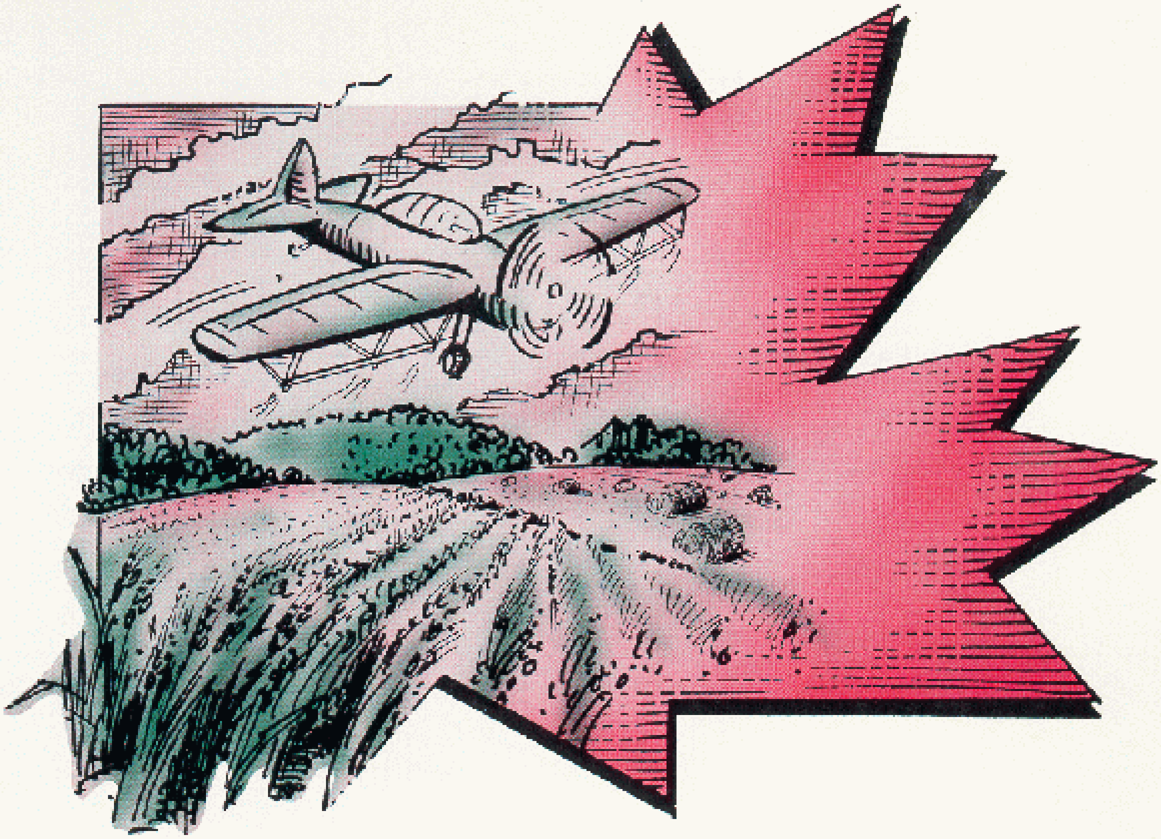

AERIAL MODULE | **MODULE – PULVÉRISATION AÉRIENNE**

BASIC KNOWLEDGE REQUIREMENTS FOR PESTICIDE EDUCATION IN CANADA

CONNAISSANCES FONDAMENTALES REQUISES POUR LA FORMATION SUR LES PESTICIDES AU CANADA

CAPCO

Health Canada Santé Canada

AERIAL MODULE

BASIC KNOWLEDGE REQUIREMENTS

FOR

PESTICIDE EDUCATION IN CANADA

AUSSI DISPONIBLE EN FRANÇAIS

Prepared by the National Task Force on Pesticide Education, Training and Certification

If you would like additional information on the Standard for Pesticide Education, Training and Certification or to be on our mailing list, please write to:

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BASIC KNOWLEDGE REQUIREMENTS FOR PESTICIDE EDUCATION IN CANADA AERIAL MODULE

The aerial module covers the knowledge requirements specific to the aerial category. This category includes the use of pesticides applied by aircraft. This includes forest land, non-agricultural land (i.e., industrial vegetation control), bodies of water for mosquito and biting fly control, and agricultural land. Application of pesticides by ground equipment to these areas is covered in separate modules.

This module includes procedures for ground crew assisting with aerial application. While the pilot should not mix pesticides, he/she may be responsible for the safety of the ground crew and therefore should know these procedures and equipment used. Where certification is also required for ground crew, the knowledge requirement may be limited to information in the aerial category which pertains to ground work only.

The knowledge requirements described in this module are additional to the knowledge requirements detailed in the Applicator Core, common to all certification categories. This module adds details to sections of the Core, where it is necessary to include Aerial specific information. An outline of the knowledge requirement for the Aerial module is presented on the following page. This outline shows which sections of the Core have been expanded in this module.

The knowledge requirements provided here are the information a trainer would use to provide training to an applicator on the responsible use of pesticides. It is targeted to the trainer for teaching purposes and is not intended as an applicator manual.

In addition to the Applicator Core, modules of knowledge requirements have been developed for the following ten pesticide categories:

Aerial
Agriculture
Aquatic Vegetation
Forestry
Fumigation
Greenhouse
Industrial Vegetation
Landscape
Mosquito and Biting Flies
Structural

AERIAL MODULE

CONTENTS

Category: AERIAL

Concept: REGULATIONS

General Objective: To know that sections of Transport Canada Air Regulations and Air Navigation Orders deal with aerial application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Aerial application of pesticides requires compliance with Transport Canada Air Regulations and Air Navigation Orders.	Know that aerial applicators must comply with provisions of Transport Canada Air Regulations and Air Navigation Orders and that certain sections deal with aerial application.	
Note: An aircraft flown for aerial application must be commanded by a pilot who holds a commercial pilot's licence, except farmers who are exempted under specified conditions of the Private Aircraft Exemption Order.		Identify the requirement for a commercial pilot's licence for aerial application.
Section 508 of the Air Regulation specifies that no person shall create a hazard to persons or property on the ground by dropping anything from an aircraft in flight.		Identify that air regulations prohibit dropping anything from an aircraft that creates a hazard.
Section 534 of the Air Regulation establishes minimum flying heights with an exemption for "special operations" (which includes spraying), but special authorization from the Minister is required for low flying over built-up areas.		Identify that there are restrictions for low flying.
Many provinces and some municipalities have regulations regarding aerial application of pesticides. Check with provincial regulators of pesticides for requirements such as permits, buffer zones and public notification.	Know that there may be provincial regulations regarding aerial application of pesticides.	Identify whether or not there are provincial regulations regarding aerial application of pesticides.
Some pesticide product labels indicate that the product can be applied aerially for certain specified uses. Some product labels indicate that no aerial use is allowed. Directions on these labels must be followed.	Know that some pesticide product labels identify whether or not aerial use is allowed. Know the interpretation of labels with no reference to aerial use.	Describe label instructions on aerial use of pesticides.
For Commercial products that have no reference to aerial application or instructions for such use, and do not carry a contra-indication, the interpretation of Agriculture Canada is that aerial use is allowed, except not on forests, bodies of water or residential areas. Confirm with provincial or federal authorities that use is approved before using products with no reference to aerial use.		Identify how to interpret labels with no reference to aerial use.

Category: AERIAL

Concept: HUMAN HEALTH - CHOLINESTERASE

General Objective: To know the importance of cholinesterase testing.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Organophosphates or carbamate pesticides which may be used in pest management programs inhibit cholinesterase. Cholinesterase is an enzyme in the blood which affects the nervous system and the way the brain sends messages to different parts of the body.	Know that cholinesterase testing is important when applying organophosphates or carbamate insecticides on a regular basis.	Identify the blood test applicators should have when handling organophosphates or carbamates on a regular basis and describe why.
Cholinesterase levels can vary widely between individuals and therefore it is important to know an individual's level of cholinesterase before handling these pesticides.		
Applicators who handle these pesticides on a regular basis should have: 1. A baseline test to determine cholinesterase enzyme levels before exposure. 2. A regular blood test to check cholinesterase levels during the exposure period.		Identify when an applicator should have the blood test.

Category: AERIAL

Concept: PESTICIDE SAFETY - STORAGE

General Objective: Know how to store pesticides safely and legally.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Temporary Storage		
Some aerial application projects require that a temporary pesticide storage location be established. Many of the principles that apply to permanent storage apply to temporary storage.	Know how to store pesticides temporarily.	List and describe requirements of a temporary pesticide storage area for aerial application.
Temporary storage locations should be away from watercourses and on ground that is flat and not highly permeable. The floor of a storage facility should be constructed to contain spills. It may be necessary to dig a ditch around the storage area to contain spills and prevent contamination of surroundings.		
Portable trailers may be used for temporary storage. They should have a vent to the outside, but may not require a fan, provided all containers are tightly sealed. The trailer must be locked to prevent reentry by unauthorized people.		
If no trailer is available, the containers must be in a securely fenced off area so that only authorized people have access to the pesticides. Guard against pesticide container deterioration by use of pallets or appropriate ground sheets.		
A sign should be put on each storage entrance warning of pesticide storage.		
An area separate from, but close to the pesticide storage area should be available for the storage of personal protective equipment.		
Spill emergency equipment, fire extinguishers, a first aid kit, eyewash station and a deluge shower (if appropriate for the type of pesticide being used) should also be located at the site.		

Category: AERIAL

Concept: PESTICIDE SAFETY - MIXING AND LOADING

General Objective: To know how to mix and load pesticides safely.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
General Considerations		
Three main considerations for mixing and loading operations include: - a carefully selected, well organized mixing and loading site; - a suitable mixing/loading system to ensure safe, efficient pesticide mixing and/or loading into the aircraft; - a well trained ground crew.	Know the main considerations for mixing and loading operations.	List the main considerations for mixing and loading operations.
Ground support equipment must: - provide safe handling and mixing of dry or liquid materials; - provide rapid loading of the aircraft; - prepare load sizes consistent with the aircraft in use; - contain the appropriate hoses, fittings, flow meters and filters; - be easily transportable if used with mobile operations.	Know basic requirements for ground mixing and loading equipment.	List the basic requirements for ground mixing and loading equipment.
Liquid Mixing and Loading Equipment		
Safe mixing and loading is a key factor in the design of ground support units, particularly when highly toxic materials are used. The components of a mixing and loading system for aircraft generally include: - a clean water tank with backflow prevention; - a pesticide concentrate tank; - a mixing tank with agitation; - suitable pumps to transfer the pesticide to the mixing tank and the mixture to the aircraft; - accurately calibrated meters to measure amounts transferred.	Know how liquid mixing and loading equipment should be designed and know major components.	List major components of a mixing and loading system and describe what is meant by a closed system.
Whenever possible, they should be designed as a closed system, where the pesticide can be removed from its containers, the containers rinsed, and the mix transferred to the aircraft without exposing individuals to pesticide concentrate or solutions.		

Category: AERIAL

Concept: PESTICIDE SAFETY - MIXING AND LOADING

General Objective: To know how to mix and load pesticides safely.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Liquid loading equipment should have the following characteristics: - tanks, hoses and couplings that are secure, large enough to easily accommodate the pumping system, and appropriate for the pesticide being used; - sight gauges that are protected and easily visible; - reliable metering units that are calibrated and monitored for accuracy; - dry-break valves that are used for filling aircraft to ensure no leakage during connect or disconnect operations; - a one-way valve that is incorporated in appropriate lines to prevent backflow from mixing tanks to chemical or solvent tanks; - a separate rinsing system that is incorporated to allow rinsing of container interiors; - valves and controls that are easily accessible and clearly marked; - filters that are used when loading water to avoid damage or contamination to the dispersal system.	Know the main safety features required for mixing and loading equipment.	Describe guidelines for tanks, hoses, couplings, gauges, metering units, valves, rinsing system and filters.
Wherever possible, decals, which describe operating procedures, should be fixed to each component and maintained in a readable condition.	Know about the use of decals.	Describe the use of decals for describing proper operating procedures.
Pesticides should be mixed just prior to use, and not left in mixing tanks for extended periods of time. They may degrade.	Know when pesticides should be mixed.	Identify when pesticides should be mixed.
A regular maintenance schedule for mixing equipment should be developed with on-going records of inspection and repairs.	Know about maintenance and inspection.	Identify that maintenance and inspections are important.
<u>Dry Materials Loading Equipment</u>		
The most common form of dry loader is a mobile crane assembly with a hopper large enough to load the aircraft in a single operation. Conveyor belts are also used.	Know the general features of dry loading equipment.	Describe the general features of dry loading equipment.

Category: AERIAL

Concept: PESTICIDE SAFETY - MIXING AND LOADING

General Objective: To know how to mix and load pesticides safely.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Dry material loaders should: - be of sturdy, reliable construction and easily mobile; - have good visibility for the operator during movement and loading; - incorporate a volume or weight measuring capability to ensure accuracy of loads.		
Mixing/Loading Responsibilities The certified individual must ensure that pesticide mixers/loaders are trained in those tasks necessary to safely do their job.	Know who is responsible for various mixing/loading functions.	Identify who should be responsible for ensuring mixers are trained, ensuring the pesticide is registered for aerial use and mixing instructions are available.
The pilot must ensure that products used meet Agriculture Canada's requirements for aerial application and must ensure proper mixing instructions are available and followed. The pilot must not perform mixing/loading, unless properly clothed and equipped for these operations. Refer also to any provincial legislation regarding mixing requirements.		State who must not perform mixing and loading.

Category: AERIAL

Concept: PESTICIDE SAFETY - PILOT'S EQUIPMENT

General Objective: To know what safety equipment a pilot should wear.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Pilots and crew must use well-designed and approved safety harnesses and should use crash helmets. Safety harnesses should: - be "4-point" (i.e., with left and right lap straps and left and right shoulder straps); - have a single point quick release; - have an inertia reel attached if all controls are not easily accessible with harness snug. Helmets should: - be considered the personal equipment of each pilot; - be individually fitted for maximum comfort; - provide high audio protection to prevent fatigue and hearing loss, particularly important for long operational times (for additional audio protection, earplugs should be worn for high noise environments or during extended operations); - be equipped with a bayonet-type mount to accept respirators suitable for the chemical being used; - be of the forced air ventilated type for extended use in hot weather; - be equipped with either a sun peak or a dark visor.	Know how to select suitable safety harnesses and crash helmets.	Describe the desirable features of safety harnesses and crash helmets.
Pilots and crew should wear comfortable, flame retardant flight suits and gloves. Nylon materials should be avoided wherever possible.	Know desirable material composition of flight suits.	Describe the desirable material composition of flight suits.

