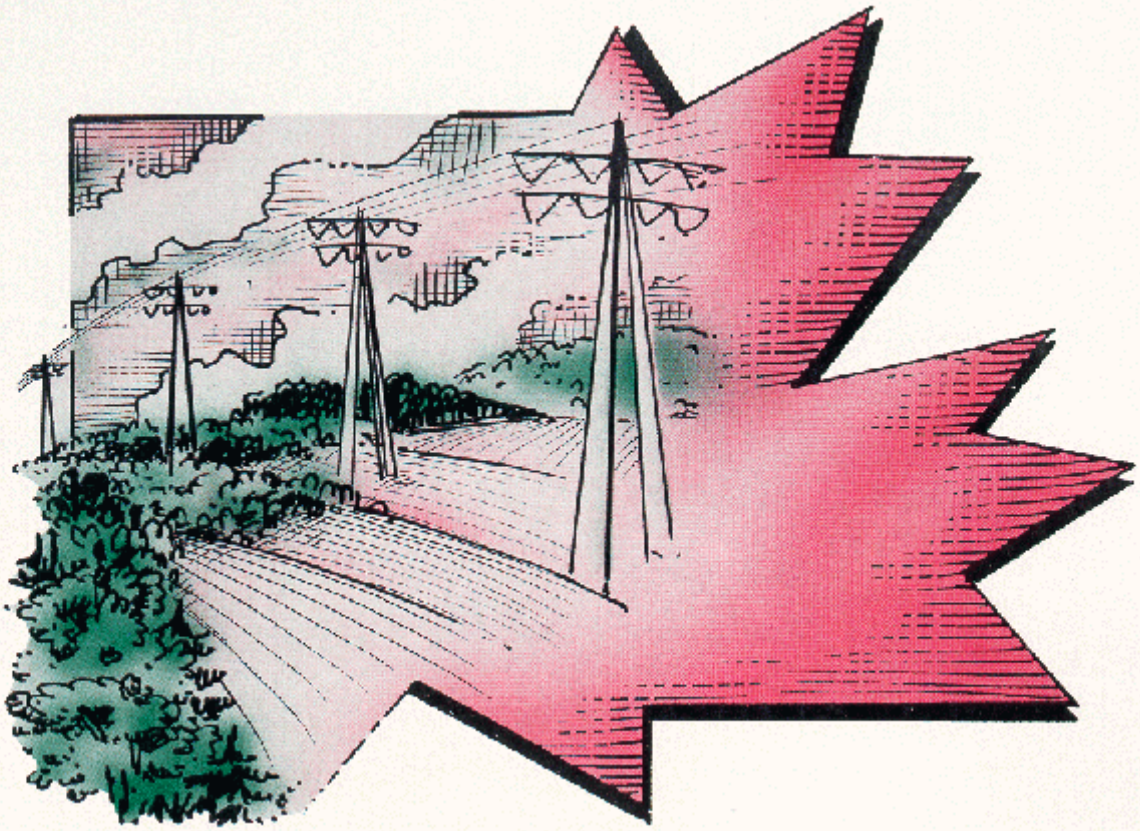

INDUSTRIAL VEGETATION MODULE **MODULE – TERRAIN INCULTE OU EMPRISE**

BASIC KNOWLEDGE REQUIREMENTS FOR PESTICIDE EDUCATION IN CANADA

CONNAISSANCES FONDAMENTALES REQUISES POUR LA FORMATION SUR LES PESTICIDES AU CANADA

CAPCO

Health Canada Santé Canada

INDUSTRIAL VEGETATION 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

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The final draft of the Industrial Vegetation module has been endorsed by the I.V.M.A.A. The final draft of the module has also been submitted to the Canadian Vegetation Management Alliance for their review. No response has been forthcoming as of January 1995.

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BASIC KNOWLEDGE REQUIREMENTS
FOR PESTICIDE EDUCATION IN CANADA
INDUSTRIAL VEGETATION MODULE

The Industrial Vegetation category includes the application of herbicides on industrial vegetation areas including roadsides, powerlines, pipelines, rights of ways, railways, well sites and equipment yards. This category also includes herbicide applications to parking lots and road beds during road construction. This category includes only ground application and does not cover aerial application, which is found in a separate category.

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

INDUSTRIAL VEGETATION MODULE

CONTENTS

Category: INDUSTRIAL VEGETATION

Concept: GENERAL INFORMATION - INTRODUCTION

General Objective: To provide a definition and scope of vegetation control of weeds on industrial areas.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Industrial vegetation management includes vegetation control on the following industrial sites: **- rights of ways such as roadsides, powerlines, pipelines, railways;** **- well, battery and other oilfield sites;** **- yards, lots etc., in industrial developments.**	**Know what industrial vegetation management is and where it is performed.**	**Describe industrial vegetation management and describe where it is used.**
In general, industrial vegetation management is necessary: **- to control noxious weeds;** **- to allow access for maintenance and emergency repair crews;** **- for erosion control;** **- for fire hazard reduction.**	**Know why industrial vegetation is required and give examples of each.**	**Describe why industrial vegetation is required.**
In addition, roadsides and railways also require vegetation control because of the following: **- road/railway sign visibility;** **- maintain driver site distance;** **- drain enhancement;** **- reduce road/rail bed deterioration;** **- snow drift control.**	**Understand that roadsides and railways have additional vegetation control requirements. Provide illustrations of the requirements.**	**Describe the additional requirements for vegetation control on roadsides and railways.**

Category: INDUSTRIAL VEGETATION

Concept: PESTICIDE SAFETY - SELECTION OF HERBICIDES

General Objective: To know how to safely prepare for an industrial vegetation herbicide application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Pre-job Functions		
Pre-job functions are those activities that need to occur prior to an application to ensure that the application will be legal, safe and effective.		
Pre-job functions include: **- a pre-job meeting;** **- a work site survey/plan;** **- proper job scheduling;** **- setting of meteorological go no/go criteria;** **- setting a firm chain of command for making go no/go meterological decisions;** **- establishing crew supervision guidelines.**	**Know the items that are considered in pre-job functions.**	**List the items to consider in pre-job functions.**
A pre-job meeting should be held to discuss the following: **- details of the job;** **- legal requirements (i.e., permits &/or permit conditions, certification requirements);** **- special job hazards, conditions and sensitive areas;** **- notification requirements;** **- personal protective equipment and safety equipment required for the job;** **- emergency response plans for herbicide spills, poisoning, herbicide fires, forest and prairie fires.**	**Know the items that a pre-job meeting should occur.**	**List and describe the items that a pre-job meeting should cover.**
The work site should be surveyed and all sensitive areas and hazards marked with special attention paid to hazards that are not readily visible.	**Know what a work site survey should cover.**	**Describe what a work site survey should cover.**
All marking tape should be removed after the application is completed or be biodegradable. Marking tape is an eye sore and can harm livestock and wildlife if they eat it.	**Understand why marking tape should be removed after application.**	**Describe why marking tape should be removed after application.**

Category: INDUSTRIAL VEGETATION

Concept: PESTICIDE SAFETY - SELECTION OF HERBICIDES

General Objective: To know how to safely prepare for an industrial vegetation herbicide application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
A written vegetation management plan should be prepared that includes: - a map showing site conditions, sensitive areas and hazards; - a record of application decisions made for the site.	Know what a vegetation management plan should include.	Describe what a vegetation management plan should include.
Proper job scheduling is important for the following reasons: - so that applicators get adequate rest breaks; - so difficult work is performed when crews are rested.	Know why proper job scheduling is important.	Identify why proper job scheduling is important.
Setting site specific meterological go no/go criteria (i.e., wind speed, showers, dew) is important so all on the job applicators know the conditions under which herbicides can and cannot be applied safely.	Know why setting a meterological go no/go criteria is important.	Identify why setting a meterological go no/go criteria is important.
Setting a firm chain of command for making meteorological go no/go decisions is important so all applicators on the job will know who to call on for verification when they are uncertain about making a meteorological decision. This allows for consistency regarding meterological decisions on a specific work site.	Know why it is important to have a firm chain of command to make meteorological go/no go decisions.	Identify why it is important to have a firm chain of command to make meteorological go/no go decisions.
Crew supervision guidelines ensure the application is performed: - safely, - properly; - consistently for all members of one crew and between different crews.	Know the reasons why crew supervision guidelines are important.	Identify the reasons why crew supervision guidelines are important.
Crew supervision guidelines should include: - in person or radio contact with crew personnel at least daily; - supervisor being on-site during difficult or potential high risk jobs; - spot checks of job site to ensure that safe operating procedures and specific job instructions are being followed.	Know the parameters of good supervision.	Identify the parameters of good supervision.

