



Avalanche Safety Plan

Ministry of Transportation and Infrastructure

Avalanche and Weather Programs

Effective: November 1, 2022

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1.0 Introduction

Avalanche and Weather Programs Overview

British Columbia provincial highways pass through some of the most spectacular mountain scenery in the world. At numerous locations in the mountains, our highway system is susceptible to the effects of snow avalanches.

Ministry of Transportation and Infrastructure staff who work in the Avalanche and Weather Programs are responsible for ensuring that motorists and workers can rely on a safe provincial transportation system during the winter months.

The Ministry Avalanche and Weather Programs mandate is to:

- Ensure the safety of all highway users.
- Minimize the frequency and duration of avalanche-related road closures.
- Provide effective environmental sensing services that support the safety and integrity of the provincial highways system.

Eight avalanche program field offices are located as follows:

- Bear Pass Avalanche Program based in Stewart
- Central Avalanche Program based in Penticton
- Coast - Chilcotin Avalanche Program based in Pemberton
- Columbia Avalanche Program based in Revelstoke
- Kootenay Regional Avalanche Program based in Nelson
- Kootenay Pass Avalanche Program based in Nelson
- Northwest Avalanche Program based in Terrace
- North Cascades Avalanche Program based in Hope

During winter months, Ministry Avalanche Technicians from the eight field offices maintain a constant watch over weather and snowpack conditions in 62 avalanche areas around the province. They use a sophisticated network of electronic weather stations, assess reports of regional avalanche conditions, observe avalanche occurrences and investigate the structure of the mountain snowpack. When this information indicates that avalanches may soon affect the highway a temporary highway closure is initiated to ensure the safety of all highway users. Closures remain in effect until the snowpack regains stability through further change in the weather conditions or natural avalanche activity. Every effort is made to ensure closures are as short as possible and that the highway is reopened as soon as the avalanche risk is reduced to an acceptable operational hazard level (operational risk band).

During closures, the Ministry Avalanche Technicians may be able to use explosive devices to artificially trigger the avalanches. The most common method of explosive triggering employed by the Ministry is to deploy explosives from a helicopter into the avalanche prone slopes.

At several critical locations, the Ministry has invested in avalanche control devices that can be remotely fired. This allows the Ministry Avalanche Technicians to artificially trigger avalanches during all weather conditions.

In some locations engineering solutions have been undertaken to reduce or eliminate the effect of avalanches on our highway system. This type of structural mitigation method includes snow sheds, arresting mounds or walls, diversion dikes, benches, catchment basins or avalanche fencing.

Geographic Referencing

The eight Ministry avalanche programs monitor approximately 1400 individual avalanche paths around the province. Each avalanche path has a reference name and number. In most situations, a number of these avalanche paths are grouped along a specific section of a highway, and this group of avalanche paths is called an avalanche area. There are 62 distinct highway avalanche areas; each area is identified by a name and a five-digit avalanche area code.

Each avalanche path is documented in an Avalanche Atlas. There is an atlas for each avalanche area. The original atlases were produced in the late 1970s and early 1980s. Much of the information from those original atlases forms the core of a newer series of atlases that can be published as needed from the Ministry Snow Avalanche Weather System (SAWS) software.

Maps of each avalanche area have been produced as a series of “strip maps” designed to fold into the hard copy avalanche atlases. The original strip maps were all based on the National Topographic System (NTS) 1:50,000 map series, one map for every avalanche area. The original maps are being replaced with new strip maps based on 1:20,000 trim mapping.

The locations of all the highway avalanche areas managed by the Ministry are shown in the map in Figure 1 Ministry of Transportation and Infrastructure Avalanche Area Locations.

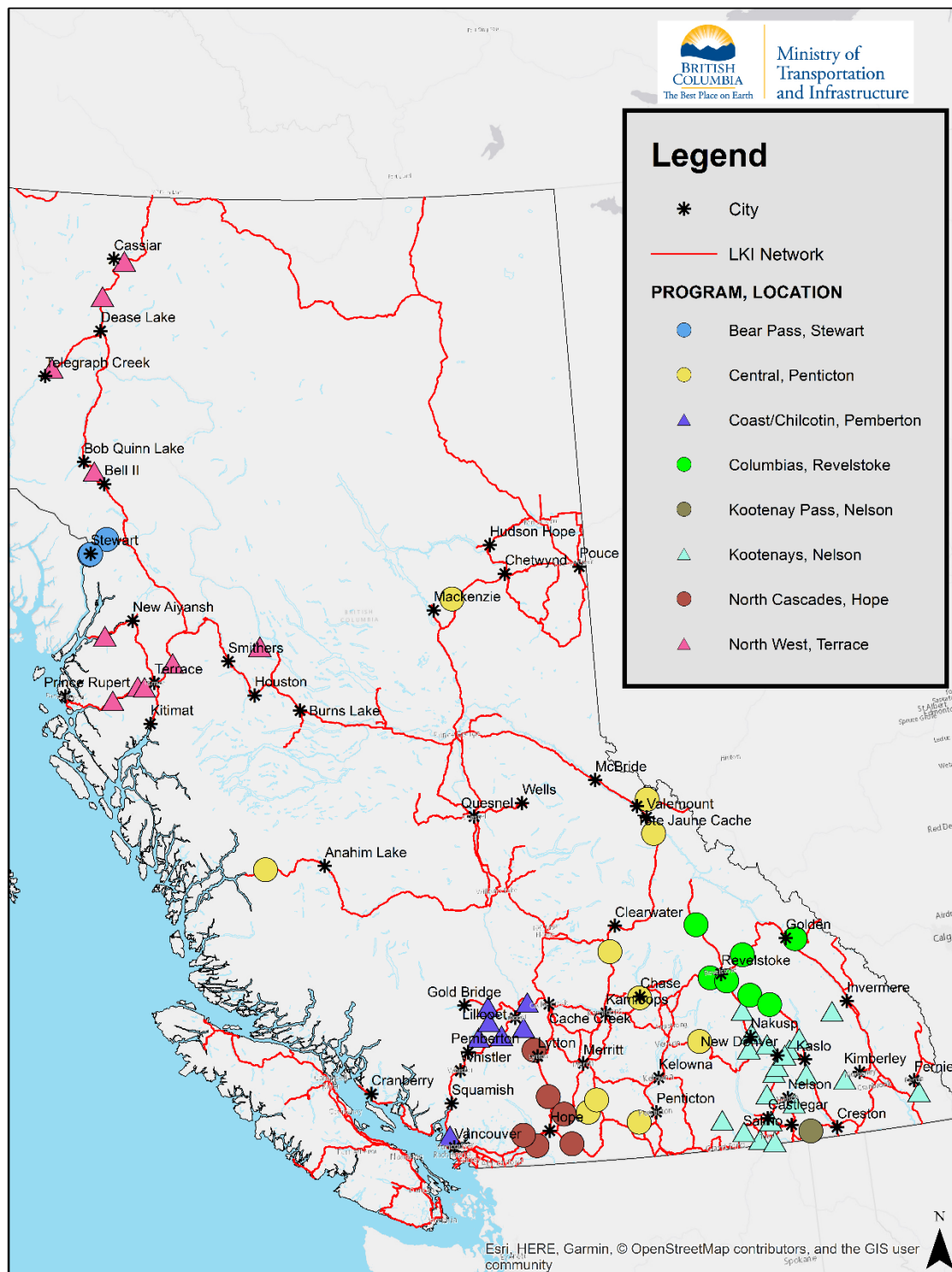


Figure 1 Ministry of Transportation and Infrastructure Avalanche Area Locations

Overview of the Ministry Avalanche Safety Plan

In October 2009 the Ministry published the first version of this Avalanche Safety Plan. Newly established regulation from WorkSafeBC was the trigger for developing the Avalanche Safety Plan.

