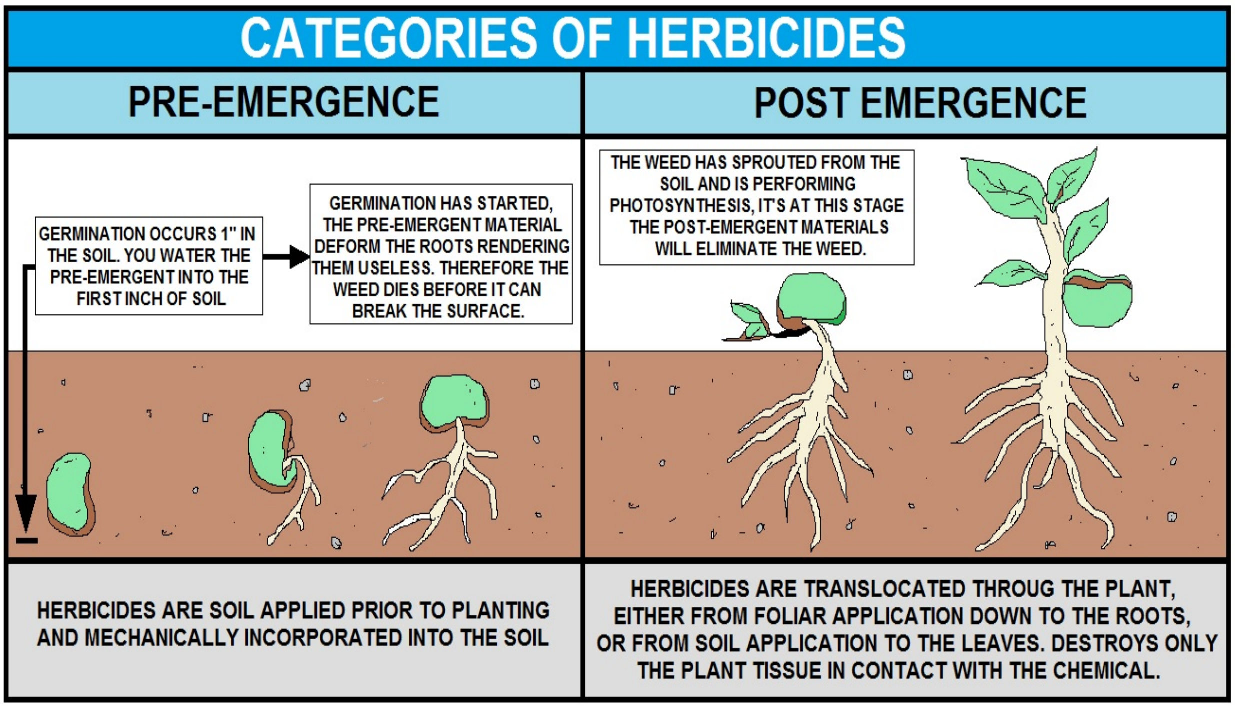
Areas adjacent to buildings, residences and livestock should be treated with extra care. Try to fly parallel to the property line, leaving a border of untreated crop to avoid possible drift onto unwanted areas. Adjust pullout and drop-in paths and avoid making turns over houses. Use caution when fields include or are adjacent to waterways, canals, or reservoirs. Treat fields with care if sensitive crops are planted next to them. Be certain that beekeepers are warned if they have beehives near the field to be treated and you are applying chemicals harmful to bees. These guidelines have been prepared to offer practical help to all those involved in applying pesticides by air for food and fiber production and apply equally for vector control in public health programs. The potential for high productivity and safe aircraft deployment can only be realized when the spray operation is well organized, and the people involved are fully trained and aware of their responsibilities.

Aerial spraying can be used to treat large areas quickly and, unlike ground spraying, can be carried out when field conditions prevent wheeled vehicle access, which enables the timing of spray treatments to be improved and soil compaction reduced. There are, however, certain disadvantages associated with aircraft spraying. High wind speed and temperature inversion may limit treatment application whilst trees, waterways, environmental considerations, and overhead power lines may also prevent some fields from being treated.

Accurate deposition in dense crop canopies can also be more difficult to achieve with aircraft. Volatility and spray drift can be a problem with aerial spraying and environmental contamination can be significant if spraying is incorrectly executed.

Federal and state codes for pesticide use and application, and FAA regulations are already in place, this course is offered as additional guidance. The importance of referring to the existing legislation cannot be over emphasized, as the failure to comply may have legal implications if a product complaint arises or an off-target contamination incident occurs.

Spraying Pre- and Post-Emergent Crops
Traditional agricultural crop pesticides can either be applied pre-emergent or post-emergent, a term referring to the germination status of the plant. Pre-emergent pesticide application, in conventional agriculture, attempts to reduce competitive pressure on newly germinated plants by removing undesirable organisms and maximizing the amount of water, soil nutrients, and sunlight available for the crop. An example of pre-emergent pesticide application is atrazine application for corn.



PRE-EMERGENCE / POST EMERGENCE HERBICIDES

Glyphosate mixtures are often applied pre-emergent on agricultural fields to remove early germinating weeds and prepare for subsequent crops. Pre-emergent application equipment often has large, wide tires designed to float on soft soil, minimizing both soil compaction and damage to planted (but not yet emerged) crops. A three-wheel application machine, such as the one pictured on the right, is designed so that tires do not follow the same path, minimizing the creation of ruts in the field and limiting sub-soil damage.

Post-emergent pesticide application requires the use of specific chemicals chosen minimize harm to the desirable target organism. An example is 2,4-Dichlorophenoxyacetic acid, which will injure broadleaf weeds (dicots) but leave behind grasses (monocots). Such a chemical has been used extensively on wheat crops, for example.

A number of companies have also created genetically modified organisms that are resistant to various pesticides. Examples include glyphosate-resistant soybeans and Bt maize, which change the types of formulations involved in addressing post-emergent pesticide pressure.

It is important to also note that even given appropriate chemical choices, high ambient temperatures or other environmental influences, can allow the non-targeted desirable organism to be damaged during application. As plants have already germinated, post-emergent pesticide application necessitates limited field contact in order to minimize losses due to crop and soil damage.

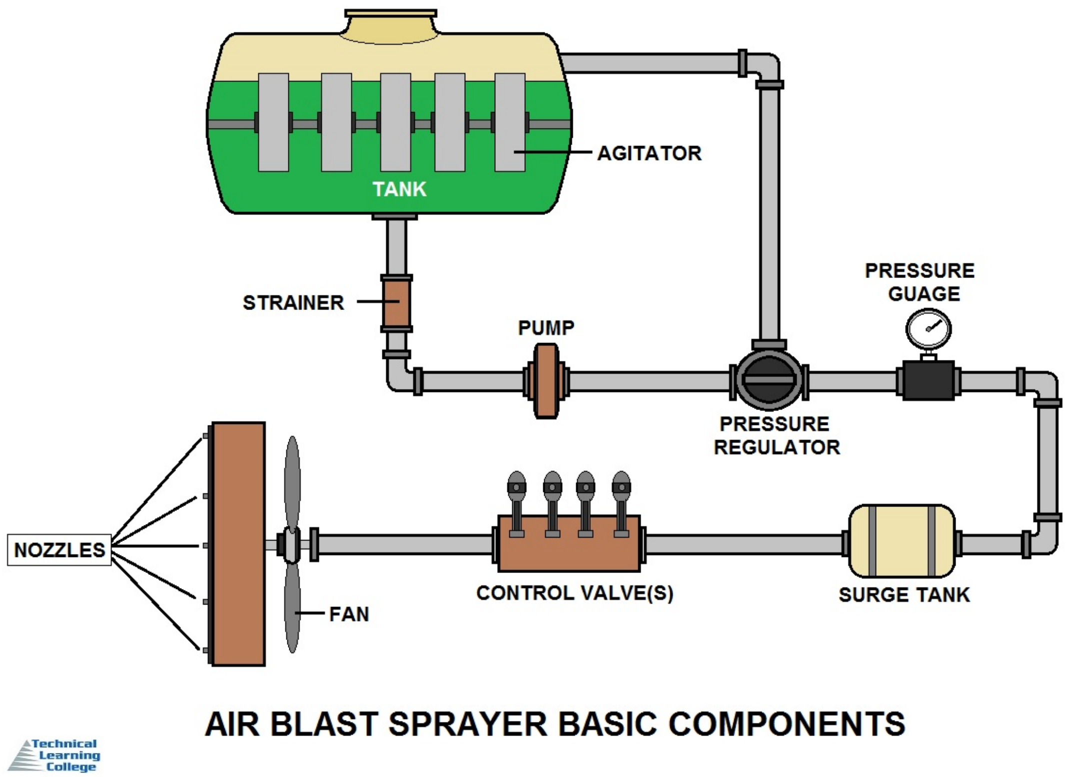
Typical industrial application equipment will utilize very tall and narrow tires and combine this with a sprayer body which can be raised and lowered depending on crop height. These sprayers usually carry the label ‘high-clearance’ as they can rise over growing crops, although usually not much more than 1 or 2 meters high.

In addition, these sprayers often have very wide booms in order to minimize the number of passes required over a field, again designed to limit crop damage and maximize efficiency. In industrial agriculture, spray booms 120 feet (40 meters) wide are not uncommon, especially in prairie agriculture with large, flat fields. Related to this, aerial pesticide application is a method of top dressing a pesticide to an emerged crop which eliminates physical contact with soil and crops.

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

Air Blast Sprayer Introduction

Air Blast sprayers, also known as air-assisted or mist sprayers, are often used for tall crops, such as tree fruit, where boom sprayers and aerial application would be ineffective. These types of sprayers can only be used where overspray—spray drift—is less of a concern, either through the choice of chemical which does not have undesirable effects on other desirable organisms, or by adequate buffer distance. These can be used for insects, weeds, and other pests to crops, humans, and animals. Air blast sprayers inject liquid into a fast-moving stream of air, breaking down large droplets into smaller particles by introducing a small amount of liquid into a fast-moving stream of air.



AIR BLAST SPRAYER BASIC COMPONENTS

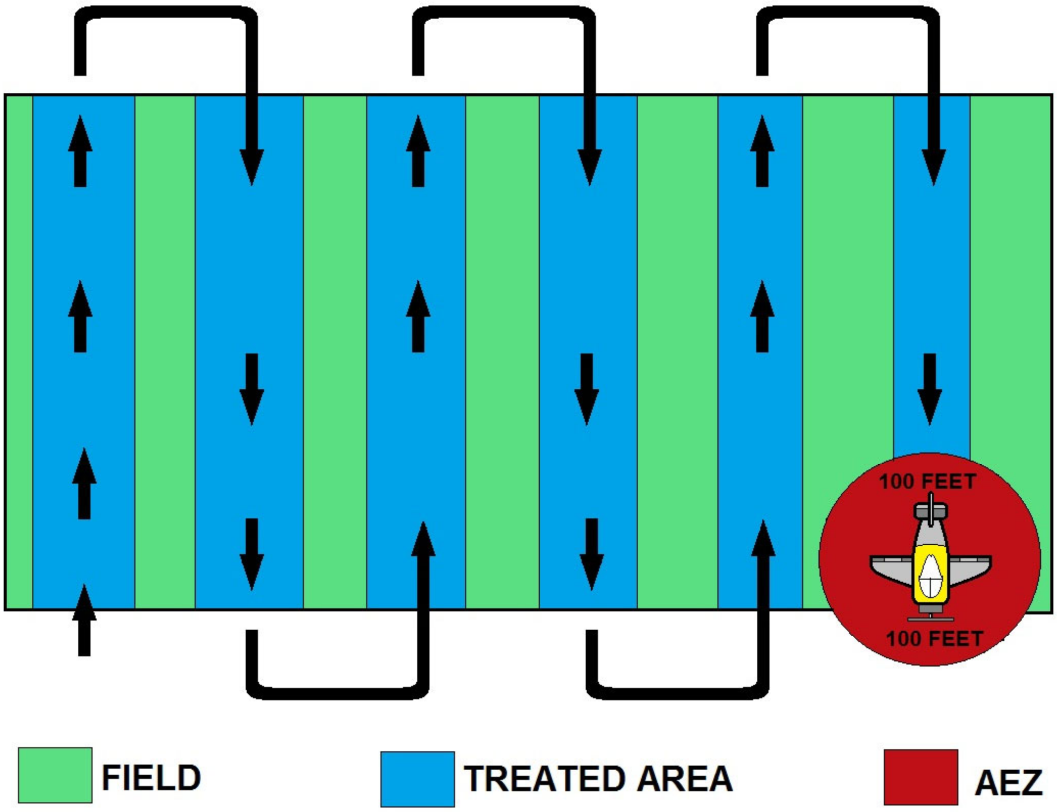
Foggers

Foggers fulfill a similar role to mist sprayers in producing particles of very small size but use a different method. Whereas mist sprayers create a high-speed stream of air which can travel significant distances, foggers use a piston or bellows to create a stagnant area of pesticide that is often used for enclosed areas, such as houses and animal shelters.

Accurate Aerial Spraying

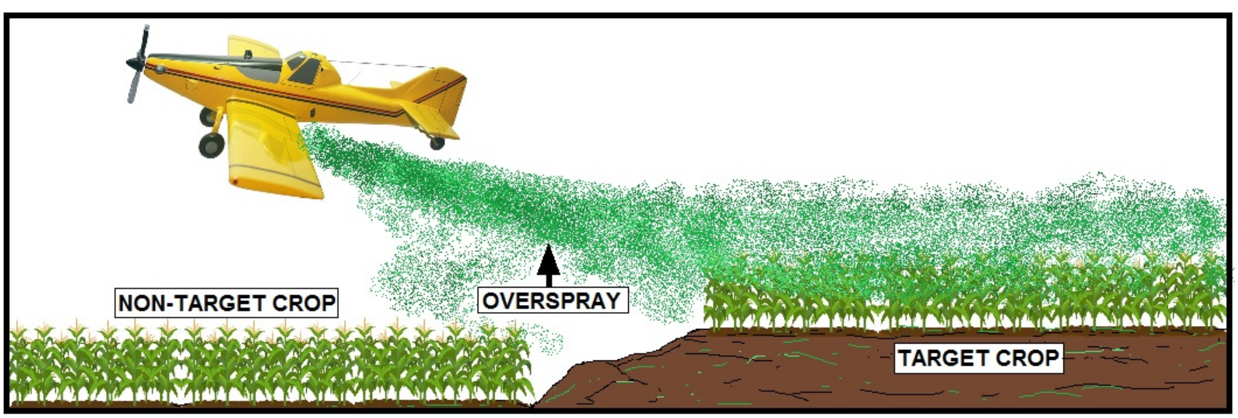
Accurate aerial spraying over undulating rangelands and forest tracts is more difficult to achieve than when treating smaller crop areas and, in these circumstances, electronic track guidance may be financially justified. Both the self-contained Inertial Navigation System (INS) and the Doppler System 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.



APPLICATION EXCLUSION ZONE (AEZ) - OUTDOOR PRODUCTION

(100 Feet for Aerial, Airblast, Fumigant, Smoke, Mist and Fog Applications, as well as Spray Applications using very Fine OR Fine Droplet sizes)



EXAMPLE OF AERIAL APPLICATION OVERSPRAY HAZARDS

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What is Part 137?

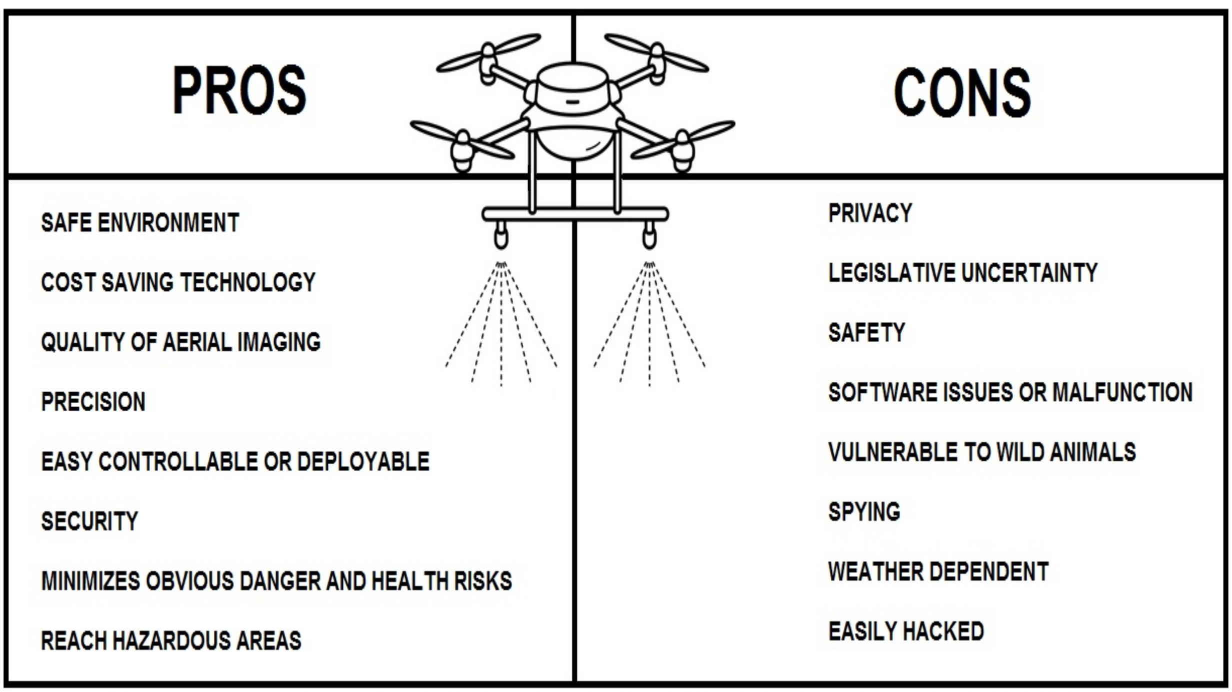
14 CFR Part 137 is entitled “Agricultural Aircraft Operations”. That name might make Part seem like an all-encompassing rule for aircraft operations that involve agriculture. Thankfully, that is not the case.

Based on the definition of Part 137, agricultural operations are defined as such:

- Dispensing of any substance intended for plant nourishment, soil treatment, pest control, or propagation of plant life
- Dispensing of an economic poison (pesticide, defoliant, plant regulator, or any other substance listed in Part 137.3)
- Engaging in any dispensing activity directly affecting agriculture, horticulture, or forest preservation

Part 137 is not a rule that was specifically formulated for drones. Instead, it is a general rule for aircraft operations that just happens to overlap with some examples of professional drone use. As far as drone pilots are concerned, agricultural spraying is considered by the FAA as a type of “Advanced Operations” that requires special certification.

As of February 2021, only 37 companies in the US have received Part 137 certification. Part 137 certification can be granted to both companies and individuals but there does not seem to be a single example of the latter.



PROS AND CONS OF UNMANNED DRONES FOR PESTICIDE APPLICATIONS

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Who needs Part 137 certification?
Drone operations that involve agricultural spraying will need to be done by a pilot with a Part 137 certification. To be more specific, the “economic poison” mentioned in Part 137 refers to:

- Any substance or mixture intended for preventing, destroying, repelling, or mitigating any insects, rodents, nematodes, fungi, weeds, and other forms of plant or animal life or viruses, except viruses on or in living man or other animals, which the Secretary of Agriculture shall declare to be a pest, and

- Any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

Part 137 regulations will apply to any drone pilot who conducts agricultural operations as covered by the definition listed above.

DRONE FLIGHT CHECKLIST

WHILE AT HOME	BEFORE TAKEOFF	AFTER TAKEOFF	ONCE LANDED
☐CHECK WEATHER	☐NOTIFY SPECTATORS	☐ HOVER NEARBY FOR 20 SECONDS	☐TURN OFF DRONE, THEN CONTROLLER
☐DRONE BATTERY CHARGED	☐UNPACK EQUIPMENT	☐ LISTEN & WATCH FOR ANY ABNORMALITIES	☐ENSURE DESIRED FOOTAGE WAS CAUGHT
☐CONTROLLER CHARGED	☐INSERT SD CARD	☐ TEST CONTROLS	☐INSPECT DRONE FOR ANY DAMAGE
☐APP UPDATED	☐REMOVE GIMBAL LOCK	☐ CONTINUOUSLY MONITOR SIGNAL	☐FASTEN GIMBAL LOCK
☐FIRMWARE UPDATED	☐INSPECT DRONE	☐ KEEP DRONE WITHIN VISUAL LINE OF SIGHT	☐PACK EQUIPMENT & LOG FLIGHT
☐SD CARD FORMATTED	☐CALIBRATE COMPASS		
☐ALL GEAR READY	☐CHECK SATELLITE STRENGTH		
☐CHECK NOTAMS	☐CHECK SIGNAL STRENGTH		
☐RESEARCH FLIGHT AREA	☐ENSURE RTH IS SET		
☐GET PERMISSIONS	☐SPECIFY LOST SIGNAL ACTION		

CHECKLIST FOR DRONE FLIGHTS

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Chemical Container Handling - Introduction

All applicators, workers or handlers 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 and 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

PESTICIDE POST TREATMENT WARNING SIGN EXAMPLES

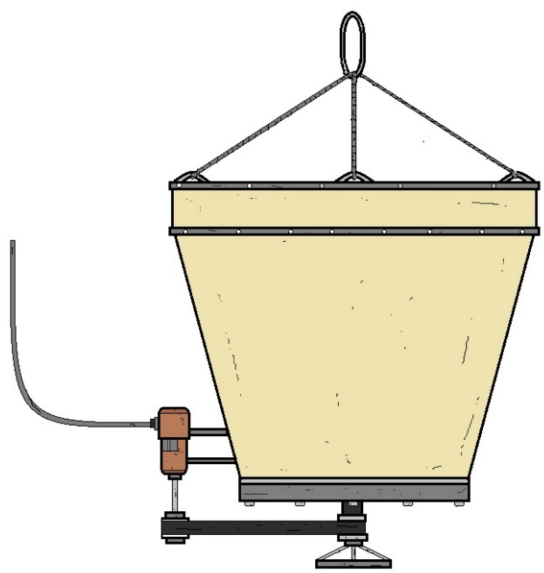
Post-Treatment Warnings

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.



HELICOPTER CENTRIFUGAL SPREADER FOR DRY MATERIALS

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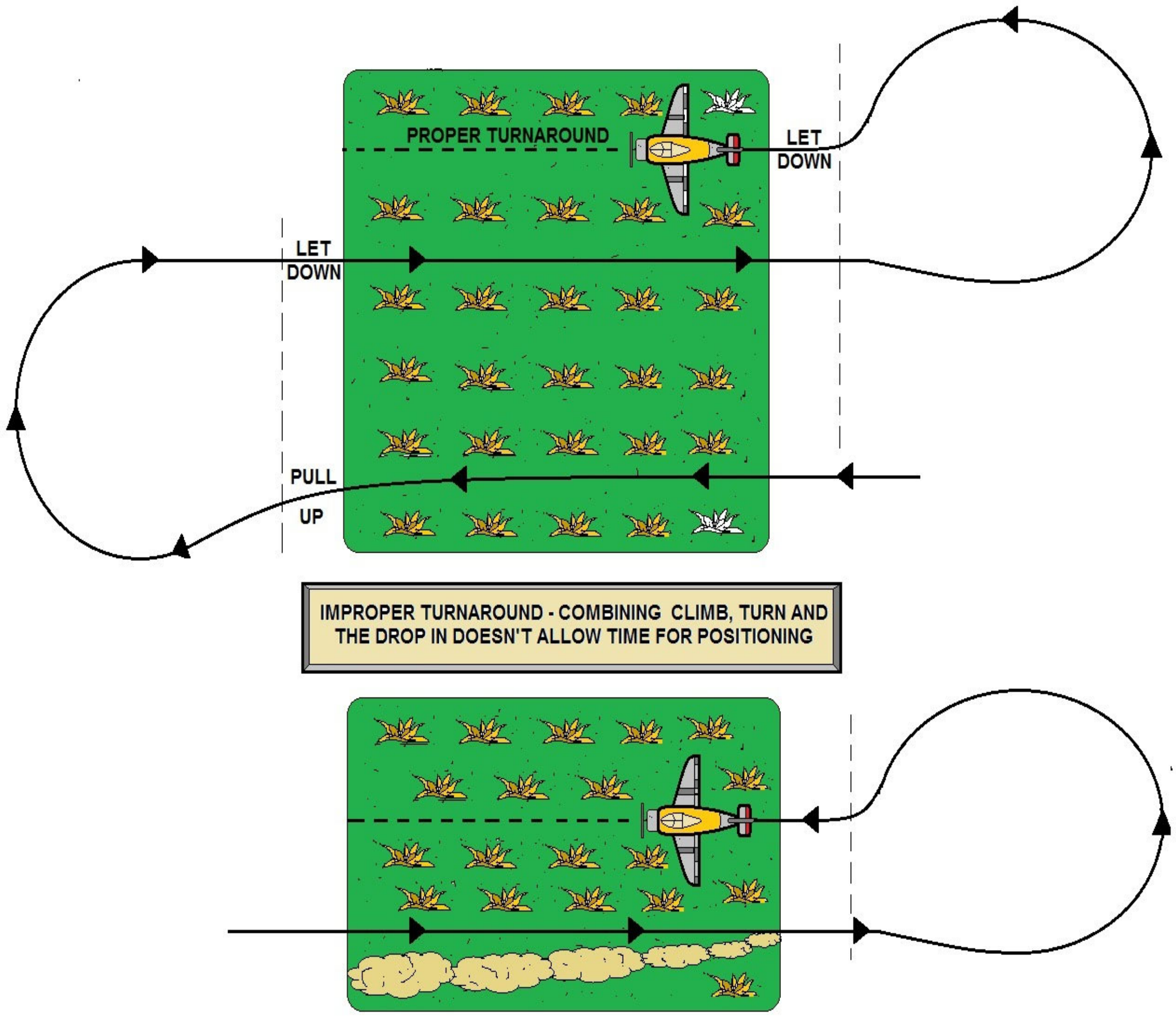
Undiluted Sprays and Ultra-low Volume (ULV) formulations Guidelines
The following guidelines have been drawn up to cover the application of both conventional aqueous undiluted sprays and ultra-low volume (ULV) formulations. They provide information and advice on safe practices.

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.



PESTICIDE APPLICATION
(FIELD FLIGHT PATTERN & PROPER TURN AROUND)

APPLICATION EXCLUSION ZONE IS A RESTRICTED AREA AROUND PESTICIDE EQUIPMENT DURING AN APPLICATION. THE AEZ MOVES AS THE APPLICATION CONTINUES. THE AGRICULTURAL EMPLOYER MUST KEEP WORKERS AND OTHER PEOPLE OUT THE ZONE DURING APPLICATIONS. AGRICULTURAL EMPLOYERS MUST ALSO KEEP WORKERS OUT OF TREATED AREA UNTIL THE RESTRICTED ENTRY LEVEL (REI) HAS PASSED

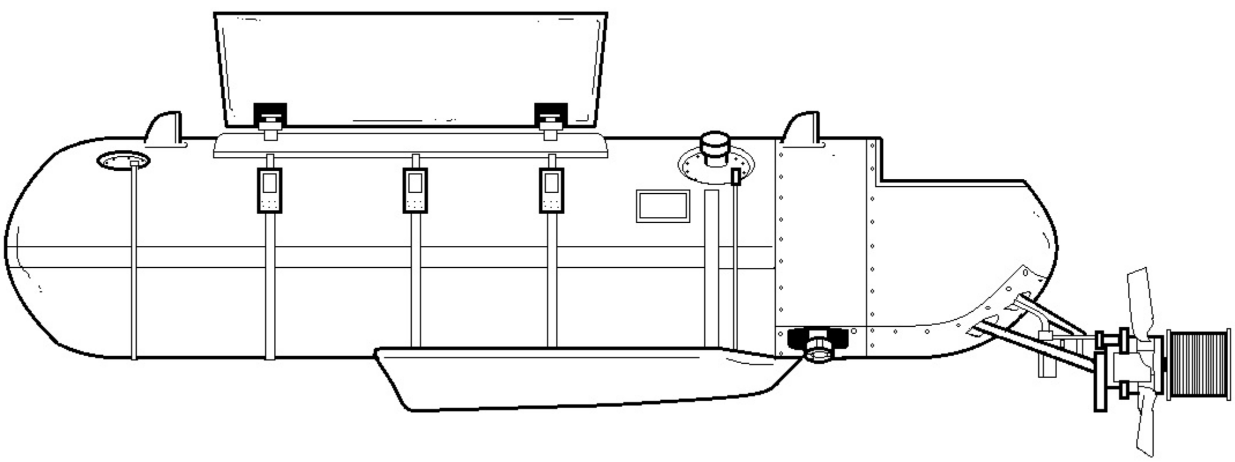
HOW LARGE IS THE APPLICATION EXCLUSION ZONE?

WORKERS MUST BE KEPT AT LEAST 100 FEET AWAY FROM: AIRCRAFT OR AIR BLASTERS FUMIGANT, MIST OR FOG APPLICATIONS SPRAY WITH EXTRA FINE, VERY FINE OR FINE DROPLETS	100 feet
WORKERS MUST STAY AT LEAST 25 FEET AWAY FROM: SPRAY WITH MEDIUM DROPLETS (or larger) WHEN THE APPLICATION IS MADE MORE THAN ONE FOOT ABOVE THE GROUND	25 feet
ALL OTHER APPLICATIONS TYPES HAVE NO APPLICATION EXCLUSION ZONES	No AEZ

CONTACT YOUR EMPLOYER ABOUT RESTRICTED ZONES AND DROPLET SIZE BEFORE YOUR SHIFT

? HOW FAR WOULD 100 feet BE? ?

APPLICATION EXCLUSION ZONE (AEZ)



SPRAY ATOMIZER

Topic 1 - Aerial Application Introduction Post Quiz
Internet Link to Assignment…
http://www.abctlc.com/downlaods/PDF/AerialApplicationAss.pdf

Answers are after the Glossary in rear
Fill in the blank

1. ___________can be a problem with aerial spraying and environmental contamination can be significant if spraying is incorrectly executed.

Ultra-Low Volume (ULV)

2. Ultra-low volume application of pesticides has been defined as spraying at a Volume _____________of less than 5 L/ha for field crops or less than 50 L/ha for tree/bush crops.

Field Application

3. __________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.

Enclosed Cabs

4. Enclosed cabs must have ________that totally surrounds the occupants and prevents contact with pesticides outside of the cab.

Advantages of Rotary Wing Aircraft

5. 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__________.

Chemical Handling

6. Handling and loading chemical products must only be carried out by________________.

Dry-Material Spreaders

7. ______________are used to distribute dry formulations of herbicides, fertilizers, and seed.

8. Fixed-wing aircraft use _____________while helicopters use rotary spreaders. Venturi spreaders clamp to the gate box at the base of the hopper.

9. A recent approach for helicopters is to use ____________and forced-air boom.

Swath Pattern Application

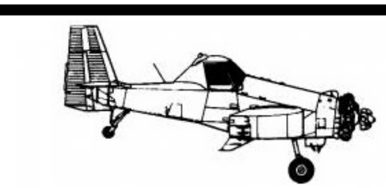
10. __________are valuable for metering pelleted herbicides or hard slick grass seed in fixed-wing aircraft.

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

Topic 2 - Understanding Hydraulics and Sprayer Principles

Section Focus: You will learn the basics of fluid mechanics and hydraulic principles. At the end of this section, you will be able to describe water mechanics and hydraulic principles necessary to apply chemical. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: In order to design and apply pesticide spray/flow rates, pumping system, calculate pump/chemical flows, we need to master this area of engineering.



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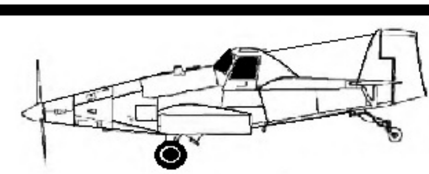


THRUSH 510G

PARAMETERS			
LENGTH / ft.	31.00 feet	LENGTH / ft.	32.3 feet
HEIGHT / ft.	12.1 feet	HEIGHT / ft.	9.3 feet
WING SPAN / ft.	58.0 feet	WING SPAN / ft.	47.5 feet
WING AREA / ft.	131.2 feet	WING AREA / ft.	111.2 feet
EMPTY WEIGHT / lbs.	5974.5 lbs.	EMPTY WEIGHT / lbs.	4700.2 lbs.
MAX. TAKE OFF WEIGHT / lbs.	11684.5 lbs.	MAX. TAKE OFF WEIGHT / lbs.	10500.6 lbs.
MAXIMUM SPEED / mph	142.9 mph	MAXIMUM SPEED / mph	149.7 mph
SPRAY WIDTH / ft.	147.6 ft.	SPRAY WIDTH / ft.	137.7 ft.

CROP DUSTER AIRCRAFT EXAMPLES

Understanding how pesticides are applied and how airplanes fly.

Definition: **Hydraulics** is a branch of engineering concerned mainly with moving liquids. The term is applied commonly to the study of the mechanical properties of water, other liquids, and even gases when the effects of compressibility are small. Hydraulics can be divided into two areas, hydrostatics and hydrokinetics.

Hydraulics: ***The Engineering science pertaining to liquid pressure and flow.***
The word ***hydraulics*** is based on the Greek word for water, and originally covered the study of the physical behavior of water at rest and in motion. Use has broadened its meaning to include the behavior of all liquids, although it is primarily concerned with the motion of liquids.

Hydraulics includes the manner in which liquids act in tanks and pipes, deals with their properties, and explores ways to take advantage of these properties.

Hydrostatics, the consideration of liquids at rest, involves problems of buoyancy and flotation, pressure on dams and submerged devices, and hydraulic presses. The relative incompressibility of liquids is one of its basic principles.

Hydrodynamics, the study of liquids in motion, is concerned with such matters as friction and turbulence generated in pipes by flowing liquids, the flow of water over weirs and through nozzles, and the use of hydraulic pressure in machinery.

Hydrostatics
Hydrostatics is about the pressures exerted by a fluid at rest. Any fluid is meant, not just water. Research and careful study on water yields many useful results of its own, however, such as forces on dams, buoyancy and hydraulic actuation, and is well worth studying for such practical reasons.

Hydrostatics is an excellent example of deductive mathematical physics, one that can be understood easily and completely from a very few fundamentals, and in which the predictions agree closely with experiment.

There are few better illustrations of the use of the integral calculus, as well as the principles of ordinary statics, available to the student. A great deal can be done with only elementary mathematics. Properly adapted, the material can be used from the earliest introduction of school science, giving an excellent example of a quantitative science with many possibilities for hands-on experiences.

The definition of a fluid deserves careful consideration. Although time is not a factor in hydrostatics, it enters in the approach to hydrostatic equilibrium. It is usually stated that a fluid is a substance that cannot resist a shearing stress, so that pressures are normal to confining surfaces.

Geology has now shown us clearly that there are substances which can resist shearing forces over short time intervals, and appear to be typical solids, but which flow like liquids over long time intervals. Such materials include wax and pitch, ice, and even rock.

A ball of pitch, which can be shattered by a hammer, will spread out and flow in months. Ice, a typical solid, will flow in a period of years, as shown in glaciers, and rock will flow over hundreds of years, as in convection in the mantle of the earth.

Shear earthquake waves, with periods of seconds, propagate deep in the earth, though the rock there can flow like a liquid when considered over centuries. The rate of shearing may not be strictly proportional to the stress but exists even with low stress.

Viscosity may be the physical property that varies over the largest numerical range, competing with electrical resistivity. There are several familiar topics in hydrostatics which often appears in expositions of introductory science, and which are also of historical interest and can enliven their presentation. Let’s start our study with the principles of our atmosphere.

Atmospheric Pressure

The atmosphere is the entire mass of air that surrounds the earth. While it extends upward for about 500 miles, the section of primary interest is the portion that rests on the earth's surface and extends upward for about 7 1/2 miles. This layer is called the troposphere.

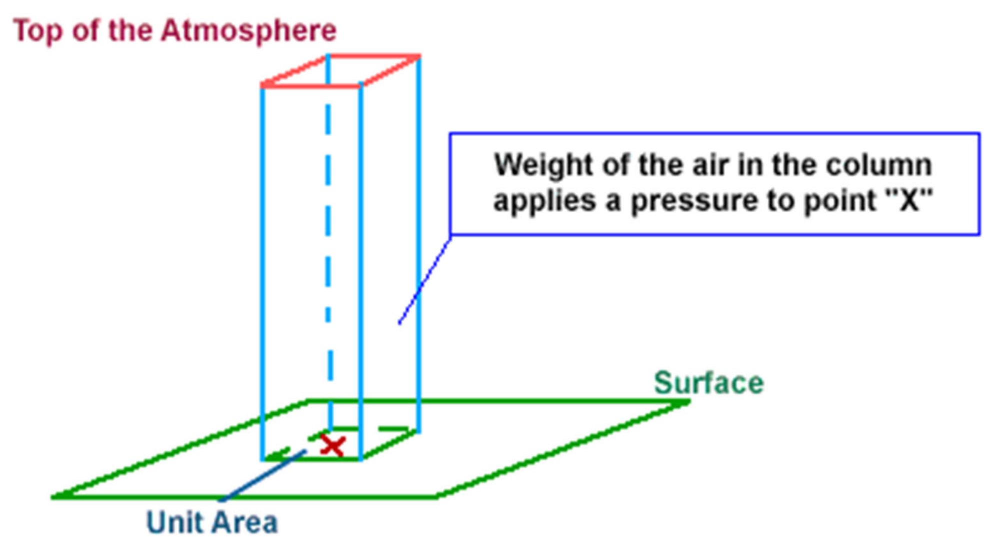
If a column of air 1-inch square extending all the way to the "***top***" of the atmosphere could be weighed, this column of air would weigh approximately 14.7 pounds at sea level. Thus, atmospheric pressure at sea level is approximately 14.7 psi.

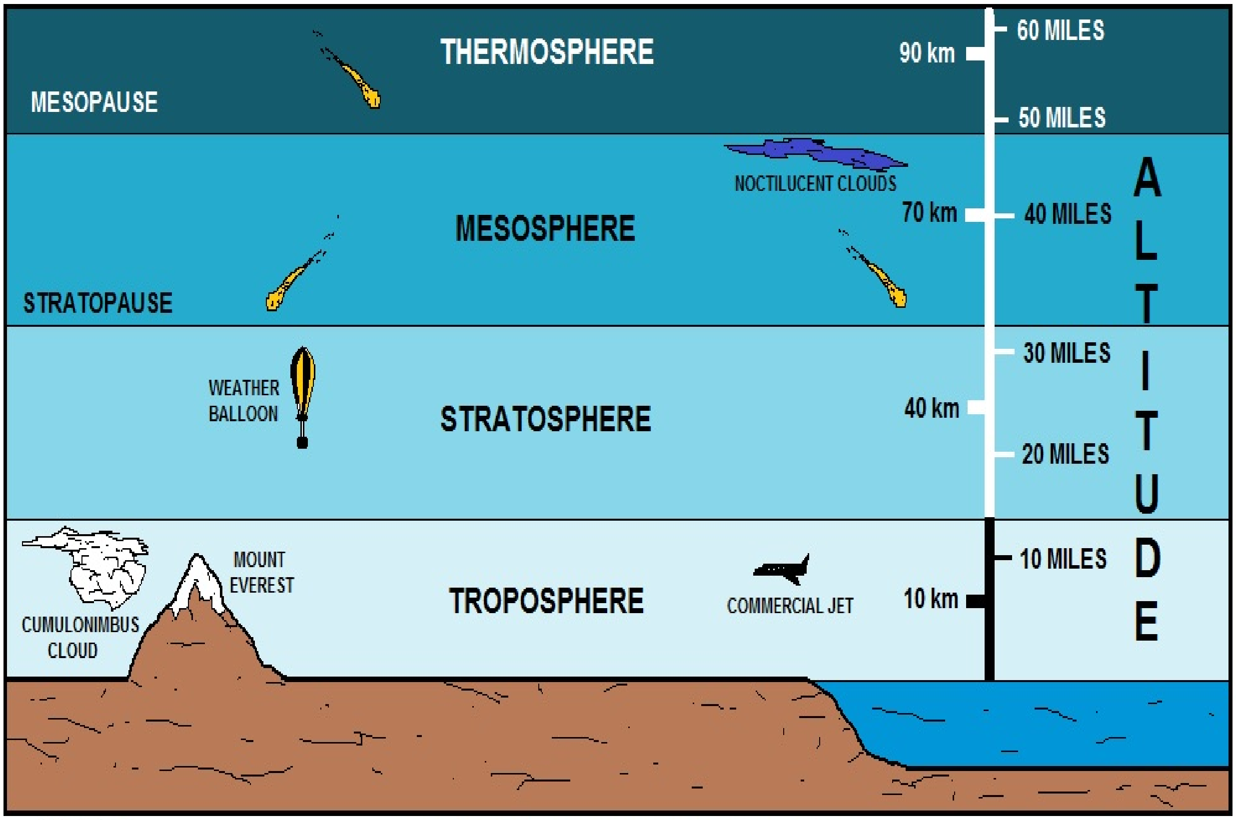
As one ascends, the atmospheric pressure decreases by approximately 1.0 psi for every 2,343 feet. However, below sea level, in excavations and depressions, atmospheric pressure increases. Pressures under water differ from those under air only because the weight of the water must be added to the pressure of the air.

Atmospheric pressure can be measured by any of several methods. The common laboratory method uses the mercury column barometer. The height of the mercury column serves as an indicator of atmospheric pressure. At sea level and at a temperature of 0° Celsius (**C**), the height of the mercury column is approximately 30 inches, or 76 centimeters. This represents a pressure of approximately 14.7 psi. The 30-inch column is used as a reference standard.

Another device used to measure atmospheric pressure is the aneroid barometer. The aneroid barometer uses the change in shape of an evacuated metal cell to measure variations in atmospheric pressure. The thin metal of the aneroid cell moves in or out with the variation of pressure on its external surface. This movement is transmitted through a system of levers to a pointer, which indicates the pressure.

The atmospheric pressure does not vary uniformly with altitude. It changes very rapidly. Atmospheric pressure is defined as the force per unit area exerted against a surface by the weight of the air above that surface. In the diagram on the following page, the pressure at point "**X**" increases as the weight of the air above it increases. The same can be said about decreasing pressure, where the pressure at point "**X**" decreases if the weight of the air above it also decreases.





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ATMOSPHERE DIAGRAM

UNIT	ABBREVIATION	EQUIVALENT NUMBER OF PASCALS
ATMOSPHERE	atm	1 atm = 101,325 Pa
BAR	bar	1 bar = 100,025 Pa
MILLIMETER OF MERCURY	mmHg	1 mmHg = 133.322 Pa
INCHES OF MERCURY	inHg	1 inHg = 3386 Pa
PASCAL	Pa	1
KILOPASCAL	kPa	1 kPa = 1000 Pa
POUNDS PER SQUARE INCH	psi	1 psi = 6,893 Pa
TORR	torr	1 torr = 133.322 Pa

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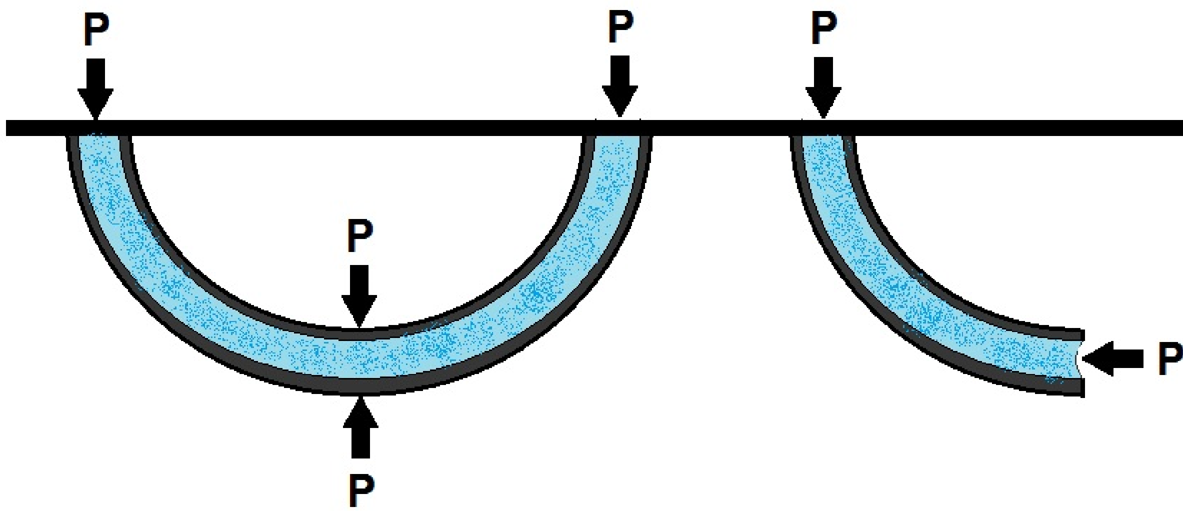
DIFFERENT UNITS OF PRESSURE

Pressure

By a fluid, we have a material in mind like water or air, two very common and important fluids. Water is incompressible, while air is very compressible, but both are fluids. Water has a definite volume; air does not. Water and air have low viscosity; that is, layers of them slide very easily on one another, and they quickly assume their permanent shapes when disturbed by rapid flows. Other fluids, such as molasses, may have high viscosity and take a long time to come to equilibrium, but they are no less fluids. The coefficient of viscosity is the ratio of the shearing force to the velocity gradient. Hydrostatics deals with permanent, time-independent states of fluids, so viscosity does not appear, except as discussed in the Introduction.



EQUALITY OF PRESSURE DIAGRAM

A fluid, therefore, is a substance that cannot exert any permanent forces tangential to a boundary. Any force that it exerts on a boundary must be normal to the boundary. Such a force is proportional to the area on which it is exerted and is called a pressure. We can imagine any surface in a fluid as dividing the fluid into parts pressing on each other, as if it were a thin material membrane, and so think of the pressure at any point in the fluid, not just at the boundaries. In order for any small element of the fluid to be in equilibrium, the pressure must be the same in all directions (or the element would move in the direction of least pressure), and if no other forces are acting on the body of the fluid, the pressure must be the same at all neighboring points.

Therefore, in this case the pressure will be the same throughout the fluid, and the same in any direction at a point (Pascal's Principle). Pressure is expressed in units of force per unit area such as dyne/cm^2, N/cm^2 (Pascal), pounds/in^2 (psi) or pounds/ft^2 (psf). The axiom that if a certain volume of fluid were somehow made solid, the equilibrium of forces would not be disturbed is useful in reasoning about forces in fluids.

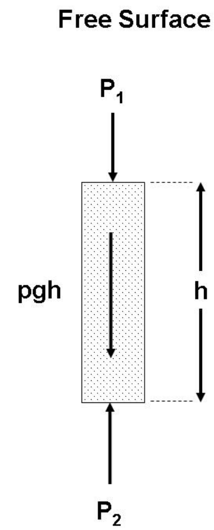
On earth, fluids are also subject to the force of gravity, which acts vertically downward, and has a magnitude $\gamma = \rho g$ per unit volume, where g is the acceleration of gravity, approximately 981 cm/s^2 or 32.15 ft/s^2, ρ is the density, the mass per unit volume, expressed in g/cm^3, kg/m^3, or slug/ft^3, and γ is the specific weight, measured in lb/in^3, or lb/ft^3 (pcf).

Gravitation is an example of a body force that disturbs the equality of pressure in a fluid. The presence of the gravitational body force causes the pressure to increase with depth, according to the equation dp = ρg dh, in order to support the water above. We call this relation the barometric equation, for when this equation is integrated, we find the variation of pressure with height or depth. If the fluid is incompressible, the equation can be integrated at once, and the pressure as a function of depth h is p = ρgh + p0.

The density of water is about 1 g/cm^3, or its specific weight is 62.4 pcf. We may ask what depth of water gives the normal sea-level atmospheric pressure of 14.7 psi, or 2117 psf.

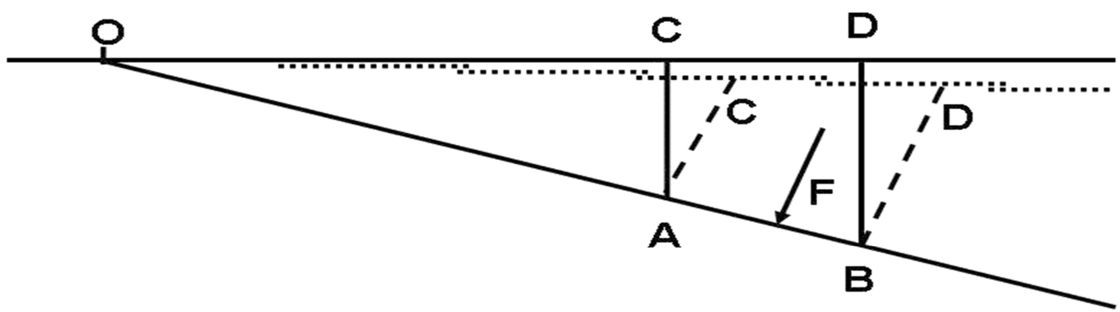
This is simply 2117 / 62.4 = 33.9 ft of water. This is the maximum height to which water can be raised by a suction pump, or, more correctly, can be supported by atmospheric pressure. Professor James Thomson (brother of William Thomson, Lord Kelvin) illustrated the equality of pressure by a "curtain-ring" analogy shown in the diagram. A section of the toroid was identified, imagined to be solidified, and its equilibrium was analyzed.

The forces exerted on the curved surfaces have no component along the normal to a plane section, so the pressures at any two points of a plane must be equal, since the fluid represented by the curtain ring was in equilibrium.



Increase of Pressure with Depth

The diagram illustrates the equality of pressures in orthogonal directions. This can be extended to any direction whatever, so Pascal's Principle is established. This demonstration is similar to the usual one using a triangular prism and considering the forces on the end and lateral faces separately.



Thrust on a Plane

Free Surface Perpendicular to Gravity

When gravity acts, the liquid assumes a free surface perpendicular to gravity, which can be proved by Thomson's method. A straight cylinder of unit cross-sectional area (assumed only for ease in the arithmetic) can be used to find the increase of pressure with depth. Indeed, we see that $p2 = p1 + \rho gh$. The upper surface of the cylinder can be placed at the free surface if desired. The pressure is now the same in any direction at a point, but is greater at points that lie deeper. From this same figure, it is easy to prove Archimedes' Principle that the buoyant force is equal to the weight of the displaced fluid, and passes through the center of mass of this displaced fluid.

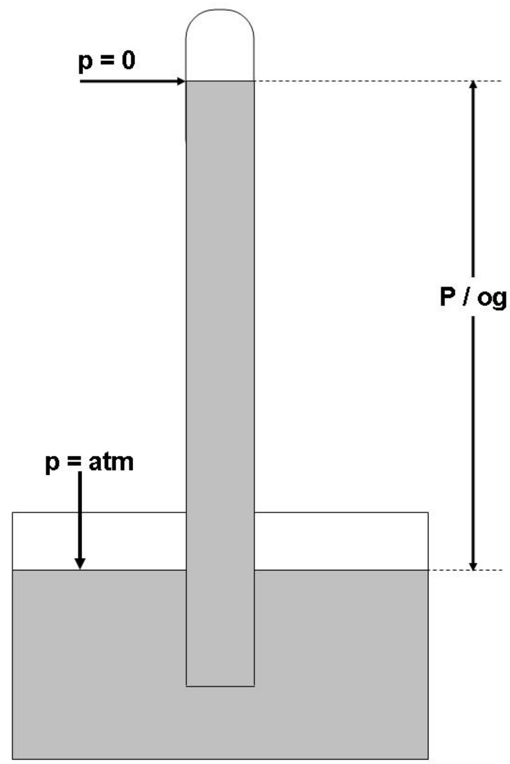
Geometric Arguments

Ingenious geometric arguments can be used to substitute for easier, but less transparent arguments using calculus. For example, the force acting on one side of an inclined plane surface whose projection is AB can be found as in the diagram on the previous page.

O is the point at which the prolonged projection intersects the free surface.

The line AC' perpendicular to the plane is made equal to the depth AC of point A, and line BD' is similarly drawn equal to BD. The line OD' also passes through C', by proportionality of triangles OAC' and OAD'.

Therefore, the thrust F on the plane is the weight of a prism of fluid of cross-section AC'D'B, passing through its centroid normal to plane AB. Note that the thrust is equal to the density times the area times the depth of the center of the area; its line of action does not pass through the center, but below it, at the center of thrust. The same result can be obtained with calculus by summing the pressures and the moments.



Barometer

Atmospheric Pressure and its Effects

Suppose a vertical pipe is stood in a pool of water, and a vacuum pump applied to the upper end. Before we start the pump, the water levels outside and inside the pipe are equal, and the pressures on the surfaces are also equal and are equal to the atmospheric pressure.

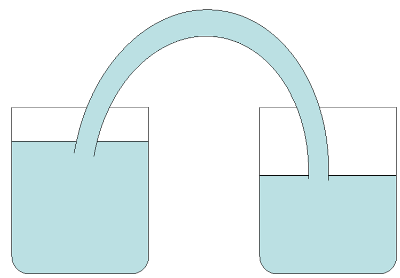
Now start the pump. When it has sucked all the air out above the water, the pressure on the surface of the water inside the pipe is zero, and the pressure at the level of the water on the outside of the pipe is still the atmospheric pressure.

Of course, there is the vapor pressure of the water to worry about if you want to be precise, but we neglect this complication in making our point. We require a column of water 33.9 ft high inside the pipe, with a vacuum above it, to balance the atmospheric pressure. Now do the same thing with liquid mercury, whose density at 0 °C is 13.5951 times that of water. The height of the column is 2.494 ft, 29.92 in, or 760.0 mm.

Standard Atmospheric Pressure

This definition of the standard atmospheric pressure was established by Regnault in the mid-19th century. In Britain, 30 in. Hg (inches of mercury) had been used previously. As a practical matter, it is convenient to measure pressure differences by measuring the height of liquid columns, a practice known as manometry. The barometer is a familiar example of this, and atmospheric pressures are traditionally given in terms of the length of a mercury column. To make a barometer, the barometric tube, closed at one end, is filled with mercury and then inverted and placed in a mercury reservoir. Corrections must be made for temperature, because the density of mercury depends on the temperature, and the brass scale expands for capillarity if the tube is less than about 1 cm in diameter, and even slightly for altitude, since the value of g changes with altitude.

The vapor pressure of mercury is only 0.001201 mmHg at 20°C, so a correction from this source is negligible. For the usual case of a mercury column (α = 0.000181792 per °C) and a brass scale (&alpha = 0.0000184 per °C) the temperature correction is -2.74 mm at 760 mm and 20°C. Before reading the barometer scale, the mercury reservoir is raised or lowered until the surface of the mercury just touches a reference point, which is mirrored in the surface so it is easy to determine the proper position.



Siphon

An aneroid barometer uses a partially evacuated chamber of thin metal that expands and contracts according to the external pressure. This movement is communicated to a needle that revolves in a dial. The materials and construction are arranged to give a low temperature coefficient. The instrument must be calibrated before use, and is usually arranged to read directly in elevations. An aneroid barometer is much easier to use in field observations, such as in reconnaissance surveys. In a particular case, it would be read at the start of the day at the base camp, at various points in the vicinity, and then finally at the starting point, to determine the change in pressure with time. The height differences can be calculated from $h = 60{,}360 \log (P/p) [1 + (T + t - 64)/986]$ feet, where P and p are in the same units, and T, t are in °F. An absolute pressure is referring to a vacuum, while a gauge pressure is referring to the atmospheric pressure at the moment. A negative gauge pressure is a (partial) vacuum. When a vacuum is stated to be so many inches, this means the pressure below the atmospheric pressure of about 30 in. A vacuum of 25 inches is the same thing as an absolute pressure of 5 inches (of mercury).

Vacuum

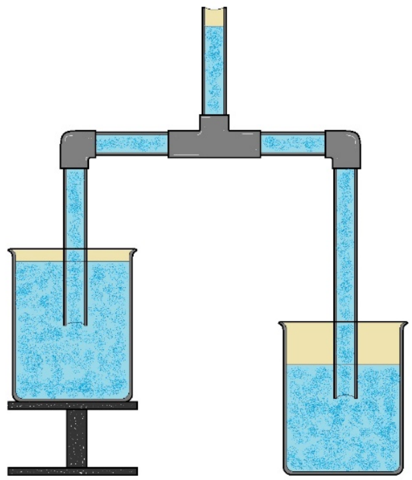
The term ***vacuum*** indicates that the absolute pressure is less than the atmospheric pressure and that the gauge pressure is negative. A complete or total vacuum would mean a pressure of 0 psia or –14.7 psig. Since it is impossible to produce a total vacuum, the term vacuum, as used in this document, will mean all degrees of partial vacuum. In a partial vacuum, the pressure would range from slightly less than 14.7 psia (0 psig) to slightly greater than 0 psia (-14.7 psig).

Water Pressure

The weight of a cubic foot of water is 62.4 pounds per square foot. The base can be subdivided into 144-square inches with each subdivision being subjected to a pressure of 0.433 psig. Suppose you placed another cubic foot of water on top of the first cubic foot. The pressure on the top surface of the first cube which was originally atmospheric, or 0 psig, would now be 0.4333 psig as a result of the additional cubic foot of water. The pressure of the base of the first cubic foot would be increased by the same amount of 0.866 psig or two times the original pressure.

Pressures are very frequently stated in terms of the height of a fluid. If it is the same fluid whose pressure is being given, it is usually called "head," and the factor connecting the head and the pressure is the weight density ρg. In the English engineer's system, weight density is in pounds per cubic inch or cubic foot. A head of 10 ft is equivalent to a pressure of 624 psf, or 4.33 psi. It can also be considered an energy availability of ft-lb per lb. Water with a pressure head of 10 ft can furnish the same energy as an equal amount of water raised by 10 ft. Water flowing in a pipe is subject to head loss because of friction.

Take a jar and a basin of water. Fill the jar with water and invert it under the water in the basin. Now raise the jar as far as you can without allowing its mouth to come above the water surface. It is always a little surprising to see that the jar does not empty itself, but the water remains with no visible means of support. By blowing through a straw, one can put air into the jar, and as much water leaves as air enters. In fact, this is a famous method of collecting insoluble gases in the chemical laboratory, or for supplying hummingbird feeders. It is good to remind oneself of exactly the balance of forces involved.



PASCAL'S SIPHON

Another application of pressure is the siphon. The name is Greek for the tube that was used for drawing wine from a cask. This is a tube filled with fluid connecting two containers of fluid, normally rising higher than the water levels in the two containers, at least to pass over their rims. In the diagram, the two water levels are the same, so there will be no flow. When a siphon goes below the free water levels, it is called an inverted siphon. If the levels in the two basins are not equal, fluid flows from the basin with the higher level into the one with the lower level, until the levels are equal.

A siphon can be made by filling the tube, closing the ends, and then putting the ends under the surface on both sides. Alternatively, the tube can be placed in one fluid and filled by sucking on it. When it is full, the other end is put in place. The analysis of the siphon is easy, and should be obvious. The pressure rises or falls as described by the barometric equation through the siphon tube. There is obviously a maximum height for the siphon which is the same as the limit of the suction pump, about 34 feet. Inverted siphons are sometimes used in pipelines to cross valleys. Differences in elevation are usually too great to use regular siphons to cross hills, so the fluids must be pressurized by pumps so the pressure does not fall to zero at the crests.

Liquids at Rest
In studying fluids at rest, we are concerned with the transmission of force and the factors which affect the forces in liquids. Additionally, pressure in and on liquids and factors affecting pressure are of great importance.

Pressure and Force
Pressure is the force that pushes water through pipes. Water pressure determines the flow of water from the tap. If pressure is not sufficient then the flow can reduce to a trickle and it will take a long time to fill a kettle or a cistern. The terms ***force*** and ***pressure*** are used extensively in the study of fluid power. It is essential that we distinguish between the terms.

Force means a total push or pull. It is the push or pull exerted against the total area of a particular surface and is expressed in pounds or grams. Pressure means the amount of push or pull (force) applied to each unit area of the surface and is expressed in pounds per square inch (lb/in^2) or grams per square centimeter (gm/cm^2). Pressure maybe exerted in one direction, in several directions, or in all directions.

Computing Force, Pressure, and Area
A formula is used in computing force, pressure, and area in fluid power systems. In this formula, P refers to pressure, F indicates force, and A represents area. Force equals pressure times area. Thus, the formula is written:

Development of Hydraulics

Although the modern development of hydraulics is comparatively recent, the ancients were familiar with many hydraulic principles and their applications. The Egyptians and the ancient people of Persia, India, and China conveyed water along channels for irrigation and domestic purposes, using dams and sluice gates to control the flow. The ancient Cretans had an elaborate plumbing system.

ARCHIMEDES

Archimedes studied the laws of floating and submerged bodies. The Romans constructed aqueducts to carry water to their cities.

After the breakup of the ancient world, there were few new developments for many centuries. Then, over a comparatively short period, beginning near the end of the seventeenth century, Italian physicist, Evangelista Torricelle, French physicist, Edme Mariotte, and later, Daniel Bernoulli conducted experiments to study the elements of force in the discharge of water through small openings in the sides of tanks and through short pipes. During the same period, Blaise Pascal, a French scientist, discovered the fundamental law for the science of hydraulics.

Pascal’s law states that increase in pressure on the surface of a confined fluid is transmitted undiminished throughout the confining vessel or system.

For Pascal’s law to be made effective for practical applications, it was necessary to have a piston that "fit exactly." It was not until the latter part of the eighteenth century that methods were found to make these snugly fitted parts required in hydraulic systems.

This was accomplished by the invention of machines that were used to cut and shape the necessary closely fitted parts and, particularly, by the development of gaskets and packings. Since that time, components such as valves, pumps, actuating cylinders, and motors have been developed and refined to make hydraulics one of the leading methods of transmitting power.

Liquids are almost incompressible.

For example, if a pressure of 100 pounds per square inch (**psi**) is applied to a given volume of water that is at atmospheric pressure, the volume will decrease by only 0.03 percent. It would take a force of approximately 32 tons to reduce its volume by 10 percent; however, when this force is removed, the water immediately returns to its original volume.

Other liquids behave in about the same manner as water.

Another characteristic of a liquid is the tendency to keep its free surface level. If the surface is not level, liquids will flow in the direction which will tend to *make* the surface level.

Evangelista Torricelli
Evangelista Torricelli (1608-1647), Galileo's student and secretary and a member of the Florentine Academy of Experiments, invented the mercury barometer in 1643, and brought the weight of the atmosphere to light. The mercury column was held up by the pressure of the atmosphere, not by horror vacui as Aristotle had supposed. Torricelli's early death was a blow to science, but their ideas were furthered by Blaise Pascal (1623-1662).

Pascal had a barometer carried up the 1465 m high Puy de Dôme, an extinct volcano in the Auvergne just west of their home of Clermont-Ferrand in 1648 by Périer, their brother-in-law. Pascal's experimentum crucis is one of the triumphs of early modern science. The Puy de Dôme is not the highest peak in the Massif Central--the Puy de Sancy, at 1866 m is, but it was the closest. Clermont is now the center of the French pneumatics industry.

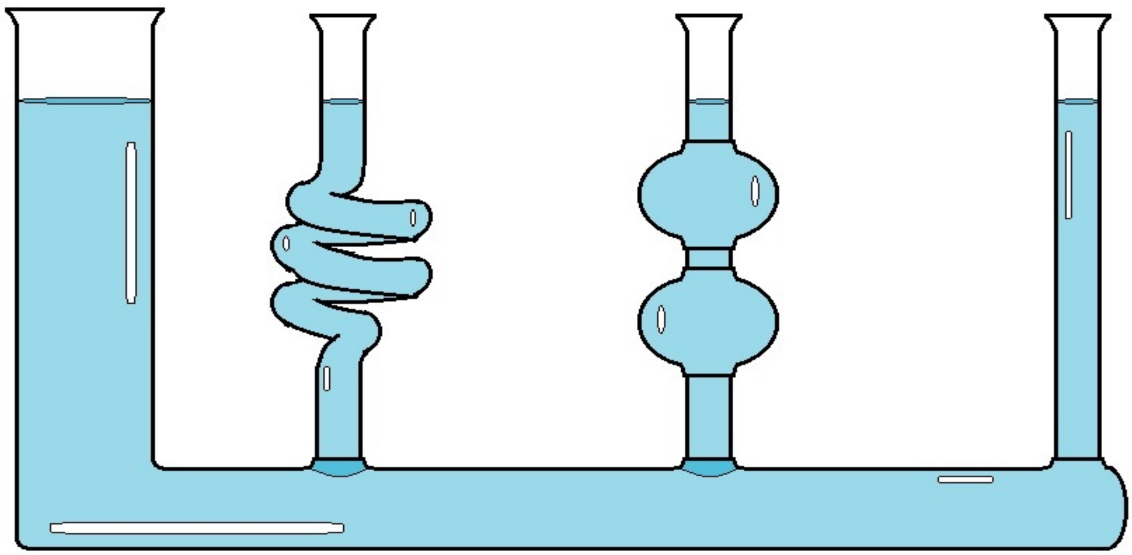
Meteorology
The atmospheric pressure is of great importance in meteorology, since it determines the winds, which generally move at right angles to the direction of the most rapid change of pressure, that is, along the isobars, which are contours of constant pressure.

Certain typical weather patterns are associated with relatively high and relatively low pressures, and how they vary with time. The barometric pressure may be given in popular weather forecasts, though few people know what to do with it. If you live at a high altitude, your local weather reporter may report the pressure to be, say, 29.2 inches, but if you have a real barometer, you may well find that it is closer to 25 inches. At an elevation of 1500 m (near Denver, or the top of the Puy de Dôme), the atmospheric pressure is about 635 mm, and water boils at 95 °C.

In fact, altitude is quite a problem in meteorology, since pressures must be measured at a common level to be meaningful. The barometric pressures quoted in the news are reduced to sea level by standard formulas that amount to assuming that there is a column of air from your feet to sea level with a certain temperature distribution, and adding the weight of this column to the actual barometric pressure. This is only an arbitrary 'fix' and leads to some strange conclusions, such as the permanent winter highs above high plateaus that are really imaginary.

Pascal's Law

The foundation of modern hydraulics was established when Pascal discovered that pressure in a fluid acts equally in all directions. This pressure acts at right angles to the containing surfaces. If some type of pressure gauge, with an exposed face, is placed beneath the surface of a liquid at a specific depth and pointed in different directions, the pressure will read the same. Thus, we can say that pressure in a liquid is independent of direction.



PRESSURE IN LIQUIDS

PASCAL'S VASES DEMONSTRATE THE FACT THAT THE PRESSURE OF THE LIQUID DEPENDS SOLELY ON THE DEPTH ALONE, AND NOT THE VOLUME OR THE SHAPE OF THE FLUID

Pressure due to the weight of a liquid, at any level, depends on the depth of the fluid from the surface. If the exposed face of the pressure gauges are moved closer to the surface of the liquid, the indicated pressure will be less. When the depth is doubled, the indicated pressure is doubled. Thus the pressure in a liquid is directly proportional to the depth. Consider a container with vertical sides that is 1 foot long and 1 foot wide. Let it be filled with water 1 foot deep, providing 1 cubic foot of water. 1 cubic foot of water weighs 62.4 pounds. Using this information and equation, **P = F/A**, we can calculate the pressure on the bottom of the container.

Since there are 144 square inches in 1 square foot, this can be stated as follows: the weight of a column of water 1 foot high, having a cross-sectional area of 1 square inch, is 0.433 pound. If the depth of the column is tripled, the weight of the column will be 3 x 0.433, or 1.299 pounds, and the pressure at the bottom will be 1.299 lb/in^2 (psi), since pressure equals the force divided by the area.

Thus, the pressure at any depth in a liquid is equal to the weight of the column of liquid at that depth divided by the cross-sectional area of the column at that depth. The volume of a liquid that produces the pressure is referred to as the fluid head of the liquid. The pressure of a liquid due to its fluid head is also dependent on the density of the liquid.

Gravity

Gravity is one of the four forces of nature. The strength of the gravitational force between two objects depends on their masses. The more massive the objects are, the stronger the gravitational attraction.

When you pour water out of a container, the earth's gravity pulls the water towards the ground. The same thing happens when you put two buckets of water, with a tube between them, at two different heights. You must work to start the flow of water from one bucket to the other, but then gravity takes over and the process will continue on its own.

Gravity, applied forces, and atmospheric pressure are static factors that apply equally to fluids at rest or in motion, while inertia and friction are dynamic factors that apply only to fluids in motion. The mathematical sum of gravity, applied force, and atmospheric pressure is the static pressure obtained at any one point in a fluid at any given time.

Static Pressure

Static pressure exists in addition to any dynamic factors that may also be present at the same time. Pascal's law states that a pressure set up in a fluid acts equally in all directions and at right angles to the containing surfaces. This covers the situation only for fluids at rest or practically at rest. It is true only for the factors making up static head. Obviously, when velocity becomes a factor it must have a direction, and as previously explained, the force related to the velocity must also have a direction, so that Pascal's law alone does not apply to the dynamic factors of fluid power.

The dynamic factors of inertia and friction are related to the static factors. Velocity head and friction head are obtained at the expense of static head. However, a portion of the velocity head can always be reconverted to static head.

Force, which can be produced by pressure or head when dealing with fluids, is necessary to start a body moving if it is at rest, and is present in some form when the motion of the body is arrested; therefore, whenever a fluid is given velocity, some part of its original static head is used to impart this velocity, which then exists as velocity head.

Volume and Velocity of Flow

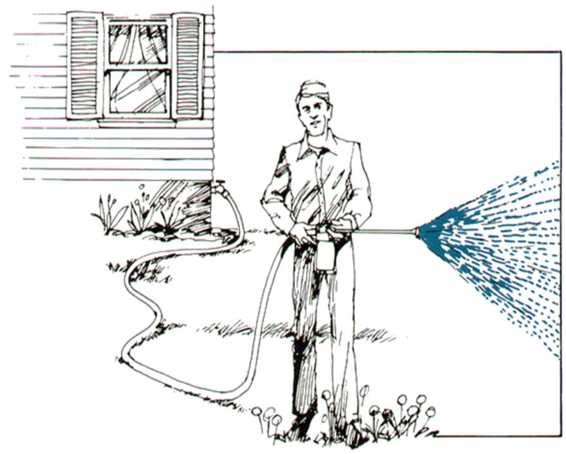
The volume of a liquid passing a point in a given time is known as its *volume of flow* or flow rate. The volume of flow is usually expressed in gallons per minute (gpm) and is associated with relative pressures of the liquid, such as 5 gpm at 40 psi. The *velocity of flow* or velocity of the fluid is defined as the average speed at which the fluid moves past a given point. It is usually expressed in feet per second (fps) or feet per minute (fpm). Velocity of flow is an important consideration in sizing the hydraulic lines.

Volume and velocity of flow are often considered together. With other conditions unaltered—that is, with volume of input unchanged—the velocity of flow increases as the cross section or size of the pipe decreases, and the velocity of flow decreases as the cross section increases. For example, the velocity of flow is slow at wide parts of a stream and rapid at narrow parts, yet the volume of water passing each part of the stream is the same.

Bernoulli's Principle

Bernoulli's principle thus says that a rise (fall) in pressure in a flowing fluid must always be accompanied by a decrease (increase) in the speed, and conversely, if an increase (decrease) in, the speed of the fluid results in a decrease (increase) in the pressure.

This is at the heart of a number of everyday phenomena. As a very trivial example, Bernoulli's principle is responsible for the fact that a shower curtain gets "***sucked inwards***" when the water is first turned on. What happens is that the increased water/air velocity inside the curtain (relative to the still air on the other side) causes a pressure drop.

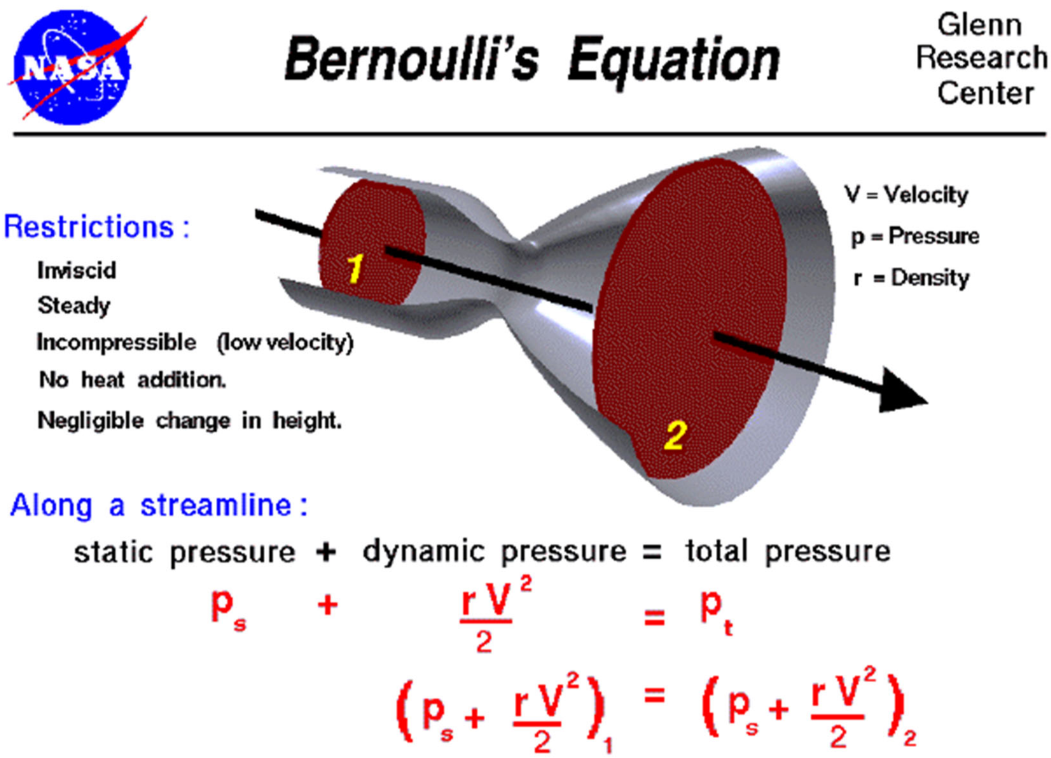


The pressure difference between the outside and inside causes a net force on the shower curtain which sucks it inward. A more useful example is provided by the functioning of a perfume bottle: squeezing the bulb over the fluid creates a low pressure area due to the higher speed of the air, which subsequently draws the fluid up. This is illustrated in the following figure.

Bernoulli's principle also tells us why windows tend to explode, rather than implode in hurricanes: the very high speed of the air just outside the window causes the pressure just outside to be much less than the pressure inside, where the air is still.

The difference in force pushes the windows outward, and hence they explode. If you know that a hurricane is coming it is therefore better to open as many windows as possible, to equalize the pressure inside and out.

Another example of Bernoulli's principle at work is in the lift of aircraft wings and the motion of "***curve balls***" in baseball. In both cases the design is such as to create a speed differential of the flowing air past the object on the top and the bottom - for aircraft wings this comes from the movement of the flaps, and for the baseball it is the presence of ridges. Such a speed differential leads to a pressure difference between the top and bottom of the object, resulting in a net force being exerted, either upwards or downwards.



Understanding the Venturi

It is not easy to understand the reason low pressure occurs in the small diameter area of the venturi. This explanation may seem to help the principle. It is clear that all the flow must pass from the larger section to the smaller section.

Or in other words, the flow rate will remain the same in the large and small portions of the tube. The flow rate is the same rate, but the velocity changes. The velocity is greater in the small portion of the tube. There is a relationship between the pressure energy and the velocity energy; if velocity increases the pressure energy must decrease.

This is known as the principle of conservation of energy at work which is also Bernoulli's law. This is similar to the soapbox derby car in the illustration at the top of a hill. At the top or point, the elevation of the soapbox derby car is high and the velocity low. At the bottom the elevation is low and the velocity is high, elevation (potential) energy has been converted to velocity (kinetic) energy.

Pressure and velocity energies behave in the same way. In the large part of the pipe the pressure is high and velocity is low, in the small part, pressure is low and velocity high.

Properties of Fluids

Fluids are not strictly continuous media in the way that all the successors of Euler and Bernoulli have assumed, for fluids are composed of discrete molecules. The molecules, though, are so small and, except in gases at very low pressures, the number of molecules per milliliter is so enormous that they need not be viewed as individual entities.

There are a few liquids, known as liquid crystals, in which the molecules are packed together in such a way as to make the properties of the medium locally anisotropic, but the vast majority of fluids -including air and water- are isotropic.

In fluid mechanics, the state of an isotropic fluid may be completely described by defining its mean mass per unit volume, or density (ρ), its temperature (T), and its velocity (v) at every point in space, and just what the connection is between these macroscopic properties and the positions and velocities of individual molecules is of no direct relevance.

Isotropic Fluid or Newtonian Fluid
If the fluid is also isotropic (that is, its mechanical properties are the same along any direction), the viscosity tensor reduces to two real coefficients, describing the fluid's resistance to continuous shear deformation and continuous compression or expansion, respectively.

Fluid Statics
Fluid statics or hydrostatics is the branch of fluid mechanics that studies fluids at rest. It embraces the study of the conditions under which fluids are at rest in stable equilibrium; and is contrasted with fluid dynamics, the study of fluids in motion.