Category: INDUSTRIAL VEGETATION

Concept: PESTICIDE SAFETY - APPLICATION OF HERBICIDES - HAZARD ASSESSMENT OTHER THAN HERBICIDE

General Objective: To know how to safely protect against hazards, other than herbicides, when performing an industrial vegetation herbicide application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Hazard Assessment		
Hazards, other than the herbicide application, may include the following: **- terrain and weather hazards;** **- man-made hazards;** **- traffic hazards;** **- strenuous physical demands.**	**Know what other hazards, other than herbicides, may be present.**	**Identify the hazards, other than herbicides, that may be present.**
Terrain and Weather Hazards		
Terrain and weather hazards include: **- uneven terrain;** **- overhanging brush;** **- electrical storms;** **- high winds;** **- cold and hot weather survival;** **- forest and prairie fires;** **- wildlife.**	**Know the terrain and weather hazards that may be present.**	**Identify terrain and weather hazards that may be present.**
Applicators must: **- be trained to be aware of, and deal safely with, terrain and weather hazards;** **- wear appropriate personal protective equipment;** **- leave the site if conditions become life threatening (i.e., electrical storms while spraying under electrical power lines or if forest or prairie fire begins);** **- set meteorological go no/go criteria for each job;** **- establish a firm chain of command for making go no/go weather decisions.**	**Know what applicators must do to protect against weather and terrain hazards.**	**List the things an applicator must do to protect against weather and terrain hazards.**
Man-made Hazards		

Category: INDUSTRIAL VEGETATION

Concept: PESTICIDE SAFETY - APPLICATION OF HERBICIDES - HAZARD ASSESSMENT OTHER THAN HERBICIDE

General Objective: To know how to safely protect against hazards, other than herbicides, when performing an industrial vegetation herbicide application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Man-made hazards include: **- underground pipelines;** **- overhead powerlines;** **- trees contacting powerlines;** **- hidden tree stumps left by fallers;** **- unexpected hydrogen sulphide releases (from oilfield areas).**	**Know the man-made hazards that may be present.**	**Identify the man-made hazards that may be present.**
Applicators must: **- be trained to identify the man-made hazards;** **- constantly look for and mark hazards;** **- use appropriate protective equipment;** **- follow safe work procedures whenever they spray near man-made hazards;** **- be certified when working within the safe limits or approach of energized powerlines.**	**Know what an applicator needs to do to protect against man-made hazards.**	**Identify the things an applicator needs to do to protect against man-made hazards.**
Equipment Hazards		
Equipment hazards include: **- powered and mobile equipment such as chippers and spray trucks;** **- power tools such as chainsaws and motorized herbicide backpacks;** **- handtools, such as handsaws, axes.**	**Know the types of equipment hazards that may be present.**	**Identify the types of equipment hazards that may be present.**
Applicators must protect themselves and bystanders from equipment hazards in the following ways:	**Know the steps applicators must take to ensure their protection and the protection of bystanders against equipment hazards.**	**List the steps an applicator must take to ensure their protection and the protection of bystanders against equipment hazards.**

Category: INDUSTRIAL VEGETATION

Concept: PESTICIDE SAFETY - APPLICATION OF HERBICIDES - HAZARD ASSESSMENT OTHER THAN HERBICIDE

General Objective: To know how to safely protect against hazards, other than herbicides, when performing an industrial vegetation herbicide application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
- before using any equipment, some provinces require that applicators be fully trained and certified in the use of the equipment (e.g., cutter/skidder program, arborist certification). This training must include documentation of safe operating procedures for performing hazardous jobs; - follow all manufacturer's guidelines for operation of the equipment; - wear appropriate personal protective equipment (i.e., as indicated in manufacturers operator's manual or certification course); - ensure equipment is maintained regularly as recommended by the manufacturer; - always pay attention to the job and risks at hand; - ensure that bystanders are kept a safe distance from the equipment while it is in operation; - ensure that unauthorized persons do not have access to the equipment.		
Traffic Hazards		
Traffic hazards exist when applicators are applying herbicides along a road rights of ways.	Know when traffic hazards exist.	Identify when traffic hazards exist.
Applicators must protect themselves and their assistants against traffic hazards by doing the following: - wearing high-visibility vests; - spraying when traffic volume is low; - controlling traffic with signs and flaggers when the movement of vehicular traffic endangers applicators, or assistants; - operating in the same direction as traffic flow; - following provincial traffic safety bylaws.	Know the steps an applicator must take to protect themselves and their assistants when traffic hazards exist.	Identify the steps an applicator must take to protect themselves and their assistants when traffic hazards exist.
Strenuous Physical Demands		

Category: INDUSTRIAL VEGETATION

Concept: PESTICIDE SAFETY - APPLICATION OF HERBICIDES - HAZARD ASSESSMENT OTHER THAN HERBICIDE

General Objective: To know how to safely protect against hazards, other than herbicides, when performing an industrial vegetation herbicide application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Industrial vegetation control can involve strenuous physical demands. An applicator should have a "fitness to work" medical to assess his/her physical status in relation to the tasks required to perform on the job. Only physicians who are specifically trained to assess fitness to work levels should conduct these examinations.	Know what applicators must do to protect themselves against strenuous physical demands.	Describe what applicators must do to protect themselves against strenuous physical demands.
Personal protective equipment is required to protect against hazards associated with the use of equipment to apply herbicides.	Know that personal protective equipment is required to protect against hazards associated with the use of equipment to apply herbicides.	Describe what personal protective equipment is required to protect against hazards associated with the use of equipment to apply herbicides.
The applicator has to protect the following: - limbs; - head; - hearing; - eyes.	Know what parts of the body an applicator has to protect.	List the parts of the body the applicator has to protect.
The head can be protected with the use of a CSA approved hard hat.	Know how to protect the head.	Describe how to protect the head.

Category: INDUSTRIAL VEGETATION

Concept: PESTICIDE SAFETY - PERSONAL PROTECTIVE EQUIPMENT TO PROTECT AGAINST HAZARDS OTHER THAN HERBICIDE

General Objective: **To know how to select and correctly wear personal protective equipment that is required to protect against hazards associated with the use of equipment to apply herbicides for industrial vegetation control.**

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Limbs can be protected by the use of the following equipment: **- chemically resistant, CSA approved safety toed (and in some instances, steel shanked) boots;** **- chainsaw pants (where applicable);** **- gloves.** **Gloves should be tight fitting as well as chemically resistant. Do not wear gauntlet styled gloves when working with powered equipment or powered hand tools as they can be awkward and may get caught in machinery.**	**Know how to protect the limbs.**	**Describe how to protect the limbs.**
Hearing can be protected against equipment with the use of CSA approved ear muffs or ear plugs. **Proper fit is important with the use of ear muffs. Ensure hair, helmet straps, barrettes, etc., do not interfere with the seal between the cuff and the head.** **Foam pads are available to cushion and seal where an applicator's glasses pass under the muff.** **Ear plugs fit directly into the ear canal. Two types of ear plugs are available:** **- reusable;** **- disposable.**	**Know how to protect the hearing.**	**Describe how to protect the hearing.**
NOTE: Some chemical pest control methods may require additional personal protective equipment such as CSA approved lanyards, safety belts and lifelines. For specific information refer to the operator's manuals for equipment needing this type of protective equipment.	**Know that additional personal protective equipment may be required depending on the type of equipment being used.** **Know where to find information regarding what type of personal protective equipment may be required.**	**Identify the additional personal protective equipment that may be required depending on the type of equipment being used.** **Identify where to find information regarding what type of personal protective equipment that may be required.**
Eyes must be protected from foreign objects such as wood chips that scatter during hack and squirt and stump treatment operations.		

Category: INDUSTRIAL VEGETATION

Concept: PESTICIDE SAFETY - PERSONAL PROTECTIVE EQUIPMENT TO PROTECT AGAINST HAZARDS OTHER THAN HERBICIDE

General Objective: **To know how to select and correctly wear personal protective equipment that is required to protect against hazards associated with the use of equipment to apply herbicides for industrial vegetation control.**

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
To protect eyes, applicators must wear safety glasses with side shields, safety goggles or face shields depending on the hazard.	**Know how to protect the eyes.**	**Describe how to protect eyes.**

Category: INDUSTRIAL VEGETATION

Concept: **PESTICIDE SAFETY - CLEAN-UP AND MAINTENANCE OF EQUIPMENT REQUIRED TO PROTECT AGAINST THE HAZARDS, OTHER THAN HERBICIDE**

General Objective: To know how to safely and effectively clean and maintain equipment used to apply herbicides for industrial vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Care of Protective Equipment		
Care of hard hats should include: **- regular washing inside and out with soap and water;** **- checking for cracks or deterioration.**	**Know how to care for and clean hard hats.**	**Describe how to care for and clean hard hats.**
Hard hats must be discarded after they have sustained an impact with another object with sufficient force to cause rippling, cracking, or other damage of the outer or inner surface.	**Know when to discard hard hats.**	**Identify when hard hats should be discarded.**
Maintenance of steel-toed boots involves regular washing with soap and water.	**Know how to maintain steel-toed boots.**	**Describe how to maintain safety-toed boots.**
Steel-toed boots should be checked regularly for integrity of steel toe to the rest of the footwear. The boots should be discarded after the steel in the toe becomes exposed.	**Know when to discard steel-toed boots.**	**Describe when to discard steel-toed boots.**
Maintenance of ear muffs involves regular cleaning with soap and water.	**Know how to maintain ear muffs.**	**Describe how to maintain ear muffs.**
Replace ear muffs when the soft padding around the inner portion of the muff is hard or cracked.	**Know when to replace ear muffs.**	**Identify when to replace ear muffs.**
Reusable ear plugs must be washed regularly with soap and water. When not in use, keep ear plugs inside protective case.	**Know how to maintain reusable ear plugs.**	**Describe how to maintain reusable ear plugs.**
Replace reusable ear plugs when the plug becomes hard and cracked.	**Know when to replace reusable ear plugs.**	**Identify when to replace ear plugs.**
Disposable ear plugs are intended for a single use. If the ear plugs are used more than once, they should be stored in a protective case and discarded when they become dirty or hard.	**Know when to dispose of disposable ear plugs.**	**Identify when to dispose of ear plugs.**
Maintenance of safety glasses, goggles or face shields involves regular cleaning with soap and water. Eye protection gear must be stored in a clean, dry area away from direct sunlight.	**Know how to maintain and store eye protection gear.**	**Describe how to maintain and store eye protection gear.**

Category: INDUSTRIAL VEGETATION

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand the pest management principles used in industrial vegetation control that are required to carry out effective weed control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Weeds		
A weed is a plant growing where it is not wanted.	**Know what a weed is.**	**Define what a weed is.**
Weeds are pests when they: **- compete with cultivated plants for light, water and nutrients;** **- harm people or livestock;** **- contaminate foods;** **- are alternate hosts for other pests;** **- reduce access or visibility along transportation corridors;** **- create a transmission line hazard along utility corridors;** **- are aesthetically unpleasing.**	**Know when weeds are pests.**	**List examples of when weeds are pests.**
Types of Weeds		
Weeds are usually classified according to how long they live. Weeds can be annuals, biennials or perennials.	**Know the weed classification according to how long the weed lives and know the difference between annual, biennial and perennial weeds.**	**Describe how weeds are classified according to how long they live. Describe annual, biennial and perennial weeds.**
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.		
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.		

