PUBLIC SAFETY LIFELINE VOLUNTEER AVALANCHE SAFETY PLAN

EMERGENCY MANAGEMENT BC

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Rev.1 – December 2020
Rev.0 – August 2019

Table of Contents

Revision Table

Section	Item
Revision 1 - December 2020	
6.2.2	Clarification that an Avalanche Professional can provide avalanche danger ratings within a regional bulletin.
8	Revised term “organized avalanche rescue team leader” to “GSAR winter team leader”.
8	Revised GSAR winter field team leader training qualifications with respect to HEC operations. Table 3.
Appendix E	Revised GSAR winter field team leader training qualifications with respect to HEC operations. Table 3.

1 Introduction

The purpose of this Avalanche Safety Plan (ASP) is to outline operational procedures for minimizing snow avalanche risk to Emergency Management British Columbia (EMBC) volunteer Ground Search and Rescue (GSAR) groups in British Columbia. These volunteers respond to hundreds of incidents per year and as a result, may have significant exposure to avalanche hazard. In Canada, avalanches are responsible for, on average, approximately twelve fatalities per year (10-year average). Most of these fatalities occur in British Columbia and western Alberta. The majority of avalanche fatalities result from people triggering the same avalanche that kills them (McClung & Schaerer, 1993). Appendix A contains background information on snow avalanches.

The majority of GSAR responses take place in wilderness areas, making it unlikely that a comprehensive or detailed avalanche hazard assessment has been conducted for the area. GSAR training exercises may also involve avalanche risk, undertaken in a more controlled environment with coordinated planning and risk assessment. In all situations where EMBC volunteer GSAR groups are exposed to avalanche risk, a qualified Avalanche Safety Officer (ASO) must be identified and must lead the avalanche risk assessment component of the Avalanche Operations Plan (AOP). This is to ensure that an adequate avalanche risk assessment is conducted and that suitable avalanche safety measures are established prior to and during any operational deployment.

EMBC volunteer GSAR groups may be exposed to avalanche risk through any of the following four scenarios:

- Non-avalanche related GSAR responses where avalanche risk exists
- Rescue of injured, buried or stranded persons after an avalanche involvement
- Recovery of human remains after an avalanche involvement
- Training exercises in avalanche prone areas

1.1 Non-avalanche related GSAR responses where avalanche risk exists

The location of the subject may be known (rescue) or may not be known (search) and GSAR personnel could be required to pass through avalanche hazard zones in order to conduct their assignment. This type of response requires an awareness of the local avalanche hazard conditions and an avalanche risk assessment to determine to what degree field teams will be exposed to avalanche risk. The degree of risk may be such that an area is not searched until later when conditions improve, a different access route or mode of transport is necessary, or a higher degree of competency in the field personnel is required.

1.2 Rescue of injured, buried or stranded persons after an avalanche involvement

The location of the incident is known, and people are thought to be alive but buried in an avalanche, injured or in further danger. Responders are able to reach the location but must be aware of further avalanche risk at the incident site or during access/egress to the area. This

scenario may present the greatest danger, as responders are eager to provide assistance and may do so with minimal thought for their own safety. Thoughtful assessment is required to determine the circumstances and conditions related to the incident, as this information has implications on the urgency of the response. How many people are buried or injured? Are people still buried? For how long have they been buried? What is the nature of the injuries? In this situation, an ASO must be assigned and a detailed avalanche risk assessment included with the AOP.

1.3 Recovery of human remains after an avalanche involvement

The chance for the live recovery of a person buried in an avalanche diminishes rapidly over a short period of time. The literature suggests that within the first 10-12 minutes of burial, there is an 80% chance of survival. Following that, survivability decreases rapidly to less than a 10% chance after 40 minutes of burial (Haegeli et al. 2011). There are different considerations to be made when determining the survivability of persons who have been buried in a vehicle or building, as their likelihood of survival may be higher due to the nature of the burial.

Responders must carefully consider their response when all the information suggests the time between burial and their arrival is excessive (>2.5 hours). The recovery of deceased persons may be much slower and allow for more careful consideration of the process and associated risks. A variety of factors can contribute to the decision to not provide an immediate response including but not limited to the following:

- The risk to rescue personnel.
- Insufficiently trained or inexperienced rescue personnel.
- Elevated avalanche danger rating.
- Greater than 2.5 hours has elapsed from the time of burial of the subject.
- The size, type and burial depth of the avalanche
- Avalanches into catchment areas or terrain traps (e.g. water or crevasses).

1.4 Training exercises in avalanche prone areas

GSAR groups must train for operations in avalanche terrain in order to undertake the three types of responses described above. Training exercises provide the opportunity for slower planning without the urgency of an emergency response. All training exercises where groups are exposed to avalanche risk must appoint an ASO to undertake avalanche risk assessments and develop safety measures as part of the AOP.

2 Organization of Search and Rescue Activities

During GSAR operations in avalanche risk zones, each of the following roles are required to be fulfilled by one or more individuals (EMBC Winter Response policy 2.08). Often because of the complexity of GSAR operations and the nature of avalanches, key functions are staffed by a single individual. Functions can be fulfilled by registered EMBC volunteers, agency personnel, industry representatives (trained convergent volunteers) and contractors.

2.1 Emergency Management British Columbia

EMBC provides support and assistance to recognized GSAR volunteers. When tasked by a requesting agency, through the issuance of a task number, EMBC supports the activation of local GSAR groups. GSAR groups are community-based volunteer organizations that have various levels

of skill, training and equipment in ground and inland water search and rescue and in some cases other special disciplines such as road rescue. A number of these groups are trained and equipped to respond to various aspects of rope rescue, swift water rescue, and organized avalanche rescue to the identified needs in their operational areas.

EMBC provides Workers Compensation coverage, reimbursement of operational expenses and repair and/or replacement of equipment during tasks and liability coverage for responders per established policies. EMBC provides training task numbers in order to provide Workers Compensation coverage and liability coverage to SAR volunteers for regular training and pre-approved special training tasks.

EMBC maintains a database of volunteers involved in recognized GSAR groups in British Columbia and issues photo identification cards. Registration is done through the GSAR groups. It is the responsibility of each GSAR volunteer to maintain valid registration with EMBC. To be eligible for expense reimbursement, members are required to be registered with EMBC.

Regarding GSAR operations in avalanche hazard areas, SAR Commanders (government agency or department representatives with jurisdictional authority) in conjunction with EMBC Regional Duty Managers are responsible for the ongoing monitoring/evaluation of the overall search and rescue effort.

2.2 SAR Commander (Incident Command – IC)

The SAR Commander is the representative from the agency with responsibility for the type of search and/or rescue and/or recovery that is occurring. They are responsible for the management of all incident operations at the incident site. During the majority of GSAR operations in British Columbia, the role of SAR Commander is filled by a representative of the Royal Canadian Mounted Police (RCMP).

Requesting agencies with authority to function in role of SAR Commander are:

- Police Force of Jurisdiction
- British Columbia Ambulance Service
- Department of National Defense / Canadian Forces
- Canadian Coast Guard (unlikely for avalanche rescue and/or recovery)
- Parks Canada Agency
- The BC Coroner Service
- Local Authorities, including Fire / Rescue services providers.

Specifically, each of these departments and agencies can request the assistance of EMBC GSAR volunteers for GSAR related activities under the conditions outlined in EMBC Policy 2.12 Search and Rescue[1].

2.3 SAR Manager

The SAR Manager is a volunteer within an EMBC recognized GSAR Group. This person holds a certificate from the Justice Institute of BC in SAR Management and is recognized by their local GSAR group to perform the SAR Manager role. While the requesting agency retains ultimate responsibility for the task, the SAR Manager(s) is given the authority by EMBC and the requesting

[1] https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response- recovery/embc/policies/212_search_and_rescue_policy_aug_2016.pdf

agency to functionally organize the response from start to finish. Their primary responsibility is to ensure that the task is carried out safely.

The SAR Manager is responsible for ensuring that the response is planned, organized and managed. They do this in consultation with the SAR Management Team and other agencies involved, and in conjunction with other SAR Managers.

Typical SAR Management activities include:

- Manage the functional aspects of the GSAR task
- Assign Incident Command System (ICS) functions
- Development of incident and operational period objectives
- Development of the Incident Action Plan (IAP)
- Work in conjunction with planning section to develop team assignments
- Determine Operational Periods
- Communicate to EMBC Emergency Coordination Center (ECC) regularly
- Update SAR Commander and brief Media & Family Liaison Officer
- Review team assignment, debriefings & modify overall objectives accordingly
- Adequately brief incoming SAR Management team at shift changes

2.4 Avalanche Safety Officer

The Avalanche Safety Officer (ASO) is a skilled and experienced command staff member responsible for the avalanche risk assessment and AOP associated with the response. ASO's frequently coordinate onsite operations as the rescue leader; however this function can be delegated by the ASO to an Avalanche Site Safety Officer. Whenever possible, the ASO should operate independently of any other duties.

ASO's have *Advanced* training (Table 1), and the preferred **minimum** standard for a volunteer ASO is a person who has Canadian Avalanche Association (CAA) Level 2 Avalanche Operations certification and maintains either an active membership with the CAA , Association of Canadian Mountain Guides (ACMG), or Canadian Ski Guides Association (CSGA). In areas of the province where no volunteers meet this standard, then an ASO may operate under a limited scope with *Intermediate* training (Table 1) where an Avalanche Canada Avalanche Skills Training (AST) 2 or equivalent is acceptable.