Category: AERIAL

Concept: PESTICIDE SAFETY - APPLICATION

General Objective: To know safe operational procedures during aerial application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
General		
Strict adherence to safe operating procedures will permit safe, efficient and economical operations. A philosophy of "Safety First" must be the number one priority of all aerial application operations. Safe operating procedures are ineffective without thorough training of all personnel. Provide every individual involved in the aerial application project with a checklist of what to do and not to do for their job performance to be in compliance with regulations and company policy. Safe operating procedures should be reviewed on a regular basis with regard to applicability and effectiveness.	Understand the importance of safe operating procedures for everyone involved in an aerial application operation.	Identify the importance of safe operating procedures for everyone involved in an aerial application operation.
Mandatory Safety Requirements		
The pilot must be thoroughly trained in the appropriate aerial application procedures. All personnel must adhere to common sense personal habits with regard to food, drink, sleep and hygiene. Aircraft must be specifically designed for aerial application use. The landing/takeoff area must be carefully selected to provide safe operating conditions under all foreseeable conditions. A wind direction and speed indicator must be prominently visible in the landing area. The structural and operating limitations of the aircraft must be known and strictly adhered to.	Know the mandatory safety requirements for aircraft, equipment, personnel and operating procedures.	Describe the mandatory safety requirement about each of the following: - pilot training; - pilot and crew personal habits; - aircraft design; - landing/takeoff areas; - wind direction/speed indicators; - adherence to structural/operating limitations of aircraft; - aircraft maintenance; - physical/mental alertness of personnel; - pilot helmet and safety harness; - checking for ground hazards and obstacles; - knowledge of weather; - knowledge of poisoning symptoms and first aid procedures for the pesticide(s) in use.

Category: AERIAL

Concept: PESTICIDE SAFETY - APPLICATION

General Objective: To know safe operational procedures during aerial application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The aircraft must be maintained in a fully airworthy condition.		
A high state of physical and mental alertness for all personnel must be maintained and closely monitored for signs of fatigue.		
A correctly fitted, well-maintained approved safety harness must be worn by the pilot at all times (a helmet should also be worn).		
The pilot must maintain constant vigilance for ground hazards and obstacles.		
The pilot must be well-informed on current and forecast weather that would adversely affect flight safety or seriously affect application procedures.		
All personnel who may be exposed to a pesticide must know toxicity, symptoms of poisoning and correct first aid procedures for the type of pesticide being used.		
Hazards		
Powerlines, trees and other high obstacles constitute the most common hazard associated with aerial application. Most accident reports indicate the pilot was aware of the obstacle but did not provide a sufficient safety margin to avoid contact.	Know the most serious hazards associated with aerial application and how to reduce the risk.	Identify the most serious hazards associated with aerial application and how to reduce the risk.
Inadvertent stalls, and high speed stalls during pull-up or entry, constitute the second most commonly occurring factor in accidents.		
Maintaining a high level of awareness, avoiding fatigue and flying well within the aircraft's and pilot's capabilities will greatly reduce the potential for accidents.		
Safe Flying Procedures		

Category: AERIAL

Concept: PESTICIDE SAFETY - APPLICATION

General Objective: To know safe operational procedures during aerial application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Fly successive swaths upwind to avoid exposure to airborne chemical from previous runs. Racetrack patterns minimize fatigue and manoeuvring required when compared to shuttle patterns, and allow more time for alignment for the next run. With shuttle patterns, turn downwind to expedite and provide better aircraft positioning for the subsequent procedure turn onto the next swath. Do not look back during application runs. Select alignment cues during the turnaround. Fly ground contours wherever possible, avoiding up-slope flying that could cause rapid airspeed decay and possible stalls. Ensure that flaggers are always upwind of the spray and well clear of the flight path. If possible, carry out a ground inspection or receive an obstacle briefing from flaggers of the area to be overflown. If only an aerial inspection is made, circle the field at a safe altitude and check carefully for obstructions. Check for: - breaks in crop patterns for hidden obstacles; - guy wires on all poles and towers; - wires leading into house and other buildings; - single insulators on the top of high transmission lines, indicating a single support wire, often difficult to see; - lines and poles obscured by trees or foliage. Be very cautious when under-flying wires. Check for sag at centre span, and overfly if there is any doubt whatsoever. **Aircraft Handling**	Know safe procedures for the pilot during aerial application.	Describe safe procedures for the pilot during aerial applications, including: - how to avoid exposure to spray; - advantage of racetrack patterns compared to shuttle patterns; - allowing more time for 'procedure' turns; - looking back; - flying contours; - position of flaggers; - ground inspections; - aerial inspections and what to check for; - wires.

Category: AERIAL

Concept: PESTICIDE SAFETY - APPLICATION

General Objective: To know safe operational procedures during aerial application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Pilots must receive training on aircraft handling appropriate to the type of aircraft and application operations. Fixed wing pilots should receive training on stalls and spins and rotary wing pilots should receive training on potential control problems with their aircraft.	Know that pilots should receive training on aircraft handling for aerial application.	Identify that pilots should receive training on aircraft handling for aerial application.
Fixed Wing Aircraft Stalls and Spins		
Pilots should be thoroughly familiar with early symptoms of approaching stall on each type of aircraft. With unfamiliar aircraft, approaches to stalls should be carried out at a safe altitude until the symptoms are well known.	Be able to recognize early symptoms of approaching stall. Know common causes of stalls and spins of fixed wing aircraft during aerial application and how to avoid stall/spin situations.	Describe how to become familiar with the early symptoms of a approaching stall. Describe factors which could cause a stall during fixed aerial application and list four considerations to avoid stall/spin situations.
An aircraft stalls when the stalling angle of attack is exceeded. This can occur not only in level flight but at any speed if sufficient load factor is applied.		
The stall speed varies directly with the square root of the load factor. The load factor increases with weight, bank angle and ‘g' loading.		
Increased load factors occur during pull-up and turns. During turns, level flight is maintained by applying aft elevator to increase angle of attack, compensating for loss of the vertical lift component in the banked condition.		
Exercise caution when rolling the aircraft at near stall conditions. A rolling manoeuvre increases the angle of attack for the down-going wing, and decreases that of the up-going wing in direct proportion to the rate of roll.		
If the aircraft was near the stalling angle of attack upon roll commencement, the down-going wing might stall. This would result in an "out of the bottom" spin if the aircraft is rolling into a turn or an "over the top" spin if it is rolling out of the turn.		

Category: AERIAL

Concept: PESTICIDE SAFETY - APPLICATION

General Objective: To know safe operational procedures during aerial application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
To avoid stall/spin situations: - do not overload the aircraft; - avoid sudden pull-ups and tight turns; - whenever possible, do not turn during the initial pull-up at the end of a run; - keep roll rates to a minimum when commencing and completing turns.		
Rotary Wing Aircraft Handling Considerations Note: The following are general considerations, but may have to be modified for specific aircraft.		
Using torque to help in turns: When initiating a right turn at the end of a swath, the turn can be expedited by the application of collective, as the increase in power will turn the nose of the aircraft to the right. Conversely, the pilot should be aware that in the left turn, application of collective is necessary to initiate the turn. Both of these control movements require power, which, when combined with high gross weights, must be applied judiciously to prevent possible over torque or over boost. (These directions apply to aircraft with counter-clockwise blade rotation. Directions must be reversed for aircraft with clockwise blade rotation.)	Know the need for power during left and right turns and concerns at high gross weights.	Describe the need for power during left and right turns and identify concerns at high gross weights.
Vortex ring state (settling with power) can be experienced in flight conditions that include low airspeed, application of partial or full power, high gross weight, and high rate of descent. All of these conditions can be encountered during aerial application, particularly in turns. Vortex ring state can be recognized by a high rate of descent that cannot be arrested by application of collective. It is imperative that the applicator pilot be able to recognize and correct for this condition immediately due to the low level nature of the operation. The immediate corrective action is application of forward cyclic to fly out of the vortex ring. If altitude permits, lowering of the collective will also assist in alleviating the condition. Pilots should be aware that increasing the collective when encountering vortex ring state, can aggravate the situation.	Know what vortex ring state is, why it might occur during aerial applications and how to correct for it.	Describe what vortex ring state is, why it might occur during aerial applications and how to correct for it.

Category: AERIAL

Concept: PESTICIDE SAFETY - APPLICATION

General Objective: To know safe operational procedures during aerial application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Mast bumping is the striking of the main rotor head on the main rotor mast and can occur on semi-articulated blade systems (i.e., Bell 206 series) when flight conditions include large control movements and unloading of the disk. A rapid lowering of collective, combined with large cyclic movement, could lead to this condition. Pilots should be aware of the severe consequences of this condition and should try to keep their movements as smooth and slow as conditions permit.	Know what causes ‹mast bumping' and when it is a concern during aerial application and how to prevent it.	Describe what causes ‹mast bumping' and when it is a concern during aerial application and how to prevent it.
Loss of tail rotor authority (or unanticipated right yaw) is an uncommanded right yaw which does not subside of its own accord and which, if not corrected, can result in the loss of directional control of the aircraft. Flight conditions which can lead to loss of tail rotor authority are low air speeds combined with flight in relative wind azimuths of 120-240 degrees (weathercock stability), 210-340 degrees (tail rotor vortex ring state) 285-315 degrees (main rotor vortex interference) and loss of translational life which can occur at all wind azimuths. Due to the low ambient winds encountered during spray operations, the loss of translational lift is the most important consideration for the pilot. If the pilot experiences unanticipated right yaw in one of the above circumstances, the yaw rate will increase unless immediate corrective action is taken. This would include full left pedal while simultaneously applying forward cyclic to increase forward speed (for machinery of North American Manufacture). For machinery of European manufacture, these directions would be reversed due to blades rotating in opposite directions. If altitude permits, lowering of the collective will also aid in recovery.	Know the causes of loss of tail rotor authority, the most important consideration for the application pilot and corrective action.	Describe the causes of loss of tail rotor authority, the most important consideration for the application pilot and corrective action.

Safe Procedures for Flaggers

Category: AERIAL

Concept: PESTICIDE SAFETY - APPLICATION

General Objective: To know safe operational procedures during aerial application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
When flagger personnel are used, new flaggers should be trained on proper flagging procedures and paired with experienced personnel until they know company procedures and possess required skills. Training should include: - wear protective clothing that is appropriate for the pesticide and highly visible from the air. White, liquid proof overalls provide good protection and good visibility; - keep the aircraft in sight at all times. Never turn your back to an approaching aircraft; - start on the downwind side of the field, working into wind to avoid chemical exposure due to drift; - move to the next up-wind position as soon as the aircraft is lined up for the next run; - be alert for guy wires and other obstacles. Avoid flagging near them and inform the pilot of their presence; - be knowledgeable about the toxicity of the pesticide in use, its effects upon humans, and proper first aid procedures if poisoning is suspected; - be well versed on procedures to follow in the case of an aircraft accident.	Know safe flagging procedures.	

Category: AERIAL

Concept: ENVIRONMENT - PROTECTING THE ENVIRONMENT, INCLUDING BYSTANDERS

General Objective: To know major concerns for, and guidelines to prevent, pesticide exposure to bystanders and harm to the environment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Aerial applicators should have a basic understanding of the potential impact of pesticides on the environment and ways to protect the environment for each category of pesticide use.		
Agriculture		
Impacts: Potential environmental impacts from aerial applications in agriculture include the following: - exposure of workers or bystanders to harmful pesticides; - contamination of domestic water supplies; - contamination of crops (particularly organically grown crops) or cropland devoted to organic crops, adjacent to treated areas; - poisoning of honey bees and other pollinating insects; - contamination of natural waterbodies and effects on aquatic organisms (i.e., downstream poisoning of birds and other animals inhabiting hedge rows along the borders of treated fields; - elimination of beneficial insects which hold pest insects in check.	Know environmental impacts of special concern for aerial application to agricultural land.	Identify environmental impacts of special concern for aerial application to agricultural land.
Guidelines (for environmental and bystander protection): - do not spray fields occupied by farm workers or bystanders. It may be necessary to post warning signs to keep people out; - apply pesticides at a time of day when bystanders are least likely to be near (e.g., do not spray areas near public roadways when school children are present, particularly between the hours of 7:30 to 9:00 am and 2:30 to 4:30 pm); - leave adequate buffer zones around treatment areas to ensure there is no contamination of adjacent land devoted to organically grown crops; such farmland should be identified; - do not contaminate domestic water supplies or fish bearing waters directly or indirectly through drift, runoff or leaching; - a ground field observer in communication with the pilot should be used to monitor weather parameters and drift where there is a potential hazard; - minimize spraying to fence rows and field edges which are often animal habitat.	Know guidelines for preventing exposure to bystanders and harmful environmental effects from aerial application to agricultural land.	Describe guidelines for preventing exposure to bystanders and harmful environmental effects from aerial application to agricultural land.

Category: AERIAL

Concept: ENVIRONMENT - PROTECTING THE ENVIRONMENT, INCLUDING BYSTANDERS

General Objective: To know major concerns for, and guidelines to prevent, pesticide exposure to bystanders and harm to the environment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Forestry		
Impacts: While the potential for ill effects to people is likely to be minimal there must be no applications where bystanders or unprotected workers are present in the area. There is also a concern for the contamination of berries picked for human consumption.	Understand the need to prevent bystander exposure to pesticides during application and from contaminated berries which are picked.	State that there is a need to prevent bystander exposure to pesticides during application and from contaminated berries.
Potential impact of pesticides on the environment in forestry is a special concern because very large areas may be treated which may be habitat for diverse plants and animals.	Understand the concern for preventing harmful environmental effects in forestry applications.	Identify the concern for preventing harmful environmental effects in forestry applications.
Herbicide application for site preparation or brushing and conifer release is associated with the following concerns: - potential for contamination of waterbodies and indirect effects on aquatic animals by sublethal effects or alteration of planktonic food supplies; - loss of vegetation canopy over streams, which protect against temperature extremes and erosion, and contain insects and plants important to the stream ecosystem; - loss of cover for birds, ungulates, carnivores and their prey; - loss of forage vegetation, particularly for ungulates; - loss of diversity of plant species, which encourages pest species and is ecologically unstable.	Know potential harmful environmental effects of special concern for aerial application of herbicides in forestry.	Identify potential harmful environmental effects of special concern for aerial application of herbicides in forestry.
Use of some insecticides in forestry, particularly organophosphates and carbamates, may have a direct toxic effect on songbirds. These insecticides may have an indirect effect by altering bird behaviour. Insecticides applied over large areas may also have an impact by removing insects important as food sources and as pollinators. There is a concern for contamination of domestic water supplies and waters which harbour fish and other aquatic animals.	Know potential harmful environmental effects of special concern for aerial application of insecticides in forestry.	Identify potential harmful environmental effects of special concern for aerial application of insecticides in forestry.

Category: AERIAL

Concept: ENVIRONMENT - PROTECTING THE ENVIRONMENT, INCLUDING BYSTANDERS

General Objective: To know major concerns for, and guidelines to prevent, pesticide exposure to bystanders and harm to the environment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Guidelines (for environmental and bystander protection): - the pilot should conduct a thorough pre-treatment aerial inspection of the treatment site in the company of a project supervisor to ensure the pilot's familiarity with the treatment area; - mark environmentally sensitive areas on aerial photographs for reference during application; - prevent entry of bystanders to treatment areas during application; - avoid spraying when berries are ripening if there is any potential for contaminating wild berries for human consumption; - prevent contamination of water used for domestic purposes; - maintain a suitable buffer zone to prevent spray drift into environmentally sensitive areas such as fish bearing waterbodies and stream side vegetation, as identified by local fish and wildlife officials (a specific buffer zone width may be required by provincial authorities); - survey treatment areas near watercourses or waterbodies and ensure the boundaries are clearly defined or marked; - where flagging is used, such as balloons or plastic markers, they should be located along the boundary of the treatment area, not the area to be protected; - begin the first spray swath wherever possible along the edge of the treatment area which borders a stream or river; subsequent swaths can be perpendicular; - if a treatment area is bounded on two sides by sensitive areas, make certain the treatment block is large enough for aerial application with the appropriate buffer zones; - an experienced ground crew should be present to monitor drift and to inform the pilot of changing conditions or excessive drift; - when using herbicides in areas important for wildlife browse, options include leaving areas in a large block to be treated in following years or selective application in some areas by ground only.	Know guidelines for preventing exposure to bystanders and harmful environmental effects from aerial application in forestry.	Describe guidelines for preventing exposure to bystanders and harmful environmental effects from aerial application in forestry.