Category: INDUSTRIAL VEGETATION

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand the pest management principles used in industrial vegetation control that are required to carry out effective weed control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Perennial weeds are plants that live more than two years. Often no seed is produced the first year; thereafter seeds can occur every year for the life of the plant. Almost all perennial weeds spread by seed. Many also spread by other plant parts such as creeping stems, stolons, creeping roots, rhizomes (a root-like underground stem), underground bulbs or a broken piece of root. There are shallow-rooted and deep-rooted perennials. Perennial weeds also include woody plant species growing where they are not wanted.		
Brush control is a broad term used to describe the control of perennial woody plant species that are weeds.	**Know what brush control means.**	**Define brush control.**
Weed Identification Characteristics		
The following physical structures will aid in the identification of weeds and desirable vegetation: **- leaves, e.g.,** **compound or simple** **shape** **margins** **surface (smooth or hairy)** **arrangement along the stem** **(opposite, alternate, whorled)** **- stems, e.g.,** **branching habit** **woody or herbaceous** **upright or spreading** **- flowers, e.g.,** **arrangement** **number of petals, sepals** **reproductive parts** **seeds** **- roots, e.g.,** **fibrous, creeping, tap**	**Know the major physical structures of plants that will aid in the identification of weeds.**	**List and describe the major physical structures of plants that will aid in the identification of weeds.**
Identifying Leaf Stages		

Category: INDUSTRIAL VEGETATION

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand the pest management principles used in industrial vegetation control that are required to carry out effective weed control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Knowing how to identify desirable plant (e.g., tree, turf) and weed leaf stages is important because: **- herbicide labels refer to weed and desirable plant leaf stages;** **- herbicides are often only effective when desirable plants and weeds are at certain stages of growth. There might not be enough leaf area for efficacy if herbicides are applied too early; apply too late and weed control may not be achieved or desirable plants could be damaged;** **- weed sizes and leaf numbers change rapidly. Avoid applying herbicides past the stage when they will be effective by regularly monitoring growth of weeds and surrounding plants or desirable vegetative growth.**	**Understand why it is important to know how to identify leaf stages of desirable plants and weeds.**	**Identify why it is important to know how to identify leaf stages of desirable plants and weeds.**
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. **Cotyledons are not counted when determining leaf number.**	**Know how to distinguish between cotyledons and true leaves.**	**Describe cotyledons and true leaves.**
Alternate leaves emerge from alternate sides of the stem and are not directly opposite each other. **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.**	**Be able to recognize alternate, opposite and whorled leaf arrangements.**	**Describe alternate, opposite and whorled leaf arrangements.**
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 broadleaf plants.**	**Describe how to accurately count the number of leaves on each plant.**

Category: INDUSTRIAL VEGETATION

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand the pest management principles used in industrial vegetation control that are required to carry out effective weed 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 to 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 tillers.**	**Describe tillers.**
Weed Management/Brush Control Methods		
Weed management methods include: **- sanitation;** **- cultural control;** **- mechanical control;** **- biological control;** **- chemical control.**	**Know the five types of weed management methods.**	**List the types of weed management methods.**
Integrate Pest Management		
Use a combination of weed management methods. Plan your control program by considering the pest, the desirable vegetation, site conditions (including long term plans for the treatment area), the environment, human safety and public concerns.	**Understand the concept of integrated pest management.**	**Describe integrated pest management.**
Sanitation emphasizes prevention and includes: **- using certified seed to prevent weed seed occurrence;** **- controlling weeds in nearby ditches, fencelines, roads, etc.;** **- cleaning machinery before moving it between job sites;** **- cleaning the feet and hair of animals before moving them to a new area.**	**Know how sanitation can be used as a weed management method.**	**Describe how sanitation can be used as a weed management method.**

Category: INDUSTRIAL VEGETATION

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand the pest management principles used in industrial vegetation control that are required to carry out effective weed control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Cultural control emphasizes competition to discourage weeds and includes: **- seeding grasses/herb mixtures after soil disturbance;** **- planting nurse or companion crops; a fast growing crop planted along with a slower growing crop competes with the weeds and is mowed when the slower crop is established;** **- increasing plants' ability to compete against weeds by using good cultural practices (e.g. optimum fertilizer rates, watering, etc.);** **- leave desirable vegetation rather than bare ground (prone to wind and water erosion) helps protect against weed re-establishment;** **- burning to control brush weeds;** **- on rights-of-ways, achieving a relatively stable plant ecosystem of low brush and grasses with fairly high resistance to invasion by incompatible tall growing trees and shrubs,** **- encouraging, where possible, secondary use of rights-of-ways to assist in tall brush control (i.e., grazing, farm crops, tree nurseries, recreational uses), and** **- use of 15 cm layer of crushed rock under electrical installations to reduce weed invasion.**	**Know how cultural control can be used as a weed management/brush control method.**	**Describe how cultural control can be used as a weed management/brush control method.**
Mechanical control disrupts weeds and is often used in sensitive areas where herbicide use is not possible. These areas include: **- near water;** **- near sensitive desirable vegetation;** **- when brush is too tall to spray with herbicide;** **- where herbicide-susceptible non-target vegetation is intermixed with weeds;** **- when dead brush (due to herbicide application) is undesirable.**	**Know how mechanical control can be used as a weed management/brush control method.**	**Describe how mechanical control can be used as a weed management/brush control method.**

Category: INDUSTRIAL VEGETATION

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand the pest management principles used in industrial vegetation control that are required to carry out effective weed control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Mechanical control includes: **- cutting weedy tops prior to weed seed production;** **- tillage and hand weeding or hand slashing and trimming of brush (where amount of brush is small or trees are too large for brushing or brush mowing hazards are present);** **- mowing herbaceous weeds or brush mowing tree and shrub weeds;** **- machine clearing where brush is completely cleared by blade, bucket or backhoe equipment;** **- girdling (removing a strip of bark around the trunk of the tree) especially with species such as alder, white birch and black cottonwood effectively controls these woody weeds.**		
Biological control involves the use of living organism to control the weed pest and includes: **- grazing a site before weeds go to seed;** **- releasing pest-specific insects (e.g., insect control of nodding thistle);** **- encouraging native or naturalized insects/diseases to control pest.**	**Know how biological control can be used as a weed management/brush control method.**	**Describe how biological control can be used as a weed management/brush control method.**
Chemical control is the use of herbicides to control weeds.	**Understand that chemical control is a weed management/brush control method.**	**Identify chemical control as a weed management/brush control method.**
Types of Herbicides		
Herbicides are classified according to: **- selectivity;** **- mode of action;** **- timing of application;** **- residual effectiveness.**	**Know the ways herbicides are classified.**	**List the ways herbicides are classified.**
Selectivity describes whether a herbicide kills all plants or only some plants. Herbicides are either selective or non-selective.	**Know how to classify herbicides according to selectivity and know the difference between selective and non-selective herbicides.**	**Describe how to classify herbicides according to selectivity. Identify selective and non-selective herbicides.**

Category: INDUSTRIAL VEGETATION

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand the pest management principles used in industrial vegetation control that are required to carry out effective weed control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Selective herbicides only kill or damage certain plants. **Non-selective herbicides kill or damage all plants in a treated area.**		
Mode of action explains how the herbicide kills a plant. Herbicides are either contact or systemic herbicides.	**Know how to classify herbicides according to mode of action.**	**Describe how to classify herbicides according to mode of action.**
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. **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.**	**Know the difference between contact and systemic herbicides.**	**Identify contact and systemic herbicides.**
Timing of application classifies herbicides according to when they are applied (at different stages of desirable vegetation or weed growth). Herbicides are classified as: **- preplant;** **- pre-emergent;** **- post-emergent.**	**Know how to classify herbicides according to timing of application.**	**Describe how to classify herbicides according to timing of application.**
Preplant: The herbicide is applied to the soil before seeding or transplanting. Preplant treatments are usually incorporated into the soil. These are called preplant soil-incorporated treatments. **Pre-emergence: The herbicide is applied to the soil after planting but before the emergence of the specified weed. Pre-emergence may refer to the germination of either the weed or the crop; check the herbicide label for instructions on specific herbicides. Pre-emergence herbicides control weeds before or soon after they emerge.**	**Know the difference between pre-plant, pre-emergent and post-emergent herbicides.**	**Identify pre-plant, pre-emergent and post-emergent herbicides.**

Category: INDUSTRIAL VEGETATION

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand the pest management principles used in industrial vegetation control that are required to carry out effective weed control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Post-emergence: The herbicide is applied after the specified crop or weed has emerged. The application may be made soon after emergence or up to a specific height or leaf number. Post emergence herbicides control established weeds.		
Residual effectiveness refers to how long the herbicide is biological active once applied. Herbicides are either non-residual or residual.	**Know how to classify herbicides according to residual effectiveness.**	**Describe how to classify herbicides according to residual effectiveness.**
Non-residual herbicides are quickly inactivated in the soil after application and do not affect future vegetation.	**Know the difference between non-residual and herbicides.**	**Identify non-residual and herbicides.**
Residual herbicides do not break down quickly and may control weeds for several weeks to several years.		
Non-selective residual herbicides are herbicides that are applied to soil to prevent growth of plants for a long period of time (a few months to many years). This type of herbicides have been called soil sterilants in the past, however, as they do not sterilize the soil of all micro-organisms, they should be called non-selective residual herbicides.	**Define soil sterilant and know why it should be called a non-selective residual herbicide.**	**Describe non-selective residual herbicide.**
NOTE: Special precautions are required when using residual herbicides. Ensure that the following items have been considered:	**Know the special precautions that need to be considered when using residual herbicides.**	**List and describe special precautions that need to be considered when using residual herbicides.**
Residual herbicides are present for extensive periods of time, so they have a greater chance of being moved off-site through leaching, erosion, and/or movement with water.		
Residual herbicides can damage trees and shrubs with roots that extend into the treatment area or damage trees and shrubs later when roots grow into a treated area after an application. A buffer zone between application site and nearby woody vegetation should be indicated on the label. If not, then a rule of thumb, is that the buffer width should not be less than 1/2 times the height of the woody vegetation.		