Common duties of the Avalanche Safety Officer include:

- Identification of avalanche hazard zones
- Conduct preliminary and detailed avalanche risk assessments
- Assess site specific safety and identify winter related hazards
- Contribute to the development of the Incident Action Plan (IAP)
- Lead the development and implementation of the AOP
- Monitor rescuers progress and level of exposure to hazards
- Change, postpone or terminate rescue or recovery activities that may pose imminent safety or health danger to the rescuers,
- Use authority to take appropriate action to mitigate or eliminate unsafe conditions, operations or hazards.
- Document safe and unsafe acts, corrective actions taken on scene, accidents or injuries, and ways to improve safety on future incidents.
- Investigate accidents that may have occurred within the incident area.
- Coordinate with various teams.

- Maintain an activity log.

Through agreements with both the Ministry of Transportation and Infrastructure (MOTI) and Parks Canada, EMBC can access *Avalanche Professionals* (Table 3) to assist in responding to avalanche incidents. MOTI and Parks Canada staff are primarily responsible for their own operations but may be able to assist in a GSAR response and/or recovery operation at the request of EMBC. EMBC also maintains a list of selected contractors and GSAR Volunteers that are Avalanche Professionals or meet the *Advanced* training standard.

2.5 Avalanche Site Safety Officer

An Avalanche Site Safety Officer (ASSO) is required for all avalanche incident responses and is located on-site as part of a Strike Team/Task Force. Often the ASO will fill this role, or they may delegate it to another volunteer. The ASSO is responsible for evaluating the risk of further avalanches, identifying hazards or unsafe situations, monitoring on-site rescue operations, conducting field assessments and implementing safety measures identified in the Operations Plan. The ASSO must at minimum have an *Intermediate* level of training (Table 1).

2.6 Organized Avalanche Rescue Team Leaders

The Organized Avalanche Rescue (OAR) Team Leader is responsible for organizing, leading, and supervising a Strike Team/Task Force during on-site operations. The OAR Team Leader qualifications (Table 3) are based on the conditions identified in the Preliminary Avalanche Risk Assessment.

2.7 Organized Avalanche Rescue Team Members

OAR Team members are trained in avalanche awareness, specialized search and/or rescue techniques, navigation and survival. They are able to participate as part of a multi-disciplinary task force operating in avalanche risk zones once they have obtained the required *Introductory* training (Table 1).

2.8 Avalanche Rescue Dog Team(s)

Avalanche Rescue Dog teams in British Columbia are either Registered EMBC volunteers and members of the Canadian Avalanche Rescue Dog Association (CARDA), or general duty police dog handlers with an avalanche validation by the RCMP or Parks Canada.

Avalanche dog teams are validated by the RCMP to the EMBC Avalanche Search and Rescue Dog Standard. These teams are capable of searching snow avalanches and winter mountain terrain with dogs, probes and avalanche transceivers. Dog handlers are assessed in ski mountaineering and winter mountain travel and as a minimum will hold a CAA Level 1. Where reasonably practical, it is EMBC policy to call upon the assistance of CARDA resources during operations in avalanche hazard areas; this is both for public and responders' safety.

Table 1. Avalanche training requirements[2]

Training Level	Required Courses
Introductory	- AST 1 or JIBC Avalanche Skills for SAR - JIBC OAR Team Member
Intermediate	- JIBC OAR Team Leader - AST 2 - CAA Avalanche Operations Level 1
Advanced	- CAA Avalanche Operations Level 2
Avalanche Professional	- Professional member of the CAA or Association of Canadian Mountain Guides (ACMG) or Canadian Ski Guides Association (CSGA) with CAA Avalanche Operations Level 2.

3 Communications Expectations

3.1 Onsite Operations

GSAR Command Staff are responsible for ensuring adequate communications with field teams. Typically, this is accomplished through VHF radio communications or satellite telephone communication devices. Check in procedures for field teams should include a well-being check every 30 minutes or as directed by the ASO.

3.2 Emergency Coordination Centre

The Emergency Coordination Centre (ECC) maintains a 365/24/7 operations centre to support search and rescue activities. SAR Managers are responsible to communicate with the ECC on a frequent basis:

- At the start and end of each operational period
- Two-hour updates for rescue activities
- Four-hour updates for search activities
- Any change to the search status of the subject(s) (located, deceased, etc.)

3.3 Avalanche Canada

Avalanche incident details should be submitted at the earliest opportunity to Avalanche Canada via their online reporting tool. www.avalanche.ca/mountain-information-network/submit

3.4 British Columbia Coroners Service

Avalanche-related information that is collected or observed in the field while conducting site safety assessments, or during other stages of body recovery operations, is of value to the BC Coroners Service and this information should be provided to the coroner as soon as it is practical. However, while the greatest amount of relevant avalanche-related detail is requested for the purpose of supporting the coronial investigation, the immediate safety of GSAR team members must always take precedence over data-collection and over any other tasks associated with the recovery of human remains.

[2] Table 1 and 2 are also provided in Appendix G for quick reference.

4 Operational Objectives and Safety Priorities

GSAR operations expose rescuers to different levels of risk depending on the nature of the activity and the conditions at the time of the response. The British Columbia Emergency Management System (BCEMS) establishes response objectives set out in priority as follows to:

- ensure the health and safety of all responders,
- save lives,
- reduce suffering,
- protect public health,
- protect infrastructure,
- protect property,
- protect the environment,
- reduce economic and social losses.

In British Columbia, BCEMS has been adapted from the Incident Command Systems and is utilized during incident response. ICS is a standardized incident management system, which provides a framework organized around major functional units. Components include common terminology, modular organization, integrated communications, unified command structure, incident action plan, manageable span of control, designated facilities and comprehensive resource management.

For search and rescue personnel working in the field, a GSAR Safety Maxim establishing the order of safety priorities has been created to aid in decision making:

- Self
- Team
- By-standers
- Subject

Levels of risk are controlled by both the diligence of program managers, who must attend to administrative details required by good risk management, and the knowledge, skills, and abilities of GSAR responders, who deliver the services in sometimes harsh environments and difficult circumstances.

5 Ground Search and Rescue Operational Phases

Ground Search and Rescue operational phases are characterized below and illustrated in Figure 1. This list specifies what type of activities are taking place and are not taking place during a specific phase of a GSAR response.

5.1 Advisory

The notice of an ongoing or impending incident that may require GSAR resources. This can be characterized as the early dialogue or information exchange pertaining to an incident before it is determined that a GSAR resource will be deployed. Advisories may be issued to GSAR resources for operations occurring adjacent to their response areas or to inform of potentially dangerous conditions which could increase the likelihood of a response (e.g.: flood, fire, weather, avalanche warnings or special advisories).

5.2 Deployment

The actual relocation of a GSAR resource to an incident site, staging area or other point of

departure. Deployment is the initiation of on-site SAR operations.

5.3 On-site Operations

The GSAR resources at the incident site and/or staging area are undertaking assignments. For GSAR Activities in avalanche risk zones the ASO is responsible for initiating on-site operations.

5.4 Demobilization

The notice of release of GSAR resources from assignments and preparation to return to the point of departure / point of origin.

5.5 Return to Readiness

The process to return GSAR resource to pre-advisory state of readiness. Personnel and equipment are ready for response to future incidents and includes a debriefing process.

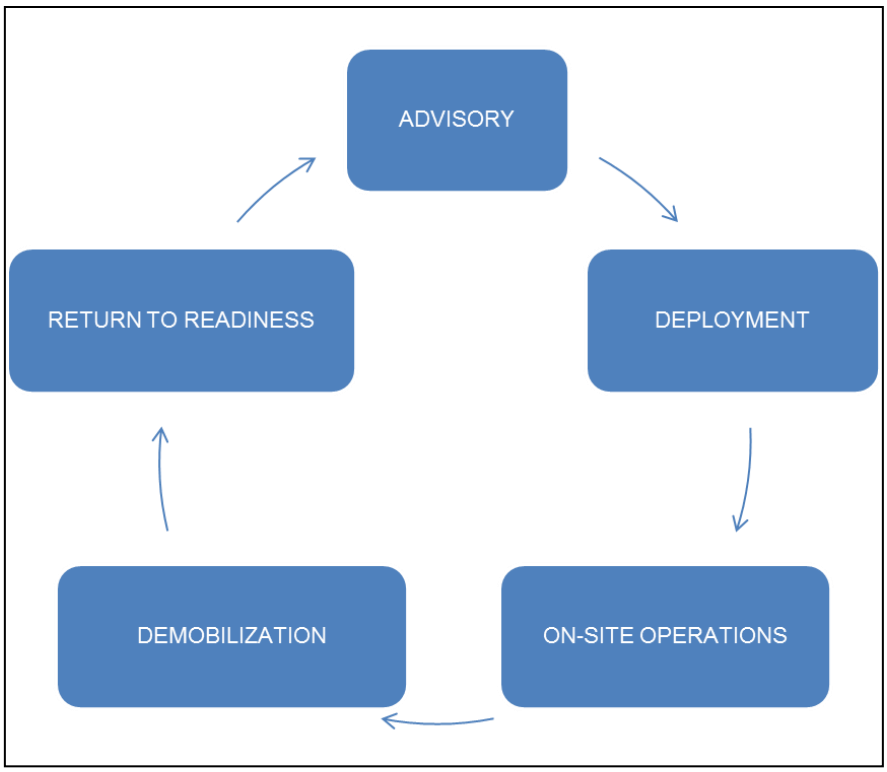


Figure 1. GSAR Operational Phases

6 The Avalanche Risk Assessment Process for GSAR Response

The process of risk assessment is a sequential examination of different factors which includes the use of the Response Assessment and Decision Making Support tool (RADeMS) that strives to determine the degree of risk, whether or not it's acceptable, and what mitigations are necessary to keep the risk within acceptable levels (Figure 2).