Category: AERIAL

Concept: ENVIRONMENT - PROTECTING THE ENVIRONMENT, INCLUDING BYSTANDERS

General Objective: To know major concerns for, and guidelines to prevent, pesticide exposure to bystanders and harm to the environment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Industrial Vegetation		
See forest herbicide use.	Know potential harmful environmental effects of special concern and guidelines to protect the environment for aerial application of herbicides for industrial vegetation management.	Identify potential harmful environmental effects of special concern and describe guidelines to protect the environment for aerial application of herbicides for industrial vegetation management.
Mosquito Control		
Impacts: Sloughs, ponds, marshes and other still water areas which breed mosquitoes can support rich and diverse fish and wildlife populations. Mosquito larvae can be a food source for insects, fish and other animals. In larvicide programs, areas of high fish and wildlife value should be identified and given protection. Areas which are usually protected from pesticide treatment for larvae include back channels of streams and rivers which are often fish rearing areas, weedy shorelines of lakes which are essential areas for waterfowl and fish and drainage ditches connected to fish bearing waters. Pesticide drift onto these protected areas and into other non-target waters is a major concern for applicators. Adulticiding over residential areas raises concerns about the potential hazard to health for exposed individuals.	Know potential harmful environmental effects of special concern for aerial application for mosquito control.	Identify potential harmful environmental effects of special concern for aerial application for mosquito control.

Category: AERIAL

Concept: ENVIRONMENT - PROTECTING THE ENVIRONMENT, INCLUDING BYSTANDERS

General Objective: To know major concerns for, and guidelines to prevent, pesticide exposure to bystanders and harm to the environment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Guidelines (for environmental and bystander protection): - a larviciding program is generally preferable to adulticiding for effectiveness and to reduce widespread pesticide dispersal in the environment; - do not apply pesticides to waters used for domestic purposes; - do not apply pesticide to fish habitat identified as non-target areas by local fisheries authorities and prevent contamination from drift; - both larvicides and adulticides should only be applied by air where it is not reasonable to apply with ground based equipment to minimize drift; - before aerial applications, provide adequate public notice so that affected residents will know of the program and take any necessary protective measures; - maintain a contact person at a publicized telephone number to receive questions and provide advice during aerial applications; - do not conduct aerial applications when residents and bystanders are unprotected and exposed to the spray; - if necessary, advise residents with home gardens to wash produce or leave produce unharvested for specified time periods; - beekeepers in proposed treatment areas should be notified when insecticide use may pose a hazard to their colonies.	**Know guidelines for preventing exposure to bystanders and harmful environmental effects from aerial application for mosquito control.**	**Describe guidelines for preventing exposure to bystanders and harmful environmental effects from aerial application for mosquito control.**

Category: AERIAL

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Pest Management Information		
Aerial applicators may work in varied pest management disciplines including agriculture, forestry, industrial vegetation management and mosquito and biting fly control. Diverse pests may be the target including weeds, insects and diseases. Aerial applicators should have sufficient understanding of the biology of these pests to communicate with pest management specialists about pest and pesticide characteristics important for control such as: - general classification of a pest; - vulnerable pest stage; - location of pests; - timing of application; - mode of action of pesticides; - integrated pest management.	Know the types of pest management information about which aerial applicators should be knowledgeable.	List the types of pest management information about which aerial applicators should be knowledgeable.
As well, applicators should know the general objectives of pest management in the various categories of pest management operations.		
Weeds		
Weed Characteristics		
A weed is a plant growing where it is not wanted.	Know what a weed is.	Define the term weed in pest management.
Weeds are pests when they compete with crop plants for light, water or nutrients; when they reduce access or visibility along transportation corridors or create a transmission line hazard along utility corridors. Weed control is more commonly referred to as vegetation control in forestry or right-of-way situations.		
Weeds are classified according to how long they live.	Know the weed classification according to how long the weed lives.	Describe how weeds are classified according to how long they live.

Category: AERIAL

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Annual weeds complete their life cycle within one year. Most annuals produce many seeds to ensure their survival. Annuals can be divided into two groups: summer annuals which germinate in the spring, and winter annuals which germinate in the fall.	Know the difference between annual, biennial and perennial weeds.	Describe the difference between annual, biennial and perennial weeds.
Biennial weeds live more than one year but less than two years. They grow from seed which usually germinates in the spring. The first year they store food, usually in short fleshy roots. Usually the foliage is only a rosette of leaves. Next season the plant uses the stored food and grows vigorously. It produces seed in the summer or fall and then dies.		
Perennial weeds live more than two years. Often no seed is produced the first year; thereafter seeds may be produced every year for the life of the plant. Most perennial weeds spread by seed. Many also spread vegetatively by producing creeping stems or roots, rhizomes and bulbs. There are shallow-rooted and deep-rooted perennials.		
Plants are also classified according to structural similarities, including the following types:	Know how plants are classified according to structural similarities. Know the difference between conifers and flowering plants.	Describe how plants are classified according to structural similarities. Describe the difference between conifers and flowering plants.
Conifers have needles or scale-like leaves and produce seeds in cones. Most are evergreen. They are referred to as softwood trees in contrast to some hard-wood broadleaf trees.		
Flowering plants produce seed from flowers. They include herbaceous (soft-stemmed) plants such as grasses, thistles, dandelions, etc. and woody plants such as various brush, shrub and tree species. Woody plants are classified as evergreen or deciduous.		

Category: AERIAL

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Identifying Leaf Stages		
Some labels refer to weed and/or crop leaf stages (primarily for agriculture). These herbicides are only effective when crops and weeds are at certain stages of growth. There might not be enough leaf area for efficacy if herbicides are applied too early; if applied too late, weed control may not be achieved, or desirable plants may be damaged.	Understand why it is important to apply a herbicide at the correct crop and weed leaf stages when specified on labels.	Identify why it is important to apply a herbicide at the correct crop and weed leaf stages when specified on labels.
Weed size and leaf numbers change rapidly. Avoid applying herbicides at a stage when they will not be effective. If you make recommendations about when to apply herbicides in agriculture, you should know how to determine leaf numbers.		
Leaf Stages of Broadleaf Plants		
Cotyledons are the seed leaves, and are usually the first to appear. They are usually a different shape than the true leaves and may dry up and disappear at an early stage. On a few plants they stay beneath the soil surface.	Know how to distinguish between cotyledons and true leaves.	Describe cotyledons and true leaves.
Cotyledons are not counted when determining leaf number.		
Alternate leaves emerge from alternate sides of the stem and are not directly opposite each other.	Be able to recognize alternate, opposite and whorled leaf arrangements.	Describe alternate, opposite and whorled leaf arrangements.
Opposite leaves are pairs of leaves coming from the same node on the stem.		
Whorls are groups of 3 or more leaves coming from the same node on the stem.		
When counting leaf numbers count each true leaf whether alternate, opposite or in a whorl, unless the recommendation refers to the number of whorls.	Know how to count leaves of broadleafed plants.	Describe how to accurately count the number of leaves on each plant.

Category: AERIAL

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Compound leaves are made up of several leaflets (small leaves attached to the same leaf stalk). Each compound leaf (group of leaflets) is counted as one leaf. Do not count each leaflet. Alfalfa and clover have compound leaves.		
Leaf Stages of Grasses		
Count all the leaves on the main shoot. A leaf should be counted as soon as it emerges. Do not include tillers in a leaf count.	**Know how to count leaves of grasses.**	**Describe how accurately count the number of leaves on a grass plant.**
Tillers (or stools) are the secondary shoots of a grass plant, which emerge from the base of the leaves, generally at the three to five leaf stage.	**Be able to recognize them.**	**Describe tillers.**
Weed Management Methods		
Weed management should consider methods which fit an integrated pest management approach. The various weed control methods include sanitation, cultural control, mechanical control and biological control as well as chemical control (herbicides). Often, a combination of weed management methods are used. When herbicides are used, they should be part of an integrated pest management program.	**Know weed management methods.**	**List weed management methods.**
Types of Herbicides		
Herbicides are classified according to selectivity, mode of action, timing of application and residual effectiveness.	**Know the ways herbicides are classified.**	**List the ways herbicides may be classified.**
Selectivity: Selective herbicides only kill or damage certain plants; non-selective herbicides kill or damage all plants on a treated area. Some herbicides can be selective or non-selective depending on the application rate.	**Understand the difference between selective and non selective herbicides.**	**Describe selective and non selective herbicides.**

Category: AERIAL

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Mode of action explains how the herbicide kills a plant and includes:		
1. Contact herbicides kill plant parts contacted by the herbicide. There is little or no movement of the herbicide in the plant. Contact herbicides are effective against annual weeds but they only "burn-off" the tops of perennial weeds.	**Know the difference between contact herbicide and systemic herbicides.**	**Describe contact herbicide.**
2. Systemic herbicides enter the roots or above ground parts of plants. These herbicides move or are translocated in the plant. Effects may not show for a week or more after treatment. Too much herbicide on the leaves may kill the leaf cells too quickly and prevent translocation to the site of action in a plant.		**Describe systemic herbicide.**
Timing of application classifies herbicides according to when they are applied (stages of plant growth and includes):		
1. Preplant herbicides are applied to the soil before seeding or transplanting. Preplant treatments are usually incorporated into the soil. These are called preplant soil-incorporated treatments.	**Understand the difference between preplant, pre-emergence and postemergence herbicides.**	**Describe preplant, pre-emergence and postemergence herbicides.**
2. Pre-emergence herbicides are applied to the soil after planting but before the emergence of the specified crop or weed. Pre-emergence may refer to the germination of either the weed or the crop; check the pesticide label for instructions on specific herbicides. Pre-emergence herbicides control weeds before or soon after they emerge.		
3. Postemergence herbicides are applied after the specified crop or weed has emerged. The application may be soon after emergence or up to a specific height or leaf number. Postemergence herbicides control established weeds.		
Residual effectiveness refers to how long the herbicide is biologically active once applied, and includes:		

Category: AERIAL

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
1. Non-residual herbicides are quickly inactivated in the soil after application. **2. Residual herbicides do not break down quickly and may control weeds for several weeks to years. These must be used with caution to prevent harm to desirable plants or off-site movement.**	**Understand the difference between non-residual and residual herbicides.**	**Describe non-residual and residual herbicides.**
Factors Affecting Herbicide Effectiveness		
Many factors affect how well a herbicide works. Some are shape and surface of leaves, weather, age of the weed, soil type, soil moisture, cultivation, and resistance.	**Know the main factors that affect herbicide effectiveness.**	**List the main factors that can affect herbicide effectiveness.**
Shape and surface of leaves - thin upright leaves are hard to cover with spray. Hairy or waxy plant surfaces may reduce the herbicide contact. Surfactants or surface active agents can be added to the herbicide formulations to increase the wetting ability of the spray so it won't bead, or to cut through waxy surfaces and aid penetration into the leaf. They should be added only if specified by the herbicide label.	**Know how leaf shape and surface affect herbicide effectiveness.**	**Describe how leaf shape and surface affect herbicide action.**
Weather - temperature, humidity, rain and wind may affect herbicide effectiveness. Moderate conditions are usually better than extremes. The herbicide label will indicate what weather conditions should be avoided.	**Know how weather conditions may affect herbicide action.**	**Describe weather conditions that may affect herbicide action.**

Category: AERIAL

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Cool or dry conditions slow the production and movement of nutrients in the plant and reduce the movement of systemic herbicides. Hot dry weather may make the herbicide evaporate quickly from the weed leaves and, therefore, reduce effectiveness.		
Rain during or after an application can wash the herbicide off plants. However, some soil-applied herbicides require irrigation or rain after application.		
Wind can cause drift and prevent the herbicide from reaching the target.		
Age of the weed - herbicides are often more effective on young rapidly-growing weeds. Systemic herbicides which move with the nutrients and water can spread faster in rapidly growing younger weeds than in older plants. Herbicides are less likely to kill plants that are in full flower or producing seed.	Know how the age of a weed may affect herbicide action.	Describe how the age of a weed may affect herbicide action.
Perennial weeds often become more resistant to herbicides as they grow older, but may become more susceptible again in the bud or early flowering stage. In this stage, food is being stored in roots. Certain herbicides are also translocated to these sites with the food and so kills the entire plant.		
Soil type - for soil active herbicides, more herbicide may be needed for organic (peat or muck) or fine textured soils (clay or silt). These soils hold more herbicide on the soil particles and this reduces the amount available for weed control. Sandy soils usually need less herbicide. The herbicide label will state how much is needed. Never use more than the label rate.	Know how soil type may affect herbicide action.	Describe how soil type may affect herbicide action.
Soil moisture - soil applied herbicides generally work best in a warm, moist soil. The moisture helps the herbicide move to the weeds.	Know how soil moisture may affect herbicide action.	Describe how soil moisture may affect herbicide action.

Category: AERIAL

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Cultivation - cultivating before a herbicide application can make herbicides more or less effective depending on the weed and the herbicide. Some weeds may be weakened by cultivation and become easier to control while other weeds may be broke into pieces and be harder to control. Read label directions before cultivating to see if it will be beneficial. **The stale seed bed technique is to cultivate unseeded soil so that weed seeds are encouraged to germinate. When they appear they are sprayed with a non-selective herbicide. The crop can then be planted.**	**Know how cultivation may affect herbicide action.**	**Describe how cultivation may affect herbicide action.**
Resistance - some weeds have developed resistance to certain pesticides.	**Know that some weeds have developed resistance to certain herbicides.**	**Indicate whether weeds can develop resistance to a herbicide.**

Category: AERIAL

Concept: PEST MANAGEMENT - INSECTS AND MITES

General Objective: To understand pest management principles required to carry out effective insect and mite control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Insect and Mite Characteristics		
Insects are a group of animals that have 6 legs, an exterior skeleton, and 3 body sections (head, thorax and abdomen) in the adult stage. Many adults have wings.	Know basic features of insects and mites.	Describe basic features of insects and mites.
Mites are members of a group of animals that include spiders and ticks. They also have an exterior skeleton but are extremely small (0.1 - 1 mm in length), have no wings, generally have 8 legs and one main body section.		
There are many different insects and mites. Only a few are pests. Insects and mites are only pests when they damage property, crops, food, feed and livestock, and when they carry diseases affecting man or animals.	Know when insects or mites are pests.	Identify when insects and mites are pest.
Often insects that become pests are present in low numbers for most of the time until conditions become right for their populations to expand rapidly. In such cases, they may multiply so fast that for a while, natural enemies such as birds, predator insects, and diseases cannot contain the population levels. After several years, their natural enemies increase and usually reduce the pest population to low numbers again.	Know why native species of insect or mite populations occasionally increase to become severe pests.	Describe why native species of insect or mite populations occasionally increase to become severe pests.
Sometimes insect pests are introduced species - that is they expand rapidly because they have been transported from other geographical areas. In the new location there may be no natural enemies to contain them.	Know why an introduced insect species may be a significant pest.	Describe why an introduced insect species may be a significant pest.
Insect and Mite Life Cycles		
Insects and mites change as they grow. Insects go through 3 or 4 different stages. Two common sequences of insect stages are:		
1. Egg to young to adult (gradual development). The young are similar in appearance to the adult but are wingless and lack reproductive organs; for example, aphids and grasshoppers.	Know the most common sequences of growth that insects may go through.	Describe the most common sequences of growth that insects may go through, and provide an example of each.