Category: INDUSTRIAL VEGETATION

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand the pest management principles used in industrial vegetation control that are required to carry out effective weed control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The height of the water table, especially when combined with coarse textured soil, can lead to groundwater contamination. A high water table is indicated when aquatic vegetation such as sedges or cattails/bulrushes are present or where ice flows are present in winter. **Residual herbicides can limit the future use of the treated area. A residual herbicide should only be used if the present use will continue for a period greater than the residual period of the herbicide.** **The persistence of residual herbicides can vary substantially depending on the product, rate, formulation, concentration, weather conditions and soil conditions.** **Avoid steep slopes or areas subject to erosion and runoff. The movement of herbicide containing soil from an application site can cause adverse effects where the soil is carried.** **When using residual herbicides, a site specific plan including the following is critical to ensure no adverse impact on the surrounding environment:** **- soil type and structure;** **- pH of the soil;** **- proximity to water bodies;** **- site drainage patterns;** **- surrounding land ownership/use.**		

Category: INDUSTRIAL VEGETATION

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand the pest management principles used in industrial vegetation control that are required to carry out effective weed control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Factors Affecting Herbicide Effectiveness **There are many factors that affect herbicide effectiveness. The main ones are:** **- shape and surface of leaves;** **- weather;** **- age of the weed;** **- soil type & other factors;** **- soil moisture;** **- cultivation;** **- resistance;** **- mowing.**	**Know the main factors that affect herbicide effectiveness.**	**List the main factors that 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 the herbicide label says so.**		
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.** **Cool or dry conditions slow the production and movement of food in the plant and reduce the movement of systemic herbicides. Hot dry weather may make the herbicide/ herbicide carrier evaporate quickly from the weed leaves and therefore reduce effectiveness.**	**Know how the shape and surface of leaves can affect herbicide effectiveness.**	**Describe how the shape and surface of leaves affect herbicide effectiveness.**

Category: INDUSTRIAL VEGETATION

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand the pest management principles used in industrial vegetation control that are required to carry out effective weed control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
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 food 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.** **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 the roots or rhizomes. The herbicide is also translocated to these sites and so kills the entire plant.**	**Know how the age of the weed can affect herbicide effectiveness.**	**Describe how the age of the weed can affect herbicide effectiveness.**
Soil Type and Other Factors (for soil active herbicides) **Higher herbicide application rates may be needed for organic (peat or muck) or fine textured soils (clay or silt). These soils hold more herbicide on the soil particles, which reduces the amount available for weed control. Sandy soils usually need less herbicide. The herbicide label will state how much is needed. The label will state the minimum and maximum rates. Do not exceed label rates.** **Consider the increased potential for lateral movement of water and herbicide in clay soils.** **Avoid soils that are compacted as they tend to significantly increase the potential for runoff.**	**Know how soil type, organic matter and peculiarities affect herbicide effectiveness.**	**Describe how soil type, organic matter and peculiarities affect herbicide effectiveness.**

Category: INDUSTRIAL VEGETATION

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand the pest management principles used in industrial vegetation control that are required to carry out effective weed control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The following soil peculiarities could also affect the effectiveness of the herbicide: **- pH extremes;** **- high sodium levels;** **- heavy metal contamination;** **- industrial chemical spills.**		
If an area has been treated on a previous occasion, determine if a second treatment is justified. Shallow-rooted annuals can establish themselves in upper soil layers as non-selective residual herbicides move downward into the soil.	**Know where to re-apply residual herbicides.**	**Identify when to re-apply residual herbicides.**
Do not apply herbicides to frozen soil.		
Soil Moisture		
Soil-applied herbicides generally work best in a warm, moist soil. The moisture helps the herbicide move through the soil to the weed roots.	**Know how soil moisture affects herbicide effectiveness.**	**Describe how soil moisture affects herbicide effectiveness.**
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 broken into pieces and be harder to control. Read label directions before cultivating to see if it will be beneficial.	**Know how cultivation affects herbicide effectiveness.**	**Describe how cultivation affects herbicide effectiveness.**
The stale seed bed technique requires cultivating unseeded soil so that weed seeds are encouraged to germinate. When they appear they are sprayed with a non-selective herbicide. The seeds of desirable vegetation can then be planted.	**Know the procedures for the stale seed bed technique.**	**Describe the stale seed bed technique.**

Category: INDUSTRIAL VEGETATION

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand the pest management principles used in industrial vegetation control that are required to carry out effective weed control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Resistance		
There have been increased reports of weeds developing resistance to herbicides.	**Know how resistance affects herbicide effectiveness.**	**Describe how resistance affects herbicide effectiveness.**
The development of resistant weeds can be slowed by: **- using a variety of chemical and non-chemical control methods;** **- using a herbicide only when needed;** **- alternating herbicides from different chemical families or mode of action;** **- using registered tank mixes that will control weeds by way of two different modes of action.**		
Mowing		
If an industrial site has been mowed or brushed, then sufficient suckering or growth of weeds must be re-established before using a herbicide. If there is no regrowth, there will not be enough surface area for the herbicide to be absorbed and be effective. Check the herbicide label for directions.	**Know how mowing can affect herbicide effectiveness.**	**State how mowing can affect herbicide effectiveness.**

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - APPLICATION TECHNIQUES

General Objective: To understand the application techniques used for industrial vegetation herbicide application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Application techniques in industrial vegetation include: **- foliage spraying;** **- basal bark spraying;** **- stump treatment;** **- trunk wound application;** **- soil application.**	**Know the application techniques used in industrial vegetation management.**	**List the application techniques used in industrial vegetation management.**
Foliage Spraying		
Foliage spraying involves applying a liquid herbicide to leaves and stems.	**Know what foliage spraying is.**	**Describe foliage spraying.**
Characteristics of foliage spraying include: **- it is most subject to drift;** **- it is the most visible type of application.**		
Foliage spraying can also be used when undesirable brush is dormant or when brush growth is hardened off, although there are some concerns with this type of application: **- it is usually more expensive due to the need for a non-water carrier;** **- environmental concerns due to the use of a non-water carrier.**	**Know the concerns of using foliage spraying when undesirable brush is dormant.**	**Identify the concerns of using foliage spraying when undesirable brush is dormant.**
Equipment used for foliage spraying includes: **- truck-mounted boom and boomless sprayers;** **- helicopter or fixed wing aircraft;** **- backpack sprayers;** **- handguns.**	**Know what equipment is used in foliage spraying.**	**List the equipment used in foliage spraying.**
Boom and boomless sprayers are used when a broadcast application is required.	**Know when to use boom and boomless sprayers.**	**Identify when boom and boomless sprayers are used.**
Boomless sprayers have the advantage over boom sprayers when spraying on uneven terrain or around obstacles, but they do not produce as uniform a spray distribution.	**Know the advantages and disadvantages of boom and boomless sprayers.**	**Describe the advantages and disadvantages of boom and boomless sprayers.**

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - APPLICATION TECHNIQUES

General Objective: To understand the application techniques used for industrial vegetation herbicide application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Backpack sprayers and handguns are usually used where spot treatment or selectivity is required, though the chance for applicator exposure to the herbicide is higher when using these two pieces of equipment.	**Know when to use backpack sprayers. Know the disadvantage of backpack sprayers.**	**Identify when to use backpack sprayers. Describe the disadvantage of backpack sprayers.**
Basal Bark Spraying		
Basal bark spraying is the spraying of a herbicide solution on the base of a stem from knee height to ground level and also spraying of root collars. A non-water carrier is used to penetrate the bark and root collar. **Several variations on the basal bark spraying, which involve using a more concentrated herbicide solution and spraying a smaller area are sometimes used. The variations include:** **- one sided low volume;** **- thinline;** **- stream line.** **The characteristics of basal bark spraying are:** **- a high degree of selectivity is achieved, as only target plants are treated;** **- there may be additional environmental considerations due to use of non-water carrier;** **- it is more effective in late summer but can be done year-round except during heavy snow accumulations and after heavy rain;** **- it is usually done using hand-held application equipment.**	**Know what basal bark spraying is.**	**Describe basal bark spraying.**
Stump Treatment		
Stump treatment is the spraying of a herbicide solution to cut stems of trees during or after mowing or slashing to prevent suckering.	**Know what stump treatment is.**	**Describe stump treatment.**

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - APPLICATION TECHNIQUES

General Objective: To understand the application techniques used for industrial vegetation herbicide application.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The characteristics of stump treatment are: **- it is used when a high degree of selectivity is required;** **- it uses small amounts of herbicide and causes minimal environmental impact;** **- it is labour intensive.**		
Trunk Wound Application		
Trunk wound application (also called back & squirt or Injectors) are performed by making an incision in woody plants and applying herbicide to the cut or they are applied by injection.	**Know what trunk wound application is.**	**Describe trunk wound application.**
The characteristics of trunk wound application are: **- it is highly selective and causes minimal environmental impact;** **- increased physical hazard to the applicator (using hatchet);** **- it is labour intensive.**		
Trunk wound applications are sometimes used as pre or post treatment to control suckering of trees in silvicultural operations.		
Soil Application		
Soil application is the application of liquid or granular soil active residual herbicides to the soil for control of unwanted vegetation.	**Know what soil application is.**	**Describe soil application.**
The characteristics of soil application are: **- it is applied in spots or broadcast over large areas by a variety of equipment similar to foliage spraying;** **- it requires moisture to be moved into the root zone so herbicidal activity may be delayed. Soil application may not be effective in dry areas;** **- it requires complex knowledge of proper and effective environmentally sound planning and application (see Pest Management - Weeds);** **- consideration must be given to the potential for the herbicide to move away from the site during periods of high rainfall and winds.**		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - COMPONENTS