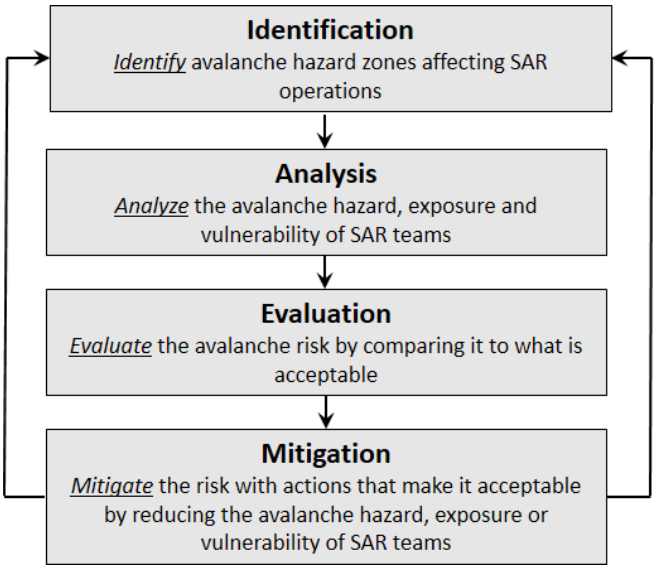


Figure 2. The universal risk management process after ISO 2018, CAA 2016).

Avalanche risk specifically is comprised of three main elements: Avalanche hazard (or danger), exposure and vulnerability (Figure 3). All three of these components integrate in different ways to produce different degrees of avalanche risk.

Figure 3. Avalanche risk triangle (adapted from: D. Crichton; Kron, 2003[3])

Avalanche hazard (or danger) is determined by a combination of the likelihood of avalanche(s) and their destructive size. These factors are driven by interactions between the terrain and the snowpack. The level of avalanche hazard can vary significantly over space and time depending on the location of the activities and the weather patterns each winter. When people or resources are not exposed to avalanche hazard, then there is no risk to them.

Exposure to avalanche hazard is measured in terms of time and space, as well as by the number of people and/or equipment exposed to the hazard. Exposure escalates as the number of people/equipment and the length of time spent in the hazard area increases. Stationary work in avalanche paths typically means personnel have a higher degree of exposure versus occasional travel through isolated avalanche paths.

Vulnerability is an expression of how susceptible something is to the consequences of an avalanche. Reduced vulnerability results in risk reduction for a given avalanche hazard. Vulnerability

[3] Kron, Wolfgang. (2003). Flood risk= hazard x exposure x vulnerability. Journal of Lake Sciences. 15. 185-204.

of people to avalanche hazards may also be reduced by using avalanche safety equipment such as transceivers and through avalanche awareness training. Vulnerability of personnel to avalanche hazard will vary depending on the mode of travel (Figure 4).

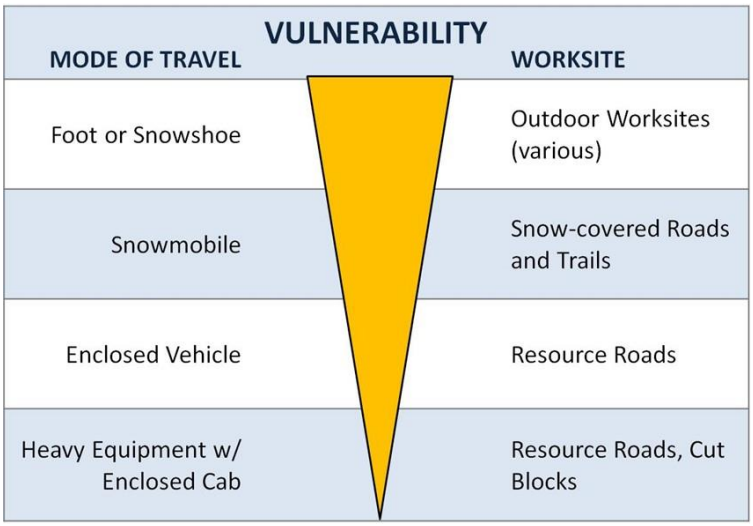


Figure 4: Vulnerability to avalanche hazard by mode of travel.

All GSAR operations occurring in areas with potential snow avalanche risk must follow the avalanche risk assessment process identified in Figure 5, which is structured around the following three broad stages:

- Initial avalanche risk identification
- Preliminary avalanche risk assessment
- Detailed avalanche risk assessment as part of the AOP.

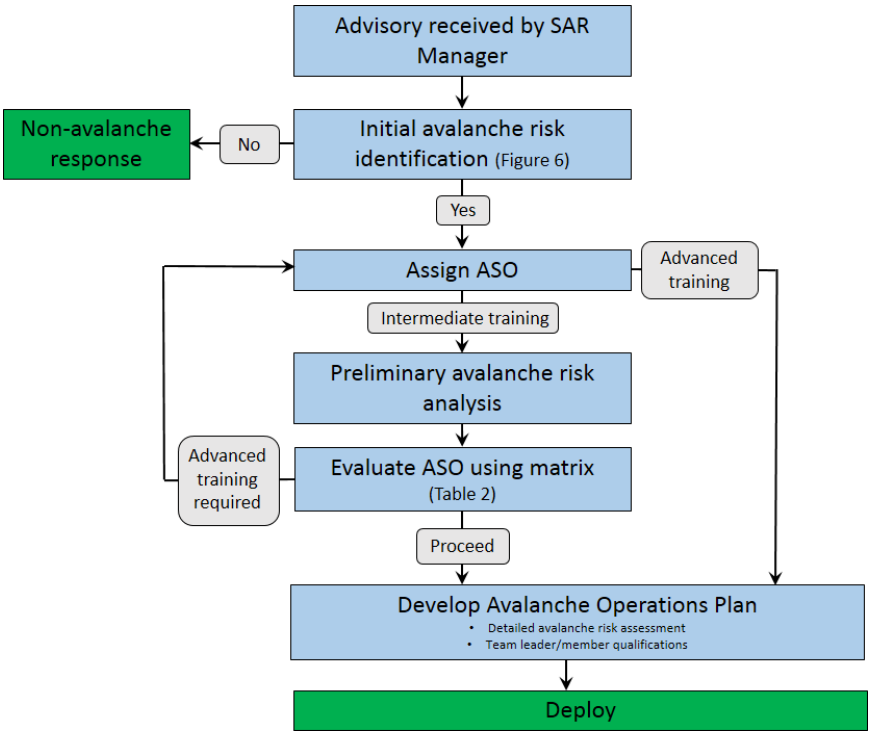


Figure 5. Overview of the GSAR Avalanche Risk Assessment process for GSAR response.

6.1 Initial Avalanche Risk Identification

When an Advisory is first received by the SAR Manager, they must make an important initial determination of whether or not the response involves avalanche risk. If the response does include exposure to avalanche risk, then the SAR Manager must appoint an ASO. SAR Managers may have varying levels of expertise with regards to making avalanche risk assessments, so Figure 6 provides a simple process to enable SAR Managers to make this early assessment.

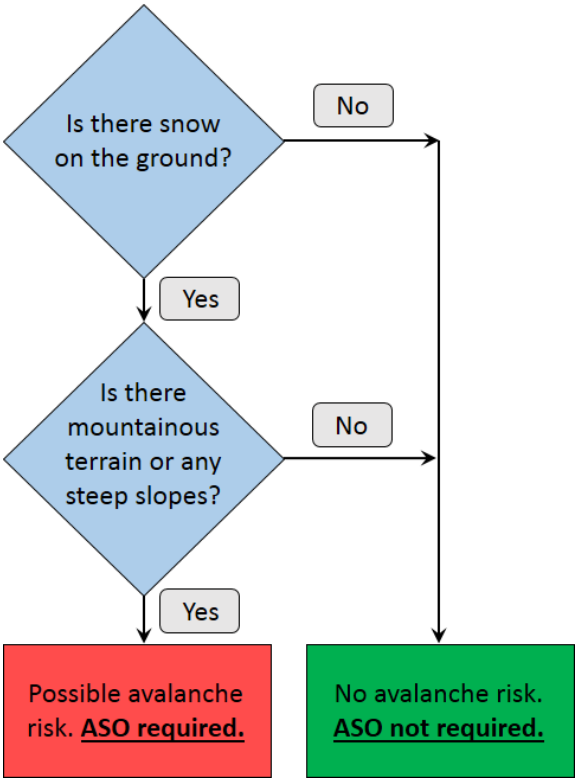


Figure 6. Initial avalanche risk identification process for SAR Managers.

6.2 Preliminary Avalanche Risk Assessment

When the presence of avalanche risk has been identified and an ASO has been assigned, their first task is to undertake a preliminary avalanche risk assessment. The purpose of this assessment is for the ASO to examine the snowpack conditions (danger rating) and the avalanche terrain severity (terrain rating) in the area of the incident and any approach/egress to the site. This is an assessment of regional trends in avalanche, weather and terrain conditions with the outcome being a general impression of the conditions and application of the ASO Matrix (Table 2). Typical information used in the preliminary assessment includes:

- Local knowledge of terrain use patterns and avalanche frequency
- RADeMS (Response Assessment and Decision Making tool
- Avalanche Canada Public Avalanche Danger Bulletin
- Avalanche Terrain Exposure Scale (ATES) classifications
- Maps - contour (1:50,000 or 1:20,000),
- Google Earth imagery, satellite imagery and oblique photos
- Canadian Avalanche Association InfoEx™ data and information4 The preliminary assessment requires the following outcomes:
  1) Determination of the ATES rating for the travel route, incident site and/or search area
  2) Determination of the Avalanche Danger Rating for the same area
  3) Application of the ASO matrix (Table 2) to determine the suitability of the ASO to develop the AOP.