Hydrostatics offers physical explanations for many wonders of everyday life, such as why atmospheric pressure changes with altitude, why wood and oil float on water, and why the surface of water is always flat and horizontal whatever the shape of its container.

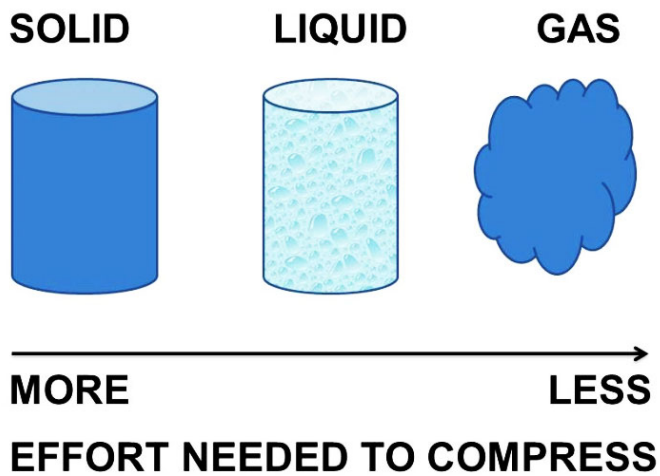
Hydrostatics is fundamental to hydraulics, the engineering of equipment for storing, transporting and using fluids. It is also relevant to some aspect of geophysics and astrophysics (i.e., in understanding plate tectonics and anomalies in the Earth's gravitational field), to meteorology, to medicine (with the context of blood pressure), and many other fields.

Fluid Dynamics
Fluid dynamics is a sub-discipline of fluid mechanics that deals with fluid flow—the science of liquids and gases in motion. Fluid dynamics offers a systematic structure—which underlies these practical disciplines—that embraces empirical and semi-empirical laws derived from flow measurement and used to solve practical problems.

The solution to a fluid dynamics problem typically involves calculating various properties of the fluid, such as velocity, pressure, density, and temperature, as functions of space and time.

It has several sub-disciplines itself, including aerodynamics (the study of air and other gases in motion) and hydrodynamics (the study of liquids in motion).

Fluid dynamics has a wide range of applications, including calculating forces and moments on aircraft, determining the mass flow rate of petroleum through pipelines, predicting evolving weather patterns, and even understanding nebulae in interstellar space and modeling explosions.



Gases and Liquids

A word is needed about the difference between gases and liquids, though the difference is easier to perceive than to describe.

In gases, the molecules are sufficiently far apart to move almost independently of one another, and gases tend to expand to fill any volume available to them.

In liquids, the molecules are more or less in contact, and the short-range attractive forces between them make them cohere; the molecules are moving too fast to settle down into the ordered arrays that are characteristic of solids, but not so fast that they can fly apart.

Thus, samples of liquid can exist as drops or as jets with free surfaces, or they can sit in beakers constrained only by gravity, in a way that samples of gas cannot.

Such samples may evaporate in time, as molecules one by one pick up enough speed to escape across the free surface and are not replaced. The lifetime of liquid drops and jets, yet, is normally long enough for evaporation to be ignored.

Properties of Fluids Key Terms

The term fluid includes both liquid and gases. The main difference between a liquid and a gas is that the volume of a liquid remains definite because it takes the shape of the surface on or in which it comes into contact, whereas a gas occupies the complete space available in the container in which it is kept. In hydraulics in civil engineering, the fluid for consideration is liquid, so, we will examine some terms and properties of the liquids

1. DENSITY OR MASS DENSITY

Density or mass density of a fluid is defined as the ratio of the mass of a fluid to its volume. Thus mass per unit volume of a fluid is called density.

It is denoted by the symbol ρ (rho). The unit of mass density in SI unit is kg per cubic meter. The density of liquids may be considered as constant while that of gases changes with the variation of pressure and temperature.

$$\rho = \frac{\text{Mass of fluid}}{\text{Volume of fluid}}$$

The value of density of water is 1gm per cubic centimeter or 1000 kg per cubic meter.

2. SPECIFIC WEIGHT AND WEIGHT DENSITY

Specific weight or weight density of a fluid is the ratio between the weight of a fluid to its volume. Thus weight per unit volume of a fluid is called weight density and it is denoted by the symbol

w.

$$w = \frac{\text{Weight of fluid}}{\text{Volume of fluid}} = \frac{(\text{Mass of fluid}) \times \text{Acceleration due to gravity}}{\text{Volume of fluid}}$$

$$= \frac{\text{Mass of fluid} \times g}{\text{Volume of fluid}} = \rho \times g$$

$$=> w = \rho g$$

The value of specific weight of specific density (w) of water is

$9.81 \times 1000 \text{ Newton/m}^3$

3. SPECIFIC VOLUME

Specific volume of a fluid is defined as the volume of a fluid occupied by a unit mass or volume per unit mass of a fluid.

Specific volume = $$\frac{\text{Volume of fluid}}{\text{Mass of fluid}} = \frac{1}{\frac{\text{Mass of fluid}}{\text{Volume of fluid}}} = \frac{1}{\rho}$$

Thus, specific volume is the reciprocal of mass density. It is expressed as m^3/kg. It is commonly applied to gases.

4. SPECIFIC GRAVITY

Specific gravity is defined as the ratio of the weight density (or density) of a fluid to the weight density (or density) of a standard fluid. For liquids, the standard fluid is taken as water and for gases, the standard fluid is taken as air.

Specific gravity is also called relative density. It is a dimensionless quantity and is denoted by the symbol S.

$$S \text{ (for liquids)} = \frac{\text{Weight density of liquid}}{\text{Weight density of water}}$$

$$S \text{ (for gases)} = \frac{\text{Weight density of gas}}{\text{Weight density of air}}$$

Thus, weight density of a liquid = S x weight density of water = S x $9.81 \times 1000 \text{ Newton/m}^3$

The density of liquid = S x Density of water = S x 1000 kg/m^3.

If the specific gravity of a fluid is known, then the density of the liquid will be equal to specific gravity of fluid multiplied by the density of water. For example, the specific gravity of mercury is 13.6. Hence density of mercury = 13.6 x 1000 kg/m^3.

5. VISCOSITY OF LIQUID:

Viscosity is defined as the property of a fluid which offers resistance to the movement of one layer of fluid over another adjacent layer of fluid. When two layers of a fluid, a distance apart move over one other at different velocities, the viscosity together with relative velocity causes a shear stress acting between the fluid layers.

The top layer causes a shear stress on the adjacent layer while the lower layer causes a shear stress on the top layer. This shear stress is proportional to the rate of change of velocity. It is denoted by the symbol τ.

$$\tau \propto \frac{du}{dy}$$

$$\tau = \mu \frac{du}{dy}$$

Where μ (mu) is the constant of proportionality and is known as the coefficient of dynamic viscosity or only viscosity, $\frac{du}{dy}$ represents the rate of shear strain or rate of shear deformation or velocity gradient.

$$=> \mu = \frac{\tau}{\frac{du}{dy}}$$

The viscosity is also defined as the shear stress required to produce unit rate of shear strain.

Units of Viscosity

In MKS system, unit of viscosity = $\frac{kgf \cdot cm}{m^2}$

CGS unit of viscosity (also called Poise) = $\frac{dyne \cdot \sec}{cm^2}$

SI unit of viscosity = Ns/m^2 =Pa-s

Unit Conversion
Conversion between MKS and CGS system

$$\frac{1\ \text{kgf-sec}}{m^2} = \frac{9.81\text{N-sec}}{m^2}$$

$$dyne = gm \times \frac{cm}{\sec^2}$$

1 N = 1000 x 100 dyne

$$\frac{1\ \text{kgf-sec}}{m^2} = \frac{9.81\text{N-sec}}{m^2} = 98.1\,poise$$

$$1\,poise = \frac{1}{10}\frac{Ns}{m^2}$$

$$1\ \text{centipoise} = \frac{1}{100}\,poise$$

KINEMATIC VISCOSITY
It is defined as the ratio between the dynamic viscosity and density of fluid. It is denoted by the Greek symbol (υ) called nu. Thus,

$$\upsilon = \frac{\text{Viscosity}}{\text{Density}} = \frac{\mu}{\rho}$$

In MKS and SI, the unit of kinematic viscosity is $\text{m}^2/\sec$ while in CGS units, it is written as cm^2/s. In CGS system, kinematic viscosity is also known as stoke.
One stoke =1 cm^2/s

Newton's Law of Viscosity:
It states that the shear stress (τ) on a fluid element layer is directly proportional to the rate of change of shear strain. The constant of proportionality is called the co-efficient of viscosity.

$$\tau \propto \frac{du}{dy}$$

$$\tau = \mu \frac{du}{dy}$$

Fluids which obey the above relation are known as Newtonian fluids and the fluids which do not obey the above relation are called Non-Newtonian fluids.

Variation of Viscosity with temperature:
The viscosity of liquids decreases with the increase in temperature, while the viscosity of gases increases with the increase in temperature.

(i) For liquids:

$$\mu = \mu_0 \left(\frac{1}{1 + \alpha t + \beta t^2} \right)$$

Where, μ = viscosity of liquid at $t^\circ C$ in poise

μ_0 = viscosity of liquid at $0^\circ C$ in poise

α, β are constants for the liquid.

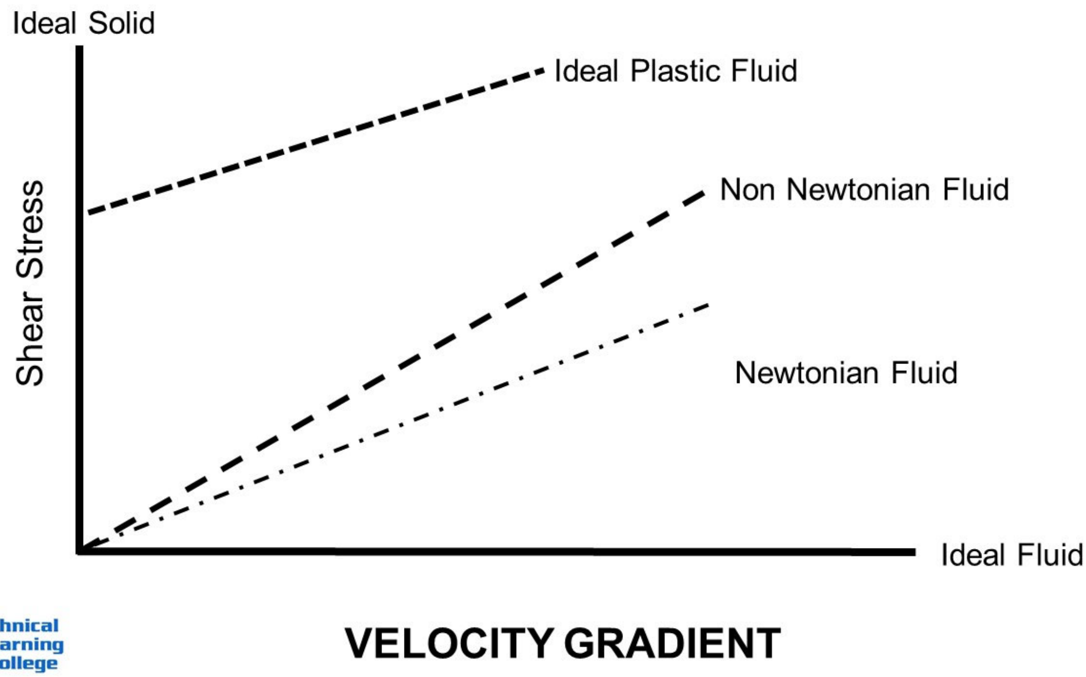
For water, $\mu_0 = 1.79 \times 10^{-3}$ poise, $\alpha = 0.03368$ and $\beta = 0.000221$

(ii) For Gases

$$\mu = \mu_0 + \alpha t - \beta t^2$$

For air, $\mu_0 = 000017$, $\alpha = 0.000000056$ and $\beta = 0.1189 \times 10^{-9}$

TYPES OF FLUIDS BASED ON VISCOSITY
The fluids may be classified into following five types:
1. Ideal fluid
2. Real fluid
3. Newtonian fluid
4. Non-Newtonian fluid
5. Ideal plastic fluid



Type of Fluids

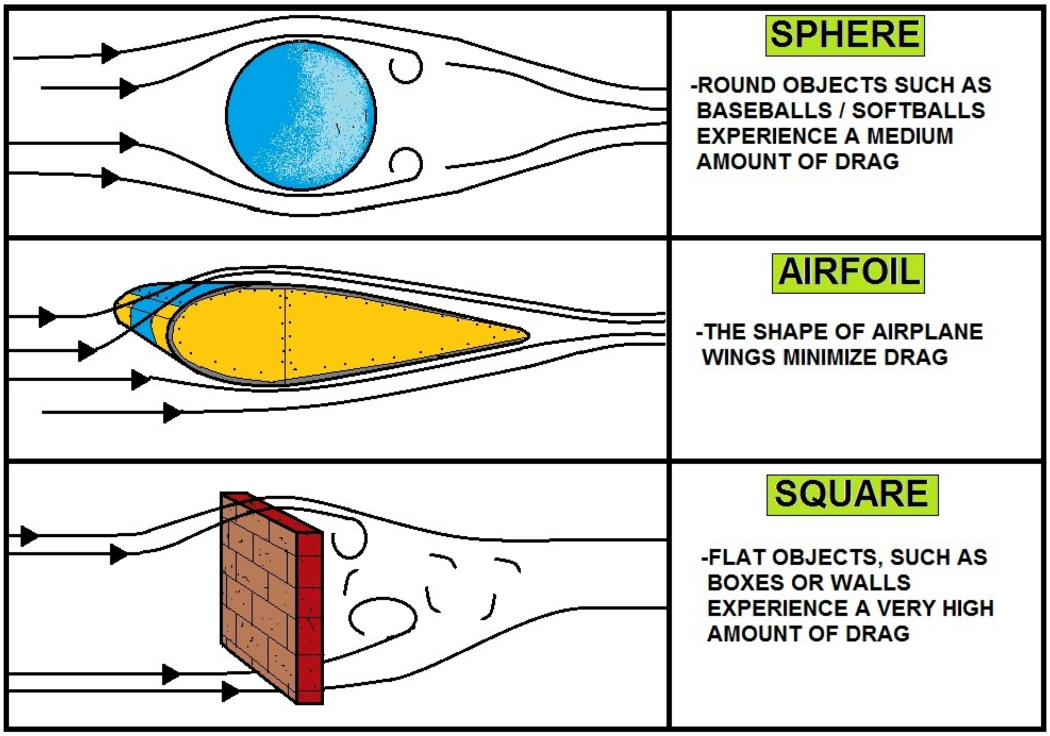
1. Ideal Fluid
A fluid which is incompressible and is having no viscosity, is known as ideal fluid. Ideal fluid is only an imaginary fluid as all the fluids which exists have some viscosity.

2. Real Fluids
A fluid which possesses viscosity is known as real fluid. All the fluids in actual practice are real fluids.

3. Newtonian Fluids
A real fluid in which the shear stress is directly proportional to rate of shear strain (or velocity gradient).

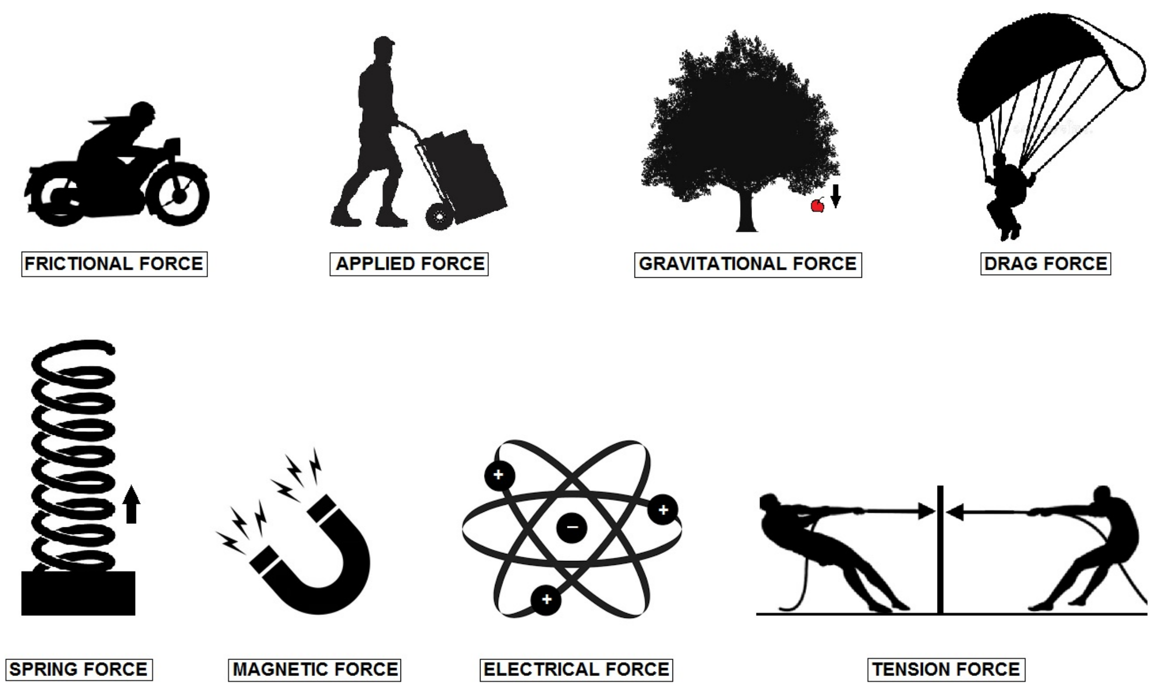
4. Non-Newtonian Fluid
A real fluid in which the shear stress is not proportional to the rate of shear strain.

5. Ideal Plastic Fluid
A fluid in which shear stress is more than the yield value and shear stress is proportional to the rate of shear strain (or velocity gradient).



DRAG FORCE (VISCOUS)

- THIS IS THE FORCE OF FRICTION CAUSED BY FLOWING FLUID
- IN THE OPPOSITE DIRECTION TO THE MOVEMENT OF FLUID

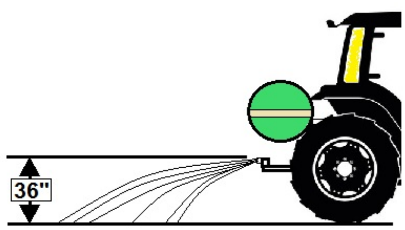


GRAVITY AND APPLIED FORCES EXAMPLES

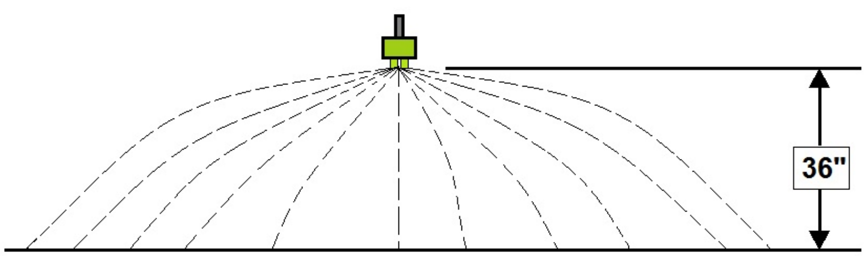
Sprayer / Disperser Mechanical Details Sub-Section

There are many other types of hand operated sprayers that are not widely used throughout the agriculture industry. Some may be used extensively for the production of specific commodities.

Motorized Sprayers
Motor powered sprayers offer many advantages over hand operated sprayers. Powered sprayers can provide high pressure sprays and the power can be used to drive agitation systems, fans for air-assisted or airblast spraying and transporting large volumes of spray mix. Properly equipped and operated, power sprayers can provide uniform coverage on a wide variety of targets. These systems can be mounted on tractors, trucks, trailers, and aircraft. Some backpack sprayers are also motorized.



NOZZLE MOUNTED VERTICALLY

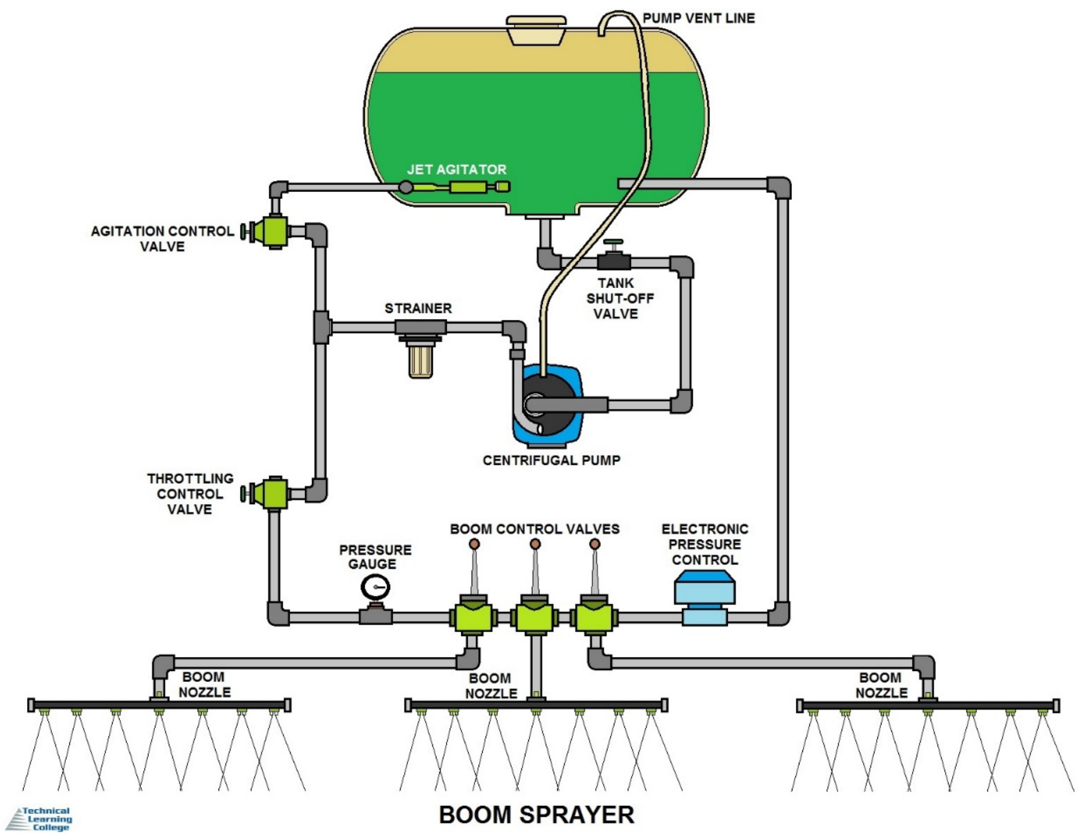


BOOMLESS NOZZLE SPRAYER

Boomless Sprayers
Motorized sprayers may be used to supply spray mix to a hand gun or hand held boom with several nozzles. With this equipment, the spray uniformity will be similar to a hand operated sprayer. However, the sprayer pressure may be constant and the operator is able to cover larger areas or targets than with a hand operated sprayer. Hand guns are useful for spot treatments and treating small areas.

Boomless Nozzles are also used to broadcast pesticides in areas not easily accessed by a boom sprayer. With this equipment good distribution of spray is obtained but the uniformity is not as good as with a properly operated boom sprayer. Boomless nozzles may be suitable for use in rough areas, and along fencelines and roadsides.

Booms
Booms are required to support nozzles along the wingspan of the craft. Booms must be strong, airfoil shaped and located near the trailing edge of the wing to offer minimum drag. Clearance between the control surfaces of the wing and the boom is essential. End caps on booms should be removable for cleaning. The location of outboard nozzles on the end of the boom is critical since the wing end and main rotor vortex are used to develop the width of the pattern. End nozzles must be inboard enough to prevent wing tip vortexes from trapping fine droplets. Such entrapment creates uneven distribution and drift. Propeller rotation shifts the spray from right to left as the pilot sees it. Nozzles need shifting to the right with respect to the fuselage to compensate for this. Ultra-Low Volume systems require supply lines to the metering spinners only. Usually, no boom is needed.



BOOM SPRAYER

Boom Sprayers
Most sprayers distribute pesticides using a boom with spray nozzles spaced at regular intervals. The most common example would be wide horizontal booms used on field sprayers to spray field crops. Depending on how the motorized sprayer is equipped, these sprayers can be used for a wide variety of tasks. A high degree of spray coverage uniformity is possible with constant spray pressure through uniformly spaced nozzles traveling at constant speeds.

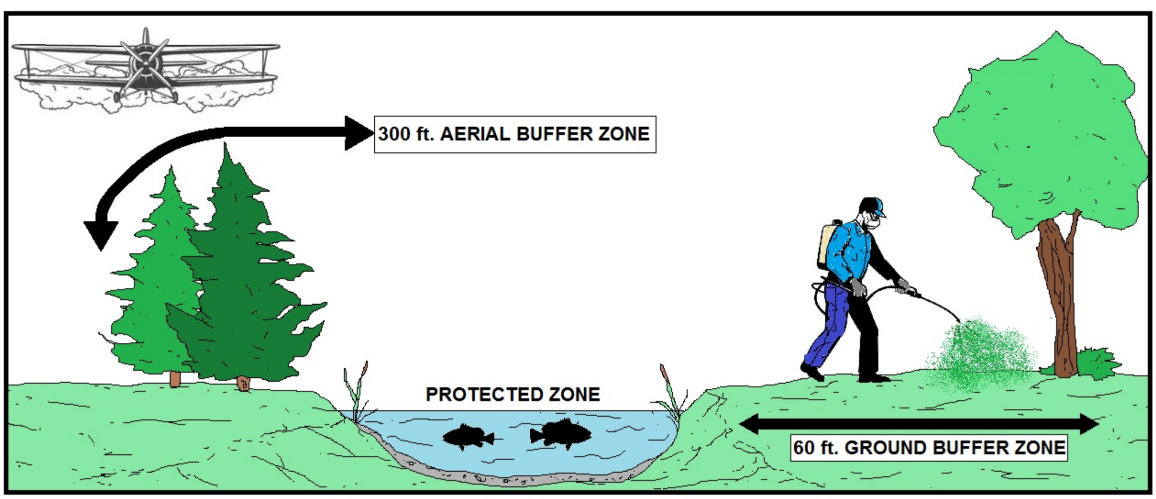
The aerial application of pesticides has several advantages for the modern agricultural producer. When properly managed, aerial application offers speed of dispersal, accessibility to crops on which ground equipment cannot operate, and reasonable cost. In many cases, the advantages also include more 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 their 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. Limitations on aerial application do exist and should be recognized. These include weather hazards, fixed obstacles, field size and shape, the distance from the point of application to the landing area, and the danger of contamination of nearby areas due to drift or misapplication. Perhaps the greatest single limiting factor is the pilot himself. A competent and effective performance by the pilot returns many benefits. Haphazard or careless applications can be harmful to the crop, the grower and the applicator, and are beneficial to no-one.

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



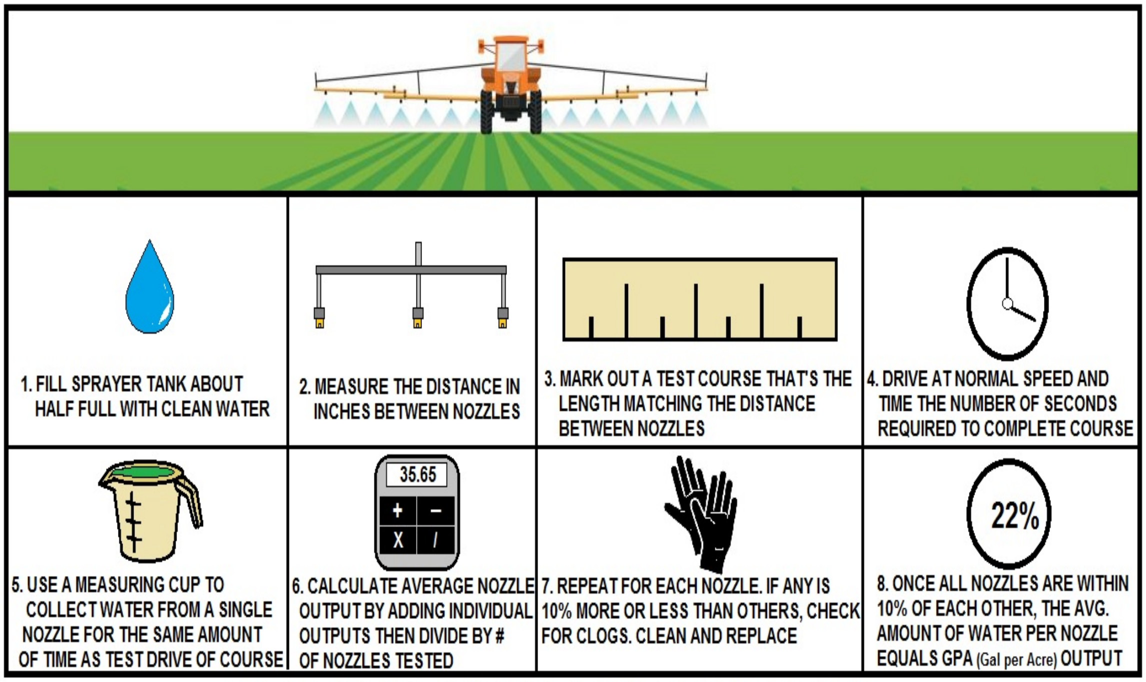
OBSERVE "NO-SPRAY" BUFFER ZONES

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

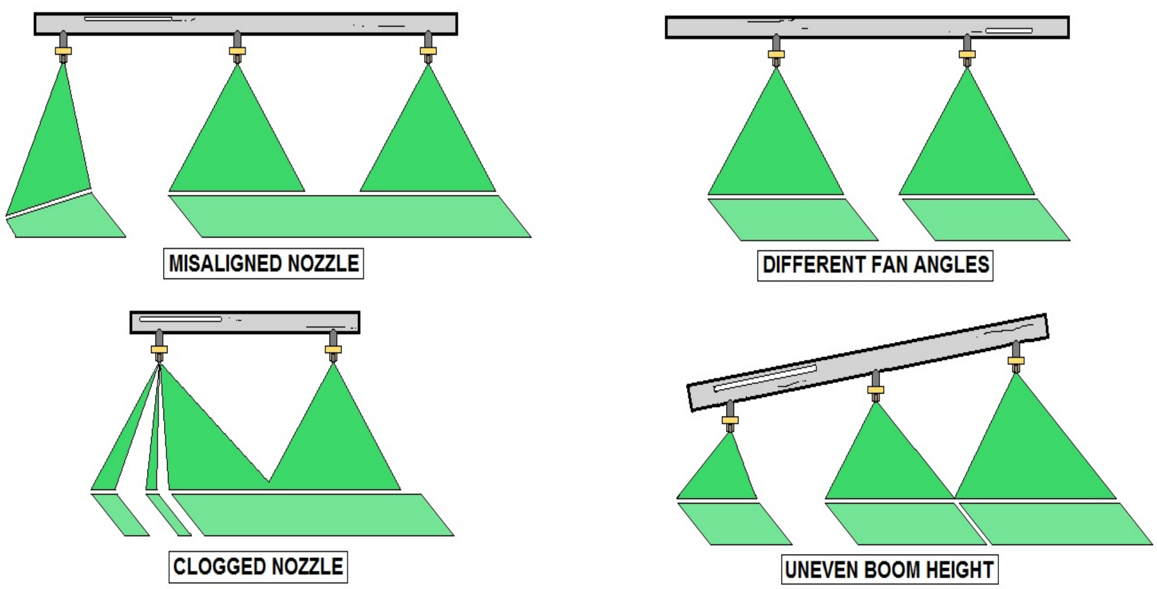
- Areas identified by informal, field-level consultation
- Beehive locations and appropriate bee buffers
- Biological control release sites, insectary sites, experimental sites
- Bodies of water (e.g., lakes, ponds, small streams, rivers)
- Endangered and sensitive species buffers (as negotiated with 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

More on Ultra Low Volume
Ultra-Low Volume (**ULV**) equipment ranges in capacity from a few ounces to 1/2 gallon per acre. Special metering and atomizing attachments such as Micronair, Mini-spin and Airfoil are frequently used to aid in droplet break-up. These spiral, rotating nozzles may be wind driven or driven from the aircraft. Wind driven nozzles are dependent upon air speed and may fail when the craft is operating at reduced speed.

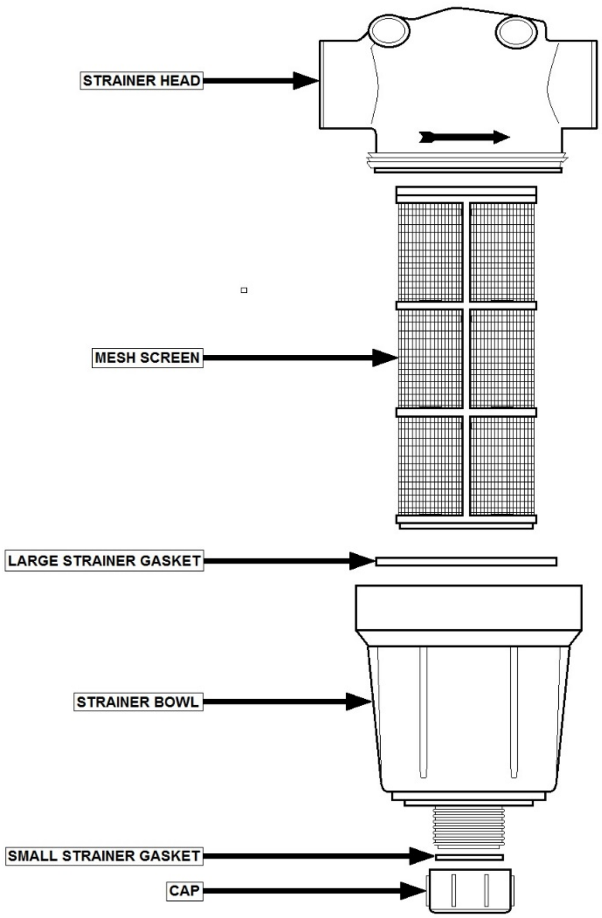
Ultra-Low Volume systems use a 3/8" inside diameter for the main line, hoses, and fittings. Hoses for intermediate nozzles may be 1/8" inside diameter. The use of concentrate sprays (no water added) increases the density of the material and allows a faster rate of all. This process is limited to certain materials and is subject to a drift hazard. Flying heights of 5 to 15 feet above ground contribute to uniformity.



BOOM SPRAYER INSPECTION / CALIBRATION



SPRAY TIP PROBLEMS (Common)



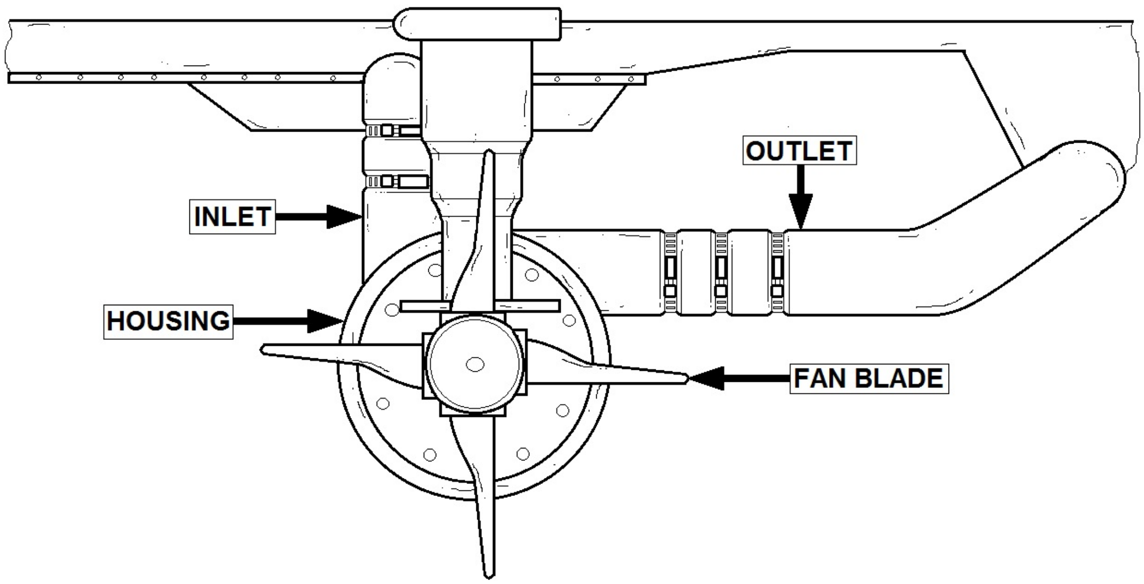
INLINE STRAINER BASIC PARTS

SPRAY QUALITY	SIZE OF DROPLETS	COLOR CODE	RETENTION ON LEAVES DIFFICULT TO WET	USED FOR	DRIFT POTENTIAL
EXTREMELY FINE (XF)	SMALL	PURPLE	EXCELLENT	EXCEPTIONS	HIGH
VERY FINE (VF)		RED	EXCELLENT	EXCEPTIONS	
FINE (F)		ORANGE	VERY GOOD	FUNGICIDE & INSECTICIDES	
MEDIUM (M)		YELLOW	GOOD	FUNGICIDES, INSECTICIDES, CONTACT HERBICIDES	
COARSE (C)		BLUE	MODERATE	SYSTEMIC HERBICIDES	
VERY COURSE (VC)		GREEN	POOR	SOIL HERBICIDES	
EXTREMELY COURSE (XC)		WHITE	VERY POOR	LIQUID FERTILIZER	
ULTRA COURSE (UC)	LARGE	BLACK	VERY POOR	LIQUID FERTILIZER	LOW

AGRICULTURAL CHEMICAL APPLICATION NOZZLE DESCRIPTIONS AND USES

Dispersal Accessories Sub-Section

Metering and dispersal are key functions of all pesticide-applying aircraft. Metering must be accurate for calibration and for the uniform, controlled delivery of liquids and solid material. Liquid dispersal systems consist of a hydraulic circuit including pump, tank, hose, boom, filters, regulators, and metering nozzles. These systems may be wind-driven or directly powered from the aircraft engine. The pump system must deliver large quantities of liquid material per unit of time. This often means that maximum output is available only at high engine RPM. For this reason, certain aircraft must be in flight to develop top delivery. Pumps and agitators must be designed to handle the desired nozzle output plus approximately 5 P.S.I. for line friction and agitation.



AIRCRAFT / CROP DUSTER PUMP BASIC PARTS

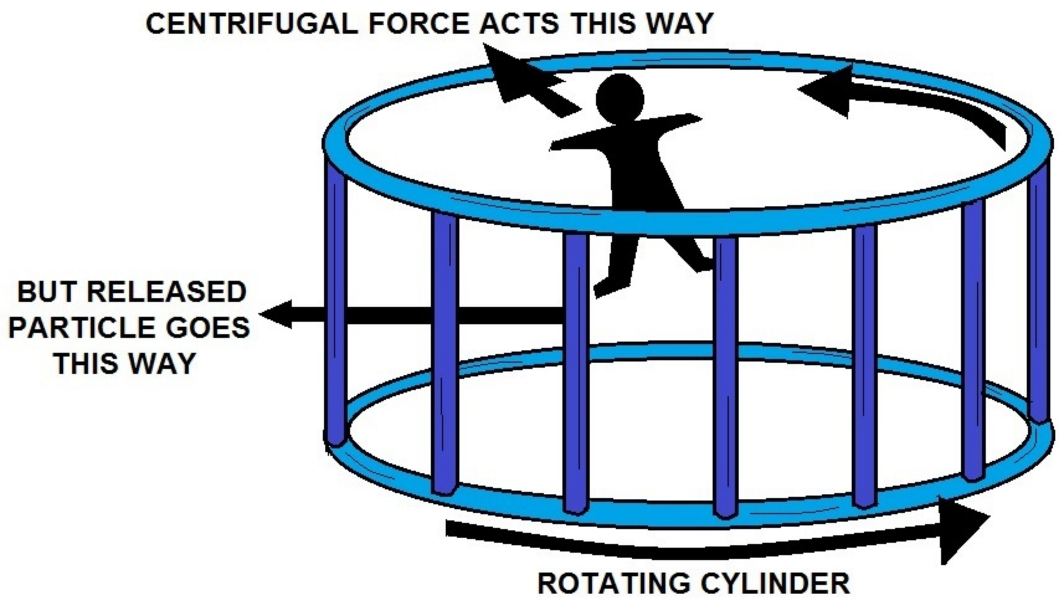
Technical Learning College

Spray pattern tests should be conducted to determine the optimum location of nozzles along the boom and the spray droplet size categories following initial setup. Spray boom shape should be airfoil or streamline to reduce turbulence around the nozzles. Catalogs from nozzle manufacturers list types and sizes for aircraft. A check valve is necessary on each nozzle to prevent leakage.

Spray nozzles type, size and orientation, operating pressure, and wind shear (aircraft speed) all influence spray droplet size. Small droplet sizes are prone to drift from the application site, so the largest droplet size possible that will maintain the desired efficacy on the targeted plant should be used. Pressure at the spray nozzle should be between 20 and 60 psi.

Research has shown that low spray pressures and high aircraft speed can increase the percentage of spray droplets that have a propensity to drift. All nozzles produce a range in droplet size particles and manufacturers usually rate their nozzles with a volume median diameter droplet size (DV0.5).

The percentage of spray droplets less than 100 micrometer (DV0.1) is an indication of potential drift. Considerable research has been conducted to determine droplet sizes under actual airspeed conditions. ASAE Standards and predictive models are available.



CENTRIFUGAL WATER EFFECTS

Centrifugal Pumps (Introduction)

Fairly low pressure (35 to 45 P.S.I.) high volume centrifugal pumps may be used for water-based materials. Shear, or air friction across the nozzle opening, serves to provide material break-up. Bi-fluid or microbial sprays call for special pumps.

Standard, dilute volume spray equipment which has a range of 1/2 to 5 gallons per acre or more must have adequate piping. The main piping and fittings should have an inside diameter of at least 1-1/2" in order to carry heavy volumes of liquid. For rates of 1/2 to 2 gallons per acre, all piping should have at least a 1" diameter.

Filter screens at the nozzles and line filters protect nozzles and other parts from wear and clogging. Screen sizes of 50 to 100 mesh will be used, depending on nozzle orifice size.

Pressure gauges located beyond the line filter indicate whether the line is clogged or opened. Line filters should be cleaned daily during spray operations.

Sprayer Troubleshooting Sub-Section

Most troubles with sprayers can be traced to foreign matter that clogs screens and nozzles and sometimes wears out pumps and nozzles. Pump deterioration is brought about by ordinary use but is accelerated by misuse. The following suggestions will help prolong the useful life of pumps and sprayers.

1. **Use clean water.** Use water that looks clean enough to drink. A small amount of silt or sand can rapidly wear pumps and other parts of the sprayer system. Water pumped directly from a well is best. Water pumped from ponds or stock tanks should be filtered before filling the tank. To avoid contamination of water supplies, regulations require that all application equipment be equipped with an air-gap separation or back-flow prevention device to prevent pesticides from being siphoned back into the water source.

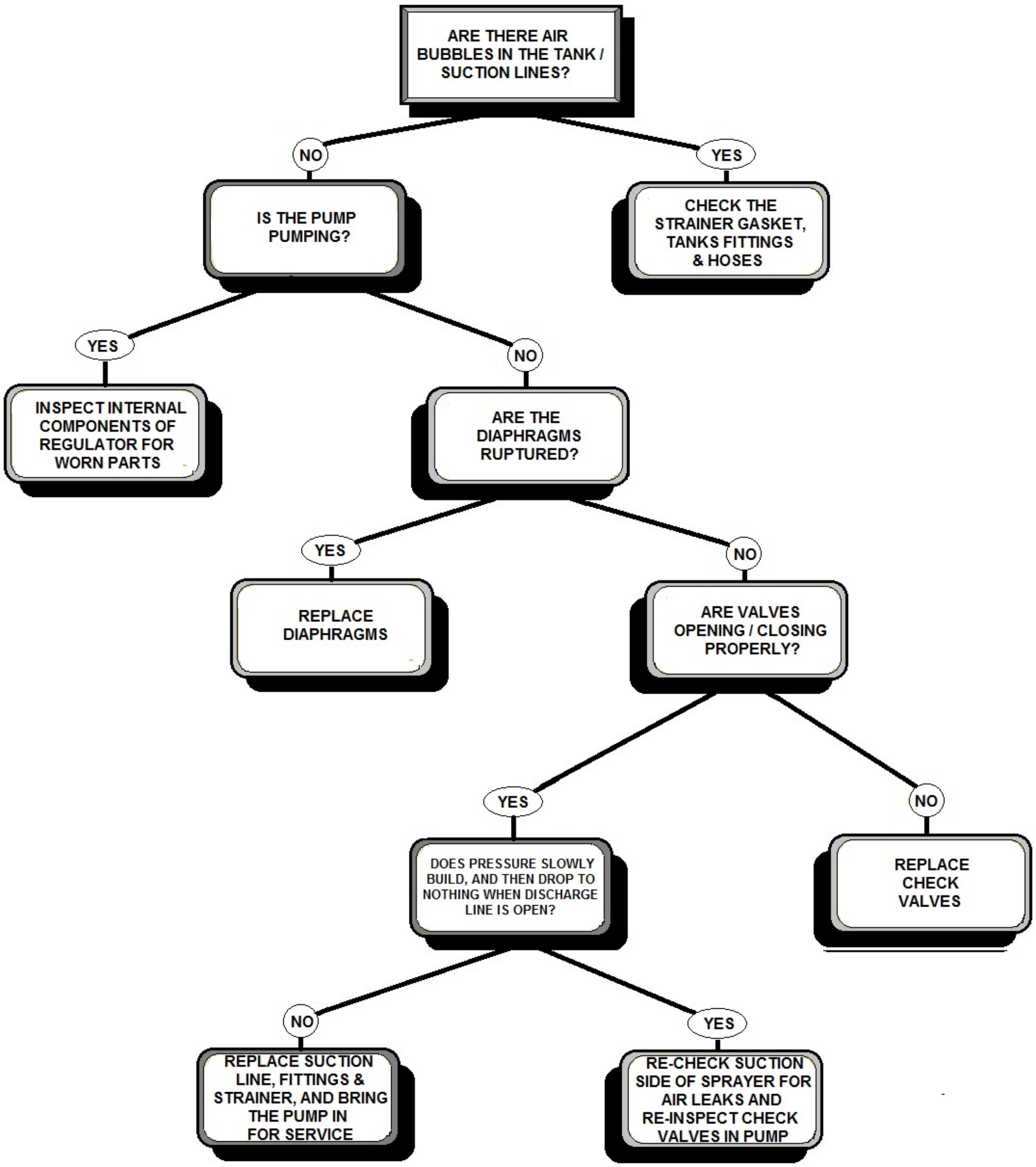
2. **Keep screens in place.** A sprayer system usually has screens in three places: a coarse screen on the suction hose; a medium screen between the pump and the boom or hose; and a fine screen in the nozzle. The nozzle screen should be fine enough to filter particles which will plug the tip orifice.

3. **Use chemicals that the sprayer and pump were designed to use.** For example, liquid fertilizers are corrosive to copper, bronze, ordinary steel, and galvanized surfaces. If the pump is made from one of these materials, it may be ruined by a single application of the liquid fertilizer.

4. **Never use a metal object to clean nozzles.** To clean nozzles, put on rubber gloves and then remove the tips and screens and clean them in water or a detergent solution using a soft brush. The orifice in a nozzle tip is a precision-machined opening. Cleaning with a pin, knife, or other metallic object can adversely change the spray pattern and capacity of the tip. If no brush is available, use a round wooden toothpick.

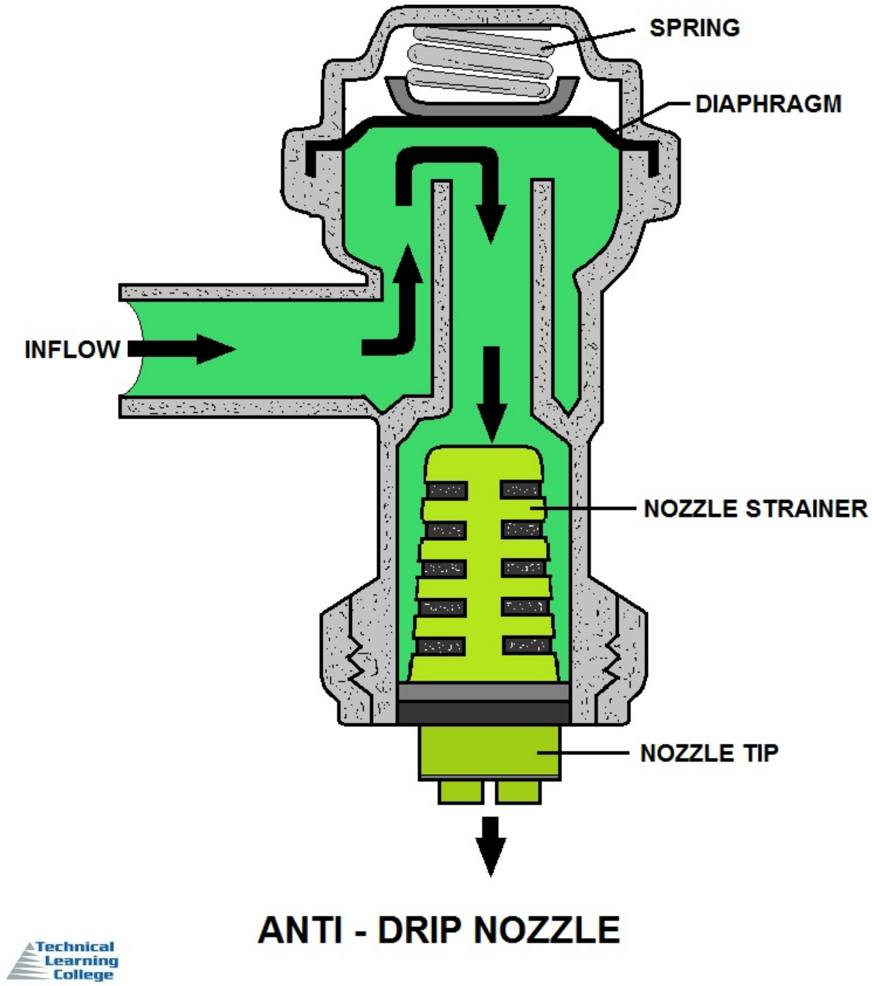
5. **Flush sprayers before using them.** New sprayers may contain metallic chips and dirt from the manufacturing process. Sprayers which have been idle for a while may contain bits of rust and dirt. Put on rubber gloves and then remove the nozzles and flush the sprayer with clean water. Clean all screens and nozzles thoroughly before using the sprayer.

6. **Clean sprayer thoroughly after use.** After use, flush the sprayer with water or flushing solution to clear lines and nozzles to prevent corrosion and material drying in the system. Be sure to wear appropriate personal protective equipment during clean-up procedures.



TROUBLESHOOTING PRESSURE ISSUES (Sprayer Pump)

Understanding Spray Nozzles



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:

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

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:

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

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.)

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.

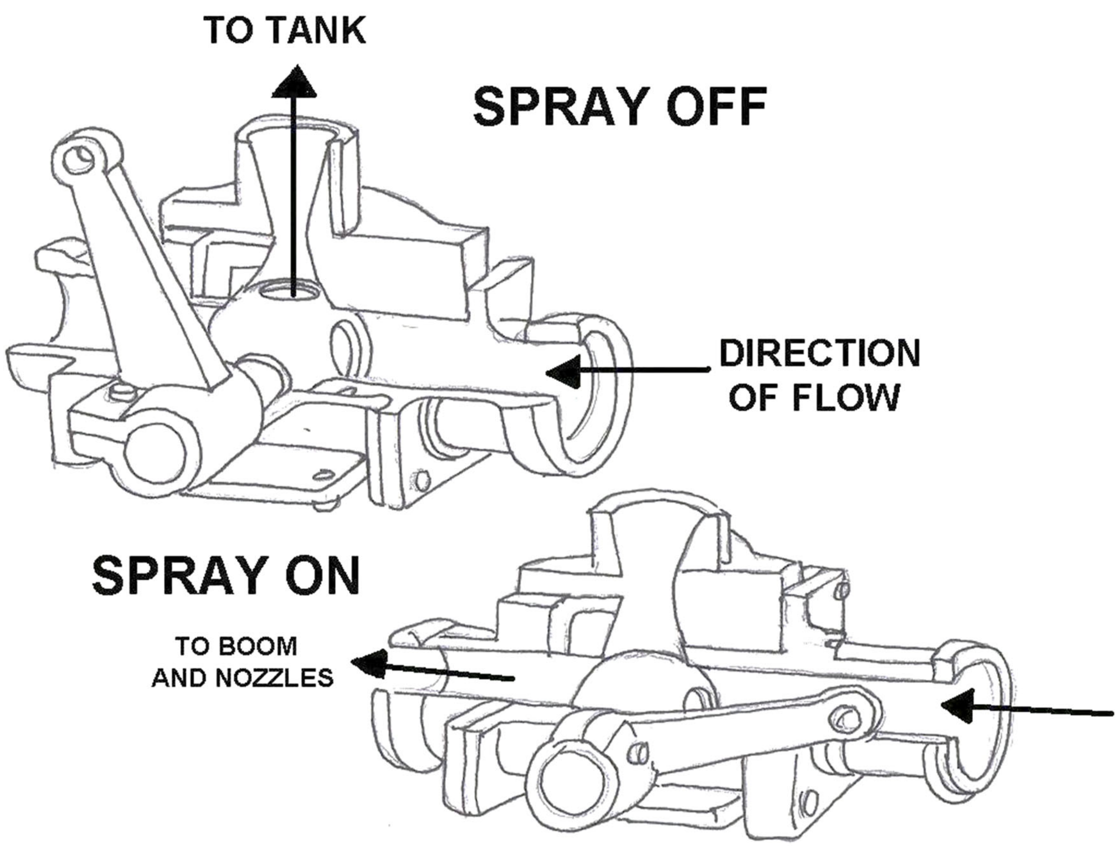
The best method of spray pattern testing consists of adding a tracer (dye, fluorescent material, etc.) to water in the tank(s) of the aircraft. The aircraft is then flown at the chosen air speed and height and the spraying system is operated at the chosen pressure. One pass is made over a row of target 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 Materials
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.



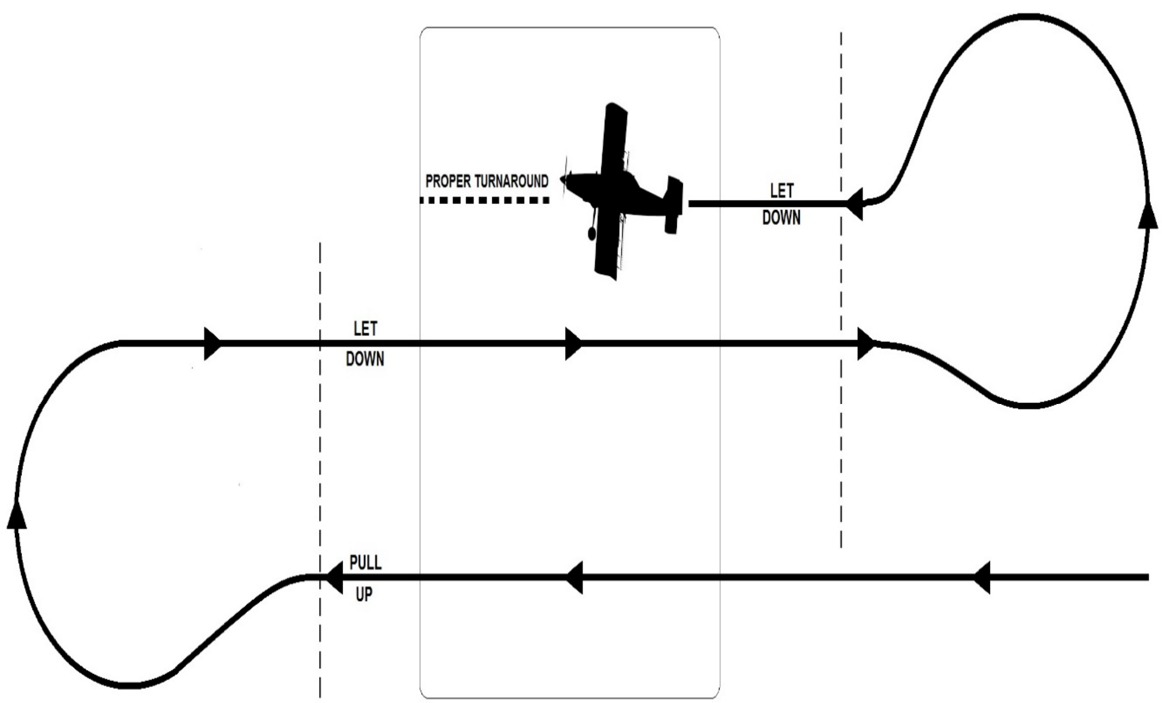
POSITIVE CUT-OFF SPRAY VALVE DIAGRAM EXAMPLE

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 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.



PROPER AERIAL SPRAY PATTERN EXAMPLE

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. 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.

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 and Temperature
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.

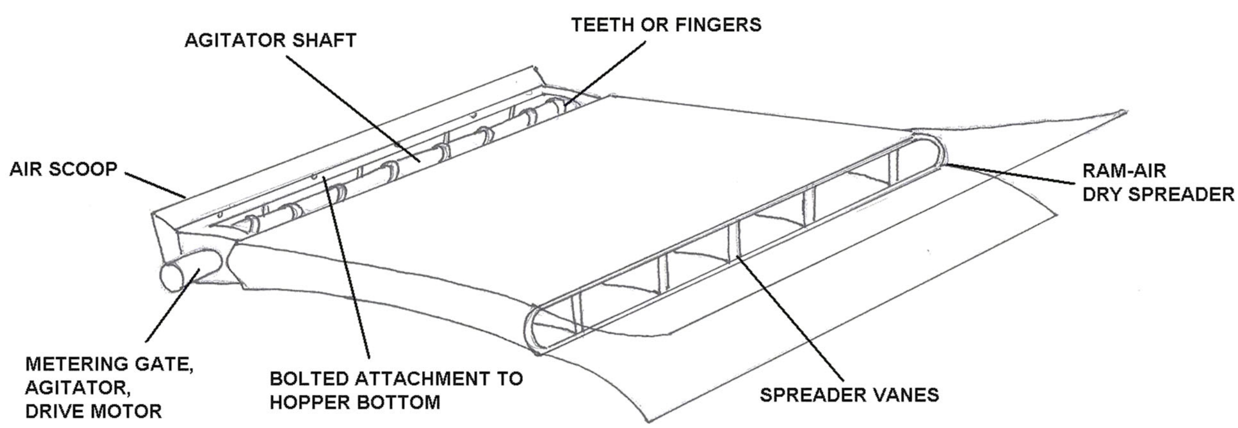
Although GPS guidance now allows for night operations, safety is still a consideration, and all safety factors **must** be considered.

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.

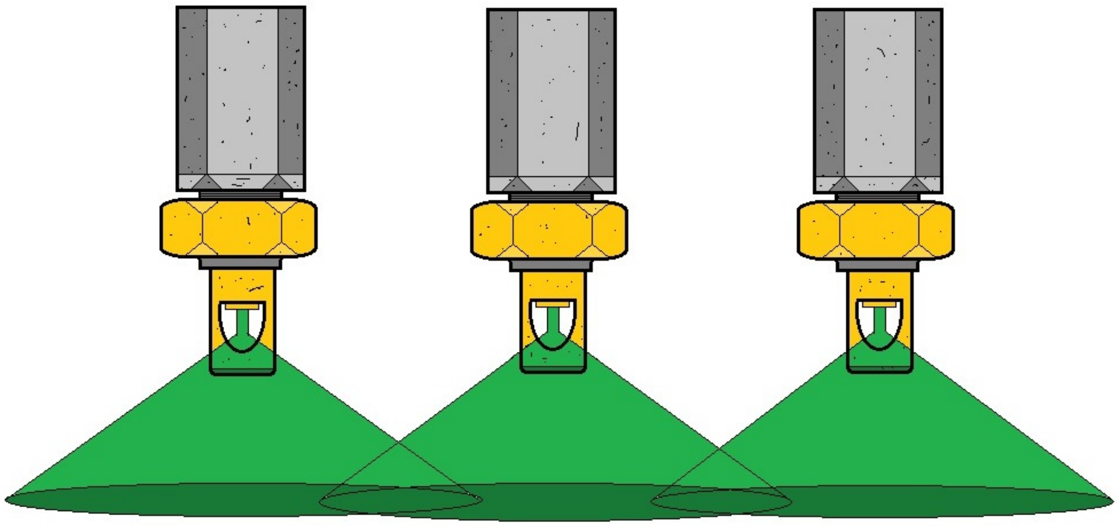
Pesticide Deposition
Record or report the following elements as indicated:

- 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)



RAM-AIR SPREADER DIAGRAM

Liquid System Inspection Sub-Section



FLAT FAN NOZZLE WITH PROPER PATTERN OVERLAP (Pesticide Application)

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.

Leak-proof Spray System Components

Check the condition of gate seal, hoses, and other spray system components to make sure they are leak-proof. 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 not** 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.

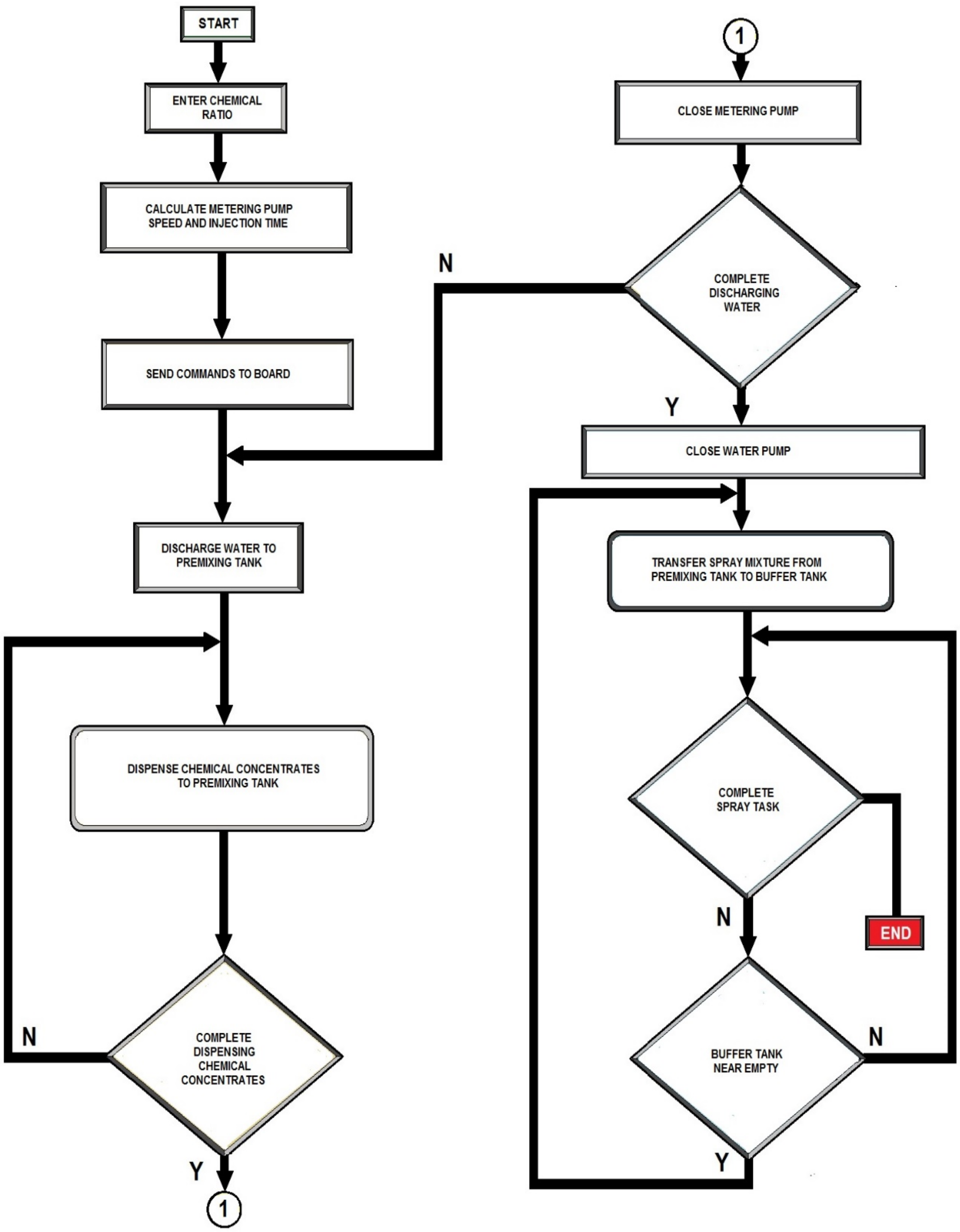
- ✓ If the aircraft is equipped with a spray boom that is longer than 3/4 of the overall wingspan and/or the outermost nozzle is more than 3 inches from the end of the spray boom, then installation of a bleed line is necessary
- ✓ Entrapped air in the boom will cause the nozzles to continue to spray 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

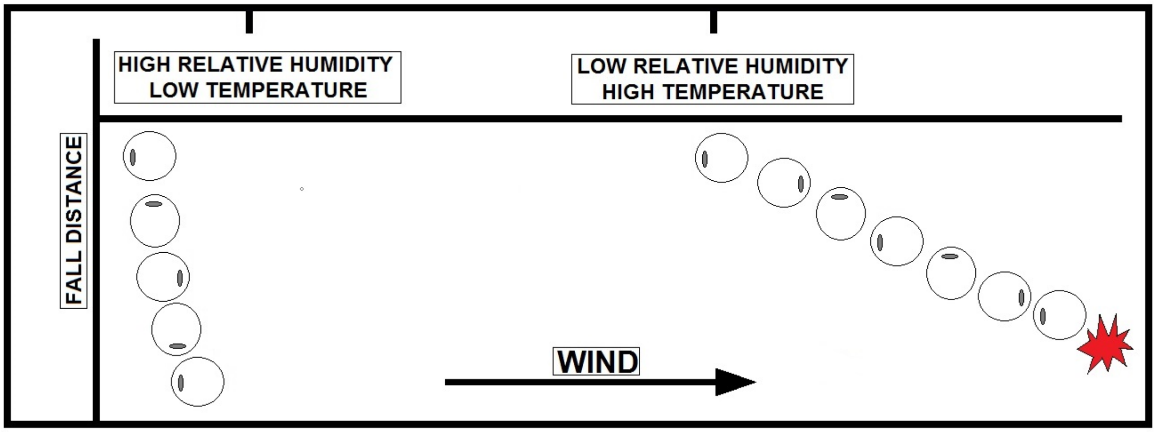
- ✓ If bleed lines are required on spray booms, then check to make sure they are installed correctly to remove entrapped air from the end of the spray boom. (See the current *APHIS Aerial Application Prospectus* for correct installation of bleed lines).

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.*



METERING PESTICIDE DISPERSAL



EVAPORATION OF PESTICIDE DROPLETS EXAMPLE

EQUIPMENT	METHOD	WEATHER	TARGET	PRODUCT	OPERATOR
SPRAYER DESIGN AIR ASSIST DIRECTION VOLUME SPEED DEFLECTORS SPRAY QUALITY PATTERN DROPLET SIZE NOZZLE ORIENTATION	FORWARD SPEED WORK RATE SPRAY TECHNIQUE ALTERNATE ROW - MIDDLE SPRAYING GEAR-UP / THROTTLE-DOWN CROP-ADAPTED SPRAYING	WIND SPEED DIRECTION TEMPERATURE RELATIVE HUMIDITY THERMAL INVERSION	CANOPY STRUCTURE TIME OF SEASON DENSITY-AREA CANOPY MANAGEMENT TARGET SIZE LOCATION	MODE OF ACTION TIMING SPRAY MIX SPECIFIC GRAVITY ADJUVANTS CARRIER VOLUME APPLICATION RATE	APTITUDE ATTITUDE MANAGER, BOSS OR OWNER

THINGS TO BE AWARE OF WHEN DOING A CALIBRATION FOR PESTICIDE APPLICATION

Topic 2 - Understanding Hydraulics and Sprayer Principles Post Quiz

Answers are after the Glossary in rear
Fill in the blank

Meteorology
1. The atmospheric pressure is of great importance in meteorology, since it determines the winds, which generally move at right angles to the direction of the most rapid change of pressure, that is, along the isobars, which are________________.

Volume and Velocity of Flow
2. The *velocity of flow* or ___________is defined as the average speed at which the fluid moves past a given point. It is usually expressed in feet per second (fps) or feet per minute (fpm).

Bernoulli's Principle
3. Bernoulli's principle thus says that a _________in pressure in a flowing fluid must always be accompanied by a decrease (increase) in the speed, and conversely, if an increase (decrease) in, the speed of the fluid results in a decrease (increase) in the pressure.

Boom Sprayers
4. Most sprayers distribute pesticides using a boom with spray nozzles spaced at regular intervals. The most common example would be ___________used on field sprayers to spray field crops.

5. The full advantages of aerial application are more likely to be realized when its use is___________.

More on Ultra Low Volume
6. Ultra-Low Volume (**ULV**) equipment ranges in capacity from a few ounces to 1/2 gallon per acre. Special metering and atomizing attachments such as Micronair, Mini-spin and Airfoil are frequently used to aid in_____________.

Dispersal Accessories
7. Metering and dispersal are key functions of all pesticide-applying aircraft. ___________must be accurate for calibration and for the uniform, controlled delivery of liquids and solid material. Liquid dispersal systems consist of a hydraulic circuit including pump, tank, hose, boom, filters, regulators and metering nozzles.

Understanding Spray Nozzles
8. 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 _______________will be set by the chemical being applied and the crop being treated as listed on the manufacturer's label.

Ultra-Low Volume (ULV) Formulations and Temperature
9. The best weather for spraying treatment is usually from________________.

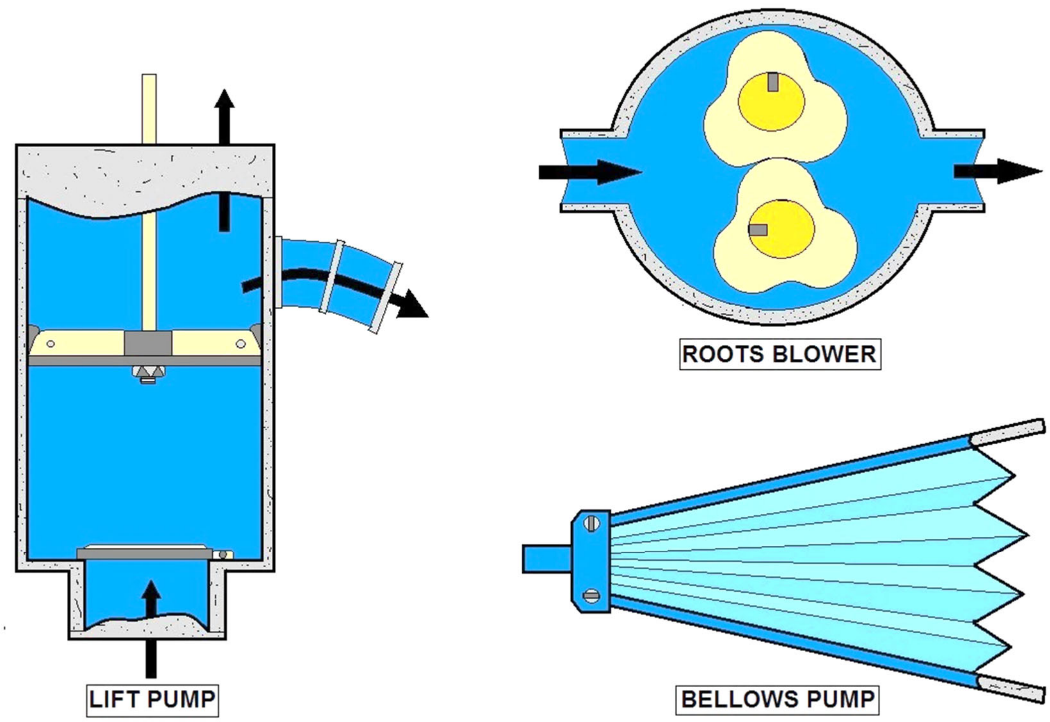
Visual Observations
10. Ground and aerial observers must ________________of many aspects of aircraft and pesticide performance during operations. Observers should be aware of the following elements and record or report them clearly and accurately.

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

Topic 3 - Understanding Pumps and Aerial Sprayers Section

Section Focus: You will learn the more about pumps and spray nozzles, specifically, the complicated spray nozzles. At the end of this section, you will be able to describe types of complicated based on application and capabilities with a focus upon the two major groups of pumps are dynamic and positive displacement and sprayer adjustment. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Pumps are used to move or raise fluids. They are not only very useful, but are excellent examples of hydrostatics. Pumps are of two general types, hydrostatic or positive displacement pumps, and pumps depending on dynamic forces, such as centrifugal pumps. Here we will only consider positive displacement pumps, which can be understood purely by hydrostatic considerations. They have a piston (or equivalent) moving in a closely-fitting cylinder and forces are exerted on the fluid by motion of the piston. This section is a continuation of the prior section.



TYPES OF POSITIVE DISPLACEMENT PUMPS

The simplest pump is the syringe, filled by withdrawing the piston and emptied by pressing it back in, as its port is immersed in the fluid or removed from it.

More complicated pumps have valves allowing them to work repetitively. These are usually check valves that open to allow passage in one direction, and close automatically to prevent reverse flow. There are many kinds of valves, and they are usually the most trouble-prone and complicated part of a pump.

The force pump has two check valves in the cylinder, one for supply and the other for delivery.

The supply valve opens when the cylinder volume increases, the delivery valve when the cylinder volume decreases.

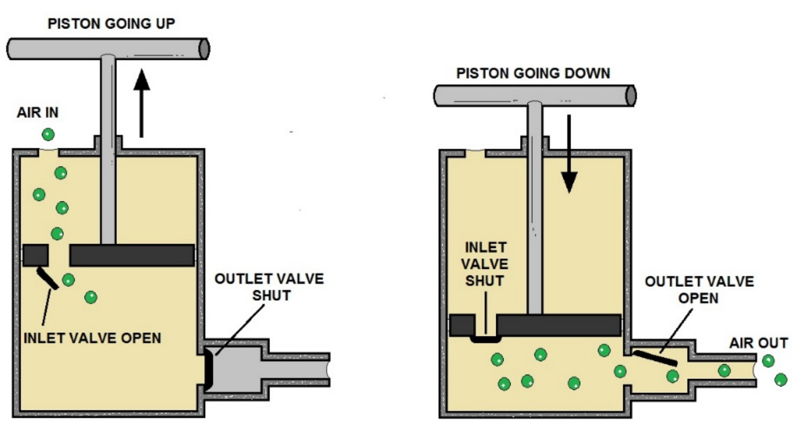
The lift pump has a supply valve and a valve in the piston that allows the liquid to pass around it when the volume of the cylinder is reduced. The delivery in this case is from the upper part of the cylinder, which the piston does not enter. Diaphragm pumps are force pumps in which the oscillating diaphragm takes the place of the piston. The diaphragm may be moved mechanically, or by the pressure of the fluid on one side of the diaphragm.

Some positive displacement pumps are shown below. The force and lift pumps are typically used for water. The force pump has two valves in the cylinder, while the lift pump has one valve in the cylinder and one in the piston.

The maximum lift, or "suction," is determined by the atmospheric pressure, and either cylinder must be within this height of the free surface. The force pump, however, can give an arbitrarily large pressure to the discharged fluid, as in the case of a diesel engine injector. A nozzle can be used to convert the pressure to velocity, to produce a jet, as for firefighting. Fire fighting force pumps usually have two cylinders feeding one receiver alternately. The air space in the receiver helps to make the water pressure uniform.

The three pumps below are typically used for air, but would be equally applicable to liquids. The Roots blower has no valves, their place taken by the sliding contact between the rotors and the housing. The Roots blower can either exhaust a receiver or provide air under moderate pressure, in large volumes. The Bellows is a very old device, requiring no accurate machining. The single valve is in one or both sides of the expandable chamber.

Another valve can be placed at the nozzle if required. The valve can be a piece of soft leather held close to holes in the chamber. The Bicycle pump uses the valve on the valve stem of the tire or inner tube to hold pressure in the tire. The piston, which is attached to the discharge tube, has a flexible seal that seals when the cylinder is moved to compress the air, but allows air to pass when the movement is reversed.



BICYCLE PUMP BASIC OPERATION

Types of Pumps

The family of pumps comprises a large number of types based on application and capabilities. The two major groups of pumps are dynamic and positive displacement.

Dynamic Pumps (Centrifugal Pump)

Centrifugal pumps are classified into three general categories:
Radial flow—a centrifugal pump in which the pressure is developed wholly by centrifugal force.
Mixed flow—a centrifugal pump in which the pressure is developed partly by centrifugal force and partly by the lift of the vanes of the impeller on the liquid.
Axial flow—a centrifugal pump in which the pressure is developed by the propelling or lifting action of the vanes of the impeller on the liquid.