General Objective: To understand the technology of mounted sprayers used in industrial vegetation control by examining the components.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Components of Mounted Sprayers		
Mounted sprayer components include: **- tanks;** **- pumps;** **- agitators;** **- filters;** **- controls;** **- pressure gauges;** **- plumbing;** **- structural framework;** **- nozzles.**	**Know the main components of mounted sprayers.**	**List the main components of mounted sprayers.**
Tanks		
Tanks hold the spray mixture and are available in a variety of shapes, sizes and materials. Desirable features in the selection of a tank are: **- corrosion resistance;** **- be strong;** **- be shaped to aid agitation;** **- be easy to fill;** **- be easy to clean;** **- have graduated markings;** **- baffles to prevent liquid movement.** **The most common shapes of tanks are oval and cylindrical. Square tanks and flat bottomed tanks should be avoided because agitation and cleaning are more difficult.** **Tank size should be proportional to sprayer boom width and sprayer output.**	**Know the desirable features of a tank.**	**List the desirable features of a tank.**

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - COMPONENTS

General Objective: To understand the technology of mounted sprayers used in industrial vegetation control by examining the components.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Tank materials include stainless steel, aluminum, fibreglass polyethylene and galvanized steel. The applicator must check the chemical label for instructions and precautions regarding herbicide reactivity with any of the above materials before use (e.g., glyphosate).		
Pumps		
Pumps provide the flow of spray mixture from the tank to the nozzle. Chose a pump suitable for the: **- required output and operating pressure;** **- herbicide properties;** **- carrier properties;** **- power supply.**	**Know the factors to consider when selecting the correct type and size of pump.**	**List the factors in selecting a pump.**
Choose a pump with sufficient capacity for the: **- number of nozzles;** **- size of nozzles;** **- agitation requirements;** **- bypass filtration requirements.**		
Once the capacity is determined, the pump should be oversized by twenty per cent.		
The type of pump affects the installation of controls. Refer to pump manufacturer's instructions.	**Know that the type of pump chosen will affect the installation of controls.**	**Identify that the type of pump will affect the controls needed.**
The most common pumps include platon diaphragm, roller and centrifugal pumps.	**Know the most common pumps.**	
Piston and diaphragm pumps require a pulsation damper to minimize pressure fluctuations.		
Roller pumps are not recommended when using abrasive formulations.		
Agitators		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - COMPONENTS

General Objective: To understand the technology of mounted sprayers used in industrial vegetation control by examining the components.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Agitation mixes the formulated herbicide and carrier together and prevents the suspended herbicides from settling out. The amount of agitation needed depends on the formulation used. It is important that adequate agitation occurs, both under and over agitation can reduce herbicide performance.	**Know why agitation is required.**	**Identify why agitation is required.**
The types of agitation systems are commonly used: **- mechanical;** **- hydraulic.** **Mechanical systems are paddles to stir the contents of the tank. Hydraulic systems use special agitation nozzles to stir the contents of the tank.**	**Know that there are two types of agitation systems commonly used.**	**Describe agitation systems.**
Filters		
Filters prevent any foreign particles and undissolved herbicides in the spray solution from damaging the pump or plugging the nozzles.	**Know why filtration is required.**	**Identify why filtration is required.**
Filters can be installed: **- in the tank opening to prevent debris from entering the tank during filling;** **- between the tank and the pump to protect the pump from damage;** **- after the pump to remove finer particles before entering the spray lines;** **- in the nozzle bodies to protect the nozzles from clogging.**	**Know where filters can be installed.**	**Identify where filters can be installed.**
Filter mesh size should be scaled from the coarsest at the tank opening, to the finest at the nozzle. Follow nozzle manufacturer's recommendations.	**Know how to select the correct filter.**	**Identify where information on filters can be found.**
Controls		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - COMPONENTS

General Objective: To understand the technology of mounted sprayers used in industrial vegetation control by examining the components.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Two common control systems are: **- pressure control systems;** **- volume control systems.** **Pressure control systems use a pressure regulating valve (PRV) to maintain a specific operating pressure.** **Volume control (Volumetric) systems allow operating pressure/nozzle output to vary according to forward speed/engine rpm.** **Control systems can be manually or electronically operated. Items such as spray monitors and controllers may improve the application of herbicides by supplying the operator with more information.**	**Know how control systems work.**	**Describe how control systems work.**
Plumbing		
Flow restrictions create a drop in pressure, resulting in a non-uniform nozzle output. **Common sources of flow restrictions are:** **- under-sized boom plumbing;** **- under-sized controls or fittings;** **- kinked or collapsed hoses;** **- undersized or clogged filters.**	**Understand how plumbing can affect the pressure.**	**List common plumbing problems which affect the pressure.**
Boom Design		
The design of the boom can affect the uniformity of application. **Excessive boom movement either vertically or horizontally during application will reduce the uniformity of spray coverage. Sprayers should be operated at a speed that minimizes boom movement.**	**Understand the importance of boom design.**	**Identify the importance of boom design.**
Pressure Gauge		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - COMPONENTS

General Objective: To understand the technology of mounted sprayers used in industrial vegetation control by examining the components.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The pressure gauge measures the operating pressure. A pressure gauge is used to initially set the sprayer at the desired pressure and can be observed for changes in pressure as an indicator of problems.	**Understand the importance of the pressure gauge.**	**Describe pressure gauges.**
Gauges are available as either liquid filled or dry. A liquid filled gauge dampens pressure pulsations resulting in a steadier reading. Pulsation dampers are available for dry gauges.		
The maximum pressure indicated on the gauge should be approximately twice the intended operating pressure.		
Gauges should sense the pressure as near to nozzles as possible.		
Nozzles		
Nozzles: **- meter the amount of spray delivered (nozzle output);** **- atomize the liquid into droplets;** **- disperse the droplets in specific patterns.**	**Understand what a nozzle does.**	**Describe what a nozzle does.**
Nozzles are available in a wide range of types, sizes and materials.		
Nozzles are classified on the basis of type of spray pattern that is developed.		
The common nozzle types are: **- flat fan nozzles;** **- boomless nozzles.**	**Know the most common nozzle types.**	**List the most common nozzle types.**
Herbicide labels may recommend specific types and sizes of nozzles. Follow label directions.		
Spray Angle		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - COMPONENTS

General Objective: To understand the technology of mounted sprayers used in industrial vegetation control by examining the components.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The nozzle spray angle is the measurement (in degrees) of the spray angle formed by a single nozzle at a specific pressure. The spray angle will vary slightly with pressure.	**Know what the nozzle spray angle refers to.**	**Define nozzle spray angle.**
To obtain the recommended overlap for a uniform application, boom height will vary depending on spray angle and nozzle spacing. Refer to nozzle manufacturer's recommendations or provincial recommendations for the required amount of overlap to achieve a uniform application.	**Understand how the spray angle affects the boom height.**	**Describe how the spray angle affects the boom height.**
Flat Fan Nozzles		
Flat fan nozzles are used for herbicide work. Properly operated flat fan nozzles can provide the greatest level of application uniformity.	**Know when to use flat fan nozzles.**	**Describe flat fan nozzles.**
Use flat fan nozzles with low pressures (between 100 and 400 KPa).		
Flat fan nozzles are intended to be used in an overlapping spray pattern, which means that one nozzle spray angle overlaps the next nozzle spray angle.	**Know how to position flat fan nozzles on a boom.**	**Describe how to position flat fan nozzles on a boom.**
Offset the nozzles slightly from the adjacent nozzle to prevent spray interference.		
The 2 most common spray angles are 80E and 110E.		
Special flat fan nozzles are also available for low pressure applications (LP flat fan), which allow spraying under low pressure and volume but maintain the spray pattern of conventional flat fan nozzles.	**Know that there are LP flat fan nozzles.**	**Describe LP flat fan nozzles.**

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - COMPONENTS

General Objective: To understand the technology of mounted sprayers used in industrial vegetation control by examining the components.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Boomless Nozzles		
Boomless nozzles are intended to be used singly or in clusters and include: **- large capacity off-centre nozzles;** **- accutrol nozzles;** **- radiarc spray systems;** **- controlled droplet application equipment.**	**Know the types of boomless nozzles.**	**List and describe the four types of boomless nozzles.**
Large capacity off-centre (boom-end) nozzles are designed to provide a boomless spray in spraying roadside ditches, pastures and places where there are many obstacles such as brush and fences. These nozzles provide coverage up to 10 metres depending on nozzle size, pressure and wind conditions.		
Accutrol nozzles are designed for industrial uses such as roadsides or other rights-of-way. Accutrol nozzles are designed to be used in combination with a spray adjuvant.		
The nozzles draw in air and mixes it with the spray to form a milky mixture resembling foam that is visible to the operator. These nozzles can be used on boom sprayers, boomless spray systems and handguns.		
The radiarc spray system is also used for industrial applications. Swath widths can be adjusted from 1 metre to 12 metres when using the pattern radius or the pattern diameter. This system uses an oscillating motor to produce the spray pattern. Drift control additives can be used with this system and it can be adapted to computer controlled spray programs.		
Controlled droplet application equipment can also be used in industrial applications. These systems use a spinning disc nozzle to create a centrifugal force that distributes droplets in a circular hollow cone spray pattern. Droplet size is controlled by rotational speed of the disc and flow volume.		
Clean Water Tanks		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - COMPONENTS