[4] InfoEx is a proprietary application owned by the Canadian Avalanche Association and requires an Avalanche Professional with an InfoEx subscription.

6.2.1 Avalanche Terrain Exposure Scale Rating

The Avalanche Terrain Exposure Scale (ATES) rates the severity of the terrain according to how people are exposed to the avalanche hazard. Avalanche Canada has developed ATES ratings for many popular recreation areas in BC and these maps are available at www.avalanche.ca/planning/trip-planner. Many areas of the province do not have ATES ratings assigned, and in this case the ASO will be required to determine the rating. See Appendix B for a description of the ATES system.

The ASO will undertake a desktop ATES assessment using various tools which may include:

- Local knowledge
- Google Earth imagery
- Topographic maps
- Air photos
- Recreational Maps
- Online ATES Ratings

6.2.2 Avalanche Danger Rating

The Avalanche Danger Scale is a 5-level rating system that ranks the severity of the avalanche hazard on a scale from *Low* to *Extreme*. The system considers the likelihood, size and distribution of potential avalanches. From November to April, avalanche danger ratings for much of the mountainous areas of BC can be obtained from Avalanche Canada's website at www.avalanche.ca and these are updated daily between 4 pm and 6 pm. However, there are areas of BC where public avalanche bulletins are not available, thus no danger rating.

When planning GSAR activities in areas with no public avalanche bulletin, the ASO should consider using Avalanche Canada's *Dangerator* tool (Figure 7) to estimate a local danger rating.

Alternatively, an Avalanche Professional can be consulted to provide a site-specific avalanche danger rating and travel advisory for specific trips and areas. A site specific danger rating provided by an Avalanche Professional can and should override a regional avalanche danger rating given the localized focus of the assessment versus a much broader, geographical regional danger rating.

Public bulletins provide danger ratings for three elevation bands (alpine, treeline, below treeline). ASO's must consider which elevation band responders will be operating in along the travel route, incident site and/or search area and apply the danger rating from that elevation band. In the case of large avalanche paths that cross several elevation bands, choose the highest danger rating.

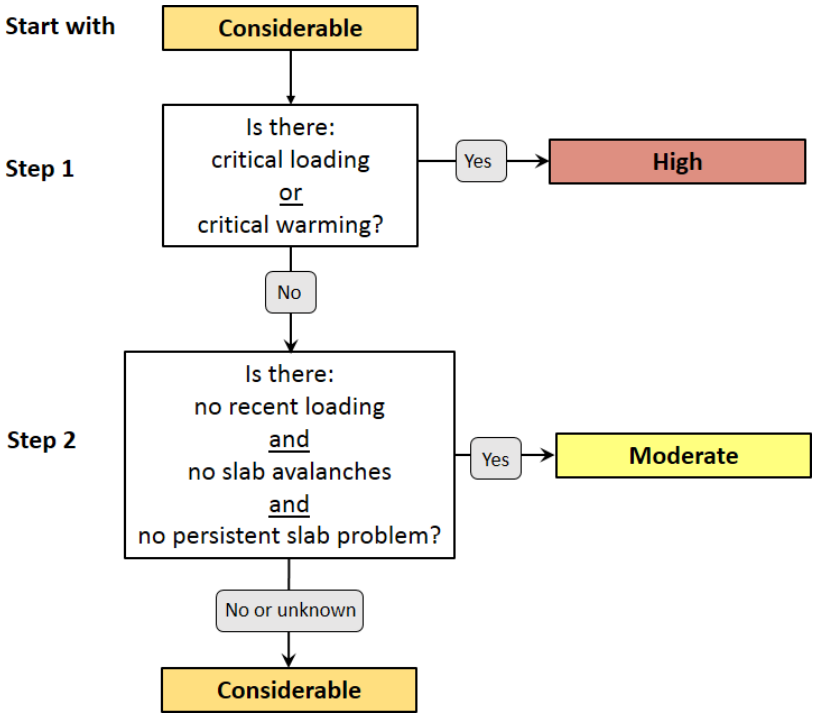


Figure 7. The Dangerator is a simplified method for determining an avalanche danger rating.

6.2.3 Apply the ASO Matrix

The ASO Matrix (Table 2) is used to ensure the person developing the AOP is properly qualified to do so and should be applied no earlier than the night before a planned deployment. Based on a combination of avalanche danger and terrain rating, the matrix sets limits and requires more (or less) qualifications depending on the conditions at the travel route, incident site and/or search area. See Table 1 for definitions of training levels.

If the ASO does not have *Advanced* training, then the matrix may require them to source another ASO with higher qualifications. If they do have *Advanced* training, then they can skip the ASO matrix and begin to develop the AOP.

Table 2. **Avalanche Safety Officer (ASO) matrix**[5]. Training levels required to develop an Avalanche Operations Plan (AOP) in avalanche terrain.

		Maximum ATES Rating			
		Simple	**Challenging**	**Complex**	**No Data**
Avalanche Danger Rating	**5. Extreme**	Advanced	Advanced	Advanced	Advanced
	4. High	Advanced	Advanced	Advanced	Advanced
	3. Considerable	Advanced	Advanced	Advanced	Advanced
	2. Moderate	Intermediate	Advanced	Advanced	Advanced
	1. Low	Intermediate	Intermediate	Advanced	Advanced
	Unknown or Not Available*	Advanced	Advanced	Advanced	Advanced

* Consult an Avalanche Professional or use the Dangerator to determine the rating (see Figure 7)

6.3 Avalanche Operations Plan

An Avalanche Operations Plan must be implemented when the outcome of a preliminary avalanche risk assessment identifies a potential avalanche risk to the operation. The Avalanche Safety Officer is responsible for developing and implementing the AOP, which must include a detailed (site-specific) avalanche risk assessment and all safety measures required to mitigate avalanche risk to the operation.

Where GSAR personnel are interacting with an established operation that has their own *Active Avalanche Safety Program* (e.g.: local ski resort, backcountry or industrial operation), the avalanche workers associated with that program can provide valuable information on local conditions and advice towards the AOP. When practical, any local avalanche professionals should be encouraged to participate in GSAR operations and contribute to the development of the AOP.

[5] Table 1 and 2 are also provided in Appendix G for quick reference.

When an AOP is established, a copy of the plan must be readily available to each person who administers (EMBC) or implements (volunteers and other GSAR responders) the operation. To assist in the documentation of the AOP, EMBC has created the Avalanche Operations Plan form[6] (Appendix D).

The AOP must be reviewed and updated at the following intervals to ensure it remains relevant for the conditions and activities:

1) When there is a significant change to the weather or avalanche conditions
2) When there is a significant change to the operational objectives
3) When there is a change of Avalanche Safety Officers
4) At the end of each operational period.

6.4 Detailed Avalanche Risk Assessment

A detailed avalanche risk assessment must be completed by the ASO as part of the development of the AOP. Detailed avalanche risk assessments are comprehensive risk assessments, initially done as desktop exercises which are then carried through to real-time, ongoing field-based assessments. Not all avalanche areas may be identified initially through this process (e.g. micro terrain features are hard to identify on a desktop analysis), but the assessment proceeds in stages and is revised as new information become available. Figure 8 shows the four fundamental components of an avalanche risk assessment described in the sections following.

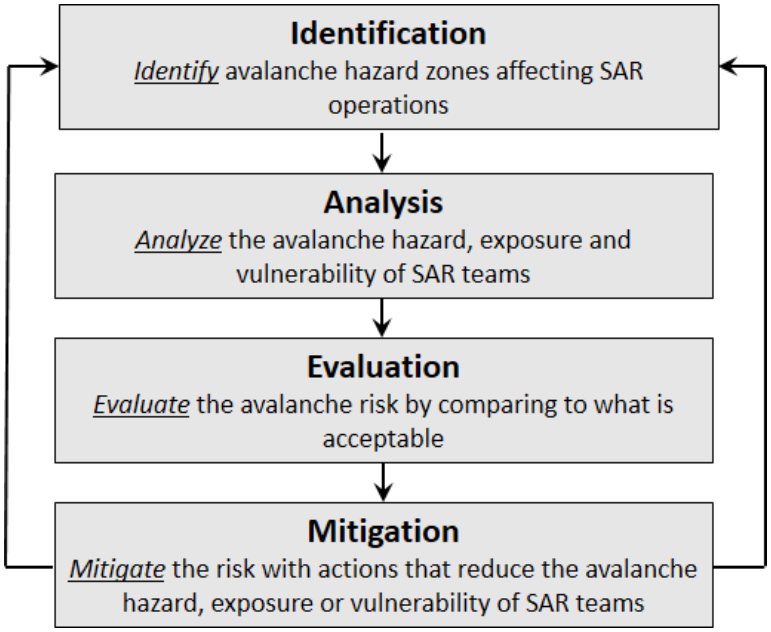


Figure 8. The components and processes of avalanche risk assessment (after ISO 31000, CAA 2016).

6.4.1 Identification of Avalanche Hazard Zones

The first and most important step in an avalanche risk assessment is the identification of avalanche hazard zones that affect the GSAR operation. These can be large, obvious avalanche paths that cut

[6] Appendix D

a swath through the forest, or they can be small, short slopes that are difficult to identify from a desktop study. The objective is to identify as much of the potential avalanche terrain ahead of time as possible, mark it on a topographical map and provide a naming reference for each zone.

Well-defined avalanche paths can be marked on a map with an arrow showing the direction of flow, and zones are marked using polygons to highlight the avalanche area. Labels should be provided to identify each area. Field teams should consider the use of flagging tape or other means of to identify major avalanche paths in the field.

6.4.2 Analysis of Avalanche Risk

After identifying avalanche zones that effect the operation, the next step is to analyse all of the available weather, snowpack, terrain, and avalanche data in order to determine the risk.