The majority of Ministry documents that are referenced in the plan are found in the appendices (<https://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/contracting-to-transportation/highway-bridge-maintenance/highway-maintenance/avalanche-safety-plan>). The Avalanche Safety Plan can be used as a navigational aid to the safe work policies, procedures, guidelines, standards and regulations that Ministry personnel responsible for the delivery of the avalanche programs are expected to follow.

The Avalanche Safety Plan is a reference framework for supervisors and workers directly involved with highway maintenance and operation in the 62 highway avalanche areas around the province. All of these supervisors and workers are required to achieve specific levels of training in order to safely work together in the highway avalanche areas or to manage work taking place in the highway avalanche areas. The workers involved in this Avalanche Safety Plan are:

- Ministry workers with duties in avalanche areas
- Ministry workers that supervise workers in avalanche areas
- Maintenance Contractor and sub-contractor workers with duties in avalanche areas
- Maintenance Contractor workers that supervise workers in avalanche areas
- Other workers that are required to perform duties related to highway operation and maintenance when they are authorized by or are working under the direction of the District Avalanche Supervisor

In some locations, there are external avalanche programs that overlap onto the same mountain terrain and corridors used by the ministry programs. This includes operations such as railways, BC hydro, communications infrastructure, forestry operations and other interests. This avalanche safety plan is not intended to meet the safety needs of workers undertaking tasks for these external operations which are unrelated to the operation and maintenance of the highway system.

Documentation Expectations

All Ministry programs are required to make and keep records related to the activities and actions of the individual and of the work unit. A diligent approach to managing avalanche risks includes a system of monitoring, reporting and documentation that will allow the organization and the individual to demonstrate that controls are in place and all reasonable care is being taken. The demanding environment of an avalanche safety program amplifies the need to document activities that demonstrate a high level of preparedness for unforeseen events and establishes a pattern of decision-making that is mindful and leads to well-planned actions.

The Avalanche Safety Plan contains several notes intended as reminders of specific documentation requirements contained in the various policies, procedures, guidelines, standards and regulations associated with operating a Ministry avalanche program. Most of the notes refer

to records that are made and kept by Ministry employees, and in a few instances, they refer to records that are made and kept by the Maintenance Contractors.

This documentation of events and activities varies from simple notations of events in program logs or field books to record keeping that is required by the maintenance contract. There are also instances of documentation that must be undertaken to comply with external regulatory requirements. While the notes in this safety plan pick up a number of the key documentation needs there, are many additional events and actions that are noteworthy and should be recorded.

Reference Materials

Appendix I – Introduction & Geographic Description

- *Listing of Avalanche Area Codes, Atlases and Maps*
- *Map Views of Avalanche Area Locations by Name*

2.0 Operational Objectives

Performance Objectives

The Ministry Avalanche and Weather Programs performance objectives ensure the safety of all highway users and to minimize the frequency and duration of avalanche-related road closures.

Throughout much of the Ministry documentation relating to avalanche safety references “highway users”. This term identifies the public travelling on the highway as well as the workers involved in the maintenance and operation of the highway system.

In order to meet the operational risk band objectives, the District Avalanche Supervisors and staff are responsible for ensuring that their programs are operated in compliance with all Ministry policies, procedures, guidelines and standards in compliance with provincial and federal regulations.

This section of the Avalanche Safety Plan describes two documents, the *Threshold Guidelines for Avalanche Safety Measures* and the *Snow Avalanche Safety Measures for Highways Manual*. The Avalanche Hazard Level scale is also introduced. These documents are fundamental to understanding the Ministries performance objectives.

The Threshold Guidelines are used in the decision-making process to ensure that the avalanche forecast is appropriate to the individual situation. The Avalanche Hazard Levels scale identifies operational safe work procedures. The performance objectives of the avalanche safety program can be applied as the limits of an operational risk band.

Snow Avalanche Safety Measures for Highways Manual

The *Snow Avalanche Safety Measures for Highways Manual* contains information on training and equipment requirements, Maintenance Contractor obligations, as well as operational procedures, emergency preparedness and record keeping.

The Ministry of Transportation and Infrastructure has identified the *Snow Avalanche Safety Measures for Highways Manual* as a contract document in the *Highway Maintenance*

Agreement, Schedule 1 Section 6 - 3.04 Snow Avalanche Response (2018) or Highway Maintenance Contracts, Maintenance Specifications Chapter 7-790 Snow Avalanche Response (2003).

The *Snow Avalanche Safety Measures for Highways Manual* will be referenced throughout this Avalanche Safety Plan. There are explanatory remarks in this plan, intended to enhance the general understanding of the *Snow Avalanche Safety Measures for Highways Manual*.

Threshold Guidelines for Avalanche Safety Measures (see Appendix II)

Identifying and describing the limits of acceptable risk in highway avalanche operations has been evolving since the beginning of the Ministry avalanche programs. Avalanche size, likely termination point, traffic volume, traffic flow characteristics and consequences related to the terrain all factor into the evaluation.

The purpose of defining *Threshold Guidelines for Avalanche Safety Measures* is to establish a consistent understanding of the primary factors that must be considered when determining avalanche hazard levels, as well as how the combinations and interactions of primary avalanche risk predictors influence avalanche hazard level assessments.

In safety programs, it is useful for all involved to understand the factors contributing to the risks in order to better understand the reasoning behind operational procedures that are used to achieve the safety objectives.

The *Threshold Guidelines for Avalanche Safety Measures* document contributes guidance on the weighting of avalanche size, frequency and termination point (considerations included in the Avalanche Hazard Levels and Specific Operational Procedures) with the additional factors of terrain features and traffic flow characteristics.

The *Threshold Guidelines for Avalanche Safety Measures* document was reviewed by the Ministry executive and implemented in December 2008.

The document also provides instruction on the method of developing site-specific traffic control procedures that are appropriate for some specific areas and are intended to enhance the ability to conduct safe highway operations near the upper limits of the Operational Risk Band.

Avalanche Hazard Levels and Specific Operational Procedures (see Appendix II)

The *Snow Avalanche Safety Measures for Highways Manual* identifies General and Specific Operational Procedures. The General Winter Operational Procedures identify procedures that must be followed throughout the avalanche season.

The Avalanche Hazard Levels and Specific Operational Procedures are designed specifically for the use of BC Ministry of Transportation and Infrastructure in our avalanche safety programs for the public highway system. The operational safety procedures assigned to each hazard level are intended to safeguard workers that are tasked with maintenance and highway operational duties inside the highway avalanche areas. All other highway users can maintain an acceptable level of safety by travelling through the highway avalanche areas in the normal flow of traffic without stopping.

