



BC Forest Safety

Avalanche Safety Resource Package

This resource package is designed to assist forestry companies to identify and assess avalanche risks. It is intended to provide basic information on avalanche safety and is not to be used as a replacement for an avalanche risk assessment or safety plan.



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Avalanche Safety Resource Package

The importance of this information to a forestry operation

Forestry activity often takes place in and around avalanche terrain. Avalanches can be a risk to workers and machinery from early winter well into the summer months. Harvesting activities can increase the risk of avalanches occurring.

When an avalanche risk is present, this triggers the requirement for a qualified person to complete an avalanche risk assessment or avalanche safety plan.

Planning for avalanche hazards is important for forest worker safety and, since 2009, has specific requirements under WorkSafeBC regulation:

www2.worksafebc.com/publications/OHSRegulation/Part4.asp#SectionNumber:4.1.1

The purpose of this resource package is to provide information and tools to assist forest companies and employees identify and assess avalanche risks. It only provides basic information on avalanche safety and is not to be used as a replacement for the avalanche risk assessment or safety plan.

This resource package will help identify:

- Introduction to avalanche safety for forestry operations.
- Information on avalanche safety regulatory requirements.
- Tools to help identify the presence of avalanche hazards.
- An example of avalanche safe work procedures.
- Links to additional resources.



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Photo Source: Parks Canada

1. Definitions

AVALANCHE

This document refers to a snow avalanche; the requirements related to landslides are not covered in this resource package.

An avalanche (or snow slide) is a volume of snow, usually more than several cubic metres, moved by gravity at perceptible speed. Snow avalanches may contain rock, broken trees, soil, ice or other material

There is no universally accepted classification system for different forms of avalanches. Avalanches are typically described by their size, their destructive potential, their initiation mechanism, their composition and their dynamics.

SLAB AVALANCHE

An event that occurs when a cohesive slab of snow lying upon a weaker layer of snow fractures and slides down a steep slope. Avalanches are typically triggered in a starting zone from a mechanical failure in the snowpack (slab avalanche) when the forces of the snow exceed its strength but sometimes only with gradual widening (loose snow avalanche). After initiation, avalanches usually accelerate rapidly and grow in mass and volume as they entrain more snow.

QUALIFIED PERSON

This refers to anyone with knowledge of the work, the hazards involved and how to control those hazards. They must also have the education, training and experience to provide qualified input on avalanche risk assessment and planning.

AVALANCHE RISK EVALUATION

Employers can determine if there is a possible risk of an avalanche at a workplace by doing an avalanche risk evaluation. This resource package provides an Avalanche Risk Identification Tool which is a form that employers can use to complete this evaluation.

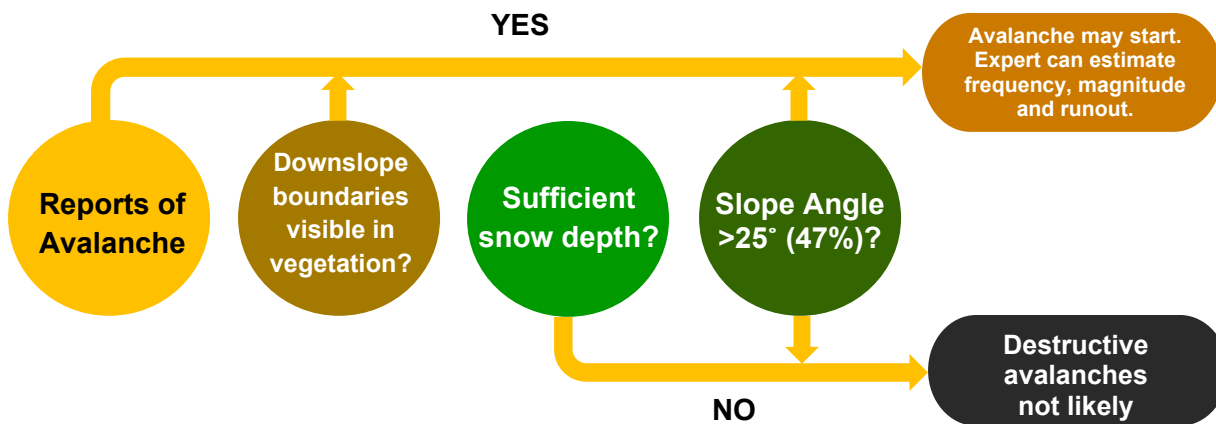
Avalanche Information:

- An avalanche is a rapid flow of snow down a hill or mountainside.
- Early winter through springtime is when most avalanches tend to occur. However, avalanche incidents have been recorded for every month of the year.