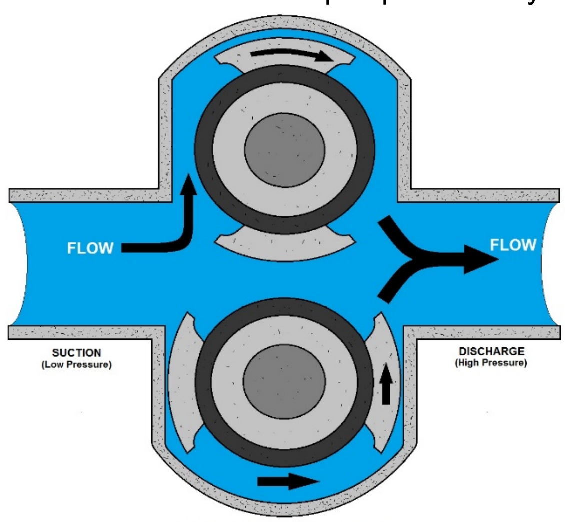
Positive Displacement Pumps

A Positive Displacement Pump has an expanding cavity on the suction side of the pump and a decreasing cavity on the discharge side. Liquid is allowed to flow into the pump as the cavity on the suction side expands and the liquid is forced out of the discharge as the cavity collapses. This principle applies to all types of Positive Displacement Pumps whether the pump is a rotary lobe, gear within a gear, piston, diaphragm, screw, progressing cavity, etc.

A Positive Displacement Pump, unlike a Centrifugal Pump, will produce the same flow at a given RPM no matter what the discharge pressure is. A Positive Displacement Pump cannot be operated against a closed valve on the discharge side of the pump, i.e. it does not have a shut-off head like a Centrifugal Pump does. If a Positive Displacement Pump is allowed to operate against a closed discharge valve it will continue to produce flow which will increase the pressure in the discharge line until either the line bursts or the pump is severely damaged or both.

Types of Positive Displacement Pumps

Single Rotor	Multiple Rotor
Vane	Gear
Piston	Lobe
Flexible Member	Circumferential Piston
Single Screw	Multiple Screw



POSITIVE DISPLACEMENT PUMP

There are many types of positive displacement pumps. We will look at:
Plunger pumps
Diaphragm pumps
Progressing cavity pumps, and
Screw pumps

Single Rotator

Component	Description
Vane	The vane(s) may be blades, buckets, rollers, or slippers that cooperate with a dam to draw fluid into and out of the pump chamber.
Piston	Fluid is drawn in and out of the pump chamber by a piston(s) reciprocating within a cylinder(s) and operating port valves.
Flexible Member	Pumping and sealing depends on the elasticity of a flexible member(s) that may be a tube, vane, or a liner.
Single Screw	Fluid is carried between rotor screw threads as they mesh with internal threads on the stator.

Multiple Rotator

Component	Description
Gear	Fluid is carried between gear teeth and is expelled by the meshing of the gears that cooperate to provide continuous sealing between the pump inlet and outlet.
Lobe	Fluid is carried between rotor lobes that cooperate to provide continuous sealing between the pump inlet and outlet.
Circumferential piston	Fluid is carried in spaces between piston surfaces not requiring contacts between rotor surfaces.
Multiple Screw	Fluid is carried between rotor screw threads as they mesh.

Plunger Pump
The plunger pump is a positive displacement pump that uses a plunger or piston to force liquid from the suction side to the discharge side of the pump. It is used for heavy sludge. The movement of the plunger or piston inside the pump creates pressure inside the pump, so you have to be careful that this kind of pump is never operated against any closed discharge valve. All discharge valves must be open before the pump is started, to prevent any fast build-up of pressure that could damage the pump.

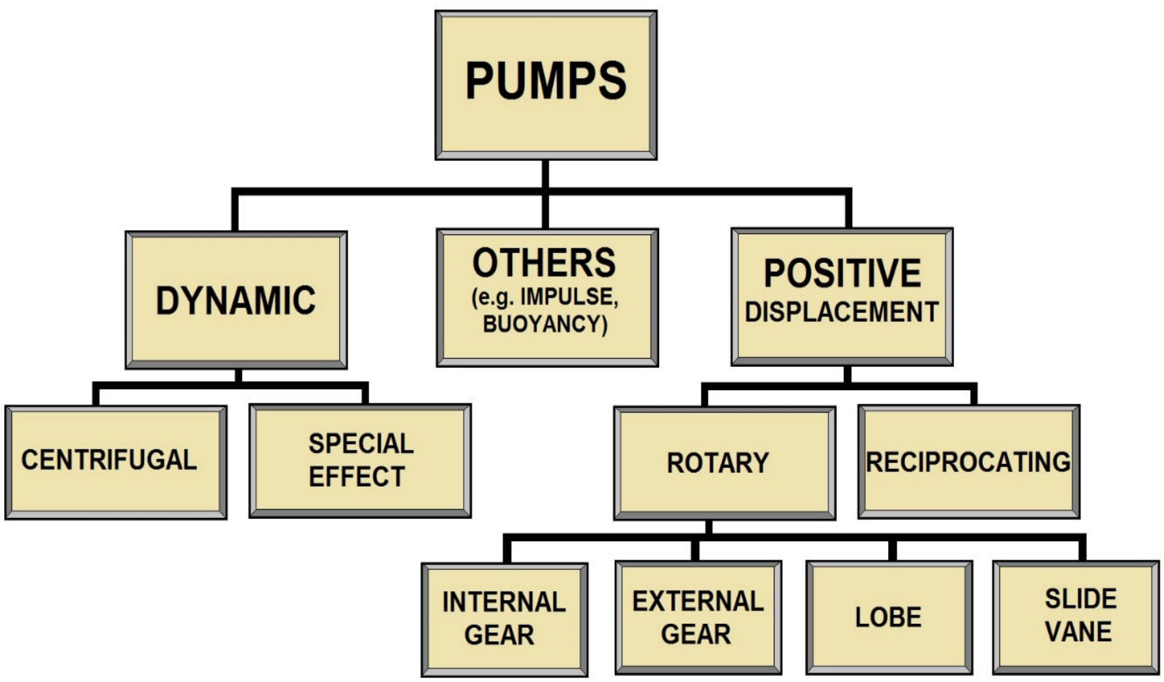
Diaphragm Pumps
In this type of pump, a diaphragm provides the mechanical action used to force liquid from the suction to the discharge side of the pump. The advantage the diaphragm has over the plunger is that the diaphragm pump does not come in contact with moving metal. This can be important when pumping abrasive or corrosive materials.

There are three main types of diaphragm pumps available:
1. Diaphragm sludge pump
2. Chemical metering or proportional pump
3. Air-powered double-diaphragm pump

Pump Categories

Let's cover the essentials first. The key to the whole operation is, of course, the *pump.* And regardless of what type it is (reciprocating piston, centrifugal, turbine or jet-ejector, for either shallow or deep well applications), its purpose is to move water and generate the delivery force we call pressure. Sometimes — with centrifugal pumps in particular — pressure is not referred to in pounds per square inch but rather as the equivalent in elevation, called head. No matter; head in feet divided by 2.31 equals pressure, so it's simple enough to establish a common figure.

Pumps may be classified on the basis of the application they serve. All pumps may be divided into two major categories: (1) dynamic, in which energy is continuously added to increase the fluid velocities within the machine, and (2) displacement, in which the energy is periodically added by application of force.

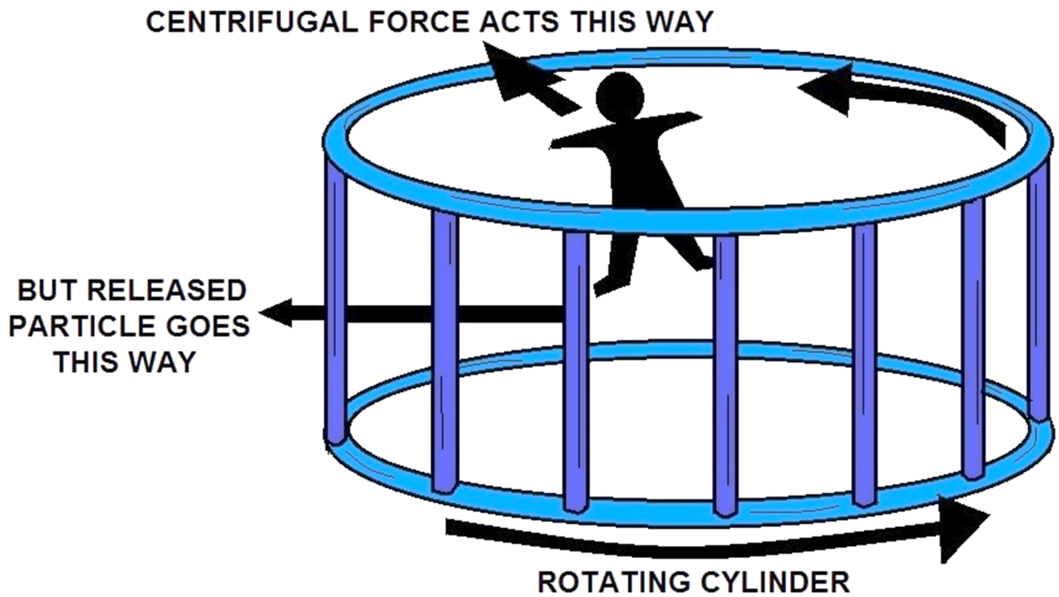


PUMP CATEGORIES

Basic Pump

The pump commonly found in our systems is centrifugal pumps. These pumps work by spinning water around in a circle inside a cylindrical pump housing. The pump makes the water spin by pushing it with an impeller. The blades of this impeller project outward from an axle like the arms of a turnstile and, as the impeller spins, the water spins with it. As the water spins, the pressure near the outer edge of the pump housing becomes much higher than near the center of the impeller.

There are many ways to understand this rise in pressure, and here are two:



CENTRIFUGAL WATER EFFECT DIAGRAM

First, you can view the water between the impeller blades as an object traveling in a circle. Objects do not naturally travel in a circle--they need an inward force to cause them to accelerate inward as they spin.

Without such an inward force, an object will travel in a straight line and will not complete the circle. In a centrifugal pump, that inward force is provided by high-pressure water near the outer edge of the pump housing. The water at the edge of the pump pushes inward on the water between the impeller blades and makes it possible for that water to travel in a circle. The water pressure at the edge of the turning impeller rises until it is able to keep water circling with the impeller blades.

You can also view the water as an incompressible fluid, one that obeys Bernoulli's equation in the appropriate contexts. As water drifts outward between the impeller blades of the pump, it must move faster and faster because its circular path is getting larger and larger. The impeller blades cause the water to move faster and faster. By the time the water has reached the outer edge of the impeller, it is moving quite fast. However, when the water leaves the impeller and arrives at the outer edge of the cylindrical pump housing, it slows down.

Spray Nozzle Usage and Categorization Sub-Section

A variety of materials are used to make nozzles, including brass, stainless steel, ceramic and nylon. There are advantages and disadvantages with each type of material. However, it is wisest to invest in the best quality nozzles available. Brass nozzles are relatively inexpensive, but they wear rapidly with abrasive materials, such as wettable powders and liquid fertilizers. Stainless steel and hardened stainless steel are the most resistant to wear, but their expense discourages some users. Frequent replacement of brass nozzles usually makes their use more costly in relation to the area sprayed. The smooth surface of nylon nozzles makes them relatively resistant to wear, but the threads are easily damaged in use, especially when over tightened.

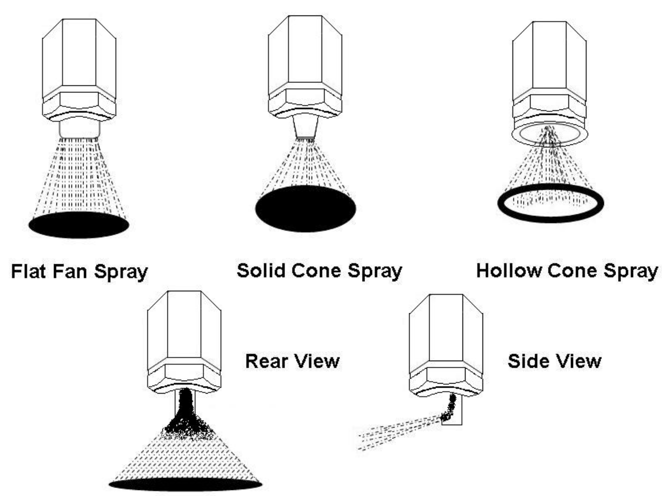
Modified nylon tips in metal housings avoid some of these problems. However, some solvents react with nylon, causing the material to swell and become unusable. Ceramic spray nozzles are also abrasion resistant, but are expensive and breakable. There are different types of spray patterns produced by nozzles each designed for a specific application.

Choosing the proper nozzle for a particular treatment will ensure good coverage and minimum drift. The selection of a nozzle is determined by the type of treatment being applied as well as certain aspects of the spray equipment such as flow rate and operating pressure. Herbicides are applied at low pressure to produce large droplets that reduce drift.

Higher pressures are used with fungicides to produce small droplets for better coverage of foliage. Insecticides are applied with pressure ranges between these two extremes. Drift control adjuvants work best with nozzles that reduce the number of fine and mist-like drops. To be effective and safe, nozzles may need to be changed for different pesticide applications.

Nozzle Review
Nozzles are a critical part of aircraft spray equipment. Their selection, location, calibration and testing are essential factors. The selection of nozzles is based on manufacturers' recommendations. Care must be exercised not to limit line pressure below 30 to 45 P.S.I. for water solutions. Special nozzles which entrain air or mix fluids in the tips are available. These are classified as foaming and bi-fluid systems. Nozzles for handling emulsions and slurries must have larger orifices.

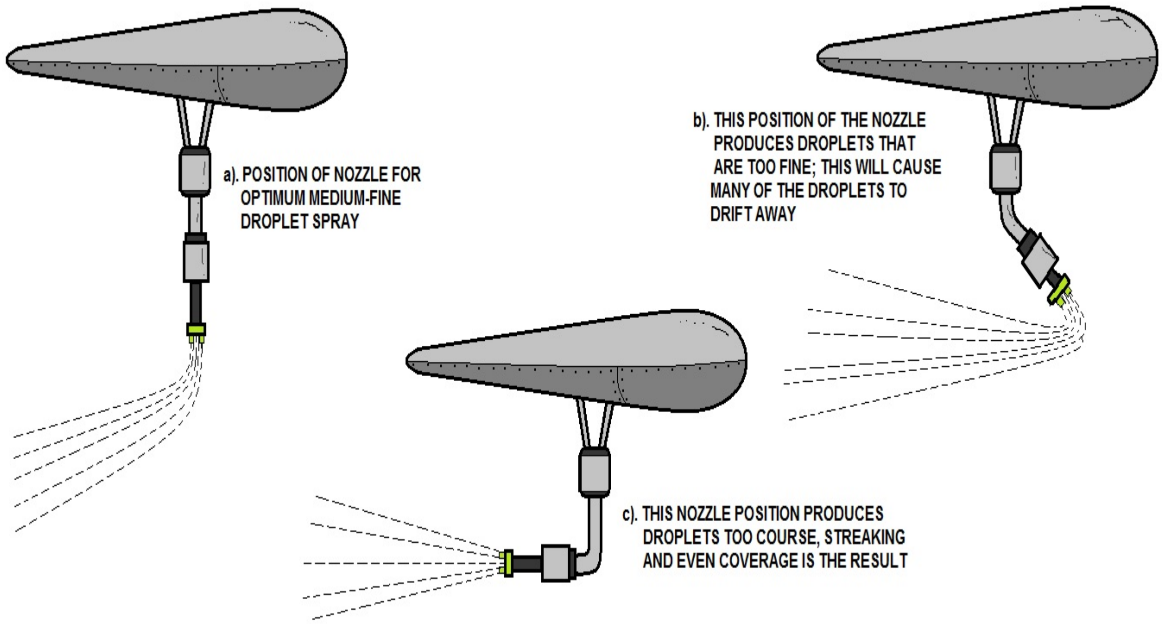
Droplet Size
Droplet size is greatly affected by nozzle orientation on the boom. More shear and liquid break-up may be obtained by orienting nozzles with the direction of flight. A swivel action is desirable.



Flooding Flat Spray

Nozzle types, in order of break-up or particle size, are: (1) fine--hollow cone; (2) intermediate--flat fan; (3) coarse--solid cone. Droplet size may also be controlled by the type of mixture being used (example: water emulsion or chemical wetting agent, etc.).

Other influencing factors are the density, viscosity and surface tension of the liquid, and the evaporative conditions in the air between the point of release from the aircraft and the point of impingement on the ground.



NOZZLE POSITIONING FOR OPTIMUM COVERAGE

SPRAY QUALITY	SIZE OF DROPLETS	COLOR CODE	RETENTION ON LEAVES DIFFICULT TO WET	USED FOR	DRIFT POTENTIAL
EXTREMELY FINE (XF)	SMALL	PURPLE	EXCELLENT	EXCEPTIONS	HIGH
VERY FINE (VF)		RED	EXCELLENT	EXCEPTIONS	
FINE (F)		ORANGE	VERY GOOD	FUNGICIDE & INSECTICIDES	
MEDIUM (M)		YELLOW	GOOD	FUNGICIDES, INSECTICIDES, CONTACT HERBICIDES	
COARSE (C)		BLUE	MODERATE	SYSTEMIC HERBICIDES	
VERY COURSE (VC)		GREEN	POOR	SOIL HERBICIDES	
EXTREMELY COURSE (XC)		WHITE	VERY POOR	LIQUID FERTILIZER	
ULTRA COURSE (UC)	LARGE	BLACK	VERY POOR	LIQUID FERTILIZER	LOW

AGRICULTURAL CHEMICAL APPLICATION NOZZLE DESCRIPTIONS AND USES

For safety and economic considerations, positive shut-off control is essential. This may be attained through the use of diaphragm or ball check valves or a suction return control. Diaphragm nozzles are considered more efficient. All types require maintenance to ensure proper performance.

Spray Nozzle Application Sub-Section

Spray nozzles can be categorized based on the energy input used to cause atomization, the breakup of the fluid into drops. Spray nozzles can have one or more outlets; a multiple outlet nozzle is known as a compound nozzle.

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.

A variety of materials are used to make nozzles, including brass, stainless steel, ceramic and nylon. There are advantages and disadvantages with each type of material. However, it is wisest to invest in the best quality nozzles available. Brass nozzles are relatively inexpensive, but they wear rapidly with abrasive materials, such as wettable powders and liquid fertilizers. Stainless steel and hardened stainless steel are the most resistant to wear, but their expense discourages some users.

Frequent replacement of brass nozzles usually makes their use more costly in relation to the area sprayed. The smooth surface of nylon nozzles makes them relatively resistant to wear, but the threads are easily damaged in use, especially when over tightened.

Modified nylon tips in metal housings avoid some of these problems. However, some solvents react with nylon, causing the material to swell and become unusable. Ceramic spray nozzles are also abrasion resistant, but are expensive and breakable. There are different types of spray patterns produced by nozzles each designed for a specific application.

Choosing the proper nozzle for a particular treatment will ensure good coverage and minimum drift. The selection of a nozzle is determined by the type of treatment being applied as well as certain aspects of the spray equipment such as flow rate and operating pressure. Herbicides are applied at low pressure to produce large droplets that reduce drift. Higher pressures are used with fungicides to produce small droplets for better coverage of foliage. Insecticides are applied with pressure ranges between these two extremes. Drift control adjuvants work best with nozzles that reduce the number of fine and mist-like drops. To be effective and safe, nozzles may need to be changed for different pesticide applications.

Rotary Spray Systems
Spray systems for rotary wing aircraft include tanks mounted on the side of the frame in line with the rotor shaft. A common cross pipe feeds the engine-driven pump. Filter, regulator and control valves are attached to the lower frame of the fuselage in view of the pilot. Boom and nozzles may be mounted on the rotor, frame, or toe of the skids, enabling the pilot to see them.

Using Pesticides Correctly
Product selection should be made taking into consideration the environmental risk, the potential applicator, worker or handler exposure hazard and the recommended dose rates. The products chosen must be used strictly in accordance with the label specification.

The majority of pesticide products and formulations approved for conventional aerial spraying are similar to products applied through conventional ground sprayers, however, when applied by air they are generally used at lower water volumes and therefore at higher spray solution concentrations. Where products used are not designed for aerial application, some formulations can present problems such as thickening, excessive foaming and emulsion inversion.

Chemicals are often used for control of invasive weeds and brush that hamper re-vegetation efforts on rangelands. Agricultural herbicides undergo extensive toxicological, environmental, plant efficacy, and cost-benefit tests before being released for widespread use. This database of knowledge enables the applicator to select herbicides to fit the targeted weeds and brush for maximum efficacy, efficiency, safety, and economics.

The number of herbicides for use on rangeland has changed little in the past two decades, and it appears that there will be little change in the next 20 years. The major change in application practice has been a shift from broad-scale aerial applications to individual plant treatments with ground equipment.

In either case, the application equipment has been designed for more precision and safer use. Global positioning systems (GPS) and geographic information systems (GIS) on aircraft or ground units allow the applicator, worker or handler to “sculpt” the landscape for multiple land-uses, e.g. wildlife habitat, grazing, water harvesting, and aesthetics.

Herbicides will continue to play a significant role both singly and in combination with fire and mechanical treatments in re-vegetation projects. Persons applying restricted-use pesticides must have state certified Applicator’s License and follow specifications on the chemical’s Product Label. It is important to note that the Directions for Use section of all pesticide product labels begin with the statement: “It is a violation of Federal law to use this product in a manner inconsistent with its labeling.”

Granular Dispersal Systems
Granular dispersal systems are used for applying dust, impregnated granules, fertilizers and seed. A hopper with agitation must be provided to prevent bridging of fine material. Fine materials less than 60 mesh require agitators to prevent bridging. Frequent inspection of metering gates is required to ensure against leakage common under flight conditions of low pressure. The metering gate is the means of calibration. Size, shape, density and flowability of material all affect the swath width, application rate and pattern. The use of granular systems is on the decline in agricultural work.

Distance between Nozzle and Target (Boom Height)
Less distance between the droplet release point and the target will reduce spray drift. Less distance means less time to travel from nozzle to target and therefore less drift occurs.

Herbicide Volatility
All herbicides can drift as spray droplets, but some herbicides are sufficiently volatile to cause plant injury from drift of vapor (fumes). For example, 2,4-D or MCPA esters may produce damaging vapors, while 2,4-D or MCPA amines are essentially non-volatile and can drift only as droplets or dry particles.

Relative Humidity and Temperature
Low relative humidity and/or high temperature will cause more rapid evaporation of spray droplets between the spray nozzle and the target than will high relative humidity and/or low temperature. Evaporation reduces droplet size, which in turn increases the potential drift of spray droplets.

Wind Direction and Velocity
Herbicides should not be applied when the wind is blowing toward an adjoining susceptible crop or a crop in a vulnerable stage of growth. The amount of herbicide lost from the target area and the distance the herbicide moves will increase as wind velocity increases, so greater wind velocity generally will cause more drift. However, severe crop injury from drift can occur with low wind velocities, especially under conditions that result in vertically stable air.

Over the past several decades the greatest and most widespread uses of herbicides have been in the production of row-crops and forages and in the clearing of brush for pasture improvement. Oversight and carelessness in the use of herbicides on these crops and pastures have often resulted in unwarranted crop damage and substantial economic loss to growers or users of herbicides.

This is especially true where small scale, high-value crops of sensitive nature are involved. Sometimes farmers and landowners unknowingly apply hazardous herbicides in such close proximity or under such unfavorable climatic conditions that they injure their own crops or those of their neighbors.

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, 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.

Leak-proof Spray System Components
Check the condition of gate seal, hoses, and other spray system components to make sure they are leak-proof. 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*.

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.

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*.

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*.

Electrostatic Sprayers

Electrostatic sprayers which apply an electrical charge to the material being sprayed reduce spraying time and improve insect and disease control per unit of chemical applied.

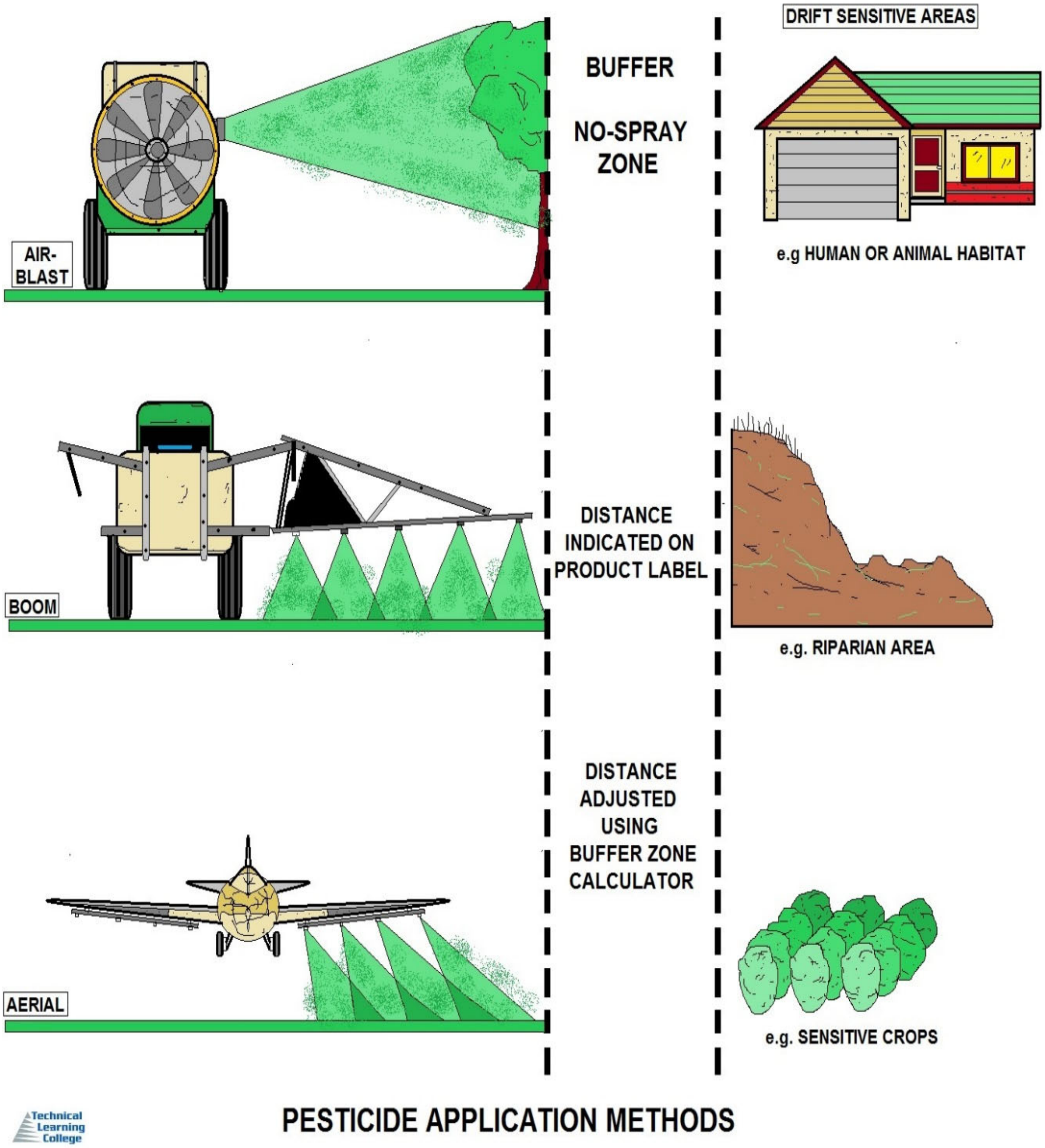
ATOMIZER EXAMPLE

The charged chemical is attracted to the opposite electric charge on the leaf surface so that retention is better. To further increase efficiency, the charged spray can be delivered with a turbulent air blast, carrying the material deeper into the plant canopy.

Such air-assisted electrostatic sprayers deposited four times more spray onto both upper and lower leaf surfaces than conventional mist-blower equipment.

Higher amounts of sprays from air-assisted electrostatic units were also found deeper in the crop canopy compared to the amounts delivered by uncharged hydraulic sprayers. These sprayers also deposit more spray on any fruit present in the canopy, however.

Some systemic insecticides are applied to the soil at planting to control early season insects. Thoroughly incorporating granules of these soil-applied chemicals increases control efficiency, while reducing hazards to birds and wildlife from surface granules and granules spilled at the ends of the rows.



PESTICIDE APPLICATION METHODS

Factors Affecting Nozzle Performance

Liquid Properties
Almost all drop size data supplied by nozzle manufacturers are based on spraying water under laboratory conditions, 70°F (21°C). The effect of liquid properties should be understood and accounted for when selecting a nozzle for a process that is drop size sensitive.

Relative Humidity
Relative humidity is a term used to describe the amount of water vapor in a mixture of air and water vapor. It is defined as the ratio of the partial pressure of water vapor in the air-water mixture to the saturated vapor pressure of water at those conditions. The relative humidity of air depends not only on temperature but also on pressure of the system of interest. Relative humidity is often used instead of absolute humidity in situations where the rate of water evaporation is important, as it takes into account the variation in saturated vapor pressure. Cold humid air can provoke the formation of ice, which is a danger to aircraft as it affects the wing profile and increases weight. Carbureted engines have a further danger of ice forming inside the carburetor. Aviation weather reports (METAR's) therefore include an indication of relative humidity, usually in the form of the dew point. In addition, air with higher humidity is less dense providing lower lift and lower propeller or turbine efficiency (this is somewhat offset by decreased drag). Pilots must take into account humidity when calculating takeoff distances since high humidity will require longer runways and will decrease the climb gradient.

Absolute Humidity
Absolute humidity is a term for the amount of water vapor in the air, and can refer to any one of several measurements of humidity. Formally, humid air is not "moist air" but a mixture of water vapor and other constituents of air, and humidity is defined in terms of the water content of this mixture, called the Absolute humidity. In everyday usage, it commonly refers to relative humidity, expressed as a percent in weather forecasts and on household humidistats; it is so called because it measures the current absolute humidity relative to the maximum. Specific humidity is a ratio of the water vapor content of the mixture to the total air content (on a mass basis). The water vapor content of the mixture can be measured either as mass per volume or as a partial pressure, depending on the usage. In meteorology, humidity indicates the likelihood of precipitation, dew, or fog. High relative humidity reduces the effectiveness of sweating in cooling the body by reducing the rate of evaporation of moisture from the skin. This effect is calculated in a heat index table, used during summer weather.

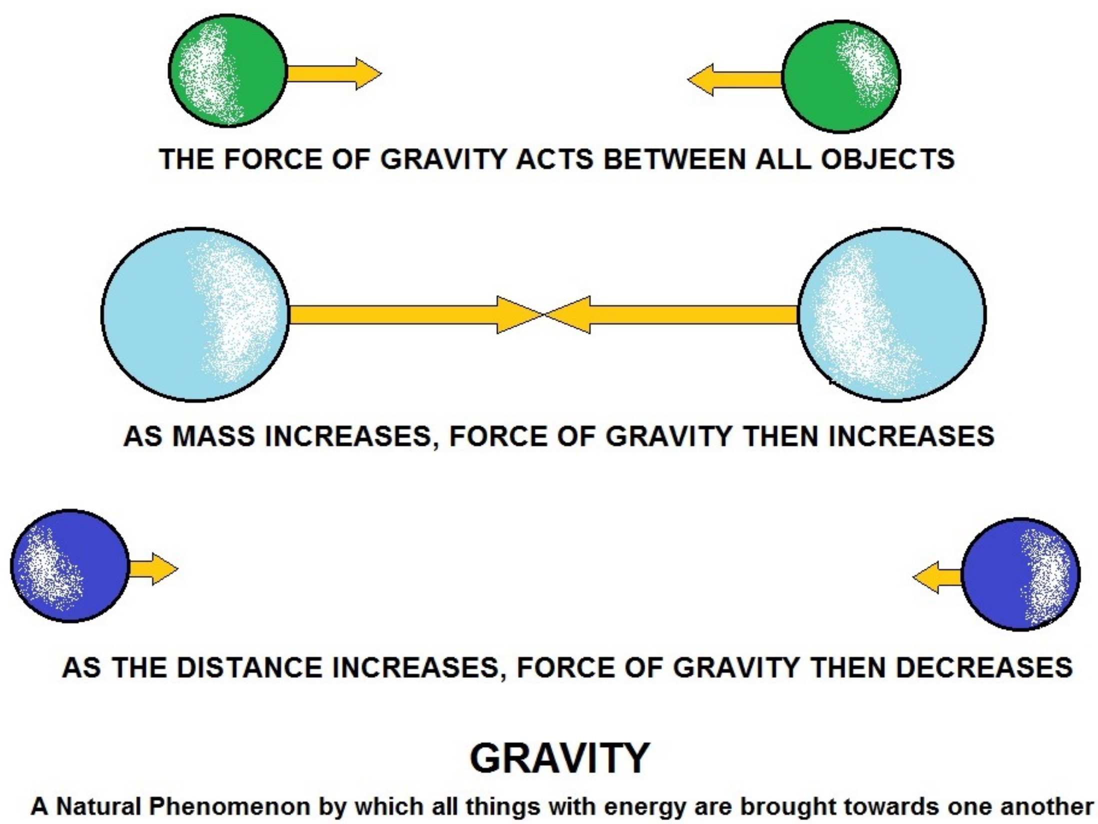
Wind Direction and Velocity
Wind velocity is measured by means of an anemometer or radar. The oldest of these is the cup anemometer, an instrument with three or four small hollow metal hemispheres set so that they catch the wind and revolve about a vertical rod; an electrical device records the revolutions of the cups and thus the wind velocity. The pressure tube anemometer, used primarily in Commonwealth nations, is conceptually a Pitot tube mounted on a wind vane. As the wind blows across the tube, a pressure differential is created that can be mathematically related to wind speed. Doppler radar can be used to measure wind speed by shooting pulses of microwaves that are reflected off rain, dust, and other particles in the air, much like the radar guns used by the police to determine the speed of an automobile.

Although the U.S. National Weather Service has estimated that tornado winds have reached a velocity of 500 mph (800 kph), the highest wind speeds ever documented, 318 mph (516 kph), were measured using Doppler radar during a tornado in Oklahoma in 1999.

The first successful attempt to standardize the nomenclature of winds of different velocities was the Beaufort scale, devised (c.1805) by Admiral Sir Francis Beaufort of the British navy. An adaptation of Beaufort's scale is used by the U.S. National Weather Service; it employs a scale ranging from 0 for calm to 12 for hurricane, each velocity range being identified by its effects on such things as trees, signs, and houses.

Winds may also be classified according to their origin and movement, such as heliotropic winds, which include land and sea breezes, and cyclonic winds, which blow counterclockwise in low-pressure regions of the Northern Hemisphere and clockwise in the Southern Hemisphere.

Temperature
Liquid temperature changes do not directly affect nozzle performance, but can affect viscosity, surface tension, and specific gravity, which can then influence spray nozzle performance.



Specific Gravity
Specific gravity is the ratio of the mass of a given volume of liquid to the mass of the same volume of water. In spraying, the main effect of the specific gravity Sg of a liquid other than water is on the capacity of the spray nozzle. All vendor-supplied performance data for nozzles are based on spraying water.

Viscosity
Dynamic viscosity is defined as the property of a liquid that resists change in the shape or arrangement of its elements during flow. Liquid viscosity primarily affects spray pattern formation and drop size. Liquids with a high viscosity require a higher minimum pressure to begin spray pattern formation and yield narrower spray angles compared to water.

Surface Tension
The surface tension of a liquid tends to assume the smallest possible size, acting as a membrane under tension. Any portion of the liquid surface exerts a tension upon adjacent portions or upon other objects that it contacts. This force is in the plane of the surface, and its amount per unit of length is surface tension. The value for water is about 0.073 N/m at 21°C. The main effects of surface tension are on minimum operating pressure, spray angle, and drop size. Surface tension is more apparent at low operating pressures. A higher surface tension reduces the spray angle, particularly on hollow cone nozzles. Low surface tensions can allow nozzles to be operated at lower pressures.

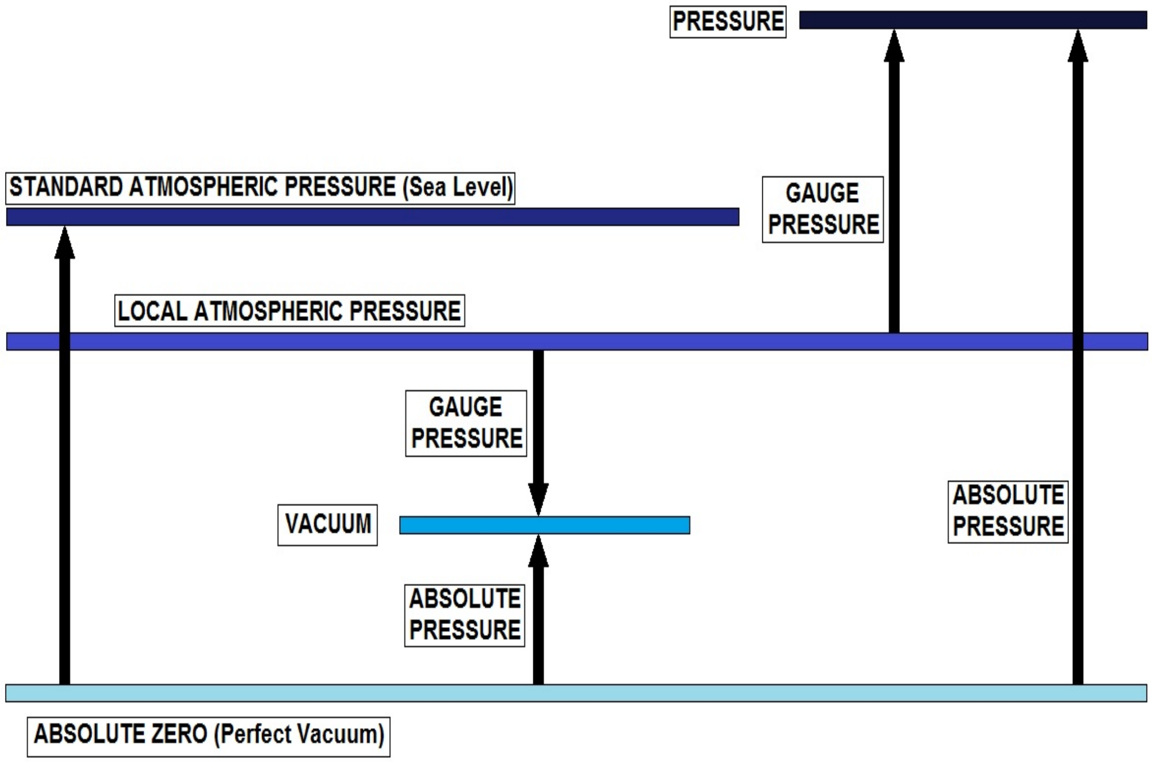
Nozzle Wear
Nozzle wear is indicated by an increase in nozzle capacity and by a change in the spray pattern, in which the distribution (uniformity of spray pattern) deteriorates and increases drop size. Choice of a wear resistant material of construction increases nozzle life. Because many single fluid nozzles are used to meter flows, worn nozzles result in excessive liquid usage.

Material of Construction
The material of construction is selected based on the fluid properties of the liquid that is to be sprayed and the environment surrounding the nozzle. Spray nozzles are most commonly fabricated from metals, such as brass, Stainless steel, and nickel alloys, but plastics such as PTFE and PVC and ceramics (alumina and silicon carbide) are also used. Several factors must be considered, including erosive wear, chemical attack, and the effects of high temperature.

Particle Size and the Pesticide Application
It is very important to understand the relationship between application and particle size.

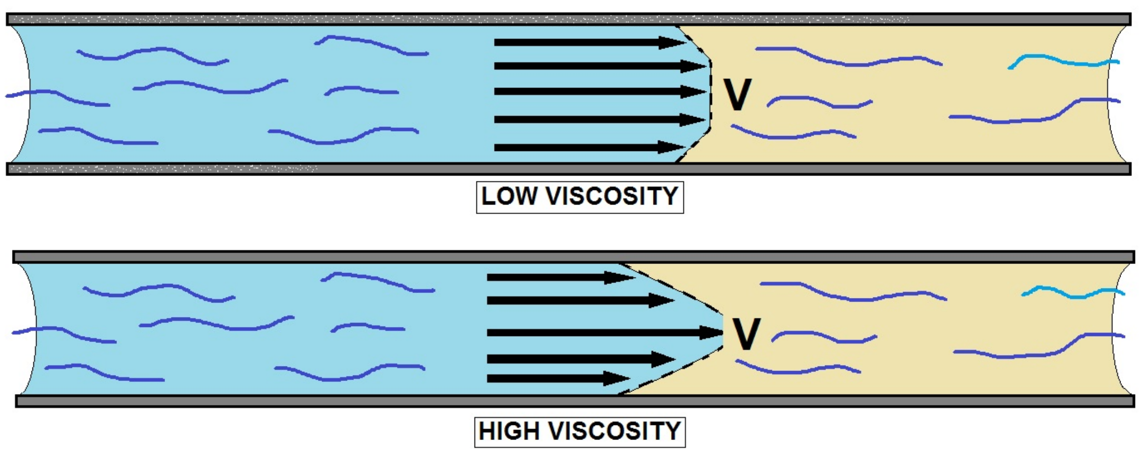
How well a pesticide works depends on the size of the droplets or particles. (For example, a liquid residual application: totally wet the surface and leave a lasting deposit of pesticide when dry for control after the initial application.)

Liquid sprays range from rain-like drops to mists and fogs. These droplets are characterized by the mass median diameter (mmd) of spray. The droplets are measured in microns. This measurement is 1/1000 of a millimeter or about 1/25,000 of an inch. The average diameter of a human hair is about 100 microns.



VACUUM / ABSOLUTE PRESSURE EXAMPLE

VELOCITY INCREASES RAPIDLY FROM WALL INWARD FOR A LOW - VISCOSITY BUT MORE GRADUALLY FOR A HIGH VISCOSITY FLUID



VISCOSITY OF LIQUID

Category of Liquid Applications

Coarse sprays contain droplets 400 microns or more from coarse disc nozzles or solid-stream gun nozzles.

Fine sprays have droplets from 100 to 400 microns, produced with high pressure through hollow-cone and fan-spray nozzles.

Mists droplet size is from 50 to 100 microns in diameter. High-pressure pumps, high-speed mechanical rotors, and atomizers produce them.

Aerosols and ULV fogs are defined as assemblages of solid particles or liquid droplets suspended in air and ranging in size from 0.1 to 50 microns. By spraying the pesticides into a blast of hot air as with the thermal aerosol generator, or by mixing them with a liquefied gas they release through small orifices, as with the household total release aerosol or "bug bomb". They are also produced by atomization from specialized nozzles, or by being thrown off the rim of high-speed rotors.

Smokes and fumes, particles range from 0.001 to 0.1 microns in diameter. They commonly produce by output of thermal fog generators. The generators use the exhaust of an internal combustion engine to vaporize the oil carrier or to partially combust the pesticide formulation.

Vapors consist of airborne insecticide in droplet sizes less than 0.001 micron.

Insecticidal dusts occur in three sizes:

Coarse about 175 microns or larger, this size is to avoid excessive drift.

Medium from 45 to 175 microns.

Fine 44 microns or less, these droplets will pass through a 325-mesh screen.

Dusters

Dusters apply a dry layer of powder mixture with a small amount of pesticide. Dust applied on porous surfaces is not absorbed as liquids are. The powder mixture lays where insects can pick it up on their hairs, legs, mouthparts, etc. The pests absorb the pesticide through the cuticle the same way as liquids. The pest can ingest particles when grooming which causes stomach poisoning. Dusts may also be inhaled through insect spiracles.

Foot Pump

This is a hand-operated plunger type blower with a container for insecticide dust. A stirrup is provided so you can hold the pump down with one foot. The operator pumps air and insecticide through a hose to the treatment area. You use this tool to apply dust to rodent burrows and other enclosed shelters.

Why Calibrate Spray Equipment

Calibration is a process of measurement. You measure the solution that comes out of the equipment during a certain period. A pest control applicator should know that the proper dosage of pesticide is applied. Without accurate calibration of sprayers, the amount of pesticide delivered will be incorrect. Over dosage will contaminate the spray area. Less than recommended dosage might fail to control the pest.

Applicators need to look regularly at the output of their equipment. Flow meters are very helpful to let the applicator know the output of the sprayer over time.

- ✓ The estimated number of sprayers that have a 10% calibration error is 60 percent.
- ✓ A large percentage of sprayers have greater than 10 percent variation in discharge from individual nozzles or tips.

How to Calibrate Equipment
Calibration does not have to be a difficult process. It can be as simple as reading a pesticide label for the mixing instructions. It can be as simple as the time it takes to spray an amount of liquid and then measure that amount. This will determine how much liquid is expelled from the sprayer during a period.

The nozzle flow rate determines the spray applied per unit area. The flow rate through a nozzle varies because of pressure in and size of nozzle. Using a nozzle with a larger opening will increase the flow rate. Increasing the pressure **will not** increase the flow rate. You cannot use pressure to make major changes in spray rate. It can however, make minor changes. The most effective way to make a large change in flow rate is to change the size of the nozzle tip.

Depending on the pressure, small changes in nozzle size can change the sprayer output. You can use nozzle catalogs to select the proper tip size.

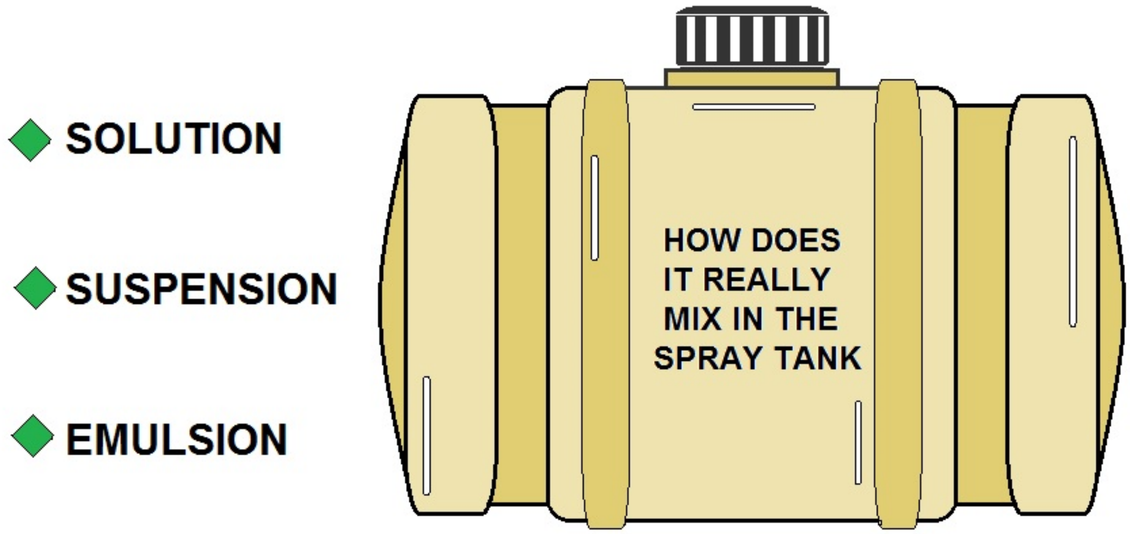
Nozzles with multiple different nozzle sizes on one tip should be calibrated. Calibrate each tip if the nozzle has four different tips then calibrate each tip separately.

Liquid Application on a Percentage Basis
The amount of active ingredient (a.i.) for structural insect control recommendations is usually in percentages. The pesticide manufacturer normally provides a spray dilution chart on the label. This chart lists the amount of formulated product that needs to be mixed with various quantities of diluent (usually water). This mixture provides the desired spray mixture. Thus, insecticide mixtures can be prepared directly from label directions without the need for calculations.

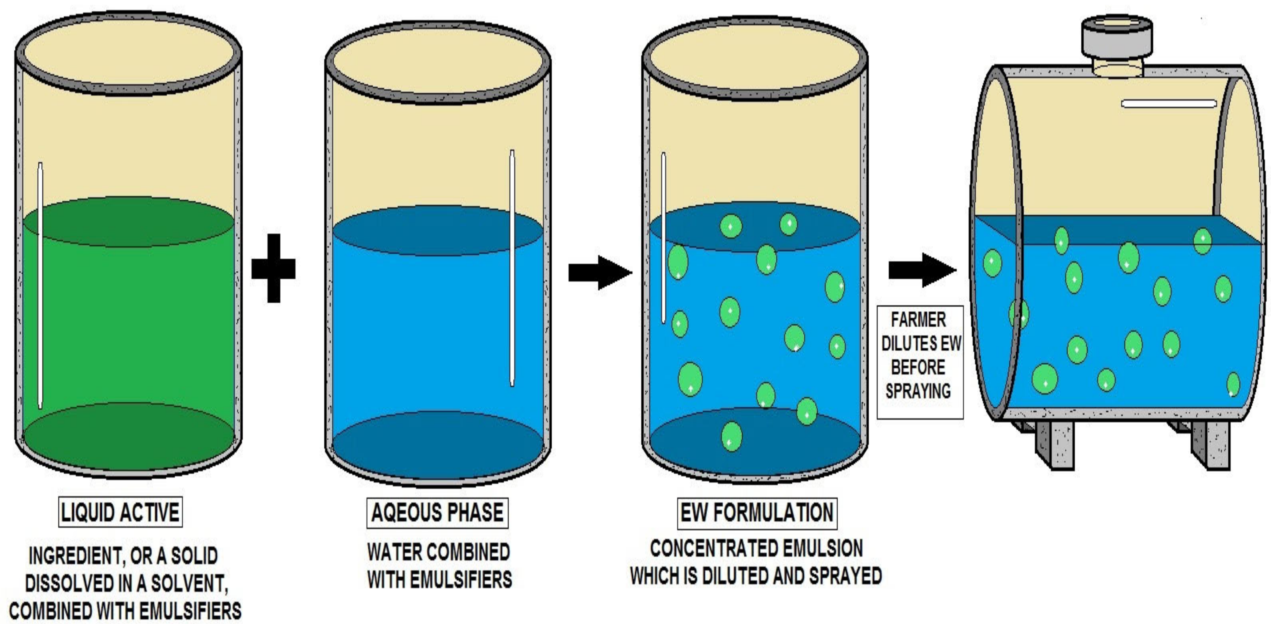
Liquid Application and Calculations
You should conduct sprayer calibration using tap water or base oil. Calibration depends on the formulation applied and equipment used. After you have properly calibrated your equipment, it is ready to use. The next step is to read the label and find the site and pest which you are treating. Then mix the pesticide and the diluent together in the sprayer tank. Put the lid on the sprayer and tighten it. Get a large bucket and spray the pesticide liquid into the bucket. Keep the time on how long you sprayed the liquid into the bucket. Measure the liquid in the bucket.

EXAMPLE: (Time of spray = 10 minutes)
(Area sprayed = 600 sq. ft)
(Accumulation of pesticide =1 pt)

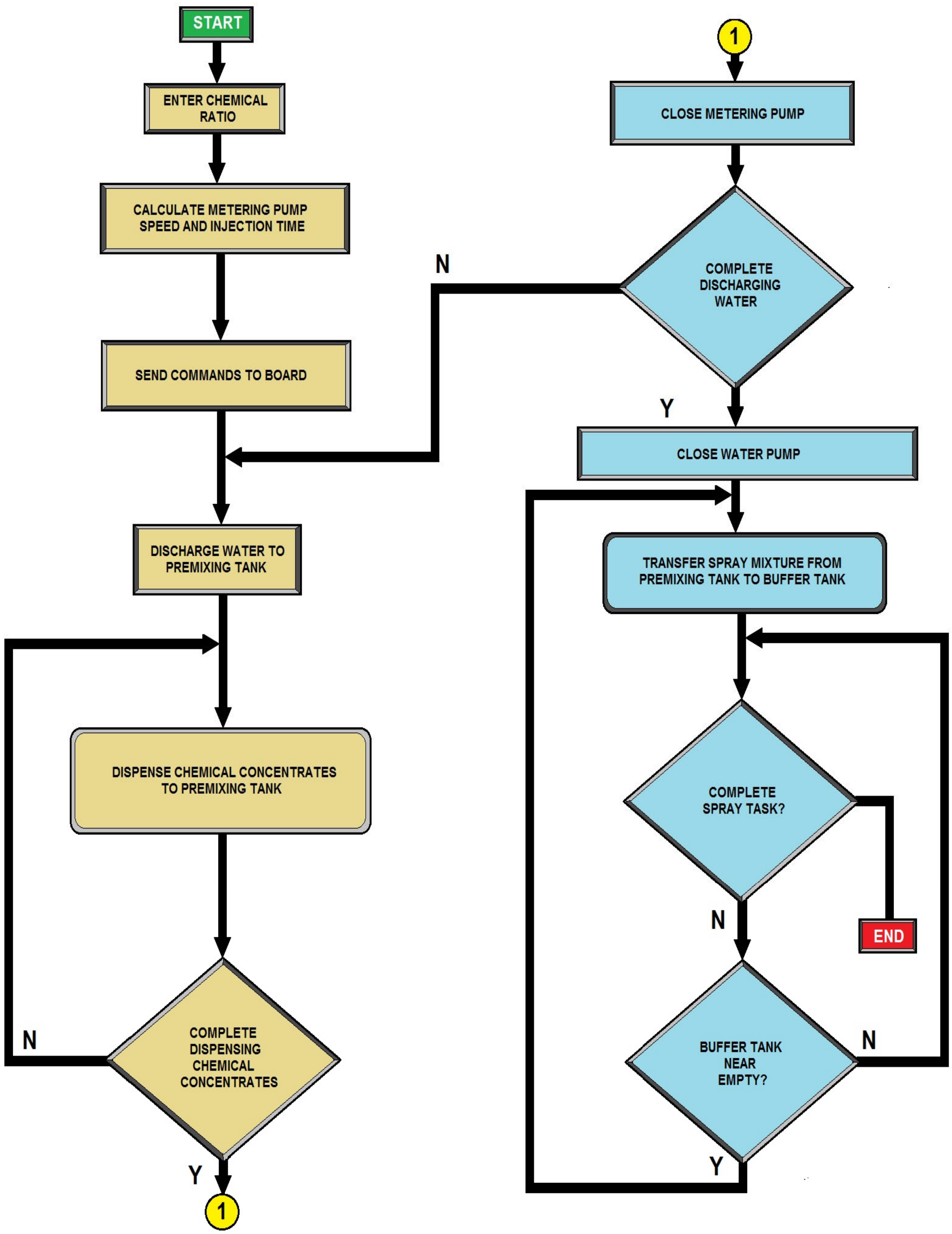
FORMULA: (Timed spray x Area sprayed x Accumulation of Pesticide)



SPRAY MIX TERMINOLOGY



CONCENTRATED AQUEOUS EMULSION PROCESS

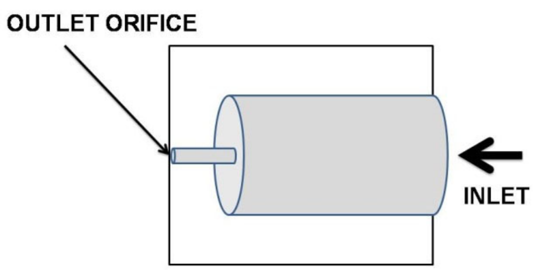


METERING PESTICIDE DISPERSAL

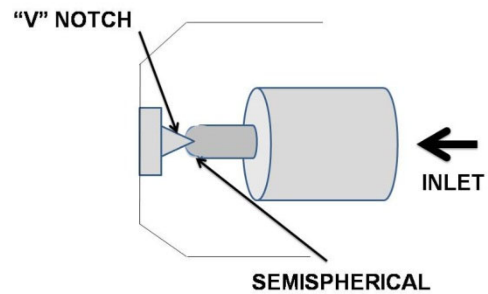
Single-Fluid Nozzles Sub-Section

Single-fluid or hydraulic spray nozzles utilize the kinetic energy of the liquid to break it up into droplets. This most widely used type of spray nozzle is more energy efficient at producing surface area than most other types. As the fluid pressure increases, the flow through the nozzle increases, and the drop size decreases. Many configurations of single fluid nozzles are used depending on the spray characteristics desired.

Plain Orifice Type Nozzle
This nozzle often produces little if any atomization, but directs the stream of liquid. If the pressure drop is high, at least 25 bar, the material is often finely atomized, as in a diesel injector. At lower pressures, this type of nozzle is often used for tank cleaning, either as a fixed position compound spray nozzle or as a rotary nozzle.



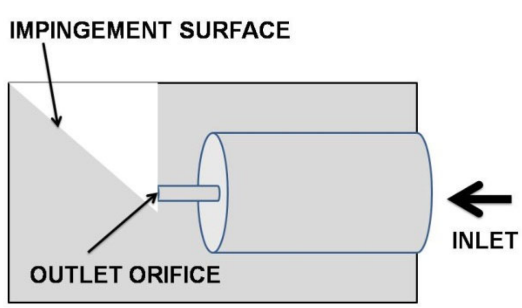
PLAIN ORIFICE NOZZLE



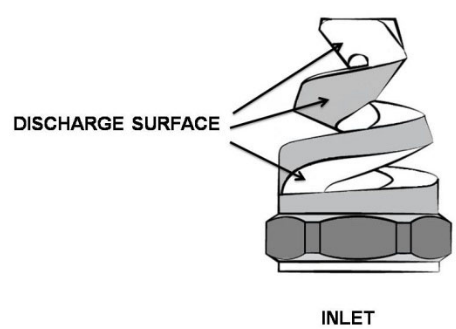
SHAPED ORIFICE NOZZLE

Shaped Orifice Nozzle
The shaped orifice uses a hemispherical shaped inlet and a "V" notched outlet to cause the flow to spread out on the axis of the V notch. A flat fan spray results which is useful for many spray applications, such as spray painting.

Surface Impingement Single Fluid Nozzle
A surface impingement nozzle causes a stream of liquid to impinge on a surface resulting in a sheet of liquid that breaks up into drops. This flat fan spray pattern nozzle is used in many applications ranging from applying agricultural herbicides to row crop to painting.



SURFACE IMPINGEMENT



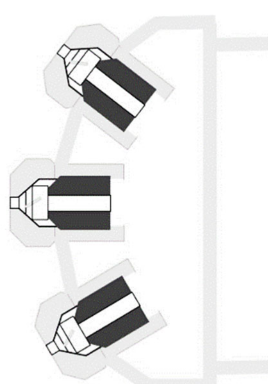
SPIRAL SPRAY NOZZLE

Spiral Design
The impingement surface can be formed in a spiral to yield a spiral shaped sheet approximating a full cone spray pattern or a hollow-cone spray pattern. The spiral design generally produces a smaller drop size than pressure swirl type nozzle design, for a given pressure and flow rate. This design is clog resistant due to the large free passage. Common applications include gas scrubbing applications (e.g. flue-gas desulfurization where the smaller droplets often offer superior performance) and firefighting (where the mix of droplet densities allow spray penetration through strong thermal currents).

Pressure-Swirl Single Fluid Spray Nozzle
Pressure-swirl spray nozzles are high-performance (small drop size) devices with one configuration shown. The stationary core induces a rotary fluid motion which causes the swirling of the fluid in the swirl chamber. A film is discharged from the perimeter of the outlet orifice producing a characteristic hollow cone spray pattern. Air or other surrounding gas is drawn inside the swirl chamber to form an air core within the swirling liquid. Many configurations of fluid inlets are used to produce this hollow cone pattern depending on the nozzle capacity and materials of construction. The uses of this nozzle include evaporative cooling and spray drying.

A spill-return pressure-swirl single-fluid nozzle is one variety of pressure swirl nozzle includes a controlled return of fluid from the swirl chamber to the feed system. This allows the nozzle pressure drop to remain high while allowing a wide range of operating rates.

Solid Cone Single-fluid Nozzle
One of the configurations of the solid cone spray nozzle is shown in a schematic diagram. A swirling liquid motion is induced with the vane structure, however; the discharge flow fills the entire outlet orifice. For the same capacity and pressure drop, a full cone nozzle will produce a larger drop size than a hollow cone nozzle. The coverage is the desired feature for such a nozzle, which is often used for applications to distribute fluid over an area.



COMPOUND PRESSURE SWIRL SPRAY NOZZLE

Compound Nozzle
A compound nozzle is a type of nozzle in which several individual single or two fluid nozzles are incorporated into on nozzle body, as shown below. This allows design control of drop size and spray coverage angle.

Two-Fluid Nozzles Sub-Section

Two-fluid nozzles atomize by causing the interaction of high velocity gas and liquid. Compressed air is most often used as the atomizing gas, but sometimes steam or other gases are used. The many varied designs of two-fluid nozzles can be grouped into internal mix or external mix depending on the mixing point of the gas and liquid streams relative to the nozzle face.

Internal-Mix Two-Fluid Nozzles
Internal mix nozzles contact fluids inside the nozzle; one configuration is shown below. Shearing between high velocity gas and low velocity liquid disintegrates the liquid stream into droplets, producing a high velocity spray. This type of nozzle tends to use less atomizing gas than an external mix atomizer and is better suited to higher viscosity streams. Many compound internal-mix nozzles are commercially used for, e.g., fuel oil atomization.

External-Mix Two-Fluid Nozzles
External mix nozzles contacts fluids outside the nozzle as shown in the schematic diagram. This type of spray nozzle may require more atomizing air and a higher atomizing air pressure drop because the mixing and atomization of liquid takes place outside the nozzle. The liquid pressure drop is lower for this type of nozzle, sometimes drawing liquid into the nozzle due to the suction caused by the atomizing air nozzles (siphon nozzle). If the liquid to be atomized contains solids an external mix atomizer may be preferred. This spray may be shaped to produce different spray patterns. A flat pattern is formed with additional air ports to flatten or reshape the circular spray cross-section discharge. Control of two-fluid nozzles

Many applications use two-fluid nozzles to achieve a controlled small drop size over a range of operation. Each nozzle has a performance curve, and the liquid and gas flow rates determine the drop size. Excessive drop size can lead to catastrophic equipment failure or may have an adverse effect on the process or product. For example, the gas conditioning tower in a cement plant often utilizes evaporative cooling caused by water atomized by two-fluid nozzles into the dust laden gas. If drops do not completely evaporate and strike a vessel wall dust will accumulate, resulting in the potential for flow restriction in the outlet duct, disrupting the plant operation.

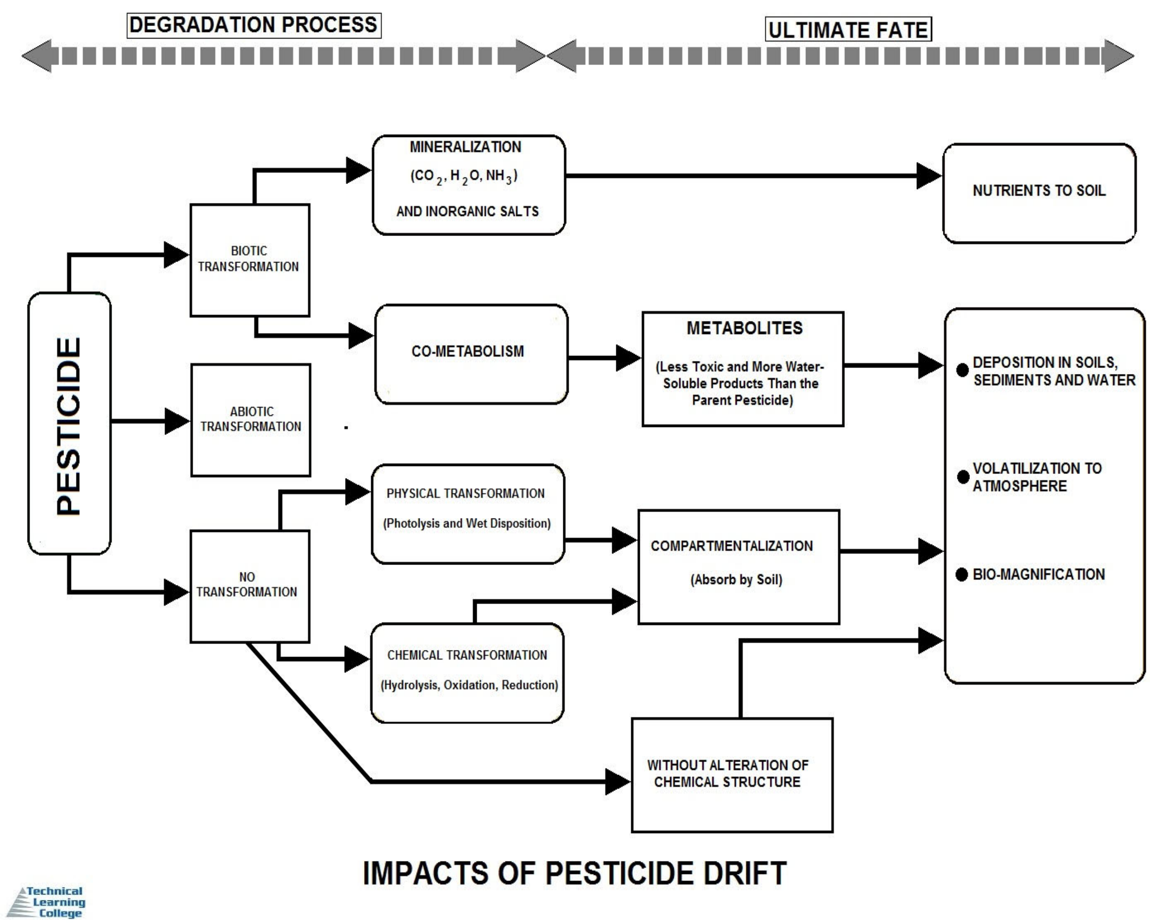
Rotary Atomizers
Rotary atomizers use a high speed rotating disk, cup or wheel to discharge liquid at high speed to the perimeter, forming a hollow cone spray. The rotational speed controls the drop size. Spray drying and spray painting are the most important and common uses of this technology.

Ultrasonic Atomizers
This type of spray nozzle utilizes high frequency (20 kHz to 50 kHz) vibration to produce narrow drop-size distribution and low velocity spray from a liquid. The vibration of a piezoelectric crystal causes capillary waves on the nozzle surface liquid film.

Electrostatic
Electrostatic charging of sprays is very useful for high transfer efficiency. Examples are the industrial spraying of coatings (paint) and applying lubricant oils. The charging is at high voltage (20 to 40 kV) but low current.

Spraying Inefficiencies
In order to better understand the cause of the spray inefficiency, it is useful to reflect on the implications of the large range of droplet sizes produced by typical (hydraulic) spray nozzles. This has long been recognized to be one of the most important concepts in spray application (e.g. Himel, 1969), bringing about enormous variations in the properties of droplets. Historically, dose-transfer to the biological target (i.e. the pest) has been shown to be inefficient.

However, relating "ideal" deposits with biological effect is fraught with difficulty), but in spite of Hislop's misgivings about detail, there have been several demonstrations that massive amounts of pesticides are wasted by run-off from the crop and into the soil, in a process called endo-drift.



IMPACTS OF PESTICIDE DRIFT

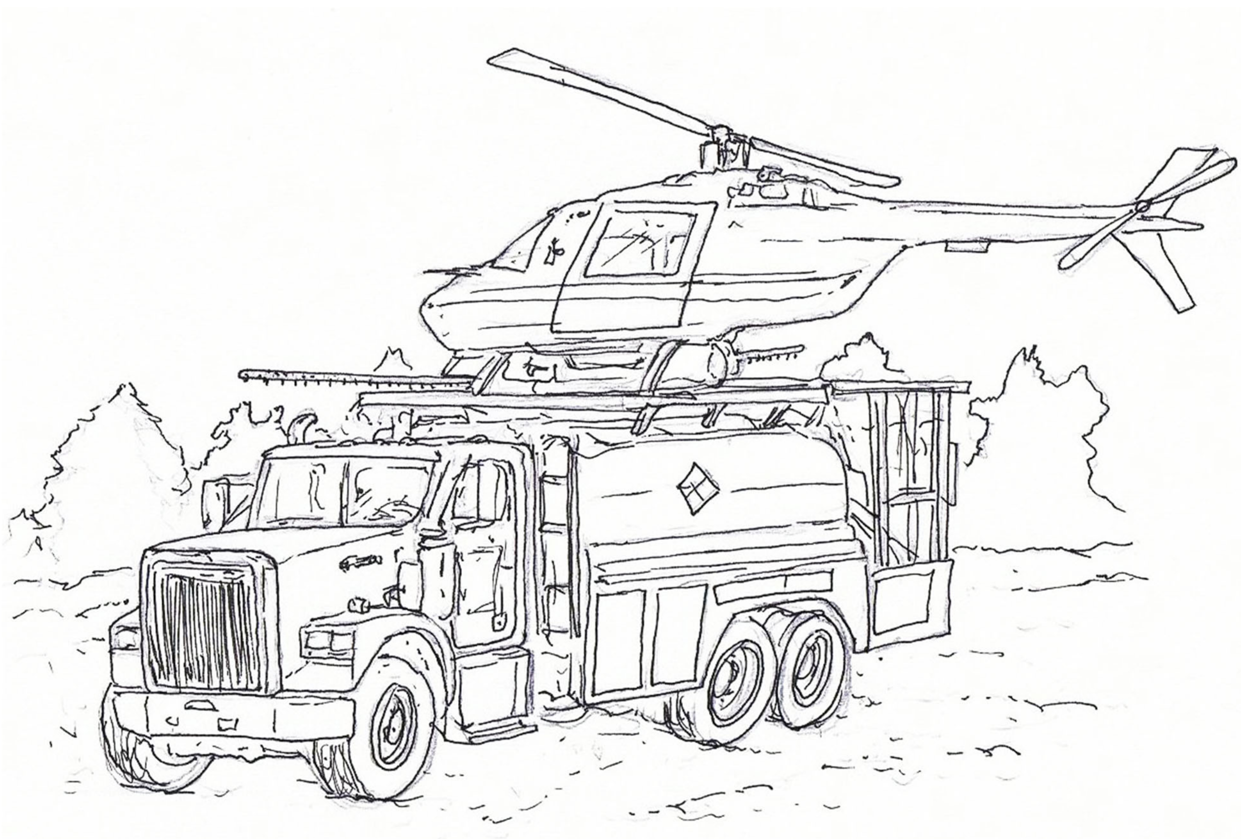
This is a less familiar form of pesticide drift, with exo-drift causing much greater public concern. Pesticides are conventionally applied using hydraulic atomizers, either on hand-held sprayers or tractor booms, where formulations are mixed into high volumes of water.

Different droplet sizes have dramatically different dispersal characteristics, and are subject to complex macro- and micro-climatic interactions (Bache & Johnstone, 1992). Greatly simplifying these interactions in terms of droplet size and wind speed, Craymer & Boyle concluded that there are essentially three sets of conditions under which droplets move from the nozzle to the target.

These are where:

- Sedimentation dominates: typically larger (>100 micrometer) droplets applied at low wind-speeds; droplets above this size are appropriate for minimizing drift contamination by herbicides.
- Turbulent eddies dominate: typically small droplets (<50 micrometer) that are usually considered most appropriate for targeting flying insects, unless an electrostatic charge is also present that provides the necessary force to attract droplets to foliage. (NB: the latter effects only operate at very short distances, typically under 10 mm.)
- Intermediate conditions where both sedimentation and drift effects are important. Most agricultural insecticide and fungicide spraying is optimized by using relatively small (say 50-150 micrometer) droplets in order to maximize "coverage" (droplets per unit area), but are also subject to drift.

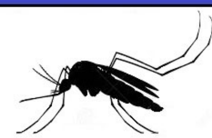
A spray nozzle is a precision device that facilitates dispersion of liquid into a spray. Nozzles are used for three purposes: to distribute a liquid over an area, to increase liquid surface area, and create impact force on a solid surface. A wide variety of spray nozzle applications use a number of spray characteristics to describe the spray.



HELICOPTER –BATCH TRUCK COMBINATION

Mosquito Adulticides Spraying Information

Some public health pesticides come in concentrated form and must be diluted to produce what is known as a tank mix.

AEDES AEGYPT		STILT MOSQUITO
		
DAYTIME (Can sting at night)	**HABITS**	NOCTURNAL
DARK (With white stripes)	**COLOR**	BROWN
ALMOST CLEAN WATER (Little organic matter)	**BREEDING SITES**	POLLUTED WATER (Contains lots of organic matter)
4 - 6 mm	**SIZES**	4 - 10 mm
SEVERAL (In multiple locations)	**EGGS**	TOGETHER (In clusters)

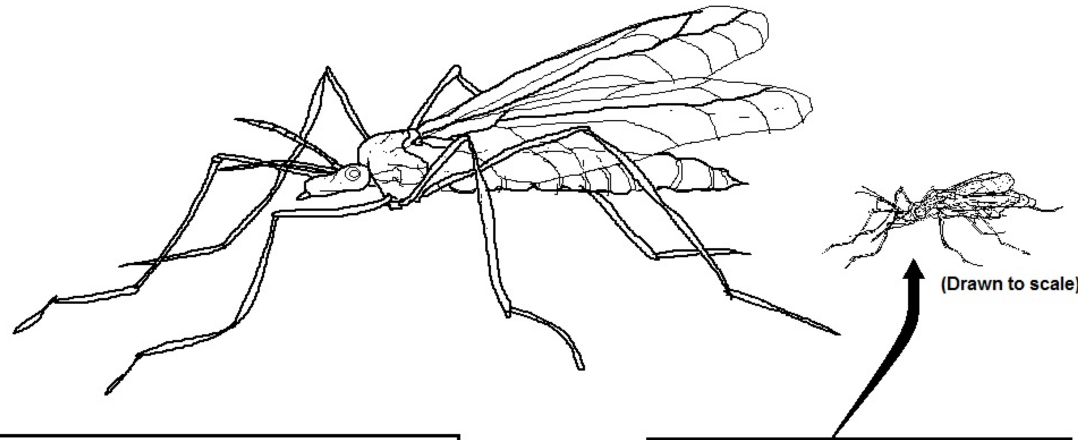
MOSQUITO COMPARISON

Mosquito adulticides that are applied as fogs or by using ultra-low volume techniques require equipment designed for these purposes. Because the labels of the pesticides used in these kinds of applications carry specific restrictions on droplet size and application rates, 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.

Some pesticide labels say the pesticide can be applied by either fixed-wing aircraft or by helicopters. The main advantage of aerial spraying is that it can be carried out quickly and at times when ground equipment cannot operate.

The main disadvantage is the increased possibility of pesticide drift onto neighboring areas and decreased spray coverage. Even when properly calibrated and operated, aircraft sprayers 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. Aerial applications 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.

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 liquid formulations, the basic choice will hinge on the spray techniques to be used. Spray techniques, in turn, often are classified on the basis of the spray volume used in an application. The three basic types of liquid spray techniques 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).



CRANE FLY

- **LOCAL GENUS:** Tipula ultima
- **SIZE:** 3/8 to 2 1/2 inch
- **HABITAT:** Humid Areas
- **HARMLESS TO HUMANS**
- **ADULTS ARE A FAVORITE FOOD OF MANY BIRDS AND SMALL MAMMALS**

MOSQUITO

- **LOCAL GENUS:** Culex pipiens
- **SIZE:** 1/8 to 1/4 inch
- **HABITAT:** Any still water
- **CAN BE HARMFUL TO HUMANS AS THEY MAY CARRY VARIOUS TYPES OF DISEASES**

CRANE FLY / MOSQUITO COMPARISON

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.
Supplies

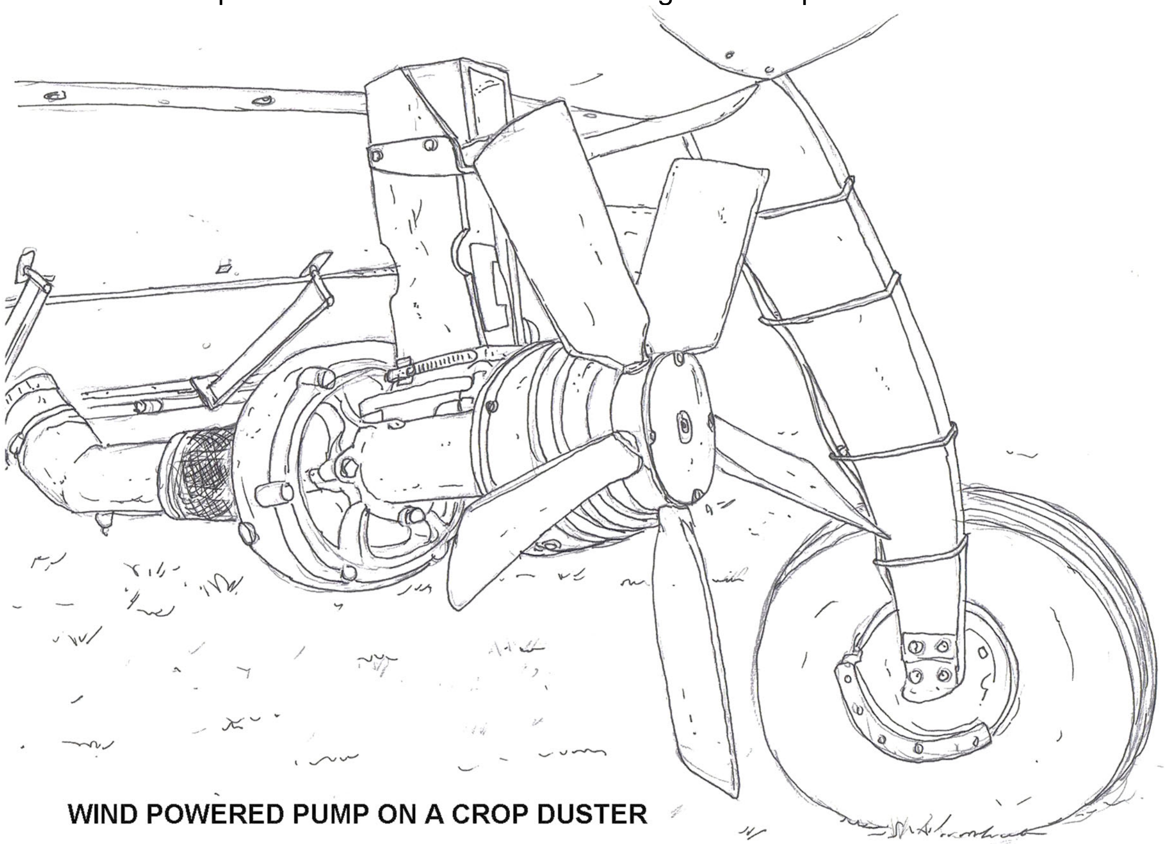
Provide workers and handlers with:
1. **Water** — enough for:
    - routine washing, and
    - emergency eyeflushing.