Category: AERIAL

Concept: PEST MANAGEMENT - INSECTS AND MITES

General Objective: To understand pest management principles required to carry out effective insect and mite control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
2. Egg to larva to pupa to adult (complete metamorphosis). The larva is very different from the adult (e.g., caterpillars, loopers, grubs, maggots); the pupa is a non-feeding stage during which complete change of shape occurs; the adult is the reproductive stage and is usually winged. Examples: mosquitoes, moths, beetles and flies.		
Mites generally go through three stages: egg to nymph to adult.	Know the stages of growth that mites generally go through.	List the growth sequence that mites go through.
The best control is usually achieved during the early stages: young, nymph, or larva. Egg and pupa are not affected by most insecticides and miticides.	Know the stages of growth during which the best control is usually achieved.	Identify when best control is usually achieved in the life cycle of insects.
<u>Insecticides and Miticides</u>		
Insecticides and miticides are often described according to how they act on (mode of action) or enter the pest.	Know how insecticides and miticides work.	
Contact pesticides must come in contact with the pest to be effective. They can be applied to the pest or on surfaces that pests touch. Some contact insecticides have a residual effect and can kill insects for some time after they are applied.		Describe how contact insecticides work.
Systemic pesticides enter plants and flow in the sap. Insects or mites which suck the sap are killed by the insecticides in it. Some insecticides are both systemic and contact.		Describe how systemic insecticides work.
Stomach poisons must be swallowed by the pest to be effective (e.g., they may be applied to foliage and ingested by defoliating caterpillars).		Describe how stomach poisons work.
Suffocating pesticides (usually oils) clog the breathing system of insects and may also affect egg survival.		Describe how suffocating insecticides work.
Growth regulators act like the insect's own hormones. They affect the normal development of the insect and it dies before it becomes an adult or before it can reproduce.		Describe how insecticide growth regulators work.

Category: AERIAL

Concept: PEST MANAGEMENT - INSECTS AND MITES

General Objective: To understand pest management principles required to carry out effective insect and mite control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Microbial insecticides contain microbes (tiny organisms). After they are eaten, the microbe or a poison the microbe produces kills the insects. They are sprayed on plants and are only poisonous to certain insects.		**Explain how microbial insecticides work.**
Factors Affecting Insecticides/Miticides Effectiveness		
Timing of application: Insects/mites may need to be present or in a specific stage of development for a pesticide to be effective.	**Know factors affecting insecticide/miticide effectiveness.**	**List and describe factors which can affect the effectiveness of insecticides/miticides.**
Resistance: Some insects/mites have developed resistance to certain pesticides or groups of insecticides.		
Weather conditions: Temperature, humidity and rain can affect the effectiveness of insecticides.		

Category: AERIAL

Concept: PEST MANAGEMENT - DISEASES

General Objective: To understand pest management principles required to carry out effective disease control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Plants are diseased when their appearance or function is not normal. Disease symptoms are caused by infection from microorganisms or environmental stress. Similar symptoms can be caused by insect damage (i.e., gall forming insects) or herbicide damage. It is important to correctly identify the cause of the symptoms so that an effective treatment can be chosen.	Know what can cause disease symptoms. Understand why it is important to correctly identify the cause of disease symptoms.	List the major causes of disease or disease-like symptoms. Identify other factors that could cause similar symptoms. Describe why it is important to correctly identify the cause of disease or disease-like symptoms.
<u>Environmental Stress</u>		
Unfavourable environmental conditions which stress plants and cause abnormal growth or disease-like symptoms include extremes of light, temperature, water or nutrients and toxic chemicals. Plants weakened by environmental stress are more likely to be infected by pests. Recognizing and relieving the stress will help prevent infectious diseases.	Know environmental conditions which can stress plants and cause abnormal growth or disease-like symptoms. Understand why it is important to recognize and relieve environmental stress.	List environmental conditions that could stress plants and cause abnormal growth or disease-like symptoms. Identify why it is important to recognize and relieve environmental stress.
<u>Infection by Microorganisms</u>		
Microorganisms that cause diseases include fungi, bacteria, viruses and nematodes. These organisms are usually too small to see. Identification is usually based on plant disease symptoms or laboratory investigations.	Know pest organisms which can cause disease. Know that disease identification is based on symptoms and laboratory investigations.	List types of organisms that can cause diseases. Describe how a disease can be identified.
Fungi are the largest group of organisms which cause plant diseases. They are simple plants which feed on living or decaying organisms. This group includes moulds, mushrooms, and rusts. Some disease symptoms that may be caused by fungi include cankers, dieback, galls, leaf spots, rots, ruts and wilts.	Know the general characteristics of fungi that cause plant diseases.	Describe what a fungus is.

Category: AERIAL

Concept: PEST MANAGEMENT - DISEASES

General Objective: To understand pest management principles required to carry out effective disease control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Most fungi reproduce by tiny spores. The spores are released into the environment and they are usually moved by wind and water. Some may land on healthy leaves of a host plant. If environmental conditions are poor, spores may remain dormant and they are fairly resistant to fungicides in this stage. If environmental conditions are good, the fungus spores germinate. When spores germinate, they usually produce threadlike filaments which can infect the host, absorb nutrients, and give off toxins that cause disease symptoms.	Know how most fungi reproduce and cause disease.	Describe how many fungi reproduce and cause disease.
The fungus is most vulnerable to fungicides between germination and infection. Infection begins when the fungus enters plant tissues. When the plant responds to an infection by growing abnormally it is said to be diseased. Inside the plant the fungus is protected and difficult to control. A systemic fungicide may control the disease if applied before the infection is too severe.		Indicate at what stages in the life cycle a fungus is typically more resistant and less resistant to a fungicide.
Bacteria cause some major plant diseases such as blights, galls and rots. Bacteria are one-celled organisms which can only be seen with a microscope. They usually enter a plant through natural openings or wounds. Under favourable conditions, bacteria reproduce very quickly, using the plant as a source of food. Bacteria are spread by wind and rain or by contact with animals or equipment.	Know the general characteristics of bacteria that cause plant diseases.	Describe what bacteria are, and how they spread.
Viruses are so small they cannot be seen with an ordinary microscope. Viruses cause diseases which often reduce plant vigour and crop yields. Viruses reproduce only within living cells. They can be spread by mechanical means (i.e., during pruning or harvesting), during propagation (e.g., in seeds, tubers, and other plant parts) or by vectors (insects, mite, nematodes, fungi).	Know what a virus is and that they can cause plant diseases.	Describe what a virus is. List ways viruses can be spread.
Mosaics, ringspot and leaf roll are examples of disease caused by viruses. No pesticides are available to control viruses directly. However, some may be used to control virus vectors.		List diseases caused by viruses. Identify whether any pesticides can be used to control a virus.

Category: AERIAL

Concept: PEST MANAGEMENT - DISEASES

General Objective: To understand pest management principles required to carry out effective disease control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Nematodes are small thread-like animals which may feed on plant roots, stems, and leaves. They can affect the movement of water and nutrients in a plant and they create wounds which may allow fungi or bacteria to enter.	Know what nematodes are and that they can cause diseases.	Describe what nematodes are.
Some symptoms that can be caused by nematodes are wilting, stunting, lack of vigour and growth deformities.		List disease symptoms that may be caused by nematodes.
<u>Approaches to Disease Management</u>		
Three things must be present for a plant disease to develop from an organism. They are: - a disease causing organism (pathogen); - a host susceptible to the disease; - an environment favourable to the disease organisms and/or unfavourable to the host.	List the three conditions necessary for a disease to develop.	List the three conditions necessary for a disease to develop.
Taking away or changing any one of these 3 things will control the disease. For example, a disease problem can be prevented by: keeping the organisms out of an area, using strains of plants that are resistant or not affected by the disease, reducing the population of disease causing organisms, or by manipulating the environment to favour the host but not the pathogen.	Understand how diseases can be controlled.	Describe how diseases can be controlled.
<u>Fungicides</u>		
Fungicides are often described according to how they work (mode of action).		
Protectant fungicides provide a protective film of fungicide on or around the host to prevent fungus spores from germinating. Protectant fungicides must be used before a fungus reaches the infected stage. After the plant is infected the fungicide normally will not kill the fungus inside the plant, but it can protect the plant from further infection. New plant growth which appears after treatment is not protected, therefore, reapplication is required. Protectants can be applied to seeds, foliage, flowers, fruit or to roots. Most control programs use protectant fungicides.	Understand how protectant fungicides work.	Describe how protectant fungicides work.

Category: AERIAL

Concept: PEST MANAGEMENT - DISEASES

General Objective: To understand pest management principles required to carry out effective disease control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Eradicant fungicides kill fungus organisms that have infected but not become well established within the plant. Eradicant fungicides have limited value for fungi which are well established within plants. Only a few fungicides are eradicants.	Understand how eradicant fungicides work.	Describe how eradicant fungicides work.
Systemic fungicides are absorbed by plants and move within them. They may act as protectants, eradicants or both. Once inside the plant, systemics move to new areas of plant growth.	Understand how systemic fungicides work.	Describe how systemic fungicides work.
<u>Factors Affecting Fungicide Effectiveness</u>		
Timing of application: In order to be effective, the fungicide should control the fungus during the infection period.	Know factors affecting fungicide effectiveness.	List and describe the factors that affect fungicide effectiveness.
Fungus life cycle and weather: The frequency of applications varies depending on the type of fungus, the fungicide, and the weather. If the fungus has a short life cycle and there are good conditions for its growth it can have many infection periods and many applications may be needed. Rain, rate of plant growth, and the type of fungicide also affect the frequency of application. If the fungicide is washed off, if new leaves grow or if the fungicide breaks down quickly, applications may need to be repeated.		
Resistance: Disease organisms are resistant to certain fungicides or groups of fungicides. They may develop resistance after repeated applications of fungicide.		

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
<u>Agricultural Pest Management</u>		

Category: AERIAL

Concept: PEST MANAGEMENT - OBJECTIVES IN AGRICULTURE, FORESTRY, INDUSTRIAL VEGETATION, AND MOSQUITO PEST CONTROL

General Objective: To understand how aerial application of pesticides may be a component of pest management programs.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Aerial applications in agriculture are used to control a wide range of weeds, insects and diseases which impact on crops. The applicator should be assured that the pest has been properly identified, so that the pesticide being used can be verified as registered for the pest and crop and is recommended by local agricultural authorities. The applicator should verify that application timing is correct, according to life stage of the pest. Before application of pesticides, there should be an assurance that the pest is having or will have a significant impact on the crop, determined from field observations of the pest and knowledge of its life cycle, and that the pesticide is being used responsibly as a component in an integrated pest management program.	Know general requirements for effective pest management, and responsible used of pesticides, by aerial application in agriculture.	Describe general requirements for effective pest management and responsible use of pesticides by aerial application in agriculture.
<u>Forestry Pest Management</u> Aerial application of pesticides in forestry is used for vegetation and insect control.		
<u>Vegetation Management</u> Vegetation management objectives include: 1. Site preparation: The improvement of a site for planting or seeding. This may include vegetation management as well as clearing debris to make planting or seeding easier, to reduce competition with crop seedlings, and improve their chance of survival.	Know the main objectives for use of herbicides in forestry.	Describe site preparation and identify vegetation management objectives.

Category: AERIAL

Concept: PEST MANAGEMENT - OBJECTIVES IN AGRICULTURE, FORESTRY, INDUSTRIAL VEGETATION, AND MOSQUITO PEST CONTROL

General Objective: To understand how aerial application of pesticides may be a component of pest management programs.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
2. Stand tending: The improvement of survival, growth and shape of crop trees. This may include brushing, which is the management of vegetation competing with seedlings or crop trees for light, moisture and nutrients. Conifer (or crop) release more specifically refers to management of vegetation which is overtopping or surrounding crop seedlings or trees to promote crop growth to a free-to-grow stage (when they have overgrown competing plants). The aim of crop release is to restrict growth of competing vegetation long enough to permit young trees to dominate.		Describe stand tending, and define brushing and conifer (crop) release. Identify the vegetation management objectives for these activities.
<u>Herbicide Use</u>		
Aerial application of herbicides may be used for site preparation or brushing and conifer release.		
Herbicide programs have the following advantages over other control methods: - less resprouting of target species than with other methods; - little or no disturbance of the soil mantle, which is desirable when sites are located on slopes with fragile soils; - generally less costly than other methods.	Know the main advantages and disadvantages of herbicide use in forestry.	List and describe the main advantages and disadvantages of herbicide use in forestry.
Herbicide programs have the following disadvantages: - potential effects on fish and wildlife or contamination of domestic water if not used properly; - lack of registered herbicides suitable for some site conditions; - public concern about the use of chemicals in the environment.		
Herbicides should be applied when the dominant problem vegetation species are most susceptible to the herbicide, and when desirable species are relatively resistant or will sustain little damage. Herbicide use in different seasons is characterized as follows:	Know suitable conditions for herbicide use with respect to weed species and crop plants.	Describe conditions suited for herbicide use with respect to weed species and crop plants.

Category: AERIAL

Concept: PEST MANAGEMENT - OBJECTIVES IN AGRICULTURE, FORESTRY, INDUSTRIAL VEGETATION, AND MOSQUITO PEST CONTROL

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
1. Budbreak sprays (late winter or early spring when new leaves of target species are just beginning to form): - herbicide absorption is mainly through the bark of stems and branches; - target species can be susceptible to some herbicides just after budbreak, while conifers are relatively resistant.	Know how herbicides are used during different seasons.	Describe the characteristics of budbreak sprays.
2. Early foliar sprays (late spring): - most plants are susceptible to herbicides during this time of active growth; - poor time for brushing and conifer release unless conifers are protected; - effective time for site preparation.		Describe the characteristics of early foliar sprays.
3. Late foliar sprays (mid-late summer): - less effective on shrubs than earlier foliar sprays; - conifer resistance to herbicides increases after growth cessation and new bud formation.		Describe the characteristics of late foliar sprays.
4. Fall sprays (late August to October): - conifers are generally resistant to some herbicides; - good time for control of some deciduous brush species as herbicides can be translocated to roots along with food reserves; - less effective time for control of many herbaceous species as growth may have ceased.		Describe the characteristics of fall sprays.
<u>Insect Management</u>		
Objectives of aerial application for insect control in forestry include the following: - attempted eradication (e.g., treatment for Asian Gypsy Moth in B.C.); - suppression of an insect epidemic; - protection of trees while letting an epidemic run its course.	Know the main objectives for insect control in forestry.	Describe the main objectives for insect control in forestry.