AVALANCHE RISK ASSESSMENT

When an avalanche risk is present, this specific risk assessment is completed by a qualified person. This assessment must consider all hazards and risks associated with avalanches including topography, vegetation, snow conditions, avalanche history, nature and duration of work activities and the workplace including any buildings and structures (including temporary ones). It also must consider how the work activities may affect the topography, vegetation and snow conditions.



AVALANCHE SAFETY PLAN

An avalanche safety plan is developed and implemented based on the information gathered in the Avalanche Risk Assessment that has determined that a person working at the workplace will be exposed to a snow avalanche risk. This plan must include measures and procedures to eliminate avalanche risks. If risk elimination is not reasonably capable of being done, risks must be minimized, including implementing an avalanche safety program.

AVALANCHE SAFETY PROGRAM

This program is part of an avalanche safety plan when avalanche risk cannot be eliminated. An avalanche safety program must include regular monitoring of weather, snow and avalanche conditions and this monitoring must be done as per what a qualified person deems to be effective.

2. Avalanche Facts*

Thousands of avalanches occur in Canada each year. They happen in many regions of Canada but are more frequent in the mountains of British Columbia, Yukon and Alberta. Avalanches can be triggered by weather including wind and rain, by warming temperatures, snowpack conditions, slope steepness, slope orientation, wind direction, terrain, vegetation and earthquakes. They can also be triggered by skiers, snowmobiles, hikers, vibrations from machinery or construction. Different combinations of these factors can create different avalanche conditions and avalanche risk. Some of these conditions, such as wind, precipitation, temperature and condition of the snowpack, can change on a daily or even hourly basis.

- An avalanche occurs when a layer of snow collapses and slides downhill. There are two main types: loose-snow (or sluff) and slab avalanches. Both types may be wet or dry. Slab avalanches are generally larger and more dangerous.
- Slab avalanches require a stronger, more bonded layer of snow over a weaker layer.
- Avalanche triggers may be natural (weather factors such as wind loading, snowfall, rainfall, solar radiation, etc.) or human caused (skiing, snowmobiling, heavy equipment, explosives etc.)
- Avalanches are caused by three factors: terrain capable of producing avalanches, sufficient snowpack and the weather. An avalanche is triggered when stress (load) applied to the snowpack exceeds its strength.
- Avalanches can travel up to 120 km/h.
- An avalanche has three main parts - the starting zone, avalanche track, and runout zone. The starting zone is where unstable snow can fracture from the surrounding snow cover and begin to slide. Typical starting zones are higher up on slopes. However, given the right conditions, snow can fracture at any point on the slope.
- The avalanche track is the path or channel that an avalanche follows as it goes downhill. Large vertical swaths of trees missing from a slope or chute-like clearings are often signs that large avalanches run frequently there, creating their own tracks. This is where the avalanche gains the most speed.
- The runout zone is where the avalanche slows down and eventually stops. There may be a large pile-up of snow and debris at the bottom of the slope, indicating that an avalanche has run through.
- The runout zone is where the snow and debris finally come to a stop. Similarly, this is also the location of the deposition zone, where the snow and debris pile the highest.
- After 10 minutes fully buried there is a less than an 80 percent chance of survival for an avalanche victim. The most common causes of death are asphyxiation, wounds and hypothermia.

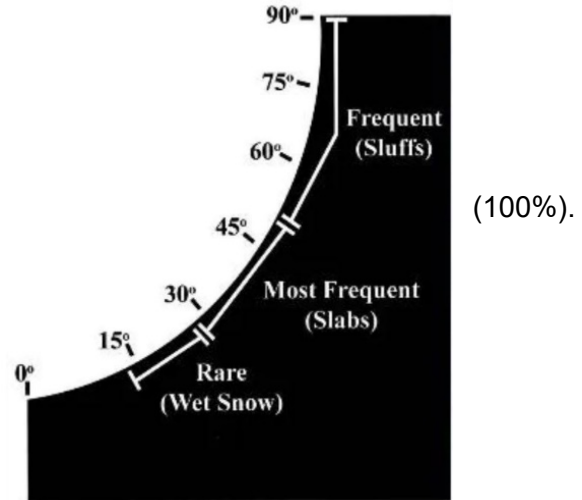
Avalanche Facts

AVALANCHE TERRAIN

- Slope angle is the most important factor.
- Dangerous slab avalanches occur most frequently at angles between 30° (58%) and 45°

GROUND ROUGHNESS & FOREST COVER

- Rough ground surfaces and vegetation helps to anchor the snowpack.
- The roughness of the ground determines how much snow is required for avalanche initiation. In general, a deeper snowpack is required for avalanches to occur on rough ground (cut blocks with high stumps and slash, talus slopes, etc.) than on smooth ground (road cut slopes, grass, rock slabs, etc.).
- The threshold snowpack depth for avalanche initiation ranges from 30 cm to > 100 cm depending on ground roughness.
- Avalanches may start and run through forested terrain. Forest densities of > 1000 stems/hectare are required to effectively prevent avalanches from initiating.