General Objective: To understand the technology of mounted sprayers used in industrial vegetation control by examining the components.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
All mounted sprayers should be equipped with a clean water tank. It provides a source of clean water for emergencies and to perform routine tasks such as nozzle and hand cleaning.	**Know why mounted sprayers need clean water tanks.**	**Identify why mounted sprayers need clean water tanks.**
Additional Components		
Additional components are available to enhance the operation of the sprayer. Electronic controls, hydraulic or electric booms, induction systems, direct injection systems **and enclosed cabs are methods that reduce exposure and increase convenience.** **Items such as spray monitors and controllers may improve application by supplying the operator with more information.** **NOTE: Drift control agents may change fluid viscosity which will affect distribution patterns, spray monitors and controllers.**	**Know that additional components can be added to a mounted sprayer to enhance its operation.**	**List the items that can be added to a mounted sprayer to enhance its operation.**
Calibration Objectives		
The two objectives of mounted sprayer calibration are: **- to ensure that the spray solution will be applied uniformly;** **- to determine volume of spray that will be applied.** **Select a calibration procedure that meets both these objectives.** **Sprayers should be calibrated:** **- when the sprayer is new;** **- at the start of the season;** **- when travel speed, nozzle spacing, or nozzles are changed;** **- when sprayer output changes;** **- when sprayer is modified.**	**Know the objectives of sprayer calibration.**	**List and describe the objectives of sprayer calibration.**

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Application Uniformity		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Application uniformity affects herbicide performance. Non-uniform application will result in localized areas of over and under application reducing the herbicides effectiveness.	**Understand the importance of uniformity in application.**	**Describe the importance of application uniformity.**
Non-uniform application can occur from: **- variations occurring across the width of the boom;** **- localized variations within the total application area.** **Variations across the width of the boom are caused by:** **- variations in pressure;** **- variations in nozzle spacing;** **- incorrect boom height;** **- variations in nozzle outputs (i.e. mismatched nozzles).** **Variations over the total application area can be caused by:** **- variations in travel speed;** **- variations in pressure;** **- excessive boom movement.** **Nozzles must be checked regularly to make sure that every nozzle has a similar output. This is critical if a uniform application is to be made.**	**Understand how non-uniformity can occur.**	**List causes of non-uniformity.**
Nozzle Output		
Nozzle output is the volume of spray solution a nozzle delivers in a specific period of time. Nozzle output is usually rated in litres per minute (L/min) or gallons per minute (gpm).	**Know what the nozzle output refers to.**	**Define nozzle output.**
Nozzle output depends on the nozzle size and operating pressure. Increasing nozzle size and/or operating pressure, increases the nozzle output.	**Understand the factors affecting nozzle output.**	**List the factors affecting nozzle output.**
Manufacturer's catalogues provide nozzle outputs in either metric or American units. Manufacturers usually list nozzle output over the range of acceptable operating pressures.	**Know where to obtain information on nozzle outputs.**	**Identify where to obtain information on nozzle outputs.**

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Nozzle Wear		
The rate that a nozzle wears depends on: **- nozzle material;** **- herbicide formulation;** **- operating pressure;** **- nozzle size;** **- the amount of use (time).** **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 these two.**	**Know the factors that affect nozzle wear rates.**	**List the factors that affect nozzle wear rates.**
Nozzle Calibration		
Nozzle calibration assesses the difference in nozzle output between used and new nozzles to determine the amount of wear and verify uniformity.	**Understand why nozzles must be calibrated.**	**Identify why nozzles must be calibrated.**
Check nozzle wear by: **1) Measuring the nozzle output (water only) for each nozzle at a constant operating pressure.** **2) Calculating the average output for the set of nozzles. Replace nozzles whose output varies by more than five percent from the average output.** **3) Replacing nozzles whose output is more than 10 percent higher than the manufacturers specified output or those that produce defective patterns.** **NOTE: Even new nozzles must be checked for uniformity in case of a manufacturing flaw, as well as to correct possible flow restrictions in the spray system that cause pressure drops.**	**Know how to check for nozzle wear.**	**Describe how to check for nozzle wear.**

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Nozzles that are properly maintained should wear evenly allowing for the replacement of entire sets of nozzles. Nozzles with streaky or skewed spray patterns should be cleaned to restore the proper pattern, or replaced even if they are not worn.		
Travel Speed		
The travel speed of the sprayer will affect the sprayer output. For a given nozzle output, increasing forward speed will decrease the sprayer output. Excessive travel speed causes boom movement, resulting in non-uniform application. Select a forward speed that will minimize boom movement.	Understand how travel speed affects sprayer output.	Describe how travel speed affects sprayer output.
Measure forward speed: - on the application site; - with the sprayer approximately half full of water; - repeated in both directions and averaging the results.	Know the procedure for measuring forward speed.	Describe the procedure for measuring forward speed.
Calculate forward speed by using the following equation: Forward Speed = Test Distance ÷ Time x Constant. Metric Units: km/h = Distance in metres ÷ Time in seconds x 3.6. Imperial Units: mph = Distance in feet ÷ Time in seconds x 0.68.	Know how to calculate forward speed.	Identify the mathematical formula for determining forward speed.
Nozzle Spacing		
Nozzle spacing is the distance between nozzles on a boom for broadcast sprayers. For single nozzle units or band spraying it is the actual width sprayed.	Know what the nozzle spacing refers to for different types of mounted sprayers.	Describe what the nozzle spacing refers to for different types of mounted sprayers.
The closer the nozzles are together, the greater the sprayer output (everything else being equal).	Understand how nozzle spacing affects sprayer output.	Describe how nozzle spacing affects sprayer output.

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Spacing of nozzles depends on: **- the type of nozzle;** **- type of weed;** **- boom height;** **- herbicide used.**	**Know the factors which will determine nozzle spacing.**	**Identify the factors which will determine nozzle spacing.**
The nozzle spacing on a boom generally is not adjusted to change the sprayer output. Nozzle spacing on a boom must be equal to ensure application uniformity.	**Know the importance of a consistent spacing across the boom.**	**Identify the importance of a consistent spacing across the boom.**
Common nozzle spacing is 50 cm on boom sprayers.	**Know the common nozzle spacing.**	**Identify the common nozzle spacing.**
Sprayer Output		
Sprayer output refers to the amount of herbicide mix (herbicide and carrier) that is applied to a unit area.	**Understand what sprayer output is.**	**Describe sprayer output.**
A specific sprayer output may be recommended on the label. Sprayer output is commonly expressed as: **- broadcast treatment stated as L/ha;** **- banding treatments stated as mL/m of row;** **- individual units stated as L/plant, spray to wet.**	**Know the units for sprayer output and herbicide rate.**	**Identify the units for sprayer output and herbicide rate.**
Herbicide rate is the amount of formulated herbicide concentrate that is applied to a unit area and is expressed in similar units.		
Sprayer output depends on: **- the nozzle output;** **- the travel speed;** **- the nozzle spacing;** **- operating pressure.**	**Know the factors that determine the sprayer output.**	**List the factors that determine sprayer output.**
Sprayer output = Nozzle output x constant ÷ travel speed ÷ nozzle spacing. **Metric Units: L/ha = L/min x 60000 ÷ km/h ÷ cm.** **Imperial Units: GPA = gpm x 5940 ÷ mph ÷ inches.**	**Know how to calculate sprayer output.**	**Identify the mathematical equation for determining the sprayer output.**

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Conversion factors can be used to convert any metric unit or measurement into either Imperial or American units.		
The constant in the formula is a conversion factor to account for different units of measurement.	**Understand what the constant in the formula refers to.**	**Describe the constant in the formula.**
Sprayer output can also be determined by measuring the volume of spray solution that was applied to a known area. If this approach is used, then it is important to also assess the uniformity of the nozzles.	**Know an alternate method of assessing sprayer output.**	**Describe an alternative method for assessing sprayer output.**
Nozzle Selection		
Select a new nozzle from manufacturer's catalogues on the basis of the nozzle output and acceptable operating pressures. Nozzle output can be determined if the sprayer output, travel speed and nozzle spacing are known.	**Understand how to select the correct size of nozzle.**	**Describe how to select the correct size of nozzle.**
Nozzle output = sprayer output x travel speed x nozzle spacing ÷ constant. **Metric units: L/min = L/ha x km/h x cm ÷ 60000.** **Imperial units: gpm = GPA x mph x inches ÷ 5940.**	**Know how to calculate nozzle output.**	**Identify the mathematical formula for determining nozzle output.**
Herbicide Use Calculations		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticide will be applied.

COURSE OUTLINE

Know the size of the treatment area. It can be obtained by measuring or from other sources such as property maps or deeds.

Area of a treatment of a rectangular or square shape site = length x width.
Total herbicide required = treatment area x herbicide rate.
Area covered per tank = tank size ÷ sprayer output.
Herbicide per tank = herbicide rate x area covered per tank.
Total number of tanks = treatment area ÷ area covered per tank.
There are several methods of calculating the volume of spray mixture (the volume of spray mixture = volume of water + volume of herbicide) for partial tanks.

The first method calculates the volume of the spray mixture based on the decimal portion of the final tank.

The volume of water for the partial tank = total volume of the tank x the decimal portion required for the final load.
Area covered by the partial tank = volume of spray mixture required for the partial tank - sprayer output.
Volume of herbicide for partial tank = herbicide rate x area covered by the partial tank.

The second method calculates the spray volume based on the area left to be sprayed.

Volume of spray mixture for the partial tank = (area left to be sprayed x herbicide rate) + (area left to be sprayed x sprayer output).
Area left to be sprayed = site size ÷ (area covered by one full tank x number of full tanks required).
Volume of herbicide for partial tank = area left to be sprayed x herbicide rate.
Volume of water required for partial tank = area left to spray x sprayer output.

The third method adjusts sprayer output (by changing forward speed or pressure) so that only full tanks are required.

INSTRUCTIONAL OBJECTIVES

Know how to calculate the size of treatment area, total herbicide required, area covered per tank, amount of herbicide required per tank, total number of tanks, volume of spray mixture required for the final load, herbicide required for the final load.

LEARNING OUTCOMES

Identify the mathematical formulas for determining the size of treatment area, total herbicide required, area covered per tank, amount of herbicide required per tank, total number of tanks, volume of spray mixture required for a partial load, herbicide required for a partial load.

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticide will be applied.