Category: AERIAL

Concept: PEST MANAGEMENT - OBJECTIVES IN AGRICULTURE, FORESTRY, INDUSTRIAL VEGETATION, AND MOSQUITO PEST CONTROL

General Objective: To understand how aerial application of pesticides may be a component of pest management programs.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
There are relatively few species of insects that are severe pests in forestry, but some cause significant economic losses. Forest insect pests causing widespread damage are of two main types:	Know the characteristics of the main types of insect pests in forestry.	List the main types of insect pests in forestry.
1. Woody tissue feeders. The most damaging of these are the bark beetles which cause very high losses in mature and over mature stands. These insects bore through the bark and chew out galleries in which to lay their eggs. Newly infested trees remain green until the following summer and then die. Bark beetles cannot be controlled by aerial sprays.		Describe the characteristics of woody tissue feeder forestry pests.
2. Defoliators. Most attacks on needles or leaves are made by a group of insects known as defoliators. The larvae (caterpillars) of moths and sawflies are the most important defoliators of conifers. Eggs laid by adults hatch into caterpillars which fed on new or old foliage, depending on the species. When the moths emerge they usually can fly and may be carried with wind up to 100 km or more away. Unlike bark beetles, defoliators do not always kill trees immediately. The needles on the branches turn brown, the trees develop a scorched appearance and normal growth is reduced. This lessens the economic value of a tree and makes it more susceptible to other insects and diseases. If several attacks occur during the life of a tree, growth loss can be substantial. An infestation can spread very rapidly from a patch of trees to thousands of hectares in a couple of years. After a period of little to no activity, populations can suddenly explode, lasting two to ten years, followed by a slow decline. Defoliators are vulnerable to parasites, diseases and extremes in temperature.		Describe the characteristics of the defoliator forestry pests.
Insecticides may be used to control the spread of a defoliator or to protect a stand of crop trees until an infestation has declined. A key factor in management is early detection and an appraisal of the course an infestation will take. When direct control is chosen, it should be carried out early in the outbreak, when the area to be treated is as small as possible.	Know the main considerations in managing an insect pest with insecticides.	Describe the main considerations in managing an insect pest with insecticides.

Category: AERIAL

Concept: PEST MANAGEMENT - OBJECTIVES IN AGRICULTURE, FORESTRY, INDUSTRIAL VEGETATION, AND MOSQUITO PEST CONTROL

General Objective: To understand how aerial application of pesticides may be a component of pest management programs.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Other Insect Pests. Two other groups of insects (sucking insects and cone and seed insects) cause damage in localized areas. These insects can cause damage in seedling nurseries and seed orchards that can be treated by aerial application to protect the large investment in these facilities.	Know that aerial applications may be made to control sucking and seed and cone insects in seedling nurseries or seed orchards.	Identify that aerial applications may be made to control sucking and seed and cone insects in seedling nurseries or seed orchards.
<u>Industrial Vegetation Management</u>		
Industrial vegetation management includes control of undesirable vegetation on industrial sites, rights-of-ways (e.g., rail, road, pipeline and hydro) and on public land.	Know the long term objective which should be part of a vegetation management program.	Describe the long term objective which should be part of a vegetation management program.
All vegetation programs should be part of a long term management program. The objective should be a relatively stable condition for a site. The reason for a vegetation problem should be evaluated before initiating controls. Vegetation management may include avoiding creating bare earth conditions which are conducive to weed development or enhancing desirable vegetation, not just treatment of weeds.		
The tolerance for weeds differs for various site uses and should be established before controls are implemented. A control method should be selected only after a variety of alternatives have been considered. Herbicide selection must always be based on a site-specific prescription, considering conditions such as weed species, soil type, topography, proximity to water and land use. When economically feasible, selective removal of the target species is preferable as it will: - reduce herbicide use; - preserve desirable vegetation; - safeguard the environment; - reduce public concern.	Know basic considerations for selection of herbicides for control of vegetation.	Describe basic considerations for selection of herbicides for control of vegetation. List reasons why selective removal of the target species may be preferable to broadcast applications.
Aerial application of herbicides for industrial vegetation control is rarely used as it is not sufficiently selective to be used in a program which encourages desirable vegetation while eliminating undesirable.	Understand why aerial application of herbicides is seldom used.	Describe why aerial application of herbicides is seldom used.

Category: AERIAL

Concept: PEST MANAGEMENT - OBJECTIVES IN AGRICULTURE, FORESTRY, INDUSTRIAL VEGETATION, AND MOSQUITO PEST CONTROL

General Objective: To understand how aerial application of pesticides may be a component of pest management programs.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Mosquito Management		
Control of mosquitoes is complex and requires careful planning and execution to reduce populations to tolerable levels and yet to be economically and environmentally acceptable. Mosquito abatement programs should generally be conducted for a community rather than individuals to achieve successful control. A critical part of a mosquito control program is the careful mapping of breeding sites. Larvae found in field surveys should be identified before any control measures are taken. There are over 50 species of mosquitoes in Canada and many are not significant pests.	Know basic considerations for a mosquito control program.	Describe basic considerations for a mosquito control program. Identify why larval identification is important in a survey of mosquito breeding sites.
Control programs should consider removal of mosquito habitat as well as pesticides. Some habitats can be removed (e.g., drained) or modified (e.g., deepened) to make them unsuitable for mosquito development.		Identify an alternative non-pesticide control method for mosquitoes.
Pesticides may be directed against the larvae (larviciding) or adults (adulticiding). Best results are usually obtained by larviciding because larvae are relatively confined and concentrated. Adults are widely dispersed and are less easily treated. The main emphasis should be treatment of larval habitats within a radius of at least 5 km beyond a residential area, with adulticiding used only as a last resort to kill adults migrating into an area.	Know that mosquitoes can be controlled with larvicides or adulticides. Know that the emphasis should be on treating larval habitats.	Describe the two options for control of mosquitoes with pesticides, and which should be considered first.
Larvicides come in a variety of formulations including emulsions and granules. The latter are more suitable for application to sites with emergent or floating vegetation and can be applied by aircraft with less potential for drift. Application of larvicides must be made to areas which are known breeding sites when the majority of larvae are mid-way through their development. The application timing with respect to larval development can be critical.	Know the major considerations for larviciding.	Describe the major considerations for larviciding.

Category: AERIAL

Concept: PEST MANAGEMENT - OBJECTIVES IN AGRICULTURE, FORESTRY, INDUSTRIAL VEGETATION, AND MOSQUITO PEST CONTROL

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Adulticiding programs are usually conducted only when their abundance is severely annoying. The mosquito abundance may be determined by bite counts or by trapping to indicate when applications should start. Two approaches for adulticiding can be taken. For either approach, aircraft mounted equipment may be used.	Know the major considerations for adulticiding.	Describe the major considerations for adulticiding.
1. Residual sprays to vegetation surfaces on which mosquitoes rest. Such sprays may be made where specific areas are to be protected or as a barrier treatment to prevent the migration of mosquitoes into an area (e.g., industrial work areas, private yards, parks and golf courses). Spraying should be done in late afternoon or evening, shortly before mosquitoes become active.	Understand the objective of using residual sprays. Know the procedure.	Describe the objective and procedure for residual sprays for adulticiding.
2. Space sprays (low-volume or fog) to kill flying mosquitoes. With space sprays, a cloud of small droplets (5 - 20 micron range) are suspended in the air which drift downward to come in contact with adult mosquitoes. The effective swath width should be about 100 m. The sprayer should travel at right angles to the direction of the wind. Space sprays should be conducted when mosquito activity is maximum and winds are less than 10-12 km/ hour. This usually occurs in the late evening, overnight and early morning.	Understand the objective of using space sprays. Know the procedure.	Describe the objective and procedure for space sprays for adulticiding.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - DISPERSAL SYSTEMS AND COMPONENTS

General Objective: To understand the components of aerial application systems.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
A. General		
A dispersal system is the equipment which releases the pesticide and distributes it in a swath along the flight path. Dispersal systems must: - be able to safely and accurately deposit material uniformly within the target area; - be accurately calibrated, with monitor systems to ensure continuing accuracy; - have rapid and secure on/off controls; - have a rapid and reliable emergency jettison system; - be easy and safe to clean; - be easily convertible from one material to another.	Know what an aerial application dispersal system is and general requirements.	Describe what an aerial application dispersal system is and list general requirements.
B. Components		
Major components of liquid dispersal systems include hoppers or tanks, pumps, filters, pressure gauges, pipes and fittings, spray booms, spray atomizers, and flowmeters. Granular dispersal system components include hoppers and spreaders. Both liquid and granular systems also utilize swath guidance or navigation systems.	Know the major components of dispersal systems.	List the major components of dispersal systems.
Hoppers and Tanks		
Hoppers hold both liquids and solids. Closed tank systems are used only for liquids. Desirable features of both include: - corrosion resistance and no leaks; - accurate means of measuring quantity on the ground and in the air; - well vented to eliminate any danger of tank collapse, and to ensure uniform flow; - suitable agitation for liquid loads so they remain well mixed; - sloped walls for hoppers holding granules to ensure uniform flow rates.	Know desirable features of pesticide hoppers and tanks.	List desirable features of pesticide hoppers and tanks.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - DISPERSAL SYSTEMS AND COMPONENTS

General Objective: To understand the components of aerial application systems.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Spray Pumps - General		
Liquid dispersal systems generally use fan or hydraulically driven centrifugal pumps. Requirements include: - mounting of pumps lower than the bottom of the tank so they will be self-priming; - sufficient output capacity to handle the spray volumes required.	Know the main ways pumps are powered. Know the requirements for their location and output capacity.	List the main ways pumps are powered. Describe the requirements for their location and output capacity.
Fan Driven Pumps		
These are powered by windmill propellers and are the most common type of pump used in aerial spraying. Their features include the following: - their main advantage is they are highly reliable; - their disadvantages are the high drag penalty they incur and their relatively low pumping efficiencies; - many have ground or air adjustable blade pitches; - they incorporate a brake or feathering device to stop the pump when not in use, or in the event of failure of a shut-off valve; - they are airspeed sensitive, and provide accurate flows only at speeds used during calibration.	Know features of fan driven pumps. Understand the advantages and disadvantages of each features.	List the features of fan driven pumps; identify their advantages and disadvantages.
Decreased sensitivity to airspeed changes and increased driving power can be obtained by mounting them in the propeller slipstream.	Know where fan driven pumps should be mounted for least sensitivity to airspeed changes and increased driving power.	Identify the most ideal location for mounting fan driven pumps.
Hydraulic Pumps		
Hydraulic pumps offer high power and no drag and are not affected by aircraft speed.	Know the advantages of hydraulic pumps.	Identify the advantages of hydraulic pumps.

Category: AERIAL

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General Objective: To understand the components of aerial application systems.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Filters		
Good filtration prevents pump damage and nozzle clogging. A large mesh screen filter upstream from the pump prevents large foreign particles from entering and damaging the pump. Smaller mesh screen filters downstream from the pump prevent smaller particles from clogging nozzles. These screens should be: - easy to remove and clean; - inspected regularly; - upstream of the pressure gauge to ensure accurate pressure measurement at the nozzles. Individual nozzle screens should be cleaned regularly or whenever a clogged nozzle is observed.	Know where filters should be located in the system, their features and when to clean them.	Describe where filters should be located in the system, their features and when to clean them.
Pressure Gauges		
Pressure gauges should be: - positioned where they can be easily read by the pilot; - have the sensor element positioned downstream of all line filters; - checked periodically for accuracy of readings.	Know where pressure gauges should be positioned. Understand that they should be checked for accuracy.	Describe where pressure gauges should be positioned. Identify the need to check them for accuracy.
Pipes and Fittings		
Pipes and fittings should: - be corrosion resistant and leak-proof; - be large enough to permit appropriate volume flows with minimum resistance; - be clear of sharp bends; - have beaded ends where connecting hoses are used and be double clamped at all connections; - inspected regularly and changed at any sign of deterioration.	Know the desirable features of pipes and fittings in an aerial dispersal system.	List the desirable features of pipes and fittings in an aerial dispersal system.
Spray Booms		

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - DISPERSAL SYSTEMS AND COMPONENTS

General Objective: To understand the components of aerial application systems.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Spray booms distribute spray to the spray atomizers, which must be positioned with the correct orientation and spacing along the boom to achieve optimum performance. Booms must be made from sturdy, corrosion resistant materials, and must be fastened securely to the aircraft structure. Nozzle check valves, diaphragm check valves or a pump suck-back system should be incorporated to prevent nozzle dripping. Streamlined booms have approximately 1/10 the drag of the same capacity round (in cross section) booms. Boom couplings should be: - secure and leak proof; - easily removable; - safety wired to prevent loosening. Booms should have easily removable end caps to permit rapid and complete flushing of the entire spray system.	**Know desirable feature of spray booms and boom couplings.**	**Describe desirable feature of spray booms and boom couplings.**
<u>Spray Atomizers</u>		
Spray atomizers break the liquid spray into droplets as it is dispersed from the sprayer. The two main types of atomizers used in aerial systems are hydraulic spray nozzles and rotary atomizers.	**Know what spray atomizers do and know the main types.**	**Describe what spray atomizers do and list the main types.**
Use manufacturer's charts to select the size and number of atomizers with the appropriate droplet type, angle and flow rate required. See the section FLOW RATE VERIFICATION for the formula for calculating required flow rate based on the required sprayer output.	**Know how to select the correct type and number of nozzles based on the required spray output and the manufacturer's specified flow rates.**	**Given the required sprayer output and manufacturer's specified nozzle flow rates (and aircraft speed and swath width), determine how many nozzles would be required.**
The total atomizers required will generally be 20-50 hydraulic nozzles or 6-10 rotary atomizers.	**Know the approximate number of atomizers commonly used.**	**Indicate the approximate number of atomizers commonly used.**

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - DISPERSAL SYSTEMS AND COMPONENTS

General Objective: To understand the components of aerial application systems.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Hydraulic spray nozzles: These atomizers produce droplets when the liquid mix is forced under pressure through a small nozzle orifice. Proper selection of these nozzles is crucial to maximizing spray effectiveness. Follow manufacturer's recommendations when selecting a boom/nozzle assembly for use. Select nozzle types to provide the correct flow rate and droplet size at a given pressure, with droplet size being selected to ensure adequate coverage while minimizing drift. Hydraulic nozzle types include: - jet: produces a solid stream of large droplets; - hollow cone: produces a cone shaped pattern, and uses a swirl plate to impart a spin to the spray; - fan: produces a flattened fan-shaped pattern; - raindrop: a disc core nozzle with an added swirl chamber to reduce small driftable droplets in the spray; - disc: utilizes only the orifice in the nozzle body, producing a solid stream of liquid that breaks up in the wind shear.	Know how hydraulic spray nozzles work. Know the factors to consider when selecting nozzles. Know the main types of hydraulic spray nozzles.	Describe how hydraulic spray nozzles work. List the factors to consider when selecting nozzles. List the main types of hydraulic spray nozzles. Describe the spray patterns produced by each.
Droplet size for a given hydraulic nozzle setup: - decreases with increased boom pressure; - decreases with smaller orifice sizes; - decreases when the nozzle is pointed 90 degrees to the relative airflow; - decreases further when pointed forward directly into the relative airflow.	Know how droplet size varies for a given hydraulic nozzle setup.	Describe how droplet size varies for a given hydraulic nozzle setup.
Nozzles must be checked regularly for wear as this affects flow rate and spray pattern. Visually check nozzles for irregular spray patterns and replace as necessary. The rate at which a nozzle wears depends on: - nozzle material; - pesticide formulation; - operating pressure; - nozzle size.	Know factors affecting nozzle wear.	List factors affecting nozzle wear.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - DISPERSAL SYSTEMS AND COMPONENTS