*If the water is stored in a tank, the water **must not** be used for mixing pesticides, unless the tank is equipped with correctly functioning anti-backsiphoning or check valves or other mechanisms (such as air gaps) that prevent pesticides from moving into the tank.*
2. **Soap and single use towels —** enough for workers' or handlers' needs.
3. **For handlers**, ***also*** provide:
    - **enough water for washing the entire body** in case of emergency, and
    - **clean change of clothes**, such as one-size-fits-all coveralls, to put on if the handlers' garments are contaminated and need to be removed right away.

Recommendation: How Much Water Should Be Provided?
Obviously, running water meets the requirement. However, if it is not available, use the following guidelines.

• **Workers:** At least 1 gallon of water is recommended for each worker using the supplies. If you find that 1 gallon per worker is inadequate to last for the entire work period, provide more water or replenish the water as needed during the work period.

•**Handlers:** At least 3 gallons of water is recommended for each handler using the supplies. If you find that 3 gallons per handler is inadequate to last for the entire work period, provide more water or replenish the water as needed during the work period.



WIND POWERED PUMP ON A CROP DUSTER

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.

Topic 3 - Understanding Pumps and Aerial Sprayers
Answers are after the Glossary in rear
Fill in the blank

Diaphragm Pumps
1. The advantage the diaphragm has over the __________is that the diaphragm pump does not come in contact with moving metal.

Pump Categories
Pumps may be classified on the basis of the application they serve. All pumps may be divided into two major categories: (1)___________, in which energy is continuously added to increase the fluid velocities within the machine, and (2) displacement, in which the energy is periodically added by application of force.

Spray Nozzle Categorization
Application
3. The second factor in determining droplet size is the__________.

Using Pesticides Correctly
4. The major change in application practice has been a shift from broad-scale aerial applications to__________.

Distance between Nozzle and Target (Boom Height)
5. Less distance means less time to travel from nozzle to target and therefore___________________.

Drain Valve(s)
6. Check all low points for drain valves or removable plugs that will_________________.

Factors Affecting Nozzle Performance
Wind Direction and Velocity
7. Wind velocity is measured by means of_____________.

Specific Gravity
8. In spraying, the main effect of the specific gravity Sg of a liquid other than water is on the___________.

Surface Tension
9. Low surface tensions can allow nozzles to be operated at______________.

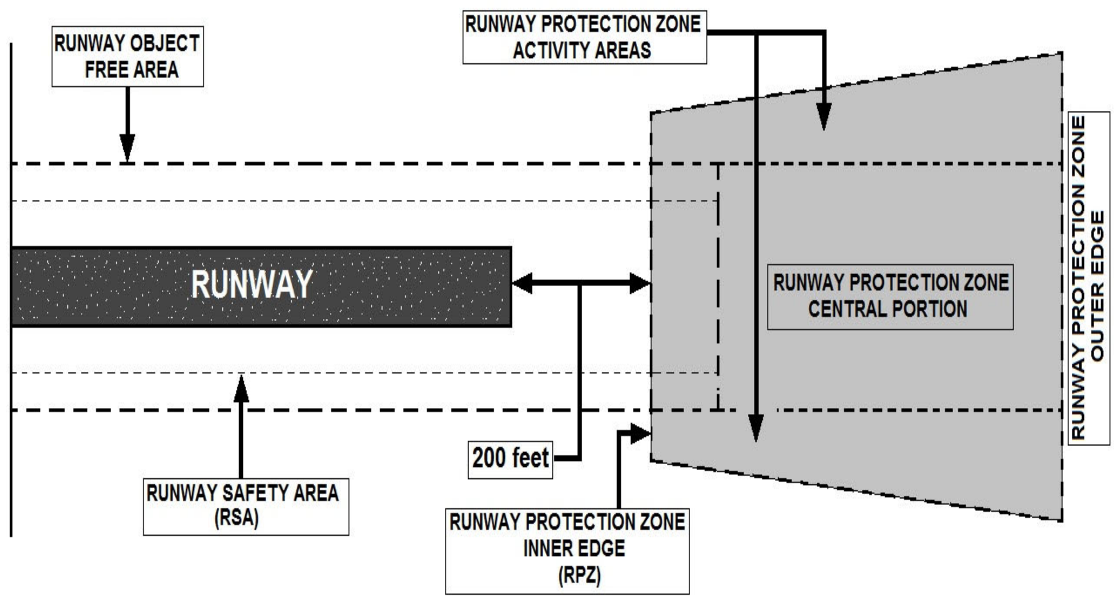
Liquid Application and Calculations

10. Then mix the pesticide and the _________together in the sprayer tank. Put the lid on the sprayer and tighten it. Get a large bucket and spray the pesticide liquid into the bucket. Keep the time on how long you sprayed the liquid into the bucket. Measure the liquid in the bucket.

Topic 4 - Aerial Application Assignment and Control Information

Section Focus: You will learn the basics of pesticide aerial application and control procedures. At the end of this section, you will be able to describe pesticide and chemical applications and safety procedures. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Aerial ppesticides are toxic to both pests, non-pests and humans. Because chemical pesticides are toxic to the target pest, they can also be harmful to human health and/or the environment.



OBJECT FREE AREAS (Airport Safety Zones)

Technical Learning College

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.

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.

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.

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.

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.

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:

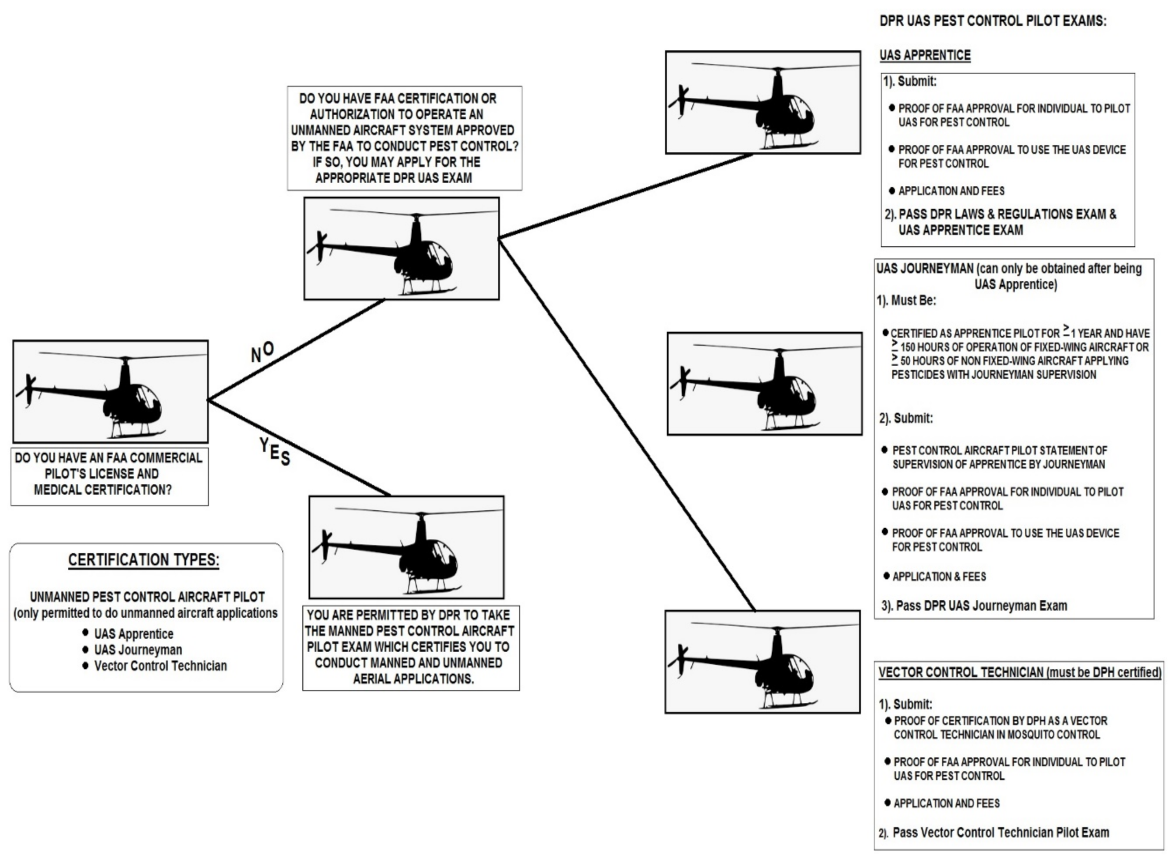
Aircraft Size
Small aircraft may be more appropriate on blocks that are less than 2 or 3 miles (3 to 5 kilometers); operating fast aircraft on blocks that are less than 2 or 3 miles is impractical

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



FAA CERTIFICATION FOR AERIAL APPLICATION LICENSES

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.

WPS Glove Requirements for Workers, Handlers, and Pilots

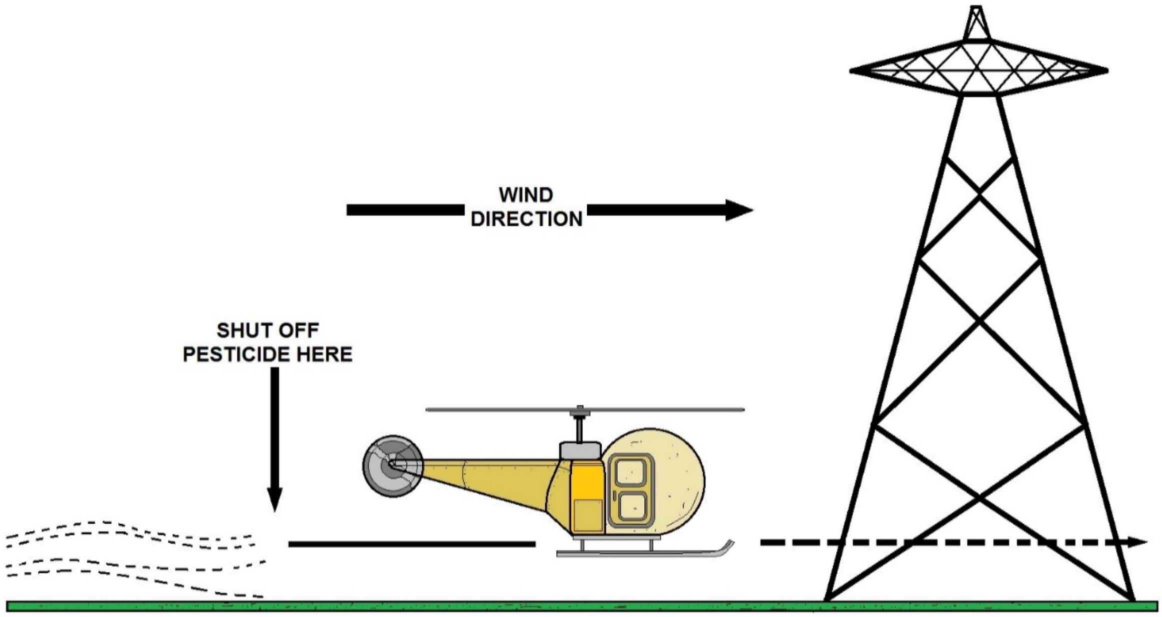
On September 1, 2004, EPA posted the final rule amending the Worker Protection Standard (WPS) for glove requirements. The final rule amended the WPS for agricultural pesticides in the following two ways:

(1) All agricultural pesticide handlers and early-entry workers covered by the Worker Protection Standard are now permitted to wear separate glove liners beneath chemical-resistant gloves and

(2) Agricultural pilots do not have to wear chemical-resistant gloves when entering or exiting aircraft. Handlers and early entry workers may choose whether to wear the liners. The liners may not be longer than the chemical-resistant glove, and they may not extend outside the glove. The liners must be disposed of after 10 hours of use, or whenever the liners become contaminated. Lined or flocked gloves, where the lining is attached to the inside of the chemical-resistant outer glove, remain unacceptable.

Regulatory action was taken to reduce the discomfort of unlined chemical resistant gloves, especially during hot or cold periods. Additionally, chemically resistant gloves do not add any appreciable protection against minimal pesticide residues found around the cockpit of an aircraft.

Aircraft Facilities Sub-Section



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

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.

Timing of Displaying Application Information

1. If workers or handlers are on your establishment at the start of an application, display the required pesticide-specific information **before the application takes place**.

2. If workers or handlers are ***not*** on your establishment at the start of an application, display pesticide-specific information **no later than the beginning of their first work period**.

3. Continue to display pesticide-specific information when workers or handlers are on your establishment **until:**

- at least 30 days after the restricted-entry interval expires, or
- at least 30 days after the end of the application, if there is no restricted-entry interval for the pesticide.

Other Responsibilities

1. Inform workers and handlers where the information is located.
2. Allow workers and handlers free, unhampered access to the information.
3. Be sure that the poster, emergency information, and application information remain legible during the time they are posted.
4. Promptly inform workers if there is any change in the information on emergency medical facilities and update the emergency information listed with the poster.

Fixed-Wing Description
Aerial Application Notification Sub-Section

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:

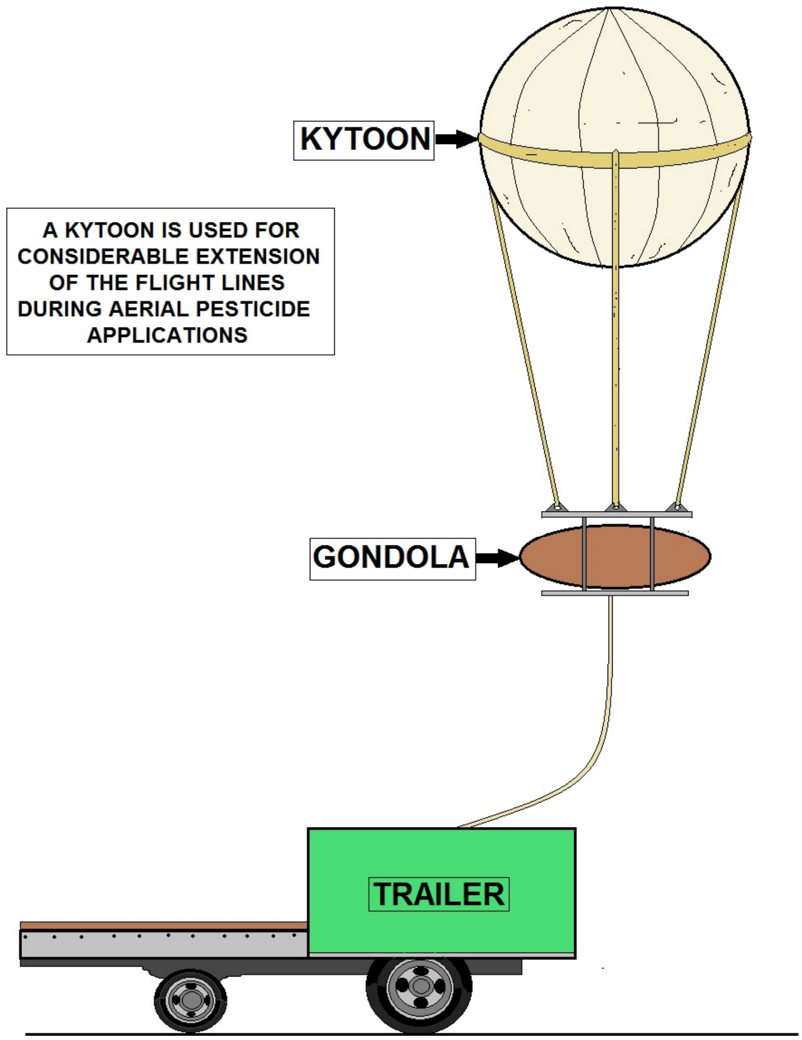
USDA-APHIS-PPD
Environmental Services
4700 River Road, Unit 149
Riverdale, MD 20737-1237
Phone: 301-734-8565   FAX: 301-734-3640

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

Aircraft Assignment and Control Operations Sub-Section



Aircraft Assignment
When assigning aircraft to treat various blocks and the choice to use faster, large-load carrying aircraft is available, and 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 workday 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.

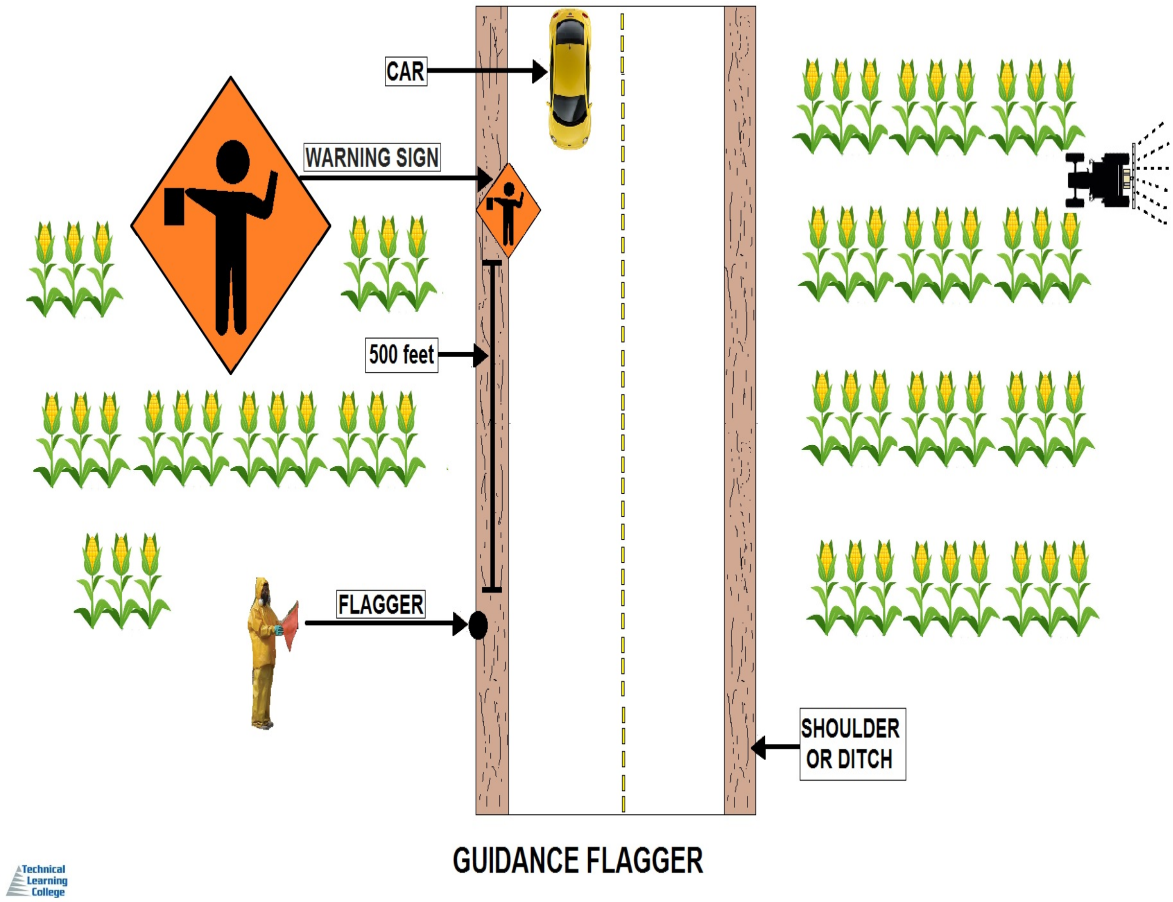
General Briefing
Hold a briefing session for all personnel, including those of the contractor, before work starts and continue to hold briefing with personnel as often as necessary during the course of the program. During briefing, describe the program, purpose, procedures to be followed, sensitive areas, obstructions, or hazards within the area and in 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.



GUIDANCE FLAGGER

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.

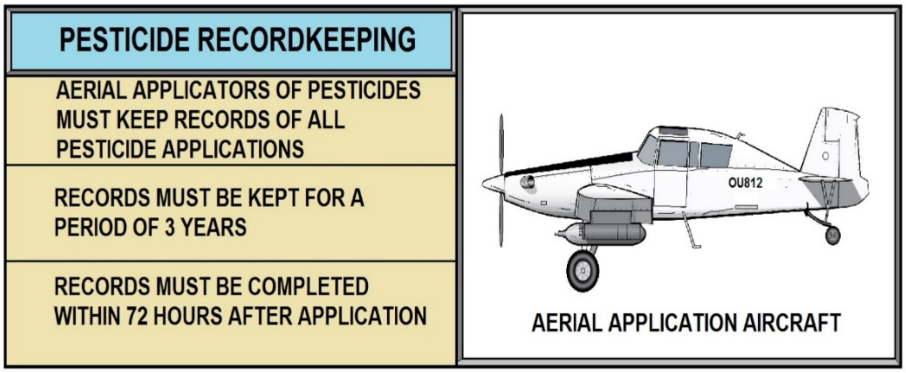
2. Distribute equipment and radios to project personnel and provide the necessary training for their work assignments.

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.

Aerial Record-Keeping Sub-Section



PESTICIDE RECORDKEEPING REQUIREMENTS FOR APPLICATORS

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

APPLICATOR NAME	APPLICATOR CERTIFICATION #	FIELD LOCATION / CROP	APPLICA-TION DATE	BRAND NAME	EPA REGISTRATION #	ACRES TREATED	TOTAL AMOUNT	APPLICATION TIME	REI	ACTIVE INGREDIENT	RATE	GPA
John Doe	246579	Circle 2, SW 1/4 Corn	05/14 2022	Balance Pro	246-540	120	360 oz.	1:30 p.m.	12 hr.	Isoxoflutole	3 oz. / A	20

PESTICIDE RECORDKEEPING FORM EXAMPLE

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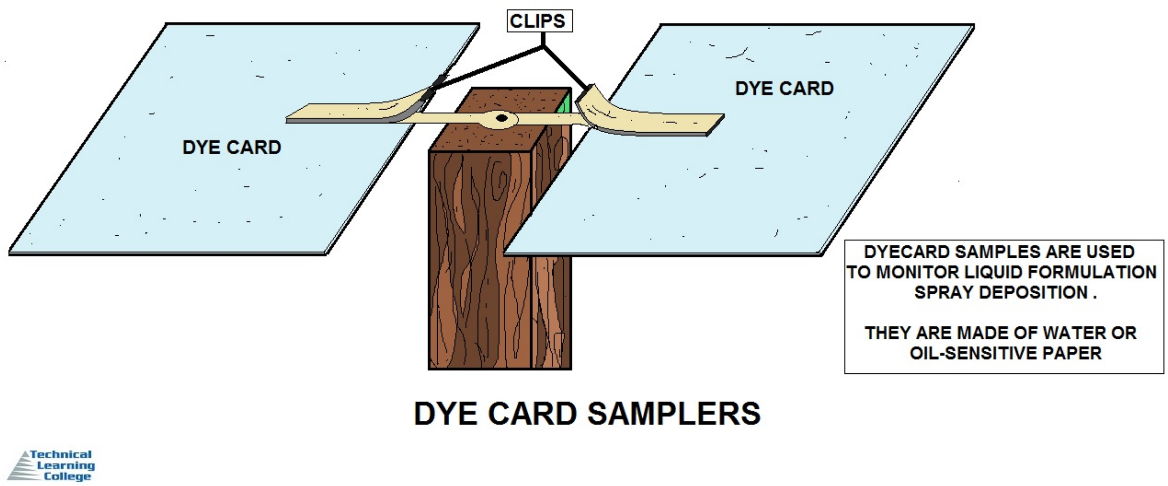
Spray Deposition Monitoring

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.



DYE CARD SAMPLERS

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.

EQUIPMENT	METHOD	WEATHER	TARGET	PRODUCT	OPERATOR
SPRAYER DESIGN AIR ASSIST DIRECTION VOLUME SPEED DEFLECTORS SPRAY QUALITY PATTERN DROPLET SIZE NOZZLE ORIENTATION	FORWARD SPEED WORK RATE SPRAY TECHNIQUE ALTERNATE ROW - MIDDLE SPRAYING GEAR-UP / THROTTLE-DOWN CROP-ADAPTED SPRAYING	WIND SPEED DIRECTION TEMPERATURE RELATIVE HUMIDITY THERMAL INVERSION	CANOPY STRUCTURE TIME OF SEASON DENSITY-AREA CANOPY MANAGEMENT TARGET SIZE LOCATION	MODE OF ACTION TIMING SPRAY MIX SPECIFIC GRAVITY ADJUVANTS CARRIER VOLUME APPLICATION RATE	APTITUDE ATTITUDE MANAGER, BOSS OR OWNER

THINGS TO BE AWARE OF WHEN DOING A CALIBRATION FOR PESTICIDE APPLICATION

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

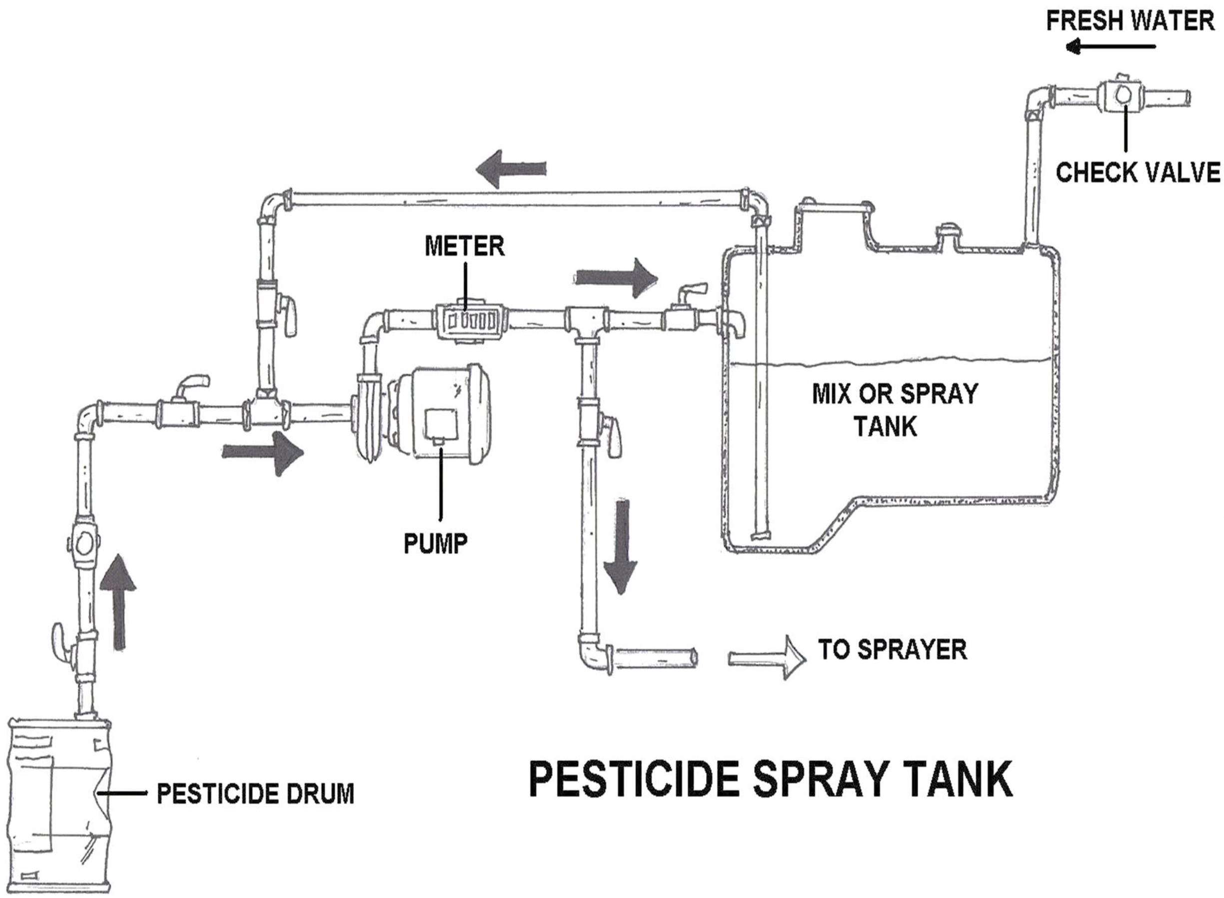
4. Determine the total amount of pesticide that has been delivered.
Initial amount delivered
+ Subsequent amounts delivered
= Total pesticide delivered

5. Determine the amount of pesticide on hand.

Total pesticide delivered

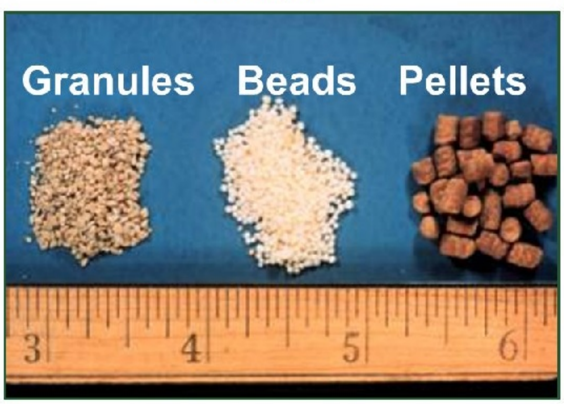
– Total amount used

= Total amount of pesticide on hand

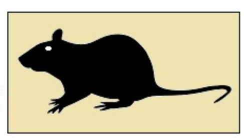


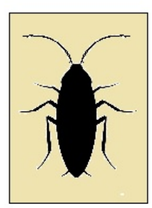
PESTICIDE SPRAY TANK

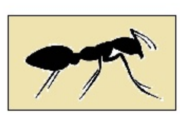
DRY FORMULATION
BAITS (B)



GRANULE (G) and PELLETS (P or PS)







ADVANTAGES

- READY TO USE
- COVERAGE NOT CRITICAL
- CONTROL PEST THAT MOVE IN AND OUT OF THE AREA

DISADVANTAGES

- ATTRACTIVE TO CHILDREN
- MAY KILL DOMESTIC ANIMALS & WILDLIFE
- DEAD PEST ODORS
- OLD BAIT MAY SERVE AS FOOD SOURCE IF INACTIVE

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PESTICIDE DRY FORMULATIONS

Personnel, Materials, and Equipment Sub-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

Crop Advisors, Workers, Handlers and Flagmen Sub-Section

Crop Advisors, Workers Handlers, and flagmen are responsible for meeting legal requirements for operational safety as well as for issuing warnings to those likely to be affected by the spray operation such as local beekeepers, and those adjacent to the area to be sprayed.

Before spraying, the Crop Advisors, Workers Handlers, and will visit the site to be treated, noting obstacles such as trees, overhead powerlines, waterways, roads and houses which may be flown over during the spraying.

Frequently an additional requirement of ground staff is to provide the link between the spray contractor and members of the general public.

The use of a Global Positioning Satellite (GPS) system for aircraft navigation is strongly recommended as a safer alternative to the use of human flagmen however, where human flagmen are used, they should be:

- ✓ able to select and use appropriate personal protective equipment;
- ✓ aware of the need to avoid contamination by working upwind from the flight path;
- ✓ aware that records of the pesticides used during the day must be readily available (e.g., for use in cases of intoxication of the worker or their family);
- ✓ able to communicate with the pilot and the staff at the loading area in the event of a change in the weather that might affect the spray operation. N.B. weather conditions at the airstrip may be very different from those at the site to be sprayed;
- ✓ appropriately trained and in possession of a recognized certificate of competence, which should be regularly updated.

Trainers, with specialist knowledge and understanding of aerial spraying, should be used to train ground crews.

	GLOVES	HARD HAT	APRON	COVERALLS	RESPIRATOR	FOOTWEAR	PROTECTIVE EYEWEAR
MIXING / LOADING	CHEMICAL RESISTANT	NO	NO	YES + LONG SLEEVED SHIRT / LONG PANTS	NO	SHOES + SOCKS	NO
ENCLOSED CAB	NO	NO	NO	NO	NO	SHOES + SOCKS	NO
OPEN CAB	CHEMICAL RESISTANT	NO	NO	YES + LONG SLEEVED SHIRT / LONG PANTS	NO	SHOES + SOCKS	NO
CLEANOUT	CHEMICAL RESISTANT	NO	NO	YES + LONG SLEEVED SHIRT / LONG PANTS	NO	SHOES + SOCKS	NO

PESTICIDE HANDLING SAFETY REFERENCE (PPE)

SPRAY QUALITY	SIZE OF DROPLETS	COLOR CODE	RETENTION ON LEAVES DIFFICULT TO WET	USED FOR	DRIFT POTENTIAL
EXTREMELY FINE (XF)	SMALL	PURPLE	EXCELLENT	EXCEPTIONS	HIGH
VERY FINE (VF)		RED	EXCELLENT	EXCEPTIONS	
FINE (F)		ORANGE	VERY GOOD	FUNGICIDE & INSECTICIDES	
MEDIUM (M)		YELLOW	GOOD	FUNGICIDES, INSECTICIDES, CONTACT HERBICIDES	
COARSE (C)		BLUE	MODERATE	SYSTEMIC HERBICIDES	
VERY COURSE (VC)		GREEN	POOR	SOIL HERBICIDES	
EXTREMELY COURSE (XC)		WHITE	VERY POOR	LIQUID FERTILIZER	
ULTRA COURSE (UC)	LARGE	BLACK	VERY POOR	LIQUID FERTILIZER	LOW

AGRICULTURAL CHEMICAL APPLICATION NOZZLE DESCRIPTIONS AND USES

Spray Equipment Selection

The selection and use of appropriate spray equipment plays an essential role in safe and efficient pesticide use. In order to obtain a license, aircraft have to be checked by the FAA, however, spray equipment must also be approved.

Much of the spray equipment is common to that which is used on terrestrial equipment, however, where aircraft are to be used for applying undiluted formulations (ULV), the sprayer system and components should be made from materials which are compatible with such formulations. Where reduced liquid flow rates for ULV spraying are used, a spray monitoring system and a flow meter are essential.

The FAA, in collaboration with the Department of Agriculture or other designated institution, should verify the spray system. This should include checks on the spray system, calibration and spray distribution to ensure that all valves, anti-drip devices, and spray nozzles are working satisfactorily. The accuracy of calibration of spray monitoring systems should also be checked.

CROP	SPRAY QUALITY	TRAVEL SPEED	DISTANCE TO TARGET	VOLUME	RATE
FIELD Carrot, Celeriac, Grape, Berry, Bulb Vegetable, Strawberry, Brassica, Leafy Vegetable, Crabapple	NOT SPECIFIED	SELECT A SPEED THAT ALLOWS PRODUCTIVITY, BUT: DOES NOT REQUIRE BOOM TO BE RAISED ABOVE 60 cm	< 60 cm	≤ 250 L/ha FOR CERTAIN CROPS	0.6 - 1.6 kg / ha
AIRBLAST Stone Fruit, Berry, Crabapple, Hops, Grapes, Pome Fruit	NOT SPECIFIED	SELECT A SPEED THAT ALLOWS PRODUCTIVITY, BUT: ALLOWS CANOPY PENETRATION WITHOUT EXCESSIVE BLOW-THROUGH	> 50 cm	NOT SPECIFIED	0.6 - 1.6 kg / ha

CHECKING SPRAYER SETTINGS

Dispersal Accessories

Metering and dispersal are key functions of all pesticide-applying aircraft. Metering must be accurate for calibration and for the uniform, controlled delivery of liquids and solid material.

Liquid dispersal systems consist of a hydraulic circuit including pump, tank, hose, boom, filters, regulators and metering nozzles. These systems may be wind-driven or directly powered from the aircraft engine. The pump system must deliver large quantities of liquid material per unit of time. This often means that maximum output is available only at high engine RPM. For this reason, certain aircraft must be in flight to develop top delivery. Pumps and agitators must be designed to handle the desired nozzle output plus approximately 5 P.S.I. for line friction and agitation.

Spray pattern tests should be conducted to determine the optimum location of nozzles along the boom and the spray droplet size categories following initial setup. Spray boom shape should be airfoil or streamline to reduce turbulence around the nozzles. Catalogs from nozzle manufacturers list types and sizes for aircraft. A check valve is necessary on each nozzle to prevent leakage.

Spray nozzles type, size and orientation, operating pressure, and wind shear (aircraft speed) all influence spray droplet size. Small droplet sizes are prone to drift from the application site, so the largest droplet size possible that will maintain the desired efficacy on the targeted plant should be used.

Pressure at the spray nozzle should be between 20 and 60 psi. Research has shown that low spray pressures and high aircraft speed can increase the percentage of spray droplets that have a propensity to drift.

All nozzles produce a range in droplet size particles and manufacturers usually rate their nozzles with a volume median diameter droplet size (DV0.5). The percentage of spray droplets less than 100 micrometer (DV0.1) is an indication of potential drift. Considerable research has been conducted to determine droplet sizes under actual airspeed conditions. ASAE Standards and predictive models are available.

Centrifugal Pumps
Fairly low pressure (35 to 45 P.S.I.) high volume centrifugal pumps may be used for water based materials. Shear, or air friction across the nozzle opening, serves to provide material break-up. Bi-fluid or microbial sprays call for special pumps.

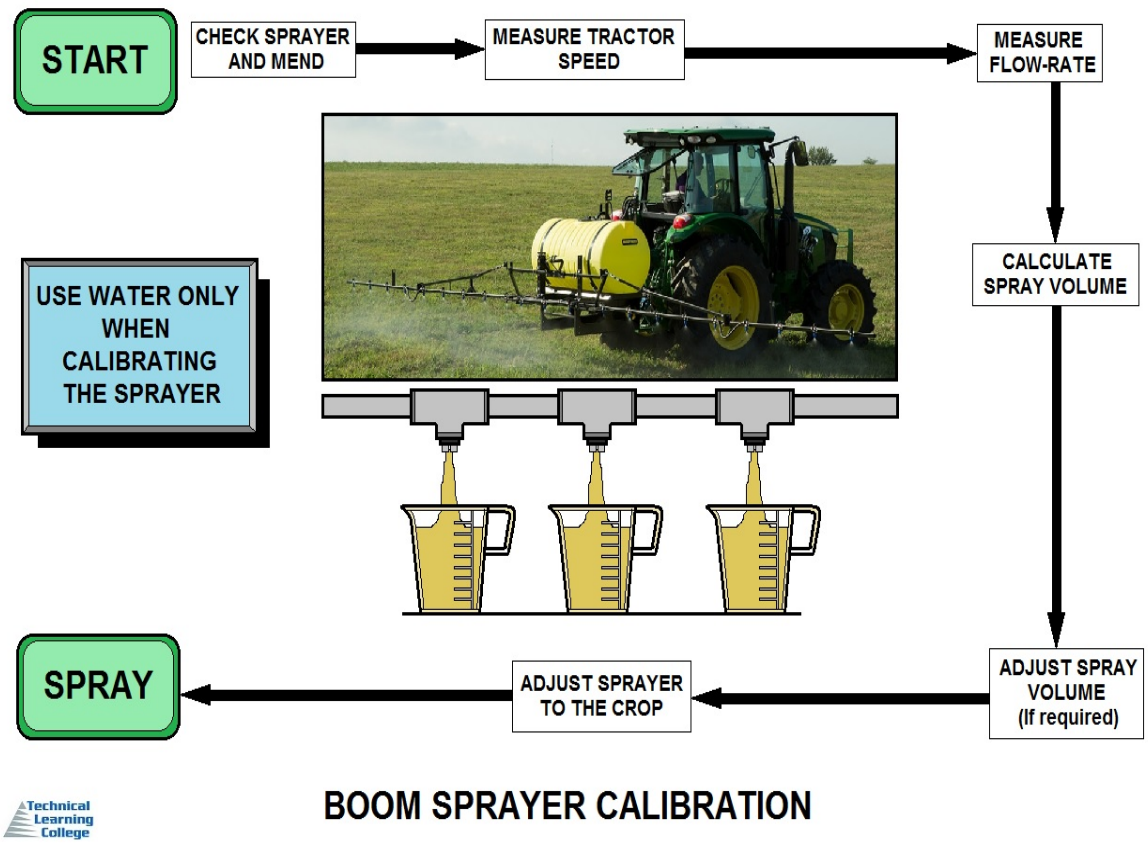
Standard, dilute volume spray equipment which has a range of 1/2 to 5 gallons per acre or more must have adequate piping. The main piping and fittings should have an inside diameter of at least 1-1/2" in order to carry heavy volumes of liquid. For rates of 1/2 to 2 gallons per acre, all piping should have at least a 1" diameter.

Filter screens at the nozzles and line filters protect nozzles and other parts from wear and clogging. Screen sizes of 50 to 100 mesh will be used, depending on nozzle orifice size. Pressure gauges located beyond the line filter indicate whether the line is clogged or opened. Line filters should be cleaned daily during spray operations.

Ultra Low Volume

Ultra Low Volume (**ULV**) equipment ranges in capacity from a few ounces to 1/2 gallon per acre. Special metering and atomizing attachments such as Micronair, Mini-spin and Airfoil are frequently used to aid in droplet break-up. These spiral, rotating nozzles may be wind driven or driven from the aircraft. Wind driven nozzles are dependent upon air speed and may fail when the craft is operating at reduced speed.

Ultra Low Volume systems use a 3/8" inside diameter for the main line, hoses and fittings. Hoses for intermediate nozzles may be 1/8" inside diameter. The use of concentrate sprays (no water added) increases the density of the material and allows a faster rate of all. This process is limited to certain materials and is subject to a drift hazard. Flying heights of 5 to 15 feet above ground contribute to uniformity.



BOOM SPRAYER CALIBRATION

Booms

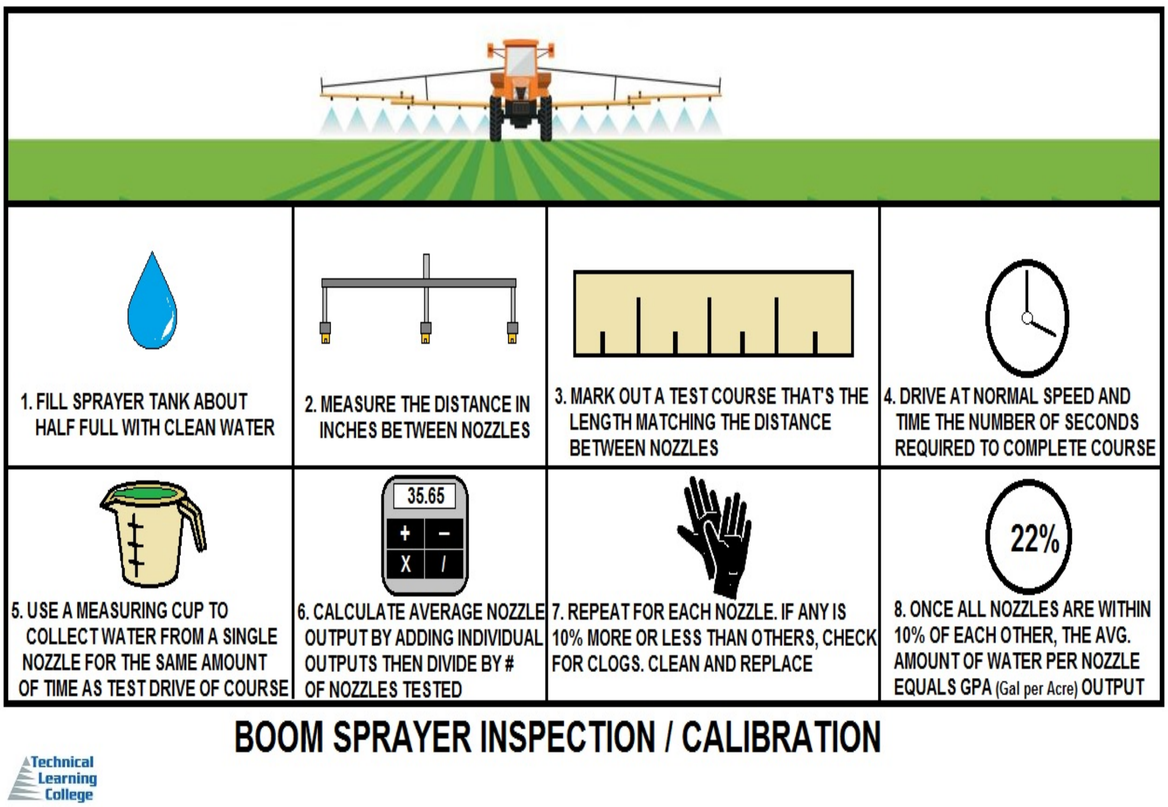
Booms are required to support nozzles along the wingspan of the craft. Booms must be strong, airfoil shaped and located near the trailing edge of the wing to offer minimum drag. Clearance between the control surfaces of the wing and the boom is essential. End caps on booms should be removable for cleaning. The location of outboard nozzles on the end of the boom is critical, since the wing end and main rotor vortex are used to develop the width of the pattern. End nozzles must be inboard enough to prevent wing tip vortexes from trapping fine droplets. Such entrapment creates uneven distribution and drift. Propeller rotation shifts the spray from right to left as the pilot sees it. Nozzles need shifting to the right with respect to the fuselage to compensate for this. Ultra Low Volume systems require supply lines to the metering spinners only. Usually no boom is needed.

Spray Boom Calibration
Use chart for distance to drive in the field. Use nozzle spacing for booms. For directed and band rigs use the row spacing.

Set throttle for spraying and operate all equipment. Note seconds required to drive measured distance.

Catch spray for the noted time in Step 2 in container marked in ounces. If boom, catch spray from one nozzle during noted time. On directed rigs, catch spray from all nozzles per row for noted time.
Nozzle or nozzle group output in ounces = gallons/acre actually applied.

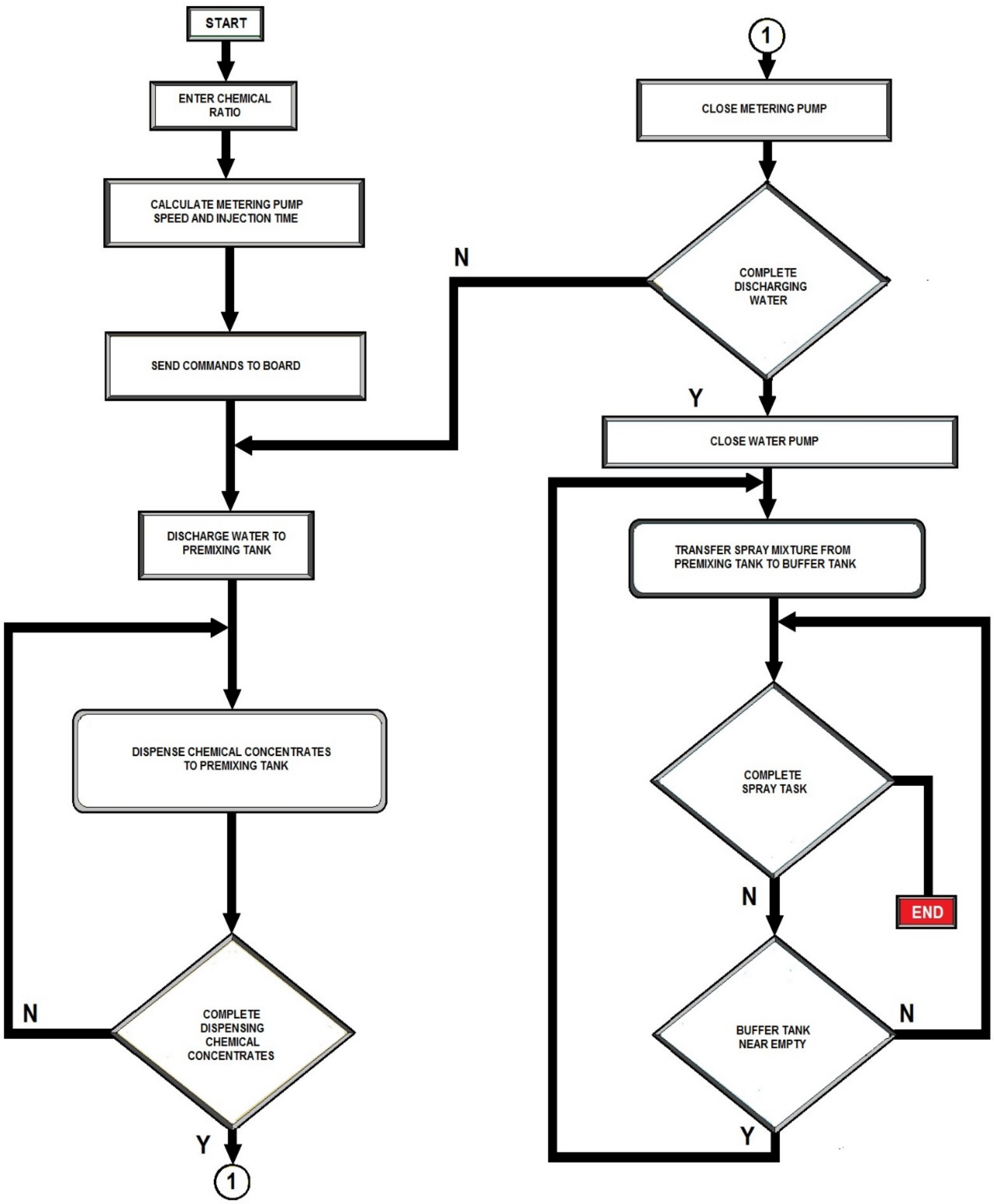
Repeat for each nozzle to assure uniform distribution. Replace any nozzles whose output is greater than 10 % of the average of all nozzles.



Row Width or Nozzle Spacing (in.)	Distance (ft.)	Row Width or Nozzle Spacing (in.)	Distance (ft.)
40	102	26	157
38	107	24	170
36	113	22	185
34	120	20	204
32	127	18	227
30	136	16	255
28	146	14	291

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.



METERING PESTICIDE DISPERSAL

Spill Cleanup and Reporting Sub-Section

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.

What to do when a spill occurs
When a minor spill occurs, make sure the proper protective equipment is available, and wear it. If pesticide has spilled on anyone, wash it off immediately, before taking any other action. Confine the spill with a dike of sand or soil. Use absorbent materials to soak up the spill. Shovel all contaminated material into a leak- proof container and dispose of it in the same manner as excess pesticides. Do not hose down the area; this spreads the chemical. Always work carefully to avoid making mistakes.

Streams and wetlands must be protected in the event of an accidental spill of any size. Even diluted chemicals pose a threat to natural habitats when released in large amounts. Extra precautions must be taken when drawing water from streams or ponds. Antisiphoning devices must be used and be in good working order. Tank mixes should be prepared at least ¼ mile from water resources. If this is not possible, make sure the ground at the mixing site does not slope toward the water, or construct an earthen dike to prevent pesticides from flowing into bodies of water or drains.

Major spills of concentrates or large quantities of spray solution are difficult to handle without assistance. Provide any first aid that is needed and confine the spill, then notify the proper authorities. Contact the local fire department using the 911 system, if available. Other phone numbers for fire departments, state and local authorities should be carried in the vehicles and by the applicators.

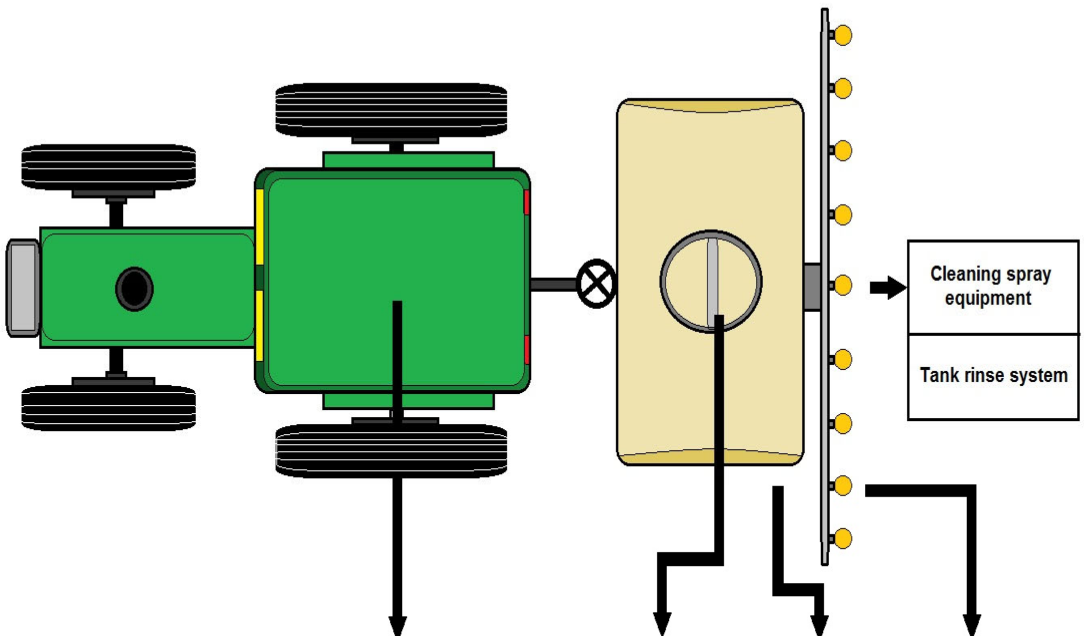
Regardless of the size of the spill, keep people away from the chemicals. Rope off the area and flag it to warn others. Do not leave the site unless responsible help, such as emergency or enforcement personnel, is there to warn others.

Significant pesticide spills must be reported to your state pesticide lead agency. Applicators, or their employers, are responsible for telephoning a spray incident report to the State Agency as soon as practical after emergency health care and efforts to contain the spill have started.

The state agencies decide if it is necessary to call **CHEMTREC** (Chemical Transportation Emergency Center), a public service of the Manufacturing Chemicals Association located in Washington, DC CHEMTREC provides immediate advice for those at the scene of an emergency. This service is available 24 hours a day (1-800-424-9300) for emergencies only.

Decontamination
(1) Decontamination solutions can be used for decontaminating surfaces and materials where spills of dust, granular, wettable powders, or liquid pesticides have occurred. The bulk of the spilled pesticide should be cleaned up or removed prior to applying any decontaminant.

(2) Several materials may be used to decontaminate pesticides. Due to the many different pesticides available and the necessity to use the correct decontamination material, all decontamination activities must be carried out only after appropriate decontamination methods have been determined by the Environmental Coordinator and/or Spill Response Team. Many pesticides, especially the organophosphates, decompose when treated with lye or lime. Fewer pesticides are decomposed by bleach. Other pesticides cannot be effectively decontaminated and should only be treated with detergent and water to assist in removal.



AREA OF EXPOSURE:	Spray drift or contaiminated clothing in the cab	Loading sprayer	Spray drift	Changing blocked nozzles or moving boom
METHODS OF REDUCING EXPOSURE:	*Pressurized cab with Carbon air filter *Protective clothing locker	*Closed transfer system *Direct pesticicide injection *Container rinse system *Chemical Induction bowl	*Low-drift nozzles *Twin-fluid nozzles	*Multiple nozzle bodies *Hydraulic boom fold system *Diaphragm check valves *Hand wash water supply

REDUCING EXPOSURE TO CROP PESTICIDE CHART

Prior Warnings Sub-Section

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 advise on field headland and boundary management and they can assist with local environmental risk assessment when a pesticide is to be used.

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.

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. 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.

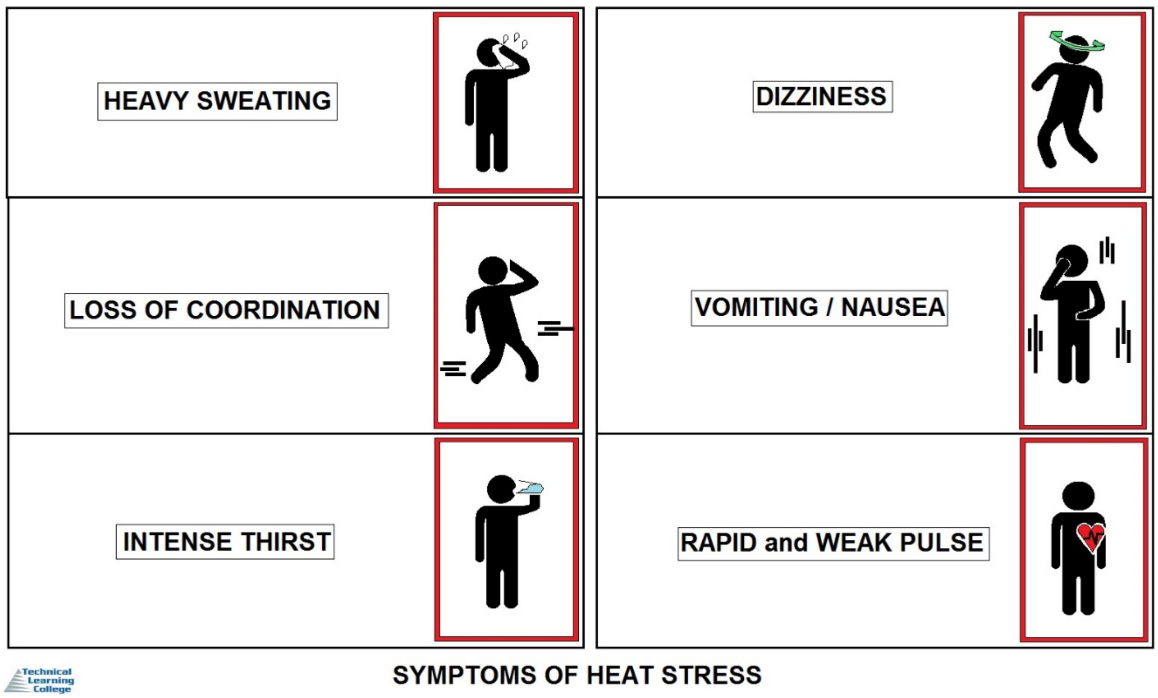
Treatment Timing
The optimum timing to spray will depend on the pest, weed and disease development stages. Treatment timing will also be governed by meteorological conditions, which may affect losses from drift and from volatile spray. Temperature, relative humidity, wind direction, wind velocity and 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.

Avoiding Heat Stress

The WPS requires employers to take any necessary steps to prevent heat illness (too much heat stress) while personal protective equipment is being worn. Employers can take many precautions against heat stress. Some of them are summarized here:

Training -- Train workers and supervisors how to control heat stress and how to recognize symptoms of heat illness.

Monitoring and adjusting workloads -- Take into account the weather, workload, and condition of the workers, and adjust work practices accordingly. Higher temperatures, high humidity, direct sun, heavy workloads, older workers, and workers unaccustomed to heat are more likely to become ill from heat.

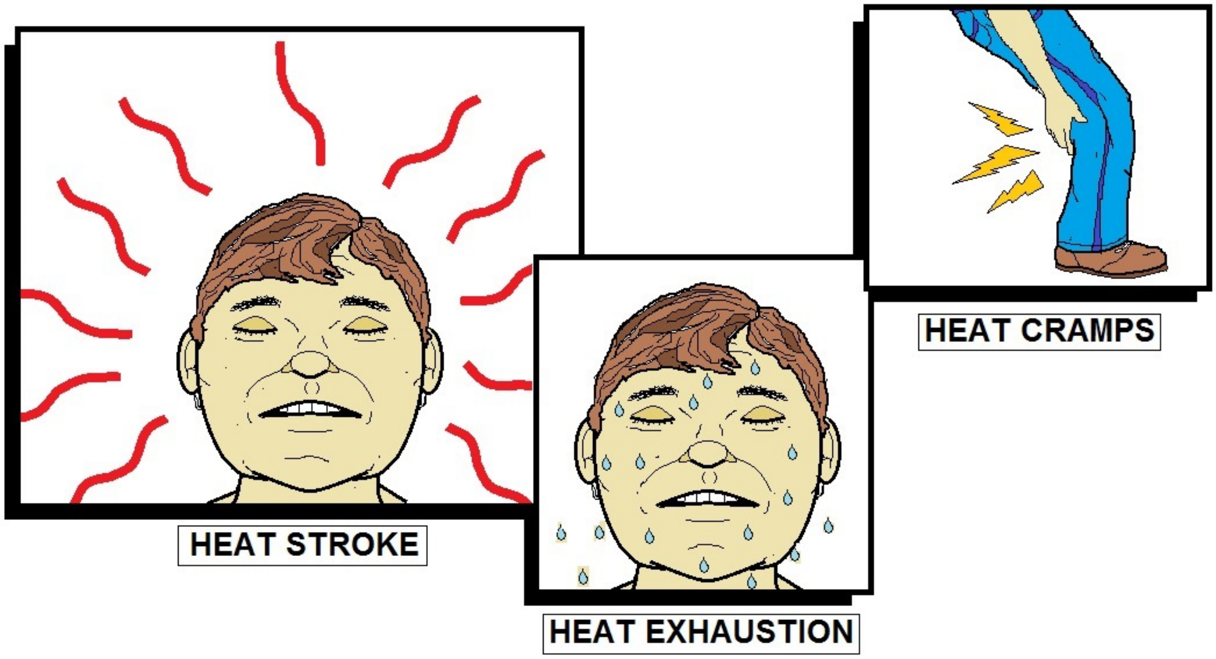


SYMPTOMS OF HEAT STRESS

Here are things to do:

-- Monitor temperature, humidity, and workers' responses at least hourly in hot environments
-- Schedule heavy work and PPE-related tasks for the cooler hours of the day
-- Acclimatize workers gradually to hot temperatures
-- Shorten the length of work periods and increase the length of rest periods
-- Give workers shade or cooling during breaks
-- Halt work altogether under extreme conditions.

Drinking -- Make sure employees drink at least the minimum required amounts of water to replace body fluid lost through sweating. Thirst does not give a good indication of how much water a person needs to drink.



HEAT RELATED ILLNESSES CHART

Heat stroke, the most serious form of heat-related illness, happens when the body becomes unable to regulate its core temperature. Sweating stops and the body can no longer rid itself of excess heat. Signs include confusion, loss of consciousness, and seizures.

Heat stroke is a medical emergency that may result in death! Call 911 immediately.

Heat exhaustion is the body's response to loss of water and salt from heavy sweating. Signs include headache, nausea, dizziness, weakness, irritability, thirst, and heavy sweating.

Heat cramps are caused by the loss of body salts and fluid during sweating. Low salt levels in muscles cause painful cramps.

Tired muscles—those used for performing the work—are usually the ones most affected by cramps. Cramps may occur during or after working hours.

Heat rash, also known as prickly heat, is skin irritation caused by sweat that does not evaporate from the skin. Heat rash is the most common problem in hot work environments.

More details on all these measures are included in EPA's "A Guide to Heat Stress in Agriculture," May 1993, available from farm supply companies and from the U.S. Government Printing Office using document number 055-000-00474-9. Issued jointly by EPA and the Occupational Safety and Health Administration, the guide offers practical, step-by-step guidance for nontechnical managers on how to set up and operate a heat stress control program.

Topic 4 - Aerial Application Assignment and Control Information

Answers are after the Glossary in rear
Fill in the blank

Notify Beekeepers
1. Many of the pesticides used in aerial treatments are _________to bees.

Spray Block, Sensitive Area, and Buffer Zone Verification
2. After taking a ________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.

Spray Deposition Monitoring
Dyecard Samplers
3. 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, __________, and droplet size; and to identify leaks in the spray system.

4. When systematically placed, ___________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.

Object Free Areas (OFAs) and Pesticide Storage
5. 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_________________.

Spray Boom Calibration
6. Use chart for distance to drive in the field. Use nozzle spacing for booms. For directed and band rigs use the______________.

7. Set throttle for spraying and operate all equipment. Note ________required to drive measured distance.

8. Catch spray for the noted time in Step 2 in container marked in ounces. If boom, catch spray from one nozzle during noted time. On____________, catch spray from all nozzles per row for noted time.

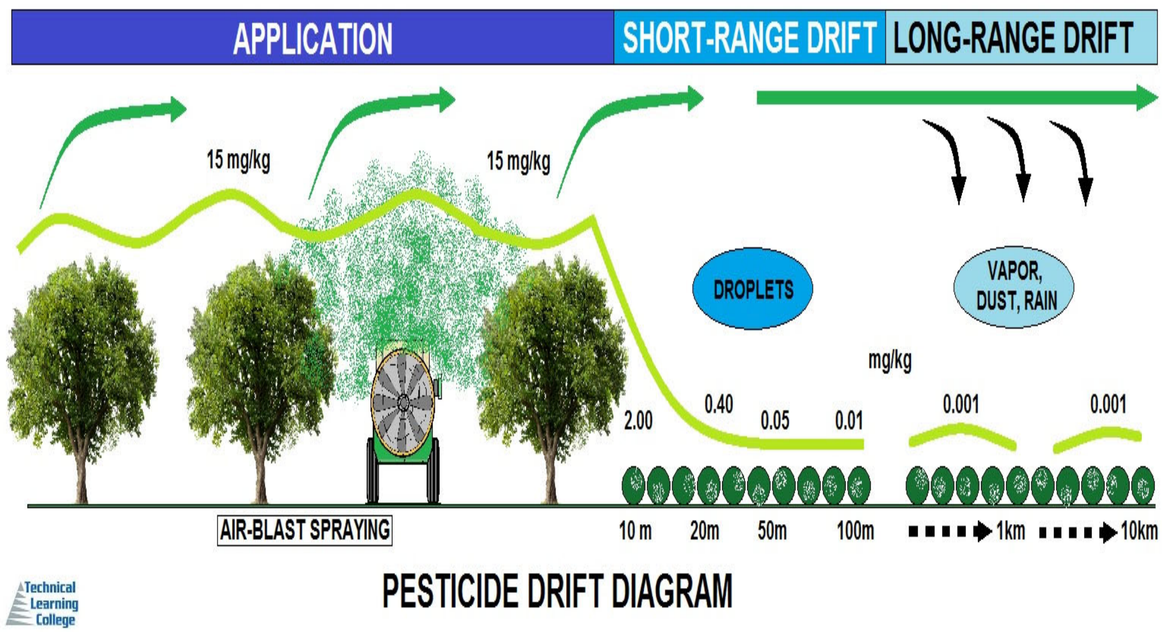
9. Nozzle or nozzle group output in ounces =___________________.

10. Repeat for each nozzle to assure uniform distribution. Replace any nozzles whose output is greater than ___________ of the average of all nozzles.

Topic 5 - Pesticide Drift Control and Training Requirements

Section Focus: You will learn the basics of pesticide drift and control procedures. At the end of this section, you will be able to describe pesticide and chemical applications and control procedures. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Drift is a desirable and necessary part of an ULV application. In fact, pesticide labels specify that ULV applications must be done during weather conditions that favor pesticide drift (temperature inversion or lateral winds below 10 MPH). In a ULV application, the longer the effective drift of the product, the greater the efficacy.



The EPA defines spray or dust drift as:
"the physical movement of pesticide droplets or particles through the air at the time of pesticide application or soon thereafter from the target site to any non- or off-target site. Spray drift shall not include movement of pesticides to non- or off-target sites caused by erosion, migration, volatility, or windblown soil particles that occurs after application or application of fumigants unless specifically addressed on the product label with respect to drift control requirements."

This definition is based on a definition of spray drift composed by participants of the National Coalition on Drift Minimization, which include representatives from federal (including the EPA and the U. S. Department of Agriculture) and state agencies and tribes, pesticide and equipment manufacturers, university scientists, and others, who have focused their attention on enhancing pesticide applicator education, application research, and regulatory initiatives to foster reductions in spray drift.

The Agency recognizes that pesticide vapor and the off-target movement of pesticides by other means, not included in this definition, can nevertheless present substantial risks to humans and the environment. The EPA generally addresses these routes of exposure and associated risk at the individual pesticide level through its regulatory programs.

In addition to the safety problems associated with the preparation and application of pesticides, there are several important problems related to pesticide use that should be understood by every applicator. These problems include pesticide drift, pesticide residues, phytotoxicity, destruction of beneficial species of animals and plants, resistance of pests to pesticides, and environmental pollution. There are many ways in which these undesirable effects can be reduced or eliminated. Each depends upon knowledge of the proper handling and use of pesticides, the components of the environment susceptible to contamination, the pesticides most likely to cause contamination, and preventive measures.

Except for ultra-low volume (ULV) spraying to control adult mosquitoes, drift is an undesirable side effect associated with both aerial and ground pesticide applications. Spray drift is defined as airborne particles produced during application of a pesticide moving outside the intended treatment area. The severity of drift depends on the physical form of the material, the method of application, weather conditions, and to a lesser degree, movement of the substrate to which the product was applied (both soil and water).

For other pesticide applications, the formulation of the pesticide is a significant factor. Dusts are most likely to drift and granules least likely. High pressure sprayers are more likely to produce fine droplets that are more likely to drift than low pressure sprays. A variety of other factors can affect the amount of drift. When spraying liquid formulations of pesticides, the nozzle and pump pressure have the greatest influence on subsequent drift. Improper or worn nozzles or excessive pressures cause the spray to be produced in a form which drifts readily.

The rate at which a drop of liquid falls through the air depends upon the size of the droplet. Very small droplets fall very slowly. These small droplets can drift for miles before they reach the ground. The method and amount of material applied also influences the hazard of pesticide drift.

Small amounts applied by hand from the ground are rarely involved in drift problems. Spray from ground air blast sprayers is highly subject to drift. Aerial applications of large quantities of pesticides always present the possibility of significant drift. A second form of drift occurs when pesticides evaporate during and after application. Certain herbicide formulations may volatilize and cause damage to plants miles from the point of application. A few herbicide formulations may drift as a result of evaporation following application; use of these may be restricted in many areas.

Drift should be avoided because:

It wastes resources, including pesticides, fuel, and technician time.

It spreads pesticides into the surrounding environment where they may become illegal residues on food crops, cause health problems, damage wildlife, and have other undesirable effects.

It can damage sensitive crops.

It has been the subject of many damage claims for crop losses. Drift can be a severe problem and should be taken into consideration before making any type of pesticide application

What Is Pesticide Spray Drift?

The EPA defines pesticide spray drift as the physical movement of a pesticide through air at the time of application or soon thereafter, to any site other than that intended for application (often referred to as off target). The EPA does not include in its definition the movement of pesticides to off-target sites caused by erosion, migration, volatility, or contaminated soil particles that are windblown after application, unless specifically addressed on a pesticide product label with respect to drift-control requirements.

How Does Spray Drift Occur?

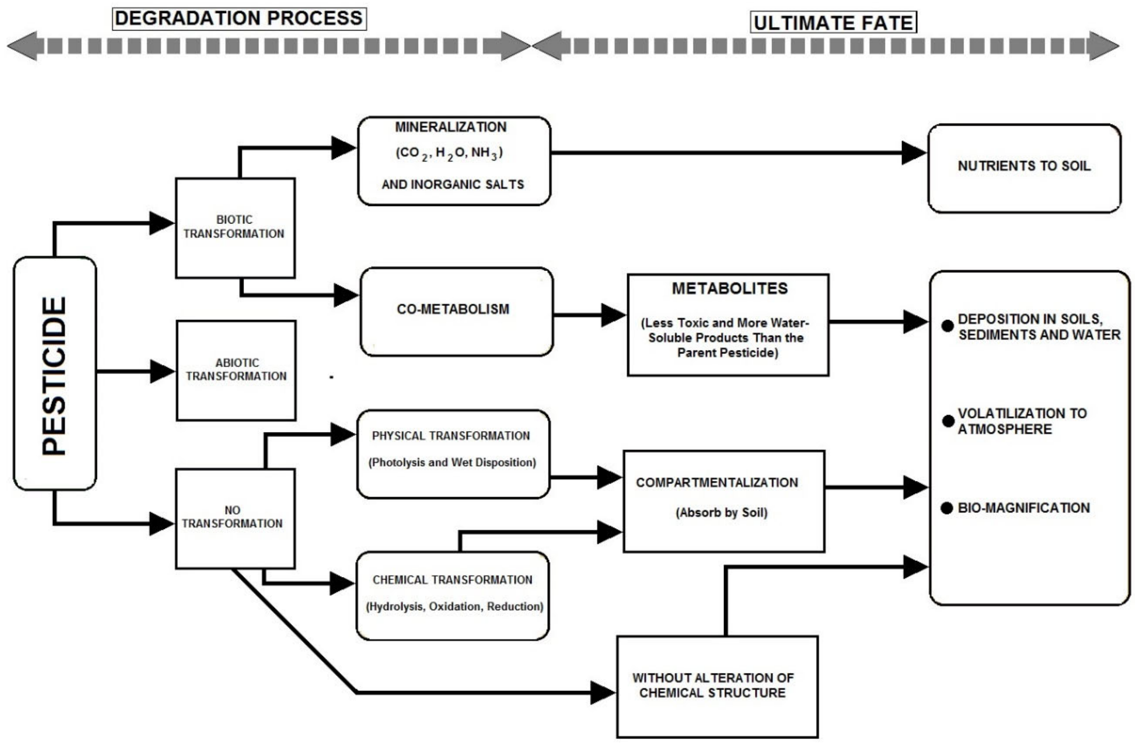
When pesticide solutions are sprayed by ground spray equipment or aircraft, droplets are produced by the nozzles of the equipment. Many of these droplets can be so small that they stay suspended in air and are carried by air currents until they contact a surface or drop to the ground. A number of factors influence drift, including weather conditions, topography, the crop or area being sprayed, application equipment and methods, and decisions by the applicator.

What Are the Impacts of Spray Drift?

Off-target spray can affect human health and the environment. For example, spray drift can result in pesticide exposures to farmworkers, children playing outside, and wildlife and its habitat. Drift can also contaminate a home garden or another farmer's crops, causing illegal pesticide residues and/or plant damage. The proximity of individuals and sensitive sites to the pesticide application, the amounts of pesticide drift, and toxicity of the pesticide are important factors in determining the potential impacts from drift.

Whenever a pesticide chemical is applied, some of the chemical becomes a deposit on or in the treated crop, animal or object. The pesticide may remain in its original chemical form, or it may be altered chemically by weathering, metabolic degradation or other processes. In any case, the quantity of material remaining is called a residue.

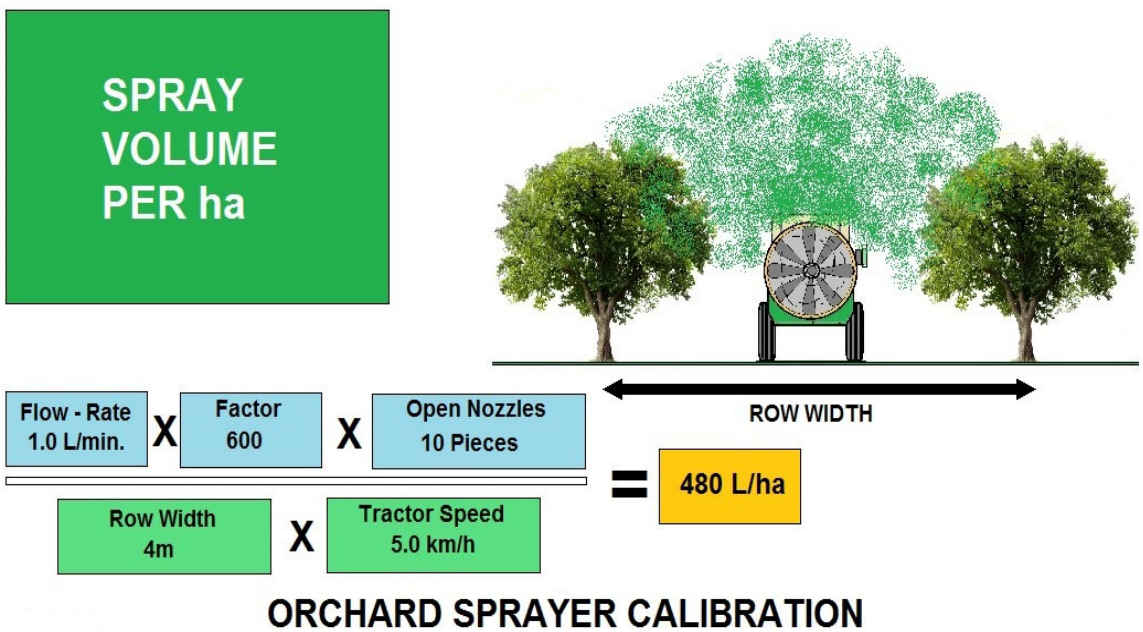
Residues may result from direct application, from drift from nearby fields, from uptake from contaminated soil, or from other sources. In some situations, residues are desirable and produce prolonged effective pest control, as in the control of certain public health and structural pests. In other situations, however, residues represent a source of unwanted and illegal contamination — for example, when residues exceed legally determined limits on food or feed crops at harvest.