*source: Government of Canada – Get Prepared, National Snow and Ice Data Center, Avalanche Canada, Interfor Workplace Avalanche Safety Brochure

3. Avalanche Safety & Regulatory Requirements

INTRODUCTION

Section 4.1.1.1 of the WorkSafeBC Occupational Health and Safety Regulation requires employers whose workers travel through, work around or within an avalanche hazard zones to conduct an evaluation to determine if there is a risk from an avalanche. If the employer determines that the risk exists, a qualified person must conduct an Avalanche Risk Assessment and develop an Avalanche Safety Plan that includes measures and procedures to reduce the risks associated with avalanches. If the avalanche risk cannot be eliminated then an Avalanche Safety Program must be developed.

1

Use Risk Identification Tool

2

If risk is present, then a qualified person does an Avalanche Risk Assessment.

3

Using info from Avalanche Risk Assessment, a qualified person builds an Avalanche Safety Plan. An Avalanche Safety Program is developed if the risk cannot be eliminated.

4

Implement Plan and Program which will probably include following Avalanche Safe Work Procedures (example provided). Provide the procedures and training on them to workers.

5

If there is significant change in the avalanche risk conditions, the qualified person must review the assessment, plan and program and update if necessary.

4. Risk Identification Tool

Snow Avalanche Risk Identification

(Complete this form prior to beginning operations)

Completed by:		Date and Time:	
Location:			
GPS Coordinates:			
Type of Work being done:			
When any of the risk factors are present, a qualified person should be retained to conduct a detailed Avalanche Risk Assessment and create an Avalanche Safety Plan prior to beginning operations.			
Risk Factor	Evaluation Criteria	Risk Factor Present?	
Avalanche History	Are there observations or reports of avalanches in the planned area of operations? Observed avalanches are the best evidence of a potential problem. Planned area of operations includes the worksite as well as the access.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
		Notes:	
Vegetation	Is there evidence of damaged vegetation from avalanches? For example: lack of mature trees, broken trees, branches broken off their uphill sides, tracks with no vegetation or just brush.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
		Notes:	
Snow Depth and Terrain	Is the snow depth at least 50cm greater than ground roughness and do slopes exceed 47%? Large slab avalanches require depth of at least 50cm greater than ground roughness. <i>For example, if rock and bushes are 50cm in height, then approximately 100cm of snow would be required for a destructive slab avalanche to start.</i> The slope angle of the potential starting zone is the most important factor affecting frequency. Typical starting zones are higher up on slopes and may exist above the planned area of operations.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
		Notes:	
Additional comments / observations:			
Reviewed and signed off by:			

5. Safe Work Procedures

The following is a quick-reference guide, courtesy of Interfor, to help identify risks and work safely around avalanche hazards. They should be used in conjunction with a site-specific Avalanche Safety Plan and Program and are not a substitute for a plan or program.

INDICATORS OF SNOWPACK INSTABILITY	
INDICATOR	EXPLANATION
Recent Avalanche Activity	This is the most reliable indicator of snow instability and elevated avalanche hazard. Observe the characteristics of the terrain and look for similarities to your worksite.
New Snow	Most avalanches occur during or soon after heavy snowfall. Snowfalls of over 30 cm in 24 hours or sustained snowfall rates at over 2 cm/hour are red flags.
Wind Loading	Wind can transport large amounts of snow into lee areas, significantly increasing the amount and rate of snow loading. Look for signs of wind loading such as snow drifts and snow blowing off ridge crests.
Rainfall	Rainfall frequently triggers avalanches by adding load to the snowpack while at the same time reducing its strength.
Rapid Warming & Solar Radiation	Avalanches are frequently triggered when the snowpack is weakened by rising air temperatures (especially to above 0° and if there is no overnight freeze) and solar radiation.
"Whumphing" & Shooting Cracks	"Whumphing" is a sound that occurs when a buried weak layer fails; it is a very strong indicator of an unstable snowpack. Shooting cracks indicate slab properties in the snowpack.