General Objective: To understand the components of aerial application systems.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
In general, the harder the nozzle material, the longer the nozzle will last, but the higher the cost. Brass is one of the softest nozzle materials and ceramic is one of the hardest. Other materials such as stainless steel and plastics fall between the two.	Know the difference in rate of wear between different nozzle materials.	Describe the difference in rate of wear between brass, stainless steel, plastic and ceramic nozzle tips.
Rotary atomizers: Rotary atomizers are most commonly used in ultra low volume (ULV) insect control programs where fine particles of uniform size are required. Droplets are formed when fluid shatters on the spinning perforated cage of the atomizer unit. Cage rotation is provided by windmilling fan blades, or electric or hydraulic motors. Atomizer output varies with boom pressure and flow restrictor setting. Units contain a diaphragm check valve to prevent dripping with booms off in-flight, or while parked.	Know how rotary atomizers function.	Describe how rotary nozzles function and how output is adjusted.
Droplet size for a rotary atomizer: - decreases with increase in cage rotational speed; - is not affected by boom pressure; - is less consistent at high flow rates as the cage becomes flooded.	Know how droplet size varies for a rotary atomizer.	Describe how droplet size varies for a rotary atomizer.
Advantages include: - the units produce a narrow droplet size spectrum over a range of droplet sizes and flow rate settings; - fewer units to maintain compared to hydraulic nozzle setups. Disadvantages include: - high initial cost; - greatly increased in-flight drag; - higher application height required for uniform coverage; - higher maintenance.	Know advantages and disadvantages of rotary atomizers.	List advantages and disadvantages of rotary atomizers.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - DISPERSAL SYSTEMS AND COMPONENTS

General Objective: To understand the components of aerial application systems.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Flowmeters		
Electronic flow meters incorporate a flow sensing device (usually located between the ball valve and the booms), a computer and a visual display. Display readouts are selected as required, and include: - volume dispersed; - volume remaining; - dispersal rates; - area covered; - spray time. Once calibrated, flowmeters provide highly accurate readings that can greatly increase application accuracy and consistency.	Understand electronic flowmeters.	Describe what electronic flowmeters do, and why they are useful.
Dry Material Spreaders		
Dry material dispersal units include a gate at the hopper outlet which can be adjusted to control the flow rate of granules onto the spreader mounted below. The ram-air type spreader is the one most commonly used. Hopper contents that fall through the gate opening are blown out the rear of the spreader. Vanes within the spreader deflect the materials laterally. Adjustment of the vanes permits adjustment of the deposit pattern.	Know how typical dry material spreaders work and list their components.	Describe how typical dry material spreaders work and list their components.
Navigation and Swath Guidance Systems		
Guidance systems provide a means for the pilot to make parallel passes with correct separation to produce uniform coverage of an area. The following systems may be used: Flaggers: Ground personnel using flags mounted on the end of long poles mark successive swath centerlines. Automatic flagman: A dispenser actuated by a button on the control stick ejects weighted paper streamers marking the flight path already flown.	Know the various types of navigation and swath guidance systems.	List types of navigation and swath guidance systems and describe how each works.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - DISPERSAL SYSTEMS AND COMPONENTS

General Objective: To understand the components of aerial application systems.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Electronic flagman: An electronic triangulation system with ground transponders and a cockpit display provide parallel track centerline guidance.		
Smoke generator: Oil injected into the engine exhaust manifold produces a thick smoke marking the line of flight and indicating wind conditions.		
Balloon markers: Ground teams position balloons to indicate swath centerlines and area boundaries (used in forestry).		
Pointer aircraft: An aircraft with an onboard navigator leads a team of spray aircraft down successive parallel spray lines (common in forestry work).		
Spotter aircraft: An aircraft (usually helicopter) is positioned at one end of a plot or the centre of a large treatment block. A navigator on the spotter aircraft directs the applicator aircraft onto flight lines and signals for booms on and off.		
Global positioning system: Displays position and flight line guidance from satellite information received by an onboard computer system.		

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - PROCEDURES

General Objective: To know standard operational procedures for aerial application of pesticides.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Application Patterns		
There are two main types of flight patterns used to apply successive swaths for uniform coverage of a treatment area: 1. Shuttle: Successive swaths are adjacent to each other and a "procedure" turn is used at each end. This pattern is used primarily for smaller width fields and in forestry work. 2. Racetrack: The area is split in half and successive swaths are applied to each half of the area, starting from the downwind side, with a broad turn at the end of each swath. This pattern is used in agricultural work for wider fields, where a normal 180 degree turn can be used to comfortably align the aircraft for the next swath. This pattern may also be used for working two separate areas (as in strip farming), where successive passes alternate from area to area. The racetrack pattern maximizes application time and minimizes time spent turning and reduces pilot fatigue.	Understand shuttle and racetrack application patterns and when they are typically used.	Describe shuttle and racetrack application patterns and identify when they are typically used.
Exit and Entry Angles		
Exit and entry angles should be equal to prevent an uneven pattern at the end of adjacent runs (particularly important when using the shuttle pattern). With a heavily loaded aircraft, abrupt pull-ups or steep entries could stall the aircraft.	Know important features of exit and entry angles.	Identify why exit and entry angles should be equal and why abrupt pull-ups and steep entries should be avoided.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - PROCEDURES

General Objective: To know standard operational procedures for aerial application of pesticides.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Procedure Turn		
This is a standard method for reversing direction 180 degrees to begin the next swath. Steps include: - begin with a pull-up at the end of a run for obstacle clearance (ensure booms are off prior to pull-up); - once safely clear of all obstacles, turn 45 degrees downwind; fixed wing aircraft level off, and reverse the turn 225 degrees to align properly for the next run; rotary wing aircraft modify this somewhat; - hopper levels, aircraft gauges and booms can be checked once the turn is safely established; - avoid turns whenever possible over buildings, open water, livestock or other sensitive areas.	Know the steps involved in the procedure turnaround manoeuvre to start a new swath run.	Describe the steps involved in the procedure turnaround manoeuvre to start a new swath run, including when to turn booms off, when and how to turn and when to check gauges.
Formation Flying		
Formation flying utilizes a lead aircraft and one or more wingmen flying with reference to lead, often with a pointer aircraft to direct the formation. It is used primarily in forestry work or for very large fields. Close formation flying must be avoided. Adequate manoeuvring space must be available for all aircraft.	Know what formation flying is.	Describe formation flying, when it is used for aerial application and the major safety consideration.
Height Estimation		
An accurate and consistent altitude ensures proper swath width and minimizes drift. For agricultural operations a boom height above crops of 8 to 10 feet (2-3 metres) is typical, while in forestry, height above canopy is typically 50-100 ft (15-30 metres). Flaggers can verify correct altitude until the proper visual cues are learned.	Know standard heights for aerial application in agriculture and forestry, why a standard height is important and the use of flaggers to verify height.	Describe standard heights for aerial application in agriculture and forestry, why a standard height is important and the use of flaggers to verify height.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - PROCEDURES

General Objective: To know standard operational procedures for aerial application of pesticides.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Speed		
Operational speeds should be constant and the same as used during calibration to ensure accurate and uniform coverage.	Know why speed during application should be constant.	Identify why speed during application should be constant.
Trimming		
Trimming runs are spray swaths flown at right angles to regular runs. They are used to cover areas missed during exit and entry, or for areas missed when flying over obstacles with booms off, or for applying alongside sensitive areas. The pilot must account for the amount of load required to complete trim runs.	Understand about trimming runs.	Describe how and when trimming runs are used.
Fuel and Oil Considerations		
For aircraft fuel and oil: - do not rely on fuel gauges for accurate readings; - refuel after a set time, with regard to aircraft endurance and fuel consumption; - use filtered fuel of proper type, and correct type of oil; - check fuel drains at the beginning of each day's operations; - check oil with each refuelling.	Know when to check aircraft fuel and oil.	Describe when to check aircraft fuel and oil.
First Flight of Day Requirements		
For first flight of the day: - a thorough walk-around inspection is mandatory; - use light load on first take-off, particularly if a new strip is being used; - start the aircraft in plenty of time to permit proper warm-up, especially in cold weather; - fully brief the mixer/loader on the day's operations.	Know the requirements for the first flight of the day.	List the requirements for the first flight of the day.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - PROCEDURES

General Objective: To know standard operational procedures for aerial application of pesticides.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Organizational Requirements		

General operating standards include:
- developing "go no-go" standards to fit the operation, considering:
  - weather;
  - proximity of sensitive areas;
  - safety hazards;
  - limitations of personnel (i.e., fatigue, experience level).
- for forestry work, making a pre-application flight over the area to be treated;
- not beginning or continuing application if there is any doubt about the proper area or effectiveness of application;
- developing direct, standardized communications between all personnel (both office and field staff). It is particularly important that the pilot or ground crew supervisor are continually aware of any changes (weather, work orders, etc.) that may jeopardize safety or effectiveness of application;
- at the end of a day's operations, ensuring all materials and equipment are available and serviceable for the next day's operations.
	Know the requirements to organize and coordinate daily operations.	List the requirements to organize and coordinate daily operations.

Calculating Pesticide Load Requirements		
1. Calculate total volume of spray mix or weight of granules required: Total Volume = Area x Required Spray Output. Total Weight = Area x Pesticide Rate. (where required spray output = spray output determined by project requirements or by label spray rate if given (L/ha).	Know how to calculate pesticide load requirements.	Describe how to calculate pesticide load requirements, including: - total spray volume; - number of loads required; - total pesticide required; - pesticide amount per load.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - PROCEDURES

General Objective: To know standard operational procedures for aerial application of pesticides.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
2. Using a load size suitable for the type of aircraft, calculate the total number of loads required: **Number of Loads Required = $\frac{\text{Total Volume}}{\text{Load Size}}$** **Try to keep this figure a whole number (i.e., if the initial calculation requires 9.3 loads, divide the project into 10 standard loads of a slightly smaller size).** **3. Calculate the amount of pesticide required for the total area, using the manufacturer's recommendations:** **Amount of Pesticide = Total Area x Pesticide Rate.** **Note: Pesticide Rate is defined as the amount of pesticide product to be applied per unit area according to label instructions.** **4. Calculate the amount of pesticide/load:** **Pesticide Amount/Load = $\frac{\text{Total Pesticide Amount}}{\text{\# of Loads}}$**		
<u>Requirement Enroute</u> **When enroute to a treatment area:** **- mentally note local landmarks to expedite return to the treatment area;** **- avoid populated areas;** **- fly at least 500 (150 m) above all obstacles;** **- use the time enroute for checking proper aircraft operation.**	**Know standard precautions enroute to a treatment site.**	**List precautions to take enroute to a treatment site.**

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - PROCEDURES

General Objective: To know standard operational procedures for aerial application of pesticides.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Requirements Upon Arrival at Spray Area		
Upon arrival at a spray area: - verify correct area; - check for susceptible neighbouring crops; - check for hazards, and ensure that the spray area is clear of all unauthorized people, traffic, livestock, wildlife, etc., confirming with ground personnel whenever possible; - check engine instruments prior to commencing spray runs.	**Know what to check after arriving at a treatment area and before commencing application.**	**List things to check after arriving at a treatment area and before commencing application.**
Guidelines for Working a Field		
When working a field: - work with a crosswind whenever possible, moving successively upwind on each swath to avoid flying through suspended spray droplets; - fly parallel to crop rows; - exercise caution when flying into the sun; - continually verify that output corresponds to area covered.	**Know the guidelines to observe during application.**	**List the guidelines to observe during application regarding direction of flight paths and output.**
Requirements for Checking Swaths		
For checking swaths: - know the number of swaths required for a particular area; - keep track of the number of swaths done; - if unfamiliar with visual cues for a particular swath width, place flags at appropriate distances apart on the landing area, and fly over them until visual cues are established.	**Know the precautions to ensure that the correct number of swaths are treated.**	**List the precautions to ensure that the correct number of swaths are treated.**
Requirements Upon Return to Loading Area		

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - PROCEDURES

General Objective: To know standard operational procedures for aerial application of pesticides.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
When returning to the loading area: - fly a consistent pattern, watching for other aircraft; - with multi-aircraft operation, establish departure and arrival procedures and stick to them; - for fixed wing aircraft, allow plenty of stopping distance when landing towards loading area - particularly important when landing downwind; - use safe taxi speeds, particularly in the loading area.	Know the guidelines for safe return to the loading area.	List the guidelines for safe return to the loading area.
<u>Guidelines for Takeoff and Landing</u>		
For takeoff and landing: - ensure landing area and approach/departure areas are suitable; - use reduced loads until takeoff performance on strip is well established; - ensure mixing/loading equipment is well clear of takeoff/landing areas.	Know guidelines for takeoff and landing.	List guidelines for takeoff and landing.
<u>Successive Departure Requirements</u>		
For successive departures: - on the first takeoff of the day, complete the entire takeoff checklist in the aircraft manual; - with high frequency takeoffs, establish an appropriate abbreviated check and use it for every takeoff. (An example is as follows: - F Fuel - quantity, tank selectors; - F Flaps - as required; - T Throttle Quadrant - full rich, full fine; - T Trim - as required; - A Aborts-go-no-go point, dump lever safety off).	Understand the use of departure checklists.	Describe the departure check list.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - PROCEDURES

General Objective: To know standard operational procedures for aerial application of pesticides.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Cleaning Application Equipment		
Rinse the equipment thoroughly at the end of each day, by flushing clean water through the pump, boom and nozzles or granular spreader. Check for and replace worn parts. Dispose of rinsate by following provincial regulations and directions on the label.	**Know the procedure to clean application equipment at the end of each day and when changing pesticides.**	**Describe the procedure to clean application equipment at the end of each day and when changing pesticides.**
Decontaminate the sprayer when changing from one type of pesticide to another. Decontamination procedures vary depending on the pesticide being used. Consult the label or the manufacturer's representative for specific recommendations.		