IMPACTS OF PESTICIDE DRIFT

Pesticide Residues

Pesticide residues are generally meant to include pesticides that are detectible in or on places other than their intended target. Fresh water reservoirs, stream bed sediments, and harvested food would be examples of places that would be tested for pesticide residues. Needless to say, if high levels of residues were found to occur in such situations, few would consider the test results to be a good thing. Pesticide residues are usually measured, and tolerances expressed in parts per million (ppm) to parts per billion (ppb) on a weight basis.

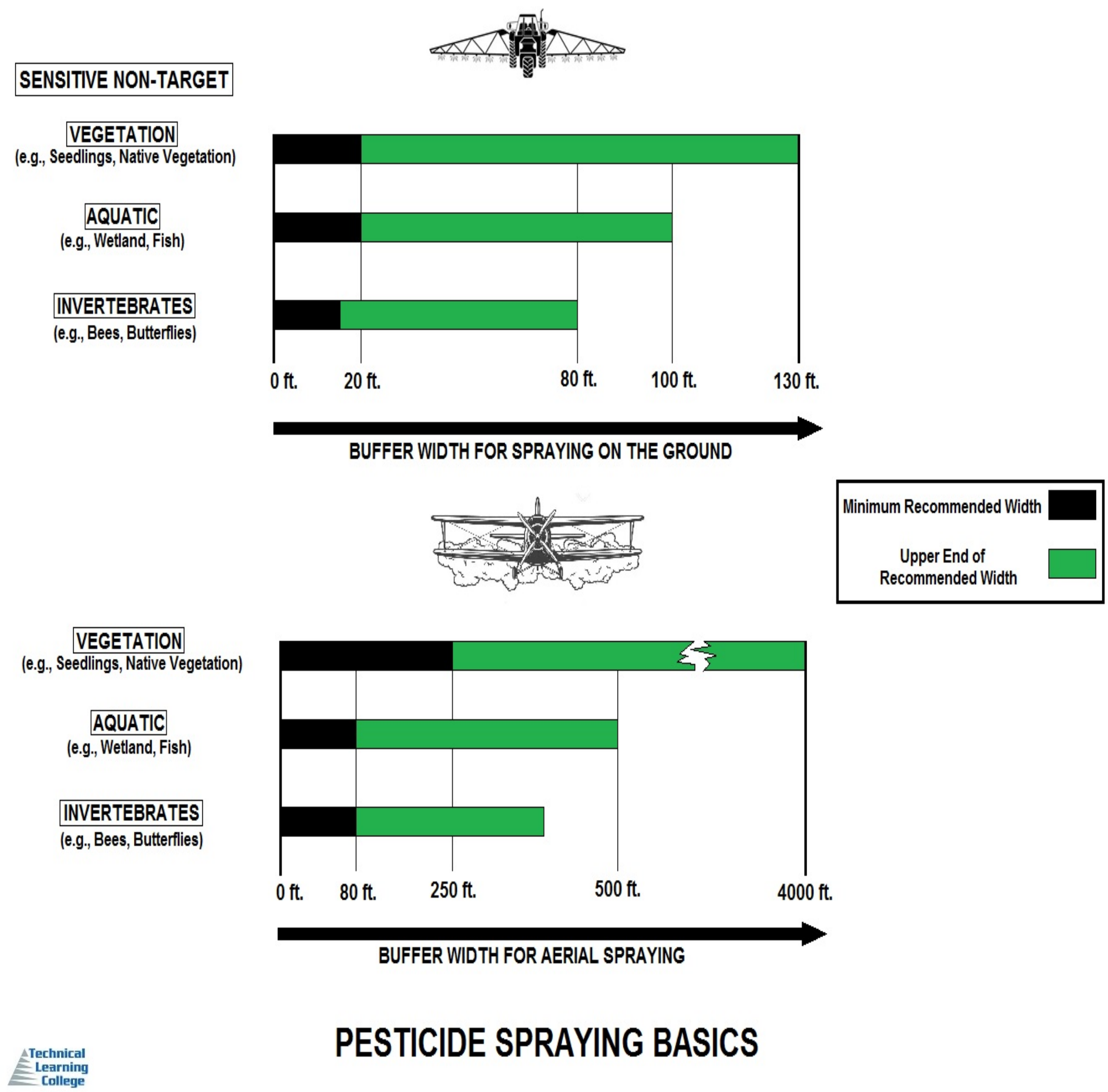


One ppm is one milligram in a kilogram, or one ounce of salt in 62,500 pounds of sugar, or one pound of pesticide in one million pounds of raw agricultural commodity. In some instances, modern analytical chemistry techniques can test residue levels below one ppb.

The residue levels allowed on food crops at harvest are legally set by the federal and state regulatory agencies and are called tolerances. Tolerances are simply the maximum amounts of pesticide permitted to be present on or in raw agricultural commodities. These tolerances represent levels of pesticide residues which scientists have determined may safely remain on the food crop without injury to the consumer. Tolerances vary according to the pesticide and the crop.

When pesticide tolerances are found to be exceed legal tolerances, the agricultural commodities involved may be seized and destroyed. Ordinarily, such situations would arise from the application of agricultural pesticides on crops, but it could happen even where pesticide applications are not specifically targeted at a crop pest, such as the application of pesticides on rice fields for mosquito control. Before allowing the use of a pesticide on food crops, EPA sets a tolerance. If no tolerance has been set for that pesticide on that crop, the pesticide cannot be legally applied on the crop. Some pesticides may be considered "safe" by EPA, and they would be exempted from a tolerance.

How Does the EPA View Off-Target Spray Drift?
The EPA recognizes the importance of exposures to pesticides resulting from spray drift. There are thousands of reported complaints of off-target spray drift each year. Reports of exposures of people, plants, and animals to pesticides due to off-target drift (often referred to as "***drift incidents***") are an important component in the scientific evaluation and regulation of the uses of pesticides. Other routes of pesticide exposure include consuming foods and drinking water which may contain pesticide residues, applying pesticides, and contacting treated surfaces in agricultural, industrial, or residential settings. The EPA considers all of these routes of exposure in regulating the use of pesticides.



Off-Target Drift
When labels of pesticide products state that off-target drift is to be avoided or prohibited, our policy is straightforward: pesticide drift from the target site is to be prevented.

However, we recognize that some degree of drift of spray particles will occur from nearly all applications.

Nevertheless, applicators and other responsible parties must use all available application practices designed to prevent drift that will otherwise occur. In making their decisions about pesticide applications prudent and responsible applicators must consider all factors, including wind speed, direction, and other weather conditions; application equipment; the proximity of people and sensitive areas; and product label directions.

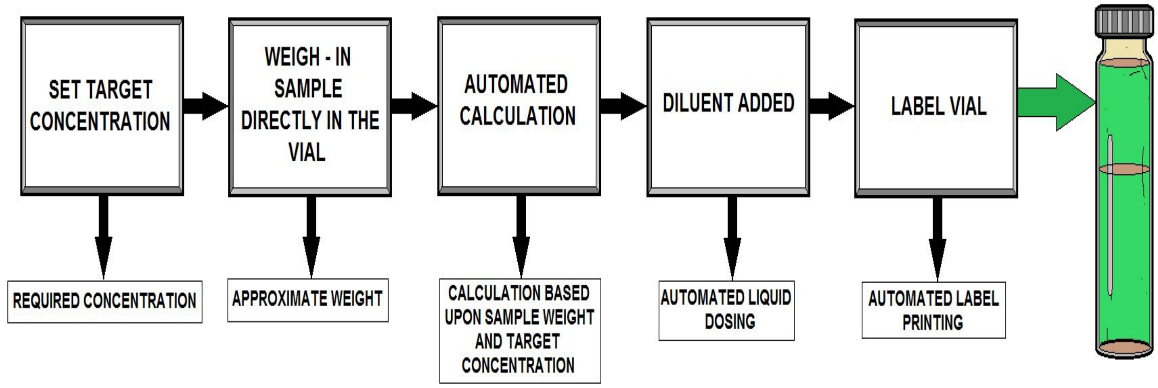
A prudent and responsible applicator must refrain from application under conditions that are inconsistent with the goal of drift prevention or are prohibited by the label requirements. The EPA uses its discretion to pursue violations based on the unique facts and circumstances of each drift situation.

How Does EPA Help Protect People and the Environment from Off-Target Spray Drift?
The EPA is responsible for a number of important programs that help protect people and the environment from potential adverse effects that can be related to off-target drift from pesticide applications. These programs include restricting how pesticides are used, certification and training of applicators, and enforcement and compliance of pesticide laws.

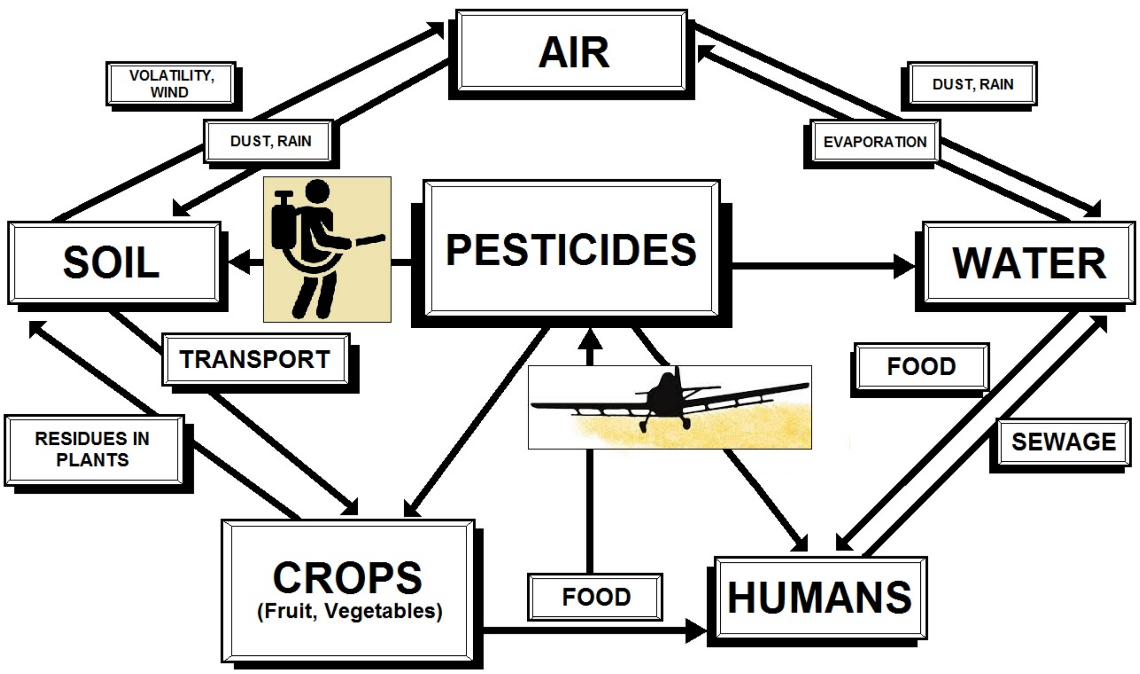
PESTICIDE USED	25 GALLON SOLUTION	DIRECTIONS
2, 4-D AMINE DICAMBA, BANVEL / CLARITY	1 - QT. HOUSEHOLD AMMONIA + DETERGENT SOLUTION FOR RINSE	AGITATE, FLUSH SOME AND LET SET OVER NIGHT. FLUSH AND RINSE.
2, 4-D ESTER BRUSH KILLERS	1 - lb. WASHING SODA + 1 - gal. OF KEROSENE + 1/4 lb. OF POWDER OR LIQUID DETERGENT	RINSE INSIDE OF TANK AND FLUSH SOME THROUGH THE SPRAYER. LET SET FOR 2 HOURS. FLUSH AND RINSE
SULFONYLUREA HERBICIDES	1 - gal / 50 gal WATER HOUSEHOLD AMMONIA + DETERGENT SOLUTION FOR RINSE	AGITATE, FLUSH SOME AND LET SET OVER NIGHT. FLUSH AND RINSE
OTHER HERBICIDES, INSECTICIDES, AND / OR FUNGICIDES	1/4 lb. OF OR LIQUID DETERGENT	AGITATE, FLUSH, AND RINSE

GENERAL CLEANING INSTRUCTIONS FOR AGRICULTURAL CHEMICALS

Technical Learning College



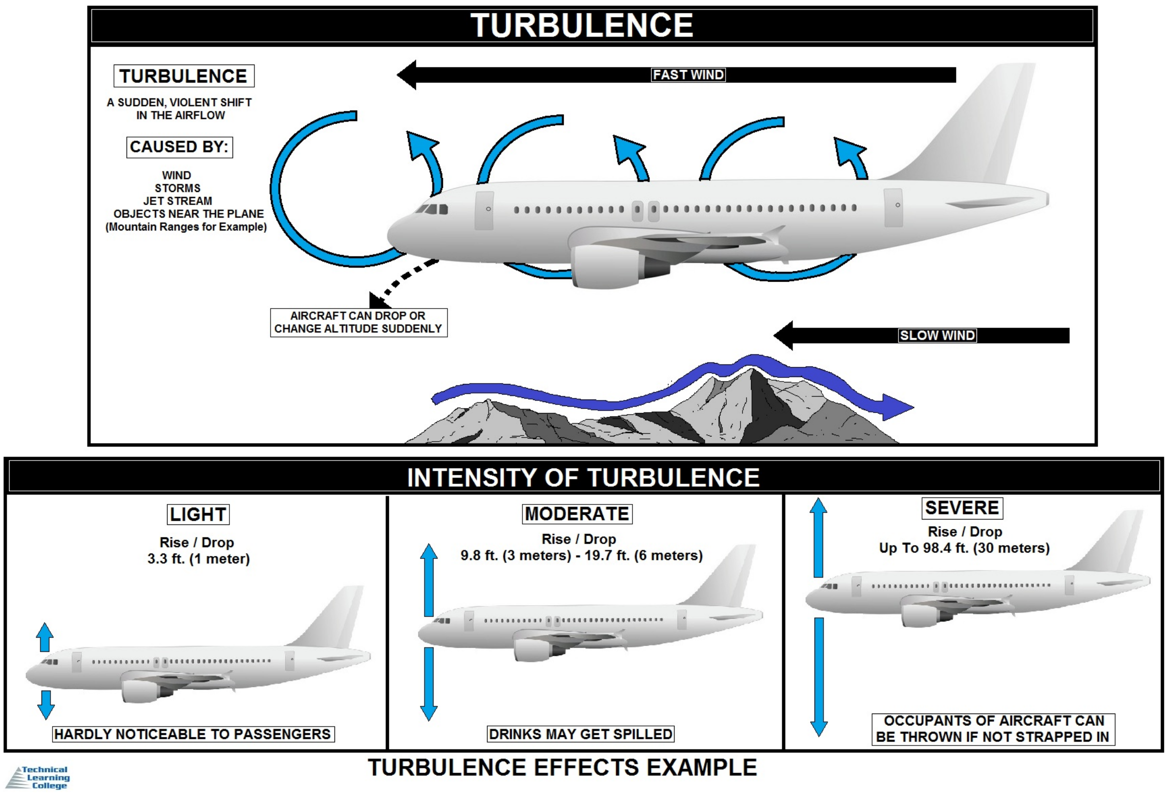
PESTICIDE RESIDUE TESTING



DRIFT EFFECTS OF PESTICIDES EXAMPLE

Training for Pilots and Ground Support Staff Sub-Section

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.



TURBULENCE EFFECTS EXAMPLE

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.

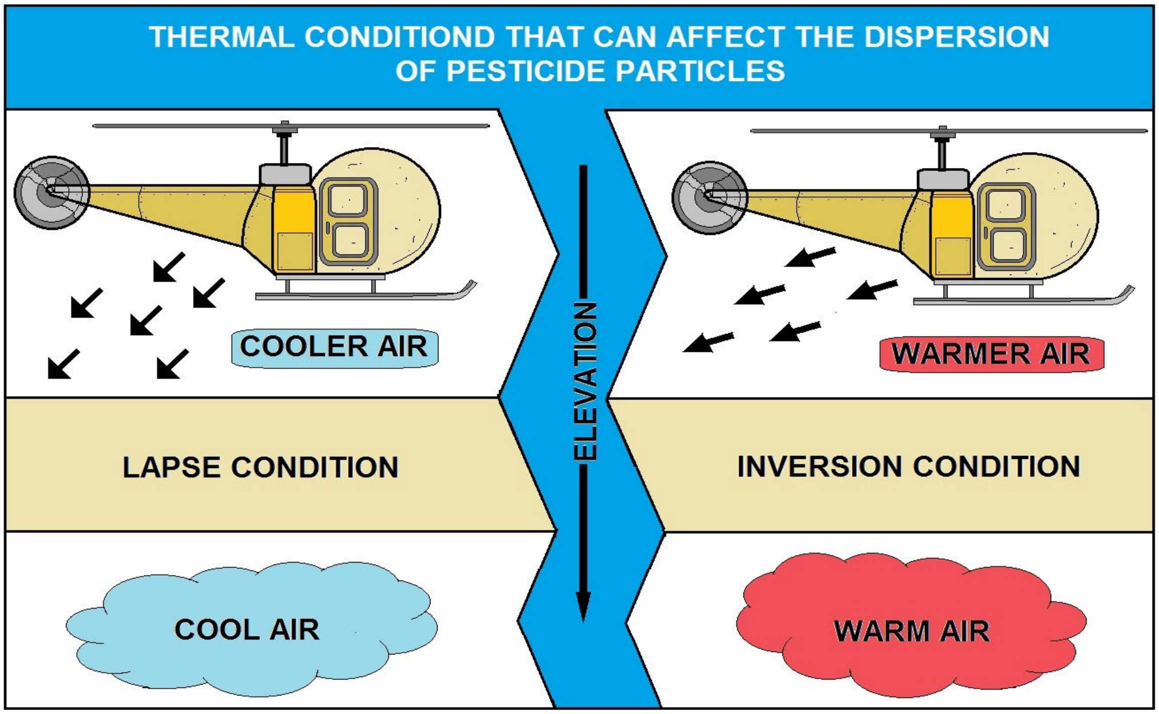
These staff must be fully conversant with their company procedures, operating manuals and practices so that products are safely mixed and loaded into the aircraft hopper in the correct amounts at the recommended dilutions.

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.



THERMAL CONDITIONS EFFECT ON PESTICIDE APPLICATION

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.

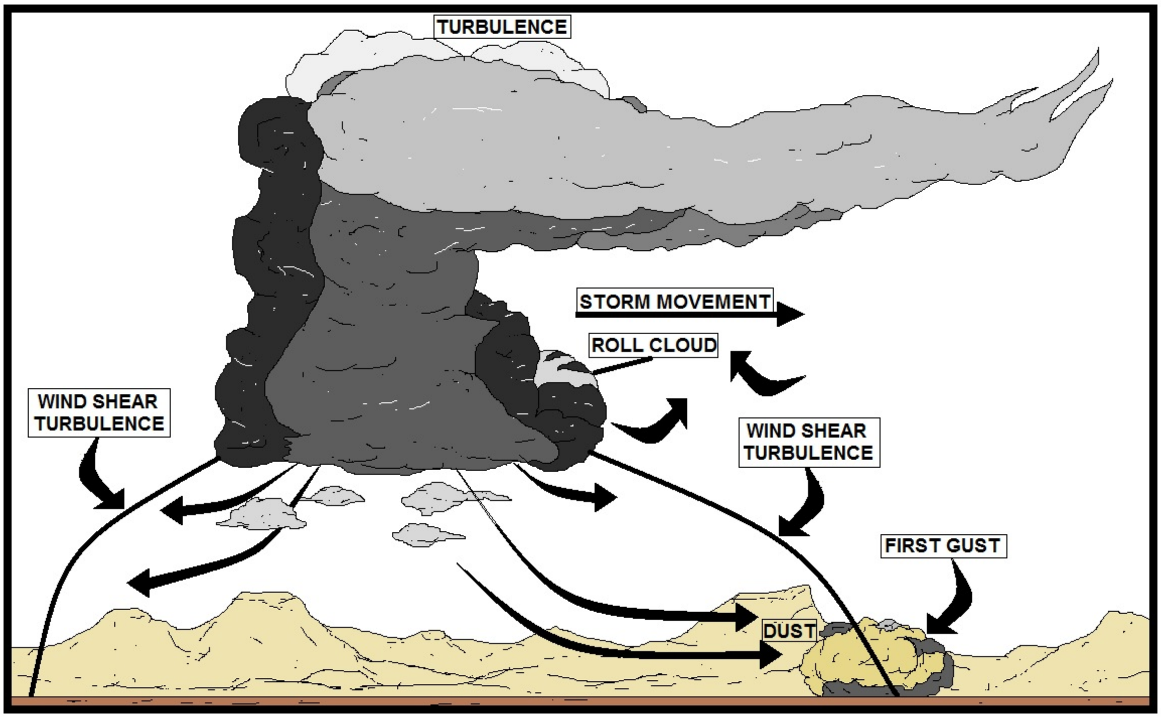
High wind velocities obviously increase the drift hazard as they carry the small droplets and particles away from their intended target. In many cases the distance can run into several miles. Winds tend to be least turbulent just before sunrise or just after sunset.

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.



EXAMPLE OF WIND SHEAR TURBULENCE

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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.

Drift reduction language on the Guthion® Solupak 50% label reads as follows:
Do not apply under conditions where possible drift to unprotected persons or to food, forage, or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption can occur. Use the largest droplet size consistent with acceptable efficacy. Formation of very small droplets may be minimized by appropriate nozzle selection, by orienting nozzles away from the air stream as much as possible and by avoiding excessive spray boom pressure. For ground boom and aerial applications, use medium or coarser spray nozzles according to ASAE 572 definition for standard nozzles or a volume mean diameter (**VIVID**) of 300 microns or greater for spinning atomizer nozzles.

Make aerial or ground applications when the wind velocity favors on-target product deposition.

Apply only when the wind speed is less than 10 mph. For all non-aerial applications, wind speed must be measured adjacent to the application site on the upwind side immediately prior to application.

Do not make aerial or ground applications into areas of temperature inversions. Inversions are characterized by stable air and increasing temperatures with increasing distance above the ground. Mist or fog may indicate the presence of an inversion in humid areas. Where permissible by local regulations, the applicator may detect the presence of an inversion by producing smoke and observing a smoke layer near the ground surface.

Low humidity and high temperatures increase the evaporation rate of spray droplets and therefore the likelihood of increased spray drift. Avoid spraying during conditions of low humidity and/or high temperatures.

All aerial and ground application equipment must be properly maintained and calibrated using appropriate carriers.

For ground boom applications, apply with nozzle height no more than 4 feet above the ground or crop canopy.

For airblast applications, turn off outward pointing nozzles at row ends and when spraying the outer two rows. To minimize spray loss over the top in orchard applications, spray must be directed into the canopy.

For ground-boom, chemigation, orchard or other airblast applications, do not apply within 25 feet of permanent water bodies (rivers, natural ponds, lakes, streams, reservoirs, marshes, estuaries, or commercial fish ponds).

For aerial application to potatoes, do not apply within 150 feet of permanent water bodies (aquatic buffer zone).

For aerial application to crops other than potatoes, do not apply within 50 feet of permanent water bodies (aquatic buffer zone).

For aerial applications, release spray at the lowest height consistent with efficacy and flight safety. If the application includes an aquatic buffer zone, do not release spray at a height greater than 10 feet above the ground or crop canopy.

For aerial applications, the spray boom should be mounted on the aircraft so as to minimize drift caused by wing tip vortices. The minimum practical boom length should be used and must not exceed 75% of the wingspan or 90% of rotor blade diameter. Use upwind swath displacement.

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!***

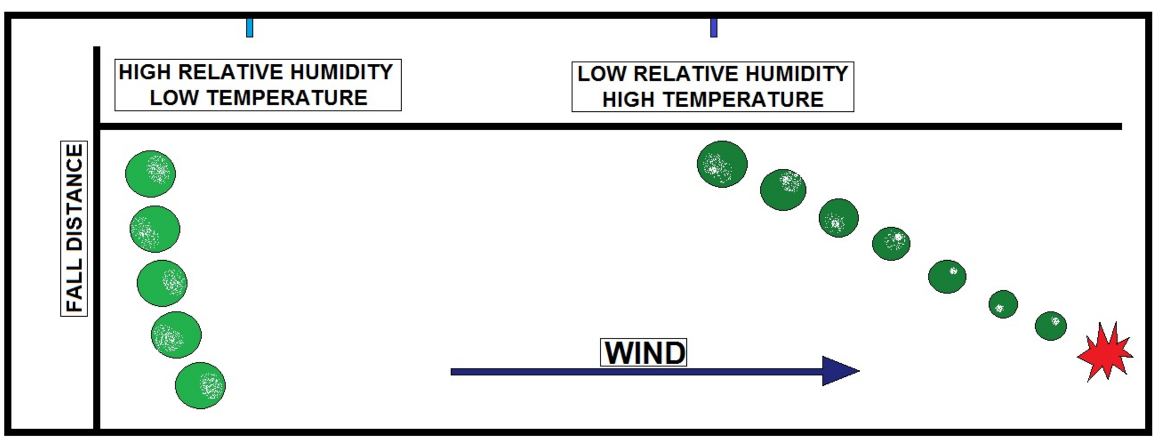
Nozzle orientation affects wind shear across the nozzle face, and subsequently droplet size.

Use a nozzle orientation that will give the desired droplet size.

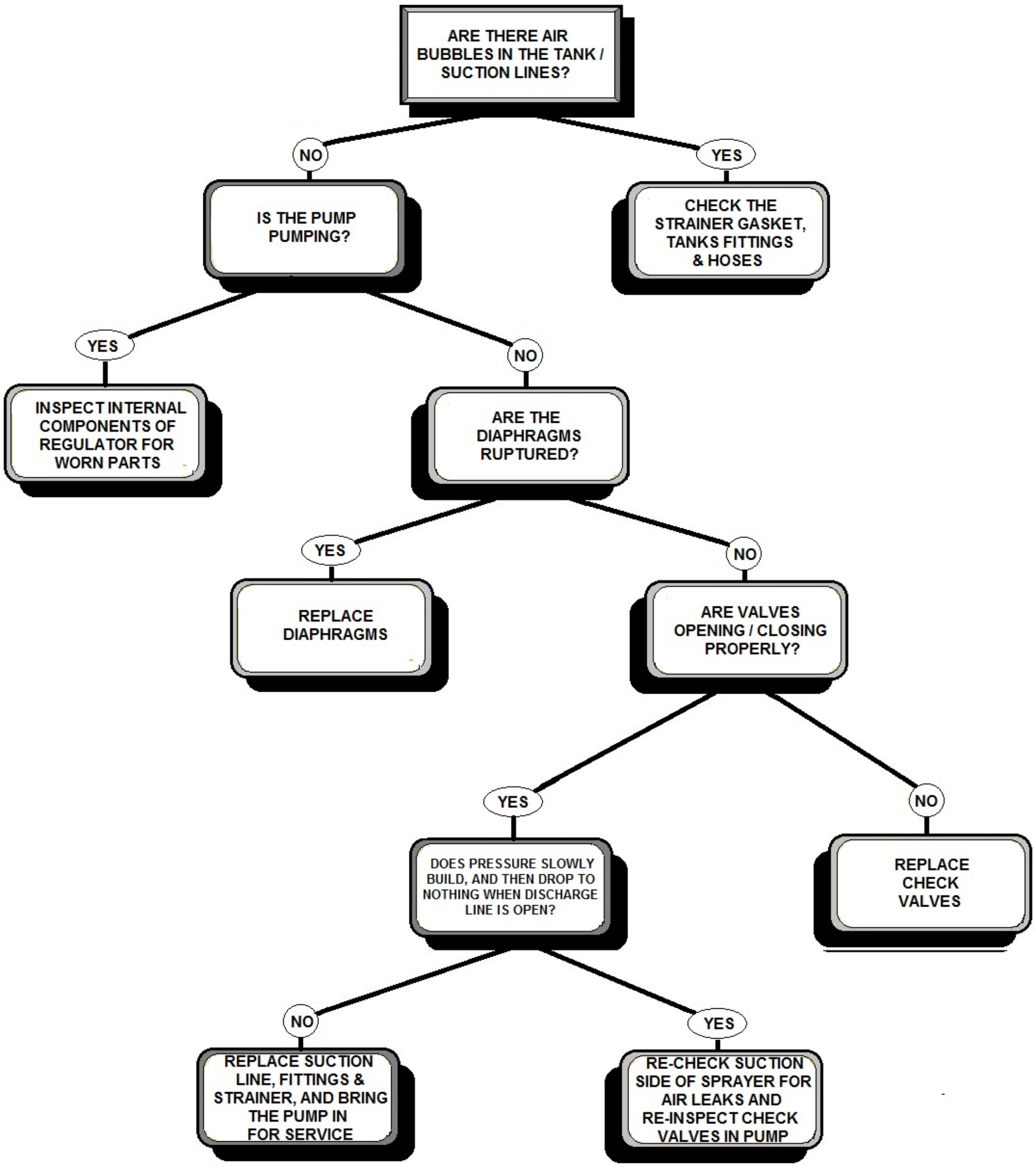
Boom length should be no more than 75% of the wingspan of fixed wing craft, or of the rotor diameter on helicopters to reduce drift caused by wingtip and rotor vortices.

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.



EVAPORATION OF PESTICIDE DROPLETS EXAMPLE



TROUBLESHOOTING PRESSURE ISSUES (Sprayer Pump)

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Chemical Control in an IPM Program

Regular field scouting, coupled with forecasting pest problems and determining economic thresholds, is used to ensure that pesticides are only applied when pest populations warrant chemical control. The traditional approach of applying pesticides routinely or at the first sign of any crop pest is replaced with a philosophy that seeks to optimize crop growth and allow natural enemies of pests the opportunity to suppress the outbreak.

Producers and consumers must understand, however, that there is no "***silver bullet***" in an IPM program and that some level of pests and diseases must be tolerated. Fortunately, most crops can tolerate a certain level of infestation before significant yield or quality losses occur.

The Label as Law

Finally, the instructions found on pesticide product labels carry the force of law — hence the saying, "The label is the law." For example, certain pesticide labels expressly prohibit aerial application of that particular pesticide product. Application of the product via aircraft could result in the aerial applicator being summoned to respond to charges in state (or federal) court. Courts have consistently ruled that pesticide label language takes precedence and must be fully obeyed.

Further, manufacturers of pesticide products often find it necessary to alter the label instructions that accompany their pesticide products. Typically, a change in label language is a consequence of some new provision in federal (or state) rule. Regardless of the reason behind a label language change, its practical importance to applicators includes: Without exception, be certain to read the entire pesticide label of every pesticide product prior to using it.

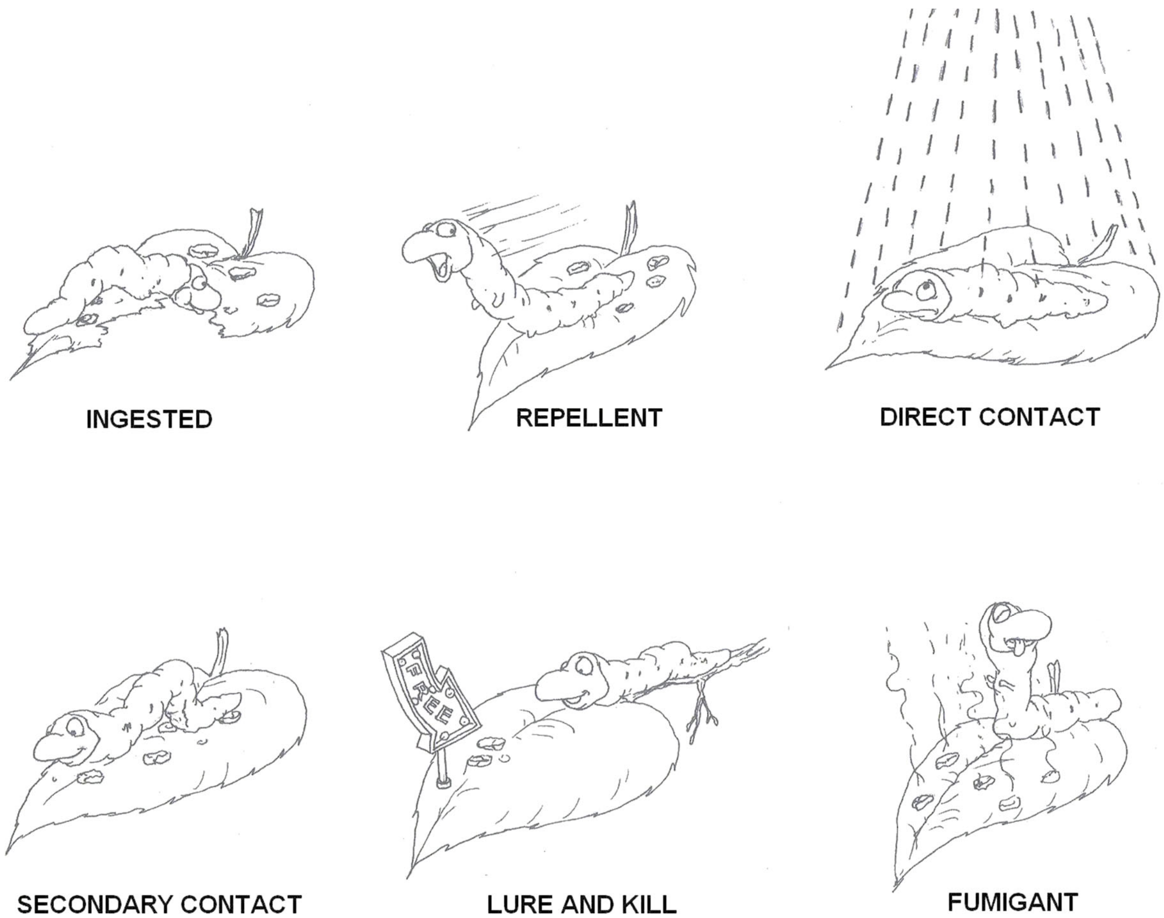
Be especially on the lookout for wording changes in:

- directions for use,
- application sites (crops, buffer zone requirements, etc.),
- application rates,
- handling precautions,
- personal protective equipment requirements,
- storage and disposal statements, and
- environmental protection measures.

Avoid the complacency that often accompanies familiarity. Just because you've "...used Product X for years..." doesn't mean you have no need to read its label. Many long-standing pesticide products now have substantially revised labels.

Re-registration (a legal process being conducted by the federal government) of all pesticide products is currently ongoing — and can be expected to continue for the next few years. One of the likely consequences of this process is that pesticide users will probably encounter new label language on many of the pesticide products that they've known about and used for years. The best way to be aware of any such change is to regularly and carefully read the pesticide product label.

Biological Pesticides
Biological pesticides, such as *Bacillus thuringiensis* (Bt), are commercially available and are effective against some pests. These products are extremely selective and of low toxicity to humans and non-target organisms. Examples of biological pesticides include bacteria, fungi, viruses, or their toxins. The bacterial insecticide, Bt, is currently the most commonly used biological pesticide. Consider using these products in place of more toxic pesticides, especially when water supplies are vulnerable to contamination. Be sure to follow all label directions for application and storage of these products.

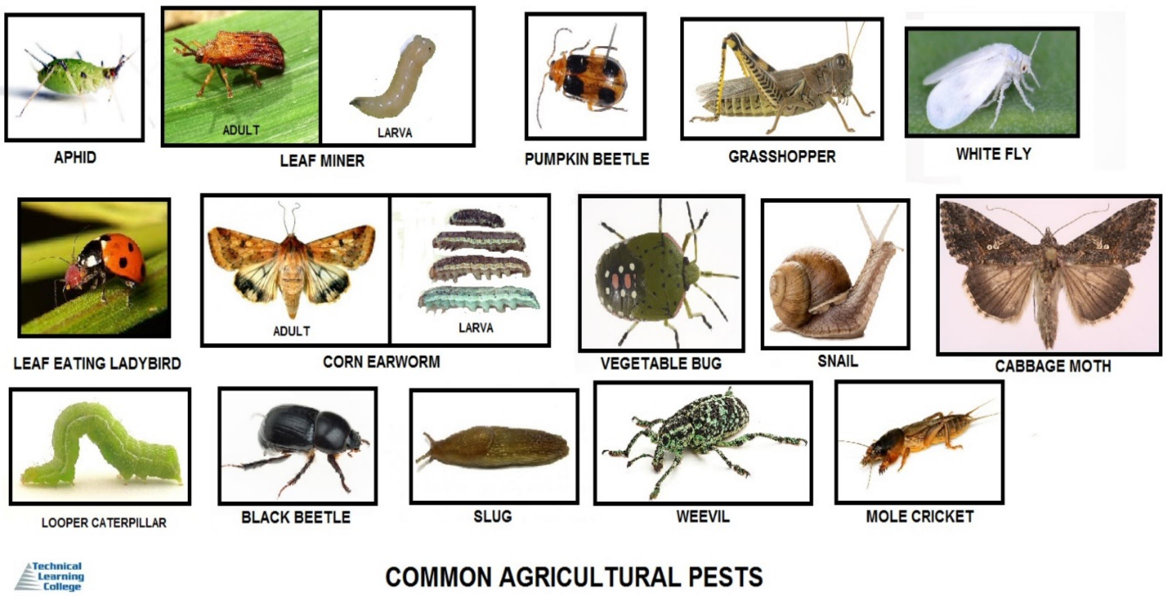


Pollinator Decline
The term pollinator decline refers to the reduction in abundance of pollinators in many ecosystems worldwide during the end of the twentieth century. Pollinators participate in sexual reproduction of many plants, by ensuring cross-pollination, essential for some species, or a major factor in ensuring genetic diversity for others. Since plants are the primary food source for animals, the reduction of one of the primary pollination agents, or even their possible disappearance, has raised concern, and the conservation of pollinators has Pesticide misuse

It is a label violation to apply most insecticides on crops during bloom, or to allow the pesticide to drift to blooming weeds that bees are visiting. Yet such applications are frequently done, with little enforcement of the bee protection directions.

Pesticide misuse has driven beekeepers out of business, but can affect native wild bees even more, because they have no human to move or protect them.

Bumblebee populations are in jeopardy in cotton-growing areas, since they are dosed repeatedly when pesticide applicators apply insecticides on blooming cotton fields while the bees are foraging. Widespread aerial applications for mosquitoes, medflies, grasshoppers, gypsy moths and other insects leave no islands of safety where wild insect pollinators can reproduce and repopulate. One such program can reduce or endanger pollinator populations for several years.



COMMON AGRICULTURAL PESTS

Weeds and Insects
Weedy areas may provide habitat for both pests and beneficial insects, but if plants in adjacent weedy areas are related to crop plants, weedy areas are more likely to be a source of insect pests. Morning glory is related to sweetpotato, for example, and nightshade to tomatoes, potatoes and eggplant.

Pests with a wide host range such as armyworms, crickets, cutworms, darkling beetles, flea beetles, grasshoppers, lygus bugs, slugs and snails, stink bugs and thrips often inhabit weedy areas and, in some cases, will attack nearby crops. Mowing weedy areas for the first time after the crop emerges may encourage migration onto crop plants. It may be best not to mow weedy areas at all or to mow before the crop emerges and regularly after emergence.

Tillage Practices and Insects
Plowing under plant debris to speed up decomposition is a common method to lower pest populations by destroying overwintering stages. Seed corn maggots, for example, survive in decomposing plant material. However, tillage operations will also reduce populations of beneficial insects. A study of field crops showed lower populations of carabid beetles and spiders in conventionally tilled fields compared to no-till fields.

Both of these predators can help control seed and seedling pests. Strip tillage preserves habitat for beneficial insects, while still destroying soil-dwelling insects in the plowed area.

Crop Rotation

Crop rotation is a traditional production practice used to enhance soil fertility and tilt, increase crop vigor, and reduce the buildup of crop pests. Crop rotations cannot solve all weed, insect, and disease problems. However, without rotations, producers are essentially locked into pesticide-based control programs. Rotations are most likely to be effective on pests that tend to be crop specific and overwinter on site. By switching to another crop, pest cycles may be interrupted when they become active and find their food source is gone.

The key to a good rotation plan is to determine which pests are of most concern and then select crops accordingly. Obviously, market factors must be considered for producers to remain profitable. Continuous corn and alfalfa, as well as vegetable only and wheat-fallow cropping systems are common. These systems have some production and marketing advantages, but usually result in weed and other pest problems. Rotating to different crops, such as from vegetables to small grains, provides the additional benefit of scavenging excess soil nitrate.

IPM programs are difficult to implement under cropping systems that do not include rotations. Where rotation is practiced, pesticide use can often be greatly reduced with no significant losses. For example, corn rootworm insecticide is used in the greatest volume of any agricultural insecticide in the United States. Rotating corn fields to any other crop generally eliminates the need for insecticide application, saving money and reducing potential environmental impacts.

Resistant Crop Varieties

Plant breeders have been selecting pest resistant varieties to improve crop productivity for many years. Now, host plant resistance is a cornerstone of many successful IPM programs.

Non-Chemical Pest Control Practices

IPM may result in reduced pesticide use by employing preventive pest management and non-chemical pest controls. Non-chemical pest management methods include crop rotation, resistant varieties, cultural practices, and biological controls. These methods are basic to effective IPM and should be the first line of defense. However, producers must plan for their use in advance of pest outbreaks to successfully use non-chemical management tools.

Plants have many natural characteristics for keeping pests at bay: repellent or toxic chemicals, thorns, hairs, and resistant tissues. The greatest plant breeding successes have been in the selection of disease resistant varieties, but insect tolerant lines have also been developed. With some pests, such as plant viruses, the only effective control is the use of resistant varieties and clean planting material.

Resistant varieties will not interfere with other pest control measures and may reduce the need for pesticide treatment. However, resistance is not available for all problems. Potential drawbacks include decreased yields, increased susceptibility to other pests, and shifts in predominant pest biotypes as a result of over-exposure to the resistance genes.

Examples of pest resistant crops include Russian wheat aphid tolerant winter wheat, curly top virus resistant sugarbeets, European corn borer resistant corn hybrids, sorghum unpalatable to birds, and dry beans with tolerance to white mold and halo blight.

Other Cultural Practices

Pests have a more difficult time getting established when crop plants are thriving. For example, many late emerging annual weeds cannot compete successfully once the crop canopy shades the row. Insects such as spider mites thrive on drought stressed plants but are much less competitive on vigorous crops. Producers should employ cultural practices to their advantage.

Optimum plant population, row spacing, fertility, and irrigation are practices that can improve crop vigor, thereby reducing pest competitiveness and impact. Growers should evaluate their production practices for areas where they can enhance crop health and vigor. Usually, these improvements will increase crop yield and economic return. Adjusting planting, tillage, and harvest dates can sometimes help crops avoid pests. Early tillage destroys weeds where some insects lay their eggs.

Tillage also is very important for destroying volunteer crops where pests such as Russian wheat aphid or wheat curl mite may overwinter or become established early. Early planting may help the shorter season corn varieties escape economic damage from second generation European corn borer.

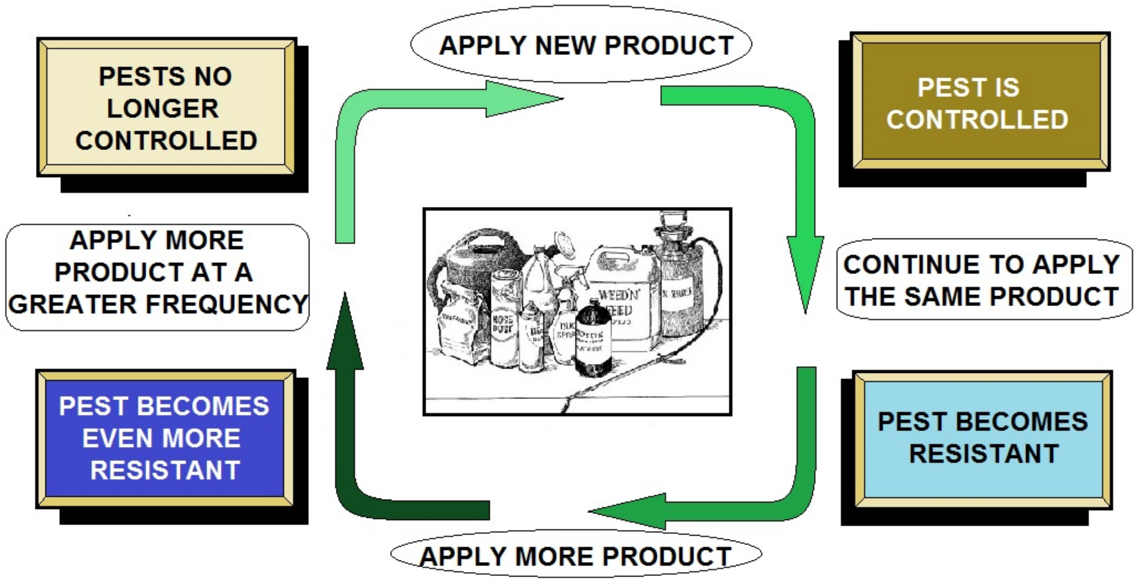
Planting too early in the spring or too late in the fall has some drawbacks that producers should consider. Late frost and slowed emergence can make plants more susceptible to disease and insect pressure. A good technique for many growers is to plant a range of maturity dates, beginning as soon as the soil is at the proper temperature for germination.

Producers may want to delay the planting of fields with problem weeds to allow for weed emergence and cultivation prior to crop establishment. Winter wheat growers can avoid wheat streak mosaic and Russian wheat aphid by delaying fall planting.

In some cases, crops can be harvested early instead of spraying. Harvesting alfalfa early may substitute for pesticide in reducing alfalfa weevil populations. An early first cutting can decrease the weevil population by mechanically damaging larvae and exposing them to predation and weather. Early harvesting is also a good way to manage foliar diseases in alfalfa. Harvesting corn for silage or high moisture grain may prevent losses caused by lodging due to stalk rot or corn borer.

To conserve beneficials in your fields:

- ✓ Preserve habitat and alternate food sources for beneficials.
- ✓ Learn to distinguish beneficial insects from pests.
- ✓ Minimize broad spectrum pesticide applications.
- ✓ Use selective pesticides that are less toxic to beneficials.
- ✓ Treat only those portions of the field where pests cause economic levels of damage.
- ✓ These natural controls often work more slowly than pesticides, but they can be effective, environmentally friendly, and economically sustainable.



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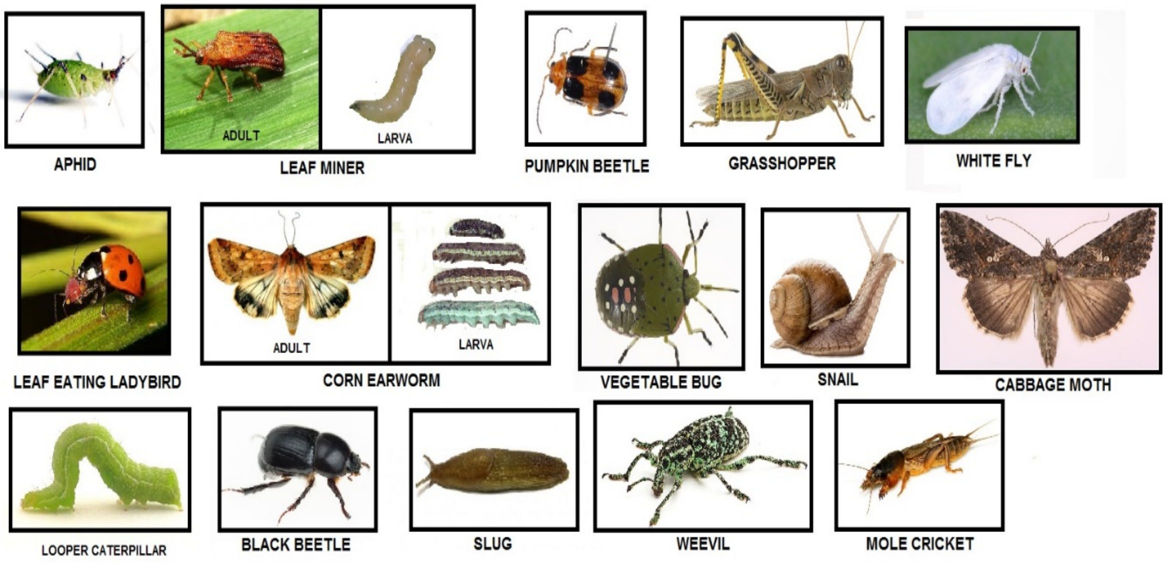
PESTICIDE TREADMILL DIAGRAM

Biological Pest Control

Beneficial organisms can help control weeds, diseases, and insects in crop fields when broad spectrum pesticides are avoided. These organisms may occur naturally or may be purposely introduced.

Beneficials include predatory insects and mites, parasitic insects, and microbial organisms. Predators such as lady beetles and green lacewings feed on plant-eating pests. Insect parasites, like the tiny braconid wasp, lay eggs on or inside the developing pest. The single-celled protozoa, Nosema, is a microbial pathogen of grasshoppers.

Additionally, grazing animals such as sheep can help control difficult weed species such as leafy spurge. Given favorable conditions, naturally occurring and introduced biological controls can do an excellent job of reducing some pests below economic injury levels. Due to the cost of introducing biological controls, conserving the natural enemies already in your field is a useful IPM technique. Unfortunately, beneficial insects are often killed when broad spectrum pesticides are applied.



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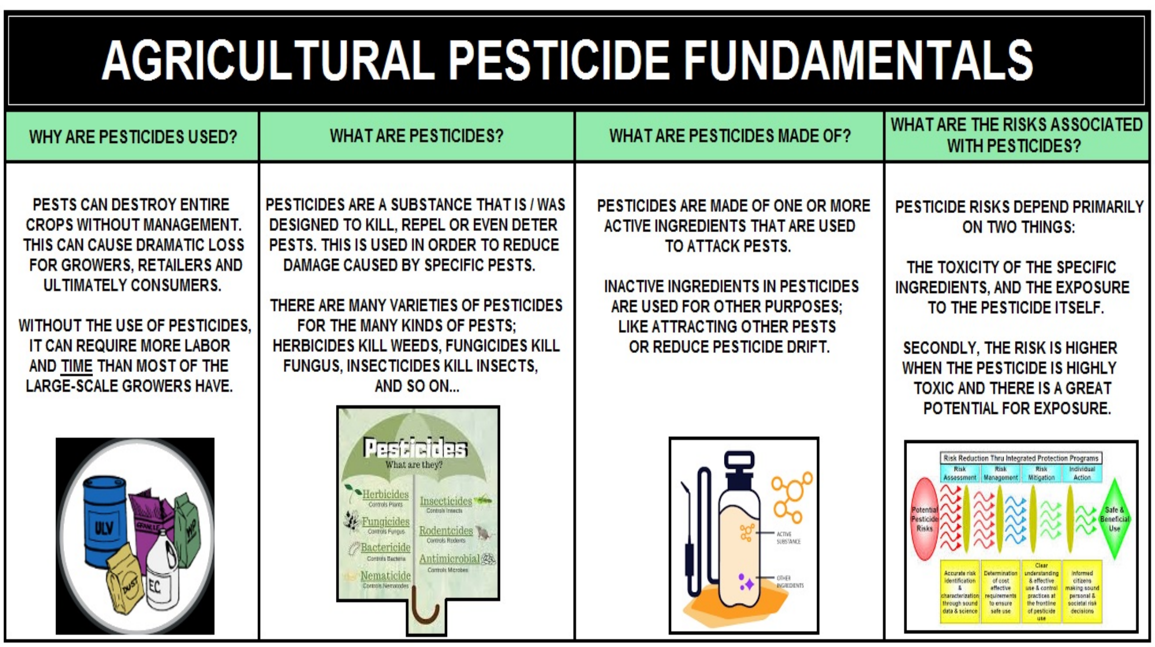
COMMON AGRICULTURAL PESTS



AGRICULTURAL PESTICIDE FUNDAMENTALS

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BIOLOGICAL CONTROL METHODS

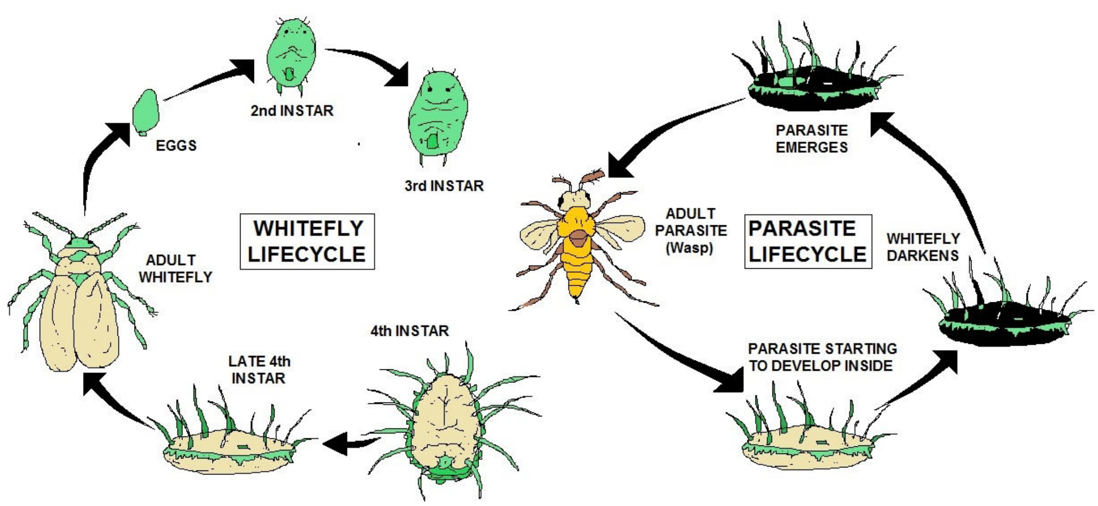
FOUR AREAS OF BIOLOGICAL PEST CONTROL

(1) USING INSECT'S NATURAL ENEMIES
SELECTIVITY INCREASING THE POPULATION OF INSECT'S NATURAL ENEMIES

(2) RESISTANT PLANT VARIETIES
USING PLANT VARIETIES, NATURAL OCCURING & BY GENTIC RESEARCH, RESISTANT TO INSECT

(3) CROP ROTATIONS
ROTATING THE TYPE OF CROP GROWN IN A PARTICULAR SPOT, SO SAME CROP IS NOT GROWN CONTINUOUSLY

(4) STERILIZATION
USE CHEMICALS OR RADIATION TO STERILIZE OR TO GENETICALLY ALTER INSECTS SO THEY ARE UNABLE TO REPRODUCE



BIOLOGICAL PEST CONTROL (Whitefly Control)

Table 1. Examples of insect biological control organisms released for pest control by the Colorado Department of Agriculture.

Control Organism	Pest Crop
Macrocentrus ancylivorus	Oriental fruit moth Peach
Hippodamia variegata	Russian wheat aphid Wheat
Tetrastichus incertus	Alfalfa weevil Alfalfa
Phrydiuchus tau	Mediterranean sage Range
Ceutorhynchus litura	Canada thistle Range
Rhinocyllus conicus	Musk thistle Range
Calophasia lunula	Toadflax Range
Microlarinus lareynii	Puncturevine Range
Aphthona flava	Leafy spurge Range
Urophora affinis	Knapweed Range

Commercially available biological control organisms are being used successfully by some growers of high value crops. A number of suppliers throughout the United States provide beneficial organisms for release in gardens, greenhouses, and fields. The economic benefit of field releases of beneficial insects is uncertain in many crops because of limited knowledge about when and how to achieve establishment and control.

Damage to Beneficial Insects

The efficient production of many crops, including fruits, vegetables, forage, and seeds, would not be possible without the activities of honey bees and other pollinating insects. Over the past 100 years or so the honey bee industry has sustained serious losses from pesticide applications. Recently, pesticide poisoning has come under suspicion for reductions in honey bees in the USA. Some agricultural pesticides used currently are known to pose a significant hazard to bees. Vector control applications are ordinarily done in a manner that minimizes risk to bees and other beneficial insects.

In addition to pesticide exposure, honey bee colonies are at risk from a variety of parasites, pathogens, marauding mammals, and other factors. To protect these valuable insects from losses due to pesticide poisoning it is necessary to know where colonies are located before starting a pesticide application, and to protect them in some way. Moving colonies to areas far from the possibility of drift and avoiding the use of pesticides known to be especially toxic to bees are two ways to minimize damage. If public health pesticide applications are planned for areas known to be close to bee colonies, it is also a sound policy to warn hive owners in advance of the applications, so they have an opportunity to protect them.

There are other pollinating insects that may suffer damage from pesticide applications, such as alkali bees and other wild bees. Wild bees are not in hives but are present in a variety of nest types. This complicates their protection from pesticides. Other insects are beneficial because they prey on or parasitize pests. There have been many studies on the effects on non-target organisms of pesticides in a variety of settings. Your local extension specialist can provide you with copies of reports of this kind of research.

By definition, pesticides that harm non-target organism populations significantly are non-selective. If use of a non-selective pesticide is considered essential, it must be justified based on the relative benefits balanced against the relative harm. In the case of public health pesticides, the threat to human health is a necessary consideration.

The ideal pesticide would be selectively nontoxic to bees and other beneficial organisms, while toxic to a specific pest. Few products available for adult mosquito control meet this ideal, but several larval mosquito control products and many herbicides are selective. For adult mosquito control and other pesticide applications, the best compromise must be found.

Restrictions during Application

The handler employer must assure that:

No pesticide is applied so as to contact any worker (directly or through drift) other than an appropriately trained and equipped handler.

Workers handling highly toxic pesticides are monitored visually or by voice communication at least every 2 hours.

Any worker who handles a fumigant in a greenhouse, including a handler entering before acceptable safe entry criteria have been met, maintains continuous visual or voice contact with another handler who has immediate access to the required PPE if rescuing the handler in the greenhouse becomes necessary.

Notice of Application to Agricultural Employers

Prior to applying any pesticide on an agricultural establishment, a handler employer must provide the following information to an agricultural employer or be assured that the agricultural employer is aware of the specific time, date, location, and description of the pesticide-treated area, labeling requirements relating to protection of workers during or after application, product name, the EPA registration number, active ingredients, REI, and notification requirements.

Pesticide Safety Training

A handler employer must assure that each handler is properly trained in pesticide safety by a qualified trainer. The minimum pesticide training required, as well as the criteria for qualified trainers, is specified in the standard. Certified handlers and handlers who have been trained under 40 Code of Federal Regulations; Part 171 are exempt from this requirement.

THE IMPORTANCE OF THIS SECTION

Regulatory agencies will enforce the requirements of the federal Worker Protection Standard (Code of Federal Regulations, Title 40, Part 170) when you use a pesticide product with labeling that refers to the Worker Protection Standard. If you do not comply with the Worker Protection Standard requirements, you will be in violation of federal law, since it is illegal to use a pesticide product in a manner inconsistent with its labeling.

This manual provides information to help you comply with the requirements of the federal Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR part 170, as published in 1992 and as amended in 1995, 1996, and 2004.

EPA may issue additional guidance about the Worker Protection Standard and the Worker Protection Standard may be amended in the future. Check with your state or tribal agency responsible for pesticides for further information and updates.

Pesticide Application Dilemma Sub-Section

The aerial application industry is seemingly plagued with contradictory studies, some of which are negative and damaging and some are positive and show how the industry has evolved to become modern day environmental stewards. As with pesticide application in general, crop dusting is associated with a number of environmental concerns, including spray drift, soil contamination, water pollution, and occupational health concerns.

Pesticide manufactures are continually evolving to address these concerns. In the infancy of the pesticide era little was known about the environmental impact of using pesticides. Over time it became evident that better chemical compounds and more focused stewardship on behalf of the applicator were going to have to be researched and implemented. Recently, pesticide manufactures have developed new products that are designed to be safely metabolized when applied to prevent any unwanted or damaging environmental impacts; these new chemical compounds are referred to as “soft chemicals”. All crop protection products must meet tough safety standards.

Only one in 20,000 chemicals actually survives the 8-10 year process of development, testing, and registration by the U.S. Environmental Protection Agency (EPA). Costs to test a pesticide's safety can range in price from $160 to $200 million. Nearly 900 scientists and program officials from the EPA make sure that products are properly registered to comply with federal law. Once on the market, they are monitored by the EPA, the Food and Drug Administration (FDA) and state pesticide enforcement agencies. This stringent regulatory system ensures the safety of our food, the safety of the products to the environment, to water and to the farm workers that mix, load and apply the products.

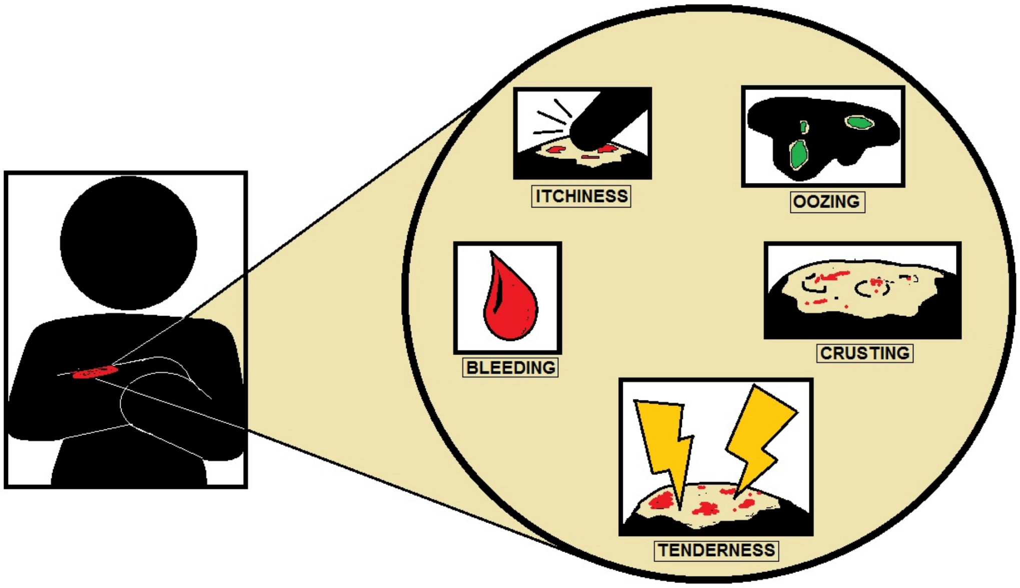
Another concern is that the aerial application of pesticides can lead to Pesticide resistance by insects, and is thus not a sustainable practice; however, this is more to do with outdated farming practices and not the actual pesticides themselves. Modern day farming utilizes Integrated pest management (IPM) in order to reduce or eliminate pesticide resistance.

In the U.S. in 1970, lawsuits and court cases involving spraying of pesticides, such as aerial application in commercial agriculture were a growing area in law, combining areas such as negligence, products liability, strict liability, statutory regulation and commercial law. Environmental and human rights issues associated with crop dusting is greatest in developing countries, where government oversight is weaker or absent, few safety practices are used, and chemicals are used that are banned in most developed countries. This has led to many developments to mandate the proper dispersal of pesticides among all users. Aerial application specifically has improved equipment and techniques to provide accurate and effective delivery of crop protection products. In the 1960s the National Agricultural Aviation Association (NAAA) was established to foster industry development to the highest standards.

Recently, NAAA developed the Professional Aerial Applicators Support System (PAASS) to educate pilots about safety, security and drift mitigation. PAASS is committed to reaching every aerial applicator in the U.S. with the latest information regarding these issues. In addition, the NAAA works with the federal government to invest in researching, developing and testing aerial application technologies to strengthen the safe application of crop protection products by air. Since the programs implementation statistical data suggests a substantial decreased to number of pesticide related incidences.

Bowen's Disease

Crop dusting involving arsenic powders has been implicated in Bowen's disease. However, lead arsenic has not been used by aerial applicators or in any other form of agriculture for three decades because of the adverse effects to human health that were not as well known when the powder was legal. There has been an ongoing debate about the effects of consuming food that has been treated with pesticides. Often the consumers receive conflicting data on this topic and find themselves in the crossfire of politically and emotionally charged facts pertaining to the pros and cons of pesticides.



SYMPTOMS OF BOWENS DISEASE
(Caused from Crop Dusting using Arsenic Powders)

The American Cancer Society states: "Many kinds of pesticides are widely used in agriculture in the production of our food supply. People who eat more fruits and vegetables, which may contain trace amounts of pesticides, generally have lower cancer risks than people who eat fewer fruits and vegetables.

Pesticides play a valuable role in sustaining our food supply. When properly controlled, the minimal risks pesticides pose are greatly overshadowed by the health benefits of a diverse diet rich in foods from plant sources." “Aerial application helps make it possible for us to have these fresh fruits and vegetables year-round. Pesticide use has resulted in increased availability and a variety of low cost, fresh fruits and vegetables year-round.

This has had significant impact on human health because there is strong evidence that increased consumption of fresh fruits and vegetables is associated with a reduced risk of chronic disease, including many cancers.

Crop protection products also play a role in enhancing the safety of the food supply by reducing levels of natural toxins, such as mycotoxins and reducing the potential for contamination of fresh produce by food borne human pathogens”.

Environmental Effects Sub-Section

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.

Sprayer Cleanout Fact Sheet
Key Points:
Proper cleaning and maintenance of spray equipment are essential parts of effective pest control.

Sulfonylurea herbicides are no more difficult to remove from application equipment than any other herbicide. As with any herbicide, if a highly sensitive crop is going to be sprayed, it is important to use thoroughly cleaned equipment. When a crop is highly sensitive to any herbicide, even a very low level of carry-over can cause damage.

Many factors can influence the effectiveness of sprayer cleaning procedures, including design and maintenance of the equipment, residues from previous applications, and the presence of tank mix partners (including additives).

Because residues from previous applications can trap subsequent compounds and make it more difficult to clean them from the system, it is important to start with clean equipment. Equipment should be rinsed immediately after spraying, using cleaning procedures specified on the label as soon as possible after rinsing so that compounds will not dry onto the surface of tanks and hoses.

The product label also notes approved product combinations. Incompatibility between products can result in deposits that are difficult to clean from equipment. For approved product combinations, it is important to add the products in the recommended order. Adding products in the wrong order can also result in deposits that are difficult to remove.

Even when the sprayer is operated until visibly empty, small amounts of spray solution can remain in the equipment. When the same equipment is used to spray different crops during the season, injury to sensitive crops may result if traces of previous products remain in the sprayer. The sensitivity of various crops to injury by different products is highly dependent on the specific product, the rate at which it is applied, the ability of the vegetation to break down the product, and the growth stage of the vegetation.

Cleanup procedures work through three primary mechanisms: dilution, deactivation, and extraction. All procedures use dilution, which lowers the concentration of the crop protection product by repeated addition and drainage of fresh cleaning solution.

Deactivation occurs when the cleaning solution causes the crop protection product to decompose into compounds that are no longer active for their intended use. Extraction occurs when the cleaning solution causes chemical deposits that can accumulate in application equipment to loosen or dissolve.

Older, poorly maintained spraying equipment with rusted, pitted components can trap crop protection products, making them difficult to remove. Multiple applications of a product over a period of time without interim rinsing can lead to a buildup of deposits.

Certain tank mixes can hinder cleanup by forming deposits and trapping products on equipment surfaces. If the sprayer is not clean prior to using, deposits from a previously used product can also trap subsequent products and ultimately reduce their exposure to the cleaning agent. These deposits can break free during subsequent applications. When proper cleanup procedures are not followed, crop protection products left in the spray system can damage sensitive crops in a future application.

Adequate cleanup procedures should be followed, according to the product label. DuPont works with sprayer manufacturers to design equipment that can be efficiently cleaned. DuPont also conducts research on improving cleanout procedures and on evaluating the effectiveness of cleaning agents.

Pest Mortality Assessment Sub-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.

Certifying and Training Applicators
The EPA also works with the USDA and state government agencies to carry out certification and training programs for pesticide applicators. States have primary responsibility for ensuring that pesticide applicators are licensed and certified, as required by Federal and state laws, to apply pesticides in an appropriate manner. Part of the program for certification can include training about how to protect people and the environment from off-target spray drift.

Enforcing Compliance with Laws
When individuals have complaints about off-target spray drift, they should report those complaints to their state or tribal government agency (either agriculture or environmental protection) that is responsible for enforcing the proper use of pesticides for that state or tribe. These agencies have the primary responsibility of enforcing lawful use of pesticide products by investigating complaints and, when appropriate, issuing penalties for improper use. When necessary, the EPA will assist these agencies with investigations.

What Other Activities Is the EPA Participating in to Promote Awareness and Education of Spray Drift Issues?
For the past few years, the EPA has been actively working together with other Federal and state agencies and tribes, pesticide and application equipment manufacturers, applicators, university scientists, and others (National Coalition on Drift Minimization) on many spray drift issues.

Coalition members, including the EPA, have focused attention on enhancing pesticide applicator education, application research, and regulatory initiatives to foster reductions in drift incidents. Members of the Coalition have produced and widely disseminated training and educational materials for applicators, assisted with development of improved pesticide product label directions for drift reduction, and promoted common awareness and understanding of technical and regulatory issues regarding spray drift.

Additional Warnings

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.

DROMADER

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.

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.

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.

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.

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 advise on field headland and boundary management and they can assist with local environmental risk assessment when a pesticide is to be used.

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.

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.

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.

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 the pilot 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.

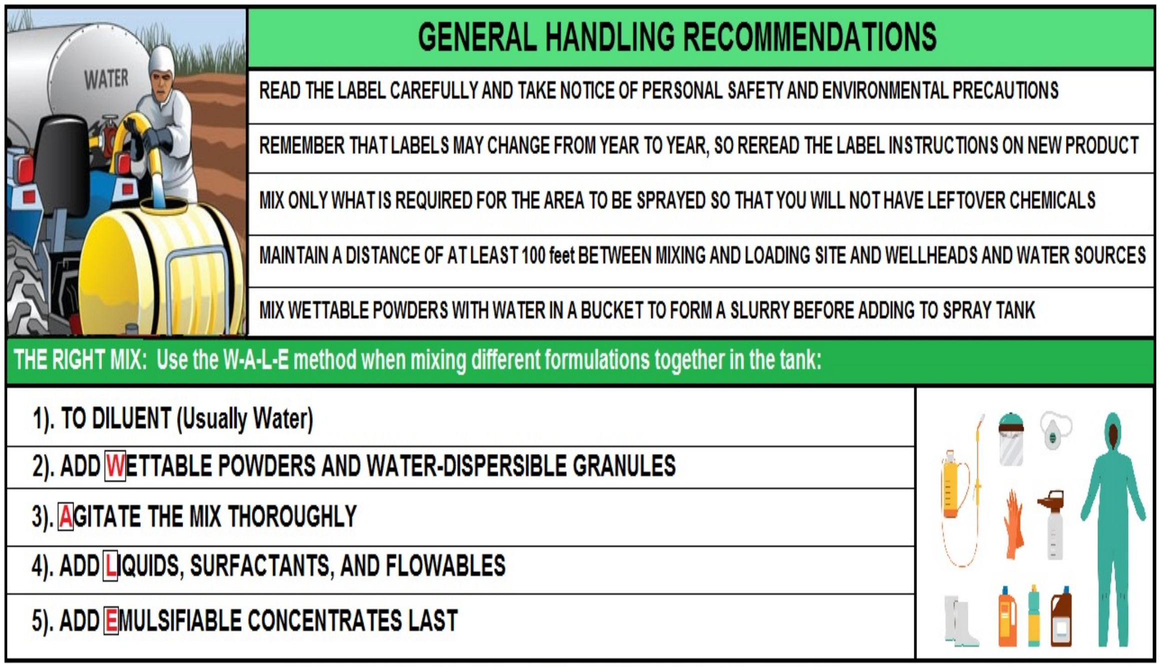
Chemical Container Handling

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



PESTICIDE MIXING AND LOADING CHECKLIST

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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.

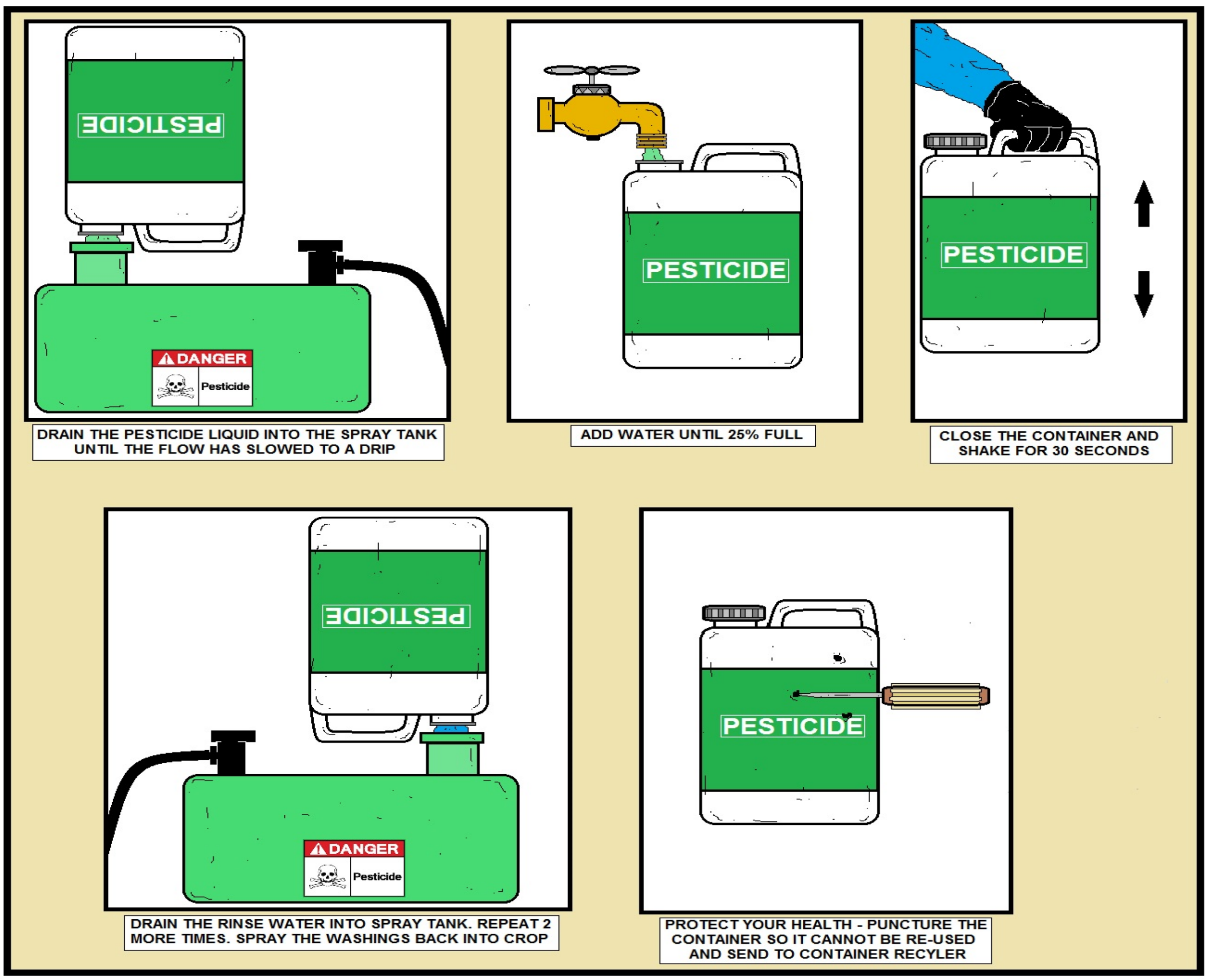
Disposal of Surplus Spray
Pesticide waste can be divided into surplus diluted spray solution and surplus concentrate material. Contaminated safety equipment, protective clothing, cockpit filter elements and material used to absorb spills all have to be correctly disposed of. Pre-planning the spray operation 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.



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PROPER DISPOSAL OF PESTICIDE CONTAINERS

Pesticide Container and Containment Rule

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.

CATEGORY	NONREFILLABLE CONTAINERS	REFILLABLE CONTAINERS	REPACKING PESTICIDE PRODUCTS	CONTAINER LABELING	CONTAINMENT STRUCTURES
WHO MUST COMPLY	REGISTRANTS	REGISTRANTS REFILLERS (Retailers, Distributors)	REGISTRANTS REFILLERS (Retailers, Distributors)	REGISTRANTS PESTICIDE USERS (Must Follow New Directions)	AG RETAILERS AG COMMERCIAL APPLICATORS AG CUSTOM BLENDERS
MAJOR REQUIREMENTS	• DOT CONTAINER DESIGN, CONSTRUCTION AND MARKING STANDARDS • CONTAINER DISPENSING CAPABILITY • STANDARD CLOSURES • RESIDUAL REMOVAL • RECORDKEEPING	• DOT CONTAINER DESIGN, CONSTRUCTION AND MARKING STANDARDS • SERIAL NUMBER MARKING • ONE-WAY VALVES OR TAMPER-EVIDENT DEVICES • STANDARD CONTAINER REQUIREMENTS	• DOT CONTAINER DESIGN, CONSTRUCTION AND MARKING STANDARDS • SERIAL NUMBER MARKING • ONE-WAY VALVES OR TAMPER-EVIDENT DEVICES • STANDARD CONTAINER REQUIREMENTS	• IDENTIFY CONTAINER AS NONREFILLABLE OR FILLABLE (All) • STATEMENTS TO PROHIBIT REUSE AND OFFER FOR RECYCLING; BATCH CODE (All Nonrefillables) • CLEANING INSTRUCTIONS • CLEANING INSTRUCTONS BEFORE FINAL DISPOSAL	• SECONDARY CONTAINMENT STRUCTURES (Dikes) AROUND STATIONARY TANKS • CONTAINMENT PADS FOR PESTICIDE DISPENSING AREAS • GOOD OPERATING PROCEDURES • MONTHLY INSPECTION OF TANKS AND STRUCTURES • RECORDKEEPING
COMPLIANCE DATE	AUGUST 17, 2009	AUGUST 17, 2011	AUGUST 17, 2011	AUGUST 16, 2011 (Based on the October 8, 2010 Final Rule)	AUGUST 17, 2009

PESTICIDE CONTAINER AND CONTAINMENT RULE

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EPA's final regulations, "Standards for Pesticide Containers and Containment" were published on 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.