AVALANCHE PROCEDURES

WHAT TO DO IF CAUGHT IN AN AVALANCHE		
On Foot: <ol style="list-style-type: none">1. Call out to alert companions2. Try to get to edge of avalanche3. Discard equipment, but leave your pack on4. Swim, kick, and fight to stay on the surface5. Grab trees or rocks6. Create an air pocket by reaching with one hand to your opposite shoulder and burying your face in the crook of your arm as the avalanche slows down7. Thrust the other arm towards the surface as the avalanche slows8. Relax and await rescue.	In a Vehicle: <ol style="list-style-type: none">1. Remain in the vehicle2. Turn off engine and headlights3. Call for assistance using radio, cellular phone, or satellite communication device4. Activate hazard lights5. If vehicle is buried and an avalanche probe is available, push it to the surface to provide a visual clue for searchers6. Ensure avalanche transceiver is transmitting7. DO NOT smoke or re-start engine8. Await rescue team.	If Road is Blocked: <ol style="list-style-type: none">1. STAY IN VEHICLE2. Back out to a safe area if it is safe to do so3. Radio for assistance from heavy equipment4. Advice on current avalanche conditions, residual hazard, and avalanche deposit removal should be sought from an avalanche technician concurrently with mobilizing heavy equipment.

AVALANCHE HAZARD RATINGS		
Avalanche Hazard	Avalanche Hazard Definitions	Typical Action
LOW	Avalanches are unlikely. OR Small avalanches are possible but are expected to terminate far above the road or worksite.	Normal operations with routine avalanche safety measures.
MODERATE	Small avalanches are probable but are expected to terminate above the road or worksite. AND/OR Large avalanches are possible but are expected to terminate far above the road or worksite.	Additional site-specific avalanche mitigation measures may be required to reduce avalanche risk.
CONSIDERABLE	Small avalanches are likely and may reach the road or worksite. AND/OR Large avalanches are probable but are expected to terminate above the road or worksite.	Site-specific travel or work restrictions may be required to reduce avalanche risk.
HIGH	Numerous small avalanches are expected to affect the road or worksite. AND/OR One or more large avalanches are expected to affect the road or worksite.	Road or worksite is closed.

STANDARD OPERATING PROCEDURES FOR WORK IN AVALANCHE HAZARD AREAS

Avalanche Hazard Rating ¹	Stationary Work		Frequency of Check-ins		Working Alone		Avalanche Rescue Equipment	
	Work on Foot	Work in Enclosed Vehicles	Work on Foot	Work in Enclosed Vehicles	Work on Foot	Work in Enclosed Vehicles	Work on Foot	Work in Enclosed Vehicles
HIGH	Road / worksite is closed	Road / worksite is closed	Road / worksite is closed	Road / worksite is closed	Road / worksite is closed	Road / worksite is closed	Road / worksite is closed	Road / worksite is closed
CONSIDERABLE	Stationary work not recommended	Stationary work not recommended	Work on foot not recommended	Call in at every km post within avalanche area with maximum 30 minutes between calls.	Working alone on foot not recommended	Working alone not recommended	Working on foot not recommended	Carry transceiver, shovel and probe inside each vehicle or ensure at least one rescue pack is available in close proximity to avalanche area. Road maintenance equipment operators should wear transceivers on body in 'transmit' mode.
MODERATE	Stationary work not recommended	Stationary work OK	Stationary work not recommended. For transitory work, check in every 5 minutes if not within sight of other workers.	Call in when entering and exiting avalanche area with maximum 30 minutes between calls.	Working alone on foot not recommended	Working alone OK.	Transceiver should be worn on body in 'transmit' mode. Wear backpack containing shovel & probe.	Carry transceiver, shovel and probe inside each vehicle or ensure at least one rescue pack is available in close proximity to avalanche area.
LOW	Stationary work OK	Stationary work OK	30 minute check-ins if not within sight of other workers in safe area	Routine workplace check-ins.	Working alone on foot not recommended	Working alone OK.	Transceiver should be worn on body in 'transmit' mode with immediate access to backpack containing shovel & probe.	Carry transceiver, shovel and probe inside each vehicle or ensure at least one rescue pack is available in close proximity to avalanche area.

¹ REFERS TO SITE-SPECIFIC AVALANCHE HAZARD RATING AS DETERMINED BY AVALANCHE TECHNICIAN. HAZARD RATING **DOES NOT** REFER TO AVALANCHE CANADA'S REGIONAL AVALANCHE DANGER.

6. Avalanche Resources

WorkSafeBC's guidelines for Snow Avalanche Assessments

www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-guidelines/guidelines-part-04#SectionNumber:G4.1.1

Avalanche Canada – public recreational avalanche forecast information

www.avalanche.ca

Canadian Avalanche Association – training and additional information

www.avalancheassociation.ca