The Avalanche Hazard Levels and Specific Operational Procedures (also called the Five Level Scale) is a table that shows the five possible hazard forecast levels alongside the expected avalanche activity and the worker safety measures associated with each level. The avalanche activity definitions in the table describe the frequency and size of avalanches expected (small or large) as well as where the avalanche flow is expected to terminate, either above or on the road. These are the parameters used for establishing the hazard level in an avalanche forecast and is used to determine the appropriate safety measures for workers in avalanche areas.

This hazard level scale provides the means for effective operational communication of expected avalanche activity and clearly identifies the specific safety measures workers are required to follow for each hazard level.

The Ministry addresses avalanche safety situations other than that of people in vehicles travelling on the public highway site-specific safety measures and specific operational procedures must be used to manage avalanche risk. For instance, during highway construction projects in avalanche terrain, a project-specific scale must be developed in order to define the operational procedures that will be required to manage the avalanche hazard exposure which will be encountered during the project. Another example is the formal agreement between the Ministry and the District of Stewart where the specific operational procedures include evacuation of a portion of the Stewart town site during periods of Extreme hazard.

North American Public Avalanche Danger Scale

The North American Public Avalanche Danger Scale was developed specifically for communication of the avalanche danger likely to be encountered in a specific area of the backcountry. The scale has no other application.

The Ministry Avalanche Hazard Levels and Specific Operational Procedures are not in any way related to the North American Public Avalanche Danger Scale. Ministry avalanche hazard forecasts for highways are never issued using the North American Public Avalanche Danger Scale; the two scales are unrelated.

Where Ministry avalanche workers are required to travel to and from off-highway worksites (see *Section 9.0 Fieldwork Sites and Working Alone or in Isolation*), it is important to evaluate the avalanche danger that is likely to be encountered while undertaking this type of fieldwork. It would be appropriate to employ the North American Public Avalanche Danger Scale to communicate information about the avalanche conditions that may be encountered while conducting the fieldwork.

Information on the North American Public Avalanche Danger Scale can be found on www.avalanche.ca the Avalanche Canada's web site.

Reference Materials

Appendix II - Operational Objectives

- *Snow Avalanche Safety Measures for Highways Manual*
- *Threshold Guidelines for Avalanche Safety Measures*

- *Highway Maintenance Agreement, Schedule 1 Section 6 - 3.04 Snow Avalanche Response (2018) or Highway Maintenance Contracts, Maintenance Specifications Chapter 7-790 Snow Avalanche Response (2003)*
- *District of Stewart & MoTI, Mt Rainey Avalanche Safety Recommendations*

3.0 Organizational Structure and Personnel

Overview

Ministry of Transportation personnel supply highway avalanche safety services for sixty-two avalanche areas; ten of the twenty-eight provincial transportation districts have one or more avalanche areas within their boundaries.

Ministry Districts are managed by District Managers. Seven of the eight District Avalanche Supervisors in the province report to District Managers, in most cases through a District Operations Manager. The District Manager (or the designated District Operations Manager) provides line supervision of the District avalanche personnel and is responsible for providing sufficient resources for the District avalanche programs.

The headquarters Avalanche and Weather Programs, under the direction of the Senior Manager, Avalanche and Weather Programs, integrates avalanche risk management by developing operational safety policy, procedures, guidelines, standards and technical direction to District Avalanche Programs. Senior Avalanche Officers assist the Senior Manager, Avalanche and Weather Programs. The District Avalanche Supervisor from the Central Avalanche Program reports directly to the Senior Manager, Avalanche and Weather Programs. District Avalanche Supervisors are tasked with delivering the avalanche safety program at the field level. Each District Avalanche Supervisor has a District Avalanche Technician a direct report and, in most cases, share in the supervision of one or two District Avalanche Assistants. It is understood that the District Avalanche Supervisor will delegate specific responsibilities to District Avalanche Technicians such as, but not limited to:

- Acting in the role of District Avalanche Supervisor when the District Avalanche Supervisor is unavailable
- Issuing of Hazard Forms and avalanche risk assessments
- Implementing Site-specific Safety Measures
- Highway maintenance and deposit removal within Ministry Avalanche Areas during highway avalanche closures
- Avalanche Search and Rescue
- Specific fieldwork

District Avalanche Programs operate in accordance within the parameters of technical guidance provided by the headquarters office.

A Ministry Area Manager, Roads, reporting to the District, helps liaise with the Maintenance Contractor in each avalanche area.

The Ministry conducts highway maintenance operations through Maintenance Contractors in twenty-eight Service Areas. Where Maintenance Contractors have operations in avalanche areas the maintenance contract contains specific requirements and responsibilities. The Ministry Avalanche Safety Plan includes the Maintenance Contractor. Ministry avalanche workers provide the avalanche safety program and Maintenance Contractor employees are appropriately trained to work alongside Ministry employees within the context of the Ministry Avalanche Safety Plan.

The policy governing the operational relationships for personnel involved in the delivery of the avalanche safety programs was put in place by the Assistant Deputy Minister in November 2009 (*Memorandum Re: Ministry Avalanche and Weather Programs Overview*, Appendix III). All Ministry personnel involved with the supervision and delivery of the avalanche programs will benefit by being familiar with this policy.

The provincial Weather Network operates a system of remote sensing stations throughout the province. This system is managed by the Weather Network Program Manager who reports to the Senior Manager, Avalanche and Weather Programs. The weather sensing network is a key data source for the District avalanche programs. District Avalanche Supervisors and managers liaise with the Weather Network Program Manager on all issues related to the development and maintenance of the provincial Weather Network.

When proposals for change within District Avalanche Programs are considered and where such changes may have an impact on the effectiveness of these programs' operations, the District Manager is responsible for ensuring the proposed changes are brought to the Senior Manager, Avalanche and Weather Programs for review. The proposed changes must have the approval of the Senior Manager, Avalanche and Weather Programs prior to implementation.

The relationship between the highway Maintenance Contractor and the avalanche programs is set out in contract documents in Appendix II. Those documents are:

- *Snow Avalanche Safety Measures for Highways Manual*
- *Highway Maintenance Agreement, Schedule 1 Section 6 - 3.04 Snow Avalanche Response (2018) or Highway Maintenance Contracts, Maintenance Specifications Chapter 7-790 Snow Avalanche Response (2003)*

Operational Resourcing of District Avalanche Programs

Avalanche operational resources are managed at the District level. All avalanche workers are required to be skilled, available and able to respond to changing, unforeseen or emergency situations. The District Manager, Transportation is responsible for ensuring that operational resources are available at a level that ensures that the avalanche workers are able to safely meet their job requirements and that enables them to meet the objectives of the Ministry standards and policies at all times. The safety of the public, Ministry avalanche workers, other Ministry workers and Maintenance Contractor personnel is contingent on District resourcing of the Ministry avalanche safety programs.

Beyond the requirements for winter response are the requirements for avalanche workers to complete administrative and project related tasks, associated with long term planning,

maintenance and improvement of the avalanche program. The Senior Manager, Avalanche and Weather Program will work with the Districts to ensure that adequate resources are available to meet these goals.