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.

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.

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.

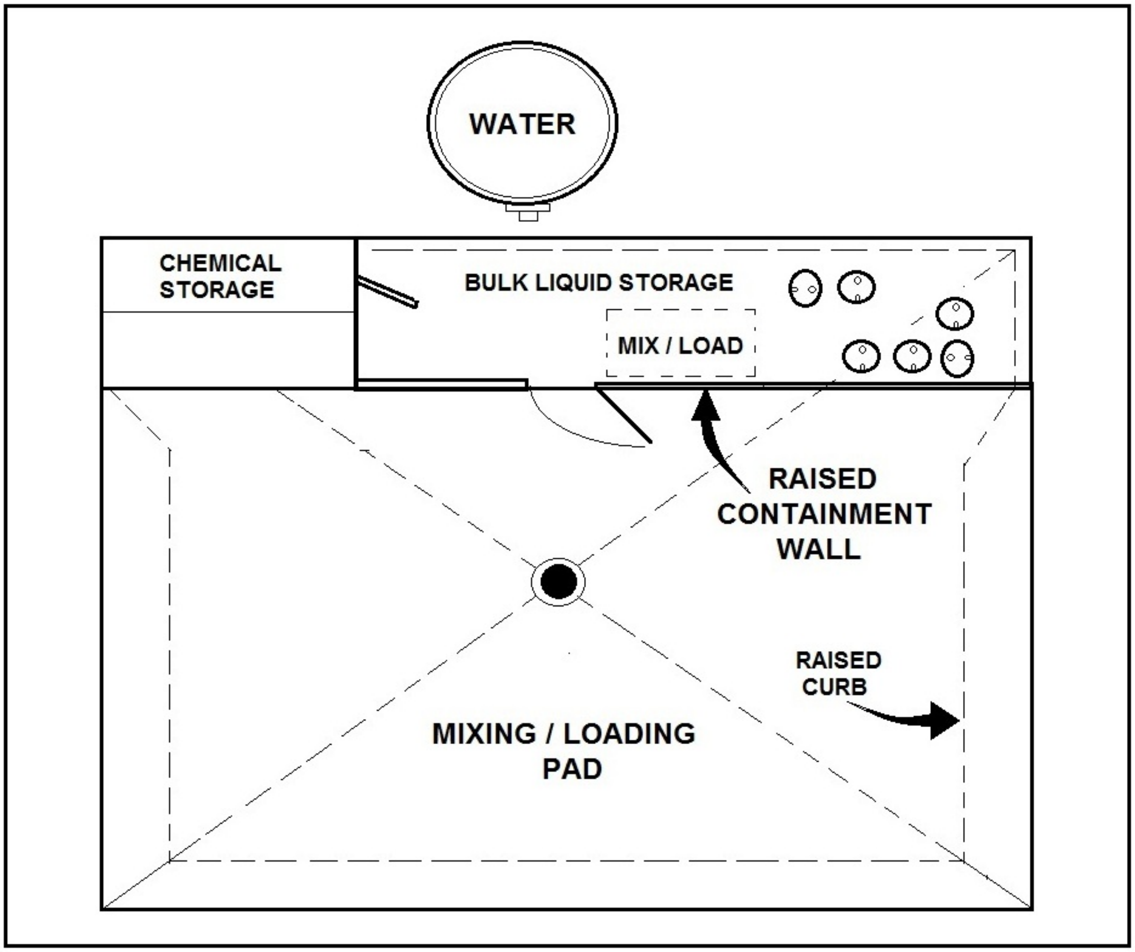
Labeling: The labeling segment includes instructions for how to properly clean pesticide containers and a statement identifying the container as non-refillable or refillable. Pesticide registrants are required to ensure that labels include the specified information. Pesticide users are required to comply with the instructions on the labels.

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.



PESTICIDE STORING AND MIXING AREA

Managing Empty Pesticide Containers

- Remove the cap. Rinse the cap into the spray tank.
- Dispose of the cap separately.
- Rinse the container immediately after emptying.
- Drain rinsate into the spray tank.
- Store the rinsed containers in a dry area.
- 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:

- 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.

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.

Secure the lid on the container.

Shake small containers or roll and tumble large containers to get rinse on all interior surfaces.

Remove the lid from the container. Drain the rinsate from the container into the spray tank.

Continue draining 30 seconds after drops start.

Repeat steps 2 through 5 two more times.

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.

Remove cover from the container. Empty the pesticide into the spray tank and let the container drain for 30 seconds after drops start.

Insert the pressure rinse nozzle by puncturing through the lower side of the pesticide container.

Hold the container upside down over the sprayer tank opening so rinsate will run into the sprayer tank.

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.

Rinse the container lid separately in a bucket of water and pour this rinse water into the spray tank.

Put the lid back on the container and dispose of according to the label directions.

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.

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.

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.

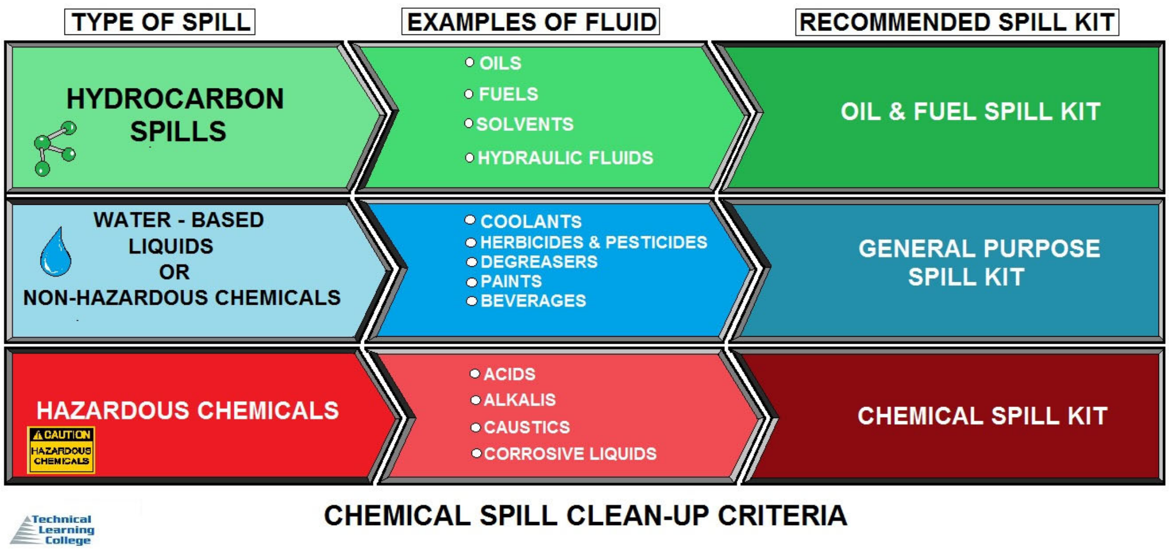
All electrical components of the spraying system should be checked, and couplings sealed for storage when units such as navigation aids and spray monitoring equipment are removed for storage. When new components are fitted to the spray system or existing ones repaired, work carried out must be recorded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

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.



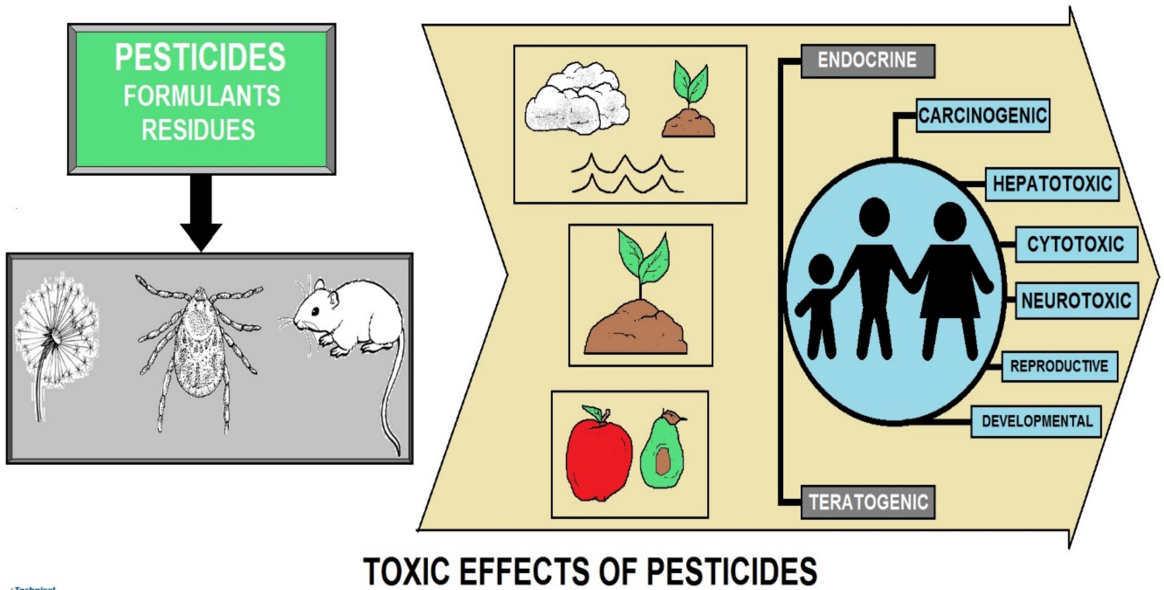
CHEMICAL SPILL CLEAN-UP CRITERIA

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.

Use of Existing Structures

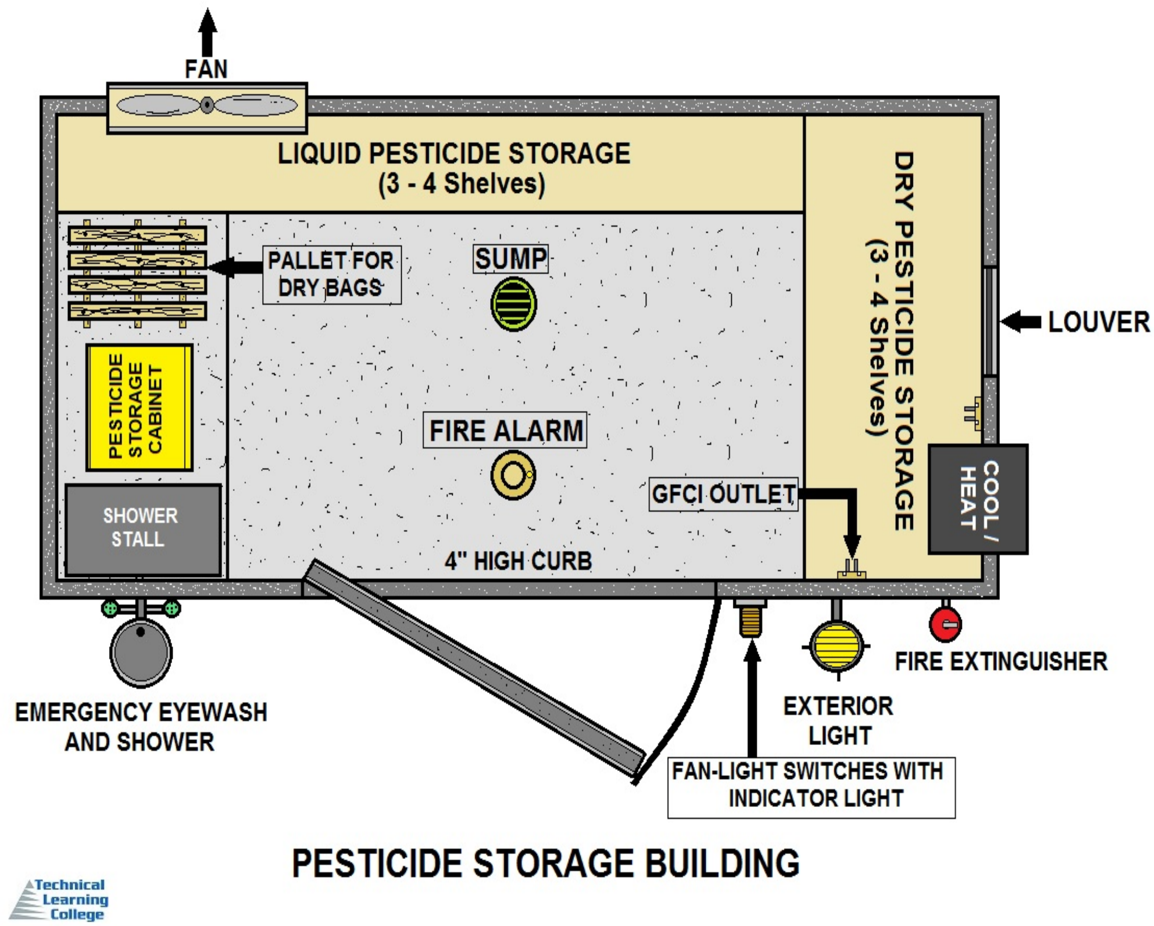
Small quantities of pesticides may be stored in a separate enclosure within an existing building, constructed of fire-resistant material and having a smooth-finished concrete floor. It is recommended this enclosure be on the first floor. All pesticides must be stored away from food, animal feed, seed, 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.

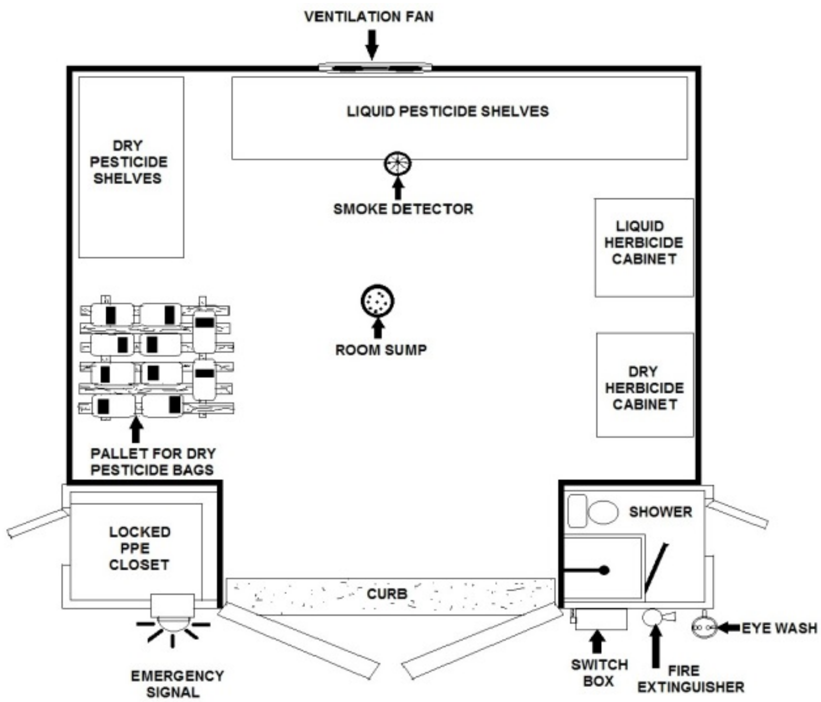
The Federal Resource Conservation and Recovery Act (RCRA) addresses the problem related to storage and disposal of hazardous wastes including pesticides. Special anti-leak precautions for storage tanks must be followed if more than 10% of their volume is buried. Keeping pesticide storage tanks and pipes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

Pesticide Storage Shed
Within the storage shed the different groups of pesticides (herbicide, insecticide, fungicide, rodenticide, etc.) must be kept separate to prevent accidental use and contamination of the different chemical groups. Metal shelves are advisable when storing these pesticides because they are much easier to decontaminate than wooden shelves. Place shelves, pallets and drums along the walls of the shed; the center must be kept clear to allow access and escape. It is important that very toxic pesticides with the signal word **DANGER POISON** be stored in a separate enclosure within the storage shed. This enclosure must be kept locked at all times except when this pesticide is being used. Vents should be built into the special enclosure to prevent toxic dust and vapor buildup.

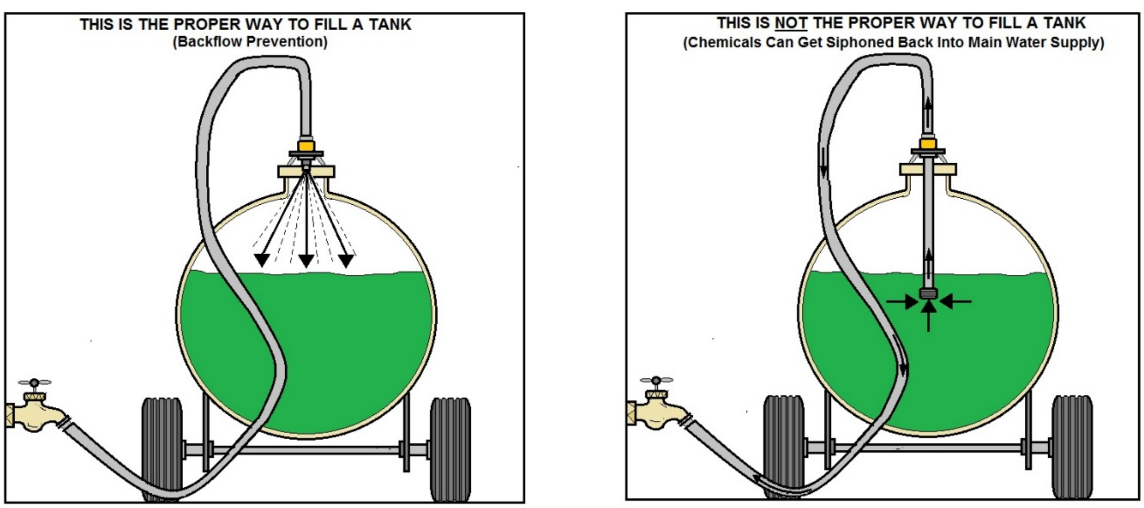
Preventing health or environmental contamination problems from occurring by careful and proper storage is the cheapest way of handling pesticide storage. In summary, keep the following points in mind when using the storage shed:

1. Keep the storage area free of unlabeled and empty containers.
2. Dispose of all containers in accordance with manufacturer’s directions.
3. Keep only enough pesticide for immediate use.
4. Keep only pesticides and application equipment in the storage area.
5. Total decontamination of the storage shed is virtually impossible; therefore, never use the shed for any other type of storage or as an animal shelter.
6. Never remove containers with pesticides from the secured storage area except when returning them to the dealer or manufacturer.
7. Always keep the pesticide storage shed secured when left unattended.



PESTICIDE STORAGE BUILDING

Pesticides by their very nature may be hazardous to those who work with or around them. Proper storage can greatly reduce the possibility of accidental exposure; therefore, take the time to evaluate your needs and plan accordingly.



PROTECTING WATER SOURCES FROM BACKSIPHON OF PESTICIDES

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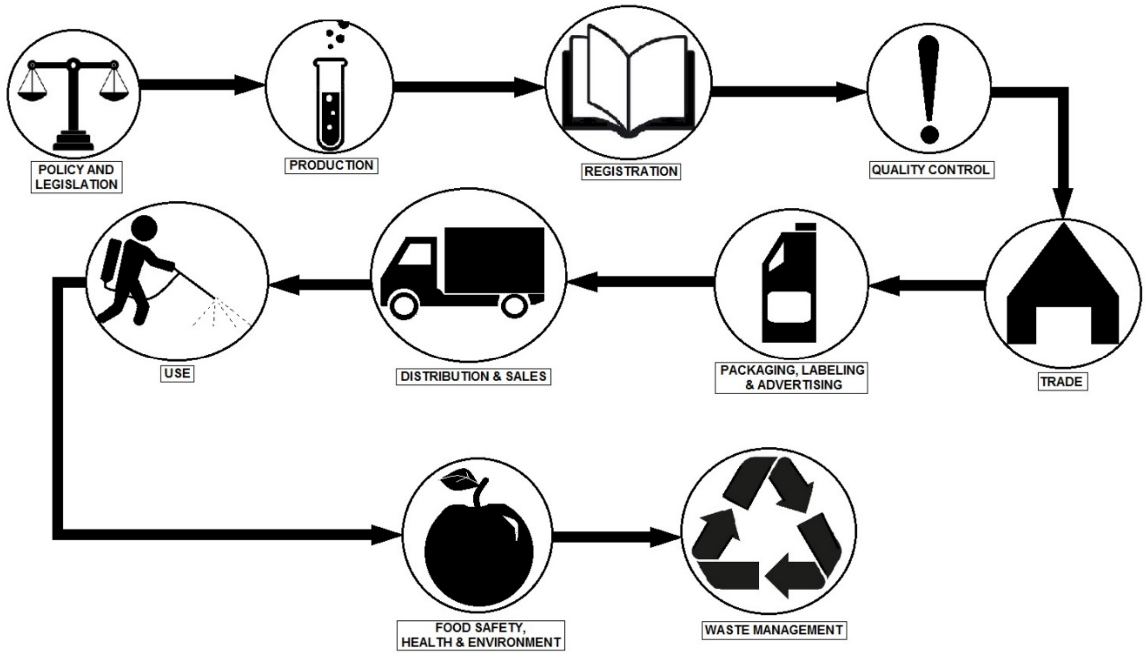


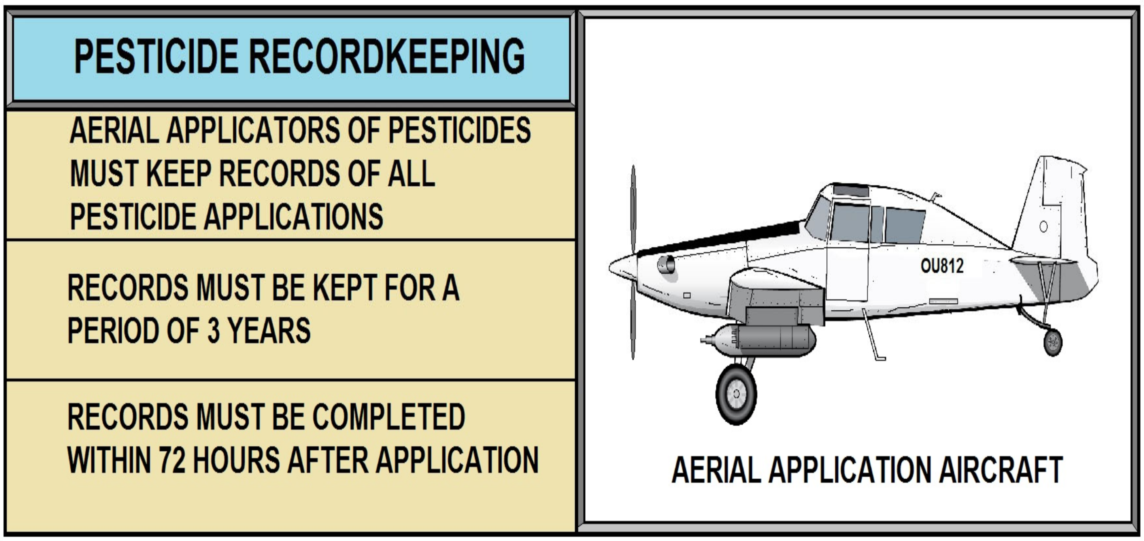
PESTICIDE MANAGEMENT (New & Current)

PESTICIDE USED	25 GALLON SOLUTION	DIRECTIONS
2, 4-D AMINE DICAMBA, BANVEL / CLARITY	1 - QT. HOUSEHOLD AMMONIA + DETERGENT SOLUTION FOR RINSE	AGITATE, FLUSH SOME AND LET SET OVER NIGHT. FLUSH AND RINSE.
2, 4-D ESTER BRUSH KILLERS	1 - lb. WASHING SODA + 1 - gal. OF KEROSENE + 1/4 lb. OF POWDER OR LIQUID DETERGENT	RINSE INSIDE OF TANK AND FLUSH SOME THROUGH THE SPRAYER. LET SET FOR 2 HOURS. FLUSH AND RINSE
SULFONYLUREA HERBICIDES	1 - gal / 50 gal WATER HOUSEHOLD AMMONIA + DETERGENT SOLUTION FOR RINSE	AGITATE, FLUSH SOME AND LET SET OVER NIGHT. FLUSH AND RINSE
OTHER HERBICIDES, INSECTICIDES, AND / OR FUNGICIDES	1/4 lb. OF OR LIQUID DETERGENT	AGITATE, FLUSH, AND RINSE

GENERAL CLEANING INSTRUCTIONS FOR AGRICULTURAL CHEMICALS

Record-keeping Review

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.



PESTICIDE RECORDKEEPING REQUIREMENTS FOR APPLICATORS

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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.

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.

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:

- ✓ "No-spray" barrier information
- ✓ Adjacent crops
- ✓ Adjuvants used
- ✓ Aircraft loading information
- ✓ Aircraft type and registration
- ✓ Application date and time
- ✓ Applicator, worker or handler exposure times
- ✓ Crop, growth stage
- ✓ Field marking method
- ✓ Field number, size and location (map reference)
- ✓ Hectares sprayed
- ✓ Lost time information
- ✓ Meteorological conditions at application
- ✓ Pilots name
- ✓ PPE used and applicator, worker or handler monitoring
- ✓ Product and dose rate
- ✓ Start and finish time
- ✓ Tank-mix information
- ✓ Target pest and growth stage
- ✓ Total amount of product used
- ✓ Water volume used

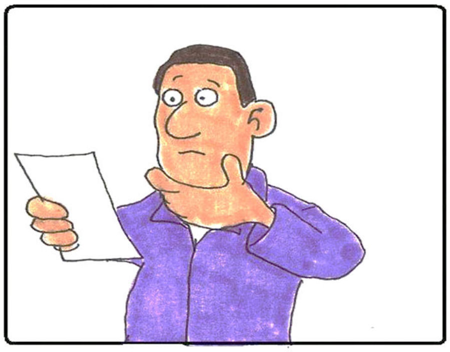
Applicator, Worker or Handler Health Surveillance

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 Safety Sub-Section

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.



READ THE SAFETY DATA SHEET

WEAR PROPER PPE

HANDLING CHEMICALS

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.

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 (mitosis) 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 occurs, 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

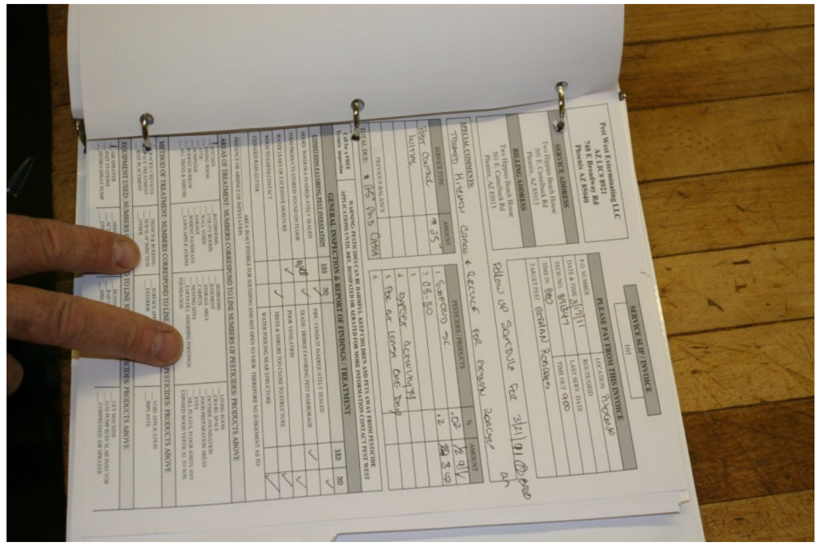
The handling of very toxic pesticides, sometimes in concentrated forms, necessitates the wearing of proper protective clothing. Puddles of pesticide spilled in the mixing or loading area can penetrate improper footwear. Only liquid-proof or rubber boots should be worn.

Aerial Application Check List

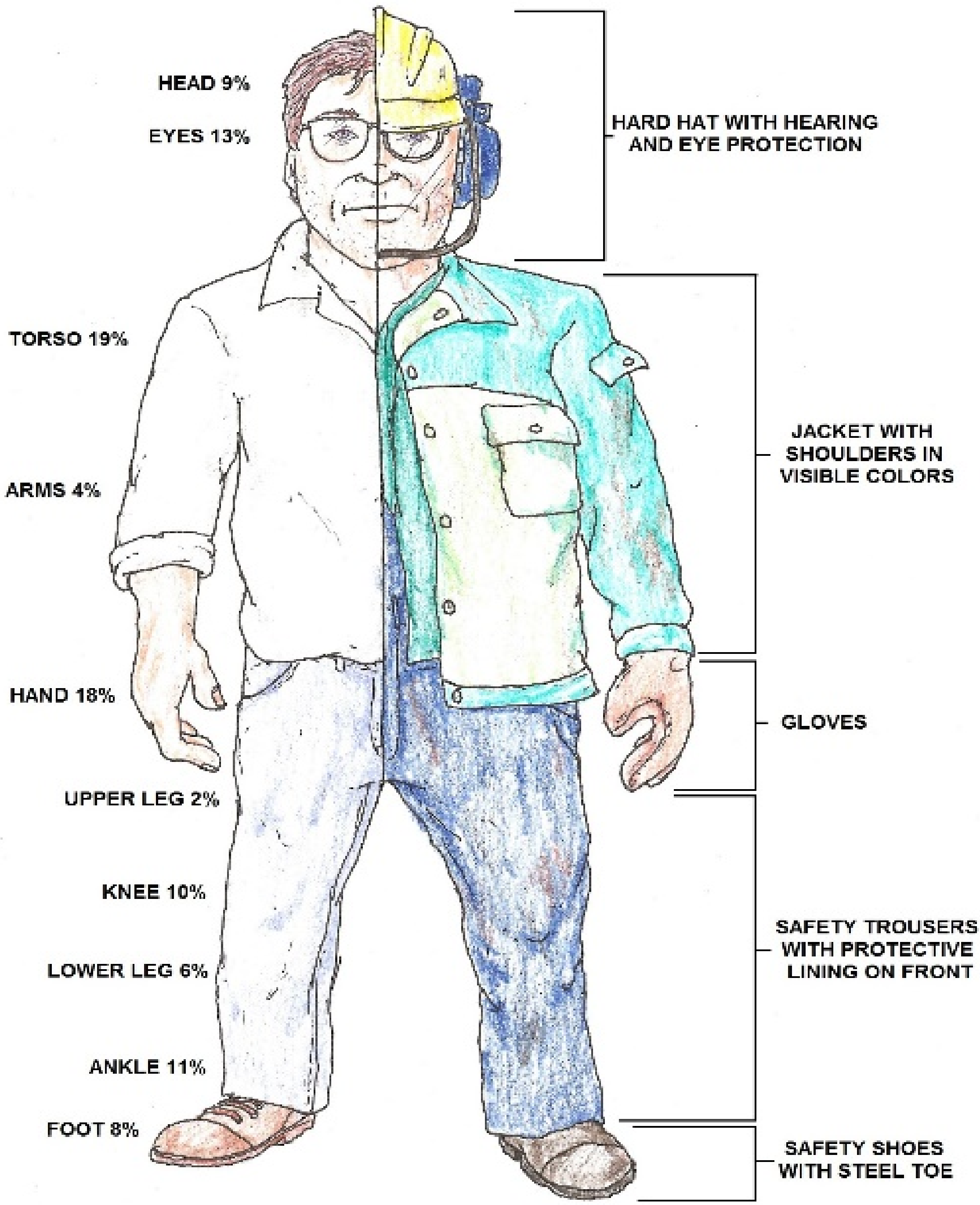
It is suggested that pilots and crew, including flagmen, review a check list at least weekly. It is easy to become complacent and careless.

Pilot Check List

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



- ✓ The pilot should not load or handle highly toxic pesticides during any operation, especially hazardous formulations.
- ✓ Engines should be shut off during loading operations.
- ✓ Hard helmets with pesticide respirators should be worn in flight.
- ✓ 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.
- ✓ Do not fly through the drift of an application.
- ✓ Stop treatments if winds rise and create a drift hazard.
- ✓ Do not turn on dispersal equipment or check the flow rate except in the area to be treated.
- ✓ 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.
- ✓ Read the label yourself and know the hazardous characteristics of the pesticide.
- ✓ Know how far and in what direction the chemical will drift.
- ✓ Do not spray or dust over flagmen.
- ✓ 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.



PERSONAL PROTECTIVE EQUIPMENT CONTAMINATION PERCENTAGE DIAGRAM

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.

- ✓ Change clothing after washing aircraft and contaminated equipment.
- ✓ Cover the hopper as soon as loading is completed.
- ✓ Do not stand in or allow runoff water to splash on you.
- ✓ Remove any chemical spilled near the fill opening.
- ✓ Tanks and hoppers should be tightly sealed so chemicals will not blow back over pilot.
- ✓ The aircraft, especially the cockpit, should be cleaned frequently.

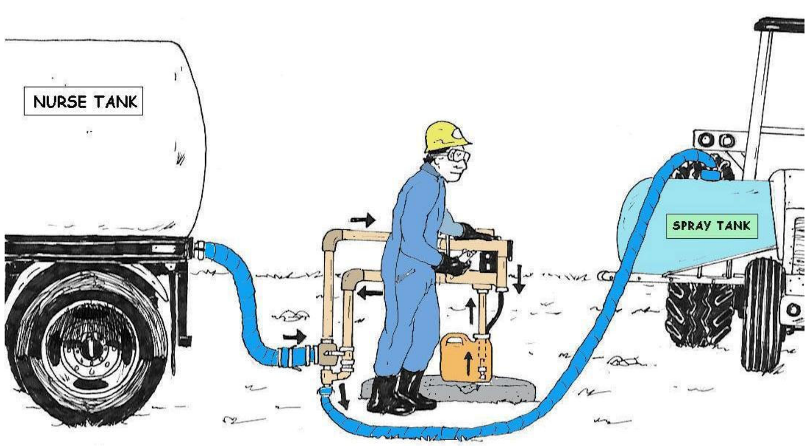
When cleaning aircraft or other equipment, use extreme care and wear protective clothing.

Flagman Check List

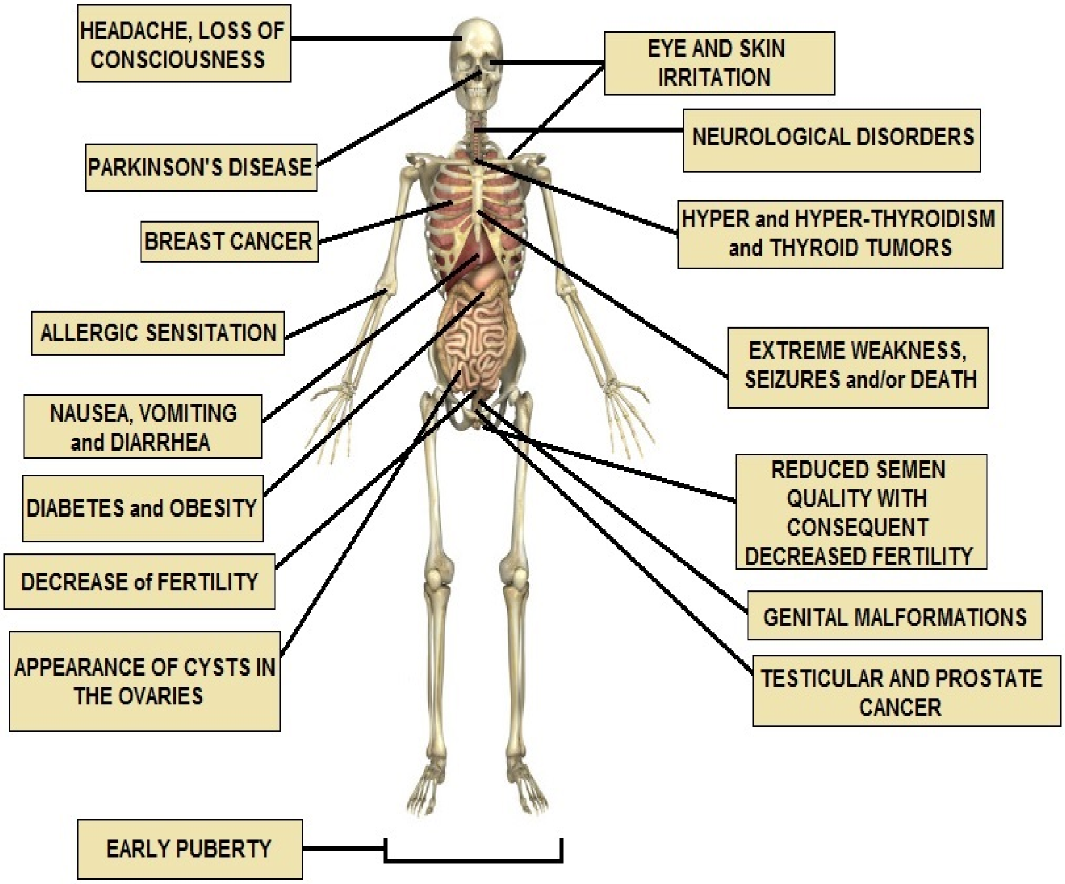
Where flagmen are used, they should do the following ***BEFORE, DURING*** and ***AFTER*** any application. A flagman should also be familiar with the pilot's check list. If the farmer is to assist the flagman, be sure the flagman is familiar with this check list.

When the flagman arrives at the field to be treated, they 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.

- ✓ Avoid as much spray or dust as possible.
- ✓ Wear the appropriate protective equipment for the pesticide being applied.
- ✓ 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***.
- ✓ Stay at the field until the pilot has completed the job. If there is an accident, you may be able to help the pilot.
- ✓ 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.
- ✓ 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 to do.



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TOXIC IMPACT OF PESTICIDES ON HUMAN BODY

	GLOVES	HARD HAT	APRON	COVERALLS	RESPIRATOR	FOOTWEAR	PROTECTIVE EYEWEAR
MIXING / LOADING	CHEMICAL RESISTANT	NO	NO	YES + LONG SLEEVED SHIRT / LONG PANTS	NO	SHOES + SOCKS	NO
ENCLOSED CAB	NO	NO	NO	NO	NO	SHOES + SOCKS	NO
OPEN CAB	CHEMICAL RESISTANT	NO	NO	YES + LONG SLEEVED SHIRT / LONG PANTS	NO	SHOES + SOCKS	NO
CLEANOUT	CHEMICAL RESISTANT	NO	NO	YES + LONG SLEEVED SHIRT / LONG PANTS	NO	SHOES + SOCKS	NO

PESTICIDE HANDLING SAFETY REFERENCE (PPE)

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Buffer Zone Summary

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.

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. Some closed transfer systems can empty and rinse chemical containers automatically and can eliminate the need for rinsing empty containers and the disposal of the contaminated water.

Topic 5 - Pesticide Drift Control and Training Requirement Post Quiz

Answers are after the Glossary in rear
Fill in the blank

The EPA defines spray or dust drift as:
1. Spray drift shall not include movement of pesticides to non- or off-target sites caused by erosion, migration, volatility, or windblown soil particles that occurs after application or application of fumigants unless ___________with respect to drift control requirements.

Pesticide Residues
2. Pesticide residues are usually measured, and tolerances expressed in parts per million (ppm) to parts per billion (ppb) on_________.

Understanding the Dangers of Drift
3. The use of surfactants tends to lower the surface tension of a spray solution and usually results in a __________than when the same formulation is used without a surfactant.

Vapor Drift (Volatilization)
4. Vapor drift can be avoided by simply refraining from the use of_______________.

Chemical Control in an IPM Program
5. The traditional approach of applying pesticides routinely or at the first sign of any crop pest is replaced with a philosophy that seeks to optimize crop growth and allow natural enemies of pests the opportunity to_____________.

Biological Pesticides
6. Examples of biological pesticides include bacteria, fungi,_____________________.

Bowen's Disease
7. Crop dusting involving _____________has been implicated in Bowen's disease.

Sprayer Field Settings
8. 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, the pilot may only occasionally check the__________________.

9. 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__________________________.

Equipment Storage

10. Both the spray equipment and the aircraft must be thoroughly cleaned ("_______________") and dried, before being stored. Aircraft storage will depend on local regulations, but the aircraft should be stored under cover and be fully secure.

Topic 6 - Complications/ Limitations / Risk

Specific Aerial Pesticide Application Fundamentals Section

Please check with your State Pesticide Agency for more information.

Section Focus: You will learn the specifics of pesticide complications, limitations and risks of pesticides. At the end of this section, you will be able to describe pesticide and chemical applications and safety procedures. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: Specific restrictions may include prohibiting the use of certain pesticides under certain conditions, prohibiting certain methods of application, requiring use of a foliage barrier, or requiring a buffer zone distance between the site of application and areas to be protected. In general, applicators must use all available drift prevention practices in order to prevent drift. During the past few years, the OPP has received and reviewed new studies on spray drift that it required from pesticide registrants to support their product registrations. The OPP has completed its review of these studies and reached conclusions about the factors that influence drift and the amounts of sprays which can drift from the application site.

LOADING RICE

Rice Applications
Granular Molinate, Thiobencarb and Carbofuran

- Granular molinate, thiobencarb, or carbofuran drifting into waterways (i.e., drainage canals) or onto levees or roadways adjacent to waterways will be considered environmental contamination. Applicators found in violation will be liable for a civil penalty.
- Granular molinate, thiobencarb, or carbofuran *shall not* be applied by air if wind speed is greater than seven miles per hour to avoid drift into drainage canals and ditches.

Liquid Thiobencarb (Abolish)
Aerial Applications
No aerial applications of liquid formulations of thiobencarb to rice shall be:

- ✓ Discharged more than ten feet above the crop or target. Discharge shall be shut off whenever it is necessary to raise the equipment over obstacles such as trees or poles.
- ✓ Applied when wind velocity is more than seven miles per hour.

Applied by aircraft except as follows:
The flow of liquid to aircraft nozzles shall be controlled by a positive shutoff system as follows:

- ✓ Each individual nozzle shall be equipped with a check valve and the flow controlled by suck back device or a boom pressure release device; or
- ✓ Each individual nozzle shall be equipped with a positive action valve.
- ✓ Aircraft nozzles shall not be equipped with any device or mechanism which would cause a sheet, cone, fan, or similar type dispersion of the discharged material except as otherwise provided.
- ✓ Aircraft boom pressure shall not exceed 40 pounds per square inch.
- ✓ Aircraft nozzles shall be equipped with orifices directed backward parallel to the horizontal axis of the aircraft in flight.
- ✓ Fixed wing aircraft and helicopters operating in excess of 60 miles per hour shall be equipped with jet nozzles having an orifice of not less than 1/16-inch diameter.
- ✓ Working boom length on fixed wing aircraft shall not exceed 3/4 of the wing span; the working boom length of helicopters shall not exceed 6/7 of the total rotor length or 3/4 of the total rotor where the rotor length exceeds 40 feet.

Helicopters operating at 60 miles per hour or less shall be equipped with:

- ✓ Nozzles having an orifice not less than 1/16 inch in diameter. A number 46 (or equivalent) or larger whirlplate may be used; or
- ✓ Fan nozzles with a fan angle number not larger than 80 degrees and a flow rate not less than one gallon per minute at 40 pounds per square inch pressure (or equivalent).
- ✓ Special precautions should be taken to avoid off-site deposition of liquid formulations of pesticides when applications are made adjacent to agricultural drains.

Ground Applications - ground applications of liquid thiobencarb must be applied as per label instructions.

Methyl Parathion
Aerial Applications
No aerial applications of liquid formulations of methyl parathion to rice shall be:

- ✓ Discharged more than ten feet above the crop or target. Discharge shall be shut off whenever it is necessary to raise the equipment over obstacles such as trees or poles.
- ✓ Applied within a 300-foot downwind buffer zone from any agricultural drain.
- ✓ Applied when wind velocity is more than five miles per hour.
- ✓ Applied without an effective drift control agent.

Applied by aircraft except as follows:

- ✓ The flow of liquid to aircraft nozzles shall be controlled by a positive shutoff system as follows:
- ✓ Each individual nozzle shall be equipped with a check valve and the flow controlled by suck back device or a boom pressure release device; or
- ✓ Each individual nozzle shall be equipped with a positive action valve.
- ✓ Aircraft nozzles shall not be equipped with any device or mechanism which would cause a sheet, cone, fan, or similar type dispersion of the discharged material except as otherwise provided.
- ✓ Aircraft boom pressure shall not exceed 40 pounds per square inch.
- ✓ Aircraft nozzles shall be equipped with orifices directed backward parallel to the horizontal axis of the aircraft in flight.
- ✓ Fixed wing aircraft and helicopters operating in excess of 60 miles per hour shall be equipped with jet nozzles having an orifice of not less than 1/8-inch diameter.
- ✓ Working boom length on fixed wing aircraft shall not exceed 3/4 of the wing span; the working boom length of helicopters shall not exceed 6/7 of the total rotor length or 3/4 of the total rotor where the rotor length exceeds 40 feet.

Helicopters operating at 60 miles per hour or less shall be equipped with:

- ✓ Nozzles having an orifice not less than 1/8 inch in diameter. A number 46 (or equivalent) or larger whirlplate may be used; or
- ✓ Fan nozzles with a fan angle number not larger than 80 degrees and a flow rate not less than one gallon per minute at 40 pounds per square inch pressure (or equivalent).
- ✓ Special precautions should be taken to avoid off-site deposition of liquid formulations of pesticides when applications are made adjacent to agricultural drains.

Ground Applications - ground equipment other than handguns shall be equipped with:

- ✓ Nozzles having an orifice not less than 1/16 inch in diameter or equivalent, and operated at a boom pressure not to exceed 30 pounds per square inch; or
- ✓ Low pressure fan nozzles with a fan angle number not larger than 80 degrees and fan nozzle orifice not smaller than 0.2 gallon per minute flow rate or equivalent and operated at a boom pressure not to exceed 15 pounds per square inch.

Malathion

No aerial applications of liquid formulations of Malathion to rice shall be:

- ✓ Discharged more than ten feet above the crop or target. Discharge shall be shut off whenever it is necessary to raise the equipment over obstacles such as trees or poles.
- ✓ Applied when wind velocity is more than seven miles per hour.

Applied by aircraft except as follows:

The flow of liquid to aircraft nozzles shall be controlled by a positive shutoff system as follows:

- ✓ Each individual nozzle shall be equipped with a check valve and the flow controlled by suck back device or a boom pressure release device; or
- ✓ Each individual nozzle shall be equipped with a positive action valve.
- ✓ Aircraft nozzles shall not be equipped with any device or mechanism which would cause a sheet, cone, fan, or similar type dispersion of the discharged material except as otherwise provided.
- ✓ Aircraft boom pressure shall not exceed 40 pounds per square inch.
- ✓ Aircraft nozzles shall be equipped with orifices directed backward parallel to the horizontal axis of the aircraft in flight.
- ✓ Fixed wing aircraft and helicopters operating in excess of 60 miles per hour shall be equipped with jet nozzles having an orifice of not less than 1/16-inch diameter.
- ✓ Working boom length on fixed wing aircraft shall not exceed 3/4 of the wing span; the working boom length of the helicopters shall not exceed 6/7 of the total rotor length or 3/4 or the total rotor where the rotor length exceeds 40 feet.

Helicopters operating at 60 miles per hour or less shall be equipped with:

- ✓ Nozzles having an orifice not less than 1/16 inch in diameter. A number 46 or equivalent) or larger whirlplate may be used; or
- ✓ Fan nozzles with a fan angle number not larger than 80 degrees and a flow rate not less than one gallon per minute at 40 pounds per square inch pressure (or equivalent).

Special precautions should be taken to avoid off-site deposition of liquid formulations of pesticides when applications are made adjacent to agricultural drains.

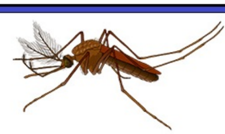
Aerial Application of Adulticides for Controlling Mosquitoes

Spraying of chemicals from aircraft is a method of mosquito control involving the application of chemicals over an area, usually a large area, to kill adult mosquitoes by direct contact.

Before an aerial application of adulticides is carried out, it is important to assess fully the rational for carrying out the application, with due consideration of the potential risks (environmental and public health) involved in relatively wide-scale application of insecticides and the potential benefits in preventing human (and horse) illness.

- ✓ Prior to the start of aerial spraying, it is necessary to determine the area over which the adulticide is to be applied, the chemical to be used and the time at which the application is to be carried out for maximum efficacy.
- ✓ Maps are required which delineate both possible target areas and areas where application should be avoided.
- ✓ Rotary wing or fixed-wing aircraft may be used.
- ✓ Small amounts of insecticide are usually applied as an Ultra-Low-Volume spray.
- ✓ Organophosphates, pyrethrins or pyrethroid-based insecticides may be used.

Culex pipiens is a serious pest, called the "*house mosquito*" because it commonly develops in small containers around the home. It shows great skill in finding ways to get into the house, where it feeds on the occupants at night. It also occurs in containers and sumps on farms and industrial plants, in polluted waters, and will feed out-of-doors at night.



MALE MOSQUITO	FEMALE MOSQUITO
USUALLY LIVE FOR ONE TO TWO WEEKS	USUALLY LIVE FOR A FEW DAYS
HAVE BUSHY PROBOSCISES	HAVE SMOOTHER AND NEEDLE-LIKE PROBOSCISES
HAVE FEATHER-LIKE HAIR ON THEIR ANTENNAE	DOES NOT HAVE FEATHER-LIKE HAIR ON THEIR ANTENNAE
OFTEN QUITE SMALLER	OFTEN BIGGER
SUCK FRUIT AND NECTAR JUICE	SUCK BLOOD, NECTAR AND FRUIT JUICE
TEND TO HATCH EARLY	TEND TO HATCH LATER
DOES NOT CARRY DISEASES	CARRY DISEASES
BUZZ AT A LOWER PITCH	BUZZ AT A HIGHER PITCH
TEND TO STAY AWAY FROM HUMANS	MORE PROXIMAL TO HUMANS
PRIMARY ROLE IS TO CARRY SPERM	ROLES ARE TO MATE AND CARRY, FERTILIZE & LAY EGGS
CAN MATE MANY TIMES	MATES ONLY ONCE
LESS LIKELY TO TAKE OFF IN RESPONSE TO INSECT REPELLENTS	LIKELY TO TAKE OFF IN RESPONSE TO INSECT REPELLENTS

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MALE / FEMALE MOSQUITO COMPARISON

Application may be repeated as required: "Two to three adulticide applications spaced 3-4 days apart may be required to significantly reduce Culex pipiens [Culex pipiens complex - Northern house mosquito] populations."

Aerial application usually occurs as soon after dawn as possible as Culex spp. are still active at this time and the wind is generally least strong, increasing efficiency of application. Following the application of adulticides, surveillance is carried out in order to assess the effectiveness of control.

Appropriate Use
The goal of adulticide use is reduction in the risk of human disease by decreasing as far as possible the number of infected adult vector mosquitoes in an area.

- ✓ Adulticiding should be used as a supplement to other methods of mosquito control: source reduction, larviciding and the use of personal protective measures.

"Adulticiding based on surveillance data is an extremely important part of any integrated mosquito management program" and aerial application is one part of such a program.

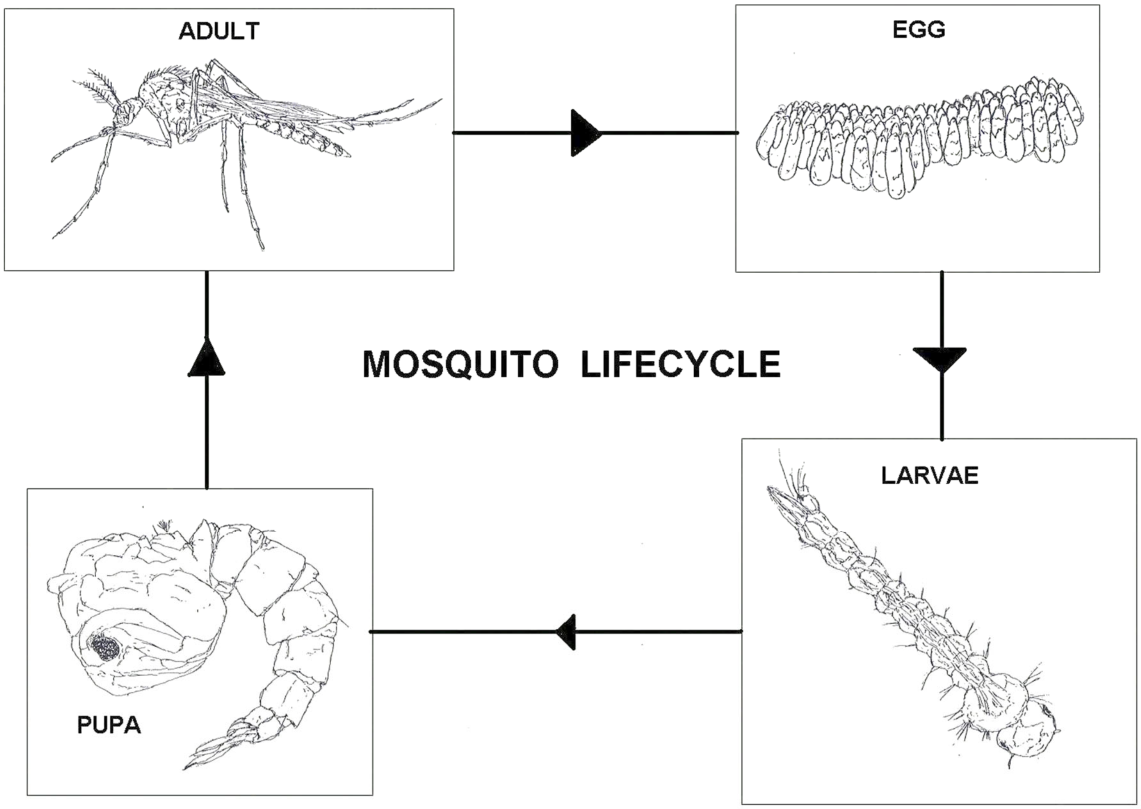
- ✓ The use of adulticides should be considered only when there is evidence from surveillance programs of enzootic WN virus at a level suggesting a high risk of human infection and also the presence of abundant adult mosquito vectors.
- ✓ The purpose of the application of adulticides is to prevent human disease by interrupting the enzootic transmission cycle or by preventing transmission to humans and domestic animals.
- ✓ The use of adulticides is most likely to be considered appropriate in areas of high human population density.
- ✓ Use in areas of low human density may be appropriate if other vertebrates such as horses are at high risk.
- ✓ Aerial spraying is appropriate for application of adulticide chemicals over large areas in a short period of time.
- ✓ "Aerial application is less prone to patchy coverage than ground-based application in areas where road coverage is not adequate."
- ✓ It is important to time the application of adulticides to match the peak activity periods of the target species.
- ✓ "Aerial spraying should be used only when necessary, because of geographic considerations and should be limited to the immediate area where the vector population has been documented to exist through vector surveillance and to adjacent areas considered at risk for imminent disease transmission."
- ✓ ”Control of adult mosquito populations using adulticides is usually reserved as a last resort".

Notes
"The EPA has determined that the insecticides labeled nationally for this type of application pose minimum risks to human health and the environment when used according to the label. Adulticides labeled for mosquito control include several organophosphates such as Malathion and naled.

Some natural pyrethrins, synthetic pyrethroids (permethrin, resmethrin and sumithrin) also hold adulticide labels." Consideration should be given when using adulticides to the potential development of resistance and ways in which the onset of resistance may be prevented.

The views of local communities regarding the potential risks and benefits of insecticide use should be considered in decisions regarding whether or not adulticides should be applied in a given area. It is important to remember that different sectors of the population may hold strong, widely divergent, views on this topic. Accurate guidance, using simple methods such as flags on poles or more sophisticated methods such as GPS, produces more efficient and effective dispersal of adulticides.

Adulticides Complications/ Limitations / Risk



"Mosquito adulticides should be considered the least desirable method of control and only used when current isolations of virus and/or evidence of disease have been established."

- ✓ "If adulticides are used, either by land or aerial application, people may be exposed to them. Pesticide exposure carries some inherent risk to people."
- ✓ Adulticiding is typically less effective and less target-specific than larviciding. "Adulticiding, the application of chemicals to kill adult mosquitoes by ground or aerial applications, is usually the least efficient mosquito control technique."
- ✓ "For adult mosquito control, insecticide must drift through the habitat in which mosquitoes are flying in order to provide optimal control benefits."
- ✓ Most Culex spp. mosquitoes are nocturnal; since many applicators will not fly at night, this reduces the effectiveness of airborne applications in control efforts aimed at Culex species.
- ✓ Effectiveness can be assessed only if appropriate mosquito surveillance systems are in place to allow comparison of mosquito populations before and after the application.

Culex pipiens provides the life cycle model for most of the domestic *Culex* in temperate areas. Inseminated adult females from the last generation of the season build body fat by feeding on carbohydrates and enter hibernation in fall. The females pass the winter in diapause and do not become active during periods of warm winter weather. Hibernating females are common in basements, outbuildings, and subterranean enclosures. Like *Culex restuans*, the females congregate near moisture and move their resting location during the winter to remain in a humid atmosphere.

Mortality can be extensive during periods of winter drought. Females emerge from hibernation during May and begin depositing egg rafts in suitable habitat. Populations of this mosquito usually peak during August, but breeding continues well into September. The adults from the last generation of the season lose all interest in blood meal hosts but will move in and out of overwintering sites during periods of mild fall weather. Larvae rarely persist in breeding habitats after females have entered hibernation.

Culex pipiens can be found in a fairly wide range of larval habitats but are generally associated with water that has a high organic content. The species utilizes temporary ground water that ranges from mildly to grossly polluted. The species also deposits its eggs in artificial containers, including tin cans, tires, and any refuse that allows stagnant water to puddle. The species is decidedly urban and reaches greatest numbers in large urban centers. Catch basins and storm drains provide ideal habitat for *Cx. pipiens*. The species becomes particularly abundant in areas where raw sewage leaks into subterranean drainage systems. Meat packing plants and slaughter house drainage ponds support high populations of this species. *Culex pipiens* can always be collected in the effluent from sewage treatment plants.

Collection

No special techniques are required to collect *Cx. pipiens* larvae. This species is common in urban settings and can usually be found in significant numbers in a variety of habitats where stagnant water collects. *Culex pipiens* will oviposit readily in buckets containing prepared straw infusions. Most piles of discarded tires contain a mixture of *Cx. pipiens* and *Cx. restuans* in addition to the tire-breeding *Aedes*.

Culex pipiens occurs on every continent except Antarctica and is the most widely distributed mosquito in the world. In North America, two races range north (*Cx. pipiens pipiens*) and south (*Cx. pipiens quinquefasciatus*) of 39ºN latitude, about the level of Sacramento. *Cx. p. pipiens* lives in the milder coastal climate areas, while *Cx. p. quinquefasciatus* is found in the warmer inland valleys. ***Culex pipiens*'** main host is wild birds, but it also feeds freely on a wide variety of warm-blooded vertebrates, including man. In northern California, it currently plays only a lesser role as a carrier of human disease, while in southern California and the Gulf Coast region, it is a major carrier of Saint Louis encephalitis. It is also the best-known carrier of West Nile Virus, a severe encephalitis virus newly arrived in the Americas that is spreading along the eastern seaboard.

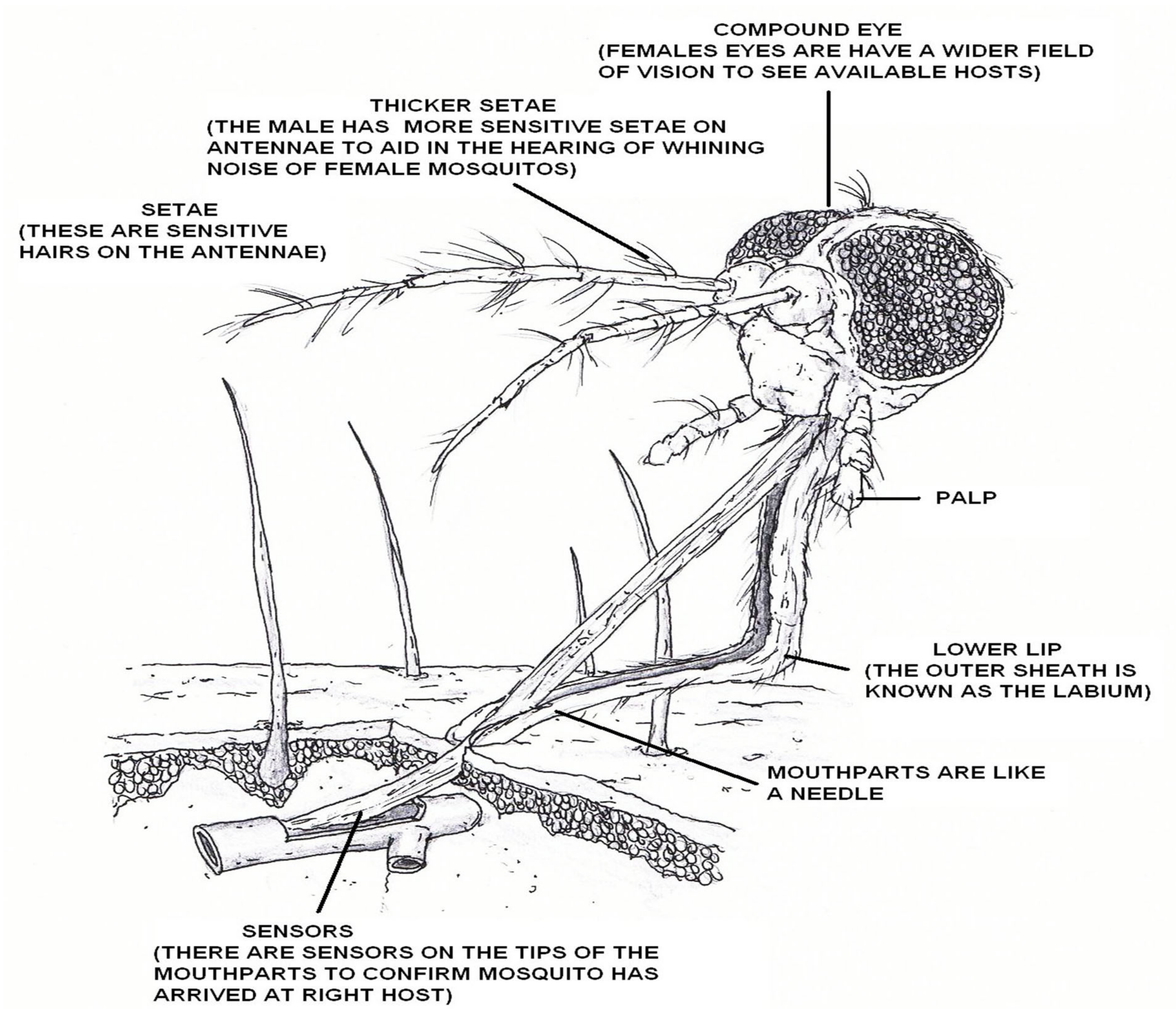
Culex pipiens larvae typically develop best in dirty, stagnant water containing abundant organic matter, in ground pools and natural and man-made containers. Vector technicians often find improperly installed or maintained underground septic tanks producing huge numbers of this species. The mosquitoes gain entrance thorough cracks in the ground, through poorly fitting or unsealed covers, or by the vent pipes made for removal of gases. We recommend that all vents be covered with window screening, preferably aluminum screen, to exclude adults. Polluted habitats do not generally support a very wide variety of species. Most larval samples from polluted water sources consist mainly of *Cx. pipiens* and *Cx restuans*. *Culex pipiens* larvae are easily distinguished from *Cx. restuans* by the length and shape of the antennae.

Where does this Mosquito normally lay its Eggs?

- ✓ In tin cans, buckets, discarded tires and other artificial containers that hold stagnant water.
- ✓ In untended bird baths, clogged rain gutters and plastic wading pools that hold stagnant water.
- ✓ In storm drains and catch basins in urban areas.
- ✓ In septic seepage and other foul water sources above or below ground level.

How does this Mosquito Overwinter?

- ✓ The last generation of adult females mate and build body fat by feeding on carbohydrates.
- ✓ Mated females find refuge in culverts, basements, and protected areas that stay above freezing.
- ✓ The body metabolism slows considerably, and winter is spent in a state of torpor.
- ✓ Females that survive the winter blood feed in spring and lay eggs that produce the summer populations.



Pesticide Clean-Up Sub-Section

Use Lye or Lime for:	Use Chlorine Bleach for:	Do not use any decontamination Chemicals for these Pesticides:
acephate	calcium cyanide	alachlor
atrazine	chlorpyrifos	chloramben
captan	fonophos	chlorinated hydrocarbons
carbaryl		diuron
dalapon		methoxychlor
diazinon		pentachlorophenol
dichlorvos		picloram
dimethoate		2,4-D
Malathion		bromacil
naled		glyphosate
propoxur		simazine

WARNING: There is a slight potential for creating toxic by-products when using these procedures. In critical situations, samples of affected soil, sediment, water, etc. should be sent to a laboratory for analysis to determine if decontamination was successful.

Pesticides amenable to treatment using lye or lime may be decontaminated when mixed with an excess quantity of either of these materials. Lye or lime can be used in either the dry form or as a 10% solution in water. Caution: caustic soda (lye) can cause severe eye damage to personnel not properly protected. Protect against contact by wearing unventilated goggles, long-sleeved work clothes with coveralls, neoprene gloves, and a chemical-resistant apron. An approved respirator should also be worn. Do not use lye on aluminum surfaces.

Bleach

For pesticides that can be degraded by treatment with bleach, in general use one gallon of household bleach (which contains approximately 5% sodium hypochlorite) per pound or gallon of pesticide spilled. If bleaching powder is used, first mix it with water (one gallon of water per pound of bleach) and add a small amount of liquid detergent. For safety reasons, a preliminary test must be run using small amounts of bleach and the spilled pesticide. The reaction resulting from this test must be observed to make sure the reaction is not too vigorous. Do not store in close proximity to, or mix chlorine bleach with, amine-containing pesticides.

Mingling of these materials can cause a violent reaction resulting in fire. Calcium hypochlorite is not recommended as a decontaminating agent because of the fire hazard. Spilled granular/bait materials need only to be swept up. When there is doubt concerning which decontaminant is appropriate, only water and detergent should be used. Nonporous surfaces should be washed with detergent and water. The decontamination solution determined to be correct should be thoroughly worked into the surface. The decontamination solution should then be soaked up using absorbent material. The spent absorbent material is then placed into a labeled leak-proof container for disposal.

Porous materials such as wood may not be adequately decontaminated. If contamination is great enough to warrant, these materials should be replaced. Tools, vehicles, aircraft, equipment and any contaminated metal or other nonporous objects can be readily decontaminated using detergent and the appropriate decontamination solution.

Disposal
All contaminated materials that cannot be effectively decontaminated as described above must be placed in properly labeled, sealed, leak-proof containers. Disposal of these containers shall be in accordance with instructions determined by the U.S. Environmental Protection Agency/State Pesticide Agency and the Spill Response Team.

Specific Restrictions
Specific restrictions may include prohibiting the use of certain pesticides under certain conditions, prohibiting certain methods of application, requiring use of a foliage barrier, or requiring a buffer zone distance between the site of application and areas to be protected.

In general, applicators must use all available drift prevention practices in order to prevent drift. During the past few years, the OPP has received and reviewed new studies on spray drift that it required from pesticide registrants to support their product registrations. The OPP has completed its review of these studies and reached conclusions about the factors that influence drift and the amounts of sprays which can drift from the application site.

U.S. Department of Agriculture
The OPP also collaborated under a cooperative research and development agreement with registrants and the U.S. Department of Agriculture (**USDA**) on the development of a model ("***AgDRIFT***") to predict distances of spray drift under many different conditions.

To ensure the scientific quality of the conduct of the studies, the conclusions that were drawn from these studies, and the predictive model, the OPP obtained independent expert peer reviews, including the Federal Insecticide, Fungicide, and Rodenticide Act (**FIFRA**), Science Advisory Panel.

These expert peer reviews supported the use of the model and these studies for the OPP's science assessments of pesticides.

Based on these studies and reviews, the OPP is now developing improved product labeling to inform applicators of requirements to control off-target spray drift. The OPP plans to publish these requirements and an implementation plan in a draft notice (PR Notice) this winter and ask for public comments.

Where Can Complaints About Spray Drift Be Directed?
If you believe that you have been exposed to pesticide spray drift and have health-related questions, you should contact your physician, local poison control center, or health department for assistance. You can also contact the National Pesticide Information Center.

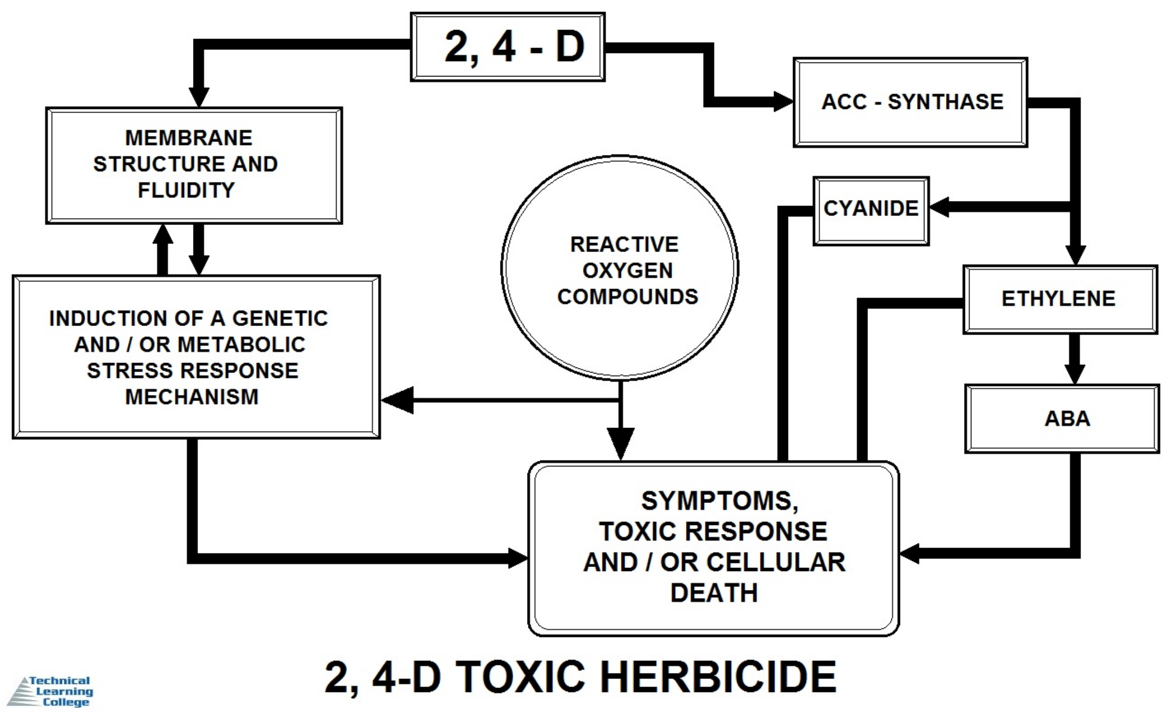
Herbicide Hazards Sub-Section

Whether there is herbicide injury to crops depends upon several factors:

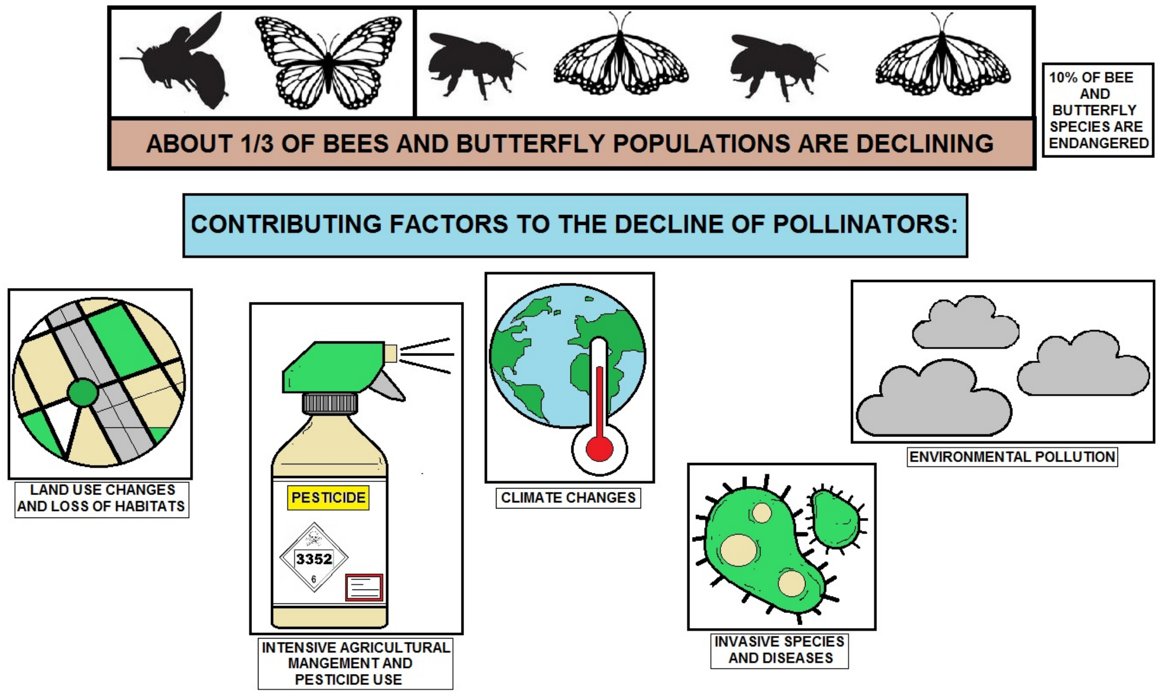
- ✓ the chemical nature of the herbicide,
- ✓ the sensitivity of the plant species,
- ✓ the methods of application,
- ✓ the proximity of target and non-target crops, and
- ✓ the behavior of the herbicide in the environment.

All herbicides can be classified as either selective or nonselective. Selective herbicides kill certain weeds with little or no injury to the crop. It is the difference in plant response that determines the effectiveness of the herbicide and safety to the crop.

Non-selective herbicides are those which will kill or injure virtually all kinds of vegetation. The risk of drift is great when the application is by foliar spray. When the soil is treated, a hazard may arise from the herbicide persisting in the soil longer than intended and interfering with growing a crop at some later time. The movement of a non-selective herbicide by runoff or by soil erosion to non-target areas is another possibility. Typical 2,4 D injury symptoms on grape leaves.



2, 4-D TOXIC HERBICIDE



VERGE OF EXTINCTION FOR POLLINATORS

Pesticide applicators and others, including landowners, play a very important role in pesticide application -- deciding whether or not to apply a pesticide and if so how best to make that application. It is their responsibility to know and understand a product's use restrictions.

They are responsible for complying with all other pesticide laws regarding pesticide applications and ensuring that their application equipment and techniques will produce a minimum of spray drift. The EPA also expects applicators to exercise a high level of professionalism in making decisions about applications.

Further information about pesticide use and hazards can be obtained from any University of Missouri Extension Center.

Drift hazards

There are two ways herbicides drift to non-target areas.

1. Mist droplets are generated by the sprayer nozzles. The size of droplet depends upon the nozzle pressure, the size of nozzle orifice and the surface tension of the spray solution.

2. Vapor may be generated depending upon the volatility of the herbicide. The amount of vapor varies with the chemical and the conditions of application.

Droplet Drift

The distance of droplet drift depends upon the size of the droplets, the velocity of the wind and the height above the ground where the herbicide is discharged. In general, larger orifices and lower pressures result in larger droplets. Conversely, the smaller the orifice and the greater the pressure, the smaller will be the size of the droplets. The smaller the droplet, the farther it will drift with wind of any particular velocity.

Vapor Drift

Volatility refers to the ability of a herbicide to vaporize and to mix freely with the air. Volatile herbicides may produce vapors that can be carried great distances from the target area to other crop sites. Such herbicide volatility can also reduce the rate of application to the target area. A row of grapevines severely injured by herbicides used to clear the nearby railroad.

Phenoxy Herbicides

The phenoxy group of herbicides has been most often involved in crop injury by off-target drift. The phenoxy group includes 2,4-D, 2,4,5-T, 2,4-DB, 2,4,5-TP (Silvex) and MCPA. These herbicides are most commonly used for the control of broad-leaved weeds in crops and for the control of undesirable woody species.
Phenoxy herbicides are more or less volatile. Vapors can arise from the herbicide while mixing, during and after application.

Phenoxy herbicides in general are formulated in two ways, as esters or amines. Esters are more effective in controlling hard-to-kill weeds but are the most hazardous in terms of volatility and consequent drift to sensitive crops.

There are two categories of esters: the regular form and the low-volatile form. The latter form is less likely to cause problems. The amine formulations are safer to use than are the esters, but they are less effective in their performance.

Susceptible Crops

Although most kinds of broad-leaved plants are susceptible to injury by phenoxy herbicides, grapes and tomatoes are the most sensitive. Cotton, soybeans, potatoes, other vegetables, legume crops and many ornamental trees, shrubs and flowers can also be severely affected.