Avalanche risk is dynamic and can change quickly, which requires the ASO to maintain an ongoing, real-time evaluation of the many variables that contribute to the risk. Hazard and risk evaluation worksheets are a useful way of organizing the different factors, some of which include:

- Terrain characteristics (elevation, aspect, slope angle, shape, forest, etc.)
- Snowpack structure (weak layers, slab properties, wind effect, etc.)
- Current and forecast weather (precipitation, temperature, wind)
- Avalanche activity
- Avalanche hazard assessment (likelihood and size of expected avalanches)
- Proposed activities
- Exposure of the responders (group size, route, time)
- Vulnerability of the responders (training, experience, equipment, etc.)
- Forecast of avalanche hazard trends through the operational period

Avalanche decision aids such as Avalanche Canada's Avaluator v2.0™ (Appendix E) or *The Dangerator* (Figure 7) can help to structure decision making by offering simplified ways to analyse and evaluate complex factors.

6.4.3 Evaluation of Avalanche Risk

Decisions regarding whether or not the risk is acceptable are made by comparing the analyzed risk level against a benchmark of what is considered acceptable. Sometimes this can be straightforward, as illustrated in Tables 2 and 3, where established benchmarks for risk evaluation are clear. However, this is often not clear, because established benchmarks do not exist for many decisions and thus the benchmark relies on the subjective judgement of the ASO and the GSAR team.

The risk of avalanches to personnel should be reduced as much as reasonably practicable. This could mean that the GSAR deployment must wait until conditions improve, or until an alternative risk reduction measure is achieved. Do not hesitate to stop or change an operation due to excessive risk to the GSAR team. Some basic guidelines are:

1) No unnecessary risk should ever be taken
2) Risk decisions must be made at the appropriate level of command
3) Risk is acceptable if the potential benefits outweigh potential costs
4) Integrate risk management into planning, preparation, and execution at all levels.

6.4.4 Mitigation of Avalanche Risk

A complete avalanche risk assessment will identify specific tactics used to reduce the risk down to an acceptable level. Each tactic should provide a reduction in either avalanche hazard, exposure and/or vulnerability of the rescue team. These tactics should be specified in the AOP and all GSAR team members must be aware of them. Some examples of mitigation tactics are:

- Reducing exposure
- Avalanche hazard zone identification and avoidance
- Implementation of terrain limitations for personnel
- Safe travel techniques such as one-at-a-time or spacing out
- Alternative travel techniques such as helicopter vs. snowcat vs. snowmobile vs. foot
- Searching from the air versus searching on the ground
- Avalanche rescue dogs Reducing vulnerability
- Experience, training and qualification of field team members
- Mandatory Personal Protective Equipment (PPE) such as transceiver, shovel and probe
- Recommended PPE avalanche flotation devices
- Personal equipment (GSAR pack, good clothing, helmet, etc.)
- Good communication and awareness by all team members Reducing hazard
- Waiting until the weather and avalanche conditions improve
- Avalanche control with explosives

7 Avalanche Risk Management Guidelines

Evaluating the potential consequences of anticipated avalanche activity in specific situations is critical to determining the avalanche risk. Correctly making such an evaluation relies on training, the knowledge, and above all, the expert judgement of the ASO. Avalanche risk management guidelines frequently go beyond “rules based” safety program objectives commonly applied in industrial risk management programs and move into the realm of expert judgement based decisions.

Avalanche risk management involves a complex process of hazard analysis that ultimately leads to a decision to:

1) Identify avalanche hazard zones
2) Classify avalanche terrain exposure using ATES
3) Assess weather, snowpack and avalanche information
4) Determine the avalanche danger rating
5) Establish, implement and maintain specific operational procedures and safety measures to reduce the risk as part of the Incident Action Plan (IAP).
6) Provide recommendations to the SAR Management Team to commence or cease GSAR operations; and
7) Provide recommendations to the SAR Management Team to implement additional mitigation measures (e.g.: explosives) to reduce avalanche risk.

ASO’s should not hesitate to make recommendations to the SAR Management Team when they believe on-site ground SAR activities should be suspended due to the level and/or nature of the avalanche risk and/or availability of suitably trained personnel.

SAR Commanders, EMBC Regional Managers, and EMBC GSAR responders are collectively responsible for ensuring that response activities are planned and conducted according to provincial and federal standards, industry practices and procedures that meet all regulatory requirements, where reasonably practicable.

8 GSAR Field Team Leaders

Training and experience are critical elements for reducing vulnerability and increasing margins of safety for GSAR field teams deployed in avalanche terrain. This ASP utilizes a field team leader qualifications matrix (Table 3) to identify the minimum level of training and experience that GSAR winter team leaders must have based upon a combination of the avalanche danger rating and avalanche terrain rating (ATES) for the area that will be accessed.

Table 3. GSAR Winter Team Leader qualifications for operating in avalanche terrain.
See Tables 1 and 4 for definitions of training levels and experience.

		Avalanche Terrain Exposure Scale Rating		
		Simple	**Challenging**	**Complex**
Avalanche Danger Rating	**Extreme**	Advanced	Advanced	Advanced
	High	Intermediate	Advanced	Advanced
	Considerable	Intermediate	Intermediate *plus* experience	Advanced
	Moderate	Introductory	Intermediate	Advanced
	Low	Introductory	Introductory *plus* experience	Intermediate *plus* experience
	Unknown or not available	Intermediate	Intermediate *plus* experience	Advanced

Notes:
1. Avalanche danger can be obtained at www.avalanche.ca or from an Avalanche Professional. Ensure the avalanche danger from the appropriate elevation band is applied.
2. Avalanche Terrain Exposure Scale (ATES) ratings can be obtained at www.avalanche.ca/planning/trip-planner, from the land manager or from an Avalanche Professional. An ASO may determine the ATES rating if they have *Intermediate* training plus experience (Appendix B).
3. Unknown or not available **–** Consult an Avalanche Professional or use the Dangerator (Figure 7).
4. At the discretion of the ASO (Advanced), a lower level of training may be applicable for a HEC pickoff rescue which involves nil-minimal ground travel and minimal time exposure to facilitate the rescue.

Experience with travel in avalanche terrain plays a key component in reducing avalanche risk. A responder's experience is defined as "where avalanche safety knowledge and skills have been used to travel safely through mountainous terrain in winter" (see Table 4).

Table 4. Guideline for what constitutes experience with avalanche risk:

Examples of Experience in Avalanche Terrain
1) Active winter recreationist (backcountry skier, climber or snowmobiler) with ≥ 5 days in each of previous 5 winters travelling through avalanche terrain; or,
2) Active occupational work experience (using backcountry skis, snowmobiles, or helicopters) with ≥ 5 days in each of the previous 5 winters travelling through avalanche terrain; or,
3) Active Organized Avalanche Response (OAR) team member with local volunteer search and rescue organization that undertakes rescues in avalanche terrain.

In addition to the minimum training and experience requirements the *Avaluator 2.0 Slope Evaluation* card (refer to Appendix E) must be used for all unguided travel in avalanche terrain. If glacier travel is required, all party members must be trained in glacier travel and crevasse rescue.

Increasingly stringent safety measures are applied as the avalanche danger and terrain complexity increases. When avalanche risk levels are close to the threshold of what is acceptable, field team leaders should recommend to the SAR Management Team that on-site ground-based GSAR operations be discontinued until conditions improve, avalanche risk is mitigated and/or suitably trained personnel are available to respond.

Ultimately, field team leaders are responsible to manage a sometimes high degree of uncertainty associated with avalanche risk management in the field. Avalanche risk assessments are often imprecise, and field team safety relies most heavily on risk identification and avoidance whenever possible.

8.1 Field Team Equipment

As a minimum, the following safety equipment is required in each field team that will travel as a self-contained unit in avalanche terrain:

- First aid kit
- Communication equipment. All field teams must have at least one means of contacting outside assistance. A second system is recommended to provide redundancy where available. Some options include:
    1) Cell phones
    2) Radios
    3) Satellite Phones
    4) Satellite Messengers
- Appropriate navigational equipment (GPS, compass, maps, etc.)
- Other equipment and preparations as expected by applicable field protocols

As a minimum, each team member is required to carry the following equipment:

- Avalanche Shovel
- Avalanche Transceiver (457 kHz standard, modern multi-antennae digital transceivers

recommended)
- Avalanche Probe
- Appropriate clothing that provides protection from sun, wind, rain, and snow.
- Protective eyewear (sunglasses or goggles) appropriate to the conditions.
- Sufficient food and water for trip and a short-term emergency situation.

Depending on the duration, location and circumstances of the trip, overnight survival equipment (e.g. sleeping bag, stove, etc.) may also need to be carried by the group.

Essential safety equipment must be routinely inspected to ensure it is in good working order and meets any appropriate manufacturer's specifications.

If essential equipment is subjected to conditions or handling that may have caused damage (e.g. if a transceiver or radio is dropped on a hard surface), it must be immediately checked for appropriate function prior to putting it back into service. If there is any question as to the item's reliability do not risk using it in the field.

8.2 Field Procedures

For Field Teams not in an enclosed vehicle: each team of 5 or fewer GSAR personnel will be accompanied by a person with the training and experience required for a team leader associated with that terrain classification and the current avalanche danger rating (see Table X). As a standard practice, a minimum of two responders should travel together when in at-risk avalanche terrain. Should any member of the field team be uncomfortable with proceeding at any point during the trip or planning, the remaining members will respect the concern and alter the plan until consensus can be achieved.

8.3 Safe Travel Measures

Avalanche risk assessments must be conducted in the field on an on-going basis.