Reference Materials

Appendix II - Operational Objectives

- *Snow Avalanche Safety Measures for Highways Manual*
- *Threshold Guidelines for Avalanche Safety Measures*
- *Highway Maintenance Agreement, Schedule 1 Section 6 - 3.04 Snow Avalanche Response (2018) or Highway Maintenance Contracts, Maintenance Specifications Chapter 7-790 Snow Avalanche Response (2003)*

Appendix III - Personnel

- *Memorandum Re: Ministry Avalanche and Weather Programs Overview*

4.0 Training

4.01. Ministry Avalanche Worker Training

Avalanche Skills Development

Avalanche workers employed by the Ministry have a mix of training requirements. Requirements are stated in the job descriptions for Ministry avalanche workers. A best practice within Ministry avalanche programs is to ensure that employee skills and training are not only commensurate with the responsibilities of their current position, but that the employee is encouraged and assisted in improving their skill and training levels to facilitate their continued professional development.

Ministry avalanche workers require continuing exposure to training opportunities in order to remain current and qualified for their duties. The Ministry recognizes that avalanche knowledge and standards are constantly improving and that providing support for the ongoing improvement of employee skills is integral to the effectiveness of the avalanche programs.

The Canadian Avalanche Association has established training guidelines for avalanche safety workers. Ministry avalanche workers and the managers that oversee avalanche programs can review these guidelines and strive to ensure that the work performed on behalf of the Ministry is undertaken by appropriately skilled workers.

The timing of participation in formal training courses can be aligned with achievements in on the job training. The Ministry will benefit from providing training opportunities at appropriate stages in an avalanche workers skill development.

First Aid Training

Ministry avalanche workers must travel in avalanche terrain beyond the highway to gather information for avalanche forecasting. If a worker is injured while travelling to or from an off-highway worksite, their co-workers must be trained to assist them.

A widely applied practice in avalanche programs in Canada is to train workers to an advanced first aid level. This is frequently viewed as having a current first aid course of approximately 40-80 hours duration. It is common to pursue first aid training that is specific to working in wilderness operations.

Other Training

Ministry workers require additional training and, in some instances, certifications. The following is a partial list of related training and materials for Ministry avalanche workers; some items on the list refer to internal Ministry documents, policies and procedures while other items identify operational skills that are developed through in-house mentoring:

- WorkSafeBC certified blaster – Avalanche Control
- Explosives Use Operational Plan
- Transportation of Dangerous Goods
- Emergency Response Assistance Plan 2-0804
- Snow Avalanche Safety Measures for Highways Manual
- Avalanche Hazard Levels and Specific Operational Procedures
- Threshold Guidelines for Avalanche Safety Measures
- Snow Avalanche Search and Rescue Plan & Response
- Check-in procedures, fieldwork incident response
- Response to Non-Highway Avalanche Incidents

4.02. Training for Working in Highway Avalanche Areas

The *Snow Avalanche Safety Measures for Highways Manual* identifies training programs for persons who work inside of Ministry avalanche areas but are not directly tasked with delivery of the active avalanche safety program.

The avalanche risk potential for each Ministry avalanche area has been evaluated and a training plan has been assigned primarily based on that risk assessment. There are two such training plans (Plan A or Plan B) and the appropriate plan for each avalanche area is identified and explained in Appendix A of the *Snow Avalanche Safety Measures for Highways Manual*.

The Maintenance Contractor is responsible to provide an annual One Day Avalanche Safety Training session for all employees and sub-contract workers (hired equipment operators are included) that work in avalanche areas. For Ministry Districts that contain avalanche areas, Ministry personnel that require this level of training include the local Roads Area Manager. Other Ministry personnel are encouraged to attend these training courses as availability permits. Personnel that require this training and the frequency of attendance are defined in the training section of the *Snow Avalanche Safety Measures for Highways Manual*. All avalanche training must be delivered by Ministry approved instructors, organizations, or by Maintenance Contractor employees who meet the required qualifications as defined in the *Snow Avalanche Safety Measures for Highways Manual* Appendix E, Guidelines for One-Day Avalanche Safety Training, Terms of Reference.

***Note:** The Maintenance Contractor must keep, and supply to the Ministry upon request, records indicating the avalanche training history of all Maintenance Contractor staff. The Ministry District Avalanche Supervisor will keep avalanche safety training records for Ministry staff.*

Follow-up Rescue Training

Rescue training sessions will be planned by the Ministry District Avalanche Supervisor as required. The purpose of the rescue training session is to assess and develop the preparedness of the Ministry and maintenance contractor to appropriately respond to an avalanche-related emergency. Sessions will focus on avalanche safety training such as:

- simulated or mock avalanche rescue
- avalanche transceiver use
- probing or shoveling techniques
- avalanche on road, reporting and response
- Highway Avalanche Incident Response Plan use
- terrain familiarization

***Note:** The Maintenance Contractor must keep, and supply to the Ministry upon request, records of avalanche follow-up training and a list of the Maintenance Contractor staff who have attended these sessions. The Ministry District Avalanche Supervisor keeps training records for Ministry staff that participate in the avalanche follow-up training.*

4.03. Untrained Workers Transiting Highway Avalanche Areas

Thousands of workers with no avalanche safety training travel safely through the highway avalanche areas every day. These workers are among the highway users whose safety is a primary objective of the Ministry avalanche programs. This highway user group includes the public at large, emergency responders as well as Ministry and Maintenance Contractor personnel that, in the course of their normal work, are not required to perform work in avalanche areas or make decisions regarding avalanche safety. These employees are not required to have any specific avalanche training. The level of risk faced by these workers has been reduced to an acceptable level by the Ministry's avalanche programs.

Like all highway users, these workers are expected to minimize their exposure to avalanches by obeying the No Stopping - Avalanche Area signs that mark highway avalanche areas. Obeying these no stopping signs effectively reduces the exposure to avalanches. When avalanche hazard levels are predicted to reach the High avalanche hazard criterion, all workers and public are evacuated from the avalanche area.

4.04. Instruction or Supervision of Untrained Workers

At times the need will arise for persons conducting highway maintenance and operations related activities, and for persons responding to emergencies and other unforeseen operational necessities to work within avalanche areas without having the formal training described in this document. In this case, the need to undertake the work will be established with the District Avalanche Supervisor who will identify the appropriate level of instruction, supervision and use of personal protective equipment.

The District Avalanche Supervisor may turn down requests for untrained workers to perform duties within avalanche areas based on avalanche forecast levels or limited need to conduct the work, or an inability to ensure the safety of untrained workers through direct instruction, supervision or use of personal protective equipment.

This exemption from the formal training requirements is applicable only for executing tasks that are the result of unforeseen circumstances and short duration. This will not apply to regular, auxiliary or as and when workers that have missed or fallen short of the training program. This should not be considered for undertaking tasks of a routine nature.

***Note:** The Ministry District Avalanche Supervisor will keep records of instances where untrained workers were required to work in avalanche areas in conjunction with the operation and maintenance of the highway. The record will include the steps taken to supervise and safeguard the untrained personnel.*

4.05. Workers and Industrial Activities Unrelated to Highway Operation and Maintenance

Persons and organizations proposing to work in Ministry avalanche areas or on the slopes above the highway during the winter are not covered by this avalanche safety plan. The Ministry does not offer any avalanche safety service to those workers. Ministry avalanche forecasts are not related to the activities undertaken by those workers.

Anyone considering work in highway avalanche areas or on the slopes above must work under their own Avalanche Safety Plan. Where these activities conflict with the Ministry Avalanche Safety Plan highway operations workers are put at increased risk. This may become a matter for WorkSafeBC involvement. No work activities should take place during avalanche season without the approval of the Senior Manager, Avalanche and Weather Programs and the District Manager where these works are proposed.