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - ENVIRONMENTAL CONSIDERATIONS

General Objective: To understand the influence of environmental conditions on the application equipment used for industrial vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Spray Drift		
Before beginning any application, evaluate the weather conditions at the site to assess the spray drift potential.	**Know the importance of evaluating weather at the site before applying herbicides.**	**Identify the importance of evaluating weather conditions.**
Minimize spray drift by: **- spraying under favourable weather conditions;** **- choosing suitable application equipment;** **- correctly operating the application equipment;** **- use of drift control agents;** **- choosing a formulation that is less subject to drift (e.g., amine versus ester solutions).**		
NOTE: drift control agents may alter viscosity and outputs and so interfere with electronic metres/monitoring systems.		
Favourable weather conditions are those that will not reduce the efficacy of the herbicide or increase the potential of environmental damage.	**Know that drift control agents may alter outputs.**	**Identify that drift control agents may alter outputs.**
Consider: **- air and ground temperature;** **- relative humidity;** **- wind speed and direction;** **- impending weather conditions;** **- water quality.**	**Know what weather conditions must be considered when applying herbicides.**	**List the weather factors to consider when applying herbicides.**
Temperature		
High air temperatures may: **- reduce effectiveness of certain herbicides,** **- increase droplet evaporation, and** **- create a temperature inversion.**	**Know how temperature may adversely affect the application of herbicides.**	**Describe how temperature may adversely affect the application of herbicides.**
High temperature combined with low relative humidity increases the rate at which airborne droplets evaporate. Evaporation decreases droplet size resulting in droplets that are more prone to drift.		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - ENVIRONMENTAL CONSIDERATIONS

General Objective: To understand the influence of environmental conditions on the application equipment used for industrial vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
A temperature inversion is a condition where air at ground level is cooler and more stable than air above the ground. The inversion prevents very fine spray droplets from settling allowing them to remain suspended in the air for long period of time and move off target.		
Wind		
Increases in wind speed will increase the potential for spray drift. Maximum acceptable wind speeds and temperatures may be referred to on the label or by provincial recommendation/legislation. If spray drift is visible, stop the application.	**Know how wind may adversely affect the application of herbicides.**	**Describe how wind may adversely affect the application of herbicides.**
No-wind conditions can cause herbicide sprays to remain suspended in air, which can be blown later onto sensitive plants. A 2 km/h. wind is generally adequate.		
Avoid wind conditions that are unpredictable, as these conditions could possibly lead to blowing droplets or vapours onto non target sensitive plants.		
Equipment		
Control droplet spray drift limiting the size of droplets that the nozzles produce. The droplet size decreases as nozzle size (output) decreases and pressure increases.	**Understand methods of operating application equipment to minimize spray drift.**	**Describe the methods of reducing spray drift.**
A specific nozzle output can be obtained by using a variety of nozzle/pressure combinations. A small nozzle operated at high pressure can have the same output as a larger nozzle at a lower pressure. Reduce the drift potential by using larger nozzles and lower pressures.		
Higher application rates will require larger nozzles, which deliver larger droplets thus reducing drift.		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - ENVIRONMENTAL CONSIDERATIONS

General Objective: To understand the influence of environmental conditions on the application equipment used for industrial vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Minimizing application rates will require larger nozzles, which deliver larger droplets thus reducing drift. **Minimize drift by lowering the boom height. Use nozzles with wider spray angles or tilt the nozzles forward (to effectively lower boom height).**		
Water Quality		
Temperature, sediment, pH, and presence of salts in the water that is mixed with herbicide, may affect herbicide performance. **The pH of a spray solution can have a significant effect on the performance of some herbicides. The active ingredient of some herbicides decreases in effectiveness when the spray solution is alkaline. The rate at which chemical breakdown occurs depends on:** **- the pH of the water;** **- the amount of chemical added to a fixed amount of water;** **- the water temperature;** **- the length of time the solution is left in the spray tank.**	**Understand how water quality may affect the performance of the herbicide.**	**List and describe the ways water adversely affects the performance of a herbicide.**
Silt and organic matter in the water can cause the following problems: **- premature pump wear;** **- plugging of screens;** **- organic matter tends to adsorb herbicides, decreasing their effectiveness.**		
If water quality is suspected as being a problem, the following should be considered in the absence of specific guidelines.	**Know what to do if water quality problems are suspected.**	**List the possible actions to take if water quality problems are suspected.**

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - ENVIRONMENTAL CONSIDERATIONS

General Objective: To understand the influence of environmental conditions on the application equipment used for industrial vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
1. Send a water sample to a lab for a chemical analysis.		
2. Seek a more suitable water source if practical.		
3. Use the minimum recommended amount of water per acre necessary to obtain good coverage and maintain desirable vegetation safety.		
4. Use the maximum recommended herbicide rate.		
5. Use adjuvants as recommended on the herbicide label.		
6. Apply herbicides as close to the optimum time as possible.		
7. Avoid spraying when weather conditions may further reduce the efficacy of the herbicide.		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - EQUIPMENT MAINTENANCE

General Objective: To understand the basic procedure in maintaining and cleaning mounted sprayers used in industrial vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Proper maintenance of the application equipment minimizes the chance of a breakdown and increases the service life.	**Understand the importance and principles of a proper maintenance program for application equipment.**	**Describe how to properly maintain application equipment.**
Rinse the equipment thoroughly at the end of each spraying day by flushing clean water through the pump, booms, and nozzles. Check all screens, filters and nozzles and clean them if necessary. Assess the sprayer for wear and replace worn or damaged parts. Critical parts to check include agitator, regulator and pressure gauge to ensure accurate operation; couplings and clamps for seal; and hose flex points for wear. Wash the sprayer and dispose of rinsate only where residues will not cause any adverse environmental harm. Follow directions on the label and provincial regulations.		
Decontaminate the sprayer when changing from one type of herbicide to another. Decontamination procedures vary depending on the herbicides being used. Consult the label or manufacturer's representative for specific recommendations.	**Know how to decontaminate the sprayer.**	**Describe how to decontaminate the sprayer.**
Temporary Storage of Spray Vehicles		
Evaluate parking site carefully when parking spray vehicles. Take the following precautions: **- do not park near susceptible vegetation as release of herbicide vapours or movement of spray solution off the vehicle deck due to rainfall onto susceptible vegetation or drainage of herbicides into storm sewers or vandalism may occur;** **- avoid urban areas.**	**Know what precautions should be taken when temporarily storing spray vehicles.**	**List and describe the precautions to take when temporarily storing spray vehicles.**

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - EQUIPMENT MAINTENANCE

General Objective: To understand the basic procedure in maintaining and cleaning mounted sprayers used in industrial vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
If parking near susceptible vegetation or parking in urban areas is unavoidable, take these precautions: **- lock all valves that could allow spray solution to escape during any unauthorized access;** **- secure herbicide containers to prevent tampering or theft,** **- inspect spray systems daily (before application) to check for tampering;** **- ensure that contaminated clothing is stored in a secured location well away from clean clothing until the contaminated clothing is cleaned or disposed of.**		
To prepare the sprayer for storage:	**Know how to prepare a sprayer for storage.**	**List and describe the steps in preparing a sprayer for storage.**
1. Thoroughly clean the sprayer. Drain it completely, especially the filters, pump, pressure regulator, controls, and other fittings that may retain water. Follow manufacturer's recommendations on the addition of antifreeze solutions. Store antifreeze in the summer for use next winter. **2. Check the sprayer for worn parts, list all the parts that need replacement, and order the parts well before the next spraying season.** **3. Before winter storage, remove the pump and follow the manufacturer's recommendations for storage.** **4. Seal all openings to prevent entry of dirt, debris, or rodents.** **5. Store the sprayer where it will not be damaged by other equipment, livestock or weather.**		
Store polyethylene tanks under cover to prevent deterioration by sunlight. Store galvanized steel tanks indoors away from moisture to prevent rusting.		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT - COMPONENTS

General Objective: To understand the technology of granular application equipment by examining their basic components.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Components of Granular Application Equipment		
The main components of granular application equipment include: **- storage hoppers;** **- metering mechanism;** **- distribution system;** **- structural framework.**	**Know the main components of granular application equipment.**	**List the main components of granular applicator equipment.**
Storage Hopper		
Storage hoppers hold the granular herbicide and are available in a variety of different shapes, sizes and materials. Desirable features in the selection of a hopper are that they: **- resist corrosion;** **- be strong;** **- be shaped to prevent bridging;** **- be easy to fill;** **- be easy to clean;** **- have graduated markings.**	**Know the desirable features of a storage hopper.**	**List the desirable features of a storage hopper.**
Agitators can be installed in hoppers to prevent bridging of the granules. The tendency of a granular product to bridge depends on: **- the herbicide characteristics;** **- shape of the hopper;** **- air temperature and humidity.**	**Know why agitators are installed in hoppers.**	**State why agitators are installed in hoppers.**
Coarse screens can be installed on hoppers to prevent pieces of the herbicide bag or clumps of product from entering the hopper. This will prevent possible clogging of the drive mechanism.		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT - COMPONENTS

General Objective: To understand the technology of granular application equipment by examining their basic components.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Metering Mechanism		
Two types of metering mechanisms are commonly used: **- gravity flow;** **- positive.**		
Gravity flow metering mechanisms use openings that can be manually adjusted in size to regulate the flow of herbicide from the hopper. A hopper agitator is usually used to provide a steady flow of granules to the opening.	**Know the difference between gravity flow and positive metering mechanisms.**	**Know the difference between gravity flow and positive metering mechanisms.**
Positive metering mechanisms use an auger or a fluted-feed roll at the bottom of the hopper to regulate the flow of granules from the hopper. Positive metering mechanisms are usually powered by a ground driven wheel, providing more accuracy than gravity flow metering mechanisms.		
Distribution System		
Granular application equipment are classified according to the type of distribution system used. Two common types of distribution systems used are: broadcast and banding.	**Know the difference between broadcast and banding distribution systems.**	**State the difference between broadcast and banding distribution systems.**
Broadcast application equipment apply granules over the entire site surface. Broadcast application equipment commonly utilize either a very wide hopper with closely spaced gravity flow openings, a single gravity flow opening with a mechanical spreader or a pneumatic delivery system.		
Band application equipment apply residual herbicide granules only in narrow bands. Banding reduces herbicide usage while still achieving vegetation control.		
Band application equipment applies residual herbicide granules only in narrow bands. Banding reduces herbicide		
granules only in narrow bands. Banding reduces herbicide usage while still achieving vegetation control.		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT - COMPONENTS