1) Evaluate terrain
   - Open slopes, sparsely treed slopes, wide-spaced glades, cut blocks >60% incline
   - Slope shapes: convex, unsupported
   - Existing avalanche paths above, at or below work site
   - Terrain traps (gullies, depressions, trees, cliffs, road beds)

2) Avoid exposure by not stopping or parking in avalanche paths (start zones, tracks, run out zones) or below steep open slopes, including large steep road cuts or terrain traps

3) Assess avalanche activity
   - Fracture lines, avalanche debris: how recent? Size, type, trigger?
   - Dig test snow profiles to monitor conditions when the hazard is increasing

4) Evaluate unstable snowpack conditions
   - Whumphing sounds or shooting cracks at the snow surface while travelling
   - Signs of significant weak layers buried in the snowpack (dig test snow profiles)

5) Monitor weather conditions for critical signs of deteriorating conditions:
   - Precipitation: type/rate (snowfall >2 cm/hour)
   - Winds: speed/direction (>25 km/hour)

- Temperatures: critical warming with recent rapid rise in temperatures (to near 0 deg. C, rain- on-snow)
- Melting snow at the surface on solar aspects due to significant sun effect

6) Maintain appropriate communication when crossing or working in avalanche terrain

7) Maintain overall decision-making and risk management of the field crew

On-going avalanche hazard assessments may be supplemented by more specific assessments of potential avalanche hazards by using the **Avaluator Slope Evaluation Tool-V.2.0** (Refer to Appendix E). This tool is designed to be used while in the field to help with continual on-site assessment of local conditions and terrain – before committing to avalanche terrain.

It is important to be aware that ***small slopes can be equally as dangerous as large slopes***. Teams should be aware that short, steep slopes within open areas and road cuts present avalanche hazards that could be easily overlooked. The terrain features may not be identifiable during the risk assessment prior to going in the field. Field teams must be aware of the hazards these terrain features present and be diligent in avoiding exposure.

If the on-going avalanche risk assessments indicate that the risk may be greater than originally thought, or that the terrain is more serious than originally expected, the operation should be temporarily suspended and re-evaluated.

9 Avalanche Safety Plan Review

It is the commitment of EMBC to ensure that the PSL Avalanche Safety Plan is reviewed as the need arises (e.g. due to changes in avalanche industry best practice, GSAR members feedback, post GSAR response operational reviews).

EMBC will commit to a full review of this ASP as a minimum once every three years.

Appendix A – Avalanche Characteristics

Avalanche Types

A snow avalanche consists of a volume of snow that moves downslope under the effect of gravity. Avalanches also may contain rock, broken trees, soil or ice in addition to snow. There are two general types of snow avalanches:

1) Slab avalanche – involves a cohesive layer of snow that "breaks" away from the underlying snow surface in the starting zone. Slab avalanche initiation results in a distinct fracture line in the starting zone; and

2) Loose snow avalanche – involves the release of surface snow with little or no cohesion. As this volume of snow begins to accelerate, it may entrain significant amounts of surface snow as it travels down slope. This is often the case with wet, loose snow avalanches descending in snow covered gullies.

Loose snow avalanches are typically smaller and less destructive than slab avalanches, although wet loose snow avalanches can be large or small. Slab avalanches are typically more dangerous and result in the largest and furthest running avalanche events.

Avalanches may occur at any time during the year where snow is present on steep terrain. They can be characterized as either dry or wet, depending on the water content of the snow.

However, avalanches that begin at higher elevations in dry snow may become wet or moist while they flow to lower elevations. Wet avalanches tend to move slower and are more likely than dry avalanches to be deflected by terrain features and often follow narrow creek gullies in forested terrain without a large visible path. Large, dry avalanches are likely to travel faster, deviate from traditional paths, and overrun terrain features. Because of their higher speed, dry avalanches are often used as the design avalanche event for planning and engineering purposes.

Large, dry avalanches that do not become wet or moist typically have two distinct layers: a dense core that flows along the ground or snow surface, and a low density (powder) layer that flows above and sometimes ahead of the denser layer. On occasion these two layers may separate and flow independently. The dense core typically has a flow depth of 1-3 m while the powder component may reach heights of tens of metres. Avalanches may reach speeds of up to 60 m/s (200 km/h). The dense core of an avalanche has a much higher impact pressure than the lower density powder component.

Avalanche Path

An avalanche path consists of three parts:

1) *Starting zone*: where an avalanche begins and accelerates. The starting zone is typically steeper than 58% (30°), but lower frequency avalanches may start on slopes between 47% and 58% (25°- 30°). The lower limit of incline in rare cases is < 47% (25°) for drysnow (McClung and Schaerer, 2006[7]). This lower limit can be further reduced in wet snow as liquid water content rises.

[7] McClung, D.M. and P.A. Schaerer, 2006. The Avalanche Handbook (Seattle: The Mountaineers).

2) *Track*: where an avalanche runs. The terrain located between the starting zone and the runout zone. Tracks are broadly characterized as *open slopes* or *channels* (gullies) and have slope angles typically between 27% and 58% (15°- 30°).

3) *Runout zone*: is the area located below the track where avalanches decelerate and come to a stop. Slope angles of runout zones are typically less than 27% (15°) for large avalanches. Small avalanches can decelerate and stop on slopes as steep as 45% (24°). Large avalanches may runout on gentle or flat terrain for long distances.

Within a larger avalanche path, smaller avalanches may start and stop at various places. Short, steep, open slopes or cliff areas will often produce small avalanches without the distinct characteristics of a starting zone, track and runout.

Avalanche Magnitude and Frequency

The magnitude and frequency of avalanches depends on snow supply and terrain**.** Snow supply is determined by the frequency of snowfalls, amount of snow that falls, and how the wind transports snow into avalanche starting zones. The slope incline, aspect, size and configuration of avalanche paths are terrain characteristics that affect the frequency and magnitude of an avalanche path. Snowpack structure can also affect magnitude. For example, a deeply buried weakness in the snowpack can result in large avalanches.

Avalanche frequency estimates are described in terms of an avalanche return period that ranges from one year (high frequency) to 100 years (low frequency) (Table 1). Annual probability of the avalanche is the reciprocal of the return period (the annual probability of a 100- year return period is 0.01).

Table 5. Avalanche Frequency[8]

Average Return Period (events/year)	Frequency Range (events/year)	Frequency Descriptor	Comments
1:1	>1:1 to 1:3	High	Routine interruption of winter operations where observed
1:10	1:3 to 1:20	Moderate	Active in major storm events or widespread avalanche cycles
1:30	1:20 to 1:50	Low	Long return period avalanches
1:100	1:50 to 1:300	Very Low	Very long return period avalanches

Avalanche magnitude is often related to frequency. In general, large destructive avalanches occur less frequently within an avalanche path, while smaller ones occur more frequently.

Likewise, frequency is related to a specific location within the avalanche path. Avalanche frequency decreases with distance travelled from the starting zone down the avalanche path.

Magnitude estimates are described in terms of the Canadian Avalanche Size Classification, which is based on destructive potential or consequence (Table 2). Scaling parameters of typical mass, path length and impact pressure are also included.

[8] Table 5 and 6 are also provided in Appendix F for quick reference

Table 6. Canadian Avalanche Size Classification[9] (McClung and Schaerer, 2006[10])

Size	Description (Destructive Potential)	Typical mass (t)	Typical path length (m)	Typical impact pressure (kPa)
1	Relatively harmless to people.	<10	10	1
2	Could bury, injure or kill a person.	10^2	100	10
3	Could bury a car, destroy a small building*, or break a few trees.	10^3	1000	100
4	Could destroy a railway car, large truck, several buildings or forest with an area up to 4 hectares (ha).	10^4	2000	500
5	Largest snow avalanches known; could destroy a village or forest up to 40 ha.	10^5	3000	1000

*e.g. a wood frame house

Uncertainty

Avalanches are complex natural phenomena and, as such, unexpected events will occur over time. Under extremely unstable snow conditions, avalanches may be observed in terrain where they would otherwise not occur, such as forested areas or low-angle open slopes. New avalanche paths may also be formed by removal of forest cover from forest harvesting or wildfire, or from slope-mass movement processes such as landslides, rockfall or debris flows.

[9] Table 5 and 6 are also provided in Appendix F for quick reference
[10] McClung, D.M. and P.A. Schaerer, 2006. The Avalanche Handbook (Seattle: The Mountaineers).

Appendix B – Avalanche Terrain Exposure Scale

The Avalanche Terrain Exposure Scale (ATES) (Parks Canada, 2004), identifies three different classes to describe the exposure to avalanche hazard: SIMPLE, CHALLENGING and COMPLEX. The table below describes the basic characteristics of the three different classes. This avalanche classification system is based on terrain analysis, not snowpack analysis. The technical model below has been designed for users trained and skilled in the subtle nuances of avalanche terrain. The ATES can be applied at whatever scale is appropriate.