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - METEOROLOGY

General Objective: To know what aspects of weather are important for aerial operations.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
General		
A high awareness of current and forecast weather conditions will permit safe and effective aerial application. The times should cover both that during application, and any time period following applications recommended by the pesticide manufacturer during which specific conditions must be met.	Know why weather should be monitored and what in particular the pilot should be aware of.	Describe why weather should be monitored and list what in particular the pilot should be aware of.
Specifically, the pilot should be aware of: - frontal movements that would affect application or the effectiveness of the chemical after application, particularly the possibility of precipitation; - wind speed and direction, gusts and squalls; - low-level turbulence; - times of sunrise, sunset (these should be used in conjunction with local weather to determine the times when sufficient light exists to commence or continue operations); - temperature and the existence and persistence of low-level inversions; - leaf wetness because of precipitation or dew, and the rate of drying; - storm and thunderstorm warnings; - cloud type, base, height and amount.		
Air Density		
Air density is a critical factor affecting aircraft performance. Two terms are used in discussions on air density.	Understand the terms air density and density altitude.	
- air density is the weight of air per unit volume; - density altitude is the altitude in the ICACO (International Civil Aviation Organization) standard atmosphere that has an air density equal to the actual operational site.		Define air density. Define density altitude.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - METEOROLOGY

General Objective: To know what aspects of weather are important for aerial operations.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
In effect, a hot humid day at sea level will make the aircraft perform as though it were at a much higher altitude. Pilots must be knowledgeable of data contained in aircraft manuals outlining the decrease in performance caused by increases in density altitude. Decreasing air density will: - decrease engine power available; - increase take-off and landing rolls; - decrease climb capability.	Know how air density can affect aircraft engine power, take-off and landing rolls, and climb capability.	Describe how air density can affect aircraft engine power, take-off and landing rolls, and climb capability.
This effect is particularly marked on non-supercharged engines. Supercharged engines and turbines are not as affected. Air density decreases with: - increasing temperature; - decreasing pressure; - increasing humidity.	Know how air density varies with temperature, pressure and humidity.	Describe how air density varies with temperature, pressure and humidity.
<u>Low-level Wind Shear</u>		
Under normal atmospheric conditions, surface friction retards the speed of the low level winds. Winds increase with altitude, with no sudden changes in speed or direction. Low level inversions, which usually happen in the evening, separate the low level winds from the effects of surface friction by a thin layer of cool, dense air. This means that pilots may encounter sudden changes in wind speed at an altitude of only a few meters. These sudden changes may cause serious control problems. Particularly hazardous situations occur when the pilot of a heavily loaded aircraft encounters a sudden increase in tailwind on climb-out or pull-up at the end of a run.	Know what low level wind shear is, how it is caused and how it may affect control and performance of the aircraft.	Describe what low level wind shear is, how it is caused and how it may affect control and performance of the aircraft.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - METEOROLOGY

General Objective: To know what aspects of weather are important for aerial operations.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Low level wind shears should be suspected whenever an inversion is present. Observing the tops of trees for movement, launching a balloon or a test flight with a lightly loaded aircraft will confirm the presence of a low level wind shear. If a low level wind shear is present, takeoffs should be made in the direction of the shear (i.e., so the aircraft climbs into an increasing headwind). On pull-ups going downwind and where the aircraft will be climbing into an increasing tailwind due to the shear, the pilot should plan to pull-up early, leaving a large margin of safety so that aircraft control and obstacle clearance is assured.	Know what to look for to check for wind shear and what precautions to take if there is one.	Describe what to look for to check for wind shear and what precautions to take if there is one.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - SWATH CHARACTERISTICS

General Objective: To know about types of, measurement of and factors affecting swath characteristics.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
A. Type of Distribution Patterns		
Distribution pattern refers to the variation in density of spray or granular materials deposited across the swath width. There are three general types of distribution patterns:	**Understand what a distribution pattern is.**	**Define distribution pattern.**
1. Uniform: A pattern in which the density of material is completely uniform across the entire swath. This pattern may seem desirable at first. However it has very poor overlap characteristics. Such patterns are excellent for one pass operations, but must be laid down precisely side by side for adjacent passes. Otherwise, areas in which they do not touch receive no deposit and areas in which there is overlap receive twice the intended amount.	**Know the uniform distribution pattern and where it can be used.**	**Describe the uniform distribution pattern and identify where it can be used.**
2. Triangular: A triangular density pattern across the swath, with maximum density in the centre and a uniform decrease toward each side. This pattern will produce considerable variation in deposit across the swath if swath spacing is not perfect. Triangular patterns are intermediate in sensitivity to errors in swath spacing.	**Know the triangular distribution pattern.**	**Describe the triangular distribution pattern.**
3. Trapezoidal: Trapezoidal patterns are relatively uniform across the centre, dropping off evenly at both ends. This pattern will maintain a uniform deposit across the centre and will produce a varied deposit only at the swath edges if the swath spacing is not perfect. This pattern is least sensitive to errors in swath spacing and is most suitable for treatments requiring adjacent passes.	**Know the trapezoidal distribution pattern and where it should be used.**	**Describe the trapezoidal distribution pattern and identify where it should be used.**

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - SWATH CHARACTERISTICS

General Objective: To know about types of, measurement of and factors affecting swath characteristics.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Total and Effective Swath Widths		
The effective swath width must not be confused with total swath width. Total swath width is the maximum distance between the ends of the ground deposit pattern, regardless of the varying densities of material along the pattern. Effective swath width is the distance between the two points on each side of the pattern centerline where the amount of spray or granules deposited is approximately 1/2 that at the centre. Separating swath centerlines by the effective swath width ensures uniformity of application rate over the entire project area.	Know the meaning of total and effective and swath widths and how to determine the distance between swath centerlines.	Define total and effective and swath widths and describe how to determine the distance between swath centerlines.
B. Determining Swath Characteristics		
General		
Swath characteristics for both liquid and granular applications are determined by flying the aircraft dispersing water or blank granules across some type of collecting or measuring apparatus or electronic analyzer placed perpendicular to its path. Density of deposited material is examined across the swath, and for liquids, the size of droplets is also examined. Analysis of the information allows a determination of total and effective swath widths and proper equipment set-up.	Know how swath characteristics are determined. Know what is assessed when analyzing swath characteristics, why and when it should be done.	Describe how swath characteristics are determined. Describe what is assessed when analyzing swath characteristics, why and when it should be done.
Prior to the working season, applicators should determine and record swath characteristics and adjust equipment configurations to give optimum swath patterns for each anticipated operation. Then, when commencing each new operation during the applicating season, just the flow rate need be verified to ensure delivery of the required spray or granule output.		
Liquids		

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - SWATH CHARACTERISTICS

General Objective: To know about types of, measurement of and factors affecting swath characteristics.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
An electronic analyzer provides the most accurate means of determining swath characteristics. A visual estimation can be made by recording spray deposition on water sensitive paper, or by using dyed water and normal paper. This system is logistically difficult to set-up and the visual estimations often give widely varying results.	Know how liquid swath characteristics can be determined.	Describe ways that liquid swath characteristics can be determined.
Granules		
A ground observer checks the number of granules per unit area across the swath width. A standard sized square wire form (e.g., 30 cm x 30 cm) is ideal for this. A second method is to place shallow pans of uniform size across the flight path, and record either the weight of material or the number of granules trapped. The quantities are plotted on a graph to determine the pattern. The effective swath width is measured from where the density or weight of granules is half that at the centre of the swath.	Know how granular swath characteristics can be measured.	Describe ways that granular swath characteristics can be measured.
Determine the aircraft output (kg/ha) after finding the effective swath width. If the output must be changed a test flight will have to be redone and the swath width remeasured.	Understand the adjustments to change the aircraft output (kg/ha) will require the effective swath width to be remeasured.	Identify the need to remeasure the effective swath width if the application rate is adjusted.
C. **Factors Affecting Swath Characteristics - General**		
Droplet Size		
Droplets move laterally due to the spanwise airflow from fixed wing aircraft. The longer a particle remains airborne (fall rate), the longer it will be affected by the spanwise airflow and the greater the swath width. The larger (and heavier) the droplet size, the faster the fall rate, and the less time these droplets will be affected by the spanwise airflow. This is particularly significant where drift must be minimized.	Know how changing the droplet size affects drift and swath width.	Describe how changing the droplet size affects drift and swath width.
Using a larger nozzle orifice to increase spray output/unit area usually results in an increased droplet size, a corresponding faster fall rate, and a decrease in swath width.	Know how droplet size is usually affected by increasing nozzle orifice size to increase output.	Describe how droplet size is usually affected by increasing nozzle orifice size to increase output.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - SWATH CHARACTERISTICS

General Objective: To know about types of, measurement of and factors affecting swath characteristics.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Boom Pressure		
With a constant airspeed the amount of material dispersed varies with boom pressure. 20-40 kpa is the normal working pressure range for hydraulic and rotary nozzles.	Know how boom pressure affects output and what is the normal working pressure.	Describe how boom pressure affects output and identify what is the normal working pressure.
Use the same boom pressures used during calibration. Using higher boom pressures than those used during calibration will cause an excess of spray output/unit area. Lower boom pressures will cause a decrease in spray output.	Understand why the boom pressure used during calibration should be used during application.	Identify the need to use the same boom pressure that was used during calibration.
Amount of Material Dispersed With Spreaders		
Spreaders impart a fanning pattern to the airflow, carrying dispersed material with it. The material moves aft and laterally, losing velocity until it eventually falls vertically (no wind situation). Higher airspeeds correspond to higher initial lateral velocities. Given a constant flow rate, higher airspeeds will result in a wider swath width.	Know how granular swath width varies with airspeed and output.	Describe how granular swath width varies with airspeed and output.
With a given airspeed, increasing the application rate means increasing the overall flow rate. The airflow then has to carry an additional weight of material. This will decrease the initial lateral velocities with a corresponding decrease in swath width.		
Airspeed		
Using airspeeds higher than that for which a fixed wing aircraft is calibrated will cause a spike to appear on the centerline of distribution patterns (i.e., the greater the airspeed, the more material is deposited near the fuselage centerline). This is the result of increased tail loadings and a subsequent increased vortex, which may cause a visible "rooster tail" effect.	Know how greater than desirable airspeed affects the distribution of deposited material across the swath.	Describe how greater than desirable airspeed affects the distribution of deposited material across the swath.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - SWATH CHARACTERISTICS

General Objective: To know about types of, measurement of and factors affecting swath characteristics.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Groundspeed		
Changes in groundspeed will vary the amount of time spent on a particular swath. Headwinds produce lower ground speeds and longer application times over a specific distance. Tailwinds increase ground speeds and decrease application times over the same distance.	Understand that it is necessary to alter airspeed when flying upwind vs downwind to even out application rates.	Identify why it is necessary to alter airspeed when flying upwind vs downwind to even out application rates.
Working an area in a back-and-forth pattern with a wind parallel to the flight path will cause an uneven application with a constant boom pressure. Flying into the wind will decrease groundspeed. The longer booms-on time will increase the amount of material deposited. Flying downwind will increase groundspeed. The shorter booms-on time will decrease the amount of material deposited. Increasing airspeed into the wind, and decreasing airspeed downwind will help to compensate for uneven application rates.		

Category: **AERIAL**

Concept: **APPLICATION TECHNOLOGY - SWATH CHARACTERISTICS**

General Objective: **To know about types of, measurement of and factors affecting swath characteristics.**

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Height of Application		
For granular applications, maximum swath width occurs at the application height at which particles are falling vertically when they reach the ground. For agricultural operations, applications are made from 2-3 meters boom height above the crop for better accuracy and to minimize drift. It is important to maintain as close as possible an application height consistent with that used during calibration, as variations will cause the distribution pattern to vary. For ULV applications used in forestry, application, altitudes are in the order of 50-100 ft/15-30 m, allowing a greatly increased swath width (often up to 200 ft/60 m with single engine aircraft).	Understand that height of application is generally 2-3 m in agriculture and 15-30 m in forestry and that height affects swath width, so height during application must be as close to that used during calibration as possible.	Describe the difference in typical application heights between agriculture and forestry and why it is important to try to maintain the heights used during calibration.
D. Factors Affecting Swath Characteristics - Fixed Wing		
Wingtip Vortices		
Dispersed chemical may be lofted by wingtip vortices. Material deposited on the outside edges of the swath frequently does not originate at the most outboard nozzles, but comes from nozzles further inboard. Material from nozzles located too far outboard is caught up in wingtip vortices and lost. Determine the farthest outboard nozzle position which is contributing to the swath width by running swath checks, and turning off one nozzle at a time starting at the wing tip until the observed swath width begins to decrease. This nozzle position will not usually be more than three quarters of the way from the fuselage centre to the wing tip.	Understand the dispersed spray may be lofted by wingtip vortices and know the procedure for determining the farthest outboard nozzle and where it is usually located.	Describe how dispersed spray may be lofted by wingtip vortices and describe the procedure for determining the farthest outboard nozzle and where it is usually located.

Category: **AERIAL**

Concept: **APPLICATION TECHNOLOGY - SWATH CHARACTERISTICS**

General Objective: **To know about types of, measurement of and factors affecting swath characteristics.**

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Propeller Wake		
With uniformly spaced nozzles, propeller wake causes pattern irregularities near the fuselage. Normally, less than the desired amount of material is deposited on the side of the downgoing blade and more on the opposite side. To compensate, locate more nozzles near the fuselage on the side of the downgoing blade. Run test swaths and adjust nozzle position accordingly until an even distribution pattern is achieved.	Know how propeller wake affects droplet distribution and how to compensate for this.	Describe how propeller wake affects droplet distribution and how to compensate for this by placement of nozzles.
E. Factors Affecting Swath Characteristics - Rotary Wing		
Speed		
At high forward speeds, material can be lofted by the helicopter rotor wake in a pattern similar to that caused by wingtip vortices from a fixed wing aircraft. At lower speeds, high rotor wake downwash velocities may be advantageous, and the up-wash velocities at the outer edges of the wake may prove to be either an advantage or a disadvantage. With large droplet size and low level application, the material may contact the ground prior to being affected by the rotor wake, with no subsequent effect upon swath distribution pattern. This is advantageous in the application of herbicides where drift should be minimal. However, during orchard spraying, it is advantageous to have the dispersed droplets distributed into the wake as it agitates the foliage. In this case, up-wash and downwash will ensure good coverage on both top and undersides of leaves.	Know how droplet dispersal may be affected by a helicopter rotor at high or low speeds and how these two situations might be used to advantage.	Describe how droplet dispersal may be affected by a helicopter rotor at high or low speeds and how these two situations might be used to advantage.
Nozzle Spacing		

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - SWATH CHARACTERISTICS

General Objective: To know about types of, measurement of and factors affecting swath characteristics.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Evenly spaced nozzles will not provide an even pattern. The pattern will be light in the centre, with two heavy areas on either side about mid-boom. To compensate, space nozzles closely near the centerline, gradually increasing separation to a maximum near mid-boom, then decreasing to even closer spacing than the centerline near the boom tip.	Know how nozzle spacing needs to be adjusted to compensate for uneven dispersal from rotary wing aircraft.	Describe how nozzle spacing needs to be adjusted to compensate for uneven dispersal from rotary wing aircraft.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - FLOW RATE VERIFICATION

General Objective: To understand flow rate verification procedures to ensure the correct amount of spray and pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Definitions		
Flow rate is the volume of spray or weight of granules delivered in a specific time period (e.g., L/min, kg/min). Flow rate verification is the measurement of flow rate from an aircraft to ensure it is suitable to provide the correct aircraft output (consistent with that obtained when determining swath characteristics). Flow rate verification is often done just before starting a treatment, usually on-site.	Know the term flow rate, why it is verified, and when it should be done.	Define flow rate. Indicate why it is verified and when it should be done.
Aircraft output refers to the amount of spray mix (for liquids) or the amount of granular pesticide (for solids) applied per unit area (e.g., L/ha, kg/ha). It is dependent upon: - flow rate; - effective swath width; - aircraft speed.	Know the term output (as used for aircraft application) and factors which affect it.	Define output and list the main factors which affect it.
When flow rate is verified for liquids, the following can be determined: - a flowmeter calibration number that will produce the required output (L/ha); or - a boom pressure (for aircraft without flowmeters) that will give the flow rate to produce the recommended output (given a fixed swath width and airspeed).	Know what the verified flow rate is used for.	Identify what the verified flow rate is used for in a plane equipped with a flowmeter and without a flowmeter.
When the flow rate is verified, the following calculations can be made, based on the confirmed aircraft output: - the total amount of spray mix or granules required for a treatment; - the number of loads (hopperfuls or tankfuls) required to complete a job; - the amount of pesticide concentrate to add to a spray tank (as discussed in the section on APPLICATION TECHNOLOGY - PROCEDURES).		List what can be calculated when the recommended output is confirmed.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - FLOW RATE VERIFICATION

General Objective: To understand flow rate verification procedures to ensure the correct amount of spray and pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Prior to arrival on-site for flow rate verification, the aircraft must be properly equipped with a dispersal system that: - is configured to provide the required droplet size and swath distribution pattern; - has nozzles which are selected to provide the desired output.	Know what is required to prepare a dispersal system before flow rate verification.	Describe what is required to prepare a dispersal system before flow rate verification.
Flow Rate and Output Formulae		
Use the following formula to determine the required flow rate of nozzles for configuring the boom and to compare with the actual flow rate determined during flow rate verification: Req'd Flow rate = Req'd Output x Effective Swath Width x Airspeed ÷ Constant. (metric: L/min = L/ha x m x km/hr ÷ 600). (imperial: g/min = gal/acre x ft x mph ÷ 495). Note that the required flow rate will have to be converted to American gallons/acre, if the nozzle flow rates are given in these units. On-site flow rate verification also requires the following formula: Actual Flow Rate = Volume Sprayed ÷ Spray Time	Know the formulae for calculating required and actual flow rates and actual output.	Describe the formulae for correctly calculating required and actual flow rates and actual output.
Flow Rate Verification Procedures for Liquid Dispersal Systems		
Prior to determining actual flow rates, the system must first be primed. Add a sufficient load to completely cover the pump intake. Spray until the pressure begins to drop, then close the spray valve. This system is now primed.	Know the procedure for priming a spray system.	Describe the procedure for priming a spray system.
Flow rate verification can now proceed using one of the following 4 methods.	Know procedures for flow rate verification using the following methods: fixed timing, open timing, known distance, and flowmeter.	Describe procedures for flow rate verification using the following methods: fixed timing, open timing, known distance, and flowmeter.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - FLOW RATE VERIFICATION

General Objective: To understand flow rate verification procedures to ensure the correct amount of spray and pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES

1. **Fixed timing method**

   A sufficient amount of water is loaded so that spraying can be continued for a pre-arranged time without depleting the system. After spraying, the actual volume sprayed will be the amount required to load to the initial level. In practice, spray times are 1 minute for heavy application rates, and 2 minutes for light rates. Actual and required flow rates are calculated. System adjustments are made so that actual flow rate equals the required flow rate to achieve the required spray output.