The review of access permit applications for work in or above the avalanche areas during winter should include Avalanche and Weather Programs staff, both District and Headquarters.

Reference Materials

Appendix II - Operational Objectives

- *Snow Avalanche Safety Measures for Highways Manual*

5.0 Equipment and Infrastructure

5.01. Signs

- Avalanche Path Identification Signs
- No Stopping - Avalanche Area and End Avalanche Area Signs
- Avalanche Control Ahead
- Danger - Avalanche Control Warning Signs
- Danger – Unexploded Avalanche Control Device
- Changeable Message Signs
- Pedestrian and Parking Restrictions
- Avalanche Closure Gates
- Signs for Magazines
- Signs for Rescue Caches

I-198-3 Avalanche Path Identification Signs

Individual yellow or orange signs with the avalanche path number and/or name are located along the highway near the runout zone of each avalanche path. These signs provide field identification of avalanche paths and facilitate clear communication about specific locations. These year-round signs are maintained by the maintenance contractor at the request of the Ministry.

***Note:** Ministry generated requests for maintenance to the avalanche path identification signs should be made in writing. A copy should be retained by the Ministry District Avalanche Supervisor.*



Figure 2 Samples of Avalanche Path Identification Signs

P-066-1 No Stopping Avalanche Area and W-106 Avalanche Area Ends

The P-066-1 No Stopping Avalanche Area signs identify hazardous areas consisting of single avalanche paths or groups of paths. These signs indicate to workers and motorists that an avalanche hazard exists and stopping is prohibited. These signs are fundamental to the highway avalanche safety program. Signs must be erected (or uncovered) just prior to the avalanche season and taken down (or covered) at the end of the season at a time specified by the District Avalanche Supervisor.

This annual pattern prompts workers to begin applying the avalanche-related safe work practices each fall as the new avalanche season begins and is considered a critical component of the avalanche safety program. Maintenance of the signs is the responsibility of the Maintenance Contractor.

Signs are placed in locations that permit motorists to observe the sign prior to entering an avalanche area. In lengthy avalanche areas or in locations that may encourage motorists to stop in the avalanche area additional signs are erected inside of the avalanche area as a reminder to motorists. The W-106 Avalanche Area Ends sign shall be used to mark the end of the avalanche area.

The P-066-1 signs are available in three sizes. The standard sign manual gives details of the size and application based on application – local/low-speed roads, arterial and expressways as well as freeways. This sign is enforceable under the Motor Vehicle Act.

***Note:** Ministry generated requests to the maintenance contractor for seasonally erecting, taking down or maintenance of the No Stopping Avalanche Area or Avalanche Area Ends signs should be made in writing. Confirmation that the task has been completed should be made in writing.*



P-066-1 NO STOPPING AVALANCHE AREA

The P-066-1 NO STOPPING AVALANCHE AREA signs indicate to motorists that an avalanche hazard exists and stopping is prohibited. The W-106 AVALANCHE AREA ENDS sign shall be used to mark the end of the hazard area.

Figure 3 P-066-1 No Stopping Avalanche Area sign

W-106 END AVALANCHE AREA SIGN

The W-106 END AVALANCHE AREA sign should be used with the P-104 NO STOPPING AVALANCHE AREA sign to indicate the end of the avalanche danger.



Figure 4 W-106 Avalanche Area Ends sign

C-57 Avalanche Control Ahead

The C-57 Avalanche Control Ahead sign is displayed by traffic control personnel as one of a series of signs leading up to a highway avalanche closure point. This sign is also displayed on the avalanche gate closure arm at some gate locations.



C-57 AVALANCHE CONTROL AHEAD

This sign is required with others in advance of road closures for avalanches and avalanche control works. There should be flags or a Type B High Intensity Flashing Yellow Light mounted directly above the sign. For positioning of the sign see Appendix A of the T.C. Manual. All signs relating to avalanche closures must be removed or covered when not required.

Figure 5 C-57 Avalanche Control Ahead sign

I-198-2 Danger – Avalanche Control May Begin Without Warning

Signs warning of expected avalanche control will be used whenever feasible at off highway access points to the danger area. These signs will be used as early in the winter season as possible to inform backcountry users of the Ministry's local avalanche operations and to warn of avalanche control blasting operations.

Maintenance of highway level blasting area warnings signs is the responsibility of the Maintenance Contractor. Where signs must be located away from the highway, maintenance is conducted by the avalanche personnel. Ensuring that these signs are in place is a condition of acceptance for the Ministry blasting procedures.

Note: An up to date list of the number and locations of these signs will be kept by the District Avalanche Supervisor. These signs should be inspected and maintained regularly.



Figure 6 I-198-2 Danger sign

Zi-198-6, Zi-198-7, Zi-198-8 Danger – Unexploded Avalanche Control Device

Signs warning of unexploded avalanche control devices will be used whenever feasible at off-highway access points to the areas where misfired explosive devices are known to exist. These signs will be posted year-round to inform backcountry users of the possibility of encountering an unexploded device.

Ensuring that these signs are in place is a condition of acceptance for the Ministry Explosive Use Operational Plan.

Note: A list of the locations of these signs will be kept by the District Avalanche Supervisor. The District Avalanche Supervisor will ensure that all information on the Danger – Unexploded Avalanche Control Device signs is correct. These signs should be inspected regularly for maintenance requirements. A record of the inspection of the signs will be kept by the District Avalanche Supervisor. Phone numbers are not on the new signs. Phone numbers should be removed or covered from existing signs.



Figure 7 Zi-198-6 or Zi-198-6-u and Zi-198-7 or Zi-198-7-u signs



Figure 8 Zi-198-8 or Zi-198-8-u sign

Changeable Message Signs

Multi-message illuminated signs are located at the start of many Ministry avalanche areas. These signs allow prompt public dissemination of messages related to avalanche control delays or highway closures.

A number of standard messages related to avalanche work can be displayed to the public. Initiating or ceasing the display of one of these standard messages is typically done at the request of District Avalanche Supervisor, the Ministry Area Manager or the Maintenance Contractor. The Maintenance Contractor monitors these signs to ensure that the messages are accurate at all times.

Personnel at the Transportation Management Center, British Columbia (TMCBC) post the requested messages onto the changeable message signs.

***Note:** A log of the date, time and message displayed is maintained by the TMCBC.*

Avalanche Closure Gates

Closure gates are situated in locations where traffic can be safely stopped outside of avalanche hazard areas. The gates are used in conjunction with standard signs. The Maintenance Contractor is responsible for maintenance of the gates.

***Note:** The Ministry should ensure, at least annually prior to the avalanche season, that all avalanche closure gates are in good operational condition, including all of the required markings and signals. Requests to the Maintenance Contractor for gate maintenance should be made in writing and a record of the request should be kept.*



Figure 9 Configuration of Avalanche Closure Gate Arm

Pedestrian and Parking Restriction Signs

In some avalanche areas, it may be desirable to install signs intended to emphasize the public safety intention of the P-066-1 No Stopping Avalanche Area signs. In particular, this may include the installation of signs that restrict parking and pedestrian traffic. Examples of these signs are found in the *Manual of Standard Traffic Signs & Pavement Markings*. The need to use and install this type of signage should be determined by Ministry district personnel in response to vehicle parking or pedestrian use of the highway at specific locations within avalanche areas.