Description	Class	Terrain Criteria
	1	Exposure to low angle or primarily forested terrain. Some forest openings may involve the run-out zones of infrequent avalanches. Many options to reduce or eliminate exposure. No glacier travel. (Photo: Grant Statham)
	2	Exposure to well defined avalanche paths, starting zones or terrain traps; options exist to reduce or eliminate exposure with careful route finding. Glacier travel is straightforward, but crevasse hazard may exist. (Photo: Grant Statham)
	3	Exposure to multiple overlapping avalanche paths or large expanses of steep, open terrain; multiple avalanche starting zones or terrain traps below; minimal options to reduce exposure. Complicated glacier travel with extensive crevasse bands or icefalls. (Photo: Bill Mark)

“Any given piece of mountain terrain may have elements that will fit into multiple classes. Applying a terrain exposure rating involves considering all of the variables described above, with some default priorities.” (Parks Canada, 2004)

Appendix C - Avalanche Terrain Exposure Scale, Technical Model

Technical Model (v.1-04)			
	1 - Simple	**2 - Challenging**	**3 - Complex**
Slope angle	Angles generally < 30º	***Mostly low angle, isolated slopes >35º***	***Variable with large % >35º***
Slope shape	Uniform	Some convexities	Convoluted
Forest density	Primarily treed with some forest openings	Mixed trees and open terrain	Large expanses of open terrain. Isolated tree bands
Terrain traps	Minimal, some creek slopes or cutbanks	Some depressions, gullies and/or overhead avalanche terrain	***Many depressions, gullies, cliffs, hidden slopes above gullies, cornices***
Avalanche frequency (events:years)	1:30 ≥ size 2	1:1 for < size 2 ***1:3 for ≥ size 2***	1:1 < size 3 ***1:1 ≥ size 3***
Start zone density	Limited open terrain	Some open terrain. Isolated avalanche paths leading to valley bottom	Large expanses of open terrain. Multiple avalanche paths leading to valley bottom
Runout zone characteristics	Solitary, well defined areas, smooth transitions, spread deposits	Abrupt transitions or depressions with deep deposits	Multiple converging runout zones, confined deposition area, steep tracks overhead
Interaction with avalanche paths	Runout zones only	Single path or paths with separation	***Numerous and overlapping paths***
Route options	Numerous, terrain allows multiple choices	A selection of choices of varying exposure, options to avoid avalanche paths	***Limited chances to reduce exposure, avoidance not possible***
Exposure time	None, or limited exposure crossing runouts only	***Isolated exposure to start zones and tracks***	***Frequent exposure to start zones and tracks***
Glaciation	None	***Generally smooth with isolated bands of crevasses***	***Broken or steep sections of crevasses, icefalls or serac exposure***

Terrain that qualifies under an **italicized** descriptor automatically defaults into that or a higher terrain class. Non-italicized descriptors carry less weight and will not trigger a default but must be considered in combination with the other factors.

“Credible local professional advice may be an adequate replacement for published terrain rating and avalanche bulletins.” (Haegeli, 2010)

Appendix D –Avalanche Operations Plan

Emergency ManagementBC

AVALANCHE OPERATIONS PLAN

Task #:	Task Name:	For Op Period #:	Avalanche Safety Officer:

Date:	Time:	Valid Until Date:	Valid Until Time:	Prepared By:

Location:	Description:

Access/Egress:

Operational Objectives:

WEATHER STATION OBSERVATIONS

Weather Site	Elevation	Time	Sky Cover	Precip. Type & Intensity	Temperature			Snowfall					Rain/Precip Gauge (mm) & Time Period	Wind Speed and Direction	Barometric Pressure and Trend
					Present	Max	Min	H20 (cm)	HN24 (cm)	HST (cm)	Date Reset (HST)	HS (cm)			

FIELD WEATHER OBSERVATIONS

Field Weather Location	Elevation	Date	Time	Sky Cover	Precip. Type & Intensity	Air Temperature	Snowfall					Wind Speed & Direction	Additional Observations
							HN (cm)	HN Time Period	HST (cm)	HST Time Period	HS (cm)		

WEATHER FORECAST

Emergency ManagementBC

AVALANCHE OPERATIONS PLAN

NEAREST NEIGHBOUR INPUT/INFOEX

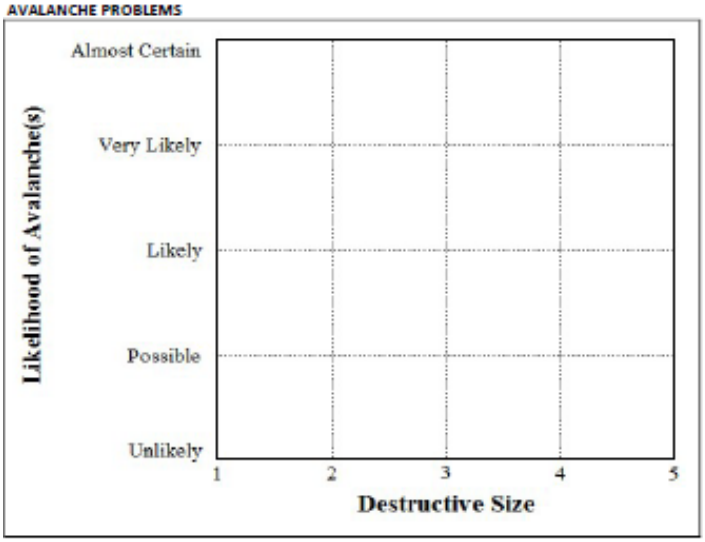
AVALANCHE ACTIVITY

SNOWPACK

AVALANCHE PROBLEMS

Layer Name	Avalanche Type	Description	Layer Depth (cm)	Sensitivity to Triggers	Size		Aspect (clockwise)		Elevation		Spatial Distribution
					From	To	From	To	From	To	

AVALANCHE PROBLEMS



AVALANCHE HAZARD DISCUSSION

Emergency ManagementBC

AVALANCHE OPERATIONS PLAN

AVALANCHE HAZARD RATINGS

	Location(s) / Elevation Band(s)	Avalanche Hazard Rating	Comments and Restrictions
1		☐ Low ☐ Moderate ☐ Considerable ☐ High/Extreme or Unknown	
2		☐ Low ☐ Moderate ☐ Considerable ☐ High/Extreme or Unknown	
3		☐ Low ☐ Moderate ☐ Considerable ☐ High/Extreme or Unknown	

AVALANCHE TERRAIN EXPOSURE SCALE CLASSIFICATION:

☐ Simple ☐ Challenging ☐ Complex ☐ Unknown

AVALANCHE INCIDENT DETAILS:

Avalanche Incident Involment Form Attached? ☐ Yes ☐ No

TERRAIN USE AND RESTRICTIONS (i.e. critical locations, locations of concern, closed areas, safe locations, access/egress, etc.)

AVALANCHE SAFETY MEASURES

AVALANCHE TECHNICIAN OBJECTIVES

AVALANCHE DANGER IDENTIFICATION / MITIGATION AND RISK CONTROL CHECKLISTS

REFERENCE DESCRIPTION

- ☐ PUBLIC AVALANCHE BULLETIN
- ☐ WEATHER FORECAST
- ☐ AVALANCHE PATH SUMMARY
- ☐ DANGERATOR

SUPPLEMENTARY REFERENCES

- ☐ AVALANCHE ATLAS's
- ☐ LOCAL AVALANCHE PROFESSIONAL
  - Name: _____
  - Name: _____

ASSIGNMENT CHECKLIST

- ☐ TEAM ASSIGNMENT
- ☐ TEAM ASSIGNMENT BRIEFING

SAFETY MEASURES

- ☐ Personal Protective Equipment (Transceiver, Shovel, Probe)
- ☐ Explosive Strike Team
- ☐ Helicopter Based Signal Search - Barryvox External Transceiver
- ☐ Helicopter Based Rescue Effort - Class D Fixed Line Helicopter Support
- ☐ Rapid Intervention Team
- ☐ _____

Page 3 of 3

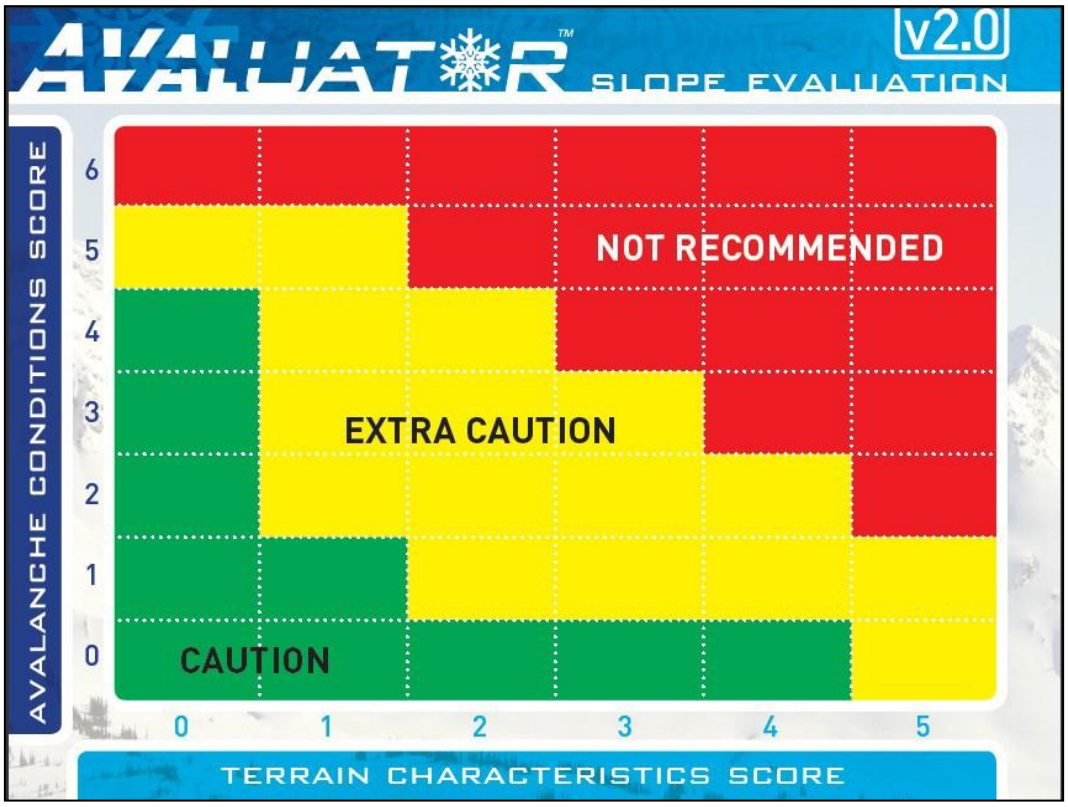
Appendix E – Avaluator 2.0 Slope Evaluation