2. **Open timing method**

   A measured amount is loaded, and sprayed until the pressure begins to fall. The spray valve is then closed. The actual amount sprayed will be the amount added initially to the system. Time is measured between booms on and booms off. Actual and required flow rates are calculated. System adjustments are made so that the actual flow rate equals the required flow rate. This method will not usually give as accurate a flow rate as the fixed timing method.

3. **Known distance method**

   Volume to be sprayed over a known distance is calculated as follows:

   Volume = effective swath width x swath length x application rate ÷ constant.
   (metric: L = m x km x L/ha ÷ 10).
   (imperial: gal = ft x miles x gal/acre ÷ 8.25).

   This is compared with the actual measured volume from a flight test over that distance, and system adjustments are made accordingly. This method is common in agricultural operations, with distances varying from 1 mile for high volume work to 2 miles for low volume work.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - FLOW RATE VERIFICATION

General Objective: To understand flow rate verification procedures to ensure the correct amount of spray and pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
4. Flowmeter method		
A load of known volume is sprayed out and compared with the volume indicated on the flowmeter. The percentage difference is then used to change the flowmeter reference number. The procedure is continued until the indicated flowmeter readings are within acceptable limits. Manufacturer's guides provide specific calibration procedures.		
Flow Rate Verification of Solid Dispersal Systems		
After finding the effective swath width: - load a measured weight of material into the aircraft; - fly several passes while dispersing material, using either the timed interval or known distance methods to calculate area being covered; - return and find the weight of material remaining, and consequently the weight of material dispersed, and establish the weight/unit area dispersed from these figures; - adjust flow rate as required.	Know the procedure for flow rate verification of solid dispersal systems.	Describe the procedure for flow rate verification of solid dispersal systems.
General Guidelines		
- for liquid flow rate verification, the deviation between required and actual flow rates should not exceed 5 percent;	Know how closely the actual flow rate should be adjusted to equal the required flow rate.	Identify how closely the actual flow rate should be adjusted to equal the required flow rate.
- also for liquid flow rate verification, the deviation between actual flow rate and the manufacturer's specified flow rate for the individual nozzles should not exceed 15 percent (replace worn nozzles, if so);	Know what deviation between actual flow rate and manufacturer's specified flow rate is excessive.	Identify what deviation between actual flow rate and manufacturer's specified flow rate is excessive.
- continually monitor flow rates after initial verification, as conditions may vary;		
- keep records of all load parameters such as boom pressure and gate settings (this will allow easier adjustment of flow rates in the future);	Know what to record for keeping track of flow rate.	List what to record for keeping track of flow rate.
- verify accuracy of hopper level markings by comparing them to loads of known size.	Know how to verify hopper level markings.	Describe how to verify hopper level markings.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - FLOW RATE VERIFICATION

General Objective: To understand flow rate verification procedures to ensure the correct amount of spray and pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
If actual rates are too high, check for: - system leaks; - pressure gauge error; - excessive nozzle wear. If actual flow rates are too low, check for: - a viscosity higher than water, if the flow rate verification was carried out using the actual formulation; - blockages in the system; - an incorrect pressure gauge reading.	Know what to check if rates are too high or low.	Describe what to check if rates are too high or low.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - DRIFT CONTROL

General Objective: To understand factors which cause drift and ways to minimize it.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
General		
Pesticide drift to non-target areas is usually the result of poor planning on the part of the applicator. As well as being inefficient, there is the potential of damage to susceptible crops, animals, or humans. The primary causes of chemical drift are: - the release of smaller than intended droplets; - atmospheric conditions conducive to drift (i.e., high winds, high temperatures, inversions, low relative humidity, etc.); - the lofting of droplets by wingtip or rotortip vortices.	Know the hazards from pesticide drift and the primary causes.	Identify the hazards from pesticide drift and the three primary causes.
Drift problems may be prevented or lessened by: - using the largest droplet size that will provide necessary coverage and control the target pest; - ensuring the smallest possible range of droplet size; - application from the correct altitude, particularly in agricultural work. (Too high an altitude increases the time the droplet will be affected by temperature and winds; too low an altitude causes a lofting effect from wing or rotor downwash. For agricultural work, a boom height of 8-10 feet (2-3 m) is considered optimum for normal conditions.); - planning application times and directions to correspond to the most favourable atmospheric conditions, keeping in mind bordering crops. (Sensitive areas should be left until optimum conditions are present.); - opening the spray valve only at proper height upon field entry, and turning it off before pull-up; - continually monitoring the weather, and ceasing operations when approaching conditions conducive to drift; - ensuring there are no nozzle or equipment leaks; - being aware of and avoiding particularly sensitive non-target areas, such as bees, nearby crops, pastures, livestock and wildlife, streams and open water areas, pastures and inhabited buildings;	Know ways that drift problems can be prevented or minimized.	Describe how drift can be prevented or minimized with regard to: - droplet size; - application height; - planning application timing; - opening spray valves; - monitoring weather; - ensuring no equipment leaks; - avoiding sensitive areas; - using appropriate buffer zone widths; - using low volatile materials; - training of staff; - wind direction.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - DRIFT CONTROL

General Objective: To understand factors which cause drift and ways to minimize it.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
- using the appropriate buffer zone widths for the prevailing conditions; - using formulations with a low volatility; - ensuring all personnel are aware of "go no-go" criteria, and can readily communicate to others the conditions falling outside these standards; - ensuring winds are blowing away from sensitive bordering areas.		
The Effect of Droplet Size Spray droplet size is one of the most important factors influencing drift. Spray droplet sizes have been classified as follows:	Know the classification of droplet sizes and the importance of droplet size with respect to drift and coverage.	Describe the classification system for droplet sizes and identify the importance of droplet size with respect to drift and coverage.

Diameter (microns)	Classification
< 50	fine aerosol
50-100	coarse aerosol
100-250	fine spray
250-400	medium spray
400-600	coarse spray
600-900	very coarse spray

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Small droplets remain airborne longer than coarser droplets, and are more likely to be adversely effected by aircraft turbulence and atmospheric conditions. Thus small droplets have a tendency to drift. The aerial applicator has to trade off between large drops (i.e., $>$ 250 microns) and their low drift potential and smaller drops (i.e., $<$ 250 microns) that give better coverage, but are a greater drift hazard. The major drift hazard occurs with pesticides $<$ 100 microns in diameter. In general, relatively large droplet sizes should be used for herbicides, finer droplets for insecticides and the finest droplets for fungicide operations.	Know what type of pesticide (herbicide, insecticide, fungicide) can be applied with the largest droplet size; which requires the smallest droplet size.	Identify what type of pesticide (herbicide, insecticide, fungicide) can be applied with the largest droplet size; which requires the smallest droplet size.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - DRIFT CONTROL

General Objective: To understand factors which cause drift and ways to minimize it.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Nozzles produce a range of droplet sizes, so minimizing drift requires minimizing the volume of spray produced as small droplets. Nozzle performance is measured by the VMD (volume mean diameter) of the droplets. VMD is the droplet size in a spray in which half the volume is composed of a large number of droplets smaller than the VMD and half has a small number of droplets larger than the VMD.	Know the definition of VMD and what it is used for.	Define VMD and identify its use.
Factors Affecting Droplet Size		
Four main factors affect droplet size: 1. Orifice size - increasing nozzle orifice size increases droplet size; decreasing nozzle orifice reduces droplet size. 2. Nozzle orientation - placing the nozzle at right angles to the relative airflow produces fine droplets when compared to nozzles oriented rearward. Nozzles pointing directly into the relative airflow produce much finer droplets with a very uneven droplet size. 3. Boom pressure - increasing boom pressure with hydraulic nozzles decreases droplet size (due to atomization), and produces a greater variation in overall droplet size. 4. Nozzle placement on the boom - droplets released into the airflow over the top and trailing edge of a wing breakup in the turbulence, decreasing average droplet size. Mounting nozzles below the turbulence reduces this effect significantly.	Know how orifice size, nozzle orientation, pump pressure, and nozzle placement on the boom affect droplet size.	Describe how orifice size, nozzle orientation, pump pressure, and nozzle placement on the boom affect droplet size.

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - DRIFT CONTROL

General Objective: To understand factors which cause drift and ways to minimize it.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The Effect of Vaporization and Volatility on Droplet Size		
The more volatile a liquid, the easier it evaporates and the smaller the droplet size when it does evaporate. Evaporation of water-based or other highly volatile sprays can cause a drift problem. Higher temperatures and low relative humidities increase evaporation and decrease droplet size. This means that even if the optimum size were released, evaporation could reduce droplet size sufficiently to create a drift hazard.	Know how evaporation can affect droplet size and conditions which promote evaporation.	Describe how evaporation can affect droplet size and conditions of temperature and humidity which promote evaporation.
Drift due to evaporation may be minimized by: - using water based solutions at low temperature, high humidities and from the correct altitude; - using oil based or other low volatile solutions when high temperatures and low relative humidities are encountered; - using the largest possible droplet size that will ensure complete coverage.	Know ways to minimize drift due to evaporation.	List ways to minimize drift due to evaporation.
Atmospheric Conditions Conducive to Drift		
Two types of air motion may produce drift hazards: - horizontal (i.e., wind); - vertical (i.e., thermal).	Know how wind and thermals can affect drift.	Describe how wind and thermals can affect drift.
A small amount of wind will help evenly distribute the chemical, while too much will cause drift. Maximum acceptable wind speed will vary with the type of chemical being used, height of dispersal and size of the area being treated.		
High temperatures can cause thermals that carry spray droplets upward and could prevent the spray from reaching the ground in the intended area.		
Inversions		

Category: AERIAL

Concept: APPLICATION TECHNOLOGY - DRIFT CONTROL

General Objective: To understand factors which cause drift and ways to minimize it.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
During late evenings and early mornings, a cool, thin layer of air may form above the ground, with a warmer layer above it (i.e., temperature increases with height above ground). This is known as an inversion, since temperatures normally decrease with increasing altitude. Low lying layers of haze or mist, or smoke plumes which rise and abruptly level off, are indications of an inversion. This cool layer may be sufficiently dense to suspend spray droplets. Pesticides applied under these conditions may drift along the top of the cool air for great distances and might settle out where they could cause serious damage. An OAT (Outside Air Temperature) gauge on spray aircraft permits early identification or confirmation of an inversion when temperature on the ground can be compared with that at application height.	Know what an inversion is, how it can be identified and how it can result in drift.	Describe what an inversion is, how it can be identified and how it can result in drift.

Category: AERIAL

Concept: EMERGENCY RESPONSE

General Objective: To know how to prepare for and respond to emergencies specific to aerial application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
General		
Most accidents are the result of: - collision with obstructions; or - inadvertent stalls.	Know the reasons for most accidents in aerial application.	List the main reasons for most accidents in aerial application.
Accident potential is greatly reduced through: - early recognition of stall symptoms and instinctive stall recovery procedures; - a comprehensive preventative maintenance program; - adequate training for aerial application procedures; - flying the aircraft well within aircraft and pilot capabilities; - immediate responses to in-flight emergencies because little time is available due to the low altitudes; - practising correct responses to in-flight emergencies until they become instinctive.	Know how accident potential is reduced.	List ways that accident potential is reduced.
Pilots must know the contents of the aircraft manual thoroughly. Of particular importance are the emergency procedures. The pilot must be aware of the location of and operation of dump valves and switches, and visually inspect the system before each flight. Before operations begin, identify on a map a possible dumping site that would be accessible and have little impact in case a pesticide load had to be jettisoned to facilitate landing.	Know how to prepare for load jettison.	List ways to prepare for load jettison.
Load Jettison		
Load jettison may be necessitated by engine problems or to increase climb performance for obstacle clearance. Jettisoning the load: - increases climb performance; - increases glide capability with engine inoperative; - greatly reduces risk of damage during an emergency landing; - increases aircraft manoeuvrability.	Know why load jettison may be required and its main beneficial effects on the aircraft.	Describe why load jettison may be required and list the main beneficial effects on the aircraft.

Category: AERIAL

Concept: EMERGENCY RESPONSE

General Objective: To know how to prepare for and respond to emergencies specific to aerial application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
If jettison is required the entire load should be jettisoned. A sharp pitch-up occurs when jettisoning a full load. A full water load should be jettisoned as part of the transition procedure to a new aircraft.	**Know that jettisoning should be practised on a new aircraft.**	**Describe that jettisoning should be practised on a new aircraft.**
<u>Forced Landings</u>		
Observe the following precautions: **- jettison the load whenever possible;** **- for fixed wing aircraft: land into the wind, three point altitude; if total engine failure occurs at low altitude, land straight ahead, avoiding abrupt manoeuvres;** **- for rotary wing aircraft: if autorotating to uneven ground and rollover is imminent, consideration should be given to rolling the aircraft to the right, to allow rotating blades to fall behind the aircraft, away from the cabin (opposite for European helicopters).**	**Know precautions for a forced landing.**	**List precautions for a forced landing.**
<u>Aircraft Crashes - Pilot Procedures</u>		
Observe the following procedures: **- if time permits, turn off battery master and mags before leaving aircraft;** **- do not attempt to extinguish a fire if it in any way jeopardizes personal safety;** **- wash off any personal chemical contamination as soon as possible.**	**Know pilot procedures if an aircraft crashes.**	**List pilot procedures if an aircraft crashes.**

Category: AERIAL

Concept: EMERGENCY RESPONSE

General Objective: To know how to prepare for and respond to emergencies specific to aerial application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Aircraft Crashes - Ground Crew Procedures		
Practising emergency responses will help ensure correct procedures are followed in the event of an accident. If an accident occurs: - go immediately to the crash site; - carry a fire extinguisher if available; - if the pilot is not seriously injured, provide whatever help is appropriate; - wash off any chemical contamination on the pilot as soon as possible; - in the case of serious injury, provide first aid in accordance with established first aid procedures; - attempt to extinguish any fires, but do not put your personal safety in jeopardy; - seek assistance as soon as possible.	Know ground crew procedures if an aircraft crashes.	List ground crew procedures if an aircraft crashes.