Avalanche Rescue Cache Signs

Avalanche Rescue Cache locations are identified by signs that will help rescue personnel rapidly access the Avalanche Rescue Cache. A large red-on-white sign should be placed in a high visibility location on the exterior of the building where the avalanche rescue equipment is cached. A second, similar but smaller, sign should be placed on the door of the rescue room or on the exterior of the locker(s) that contain the avalanche rescue equipment.

Note: The Maintenance Contractor will inventory and inspect the condition of the Avalanche Rescue Cache equipment, including these signs, prior to the avalanche season and following any mid-season use of the avalanche rescue equipment. A report on the inspection and the cache inventory will be supplied to the Ministry upon request.



Figure 10 FM-001 and FM-002 signs

Explosive Magazine Signs

A warning sign that is readable at a distance of 8m must be posted on each usual approach to the magazine. The sign must be positioned so that it does not attract unwanted attention and minimizes the possibility that a bullet shot in the direction of the sign would hit the magazine.



Figure 11 FM-003 sign

Reference Materials

Appendix II – Operational Objectives

- *Snow Avalanche Safety Measures for Highways Manual*

Appendix VIII – Explosives

- *Explosive Use Operational Plan*

BC Ministry of Transportation and Infrastructure, Engineering Branch

The Manual of Standard Traffic Signs & Pavement Markings

http://www.th.gov.bc.ca/publications/eng_publications/electrical/most_pm.pdf

Traffic Management for Work on Roadways

<https://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/engineering-standards-guidelines/traffic-engineering-safety/trafficmanagementmanual>

5.02. Avalanche Rescue Equipment Caches

Avalanche search and rescue equipment is stored in established caches at locations adjacent to highway avalanche areas across the province. The Maintenance Contractor is responsible for storage and maintenance of the avalanche search and rescue equipment. The equipment is initially provided by the province. All Ministry and Maintenance Contractor personnel identified in the training sections of *Snow Avalanche Safety Measures for Highways Manual* are trained in the use of the equipment.

Avalanche Rescue Cache Contents and Storage

Avalanche Rescue Cache requirements for each highway avalanche area have been identified and will fall into one of three “Levels” of avalanche rescue cache. Appendix A of the *Snow Avalanche Safety Measures for Highways Manual* identifies the Avalanche Rescue Cache level for each avalanche area across the province.

The Avalanche Rescue Cache content requirements for each cache level are found in Appendix B of the *Snow Avalanche Safety Measures for Highways Manual*.

Avalanche Rescue Cache Locations

Avalanche Rescue Caches are located in clean, dry conditions in designated locations adjacent to Ministry avalanche areas across the province. The location of each cache is well marked by signs and access to the cache is never locked during the avalanche season.

Appendix A of the *Snow Avalanche Safety Measures for Highways Manual* contains a table that identifies the location of Avalanche Rescue Caches, the avalanche area(s) the cache is intended for and the level of the Avalanche Rescue Cache. Demonstrating the exact location of Avalanche Rescue Caches to workers is a requirement of the annual training program.

Avalanche Rescue Equipment Maintenance and Inventory

The Maintenance Contractor is responsible for the safe and secure storage of the Avalanche Rescue Cache equipment. Replacement of misused, lost or stolen equipment is the responsibility of the Maintenance Contractor. Replacement of worn or defective equipment will be initiated by the Maintenance Contractor. Replaced materials and equipment must be of an equal, or better type and quality, as approved by the District Avalanche Supervisor. The Maintenance Contractor must consult with the local District Avalanche Supervisor to ensure quality and compatibility with existing avalanche rescue equipment.

Rescue caches are a key component of the Ministry emergency preparedness for an avalanche incident. It is important for Ministry avalanche programs to be fully aware of the condition of the rescue caches and to be able to demonstrate that awareness.

The Maintenance Contractor will inventory and inspect the condition of the rescue cache equipment prior to the avalanche season and following any mid-season use of the equipment.

The Maintenance Contractor is responsible for ensuring that all avalanche rescue equipment which requires batteries is checked for condition and function, and the batteries replaced with new batteries annually prior to avalanche season. Batteries must be removed from equipment at the end of the avalanche season.

***Note:** The Maintenance Contractor will provide records of Avalanche Rescue Cache inspections and inventories to the Ministry upon request. The records should include a record of annual battery replacement as well as details of the presence and condition of the avalanche rescue equipment along with a list of any damaged or missing avalanche rescue equipment.*

Avalanche Rescue Transceivers

See *Section 5.03 Avalanche Safety Equipment for Workers* of this plan as well as *Section 4.2* of the *Snow Avalanche Safety Measures for Highways Manual*.

Avalanche Rescue Equipment in Vehicles and Heavy Equipment

In addition to radio equipment, the maintenance contractor must supply and ensure that all maintenance vehicles or equipment working in avalanche hazard areas are equipped with equipment specified in *Section 4.6* of the *Snow Avalanche Safety Measures for Highways Manual*.

Ministry District Avalanche Supervisor vehicles should be equipped with rescue packs similar to those described as first party packs in Appendix B of the *Snow Avalanche Safety Measures for Highways Manual*. In some locations, the Ministry Area Managers and/or Maintenance Contractor foremen carry similar packs in their vehicles.

Reference Materials

Appendix II – Operational Objectives

- *Snow Avalanche Safety Measures for Highways Manual*

5.03. Avalanche Safety Equipment for Workers

Ministry Avalanche Workers

Ministry avalanche workers are supplied with the avalanche safety equipment required in the course of their day to day duties. A listing of specific equipment items for every worksite is not a part of this document; appropriate worker safety equipment requirements vary with location and activity. There are, however, certain pieces of safety equipment that are standard across the province. These include:

- avalanche rescue transceivers
- avalanche probe
- shovel
- MoTI radio set - communications equipment
- First Aid kit

Ministry workers also require equipment for safe travel over the snow while conducting fieldwork. This includes ski mountaineering equipment, packs and survival equipment.

Additional equipment is carried in the vehicles supplied by the Ministry. This includes:

- first party avalanche rescue pack
- flagging vest
- shovel
- flashlight
- blanket/sleeping bag
- MoTI radio set - communications equipment
- first Aid kit
- collapsible probe
- Avalanche Search and Rescue Plans

Note: *The Ministry District Avalanche Supervisor will maintain an inventory of Ministry equipment. Avalanche rescue transceivers are tested at least once per season and a record of the testing is maintained.*

Maintenance Contractor Workers

Maintenance Contractor employees are required to carry, and be trained to use, avalanche safety equipment in accordance with the *Snow Avalanche Safety Measures for Highways Manual*.

That document describes the issuing of avalanche rescue transceivers to workers for individual or shared use. There are details on testing and inventory of rescue transceivers and the documentation required.

Additional equipment is carried in contractor vehicles and equipment that is used for work in avalanche areas. This includes:

- snow shovel
- WorkSafeBC – Basic first aid kit
- flashlight
- sectional snow avalanche rescue probe
- MoTI radio set - communications equipment
- Avalanche Rescue Initial Response form

In some areas, the light trucks used by road foremen carry Task Force Team avalanche rescue packs.