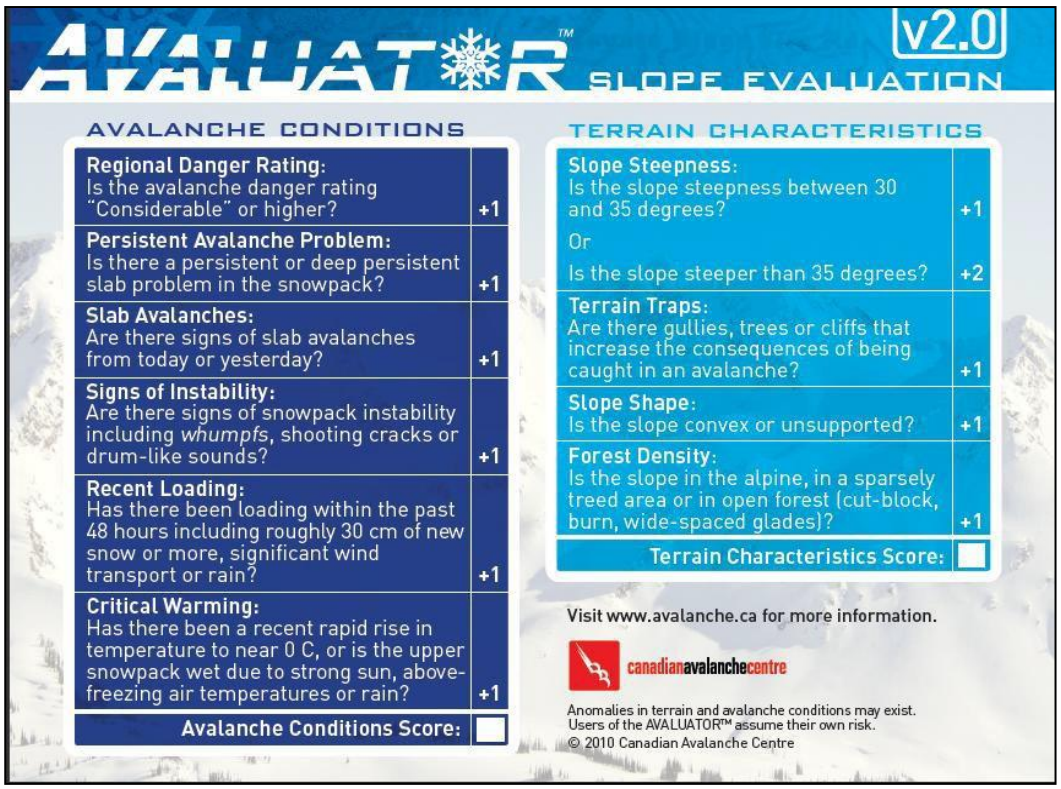
The Avaluator 2.0 Slope Evaluation tool is designed to be used while in the field to help with continual on- site assessment of local conditions and terrain – before committing to travel in avalanche terrain.

On-slope ratings are independent of the pre deployment rating. Discrepancies are likely, so the Slope Evaluation score could override original rating. Factors include local, small scale variations in terrain, rapid changes in conditions, and variations in conditions over the terrain.

Accurate slope evaluation relies on your ability to see the terrain and conditions around you. Remember your ability to gather accurate info may be limited by distance; blocking terrain features; and poor weather.

- Be prepared to downgrade a rating based on the results of a slope evaluation (i.e. from Green to Yellow)
- Upgrading a rating (i.e. from Yellow to Green) is discouraged.


AVALUATOR™
v2.0
SLOPE EVALUATION
AVALANCHE CONDITIONS SCORE
6
5
4
3
2
1
0
NOT RECOMMENDED
EXTRA CAUTION
CAUTION
0
1
2
3
4
5
TERRAIN CHARACTERISTICS SCORE


AVALUATOR™
v2.0
SLOPE EVALUATION
AVALANCHE CONDITIONS
Regional Danger Rating: Is the avalanche danger rating "Considerable" or higher? +1
Persistent Avalanche Problem: Is there a persistent or deep persistent slab problem in the snowpack? +1
Slab Avalanches: Are there signs of slab avalanches from today or yesterday? +1
Signs of Instability: Are there signs of snowpack instability including whumpfs, shooting cracks or drum-like sounds? +1
Recent Loading: Has there been loading within the past 48 hours including roughly 30 cm of new snow or more, significant wind transport or rain? +1
Critical Warming: Has there been a recent rapid rise in temperature to near 0 C, or is the upper snowpack wet due to strong sun, above-freezing air temperatures or rain? +1
Avalanche Conditions Score:
TERRAIN CHARACTERISTICS
Slope Steepness: Is the slope steepness between 30 and 35 degrees? +1
Or
Is the slope steeper than 35 degrees? +2
Terrain Traps: Are there gullies, trees or cliffs that increase the consequences of being caught in an avalanche? +1
Slope Shape: Is the slope convex or unsupported? +1
Forest Density: Is the slope in the alpine, in a sparsely treed area or in open forest (cut-block, burn, wide-spaced glades)? +1
Terrain Characteristics Score:
Visit www.avalanche.ca for more information.
canadianavalanchecentre
Anomalies in terrain and avalanche conditions may exist.
Users of the AVALUATOR™ assume their own risk.
© 2010 Canadian Avalanche Centre

Appendix F – Avalanche Frequency and Magnitude Tables

Table 5. Avalanche Frequency

Average Return Period (events/year)	Frequency Range (events/year)	Frequency Descriptor	Comments
1:1	>1:1 to 1:3	High	Routine interruption of winter operations where observed
1:10	1:3 to 1:20	Moderate	Active in major storm events or widespread avalanche cycles
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Table 6. Canadian Avalanche Size Classification (McClung and Schaerer, 2006[2])

Size	Description (Destructive Potential)	Typical mass (t)	Typical path length (m)	Typical impact pressure (kPa)
1	Relatively harmless to people.	<10	10	1
2	Could bury, injure or kill a person.	10^2	100	10
3	Could bury a car, destroy a small building*, or break a few trees.	10^3	1000	100
4	Could destroy a railway car, large truck, several buildings or forest with an area up to 4 hectares (ha).	10^4	2000	500
5	Largest snow avalanches known; could destroy a village or forest up to 40 ha.	10^5	3000	1000

*e.g. a wood frame house

Appendix G – Tables for reference

Table 1. Avalanche training requirements.

Training Level	Required Courses
Introductory	- AST 1 - JIBC OAR Team Member
Intermediate	- JIBC OAR Team Leader - AST 2 or - CAA Avalanche Operations Level 1
Advanced	- CAA Avalanche Operations Level 2
Avalanche Professional	- Professional member of the CAA or Association of Canadian Mountain Guides (ACMG) or Canadian Ski Guides Association (CSGA) with CAA Avalanche Operations Level 2.

Table 2. Avalanche Safety Officer (ASO) matrix. Training levels required to develop an Avalanche Operations Plan (AOP) in avalanche terrain.

		Maximum ATES Rating			
		Simple	**Challenging**	**Complex**	**No Data**
Avalanche Danger Rating	**5. Extreme**	Advanced	Advanced	Advanced	Advanced
	4. High	Advanced	Advanced	Advanced	Advanced
	3. Considerable	Advanced	Advanced	Advanced	Advanced
	2. Moderate	Intermediate	Advanced	Advanced	Advanced
	1. Low	Intermediate	Intermediate	Advanced	Advanced
	Unknown or Not Available*	Advanced	Advanced	Advanced	Advanced

* Consult an Avalanche Professional or use the Dangerator to determine the rating.

Table 3. GSAR Winter Team Leader qualifications for operating in avalanche terrain. See Tables 1 and 4 for definitions of training levels and experience.

Avalanche Danger Rating	Avalanche Terrain Exposure Scale Rating: Simple	Challenging	Complex
Extreme	Advanced	Advanced	Advanced
High	Intermediate	Advanced	Advanced
Considerable	Intermediate	Intermediate *plus* experience	Advanced
Moderate	Introductory	Intermediate	Advanced
Low	Introductory	Introductory *plus* experience	Intermediate *plus* experience
Unknown or not available	Intermediate	Intermediate *plus* experience	Advanced

Notes:

1. Avalanche danger can be obtained at www.avalanche.ca or from an Avalanche Professional. Ensure the avalanche danger from the appropriate elevation band is applied.
2. Avalanche Terrain Exposure Scale (ATES) ratings can be obtained at www.avalanche.ca/planning/trip-planner, from the land manager or from an Avalanche Professional. An ASO may determine the ATES rating if they have *Intermediate* training plus experience (Appendix B).
3. Unknown or not available **–** Consult an Avalanche Professional or use the Dangerator (Figure 7).
4. At the discretion of the ASO (Advanced), a lower level of training may be applicable for a HEC pickoff rescue which involves nil-minimal ground travel and minimal time exposure to facilitate the rescue.

Table 4. Guideline for what constitutes experience with avalanche risk:

Examples of Experience in Avalanche Terrain
1) Active winter recreationist (backcountry skier, climber or snowmobiler) with ≥ 5 days in each of previous 5 winters travelling through avalanche terrain; or,
2) Active occupational work experience (using backcountry skis, snowmobiles, or helicopters) with ≥ 5 days in each of the previous 5 winters travelling through avalanche terrain; or,
3) Active Organized Avalanche Response (OAR) team member with local volunteer search and rescue organization that undertakes rescues in avalanche terrain.