General Objective: To understand the technology of granular application equipment by examining their basic components.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Band application equipment can utilize: **- simple spreaders to distribute the granules across the desired band width on the soil surface;** **- small drop tubes or soil openers to deposit the granules under the soil surface near the seed in well defined bands.**		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT - CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of granules will be uniformly applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Calibration Objectives		
The two objectives of granular application equipment calibration are: **- to determine the application equipment output;** **- to verify that uniform and correct placement can occur.**	**Know the objectives when calibrating granular application equipment.**	**State the objectives when calibrating granular application equipment.**
Application Uniformity		
Application uniformity affects herbicide performance. Non-uniform application will result in localized areas of over and under application reducing the herbicide effectiveness.		
Non-uniformity can result from: **- variations in granule flow rates;** **- variations in forward speed;** **- variations in discharge heights when banding.**	**Understand the importance of application uniformity.**	**Explain the importance of application uniformity.**
Application Equipment Output		
Application equipment output refers to the weight of herbicide per unit area that the granular application equipment applies. **The herbicide rate refers to the weight per unit area that is recommended on the herbicide label.** **Application equipment output and herbicide rate are commonly expressed as:** **- broadcast treatment stated as kg/ha;** **- banding treatment stated as kg/ha or kg/m of row.** **Conversion factors can be used to convert metric units to Imperial units.**	**Know what the terms application equipment output and pesticide rate refer to.**	**Define application equipment output and pesticide rate.**

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT - CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of granules will be uniformly applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The application equipment output depends on: **- the granule flow rate;** **- the forward speed;** **- the treatment width.**		
Granule Flow Rate		
Granule flow rate is the rate which granules flow from the hopper. Granular flow rate depends on: **- the granule size and density;** **- chemical characteristics;** **- air temperature and humidity.**	**Know what the term granular flow rate refers to. Know what factors can affect the granular flow rate.**	**Define granular flow rate and explain the factors that affect it.**
An increase in the humidity level can result in a decrease in granule flow rate.		
The metering mechanism can be adjusted to regulate the granule flow rate from the hopper. The correct setting is determined during the calibration procedure. Once set, metering mechanisms are not usually adjusted during the application.		
The flow rate of gravity flow mechanisms can be adjusted by changing the size of the opening. The rotational speed of the agitator can also affect the flow rate.		
The flow rate of positive metering mechanisms can be adjusted by changing the exposed metering surface area or the rotational speed of the metering mechanism.		
Site conditions will affect the flow rate from the hopper. Bouncing that occurs on rough sites will tend to disrupt the steady flow of granules, decreasing uniformity.		
The granular flow rate of every discharge orifice should be measured to ensure uniform application across the total width of the applicator.		
Travel Speed		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT - CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of granules will be uniformly applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The travel speed will affect the application equipment output. **For granular application equipment using gravity flow metering mechanisms, increasing travel speed will decrease the application rate, for a given setting.** **For granular application equipment using positive metering mechanisms, small changes in forward speed do not significantly alter the application equipment output when the metering mechanism is ground driven.** **Regardless of the metering mechanism, the travel speed selected during calibration should be maintained during application.**	**Know how the travel speed affects application equipment output.**	**Explain how travel speed affects application equipment output.**
Treatment Width **The treatment width used to determine the application equipment output depends on the type of distribution system used.** **For broadcast application equipment, the treatment width equals the actual total width that granules are applied.** **For band application equipment, the treatment width equals the total of all the individual band widths for one pass.** **When granules that are required to be banded under the soil surface, the application equipment output is generally expressed as kg/m and treatment width is not considered.**	**Know how treatment width affect application equipment output.**	**Explain how treatment width affects application equipment output.**
Granular Application Equipment Calibration		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT - CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of granules will be uniformly applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Granular application equipment should be calibrated: **- when the application equipment is new;** **- at the start of the season;** **- when the travel speed, meter mechanism, weather conditions, or herbicide are changed;** **- when the application equipment output changes.** **Determine a suitable site speed, taking into consideration the site conditions. Select the appropriate gear/rpm setting that will provide the desired travel speed. Record this information and maintain this speed throughout calibration and application.** **Mark a test distance on the site where the application will occur or in an area having similar soil and terrain conditions. The distance should be at least 50 meters in length. Select a fairly level area and repeat the test in both directions, averaging the results. Fill the hoppers approximately half full for average weight conditions. To minimize the error in collecting granules, the acceleration and deceleration distances should be kept as short as possible when the flow rate can not be controlled by the operator.** **To obtain the correct application equipment output, first consult the operators manual for the recommended setting of the metering mechanism. Always complete the calibration procedure to verify that the granule flow rate is correct. Never assume that the operators manual is correct, as the flow rate will vary significantly depending on the type of herbicide, weather, and site conditions.** **Attach bags or other containers under each opening to collect the granules during calibration. If possible use a blank carrier to minimize exposure. Special collection containers that are calibrated with a scale measuring grams, that eliminate weighing may be available. For granular equipment with a pneumatic delivery system, use either porous mesh bags (e.g., nylons) or shut off the air flow and catch the granules at the metering mechanism.**	**Know how to calibrate granular application equipment.**	**Explain how to calibrate granular application equipment.**

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT - CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of granules will be uniformly applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Operate the application equipment over the test distance at the correct gear/rpm selection. Remove the bags/ containers, weigh and record the quantity collected in each. Sufficient material must be collected during the test to allow for accurate weighing on scales that are available. **Do not use a scale that is used for food.** **Assess the flow rate uniformity by comparing the individual values to the average value. Adjust and recalibrate if necessary.** **Always verify that the correct placement of granules occurs during calibration. To adjust band width, spreaders or tubes may be adjusted in height.** **Calculate the calibration area, total amount collected, treatment area, and total amount of herbicide required.**		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT - CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of granules will be uniformly applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Calculations		
Calibration area = test distance length x test distance width. Convert units to hectares or acres. **Total granule flow rate = sum of the weights of individual openings.** **Treatment area (square/rectangular shape) = site length x site width. Convert units to hectares or acres.** **Broadcast or Banding (kg/ha units): Application equipment output = total granule flow rate ÷ calibration area. Record this in the operators manual for future reference.** **Banding (kg/m units): Application equipment output = total granule flow rate ÷ number of bands ÷ calibration test distance.** **Total herbicide required = treatment area x application equipment output.**	**Know how to perform the field calculations for granular application equipment.**	**Given a situation; calculate the area, application equipment output and total pesticide required.**

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT - ENVIRONMENTAL CONSIDERATIONS

General Objective: To understand the influence of environmental conditions on the application equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Weather Conditions **Before beginning any application, always evaluate the weather conditions at the site to assess potential problems.** **High winds could affect the distribution of granules, decreasing uniformity or changing band width.** **A change in the humidity level can alter the flow rate of the granules, in turn affecting the application rate.**	**Know the environmental conditions which may influence a granular application.**	**State the environmental conditions which may influence a granular application.**
Wildlife **If possible incorporate granular herbicides into the soil to reduce wildlife impact by minimizing potential of ingestion.**		

Category: INDUSTRIAL VEGETATION

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT - EQUIPMENT MAINTENANCE

General Objective: To understand the basic procedure in maintaining and cleaning granular applicators used in industrial vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Maintenance		
Proper maintenance of the application equipment minimizes the chance of a breakdown and increases the service life.	**Understand the importance and principles of a proper maintenance program for application equipment.**	**Explain the importance and methods of properly maintaining application equipment.**
Never leave granules in the hoppers for extended periods as they can absorb moisture and harden into lumps. Before using the application equipment make sure that all moving parts are not seized from corrosion.		
The abrasive nature of the granules will require that all moving parts of the application equipment be frequently greased or oiled. Excessive lubrication can accumulate the granules, dust and dirt which can cause rapid wear and possibly interface with the operation of the equipment.		
Check all tires for proper inflation before use. The air pressure used will determine the effective size of the tire and the application rate. Over inflated tires increase bouncing, decreasing uniformity.		
Check the delivery system to make sure the granules have an unobstructed path from the metering mechanism to the target.		
To prepare the equipment for storage: **- thoroughly clean the equipment, wearing appropriate protective clothing;** **- lubricate all moving and vital parts. Follow the manufacturer's recommendations;** **- check the equipment for worn parts, and replace them;** **- store the equipment where it will not be damaged by other equipment, livestock or weather.**		

Category: INDUSTRIAL VEGETATION

Concept: PROFESSIONALISM - BERRY PICKING AREA PRECAUTIONS

General Objective: **To understand the precautions that need to be taken regarding berry picking areas that are intermixed with industrial vegetation control sites.**

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Berry picking areas can be prevalent in industrial vegetation control sites. Berries can be important as: **- source of food for wild animals;** **- source of food for people;** **- a source of income for people.**	**Know why berry picking areas need additional precautions.**	**Identify why berry picking areas need additional precautions.**
Spraying of berry picking areas can lead to contamination of the berries, or killing of the berry plants.		
It is important that berry picking areas are identified in a site management plan and that the following precautions are taken: **- the berry picking area is not sprayed and other forms of vegetation control are practised, or;** **- the berry picking area, if it must be sprayed, should be sprayed after the berries are picked. The herbicide should be used on a spot treatment over weeds only, so berry producing plants are not affected.**	**Know what types of precautions must be taken to prevent herbicide contamination of the berries.**	**Describe what precautions must be taken to prevent herbicide contamination of the berries.**
If a known berry picking area is accidentally sprayed, then the site must be posted until the berries have fallen off the branches.	**Know what to do if a berry picking area is accidentally sprayed.**	**Describe what to do if a berry picking area is accidentally sprayed.**