Because grapes are one of the crops most sensitive to phenoxy herbicides, these herbicides should not be applied in an area where vineyards are established. Great distances between the site of application and the location of a vineyard, tomato field, melon patch or greenhouse may not afford protection against injury from drift.

Problems of drift are common and often result in hardship for the grower of the susceptible crop, judgments against the applicator for crop losses and a bad reputation for the herbicide. Typical leaf-curl symptoms of soybeans exposed to phenoxy herbicides.

Symptoms of Injury
Mere traces of a phenoxy herbicide may cause sensitive plants to produce abnormally large leaves, exaggerated distances between leaves and multiplied or enlarged flowering or fruiting parts.

Greater concentrations of the herbicide can cause stunting and cupping of leaves, spiraling growth of soft shoots, clearing and enlargement of major leaf veins and severe distortion of flowering or fruiting parts. After severe exposure, leaves may be fan-shaped or severely stunted and curled, with extensive development of small teeth along leaf margins.

When grapes are visibly affected, there will generally be uneven or delayed coloring of the fruit. Reduced production of sugars within the fruit can render the crop worthless. Shoots grow either excessively long or may be stunted, and the canes may lose their ability to survive normal winter temperatures. Leaves exhibit the characteristic fan shape with sawtooth margins.

Affected tomato plants exhibit cupped or elongated leaves with enlarged pale veins and toothy margins. Stem twisting, severe stunting of plants, puffy fruits or abortion of flowers commonly occur. Soybeans usually exhibit leaf distortion at lowest levels of exposure while higher levels can result in yellowing of foliage and defoliation.

Greenhouse crops, vegetables, ornamental plants and desirable native vegetation are affected in various ways. The leaves and stems of shrubs or trees may become stunted, stretched, twisted or spindly to the extent of being unsightly or worthless.

Long-term Effects
Woody plants such as grapes, apples and peaches which show substantial stem and leaf distortion usually fail to produce a marketable crop. If the symptoms are sudden or severe, one to three years may be required for recovery. Severe cases of phenoxy herbicide injury may result in stunted growth and poor ripening for two to four years after exposure. Growers seeking monetary compensation should be aware of these long-term effects and not be too quick to settle damage claims.

Annual crops of herbaceous plants such as florist crops, field crops and vegetables do not have the same potential for long-term losses. But the value of a single season's crop can constitute a major economic loss to either the grower or the user of the herbicide.

Other Herbicides
Several herbicides other than the phenoxys can also injure sensitive crops. Some of those applied to soils to control woody plants or weeds in crops may be absorbed by the extensive roots of nearby plants such as fruit trees, nut trees and grape vines. Certain non-phenoxy herbicides used to kill woody plants by application to the foliage can cause problems when they drift to economic crops.

Preventing Crop Injury
Awareness is the key to preventing damage by phenoxy and other herbicides. Once applicators are aware of the hazards and possible consequences of misuse they can take several steps to prevent problems:

- ✓ Learn the locations of sensitive crops in the area.
- ✓ Avoid use of ester formulations of phenoxy herbicides in any area near sensitive crops.
- ✓ Use amine forms of phenoxy herbicides to reduce the risk of vapor drifting to nearby sensitive crops.
- ✓ Apply pesticides, especially herbicides, on a calm day or when a light breeze is blowing away from sensitive crops.
- ✓ Spray when temperatures will remain below 90 degrees F to prevent or reduce vaporization.
- ✓ Use sprayer nozzles with larger orifices and operate at lower pump pressures to reduce the production of fine droplets.

Resolving Problems
User responsibility. Registration and labeling of a particular pesticide clearly give individuals the right to apply the pesticide as long as they follow the directions for use and the precautions stated on the label. The use of a pesticide in any way contrary to the label is a violation of federal law. Misuse of a pesticide may make the user liable to either criminal prosecution or to civil proceedings or both.

Although there is no legal obligation for herbicide applicators to take stock of sensitive crops in the area of application and to consult and cooperate with neighbors in matters of herbicide use, it is advisable to do so.

Rights of injured parties. Those who grow specialty crops which may be injured as a result of pesticide misuse have rights protected by law. Through civil proceedings, injured parties may attempt to regain financial losses or to secure punitive judgments.

Growers of sensitive crops are not obligated to inform operators of surrounding farms and local industries of the presence and sensitivity of their crops, but it is advisable to seek the cooperation of neighbors in the use of hazardous pesticides. Reporting incidents of pesticide damage. Two governmental agencies may exercise regulatory powers in situations of herbicide misuse.

Further information about pesticide use and hazards can be obtained from any University of Missouri Extension Center.

Spray Pressure
Spray pressure influences the size of droplets formed from the spray solution. The spray solution emerges from the nozzle in a sheet, and droplets form at the edge of the sheet. Increased nozzle pressure causes the sheet to be thinner, and this thinner sheet will break into smaller droplets than from a sheet produced at lower pressure.
Also, larger orifice nozzles with high delivery rates produce a thicker sheet of spray solution and larger droplets than smaller nozzles.

Communication
The majority of drift complaints pertain to trees, shrubs and ornamentals. Communicating with non-agricultural rural residents may reduce complaint submissions originating from lack of knowledge of products used and injury symptoms.

Other Components
Flow control devices are necessary to make the tank, pump and nozzles work together. Depending on the application system, these devices may include pressure regulators, unloader valves and control valves. Because both the spray pattern and flow rate are determined by operating pressure, each sprayer should be equipped with a pressure gauge. The gauge should be placed where it may be easily seen. Strainers are also required for effective treatments. Strainers trap particles and debris in the spray mixture and protect the pump, control devices and nozzles from damage.

Dispersal Summary
All nozzles produce a range of droplet sizes. The small, drift-prone particles cannot be eliminated but can be reduced and kept within reasonable limits.

Here are some tips:
- ✓ Select low or nonvolatile pesticides.
- ✓ Read and follow the pesticide label. Instructions on the pesticide label are given to ensure the safe and effective use of pesticides with minimal risk to the environment. Each pesticide is registered for use on specific sites or locations. Surveys indicate approximately 65 percent of drift complaints involved application procedures in violation of the label.
- ✓ Apply a pesticide only if economic thresholds warrant an application.
- ✓ Use spray additives within label guidelines. This will increase the droplet sizes and pesticide effectiveness.
- ✓ Use larger orifice sizes. This will give larger droplets and will increase the number of tank refills, but will improve coverage and effectiveness.
- ✓ Avoid high pressure. High pressure creates finer droplets; 45 PSI should be considered maximum for conventional broadcast spraying.
- ✓ Use drift-reduction nozzles. They will produce larger droplets when operated at low pressures.
- ✓ Use wide angle nozzles, low boom heights, and keep the boom stable.
- ✓ Drift is minimal when wind velocity is less than 10 mph. Do not spray when wind is greater or blowing towards sensitive crops, gardens, dwellings, and livestock or water sources.
- ✓ Use shielded booms. When banding, use shroud covers.

Topic 6 - Complications/ Limitations / Risk Post Quiz

Answers are after the Glossary in rear
Fill in the blank

Bleach

1. For pesticides that can be degraded by treatment with bleach, in general use one gallon of household bleach (which contains approximately 5% sodium hypochlorite) per pound or gallon of__________________.

Specific Restrictions

2. Specific restrictions may include prohibiting the use of certain pesticides under certain conditions, prohibiting certain methods of application, requiring use of a foliage barrier, or requiring a ___________between the site of application and areas to be protected.

3. In general, applicators must use __________in order to prevent drift.

Droplet Drift

4. The smaller the droplet, the farther it will drift with______________.

Vapor Drift

5. Volatile herbicides may produce __________that can be carried great distances from the target area to other crop sites.

Phenoxy Herbicides

6. The phenoxy group of herbicides has been most often involved in crop injury by off-target drift. The phenoxy group includes 2,4-D, 2,4,5-T, 2,4-DB, 2,4,5-TP (Silvex) and MCPA. These herbicides are most commonly used for the control of broad-leaved weeds in crops and for the control of________________.

7. Phenoxy herbicides are more or less__________. Vapors can arise from the herbicide while mixing, during and after application.

8. _______are more effective in controlling hard-to-kill weeds but are the most hazardous in terms of volatility and consequent drift to sensitive crops.

Other Components

9. ___________trap particles and debris in the spray mixture and protect the pump, control devices and nozzles from damage.

Dispersal Summary
10. All nozzles produce a range of droplet sizes. The ____________cannot be eliminated but can be reduced and kept within reasonable limits.

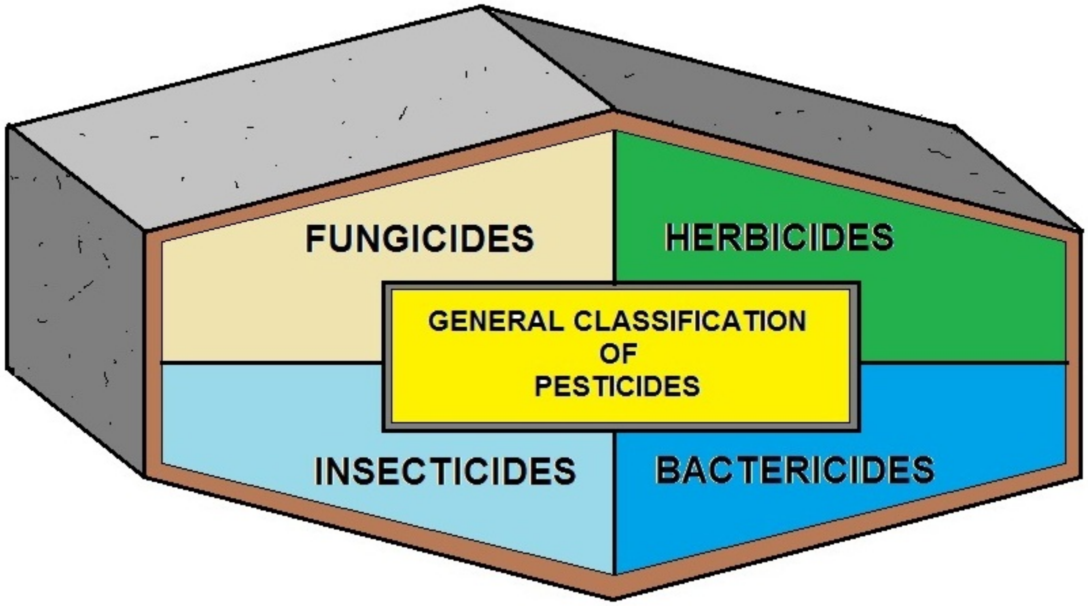
Topic 7 - Aerial and Agricultural Pesticides Section

Section Focus: You will learn specific aerial and agricultural pesticides. At the end of this section, you will be able to describe pesticide and chemical applications and safety procedures. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

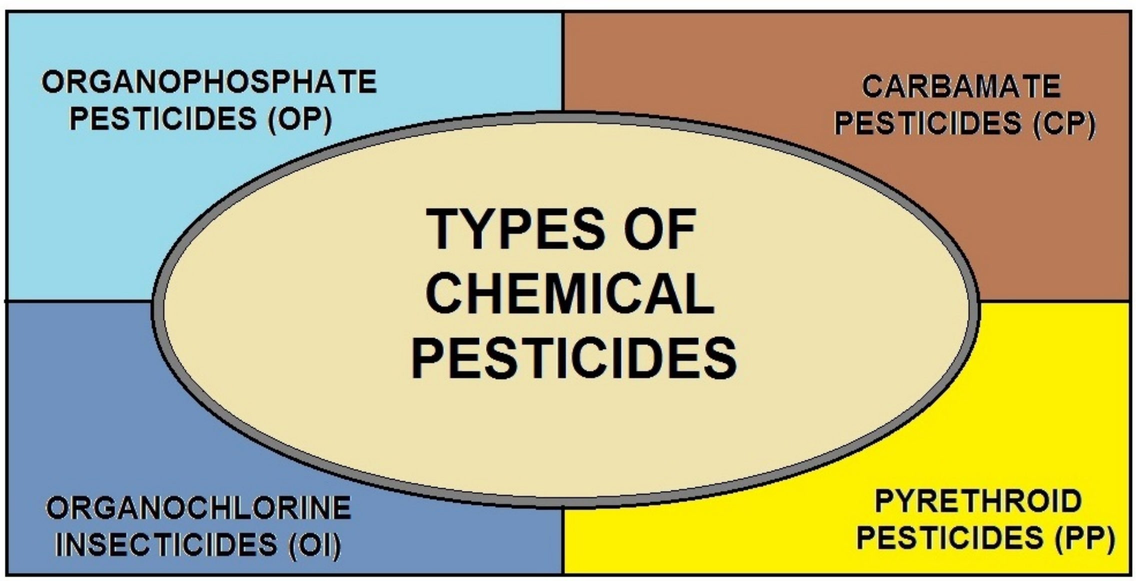
Scope/Background: An insecticide is a pesticide used against insects. They include ovicides and larvicides used against the eggs and larvae of insects respectively. The use of insecticides is believed to be one of the major factors behind the increase in agricultural productivity in the 21th century.

GROUP OF PESTICIDES	PURPOSE AND USES OF THESE PESTICIDE GROUPS
ALGAECIDES	USED TO KILL AND PREVENT GROWTH OF ALGAE (i.e: Common Use In Swimming Pools)
ANTIMICROBIALS	USED TO KILL MICROORGANISMS THAT PRODUCE DISEASES
ATTRACTANTS	THIS PESTICIDE IS USED TO ATTRACT SPECIFIC PESTS USING NATURAL INSECT CHEMICALS CALLED PHEROMONES TO CONFUSE INSECTS MATING BEHAVIOUR
AVICIDES	USED TO CONTROL PEST BIRDS
BIOPESTICIDES	THESE ARE NATURALLY OCCURING SUBSTANCES THAT HAVE PESTICIDAL PROPERTIES
DEFOLIANTS	THIS PESTICIDE GROUP CAUSES FOLIAGE TO DROP FROM A PLANT, TYPICALLY USED IN THE HARVESTING PROCESS
DESICCANTS	AIDS IN THE DRYING PROCESS OF INSECTS OR PLANTS, USUALLY IN LABRATORY PROCESS. PROMOTES DRYING OF LIVING TISSUE, SUCH AS TOPS OF UNWANTED PLANTS
FUMIGANTS	THESE PRODUCE VAPOURS OR GASES TO CONTROL AIR or SOIL BORNE INSECTS AND DISEASES.
FUNGICIDES	THIS GROUP DESTROYS FUNGI THAT INFECT ANIMALS, PLANTS or PEOPLE
HERBICIDES	THIS GROUP IS USED TO KILL WEEDS AND OTHER PLANTS THAT ARE GROWING or COMPETING WITH THE DESIRED SPECIES
INSECT GROWTH REGULATORS (IGR's)	THESE ACCELERATE or RETARD THE GROWTH RATE OF THE INSECTS
INSECTICIDES	USED TO CONTROL OR ELIMINATE INSECTS THAT AFFECT ANIMALS, PLANTS or PEOPLE
MITICIDES (Acaricides)	THESE KILL MITES THAT LIVE ON PLANTS, LIVESTOCK or EVEN PEOPLE
MOLLUSCICIDES	THESE ARE USED TO KILL SNAILS AND SLUGS
NEMATICIDES	USED TO KILL NEMATODES, WHICH ARE MICROSCOPIC WORMLIKE ORGANISMS THAT LIVE IN THE SOIL AND CAN CAUSE EXTENSIVE DAMAGE TO FOOD CROPS
OVICIDES	THESE ARE USED TO CONTROL THE INSECT'S EGGS
PISCICIDES	THESE ARE USED TO CONTROL PEST FISH
PLANT GROWTH REGULATORS (PGR's)	USED TO ACCELERATE or RETARD THE GROWTH RATE OF A SPECIFIC PLANT. SUBSTANCES (excluding Fertilizers or other plant nutrients) THAT ALTER THE EXPECTED GROWTH, FLOWERING, or THE REPRODUCTION RATE OF A PLANT
PREDACIDES	USED TO CONTROL VERTEBRATE PESTS (Birds, Mammals or Reptiles)
REPELLENTS	USED IN REPELLING PESTS SUCH AS MOSQUITOES, FLIES, TICKS and FLEAS
RODENTICIDES	USED TO KILL RATS, MICE or OTHER TYPES OF RODENTS

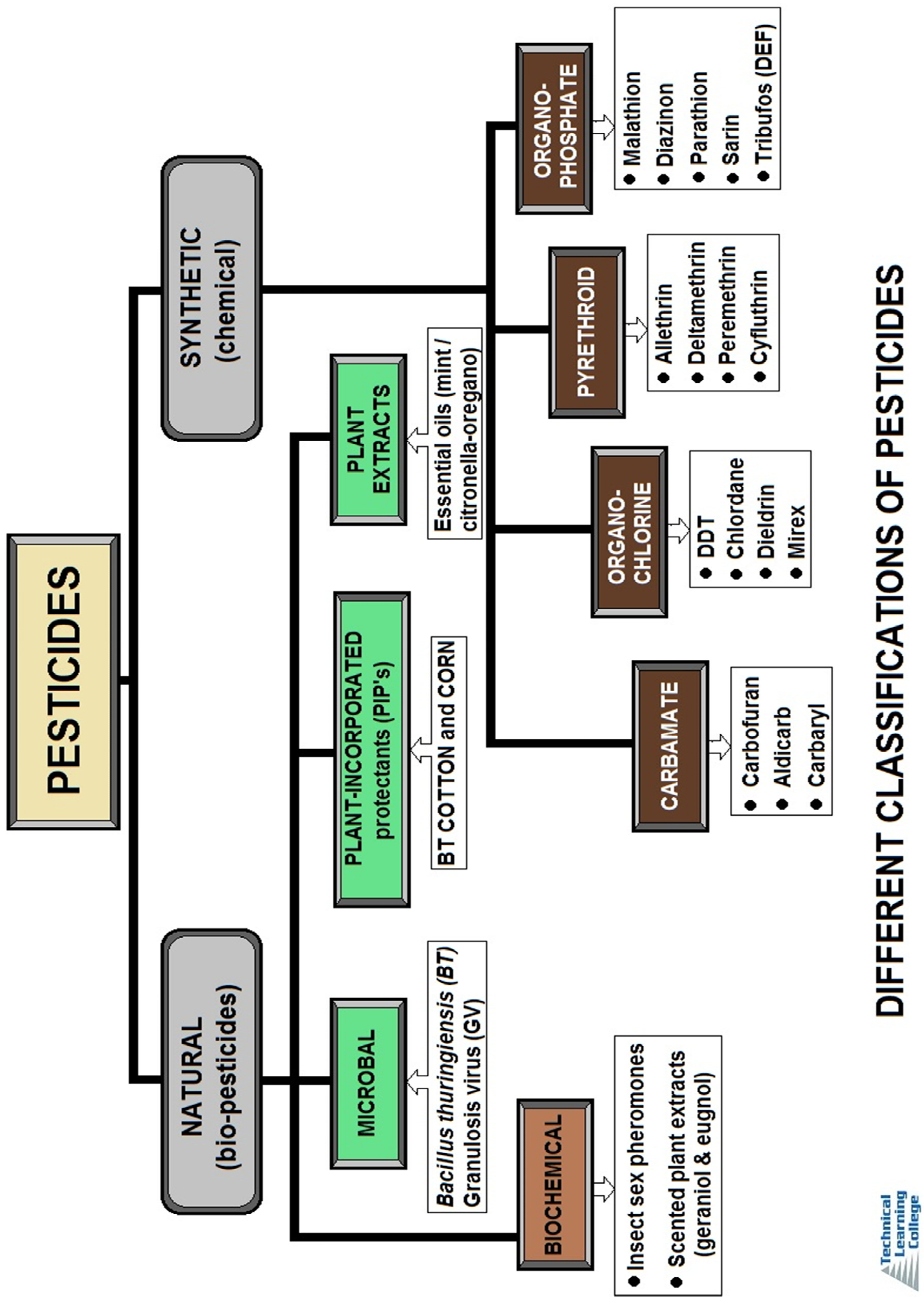
CHART SHOWING THE GROUPS OF PESTICIDES AND THEIR USES

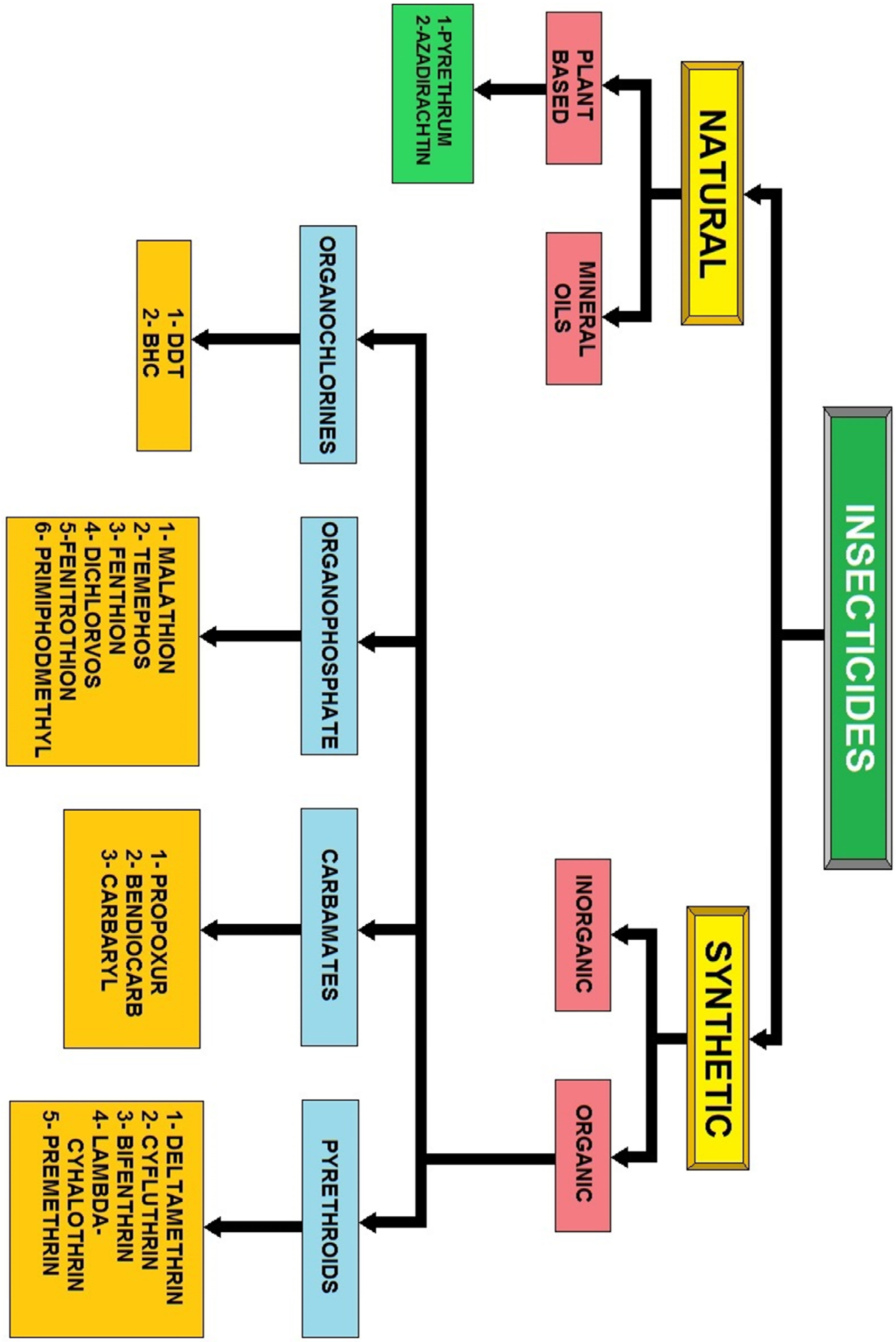


PESTICIDE CLASSIFICATION #1



PESTICIDE TYPES DIAGRAM #1


PESTICIDES
NATURAL (bio-pesticides)
SYNTHETIC (chemical)
MICROBAL
Bacillus thuringiensis (BT)
Granulosis virus (GV)
PLANT-INCORPORATED protectants (PIP's)
BT COTTON and CORN
PLANT EXTRACTS
Essential oils (mint / citronella-oregano)
BIOCHEMICAL
Insect sex pheromones
Scented plant extracts (geraniol & eugnol)
CARBAMATE
Carbofuran
Aldicarb
Carbaryl
ORGANO-CHLORINE
DDT
Chlordane
Dieldrin
Mirex
PYRETHROID
Allethrin
Deltamethrin
Peremethrin
Cyfluthrin
ORGANO-PHOSPHATE
Malathion
Diazinon
Parathion
Sarin
Tribufos (DEF)
DIFFERENT CLASSIFICATIONS OF PESTICIDES
Technical Learning College



PESTICIDES BASED UPON CHEMICAL COMPOSITION

Chemical Control Trade Names

2,4-Dichlorophenoxyacetic acid
2,4-Dichlorophenoxyacetic acid (2,4-D) is a common systemic pesticide / herbicide used in the control of broadleaf weeds. It is the most widely used herbicide in the world, and the third most commonly used in North America. 2,4-D is a synthetic auxin (plant hormone), and as such it is often used in laboratories for plant research and as a supplement in plant cell culture media such as MS medium.

2,4-D is a synthetic auxin, which is a class of plant hormones. It is absorbed through the leaves and is translocated to the meristems of the plant. Uncontrolled, unsustainable growth ensues, causing stem curl-over, leaf withering, and eventual plant death. 2,4-D is typically applied as an amine salt, but more potent ester versions exist as well.

Acephate
Acephate is an organophosphate foliar insecticide of moderate persistence with residual systemic activity of about 10-15 days at the recommended use rate. It is used primarily for control of aphids, including resistant species, in vegetables (e.g. potatoes, carrots, greenhouse tomatoes, and lettuce) and in horticulture (e.g. on roses and greenhouse ornamentals). It also controls leaf miners, caterpillars, sawflies and thrips in the previously stated crops as well as turf, and forestry. By direct application to mounds, it is effective in destroying imported fire ants.

Acephate is sold as a soluble powder, as emulsifiable concentrates, as pressurized aerosol, and in tree injection systems and granular formulations.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

Aldicarb
Aldicarb is a carbamate insecticide which is the active substance in the pesticide Temik. It is effective against thrips, aphids, spider mites, lygus, fleahoppers, and leafminers, but is primarily used as a nematicide. Aldicarb is a cholinesterase inhibitor which prevents the breakdown of acetylcholine in the synapse. In case of severe poisoning, the victim dies of respiratory failure. Aldicarb is effective where resistance to organophosphate insecticides has developed, and is extremely important in potato production, where it is used for the control of soil-borne nematodes and some foliar pests. Its weakness is its high level of solubility, which restricts its use in certain areas where the water table is close to the surface. Aldicarb is a fast-acting cholinesterase inhibitor, causing rapid accumulation of acetylcholine at the synaptic cleft. It is widely used to study cholinergic neurotransmission in simple systems such as the nematode C. elegans.

Exposure to high amounts of aldicarb can cause weakness, blurred vision, headache, nausea, tearing, sweating, and tremors in humans. Very high doses can be fatal to humans because it can paralyze the respiratory system.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

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.

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Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

Carbaryl
Carbaryl (1-naphthyl methylcarbamate) is a chemical in the carbamate family used chiefly as an insecticide. It is a white crystalline solid commonly sold under the brand name Sevin, a trademark of the Bayer Company. Union Carbide discovered carbaryl and introduced it commercially in 1958. Bayer purchased Aventis CropScience in 2002, a company that included Union Carbide pesticide operations. It remains the third most-used insecticide in the United States for home gardens, commercial agriculture, and forestry and rangeland protection. Approximately 11 million kilograms were applied to U.S. farm crops in 1976

Carbofuran
Carbofuran is one of the most toxic carbamate pesticides. It is marketed under the trade names Furadan, by FMC Corporation and Curater, among several others. It is used to control insects in a wide variety of field crops, including potatoes, corn and soybeans. It is a systemic insecticide, which means that the plant absorbs it through the roots, and from here the plant distributes it throughout its organs where insecticidal concentrations are attained. Carbofuran also has contact activity against pests. Carbofuran usage has increased in recent years because it is one of the few insecticides effective on soybean aphids, which have expanded their range since 2002 to include most soybean-growing regions of the U.S. The main global producer is the FMC Corporation. Carbofuran is banned in Canada and the European Union. In 2008, the United States Environmental Protection Agency (EPA) announced that it intends to ban carbofuran. In December of that year, FMC Corp., the sole US manufacturer of carbofuran, announced that it had voluntarily requested that the United States Environmental Protection Agency cancel all but 6 of the previously allowed uses of that chemical as a pesticide. With this change, carbofuran usage in the US would be allowed only on maize, potatoes, pumpkins, sunflowers, pine seedlings and spinach grown for seed. However, in May 2009 EPA cancelled all food tolerances, an action which amounts to a de facto ban on its use on all crops grown for human consumption.

Coumaphos
Coumaphos is a non-volatile, fat-soluble phosphorothioate with ectoparasiticide properties: it kills insects and mites. It is well known under manufacturer brand-names as a dip or wash, used on farm and domestic animals to control ticks, mites, flies and fleas. It is also used to control varroa mites in honey bee colonies, though in many areas it is falling out of favor as the varroa develop resistance and as the residual toxicity effects are becoming better understood. 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.

Cypermethrin (Common Bee Control Treatment Chemical)
Cypermethrin is a synthetic pyrethroid used as an insecticide in large-scale commercial agricultural applications as well as in consumer products for domestic purposes. It behaves as a fast-acting neurotoxin in insects. It is easily degraded on soil and plants but can be effective for weeks when applied to indoor inert surfaces. Exposure to sunlight, water and

oxygen will accelerate its decomposition. Cypermethrin is highly toxic to fish, bees and aquatic insects, according to the National Pesticides Telecommunications Network (NPTN). It is found in many household ant and cockroach killers, including Raid and ant chalk. Cypermethrin kills insects that eat or come into contact with it. Cypermethrin works by quickly affecting the insect's central nervous system.

What are some products that contain cypermethrin?
Termiticides
household insecticides
outdoor insecticides
AmmoTM
CybushR
Cynoff TM
Cyperkill
DemonR

How Toxic is Cypermethrin?
Animals
Cockroach brain cells exposed to very small doses (up to 0.02 micrograms per gram of brain weight or cg/g) of cypermethrin exhibited a nervous system response, which in cockroaches, would result in restlessness, incoordination, prostration, and paralysis.

Mice exposed to small doses (0.3 to 4.3 cg/g) of cypermethrin displayed symptoms including writhing, convulsions, and salivation.

Rats exposed to cypermethrin exhibited similar symptoms including tremors, seizures, writhing, and salivation as well as burrowing behavior.

Cypermethrin may be a weak skin sensitizer in guinea pigs.

Newborn rats were more sensitive to cypermethrin than adult rats. The liver enzymes that break down cypermethrin in the body are not completely developed in the newborn rats.

Humans
People handling or working with pyrethrins and pyrethroids (including cypermethrin) sometimes developed tingling, burning, dizziness, and itching.

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Deltamethrin (Delta Dust or Drione Dust)
Deltamethrin is an insecticide belonging to the pyrethroid family. Pyrethroids are the man-made versions of pyrethrins, natural insecticides from chrysanthemum flowers. Deltamethrin is used outdoors on lawns, ornamental gardens, golf courses, and indoors as a spot or crack and crevice treatment. In its purest form, deltamethrin is colorless or white to light beige crystals that have no odor.

Deltamethrin is in a variety of products used to kill a wide range of insects. Deltamethrin can be formulated in insecticide products as aerosols, sprays, dusts, granules and wettable powders. The illegal, unregistered product known as “Chinese Chalk” or “Miraculous Chalk” often contains deltamethrin as the active ingredient. “Chinese Chalk”, “Miraculous Chalk”, and products like them are not registered for use in the United States and illegal products such as these should be avoided at all times.

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How does Deltamethrin work?
Deltamethrin can kill insects by direct contact or if they eat it. It disrupts their normal nervous system function. It is less toxic to mammals due to their higher body temperature, larger body size, and decreased sensitivity to the chemical.

How might I be exposed to Deltamethrin?
You can be exposed to deltamethrin if you touch, eat, or breathe it in. As an example, it could be breathed in if a fine mist or dust containing deltamethrin gets in the air you breathe. Exposure to deltamethrin can be limited by reading and following label directions.

Demeton
Demeton is a phosphorothioate insecticide with the chemical formula $C_8H_{19}O_3PS_2$.

Demeton-S-methyl
Demeton-S-methyl is an organic compound with the molecular formula $C_6H_{15}O_3PS_2$. It is used as an acaricide and insecticide; more specifically it is an organothiophosphate acaricide and an aliphatic organothiophosphate insecticide, respectively. It is flammable.

Diazinon
Diazinon (IUPAC name: O,O-Diethyl O-[4-methyl-6-(propan-2-yl)pyrimidin-2-yl] phosphorothioate), a colorless to dark brown liquid, is a thiophosphoric acid ester developed in 1952 by Ciba-Geigy, a Swiss chemical company (later Novartis and then Syngenta). It is a non-systemic organophosphate insecticide formerly used to control cockroaches, silverfish, ants, and fleas in residential, non-food buildings. Diazinon was heavily used during the 1970s and early 1980s for general-purpose gardening use and indoor pest control. A bait form was used to control scavenger wasps in the western U.S. Residential uses of diazinon were outlawed in the U.S. in 2004 but it is still approved for agricultural uses.

Diazinon kills insects by inhibiting acetylcholinesterase, an enzyme necessary for proper nervous system function. Diazinon has a low persistence in soil. The half-life is 2 to 6 weeks.

The symptoms associated with diazinon poisoning in humans include weakness, headaches, tightness in the chest, blurred vision, nonreactive pinpoint pupils, excessive salivation, sweating, nausea, vomiting, diarrhea, abdominal cramps, and slurred speech.

In 1988, the Environmental Protection Agency prohibited the use of Diazinon on golf courses and sod farms because of decimation of bird flocks that congregated in these areas. In the United States as of December 31, 2004, it became unlawful to sell outdoor, non-agricultural products containing diazinon. It is still legal for consumers to use diazinon products purchased before this date, provided that they follow all label directions and precautions

Dicrotophos
Dicrotophos is an organophosphate acetylcholinesterase inhibitor used as an insecticide. Some common brand names for dicrotophos include Bidrin, Carbicron, Diapadrin, Dicron and Ektafos.

Dimethoate
Dimethoate is a widely used organophosphate insecticide used to kill insects on contact. It was patented and introduced in the 1950s by American Cyanamid. Like other organophosphates, dimethoate is an anticholinesterase which disables cholinesterase, an enzyme essential for central nervous system function.

Endosulfan
Endosulfan is an off-patent organochlorine insecticide and acaricide that is being phased out globally. Endosulfan became a highly controversial agrichemical due to its acute toxicity, potential for bioaccumulation, and role as an endocrine disruptor. Because of its threats to human health and the environment, a global ban on the manufacture and use of endosulfan was negotiated under the Stockholm Convention in April 2011. The ban will take effect in mid-2012, with certain uses exempted for 5 additional years. More than 80 countries, including the European Union, Australia and New Zealand, several West African nations, the United States, Brazil and Canada had already banned it or announced phase outs by the time the Stockholm Convention ban was agreed upon. It is still used extensively in India, China, and few other countries. It is produced by Makhteshim Agan and several manufacturers in India and China.

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Fenthion
Fenthion is an organothiophosphate insecticide, avicide, and acaricide. Like most other organophosphates, its mode of action is via cholinesterase inhibition. Due to its relatively low toxicity towards humans and mammals, fenthion is listed as moderately toxic compound in U.S. Environmental Protection Agency and World Health Organization toxicity class

Fenthion is a contact and stomach insecticide used against many sucking, biting pests. It is particularly effective against fruit flies, leaf hoppers, cereal bugs, stem borers, mosquitoes, animal parasites, mites, aphids, codling moths, and weaver birds. It has been widely used in sugar cane, rice, field corn, beets, pome and stone fruit, citrus fruits, pistachio, cotton, olives, coffee, cocoa, vegetables, and vines. Based on its high toxicity on birds, fenthion has been used to control weaver birds and other pest-birds in many parts of the world. Fenthion is also used in cattle, swine, and dogs to control lice, fleas, ticks, flies, and other external parasites.

Amid concerns of harmful effects on environment, especially birds, Food and Drug Administration no longer approves uses of fenthion. However, fenthion has been extensively used to control adult mosquitoes. After preliminary risk assessments on human health and environment in 1998 and its revision in 1999, USEPA issued an Interim Reregistration Eligibility Decision (IRED) for fenthion in January 2001. The EPA has classified fenthion as Restricted Use Pesticide (RUP), and warrants special handling because of its toxicity.

Some common trade names for fenthion are Avigel, Avigrease, Entex, Baytex, Baycid, Dalf, DMPT, Mercaptophos, Prentox, Fenthion 4E, Queletox, and Lebaycid. Fenthion is available in dust, emulsifiable concentrate, granular, liquid concentrate, spray concentrate, ULV, and wettable powder formulations.

Fenitrothion
Fenitrothion (IUPAC name: O,O-Dimethyl O-(3-methyl-4-nitrophenyl) phosphorothioate) is a phosphorothioate (organophosphate) insecticide. In experiments fenitrothion at sublethal doses affected the motor movement of marsupials, and at acute dose levels it reduced the energy of birds.

In chronic (low) dose tests, unexpectedly only the lowest concentration (0.011 microgram/liter) of fenitrothion depressed the growth of an algae, though all of the chronic dose levels used were toxic in other ways to the algae. Just half of fenitrothion's minimally effective dose altered the thyroid structure of a freshwater murrel (the snakehead fish).

Fenvalerate
Fenvalerate is an insecticide. It is a mixture of four optical isomers which have different insecticidal activities. The 2-S alpha (or SS) configuration is the most insecticidally active isomer. Fenvalerate consists of about 23% of this isomer.

Fenvalerate is an insecticide of moderate mammalian toxicity. In laboratory animals, central nervous system toxicity is observed following acute or long-term exposure. Fenvalerate has applications against a wide range of pests. Residue levels are minimized by low application rates. Fenvalerate is most toxic to bees and fish. It is found in some emulsifiable concentrates, ULV, wettable powders, slow release formulations, insecticidal fogs, and granules. It is most commonly used to control insects in food, feed, and cotton products, and for the control of flies and ticks in barns and stables. Fenvalerate does not affect plants, but is active for an extended period of time. Fenvalerate may irritate the skin and eyes on contact, and is also harmful if swallowed

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Imidacloprid
Imidacloprid is a nicotine-based, systemic insecticide, which acts as a neurotoxin and belongs to a class of chemicals called the neonicotinoids. Although it is now off patent, the primary manufacturer of this chemical is Bayer CropScience, (part of Bayer AG). It is sold under the trade names Kohinor, Admire, Advantage (Advocate) (flea killer for pets), Gaucho, Mallet, Merit, Nuprid, Prothor, Turfthor, Confidor, Conguard, Hachikusan, Premise, Prothor, Provado, and Winner. Imidacloprid is one of the most widely used insecticides and can be applied by soil injection, tree injection, application to the skin, or broadcast foliar or ground application as a granular or liquid formulation or as a pesticide-coated seed treatment.

In France, beekeepers reported a significant loss of honeybees in the 1990s, which they attributed to the use of imidacloprid (Gaucho). See Imidacloprid effects on bee population. In response to this loss of bees called "mad bee disease," the French Minister of Agriculture convened a panel of expert scientists (Comite Scientifique et Technique) to examine the impact of imidacloprid on bees. After reviewing dozens of laboratory and field studies conducted by Bayer CropScience and by independent scientists, the panel concluded that there was a significant risk to bees from exposure to imidacloprid on sunflowers and maize (corn), the only crops for which they had exposure data. Following the release of this report, the French Agricultural Ministry suspended the use of imidacloprid on maize and sunflowers. Italy, Germany, and Slovenia have also suspended certain uses of the neonicotinoids based on concerns for bees

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Malathion
Malathion is an organophosphate parasympathomimetic which binds irreversibly to cholinesterase. Malathion is an insecticide of relatively low human toxicity; however recent studies have shown that children with higher levels of Malathion in their urine seem to be at an increased risk of attention deficit hyperactivity disorder.

Malathion is a pesticide that is widely used in agriculture, residential landscaping, public recreation areas, and in public health pest control programs such as mosquito eradication. In the US, it is the most commonly used organophosphate insecticide.

Malathion was used in the 1980s in California to combat the Mediterranean Fruit Fly. This was accomplished on a wide scale by the near weekly aerial spraying of suburban communities for a period of several months. Formations of three or four agricultural helicopters would overfly suburban portions of Alameda County, San Bernardino County, San Mateo County, Santa Clara County, San Joaquin County, Stanislaus County, and Merced County releasing a mixture of Malathion and corn syrup, the corn syrup being a bait for the fruit flies. Malathion has also been used to combat the Mediterranean fruit fly in Australia.

Malathion was sprayed in many cities to combat West Nile virus. In the Fall of 1999 and the Spring of 2000, Long Island and the five boroughs of New York City were sprayed with several pesticides, one of which was Malathion. While it was claimed by some anti-pesticide groups that use of these pesticides caused a lobster die-off in Long Island Sound, there is as of yet no conclusive evidence to support this.

Malathion is also used in conjunction with diesel fuel to fog an area where there is an infestation of mosquitoes. By diluting the mixture, it becomes much weaker. It is possible to dilute the mixture to the point where mosquitoes are not killed, but become more resistant to the mixture, making it less effective in subsequent foggings.

Malathion itself is of low toxicity; however, absorption or ingestion into the human body readily results in its metabolism to malaoxon, which is substantially more toxic. Chronic exposure to low levels of Malathion have been hypothesized to impair memory, but this is disputed. According to the United States Environmental Protection Agency there is currently no reliable information on adverse health effects of chronic exposure to Malathion. Acute exposure to extremely high levels of Malathion will cause body-wide symptoms whose intensity will be dependent on the severity of exposure. Possible symptoms include skin and eye irritation, cramps, nausea, diarrhea, excessive sweating, seizures and even death.

Most symptoms tend to resolve within several weeks. Malathion present in untreated water is converted to malaoxon during the chlorination phase of water treatment, so Malathion should not be used in waters that may be used as a source for drinking water, or any upstream waters.

In 1981, B. T. Collins, Director of the California Conservation Corps, publicly swallowed and survived a mouthful of dilute Malathion solution. This was an attempt to demonstrate Malathion's safety following an outbreak of Mediterranean fruit flies in California. Malathion was sprayed over a 1,400 sq. miles area to control the flies.

In 1976, numerous malaria workers in Pakistan were poisoned by isomalathion, a contaminant that may be present in some preparations of Malathion. It is capable of inhibiting carboxyesterase enzymes in those exposed to it. It was discovered that poor work practices had resulted in excessive direct skin contact with isomalathion contained in the Malathion solutions. Implementation of good work practices, and the cessation of use of Malathion contaminated with isomalathion led to the cessation of poisoning cases.

Malathion breaks down into Malaoxon. In studies of the effects of long-term exposure to oral ingestion of malaoxon in rats, malaoxon has been shown to be 61 times more toxic than Malathion. If Malathion is used in an indoor, or other poorly ventilated environment, it can seriously poison the occupants living or working in this environment. A possible concern is that Malathion being used in an outdoor environment, could enter a house or other building; however, studies by the EPA have conservatively estimated that possible exposure by this route is well below the toxic dose of Malathion. Regardless of this fact, in jurisdictions which spray Malathion for pest control, it is often recommended to keep windows closed and air conditioners turned off while spraying is taking place, in an attempt to minimize entry of Malathion into the closed environment of residential homes.

Although current EPA regulations do not require amphibian testing, a 2008 study done by the University of Pittsburgh found that "cocktails of contaminants", which are frequently found in nature, were lethal to leopard frog tadpoles. They found that a combination of five widely used insecticides (carbaryl, chlorpyrifos, diazinon, endosulfan, and Malathion) in concentrations far below the limits set by the EPA killed 99% of leopard frog tadpoles.

A May 2010 study found that in a representative sample of US children, those with higher levels of organophosphate pesticide metabolites in their urine were more likely to have attention-deficit/hyperactivity disorder. Each 10-fold increase in urinary concentration of organophosphate metabolites was associated with a 55% to 72% increase in the odds of ADHD. The study was the first investigation on children's neurodevelopment to be conducted in a group with no particular pesticide exposure

Methiocarb
Methiocarb is a chemical mainly used as a bird repellent, as an insecticide and as molluscicide. It is toxic to humans, not listed as a carcinogen, is toxic to reproductive organs, and a potent neurotoxin. Methiocarb can also cause acute toxicity in humans if anyone is exposed to it for long periods of time. Methiocarb is also a known poison to water organisms.

Methidathion
Methidathion is an organophosphate insecticide.

Methoxychlor
Methoxychlor is used to protect crops, ornamentals, livestock, and pets against fleas, mosquitoes, cockroaches, and other insects. It was intended to be a replacement for DDT, but has since been banned based on its acute toxicity, bioaccumulation, and endocrine disruption activity. The amount of methoxychlor in the environment changes seasonally due to its use in farming and foresting. It does not dissolve readily in water, so it is mixed with a petroleum-based fluid and sprayed, or used as a dust. Sprayed methoxychlor settles on the ground or in aquatic ecosystems, where it can be found in sediments. Its degradation may take many months. Methoxychlor is ingested and absorbed by living organisms, and it accumulates in the food chain. Some metabolites may have unwanted side effects. The use of methoxychlor as a pesticide was banned in the United States in 2003 and in the European Union in 2002.

Methomyl
Methomyl is a carbamate insecticide. It was introduced in 1966, but its use is restricted because of its high toxicity to humans. Its current primary use is on alfalfa for forage.

Parathion
Parathion, also called parathion-ethyl or diethyl parathion, is an organophosphate compound. It is a potent insecticide and acaricide. It was originally developed by IG Farben in the 1940s. It is highly toxic to non-target organisms, including humans. Its use is banned or restricted in many countries, and there are proposals to ban it from all use. Closely related is "methyl parathion".

Pirimicarb
Pirimicarb is a carbamate insecticide used to control aphids on vegetable, cereal and orchard crops by inhibiting acetylcholinesterase activity. It was originally developed by Imperial Chemical Industries Ltd., now Syngenta, in 1970.

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.

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

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Phosmet

Phosmet is a phthalimide-derived, non-systemic, organophosphate insecticide used on plants and animals. It is mainly used on apple trees for control of coddling moth, though it is also used on a wide range of fruit crops, ornamentals, and vines for the control of aphids, suckers, mites, and fruit flies.

Phosphamidon *Not to be confused with phosphoramidon.*

Phosphamidon is an organophosphate insecticide first reported in 1960. It acts as a cholinesterase inhibitor.

Propoxur

Propoxur (Baygon®) is a carbamate insecticide and was introduced in 1959. Propoxur is a non-systemic insecticide with a fast knockdown and long residual effect used against turf, forestry, and household pests and fleas. It is also used in pest control for other domestic animals, Anopheles mosquitoes, ants, gypsy moths, and other agricultural pests. It can also be used as a molluscicide.

Several US states have petitioned the Environmental Protection Agency (EPA) to use propoxur against bedbug infestations, but EPA been reluctant to approve indoor use because of its potential toxicity to children after chronic exposure.

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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.

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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

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

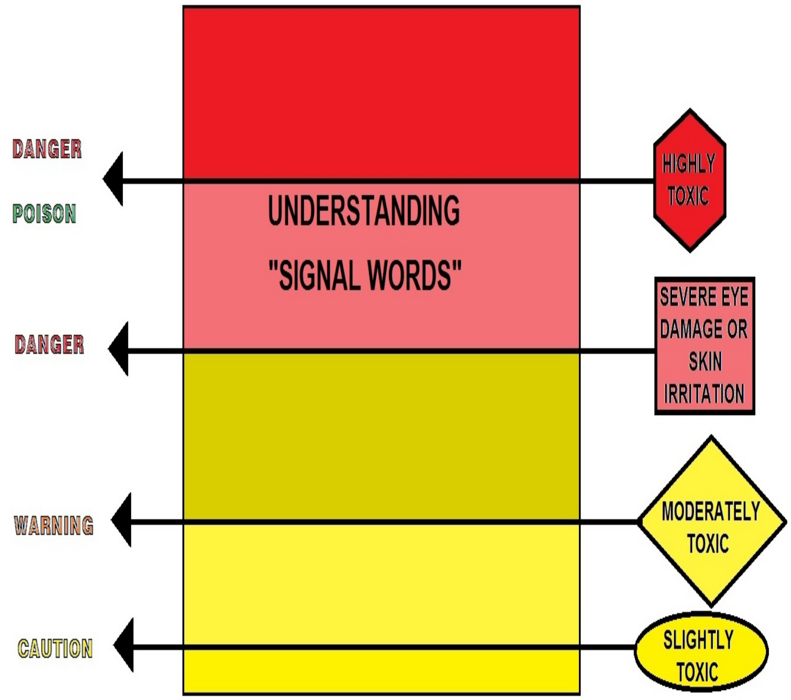
NOTE: When pesticides are used, it is the applicator's legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, is a violation of federal law.

Resmethrin

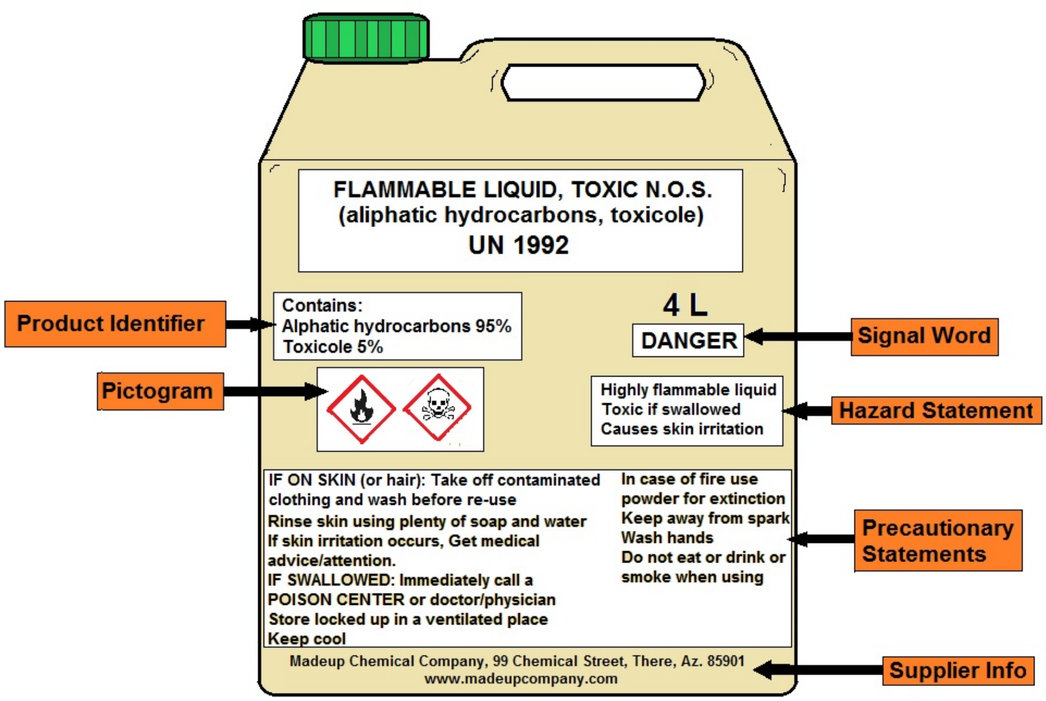
Resmethrin is a pyrethroid insecticide with many uses, including control of the adult mosquito population. The resmethrin molecule has four stereoisomers determined by cis-trans orientation around a carbon triangle and chirality. Technical resmethrin is a mixture of (1R,trans)-, (1R,cis)-, (1S,trans)-, (1S,cis)- isomers, typically in a ratio of 4:1:4:1. The 1R isomers (both trans and cis) show strong insecticidal activity, while the 1S isomers do not. The (1R,trans)- isomer is also known as Bioresmethrin,(+)-trans-Resmethrin, or d-trans-Resmethrin; although bioresmethrin has been used alone as a pesticide active ingredient, it is not now registered as a separate Active Ingredient (AI) by the U.S. EPA. The (1R,cis)-isomer is known as Cismethrin, but this is also not registered in the U.S. for use alone as a pesticide AI. Commercial trade names for products that contain resmethrin are Chrysron, Crossfire, Pynosect, Raid Flying Insect Killer, Scourge, Sun-Bugger #4, SPB-1382, Synthrin, Syntox, Vectrin and Whitmire PT-110

Always follow label instructions and take steps to avoid exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report a pesticide problem, please call 1-800-858-7378.

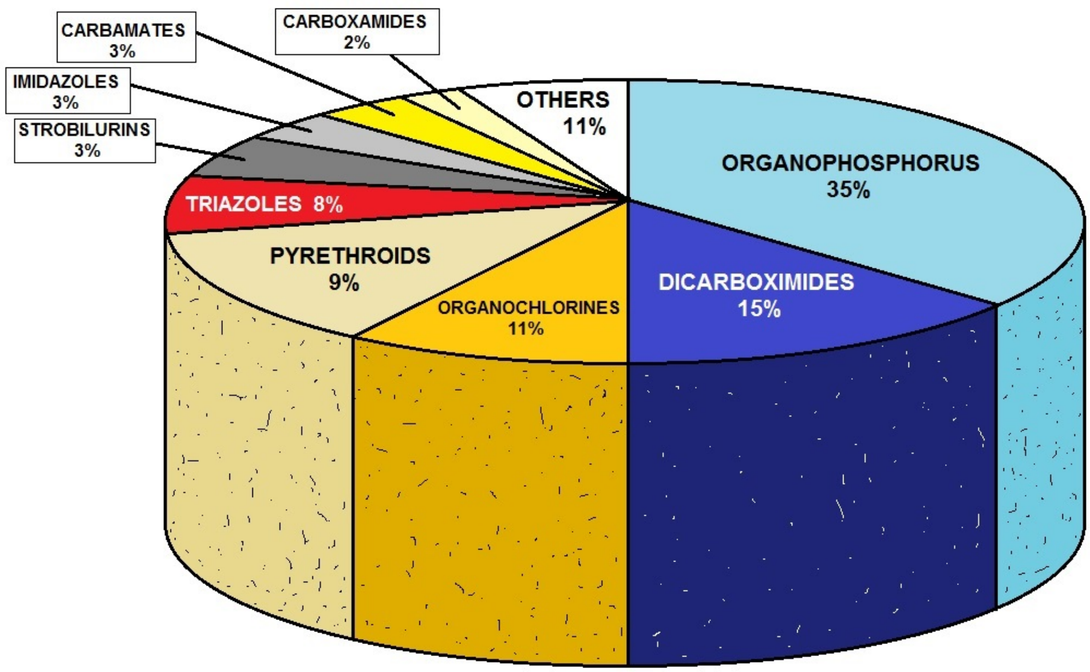
SPRAYING DEFOILANT ON COTTON



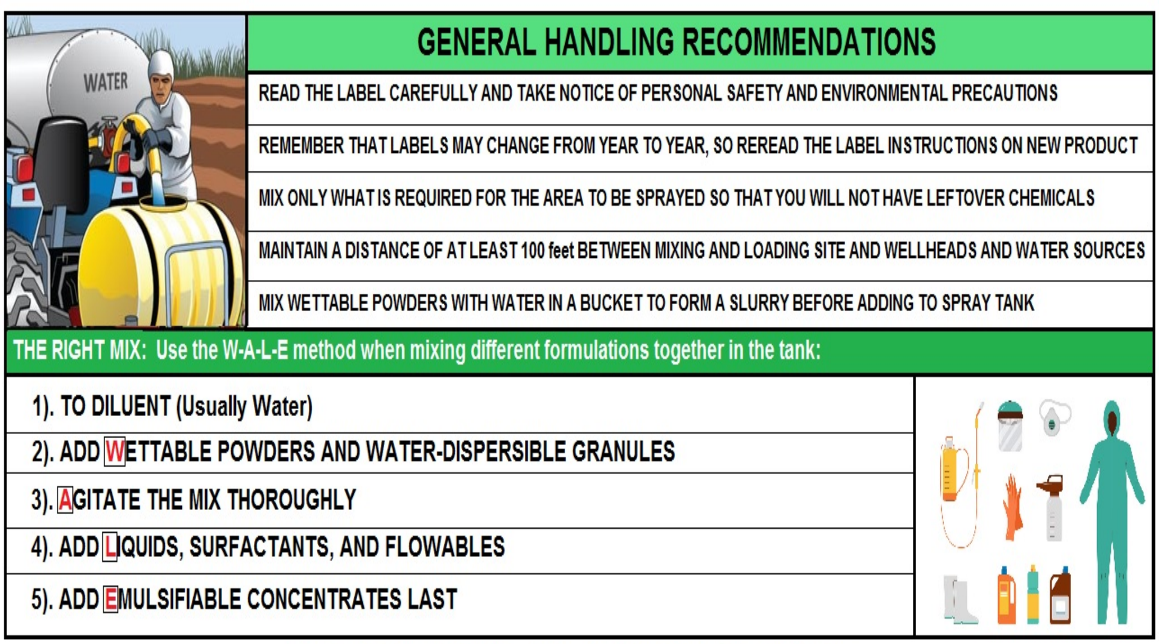
PESTICIDE SIGNAL WORDS DIAGRAM



PESTICIDE LABEL DIAGRAM



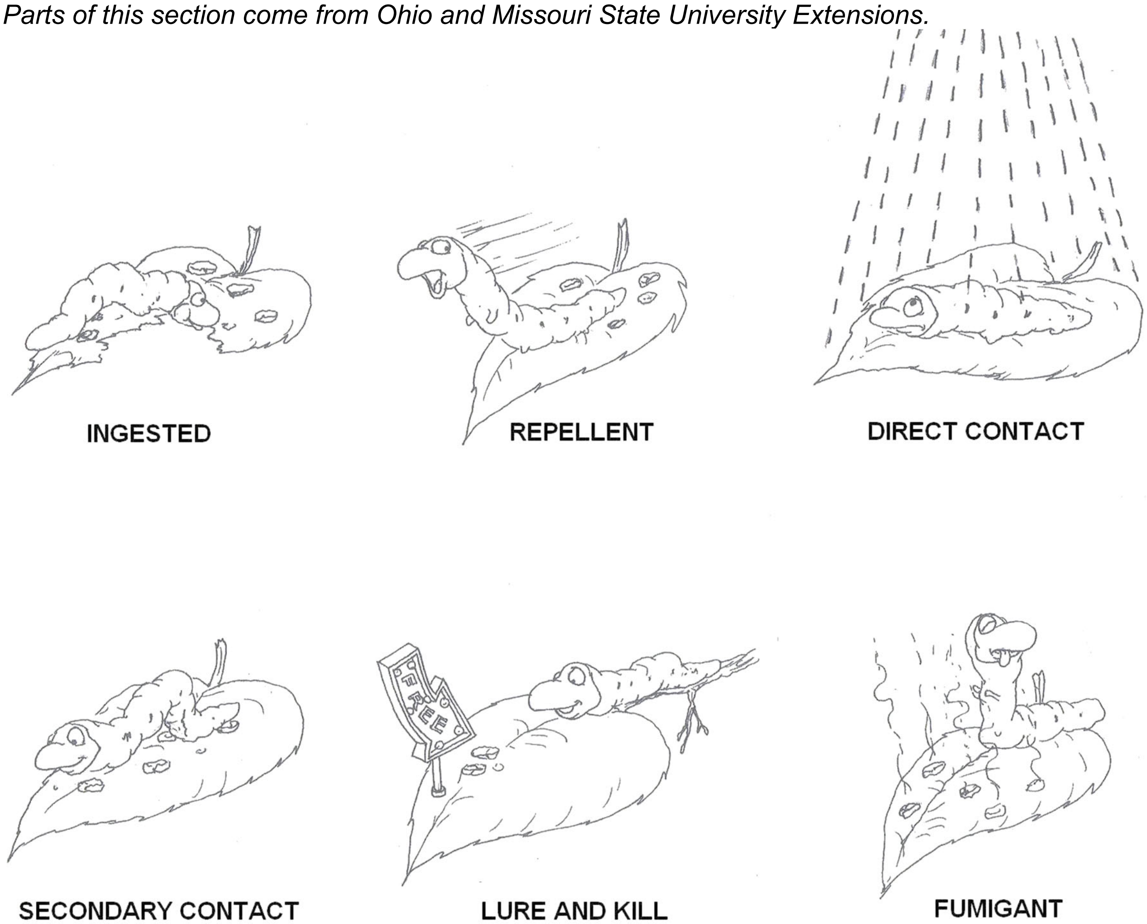
PERCENTAGE OF PESTICIDE BY CHEMICAL CLASSIFICATION



PESTICIDE MIXING AND LOADING CHECKLIST

Understanding Pesticide Adsorption Sub-Section

Parts of this section come from Ohio and Missouri State University Extensions.



PESTICIDE CONTACT METHODS #1

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.

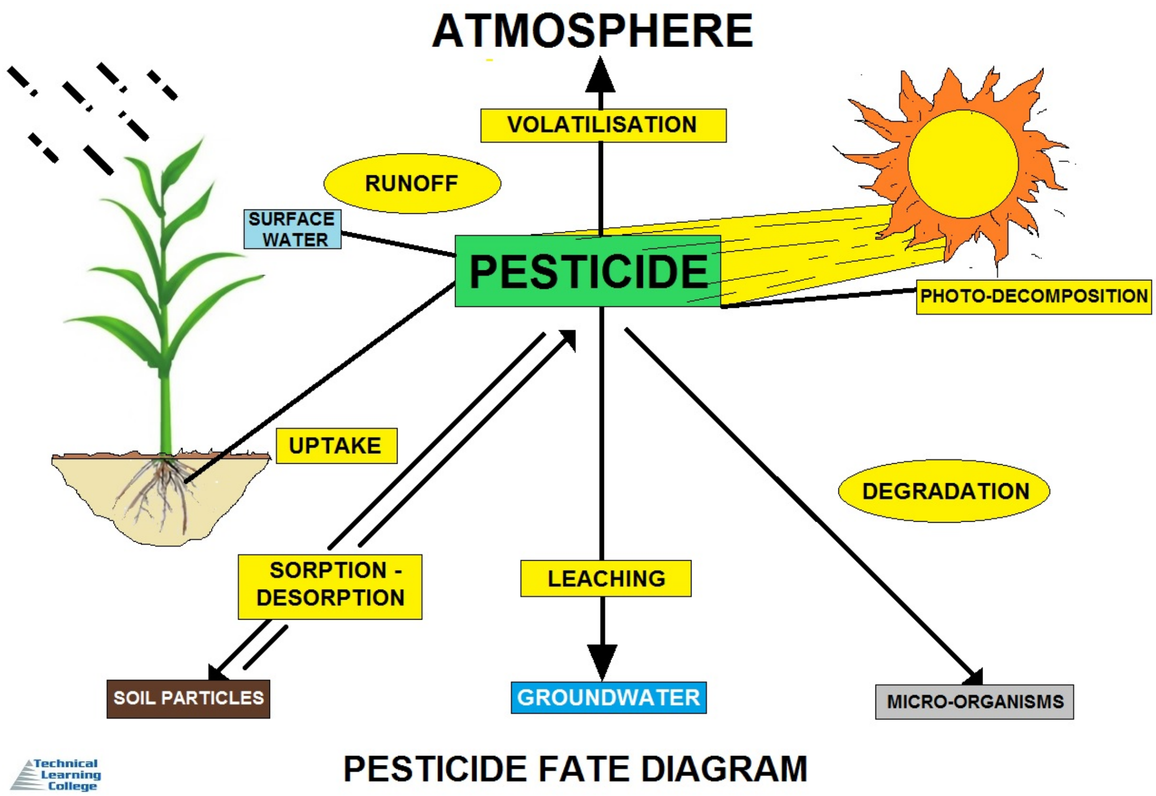
On occasions some practices might be perceived as detrimental. For example, the watering in of a surface applied herbicide makes it work better because the herbicide is root absorbed. Therefore, there is little or no runoff or leaching. In addition, the degradation of a soil applied pesticide occurs 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



PESTICIDE FATE DIAGRAM

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.

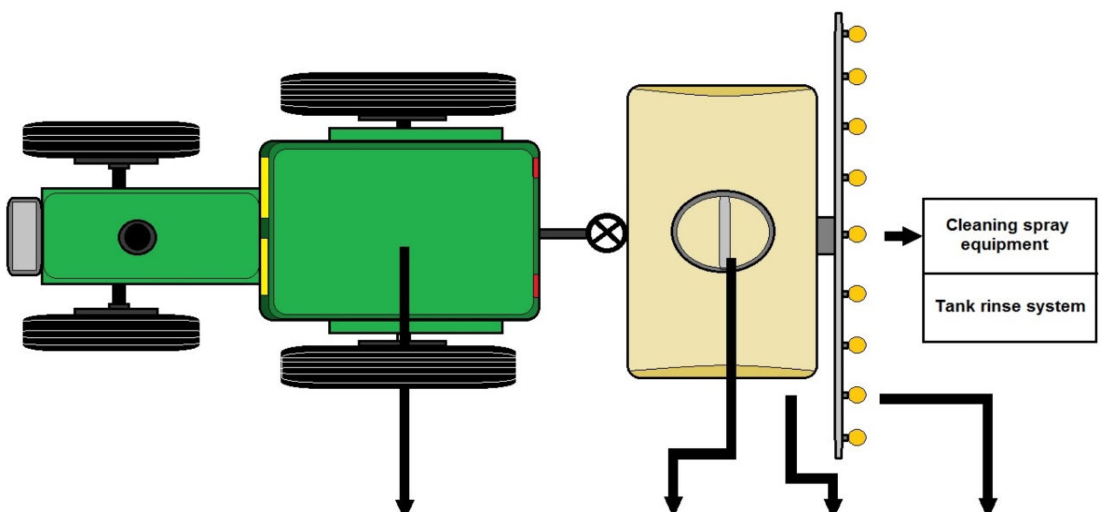
In the United States, paraquat is available primarily as a liquid in various strengths. It is classified as "restricted use," which means that it can be used only by licensed applicators. As with many chemicals, caution must be exercised during use. In the European Union, paraquat has been forbidden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

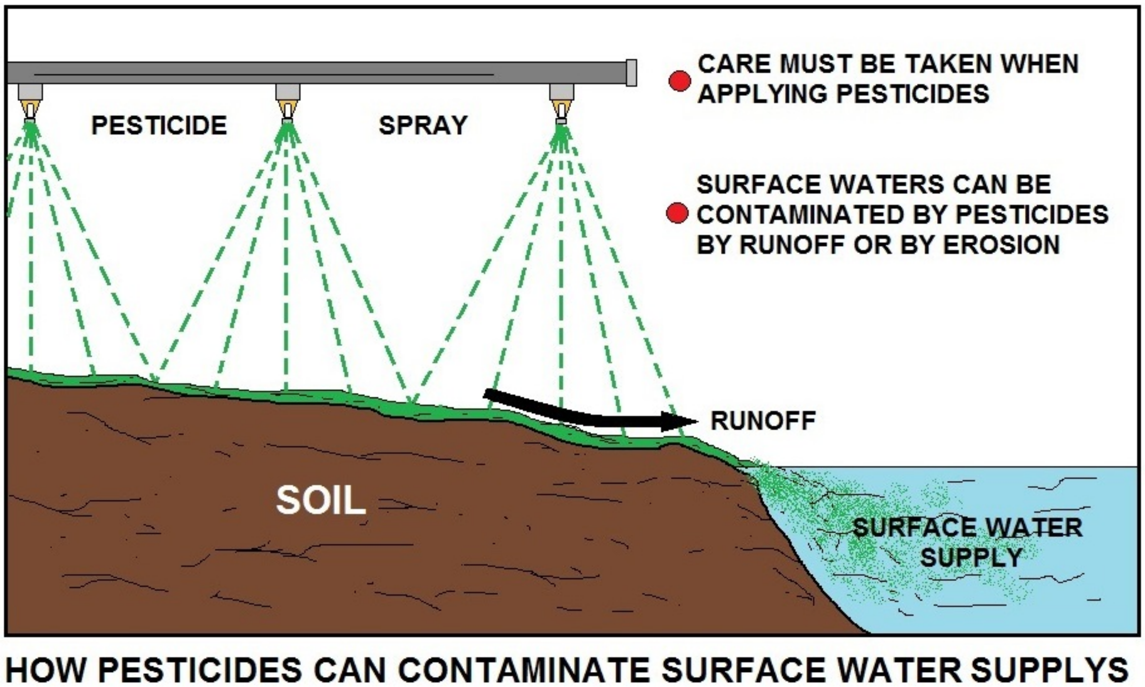


AREA OF EXPOSURE:	Spray drift or contaiminated clothing in the cab	Loading sprayer	Spray drift	Changing blocked nozzles or moving boom
METHODS OF REDUCING EXPOSURE:	*Pressurized cab with Carbon air filter *Protective clothing locker	*Closed transfer system *Direct pesticicide injection *Container rinse system *Chemical Induction bowl	*Low-drift nozzles *Twin-fluid nozzles	*Multiple nozzle bodies *Hydraulic boom fold system *Diaphragm check valves *Hand wash water supply

REDUCING EXPOSURE TO CROP PESTICIDE CHART

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.



Residual Effects of Pesticide Contamination

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

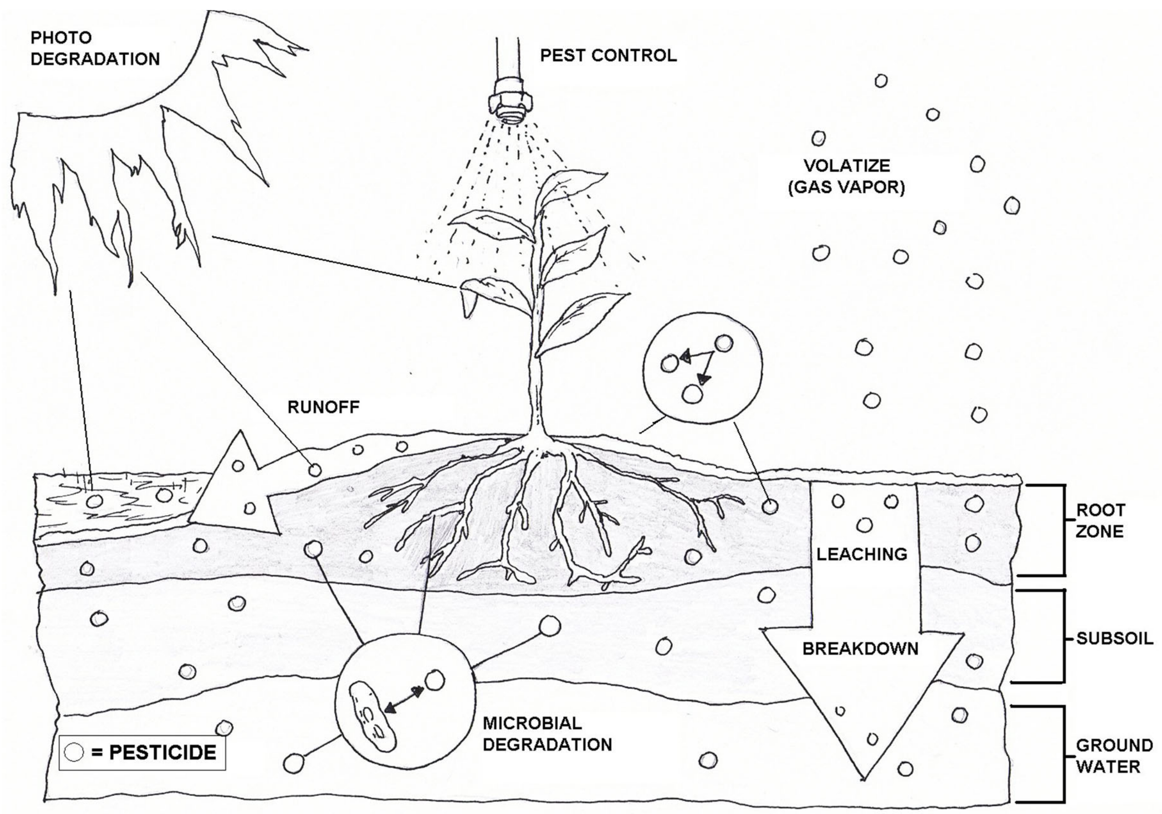
A variety of factors affect the performance of preemergence herbicides. These include timing of application in relation to weed seed germination, soil type, environmental conditions (primarily temperature and rainfall), target weed species and biotype. Ideally, preemergence herbicides should be applied 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.

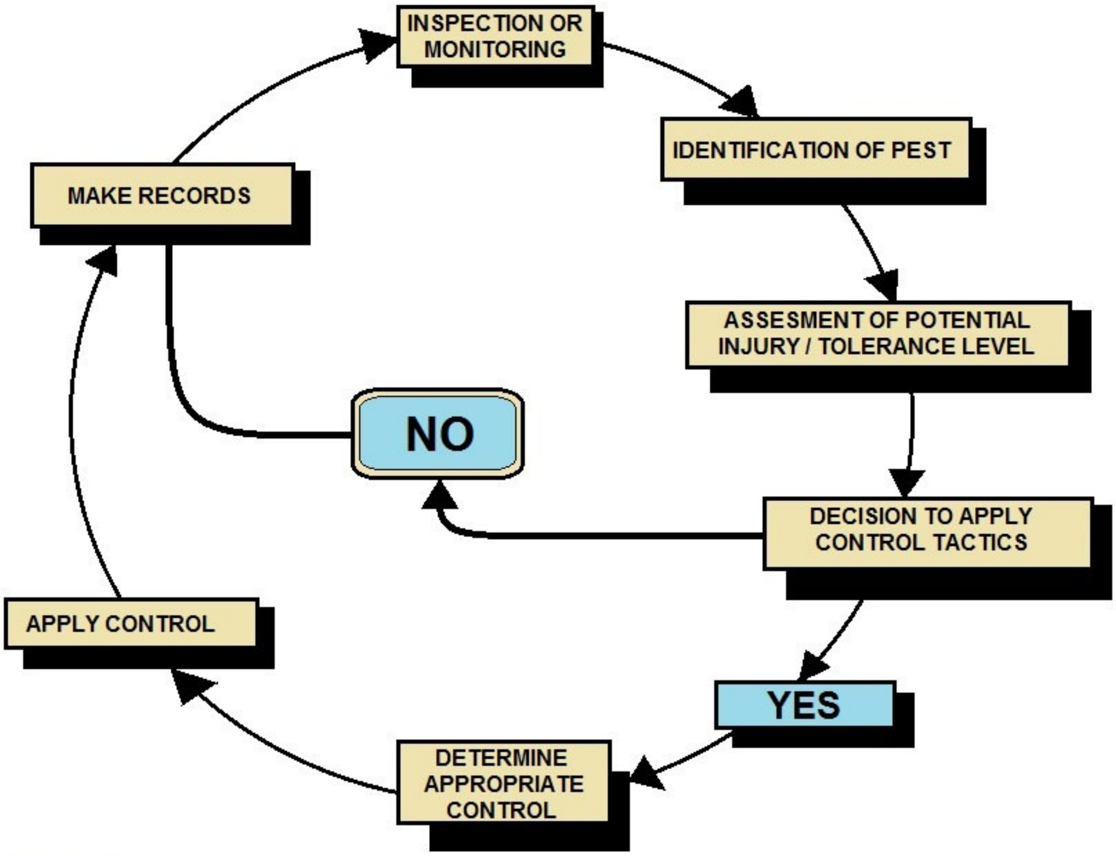
Pesticide Transfer
Pesticide transfer is sometimes essential for pest control. For example, for certain pre-emergence herbicides to be effective, they must move within the soil to reach the germinating seeds. Too much movement, however, can move a pesticide away from the target pest. This can lead to 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.



SOIL DEGRADATION FROM PESTICIDES

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.



Technical Learning College

INTEGRATED PEST MANAGEMENT (IPM)

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 nontarget 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

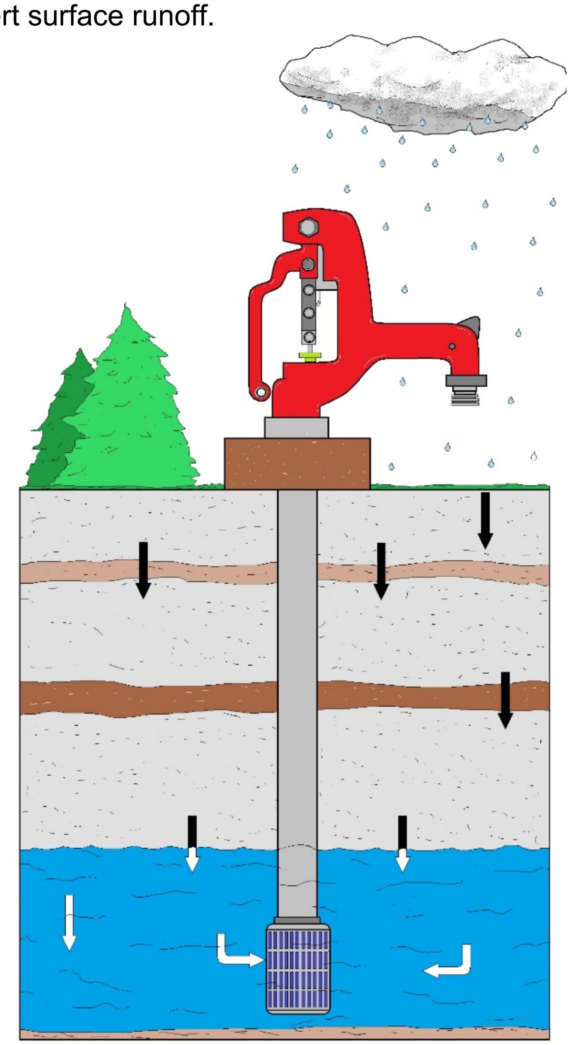
Photodegradation is the breakdown of pesticides by light, particularly sunlight. Photodegradation can destroy pesticides on foliage, on the surface of the soil, and even in the air.