***Note:** The Maintenance Contractor will maintain an inventory of all avalanche safety equipment that has been supplied by the Ministry as well as an inventory of all avalanche rescue transceivers. A copy of the inventories will be supplied to the Ministry upon request.*

Reference Materials

Appendix II – Operational Objectives

- *Snow Avalanche Safety Measures for Highways Manual*

5.04. Radio Network and Equipment

Ministry of Transportation and Infrastructure Radio Network

The Ministry owns and maintains a radio communications network for the provincial highway system. This radio network is the primary common communications system used by persons that work on Ministry highways and allows a worker province-wide communication from any location.

The radio system can be used to access the telephone network and, conversely, the telephone network may be used to access the radio network.

Transportation Management Center, British Columbia (TMCBC)

The TMCBC organizes and coordinates communication between the Ministry of Transportation and Infrastructure. This would include Ministry staff, road and bridge maintenance contractors, the RCMP, and several other stakeholders including the trucking industry and the general public. The TMCBC facilitates the response to incidents occurring on BC highways, and assists in the dissemination of road conditions and scheduled planned events information.

TMCBC staff monitors DriveBC and works to distribute road restrictions, weather information, inland ferry status, camera images, changeable sign messages to contribute information that

allows motorists to make informed decisions on the safe and efficient use of provincial highways.

The TMCBC directly contributes to the safety of workers in avalanche areas. TMCBC duties include monitoring fieldworker wellness check-ins and initiating emergency responses to events such as an avalanche on an open highway, a missed worker check-in or initiation of the emergency response plan in the event of an explosives spill. TMCBC staff also issue and distribute avalanche hazard forms as requested by the District Avalanche Supervisors.

Radio Call Book

The Ministry annually publishes and internally distributes a hard copy radio call book. The call book contains all instructions and information required to operate all features of the radio network. It also lists contact information, radio and telephone, for Ministry and Maintenance Contractor staff.

The provincial Forecast Broadcast System (FBSys) is accessed through the Ministry radio network. The radio call book contains information on accessing site-specific weather forecasts, road condition forecasts and weather observations.

Radio Equipment

All Maintenance Contractor, sub-contractor and Ministry vehicles, or any personnel working outside of their vehicles in avalanche areas must be equipped with two-way radios on the Ministry frequency. Under no circumstances should any personnel working outside their vehicles (e.g., traffic control personnel) ever be without radio communication with the maintenance supervisor.

When required, due to the operating noise of the equipment, the radios must be equipped with an external speaker or earphones. See *Section 4.5 of the Snow Avalanche Safety Measures for Highways Manual*.

Radio equipment, with the Ministry frequencies, is required for all avalanche control blasting operations on provincial highways. This is a WorkSafeBC regulation compliance requirement of the Ministry Explosive Use Operational Plan.

Reference Materials

Appendix II – Operational Objectives

- *Snow Avalanche Safety Measures for Highways Manual*

Appendix VIII – Explosives

- *Explosive Use Operational Plan*

BC Ministry of Transportation and Infrastructure, *Radio Call Book*

5.05. Weather Network and Weather Information Access

Weather Station Network

Accurate, timely, and relevant weather data is fundamental to avalanche forecasting.

There are still a small number of manual stations where District Avalanche Supervisors collect weather and snow data, but the majority of the Ministry's network is now automated, and these electronic stations fall into one of two categories. The data is used for avalanche forecasting, highway maintenance decision making, and monitoring by Highways Operations personnel.

The Remote Avalanche Weather Stations (RAWS) are instrumented and strategically located to provide relevant data to inform avalanche forecasting. Some of these installations are at roadside locations where the data is also useful for highway maintenance operations and monitoring.

The Road Weather Stations (RWS) collect data on weather and pavement conditions from strategic locations, allowing our highway Maintenance Contractors to monitor current road conditions and provide an effective response to the changing conditions. Many RWS stations are in or near avalanche areas and provide weather information to the District Avalanche Supervisors.

Current data from all the stations at roadside locations is available to the public through DriveBC.

All of the stations in the Ministry's Weather Network are installed and maintained by a dedicated team of Environmental Electronics Technologists, working with the Avalanche and Weather Programs weather network section.

The information from the stations is collected and distributed to a wide number of stakeholders through the Snow Avalanche and Weather System (SAWS).

These stakeholders include Environment Canada, various University-based research programs, the Canadian Avalanche Association, Avalanche Canada (in support of the InfoEx and the Public Avalanche Bulletin), weather forecasting contractors who supply our maintenance contractors and District Avalanche Supervisors with weather forecast products, and other agencies within the Provincial Government involved in environmental monitoring.

Forecast Broadcast System (FBSYS)

FBSYS uses text to voice technology to supply weather information over the phone or the Ministry's radio network. Ministry and maintenance contractor personnel can poll FBSYS for the latest weather observations, the most recent road weather forecast or the most recent Environment Canada public forecast. The codes for all FBSYS products are listed in the Ministry's Radio Call Book.

Stormpro

The Ministry has developed a software package for graphical display of weather data collected through the weather network. This software, Stormpro, allows Avalanche Technicians to analyze

time series of graphical weather data at stations representative of conditions in their avalanche areas. Manually entered avalanche occurrence records are included in the display options.

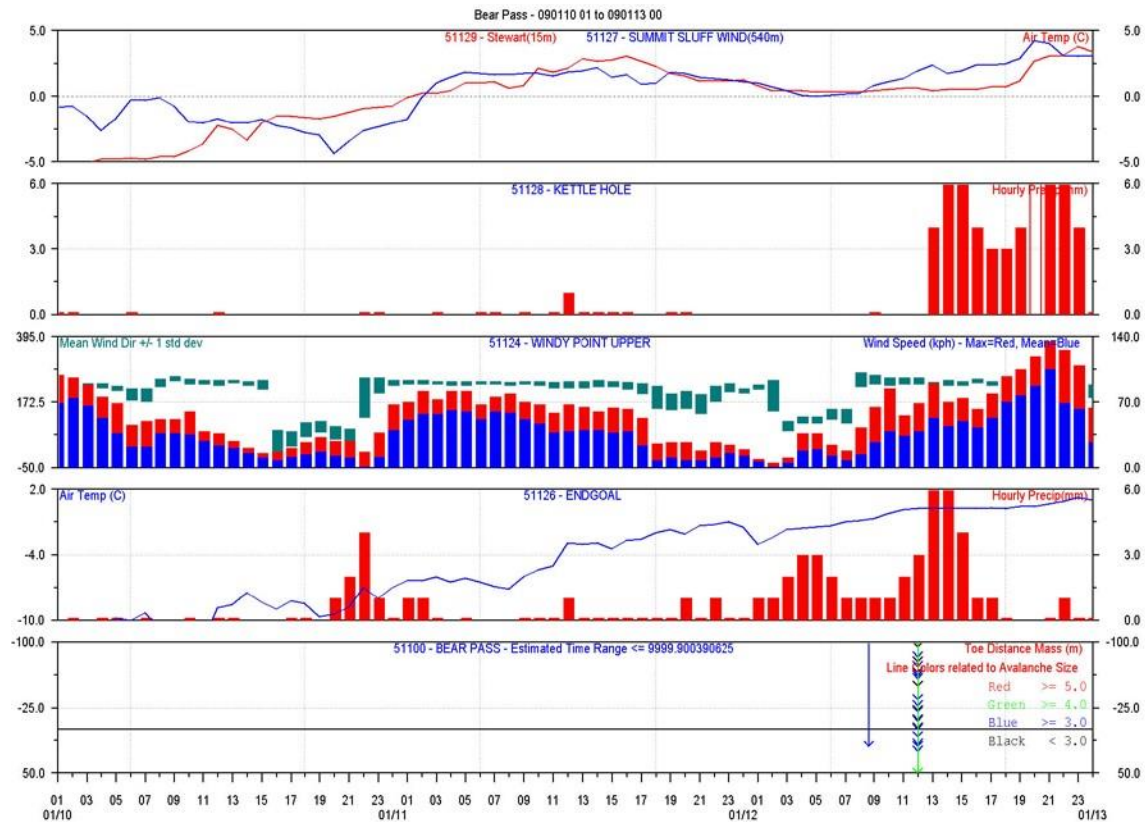


Figure 12 Stormpro graphs

Road Weather Information System (RWIS)