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.

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.



PESTICIDES LEACHING INTO GROUNDWATER SUPPLIES

First Steps in Pest Management

Identify the pest problem
Some pests (or signs of them) are unmistakable—most people recognize a cockroach or a mouse. Other signs that make you think "pest" can be misleading. For example, what may look like a plant "disease" may be, in fact, a sign of poor soil or lack of water.

Use free sources to help identify your pest and to learn the most effective methods to control it. These sources include library reference books (such as insect field guides or gardening books) and pest specialists at your County Cooperative Extension Service or local plant nurseries. These resources are usually listed on Web sites.

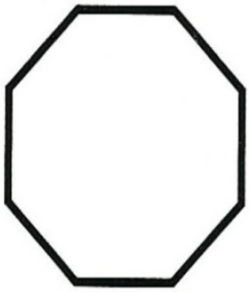
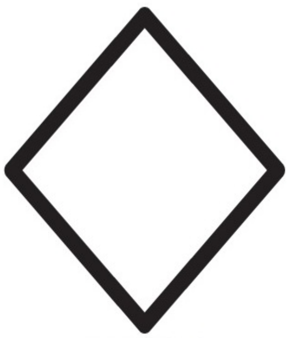
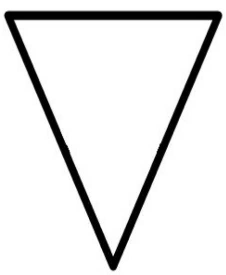
Once a pest control method has been chosen and implemented, always allow time for it to work and then evaluate its effectiveness by taking the following steps:

- Compare pre-treatment and post-treatment conditions. Is there evidence of a clear reduction in the number of pests?
- Weigh the benefits of short-term chemical pesticide control against the benefits of long-term control using a variety of other treatments, including nonchemical methods.
- It's easier to prevent pests than to control them.

You may not need to worry about the four pest control steps just mentioned **IF** you make the effort to prevent pests in the first place.

Pesticide Applicator Instructions
Pest Management (PM) can be complex. It is a matter of using the right tools. This requires special equipment and safety measures. To do well in PM it must be effective. It should not have a negative effect on people or the environment. Environment is the air. It is the water. It is the soil. It can be inside or outside structures. Simply, it is everything around us. The number and variety of pesticides have increased. Pesticide applicators need to know more about safety and proper use more than ever before. For these reasons, many state, federal laws and regulations help protect the public. They also protect the environment, pesticide applicators, and handlers from the possible bad effects caused by pesticide use.

Protection: The applicator's responsibility
Responsibility for protecting the environment from the possible bad effects of pesticide use rests on the applicator. Preserving the natural variety of our planet by protecting the environment contributes to the quality of life. Each plant and animal is part of a complex food chain. If you break one of the links then others are badly affected. One vanishing plant can affect up to 30 other species that depend on it. This includes insects, higher animals and even other plants. Applicators may see their normal work as unlikely to affect the environment, but spills and leaks while mixing, loading, and transporting, or incorrect disposal can lead to pesticides in ground or surface water or in the home of non-target organisms. Applicators often service parks, schools and other sensitive areas. Applicators have an even greater responsibility toward the public because of the indoor use of pesticides. There is a greater risk of exposing people to pesticides in these enclosed spaces. Minimal use of pesticides is the goal in these areas. You need to apply pesticides in a manner that will prevent contact with humans and other non-target sites.

SYMBOL	SIGNAL WORD		SYMBOL
	DEGREE OF HAZARD	NATURE OF PRIMARY HAZARD	
 DANGER	**DANGER** LD_{50} Less than 500 mg/kg HIGH TOXICITY REQUIRES: Goggles Respirator Gloves Skin Protection Avoid the Fumes and Mist	POISON	
 WARNING	**WARNING** LD_{50} 500 - 1000 mg/kg MODERATE TOXICITY REQUIRES: Goggles Gloves Skin Protection Avoid the Fumes and Mist	CORROSIVE	
		FLAMMABLE	
 CAUTION	**CAUTION** LD_{50} 1000 - 2500 mg/kg LOW TOXICITY REQUIRES: Gloves Skin Protection Avoid the Fumes and Mist	EXPLOSIVE	

GRAPH DEPICTING DEGREE OF RISK & HAZARD SYMBOLS RELATED TO PESTICIDES

Adjuvants

Activity of Adjuvants

Adjuvants, or additive compounds, aid in the mixing, application or effectiveness of pesticides. One class of adjuvants, compatibility agents, allow uniform mixing of compounds that would normally separate. Other types of adjuvants include spreaders, stickers, and synergists. There are nearly as many adjuvants as there are pesticides, and they provide a choice for every need. Some adjuvants are added during pesticide manufacture and are, thus, part of the formulation. Other adjuvants are added just before application. To decide when to use an adjuvant, *READ THE LABEL*. It will state when a particular adjuvant is needed, whether or not one should be added or when one is already present.

Adjuvants assist application or pesticide activity without being directly toxic to pests. However, many of these chemicals can present hazards to the applicators. The EPA has not required manufacturers to perform the same type of research and reporting on adjuvants that is required for pesticide registration. However, regulations are continually updated to protect the health of applicators and review and registration of adjuvants may be required in the future. Meanwhile, it is a good practice to use the same care in handling adjuvants as is used with pesticides. Many, but not all, adjuvants function as surfactants, or surface active agents. Surfactants improve the retention and absorption of herbicides. The benefit that they provide is offset, to a degree, by the increased drift hazard they cause. Reducing the surface tension of the spray solution permits it to break up into finer droplets, which are more likely to drift off target.

Drift control agents are adjuvants that help reduce the risk of drift. Pesticide drift is off-target spray deposit and off-target damage.

Spray thickeners reduce drift by increasing droplet size and by reducing bounce or runoff during application. Use of these adjuvants helps to comply with drift regulations, which is especially important in areas adjacent to residential areas. Lo-Drift, Nalco-Trol and Drift Proof are examples of drift control agents.

Penetrating agents dissolve the waxy layer that protects the surface of leaves. This speeds up absorption with foliar treatments. Lower application rates used with these adjuvants may provide the same control as higher rates made without them; more chemical enters the plant before breaking down or washing off. Examples of penetrating agents include Arborchem and kerosene.

Proper Handling of Pesticides

Using pesticides involves many responsibilities beyond the immediate needs of pest control. Greenhouse growers, like all agricultural producers, are expected to handle hazardous materials in a manner that reduces the exposure risk to other persons and limits contamination of the environment. Numerous federal and state regulations exist to help growers handle, store and apply pesticides properly.

Restricting How Pesticides are Used

Under Federal law, the EPA's Office of Pesticide Programs is responsible for evaluating pesticides and their uses to ensure that they can be used with a reasonable certainty of no harm to human health and not cause unreasonable risks to the environment when properly applied.

In fulfilling these duties, the EPA considers the potential impact of spray drift on humans and the environment in our evaluations of proposed pesticides for new registration and older, existing pesticides for re-registration. As a part of the EPA's evaluation of a pesticide, the EPA estimates the amounts of off-target drift and the associated potential risks to human health and the environment.

Restrictions on a pesticide's application may be triggered in two ways. For new pesticides and existing pesticides undergoing re-registration, estimated deposition levels are evaluated along with the pesticide's toxicity. For existing pesticides, available information on drift incidents is also evaluated. Based on these evaluations, the OPP may impose specific restrictions for a pesticide's application.

In addition to FIFRA, the EPA has further authority over pesticide use under the Superfund Amendment and Reauthorization Act (**SARA**) and the Resource Conservation and Recovery Act (**RCRA**). These federal regulations cover all materials classified as hazardous and, therefore, apply to pesticides. Pesticide handling and storage are also regulated by the Transportation Safety Act and the Occupational Safety and Health Act (**OSHA**).

Moving Pesticides
Interstate transport of pesticides is regulated by the Federal Department of Transportation (**DOT**). Their guidelines for safe movement are common sense rules for any transport of chemicals. All pesticides should be in the original DOT approved containers and correctly labeled. All containers should be secured against movement that could result in breaking or spilling. Never transport pesticides in a vehicle that also carries food or feed products.

Never transport pesticides in the cab of vehicles. Paper or cardboard containers should be protected from moisture. Never leave an open-bed truck containing pesticides unattended. Following these procedures is necessary when moving concentrated chemicals and is good practice for diluted mixtures.

Persons transporting chemicals must have proper protective clothing available for the safe handling of the containers. The protective gear should be in or on the vehicle for immediate access in case a spill occurs. Protection of the person managing or cleaning up a spill is the primary concern.

Agricultural Integrated Pest Management Sub-Section

IPM offers growers an array of tools to help manage pest problems. At the foundation of this approach are good growing practices, preventive pest management measures, and a regular pest monitoring program that enables producers to accurately determine if a pest control measure is economically justified. IPM uses a common sense approach to find the weak link in a pest's life cycle. Sound pest programs do not attempt to eradicate pests, but rather to manage them so that economic crop losses are minimized. IPM is the primary BMP for pest management.

It involves combining practices such as:

- ✓ Selecting crops and varieties which are resistant to pest pressures.
- ✓ Timing planting and harvest dates to minimize pest damage.
- ✓ Rotating crops.
- ✓ Monitoring pest and natural enemy populations.
- ✓ Employing beneficial insects and other biological controls.

The philosophy behind the IPM approach is to create unfavorable conditions for pest buildup by enhancing crop vigor and by protecting natural enemies that aid in controlling pest populations.

IPM relies on a combination of practices to reduce damage by insects and related pests. Crop rotation and resistant varieties can be used to avoid some pest problems. Identifying pests promptly allows necessary and effective treatments to be applied before pest populations reach damaging levels. Treating a pest problem with either synthetic or natural pesticides is only a temporary solution. If a pest is recurring from year to year, then a new management strategy should be developed. As usually practiced, IPM includes judicious use of chemical pesticides applied only after scouting reveals pests at economically damaging threshold levels.

Scouting

An IPM program depends on good scouting. The scout walks through the field and inspects plants for insects at least once a week, sometimes more frequently when weather and season favor rapid pest buildups. Scouting for pests can prevent damage by identifying problems early, and it can save money if fewer treatments are needed (see Grower Example 1.)

Scouts target specific insects and select search techniques accordingly. Grasshoppers, for example, appear first on field edges, spider mites next to harvested small grains, and armyworms next to wheat. Other specific scouting tips are given later in this chapter. As well as looking carefully at a random sample of plants, scouts may use sweep nets to sample highly mobile insects such as potato leafhoppers.

Bean leaf beetles, cucumber beetles, Mexican bean beetles, and stinkbugs will drop onto a ground cloth or 'beat sheet' when the plant is shaken. Bright, adhesive-covered cards placed near plants will trap small, hard-to-see insects such as aphids, thrips, and whiteflies. Aphids and whiteflies are attracted to yellow cards and thrips to blue ones.

Grower Example 1
Replacing automatic spray schedules with as-needed treatments based on scouting reports saved 62 percent of a group of Florida vegetable growers an average of $95 per acre. The remaining 38 percent reported costs of monitoring equaled pesticide savings. Thus all growers did at least as well economically as if they had used scheduled pesticide applications and most did better.

For some pests, adult populations are monitored for advance warning of egg-laying and larval stages. This gives the grower time to detect population buildup before damage from the larvae occurs and to schedule any necessary treatments. Black light traps are used to attract night-flying adults of such species as the European corn borer, corn earworm, armyworm, cabbage looper, hornworm, and some types of beetles.

Adults of many moths, including most of those in the cabbageworm complex, can be lured to traps by manufactured sex signals (pheromones). The pheromones for each species are different and placement of the trap must be correct in terms of height, field location (edge or center) number of lures placed, and type of lure used. Manufacturers will provide these details, but some general guidelines are given below.

Economic Injury Thresholds
Economic injury thresholds are available for some, but not all, pests in the southern states. Economic injury levels given in this chapter are only intended as general guidelines. Information from cooperative extension agents and the experience of local growers are the best guides.

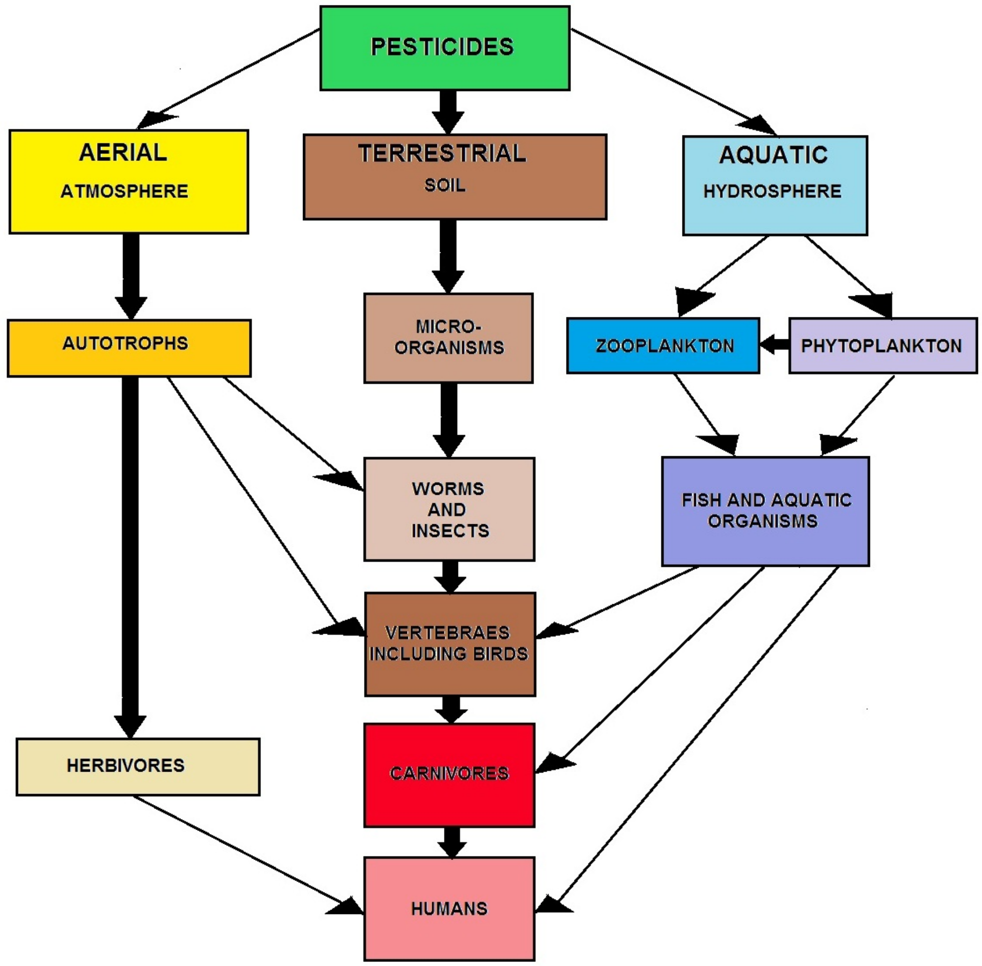
Insecticide Use
Before any insecticide is used in an IPM program, the presence of damaging levels of a pest insect should be confirmed by scouting. Unnecessary applications of insecticide increase costs, promote development of insecticide resistance, and degrade the environment. Use of insecticides sometimes increases the numbers of non-target pests.

On potatoes, for example, carbaryl (Sevin) application has produced peak green peach aphid populations that were more than ten times greater than those in untreated plots. The main factor in this population increase was direct stimulation of aphid reproduction by the carbaryl.

Total nitrogen content, which has been shown to increase aphid populations, also increased slightly, but predator and parasite populations were not affected by carbaryl.

Once the need for an insecticide is confirmed, it should be applied as efficiently as possible. In the middle of hot, dry days, insects are less active and less likely to come in contact with the insecticide. It will also be difficult to get good coverage of wilted plants, and heat will volatilize some insecticides before they reach the plant.

Using the most appropriate sprayer will also increase efficiency as only chemicals deposited on plant surfaces kill insects. For aphids and other underleaf insects, only spray deposited on leaf undersides is effective. Conventional sprayers rely on gravity and inertia to deliver pesticides. By some estimates, only half the pesticide applied adheres to the plant.



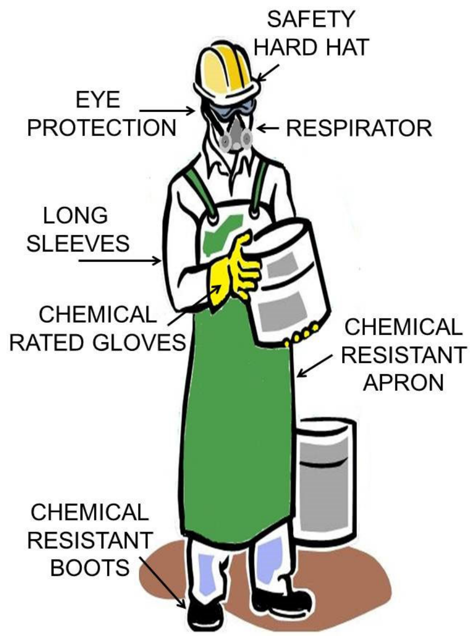
PESTICIDE FATE DIAGRAM

Persistence of a Chemical

Most organochlorine pesticides (e.g., DDT, chlordane) are very persistent. Most of the organophosphates (e.g., parathion, Malathion) and pyrethroids are much less persistent. Pyrethrins, and carbamate pesticides are nonpersistent. Some factors that influence the persistence of a chemical and the possibility that residues may remain are:

- ✓ The amount of chemical applied
- ✓ The formulation
- ✓ The pH (acidity or alkalinity) of the water diluent and of the target tissue, soil, or water.
- ✓ The nature of the surface to which it is applied.
- ✓ Exposure to weathering from wind, rain, etc.
- ✓ Chemical breakdown from high temperatures and humidity
- ✓ Photochemical reactions from sunlight
- ✓ Biological reactions.

If public health pesticides are applied properly and in accordance with label restrictions for applications around food crops residues on or in the crop should never be a problem.



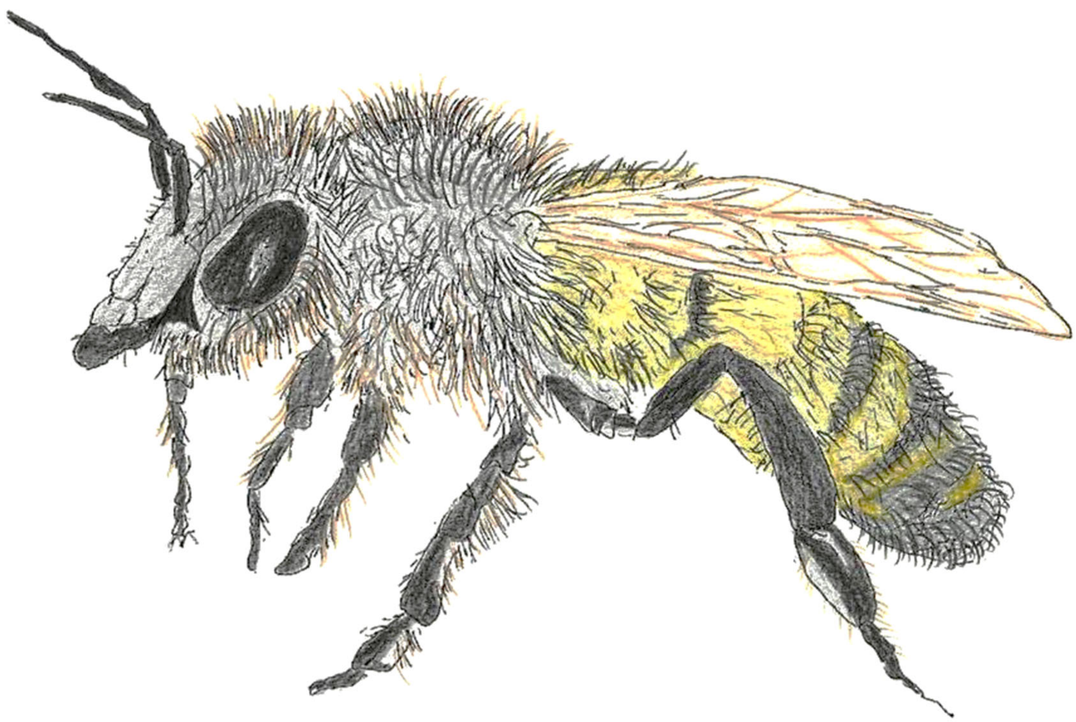
Wearing protective clothing and equipment when handling or applying pesticides reduces the risk of pesticide poisoning. Risk of pesticide poisoning is reduced because the chance of exposure is reduced.

EACH PESTICIDE HANDLER EMPLOYEE MUST HAVE AN UNDERSTANDING OF THE FOLLOWING SUBJECT AREAS TO SAFELY USE AND HANDLE PESTICIDES:
PESTICIDE PRODUCT LABELING - Format and meaning of information, such as the precautionary statements concerning human health hazards.
HAZARDS OF PESTICIDES - These are identified in product labeling, Safety Data Sheets (SDS), or PSIS Leaflet (Pesticide Safety Information Series).
PESTICIDE SAFETY REQUIREMENTS AND PROCEDURES - This in regards to regulation, PSIS Leaflets, SDS, Including Engineering Controls, for handling, transporting, storing and disposal of Pesticides.
ENVIRONMENTAL CONCERNS - This addressess the aspect of drift, runoff, and the hazards to Wildlife.
ROUTES OF ENTRY - This area addressess the hazards of which Pesticides can enter the body: Dermal (skin) , Oral (swallowed), Inhalation (breathe in), Ocular (through the eyes).
COMMON SIGNS AND SYMPTOM OF EXPOSURE - Some of the basic symptoms include: Headache, fatigue, weakness, nervousness, nausea, perspiration, eye and skin irritation.
EMERGENCY FIRST AID - Know and understand the basic procedures necessary for first aid concerning exposure to pesticides. This may include basic CPR.
USE AND CARE OF PERSONAL PROTECTIVE EQUIPMENT - Each employee who handles or may have the chance of being exposed to pesticides must have required Personal Protective Equipment available, and each employee must know and understand the proper use and care of this equipment.
THE ITEMS LISTED ABOVE ARE JUST BASICS REQUIRED TO SAFELY HANDLE PESTICIDES

Honeybee Protection Sub-Section

For vector control technicians, protecting domestic bees is primarily a concern when doing ULV adult mosquito control. The pesticides most commonly used for these applications (pyrethrins and pyrethroids) are toxic to bees. However, they are applied in minute quantities (often less than 1 ounce per acre of total volume of material) during the evening or early morning when bees are inactive. Taking the reasonable precaution of turning off the sprayer while passing the hives should be adequate to prevent any mortality in the bees from the product.

Bees are readily poisoned by organophosphates and many agricultural pesticides. When a pesticide known to be harmful to bees is used near bee hives or to any cropland where honey bees are working, special procedures must be followed. In some areas centralized private organizations operate a beekeeper notification program. Bee notification maps are maintained and each day copies of beekeepers' requests for notification from the County Agricultural Commissioner are received. Then interested bee keepers are notified by a single telephone call of all intended applications within one mile of their hives.



Honeybees   Apidae Family of Insects

The Apidae are a large family of bees, comprising the common honey bees, stingless bees (which are also cultured for honey), carpenter bees, orchid bees, cuckoo bees, bumblebees, and various other less well-known groups. The family Apidae presently includes all the genera that were previously classified in the families' Anthophoridae and Ctenoplectridae, and most of these are solitary species, though a few are also cleptoparasites. The four groups that were subfamilies in the old family Apidae are presently ranked as tribes within the subfamily Apinae.

This trend has been taken to its extreme in a few recent classifications that place all the existing bee families together under the name "Apidae" (or, alternatively, the non-Linnaean clade "Anthophila"), but this is not a widely-accepted practice.

The subfamily Apinae contains a diversity of lineages, the majority of which are solitary, and whose nests are simple burrows in the soil. However, honey bees, stingless bees, and bumblebees are colonial (eusocial), though they are sometimes believed to have each developed this independently, and show notable differences in such things as communication between workers and methods of nest construction. Xylocopines (the subfamily which includes carpenter bees) are mostly solitary, though they tend to be gregarious, and some lineages such as the Allodapini contain eusocial species; most members of this subfamily make nests in plant stems or wood. The nomadines are all cleptoparasites in the nests of other bees.

Adults measure ¾-inch long and are fuzzy, with gold and black stripes and transparent wings. Honey bees can often be identified by the balls of yellow pollen they carry on the backs of their legs. Honey bees are an important pollinator of many plants.

Genus Apis
Honey bees (or honeybees) are a subset of bees in the genus Apis, primarily distinguished by the production and storage of honey and the construction of perennial, colonial nests out of wax. Honey bees are the only extant members of the tribe Apini, all in the genus Apis.

Currently, there are only seven recognized species of honey bee with a total of 44 subspecies, though historically, anywhere from six to eleven species have been recognized. Honey bees represent only a small fraction of the approximately 20,000 known species of bees. Some other types of related bees produce and store honey, but only members of the genus Apis are true honey bees. As in a few other types of eusocial bees, a colony generally contains one queen bee, a fertile female; seasonally up to a few thousand drone bees or fertile males; and a large seasonally variable population of sterile female worker bees.

Details vary among the different species of honey bees, but common features include:
1. Eggs are laid singly in a cell in a wax honeycomb, produced and shaped by the worker bees. Using her spermatheca, the queen actually can choose to fertilize the egg she is laying, usually depending on what cell she is laying in. Drones develop from unfertilized eggs and are haploid, while females (queens and worker bees) develop from fertilized eggs and are diploid. Larvae are initially fed with royal jelly produced by worker bees, later switching to honey and pollen. The exception is a larva fed solely on royal jelly, which will develop into a queen bee. The larva undergoes several moltings before spinning a cocoon within the cell, and pupating.
2. Young worker bees clean the hive and feed the larvae. When their royal jelly producing glands begin to atrophy, they begin building comb cells. They progress to other within-colony tasks as they become older, such as receiving nectar and pollen from foragers, and guarding the hive. Later still, a worker takes her first orientation flights and finally leaves the hive and typically spends the remainder of her life as a forager.

GIANT HONEY BEE

3. Worker bees cooperate to find food and use a pattern of "dancing" (known as *the bee dance or waggle dance*) to communicate information regarding resources with each other; this dance varies from species to species, but all living species of *Apis* exhibit some form of the behavior. If the resources are very close to the hive, they may also exhibit a less specific dance commonly known as the "Round Dance".
4. Honey bees also perform tremble dances which recruit receiver bees to collect nectar from returning foragers.
5. Virgin queens go on mating flights away from their home colony, and mate with multiple drones before returning. The drones die in the act of mating.
6. Colonies are established not by solitary queens, as in most bees, but by groups known as "swarms", which consist of a mated queen and a large contingent of worker bees. This group moves *en masse* to a nest site that has been scouted by worker bees beforehand. Once they arrive, they immediately construct a new wax comb and begin to raise new worker brood. This type of nest founding is not seen in any other living bee genus, though there are several groups of Vespid wasps which also found new nests via swarming (sometimes including multiple queens). Also, stingless bees will start new nests with large numbers of worker bees, but the nest is constructed before a queen is escorted to the site, and this worker force is not a true "swarm".

Pesticide Resistance

Pesticide resistance is the ability of pests to avoid the lethal effects of pesticides. Certain populations of pests use one or more different physiological or behavioral defense mechanisms to withstand doses of pesticides that previously were lethal to the pests. This can happen through spontaneous mutations in populations resulting in genes that confer pesticide resistance, or because a small proportion of the population carries a gene for pesticide resistance naturally. In either case, resistance develops gradually to the point where pesticide applications begin to fail after repeated exposure to the same pesticide.

This is because the parts of the population that carry the gene for susceptibility are killed off, and soon, a disproportionate segment of the population carrying the gene for resistance predominates. This can be an unintended effect of using pesticides. Resistance in numerous pests of public health importance has occurred to a variety of pesticides. For mosquitoes and flies, resistance to organochlorines and organophosphates has been particularly common.

Selective pressure is the repeated exposure of a population of pests to treatments of the same pesticide over time resulting in a change in the genetic makeup of that population. In this case, the population is selected to favor resistant genes at the expense of susceptible genes, and the population becomes resistant to that pesticide. Because of the nature of population genetics, the population never becomes completely resistant, but the frequency of individuals have susceptible genes becomes very small.

Knowing the mechanisms of development of pesticide resistance is important to developing strategies to avoid creation of resistance in pest populations. The basic principle is the preservation of susceptible genes in pest populations, and the endeavor to do this is named pesticide resistance management.

Usually, when a pest population becomes resistant to one pesticide it can still be controlled by other pesticides, especially pesticides in a different family of chemicals.

Occasionally, resistance to pesticides other than the pesticide responsible for resistance may occur. This is called cross-resistance. Its occurrence is usually seen among chemically related pesticides where the mode of action is identical or very similar.

Early Signs of Resistance
Not all pest control failures are the result of resistance. Improper pest control practices may be at fault. However, if the material was timed and applied properly at the recommended rate and no other important factors (such as unfavorable weather) have interfered with the pesticide application, resistance should be considered.

Early signs of resistance may sometimes be recognized in the field. These include increasing difficulty in controlling a pest, increasing numbers of formerly minor pests, and increasing trouble with insect-transmitted disease. Developing resistance can be very subtle and may go unnoticed for a time; it may appear in certain locations or breeding sites. Suspected resistance should be reported to your supervisor immediately since early detection may make it possible to delay resistance by the application of counter measures.

Resistance Management
Based on the genetic principles of development of pesticide resistance in pests, a number of principles have evolved over the years that when implemented can either delay resistance, or avoid it entirely. Some of these principles are:

- ✓ Avoid under-dosing in pesticide applications. If this is done repeatedly it encourages survival of individual pests carrying genes for resistance, especially when the effects of the gene are not absolute (protects only partially).
- ✓ Do not always treat a given population with the same pesticide. Switch to other products periodically. This is called pesticide rotation.
- ✓ Test populations of vectors for evidence of resistance, and when it is detected switch to alternate pesticides.
- ✓ Avoid slow-release applications where pest populations are exposed for long periods of time to sub-lethal doses of one pesticide.
- ✓ Combine pesticide applications with other forms of pest management such as biological control, habitat alteration, and use of biorational pesticides. The use of biorational pesticides is not a guarantee that resistance to these products will not occur, but resistance to biorational pesticides have been far less common than to conventional pesticides.

Equipment Serviceability/Spray Calibration Sub-Section

Before spraying, several key points related to the equipment must be checked:

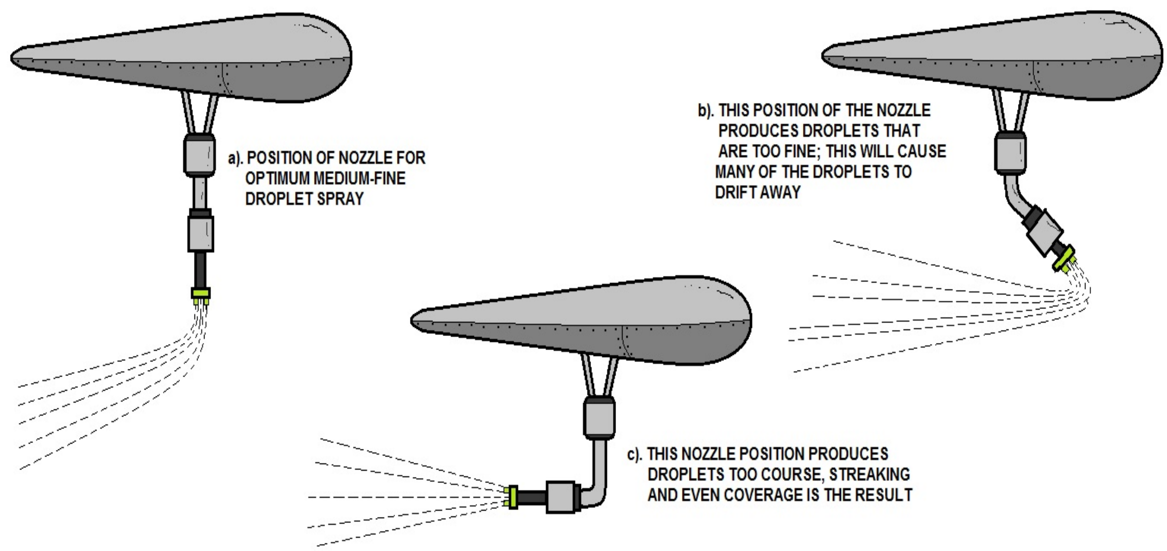
- ✓ Structures on and around the airstrip: steps, ladders, handrails and loading equipment must all be checked for serviceability.
- ✓ Guards on engine driven pumping and filling systems must be in place and secure.
- ✓ The aircraft's maintenance manual and the spray equipment manufacturer's instructions must always be consulted in the first instance.
- ✓ The pilot and the support staff are responsible for the aircraft's airworthiness, however, in many cases, the spraying system is maintained by an aircraft mechanic who must be trained and fully protected when working on the spray equipment.
- ✓ When starting up the system, before spraying it is advisable to initially rotate the spray pump by hand, irrespective of drive type (wind, hydraulic or electric) to ensure that it is free to turn.
- ✓ Blade angle on some wind driven pumps can be checked for adjustment and the transport brake, for locking the pump during ferry runs, must be fully clear when released.
- ✓ All filters must be in place and self-fill valves and couplings clean and serviceable.
- ✓ Hoses and hose joints must be visually assessed, and where component parts are wired to the aircraft for security the condition of the wires must be checked.
- ✓ In the cockpit, operation of the three way valve must be positive and the hopper emergency dump mechanism safe and operational.
- ✓ Nozzles and nozzle bodies must be checked for wear and damage and the diaphragm check valves must be in good condition to ensure a positive spray cut-off. Rotary atomizers must be in balance and rotate freely. If they are blade driven, the blades must be free from damage and correctly adjusted for the selected rotational speed (droplet size control). Liquid flow restrictor adjustment must to be checked and adjusted for the required throughput for the desired application rate.
- ✓ It may not be possible to fully pressurize the spray system on the ground, particularly where the spray pump is wind driven, but at some stage the system must be checked for leaks. The aircraft will have to be flown to check the operation of the spray system

and the efficiency of the pressure gauge. If the gauge does not return to zero when the spraying system is switched off the three way valve may not be closing correctly. This in turn will reduce the efficiency of the "suck-back" circuit when the spray is turned off.

- ✓ Aircraft mounted electronic equipment such as the spray liquid flowmeter, output printer and navigational aid system have to be checked and re-calibrated against manufacturer's calibration figures.

Adjustment and Control Checks

The spray system on/off and liquid flow rate controls are adjusted by the pilot during the operational checks. The spraying system must be checked as outlined above and the boom orientation in relation to flight direction may have to be adjusted to alter droplet size from hydraulic nozzles. Nozzle selection can be made according to product label recommendation but nozzle types; spray angles and throughputs must not be mixed on the boom. Boom orientation and nozzle positioning must be finally verified to ensure vortex creation is minimum.



NOZZLE POSITIONING FOR OPTIMUM COVERAGE

Where rotary atomizers are used, they should be adjusted for similar speeds. Occasionally inboard atomizers are adjusted to compensate for the increase in air speed from fuselage "screw", and the manufacturer's instructions should be referred to. Where liquid flow rate is controlled using an adjustable restrictor, it is important to ensure that the liquid feed is the same for each atomizer. Atomizer speed is monitored via a tachometer unit that feeds information for individual atomizer rotational speeds to a cockpit-readout.

Conventional Spray Calibration
The Department of Agriculture or Pesticide Agency may have in place a schedule of use rules for spray aircraft that include regular spray system calibration and distribution checks and general equipment serviceability assessments. To ensure such that checks are efficiently carried out the use of an independent agency or service is recommended.

CROP	SPRAY QUALITY	TRAVEL SPEED	DISTANCE TO TARGET	VOLUME	RATE
FIELD Carrot, Celeriac, Grape, Berry, Bulb Vegetable, Strawberry, Brassica, Leafy Vegetable, Crabapple	NOT SPECIFIED	SELECT A SPEED THAT ALLOWS PRODUCTIVITY, BUT: DOES NOT REQUIRE BOOM TO BE RAISED ABOVE 60 cm	< 60 cm	≤ 250 L/ha FOR CERTAIN CROPS	0.6 - 1.6 kg / ha
AIRBLAST Stone Fruit, Berry, Crabapple, Hops, Grapes, Pome Fruit	NOT SPECIFIED	SELECT A SPEED THAT ALLOWS PRODUCTIVITY, BUT: ALLOWS CANOPY PENETRATION WITHOUT EXCESSIVE BLOW-THROUGH	> 50 cm	NOT SPECIFIED	0.6 - 1.6 kg / ha

CHECKING SPRAYER SETTINGS

Spray equipment calibration must be carried out at the start of each season, after equipment repair or when changing application technique. There are three major factors, which influence sprayer calibration:

a) Speed over the ground (m/h)
b) Swath width and lane separation
c) Liquid flow rate (1/min)

a) Forward speed over the ground can be determined by timing the aircraft over a measured distance flying in both directions to compensate for wind influence. This operation must be replicated three times to obtain an average speed and is necessary as the aircraft instrumentation will indicate only speed through the air.
b) Effective swath width is taken as the lane separation for each aircraft pass and will vary between conventional and ULV application. Recommended flying height should also be checked during field observation as a function of swathe width.
c) The spray liquid flow rate from the nozzles at a given operating pressure can be obtained from the nozzle manufacturer's information sheets. Such information is generated spraying clean water and presents a good starting point. However, unless the nozzles are specifically designed for it the special conditions and the low volume rates of aerial applications may result in different flow rates than indicated in the manufacturer's information.

The spray liquid output from an aircraft fitted with an electric or hydraulic driven pump can be determined on the ground but to determine the output from a wind driven pump system the aircraft will have to be flown at spraying speed.

ULV Spray Calibration
ULV spraying applies formulations, usually undiluted, in high concentrations of both active ingredient and non- volatile agents. There is a high degree of drift associated with the small droplets used for ULV spraying, which makes the technique more suited for large areas of crop, rangeland and for public health programs.

The actual field spraying using aircraft is more demanding than that for conventional work because the viscosity and therefore the flow rate of formulations vary. Initial settings can be taken from the manufacturer's data for water but ready-to-use ULV formulations may have a higher viscosity and lower flow rate than water so will have to be corrected by multiplying the total flow rate by between 1.1 and 1.3 depending on the formulation viscosity.

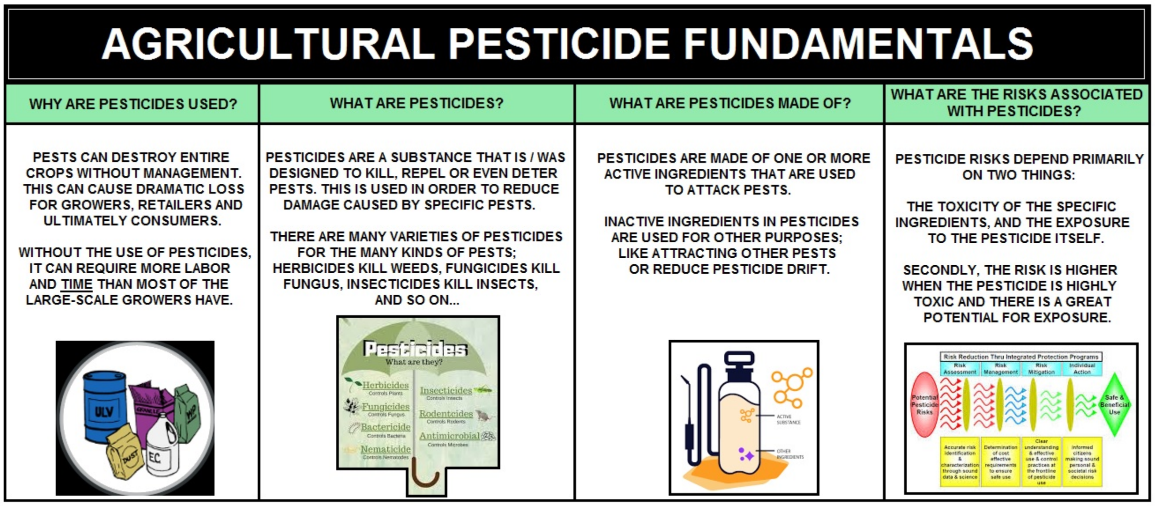
Determining the speed of the aircraft over the ground is the same as for conventional spraying, however, with ULV spraying, the swath width will be wider as the aircraft is usually flown slightly higher.

For ULV, there are fewer spray emission points on the boom than for conventional spraying and accordingly flying height should be increased by 6-10 feet to allow the spray plumes from each atomizer to fully develop and meet. Otherwise, there is the danger of leaving untreated strips on each pass, however, and alternative solution is to increase the number of outlet points on the booms (i.e. additional atomizers at closer spacing).

Flying height can be re-confirmed following and assessment of spray distribution, which must be included as part of the calibration process.

Rotary atomizers are usually propeller driven by the aircraft slipstream but where slow aircraft or helicopters are used, electric or hydraulic drives may be necessary. This is particularly important for helicopter spraying where atomizers must quickly regain operational speed to maintain the correct droplet size following sharp turns "out of and into work".

Proper Pesticide Handling Sub-Section



AGRICULTURAL PESTICIDE FUNDAMENTALS

Technical Learning College

If improperly used, pesticides can poison people, pets and livestock. They also can damage beneficial insects, birds, fish and other wildlife; harm desirable plants; and they may contaminate soil and groundwater. It is necessary to maintain careful and continuous control over the use and handling of these chemicals during the transport, storage, mixing, loading, application and disposal. Care must be exercised in cleaning equipment, clothing, and persons working with pesticides. Additionally, special precautions are necessary if pesticides are spilled or catch fire. Certain materials associated with vector control operations, including some pesticides, are considered by EPA and state pesticide agency to represent hazardous wastes.

Transporting Pesticides

Pesticides can present a particularly severe hazard if they are involved in accidents during transportation. When pesticides are spilled on the roadway, they may catch fire, be scattered by passing cars and trucks, be blown by wind onto nearby crops or people, or be washed into ditches or streams by rain. If they catch fire, the fumes and smoke may injure fire fighters, police, and people far removed from the scene of the accident.

Even under relatively uneventful circumstances, pesticides may simply contaminate the vehicle, cargo, or people transporting the chemicals. When you transport pesticides, you are legally responsible for them.

To reduce the likelihood of pesticide spills or exposure of workers riding in vehicles transporting pesticides, the following guidelines should be followed:

1. Pesticides are most safely transported in the beds of trucks.
2. Pesticides should never be transported in the passenger compartment of any vehicle.
3. People should never be allowed to ride in the beds of pick-up trucks carrying pesticides. This applies especially to children as passengers.

4. Pesticides should never be transported in the same compartment with food, feed, or clothing.
5. All pesticide containers in shipment should be secured tightly. This is especially critical for glass containers.
6. Pesticide containers made of paper, cardboard, or similar materials should be protected from moisture during transport.
7. Pesticides in parked service vehicles must be made secure from theft, tampering, and contamination.

More on Storing Pesticide
It is necessary and legally required that pesticides be stored in a safe, secure and well-identified place. Here are some rules which pertain to pesticide storage:
1. Always store pesticides in their original, labeled container with the label clearly visible.
2. Always store pesticides in tightly sealed containers and check containers periodically for leakage, corrosion breaks, tears, etc.
3. Always store pesticides where they are protected from freezing or excessive heat.
4. Always be certain that pesticide storage areas are well-ventilated to prevent the accumulation of toxic fumes.
5. Always store different types of pesticides in different areas, to prevent cross contamination and the possibility of applying a product inadvertently.
6. Never store pesticides in old bottles or food containers where they could be mistaken for food or drink for humans or animals.
7. Never store pesticides near food, feed, or seed.
8. Agencies or programs that store significant amounts of pesticide should have a designated pesticide storage facility.

Requirements for Pesticide Storage:
1. Locking doors
2. Adequate lighting
3. Adequate ventilation
4. Fire extinguishers readily available
5. Spill containment design or equipment
6. Warning placards if Category I or II pesticides are stored – including emergency contact information
7. Personal protective equipment readily available
8. Wash water and eye wash stations available
9. Presence of label and MSDS book for stored materials

Recommended for pesticide storage:
1. Fire resistant construction
2. Emergency shower station
3. Spill containment floor design or drum pallets

Mixing and Loading Pesticides
All pesticides are potentially harmful, particularly for those who work with them on a daily basis because of the potential for being exposed to large doses and the likelihood of chronic exposure. Many pesticide accidents occur when the chemicals are being mixed for use. In California, one of the most dangerous jobs related to pesticide-related illness, is the mixing

and loading of concentrated chemicals, specifically low-volume and ultra-low volume formulations.

A few common sense rules can make mixing and loading safer, thereby helping you to avoid the leading cause of pesticide-related illnesses:

1. Before handling a pesticide, READ THE LABEL.
2. Based on label recommendations, put on protective clothing and use other necessary protective equipment. Also from reading the label, follow instructions on what special equipment is necessary. If you have questions concerning protective equipment, contact your county agricultural commissioner or other expert before you open the container.
3. Mix the pesticides outdoors, in a place where there is good light and ventilation. If you must mix or load pesticides indoors or at night, make sure you have good ventilation and lighting.
4. Stand upwind of the pesticide to avoid contaminating yourself.
5. Use a sharp knife to open paper bags; do not tear them or the label.
6. Measure accurately; use only the amount you need to apply at the rate specified on the label.
7. When removing the concentrated material from the container, keep the container below your waist if possible to prevent the possibility of splashing or spilling any pesticide into your face and eyes.
8. If you splash or spill a pesticide while mixing or loading, stop immediately! Remove contaminated clothing; and wash thoroughly with detergent and water. Speed is essential if you or your clothing are contaminated. Clean up the spill.

Applying Pesticides

Careful attention to a few simple guidelines during pesticide application will greatly increase your chances of effectively controlling the pest. At the same time, attention to these details will make the job much safer for you, other people, pets, livestock, and the surrounding environment.

1. Before you begin the application, READ THE LABEL. Don't trust your memory for details concerning the use of any pesticide.
2. Check the application equipment. Look for leaking hoses or connections, plugged or worn nozzles, and examine the seals on the filter openings to make sure they will prevent spillage of the chemicals.
3. Calibrate your equipment before use. Make certain that your equipment is adjusted according to the manufacturer's specifications and meets label requirements for the product being applied. This will assure that the proper dosage is being applied to the target site.
4. Before the pesticide application starts, clear all livestock, pets and people from the area to be treated. Although it would be the ideal situation, most ULV labels do not require this. Always check the label for any specific restrictions.
5. Apply the pesticide at the recommended rate. Do not exceed the maximum application rate specified on the label or the written recommendation.
6. Apply pesticides only at the correct time and under acceptable weather conditions – check the label for specific limitations. Avoid applying pesticides when temperatures are extremely high or low. Be especially careful when temperatures exceed 85ºF or are below 50ºF.
7. When handling category I and II toxic pesticides, one should try to not work alone.
8. Use extreme care to prevent the pesticide from contaminating unintended target sites (e.g., streams, ponds, lakes or other bodies of water). Remember also that direct application of pesticides to these types of bodies of water requires special permitting.

9. Avoid situations where the pesticide may drift from the application area and contaminate non-targets.
10. Do not contaminate food or feed through careless application methods.

Equipment Clean-up
After completing the application of any pesticide, immediately clean the mixing, loading, and application equipment. The cleaning operation can be somewhat hazardous if proper precautions are not followed. People who clean the equipment must:
1. Know the correct procedures for cleaning and decontamination.
2. Wear the appropriate personal protective equipment.
3. Know and use the specific area set aside for cleaning. This will usually be on a wash rack or concrete apron that has a well-designed sump to contain all contaminated wash water and pesticides for later disposal, or in the field where rinse water may be considered part of the application.

Pesticide Wastes and Disposal Methods
Waste materials should be considered hazardous to the public, the people handling them and the environment. Deciding how to dispose of pesticide wastes should be done on a case-by-case basis. Materials that meet the legal requirements as hazardous wastes in California (some pesticides, used crankcase oil, used antifreeze, etc.) must be disposed of according to special rules.

Waste materials that are not classified as hazardous waste can be disposed of in other ways, but should never be dumped into drains or water courses of any kind. The best way to avoid all waste pesticides is to use them up in legal pesticide applications. Even the rinse water used in cleaning pesticide equipment can be used as a diluent in tank mixes that contain water soluble pesticides.

Pesticide Container Wastes
Always dispose of pesticide containers in a manner specified on the label. Pesticide container disposal can be a significant problem, particularly if you have a large number of containers. Many pesticide containers can be recycled, either as a part of a regular recycling program, if approved on the label, or by returning to the chemical supplier. Many chemical companies now re-cycle their pesticide containers.

Correct Rinse Procedure

Before disposing of any empty pesticide container, it must be rinsed. The correct rinse procedure follows:

1. Empty the container into the mixing tank and allow the pesticide to drain for an extra 30 seconds. Do not fill the tank to the desired level yet. First complete the triple rinse method described here, adding the rinse solution to the tank as described in (4) below.
2. Add the correct amount of water for thorough rinsing as follows:
   - ✓ Size of Container
   - ✓ Amount of Rinse Water
   - ✓ Less than 5 gallons
   - ✓ One-fourth container volume
   - ✓ 5 gallons or more
   - ✓ One-fifth container volume

3. Replace the container closure; then rotate and shake the container, so that the rinse reaches all interior surfaces.
4. Drain the rinse solution from the container into the mixing tank. Allow the container to drain for an extra 30 seconds after emptying.
5. Repeat this rinsing procedure at least two more times for a total of three rinses. Remember—it is important to empty each rinse into the mixing tank so that the pesticide goes on the target for which it is intended (this procedure also saves money). Never pour pesticides down an ordinary drain or flush them down a toilet!
6. Now the triple rinse procedure is complete. Let the container dry and replace the cover.

Many containers will be discarded after one use. California regulations concerning pesticide container disposal do not apply to containers in which household pesticides have been packaged. However, these containers (except aerosol cans) should be rinsed carefully and destroyed to prevent their reuse.

Unused and Excess Pesticide Disposal

Disposing of unused (still in the original container) and excess (already mixed, but not needed) pesticides can be a significant problem. For vector control agencies, the easiest solution is to mix only as much product as will be needed. This is critical for Bacillus thuringiensis var. israelensis (Bti) because it loses efficacy after 24 hours. The best way to dispose of any currently labeled pesticide is to apply it according to the label. If that is not possible because of a label change, contact your local County Agricultural Commissioner – in many instances, you will be directed to use the remainder of the product per label instructions. For any currently labeled pesticide, the best alternative would be to find another person or area with the same pest problem, so that the pesticide gets used up legally and effectively. If you cannot find another area with the same problem, you might decide to dispose of the pesticide in an approved location. Contact the California Department of Pesticide Regulation, or your County Agricultural Commissioner for specific information on regulations and pesticide dump sites.

Personal Clean-up

After you have completed the pesticide application, disposed of excess material, and cleaned the application equipment, you should thoroughly wash all your protective equipment. Remove your work clothes and place them in an area separate from other laundry items or properly dispose of them if they are disposable coverall, e.g., Tyvek®.

Do not allow children to play in or with the contaminated clothing. The pesticides on your work clothes could contaminate people who touch them, so warn whoever will be washing the clothes of the possible danger, and tell this person that pesticide-contaminated clothing should be washed separately from other clothing. Now take a shower. Wash yourself completely with soap and water. Remember to include your hair and fingernails in the wash-up. Do not put on any article of clothing worn while working with pesticides until after it has been laundered.

Pesticide Spills -Introduction

Since some pesticides qualify as hazardous materials, a variety of local, county, and state agencies will become involved in reporting and cleanup, especially if the spill occurs while pesticides are in transit. In this case, peace officers are often the first responders, and they are required to report pesticide spills under the local vehicle laws.

Pesticide spills that cannot easily be cleaned-up and decontaminated by vector control program personnel can be reported directly to the local health officer who will in turn contact the County Agricultural Commissioner or the County Health and/or Environmental Health Department. One should also use common sense judgment to determine the danger that is created with a spill, e.g., a spill that occurs in a confined and enclosed area versus an open area.

In spite of the most careful use and handling of pesticides, accidental spills and fires occasionally occur.

These range in size from small spills of a household pesticide container to huge fires involving entire manufacturing warehouses filled with the most toxic pesticides. Intelligent planning, knowledge of the chemicals involved and calm consideration of the actual hazards to be dealt with during the emergency will reduce the risk and damage resulting from the accident.

Pesticide spills can and do happen anywhere pesticides are transported, stored, or applied. When a spill occurs, it should be cleaned up as quickly and safely as possible.

For some pesticides and formulations, such as Altosid® pellets, clean-up is as simple as collecting the spilled product and using it.

PESTICIDE USED	25 GALLON SOLUTION	DIRECTIONS
2, 4-D AMINE DICAMBA, BANVEL / CLARITY	1 - QT. HOUSEHOLD AMMONIA + DETERGENT SOLUTION FOR RINSE	AGITATE, FLUSH SOME AND LET SET OVER NIGHT. FLUSH AND RINSE.
2, 4-D ESTER BRUSH KILLERS	1 - lb. WASHING SODA + 1 - gal. OF KEROSENE + 1/4 lb. OF POWDER OR LIQUID DETERGENT	RINSE INSIDE OF TANK AND FLUSH SOME THROUGH THE SPRAYER. LET SET FOR 2 HOURS. FLUSH AND RINSE
SULFONYLUREA HERBICIDES	1 - gal / 50 gal WATER HOUSEHOLD AMMONIA + DETERGENT SOLUTION FOR RINSE	AGITATE, FLUSH SOME AND LET SET OVER NIGHT. FLUSH AND RINSE
OTHER HERBICIDES, INSECTICIDES, AND / OR FUNGICIDES	1/4 lb. OF OR LIQUID DETERGENT	AGITATE, FLUSH, AND RINSE

GENERAL CLEANING INSTRUCTIONS FOR AGRICULTURAL CHEMICALS

A few general rules apply to all pesticide spill clean-ups.

1. Avoid exposure of people and animals to the pesticide. If you spill a pesticide, immediately see to it that no one is exposed or contaminated by accidentally walking into the spill or breathing the fumes.
2. Start by putting on protective clothing so that you do not contaminate yourself.
3. Provide some sort of a barrier to the spread of a liquid pesticide. A barrier may be made of dirt, sawdust, old newspapers or anything that will soak up the pesticide.
4. Remove the contaminated materials to a safe place. If the spill is inside the home or another building, soak up liquid pesticides or sweep up powders and remove them to the outside. Ventilate the area to prevent the buildup of toxic fumes.
5. Thoroughly clean the affected surface. Consult the label for specific disposal and decontamination instructions. Take care to prevent the wash from spreading and possibly contaminating a larger area. Make sure any wash does not go into storm drains or sewer systems.
6. If the spill that cannot be easily cleaned involves a public area, such as a highway, notify the police, sheriff's office, fire department, the highway patrol, or other local emergency services agency.
7. While waiting for emergency personnel to arrive, do what you can to prevent others from being exposed to the pesticide.

Remember: The highest priorities are to prevent exposure to the pesticide and to prevent the spread of the spill. In the event of a large spill that cannot be easily contained, contact emergency services personnel, tell them about the nature of the chemical and explain to them what you know about the pesticide involved. If it is a Toxicity Category I or II pesticide, their lives may depend on your warning!

Pesticide Fires

Small Fires
If a fire occurs in an area where pesticides are used or stored, and the fire is very small and easily extinguished, you may elect to attack it yourself if you follow certain precautions:

1. Use foam or carbon dioxide from a fire extinguisher in lieu of water if at all possible.
2. Wear protective safety equipment.
3. Avoid exposure of smoke, mist, spray, runoff, and concentrated pesticide chemicals.

Large Fires
In the event of any large fire, contact emergency fire services immediately! When large fires involving the presence of very toxic materials (including pesticides) occurs, the fire department responding to the emergency call will seek the aid of specialized agencies which deal with such chemical emergencies.

Whenever pesticides are involved in fires, they can create special hazards. Anyone in the vicinity of the fire may be exposed to toxic fumes, poisonous runoff, and concentrated pesticides from leaking or exploding storage containers. Here are some general rules that apply to pesticide fires.

Maintaining communications with the responding fire department is essential. Keep them updated on what chemicals you are storing, where it is stored, how much is being stored, and supply them with any information such as material safety data sheets they may request concerning the nature of the chemicals. This may allow them to prepare for possible emergencies and may save lives and property.

Before the fire department arrives you should:

1. Not risk your own health to fight a large fire — consider the risks of potentially toxic smoke, explosion, and your limited capacity to control the fire. You may inadvertently risk the health and safety of the professionals or others, particularly if you are injured in your attempts. Do not attempt to fight the fire unless you have been trained to do so; it is the job of highly trained professionals to fight fires.
2. Avoid poisoning: Keep yourself and others out of smoke, mist, spray, and pesticide runoff.
3. Notify all those in close proximity of the fire and downwind and tell them to evacuate the area.
4. Wear personal protective equipment if it can be safely retrieved.

After the arrival of the fire department, you should:

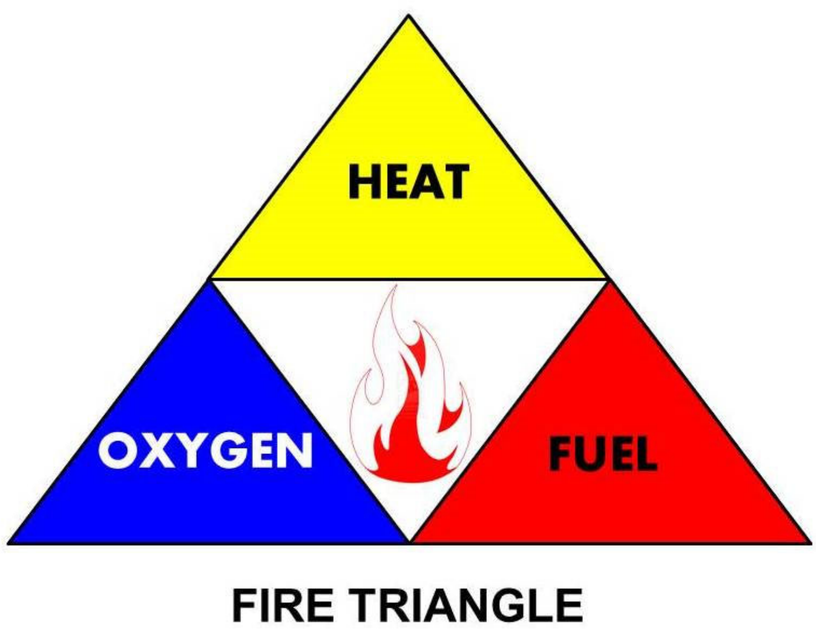
1. Without risking your health or safety, take steps to minimize contamination of areas outside the fire zone by runoff from firefighting. This can help contain spilled pesticide and thus avoid affecting people and domestic animals and the environment. It is especially important to avoid runoff of contaminated water into nearby streams or lakes.
2. Cool nearby pesticide containers; move vehicles and any threatened mobile equipment if it is safe to do so.

Adverse Pesticide Related Events

For vector control agencies, adverse pesticide related events must be reported to the California Department of Public Health and the County Agricultural Commissioner.

Adverse events (conspicuous or suspected) that must be reported:

1. Any human illness associated with a vector control pesticide application.
2. Any report of harmful non-target effects of an application to plants, domestic animals, or wildlife.
3. Any pesticide spill requiring an emergency services response.



FIRE TRIANGLE

Topic 7 - Aerial and Agricultural Pesticides Section

Answers are after the Glossary in rear
Fill in the blank

Fenthion
1. Fenthion is a(n) _______________ insecticide, avicide, and acaricide. Like most other organophosphates, its mode of action is via cholinesterase inhibition.

Malathion
2. Malathion is a pesticide that is widely used in agriculture, residential landscaping, public recreation areas, and in public health pest control programs such as_______________. In the US, it is the most commonly used organophosphate insecticide.

Permethrin
3. 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. __________have been synthesized to be similar to pyrethrins yet more stable in the environment.

Adsorption Process
4. Adsorption often occurs because of the ______________between a chemical and soil particles.

Adsorption
5. Adsorption is the binding of the pesticide to the ____________of the soil or organic matter, which is abundant in turf.

Pesticide Transfer
6. Pesticide transfer is ______________for pest control.

Volatilization
7. _______________is an important factor in determining whether a pesticide will volatilize. The higher the vapor pressure, the more volatile the pesticide.

Thermophilic Temperatures
8. Volatilization of a pesticide is______________; thermophilic temperatures typically increase pesticide losses.

Photodegradation
9. Factors that influence pesticide photodegradation include the_________________, properties of the application site, the application method and the properties of the pesticide.

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Proper Pesticide Handling

10. It is necessary to maintain _____________over the use and handling of these chemicals during the transport, storage, mixing, loading, application and disposal.

Pesticide/Insect Glossary

Acaricide: A pesticide used to control mites and ticks. Same as miticide.
Adhesive: A substance which will cause a spray material to stick to the sprayed surface, e.g., sticking agent.
Adjuvant: Any substance added to pesticide which improves the activity of the active ingredient. ***Examples***: Penetrates, spreader-stickers and wetting agents.
Adventive: Located outside habitat, though an reproductive population may not be established.
Alates: Winged forms of insects.
Anthocorids: A true bug in the family Anthocoridae.
Aphid: An insect in the family Aphididae which is sometimes called plant lice.
Algaecide (Algicide): A pesticide used to kill or inhibit the growth of algae.
Alien: Same as non-native.
Anti-Transpirant: A chemical applied directly to a plant which reduces the rate of transpiration, or water loss, by the plant.
Avicide: A chemical used to kill birds.
Bactericide: Chemical used to kill bacteria.
Band Application: The application of a pesticide or other material to a limited area such as in or beside a crop row rather than over the entire field area.
Beneficial insect: Any insect that has a life style that is advantageous to man. Insects that preserve the balance of nature by feeding on others, pollinators, and recyclers are examples of beneficial insects.
Cephalothorax: Head (ceph) and chest (thorax) area.
Cerci: Paired appendages on the end of the abdomen of many insects which are used for sensing, defense or mating.
Chewing (mouth parts): Any mouth part that literally bites to feed; other mouth part types are sucking and rasping.
Clavus: The enlarged terminal antennal segments that form a club.
Collophore: A tube-like structure on the underside of the first abdominal segment (folds under the body) of Collembola (e.g. springtails) which is used as a spring action for leaping.
Broad Spectrum Application: General purpose pesticides which can be used against a large number of pests on a wide range of crops.
Broadcast Application: The application of a pesticide or other material over the entire field or area.
Calibrate: To determine the amount of pesticide that will be applied to the target area.
Colonizing: An ant species which is successful at creating nests in new areas. While some exotic ants are successful colonizers, many colonizing species are not exotic -- and many exotics are not colonizers.
Compound eyes: The large multi-faceted eyes of insects.
Coreids: A member of the family Coreidae, which are leaf footed bugs**.**
Corium: The elongate, thickened basal portion of the fore wing of Hemiptera.
Cornicles: Tubular structure on each side of abdominal region from which pheromones or honeydew is expelled.
Coxa (pl.=coxae): Basal portion of the leg.
Crepuscular: Having activity periods during low light levels at dawn and evening.
Cursorial: Adapted for running.
Coverage: Spread of a pesticide chemical over a surface such as the leaves, fruit, stem, etc.

Dactyl: Literally, a finger or fingerlike projection on an insect body part.
Dealates: Winged forms that have shed their wings, like reproductive termites or ants.
Defoliate, defoliation: Removal of foliage from plants, often by chewing insects.
Detritivore: Any organism that eats decaying organic matter.
Diapause: An insect resting stage, usually induced by environmental signals or extreme conditions like winter or summer.
Dimorphic: Having two distinct forms.
Defoliant: A chemical which causes the leaves or foliage to drop from a plant.
Desiccant: A chemical that promotes drying or loss of moisture.
Drift: The airborne movement of a pesticide spray or dust from the target area to an area not intended to be treated.
Dust: A finely ground, dry pesticide formulation usually containing a small amount of active ingredient and a large amount of inert carrier or dilutent such as clay or talc.
Emulsifiable Concentrate: A pesticide formulation produced by dissolving the active ingredient and an emulsifying agent in a suitable solvent. When added to water, an emulsion (milky mixture) is produced.
Endosperm: A portion of a seed which contains most of the energy reserves for germination.
Estivation (aestivation) : A resting stage (quiescence) resulting from continued high temperature or xeric conditions; diapause; hibernation.
Exoskeleton: The outer portion of an insect body which may be relatively soft like a caterpillar or hardened like many beetles.
Femora: A segment of an insect leg; usually the largest segment.
Filiform: Linear shaped, as the antennae of ground beetles.
Forbs: Any broadleaf non-woody (herbaceous) plant.
Frass: Solid larval insect excrement; plant fragments made by wood-boring insects, usually mixed with excrement.
Furculum (plural: furcula): The elongate fork-like appendage on the end of the abdomen.
Exotic: Same as non-native.
Eradication: The complete elimination of either weeds, insects, disease organisms, or other pests from an area.
Fumigant: A chemical that forms vapors (gases) which is used to destroy weeds, plant pathogens, insects or other pests.
Fungicide: A chemical that kills or inhibits fungi.
gpm: Gallons per minute.
Genera: Plural of genus; A genus is a group of plants or animals with similar characteristics. Animals (insects) are classified by kingdom, phylum, class, order, family, genus, species, and author’s name. For example, the honey bee is classified as Animal (kingdom), Arthropoda (phylum), Insecta or Hexapoda (class), Hymenoptera (order), Apidae (family), *Apis* (genus), *mellifera* (species), Linnaeus (author's name). The genus and species are always italicized.
Girdle, girdling: Damage of a plant that circles the stem or branch cutting off the connective plant tissue.
Grigology: The study of crickets, grasshoppers and katydids.
Hemelytron: The first wing of a true bug (Hemiptera) which has the base more thickened than the membranous outer portion.
Hopperburn: Leaf damage caused by leafhopper feeding, which is a yellowing of the leaves.
Herbicide A pesticide used for killing or preventing plant growth. A weed or grass liquid.

Imago: The adult stage of an insect.
Instar: An insect stage between molts; molting is growth.
Internode: The part of a plant stem between the nodes. Nodes mark the point of attachment of leaves, flowers, fruits, buds and other stems.
Insecticide: A pesticide that is used to kill, inhibit, repel or otherwise prevent damage by pests.
Introduced: Same as non-native.
Invasive: A species which is spreading its geographic range into niches occupied by other species. Documentation of an invasive species requires an ecological study to demonstrate the displacement of other ants.
Larval stage (larva, larvae): An immature insect, sometimes used to include all immature stages, even eggs. Usually this term refers more specifically to the feeding stages of insects with complete metamorphosis like grubs, caterpillars, and maggots.
Maggot: In most Diptera (flies), legless larva lacking a distinct head, with cephalic (head) end pointed and caudal (rear) end blunt.
Mesophyll: Fleshy plant tissue inside a leaf or stem.
Metamorphosis: **-** change in form during an insect's growth and development.

Gradual metamorphosis - incomplete metamorphosis in which there is no pupal stage and the immatures and adults look similar excluding the wings of the adults.

Incomplete metamorphosis - any metamorphosis type that does not include the pupal stage. Incomplete metamorphosis is present in Orthoptera (grasshoppers), Hemiptera (true bugs), and several other orders.

Simple metamorphosis - any metamorphosis that occurs in insect groups where they are not winged and have no pupal stage. Insect groups with simple metamorphosis include the Collembola (springtails) and Thysanura (silverfish).

Metathorax: The second section of the insect thorax which houses the second pair of legs and the first pair of wings.
Mite: A member of the order Acari (ticks and mites)
Molt, molting process: In insects, as in snakes, the process of shedding the exoskeleton.
Naiad: A term for immature insects that are aquatic from the orders Plecoptera, Odonata, and Ephemeroptera. This term is becoming archaic and is now replaced by the more general term "***immature***" insect.
Necrosis: Death of tissue in plants or animals.
Nymphs: An immature stage of hemimetabolous insects (those with incomplete metamorphosis).
Microbial Pesticide: Bacteria, viruses, fungi and other microorganisms used to destroy or control pests.
Miticide: See acaricide.
Molluscicide: A chemical used to kill or control snails and slugs.
Native: These definitions do not necessarily define *where* a species is native. How do I define where a species is native? Sometimes the non-native status of a species is clear from previous collections and existing knowledge from biogeography and systematics. Other times, boundaries are a lot blurrier. Is a species non-native if it has been there for 400 years?
Nematicide: A pesticide that kills or otherwise controls nematodes.
Non-indigenous: Same as non-native.
Non-native: A species which is established outside its native habitat. With respect to ants, ants with an established reproducing colony.

Oothecae: A bean-like hardened egg capsule produced by female cockroaches.
Osmeterium (pl.=osmeteria): Scent-producing area behind the tibia.
Overwinter: Time spent during the winter months. Insects are often in hibernation or at least rather immobile in the colder temperatures.
Ovipositor: The egg laying apparatus of an insect. The stinger of a bee is actually a modified ovipositor.
Parthenogenesis: Egg development without fertilization.
Pedipalps: Second pair of appendages of the cephalothorax corresponding to the mandibles of insects.
Petiole: Attachment of a leaf to stem.
Phloem and xylem: Vascular tubes that allow fluid transport in plants. It is the way plants receive and distribute nutrients, hormones and water.
Photosynthesis: The chemical process that plants use to convert carbon dioxide and water to sugars and ultimately to energy.
Phyto- (prefix): Plant.
Phytophagous: Plant eating; an insect using plants as a food source.
Phytotoxemia: A toxic reaction in plants.
Poikilotherm: A cold-blooded organism.
Proboscis: A nose, or, in the case of butterflies, the coiled sucking mouthpart.
Pronotum: The plate on top of the prothorax.
Prothorax: The front part of an insect thorax which includes the attachment points for the front legs.
Protozoan: A microorganism in the kingdom Protozoa.
Pseudergates: Caste found in the lower termites (Isoptera), comprised of individuals having regressed from nymphal stages by molts eliminating the wing buds, or being derived from larvae having undergone non-differentiating molts, serving as the principle elements of the worker caste, but remaining capable of developing into other castes by further molting.
Psocids: Any insect in the order Psocoptera, which includes booklice and barklice.
Psyllid yellows: A virus disease of potatoes, tomatoes, peppers, and eggplant. See purple top.
Pupal stage (pupa): The stage in complete metamorphosis between larva and adult like the cocoon in moths.
Purple top: A purple discoloration of foliage tips caused by insect transmitted virus.
Pustulate: Pus-forming, as in spider bites.
Pesticide: A chemical or other agent used to kill or otherwise control pests.
Pisicicide: A chemical used to kill undesirable fish.
Postmergence: After the plants have appeared through the soil.
Protectant: A pesticide applied to a plant or animal prior to the appearance or occurrence of the pest in order to prevent infection or injury by the pest.
Repellant: A compound that keeps or drives away insects, rodents, birds or other pests from plants, domestic animals, buildings or other treated areas.
Rhopalid: An insect in the family Rhopalidae in the order Hemiptera (true bugs).
Rosetting: Malformation of a plant resulting in a bunched irregular growth of the leaves.
Rodenticide: A pesticide, or mixture of pesticides, used to kill or control rodents.
Scutellum: A triangular shaped section on the back of Hemiptera and some Coleoptera. It is often the identifying characteristic of Hemipterans or "***true bugs***".
Secondary reproductive: A caste of subterranean termite; also called supplemental reproductives. If these termites develop from nymphs, they are called secondary reproductives (primary reproductives are the king and queen). If they develop from

pseudergates, they are called tertiary reproductives. Supplementals may be responsible for most of the egg production in the colony.
Spinneret: A small tubular appendage from which silk threads by spiders and many larval insects are excreted.
Stippling (leaf): A speckled appearance of a leaf, usually yellowish spots on a green leaf.
Stolon: An underground portion of a plant that grows horizontally, like a grass root.
Subgroup: A subset of a group with related characters. The term group is a general and non-specific collection of similar organisms regardless of taxonomic hierarchy.
Subimago: The first winged stage of a mayfly. This is the only group to have a winged stage that molts. The final stage is the imago, or adult.
Silvicide: A pesticide used to destroy woody shrubs and trees.
Soluble Powder: A finely ground, solid material which will dissolve in water or some other liquid carrier.
Space Spray: A pesticide which is applied as a fine spray or mist to a confined area either indoors or outside.
Target: The plants, animals, structure, areas or pests to be treated with a pesticide application.
Tarsi: A foot. Insect feet are made of several segments and may have pads, hairs, or hooks.
Tegmina: Plural of tegmen, a hardened covering like the forewing of many Orthoptera and Hemiptera.
Tenaculum: A minute two-pronged structure on the underside of the third abdominal segment of Collembola (springtails) which holds the furcula (appendage used for jumping) before it is released to jump.
Termite: Any wood-eating insect in the order Isoptera.

> **soldier termite -** a caste of termites with specific structures to defend the colony, such as large mandibles or nasute mouths that produce sticky defensive substances.
> **worker termite -** a caste of termites that do most of the work in the colony. Worker termites can be all immature termites and forms that do not develop into reproductive forms or soldiers.

Tertiary reproductive termite: See secondary reproductive.
Tettigoniid: A family of Orthoptera, often called long-horned grasshoppers, which includes katydids.
Thorax: The second body segment of an insect. The thorax has all of the wings and legs attached to it.
Tip burn: A yellow or dried tip on a branch or leaf caused by insect feeding or a plant physiology disorder.
True bugs: Insects in the order Hemiptera. They are usually characterized by a scutellum, a triangular shaped section on the back.
Tramp: A widespread ant species spread by human commerce with a specific syndrome of life history characteristics: extreme polygyny, unicolonial or highly polydomous nest structure and colony reproduction by budding (sensu Passera 1994).
Transferred: Collected outside native habitat, without knowledge of established nests.
Transported: Same as transferred; often refers to animals found in quarantine inspection.
ULV: Ultra Low Volume. No water is applied with this pesticide formulation. Spray concentrates are frequently used in ULV applications.
Venation: The pattern of veins in the insect wing.
Wettable Powder: A solid (powder) pesticide formulation which forms a suspension when added to water.

Topic Post Quiz Answers

Topic 1 - Aerial Application Introduction Post Quiz Answers
1. Volatility and spray drift, 2. Application Rate (VAR) 3. Adequate pre-preparation, 4. A nonporous barrier, 5. Fixed wing aircraft, 6. Fully trained and protected staff, 7. Venturi-type and rotary-slinger spreaders, 8. Venturi spreaders, 9. Saddle tanks with an auger, 10. Positive metering systems

Topic 2 - Understanding Hydraulics and Sprayer Principles
1. Contours of constant pressure, 2. Velocity of the fluid, 3. Rise (fall), 4. Wide horizontal booms, 5. Preplanned, 6. Droplet break-up, 7. Metering, 8. Application rate (gallons per acre), 9. Dawn until mid-morning, 10. Monitor or perform visual inspections

Topic 3 - Understanding Pumps and Aerial Sprayers
1. Plunger, 2. Dynamic, 3. Aircraft speed, 4. Individual plant treatments with ground equipment, 5. Less drift occurs, 6. Allow draining the spray system, 7. An anemometer or radar, 8. Capacity of the spray nozzle, 9. Lower pressures, 10. Diluent

Topic 4 - Aerial Application Assignment and Control Information
1. Highly toxic, 2. Pretreatment reconnaissance flight, 3. Spray droplet deposition pattern, 4. Dyecards, 5. Object free areas (OFAs), 6. Row spacing, 7. Seconds, 8. Directed rigs, 9. Gallons/acre actually applied, 10. 10 %

Topic 5 - Pesticide Drift Control and Training Requirement
1. Specifically addressed on the product label, 2. A weight basis, 3. Smaller droplet size, 4. Ester-containing formulations of 2,4-D, 5. Suppress the outbreak, 6. Viruses, or their toxins, 7. Arsenic powders, 8. Spraying system 9. Blocked nozzles or incorrectly operating atomizers, 10. Decontaminated

Topic 6 - Complications/ Limitations / Risk Post Quiz
1. Pesticide spilled, 2. Buffer zone distance, 3. All available drift prevention practices, 4. Wind of any particular velocity, 5. Vapors, 6. Undesirable woody species, 7. Volatile, 8. Esters, 9. Strainers, 10. Small, drift-prone particles

Topic 7 - Aerial and Agricultural Pesticides
1. Organothiophosphate, 2. Mosquito eradication, 3. Pyrethroids, 4. Attraction, 5. Mineral components, 6. Sometimes essential, 7. Vapor pressure, 8. Highly temperature dependent, 9. Intensity of the sunlight, 10. Careful and continuous control

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