The RWIS system provides Ministry personnel and Highway Maintenance Contractors with internet access to the most up-to-date weather-related information. The site receives hourly updates from weather stations around the province and presents that data in a graphical format. During winter operations a twice-daily customized Road Weather Forecast for the RWS locations is presented with the station data.

The system also includes an alarms module, allowing users to configure alarms based on weather parameters at any station within the Ministry's network. The latest data from the station is continually compared to the threshold values specified in the user's alarm, and when the threshold is met or exceeded an alert is sent to the user via email or as a text message to a mobile device. Alarms can be based on one or more parameters using Boolean logic and parameters can be linked sequentially using and/or operators.

Manual Weather Stations

Before the implementation of electronic weather stations, the Ministry had developed a wide network of manual weather stations. Through thirty years of electronic station development and implementation the manual stations were gradually phased out. In 2017 there are only a handful of manual stations in the province. Manual weather readings may include data relevant to snow conditions that cannot be measured electronically. Manually gathered weather data may be entered into the SAWS system and is available to avalanche personnel and others using that system. The District Avalanche Supervisor is responsible for quality control of the manually gathered weather data from his avalanche areas.

Avalanche and Weather Programs Intranet Information & Mapping Site

The Ministry operates an internal intranet web mapping application that provides access to province wide avalanche forecasts, weather data and avalanche atlas information. The mapping application allows users to highlight the type of data they wish to retrieve and then identify the geographic location by selecting a highway, weather station or avalanche path.

Reference Materials

BC Ministry of Transportation and Infrastructure, *Radio Call Book*

5.06. Avalanche Atlases

Avalanche Atlases are the primary documents that describe the location and effect of avalanches on the highway. The avalanche atlas for an area should be made available to those that are making avalanche safety decisions.

Ministry avalanche atlases are digitized. The photos were scanned, and the text was entered into the SAWS program. Atlases can now be created through SAWS and published locally with up to date content. District Avalanche Supervisors are expected to edit and add information into the avalanche path summaries and attach photos to an individual avalanche path as well as select the occurrence record dates for an up to date summary of the effects on the highway.

District Avalanche Supervisors are to add or modify information in the path summaries as the conditions change or new information becomes available.

When new information is made available, such as new measurements of one or more of the path descriptors' such as width, height or angles, the District Avalanche Supervisor modifies the path summary in SAWS. When avalanche paths go through changes to vegetation or terrain, it is important to document the change in the textual descriptions. This type of information would include forest regeneration, removal of the forest through an avalanche, logging or fire as well as terrain changes such as glacier melt, debris torrent and rock falls.

The District Avalanche Supervisor is responsible for ensuring the atlases reflect the best understanding of the current state of each avalanche path. Some examples of details that should be included in path summaries include the following:

- explosive control targets
- installation of active control devices

- changes to road alignments
- creation of additional catchments or other structural mitigation
- references to studies of the avalanche path or area
- history of any non-highway facilities that may be affected by the path
- notable avalanche events, in particular, events that may have learning value for future avalanche forecasting

Where the District Avalanche Supervisor recognizes value in including other types of information that information should be documented and entered into the avalanche path summary; the path summary is intended to be the historical record of the avalanche path as well as the location where physical details are stored.

SAWS produces an automated summary of the avalanche occurrences for each avalanche path from the occurrence records database and this is included as part of each path summary.

**** Avalanche program atlases and path inventories must be reviewed, update as required and documented at a minimum frequency of once every 5 years.***

Avalanche Path Inventory

The inventory of avalanche paths that affect the highway system is not static. Terrain that is expected to produce avalanches that affect the highway should be included in the avalanche atlases. New avalanche paths are recognized following unusual avalanche events, terrain denuded of vegetation as the result of a fire, new highway construction or re-alignment are a few of the situations that bring this change in potential avalanche risk to the District Avalanche Supervisors attention. The District Avalanche Supervisor is responsible for spearheading the review of terrain where they believe there may be a potential to produce avalanches onto a highway. The District Avalanche Supervisor will ensure that a Senior Avalanche Officer is included in the review process.

In some cases, the recognition of new avalanche paths is straight forward, and a simple process of measuring the terrain and mapping the path(s) is sufficient documentation for inclusion in an atlas and into the provincial inventory. In general terms, the inclusion of a new avalanche path into an established, active, avalanche area can follow this process. The simple process is acceptable where the inclusion of new avalanche terrain does not have a significant impact on the effectiveness or resources of an existing avalanche program.

Where avalanche terrain is thought to exist (as the result of fire for instance) above a highway where there is no existing avalanche program, or where the new terrain will represent a significant change to a program, the District Avalanche Supervisor will employ a team approach to evaluating the new terrain. As with all changes to the avalanche path inventory, a Senior Avalanche Officer will be included in the consultations as will District management responsible for that highway area. There may be a requirement for the District to have an appropriately qualified engineer conduct an avalanche terrain assessment.

Potential Avalanche Paths

There are a number of avalanche paths in the Ministry inventory that may not ever produce an avalanche onto a highway. Several examples of the inclusion of non-avalanche terrain into the inventory, or inclusion of avalanche terrain that cannot reach the highway, can be found in the avalanche path inventory. Some of these paths were included following inconclusive review of air photos and terrain; where inconclusive information showed potential paths inside existing avalanche areas, then those terrain features were included as a method of erring on the side of caution. In other cases, there were recognizable avalanche paths included in the inventory despite inconclusive evidence that the highway was within the run out of the avalanche. These paths are typically described as Potential.

Removal of Avalanche Paths from the Avalanche Path Inventory

Once recognized, avalanche paths will remain in the inventory until evidence can be shown that indicates the terrain will not produce an avalanche onto a highway. Each path that is proposed for removal from the path inventory must be examined by the District Avalanche Supervisor and either a Senior Avalanche Officer or the Senior Manager of the AWP. In certain cases, and engineer may be required to conduct an independent analysis.

An Engineer's assessment may be warranted where continued monitoring of the terrain in question represents a significant draw on the resources of the avalanche program. Another application of an engineer's assessment may be to allow better land use practices in areas once erroneously thought to be impacted by avalanche.

Avalanche Strip Maps

Maps of each avalanche area are available and are a part of the atlas. Updates to the strip maps are undertaken as a team effort by the District Avalanche Supervisors and the Senior Avalanche Officers.

Avalanche strip maps show outlines of the avalanche paths that are managed by the Ministry avalanche programs. Not all terrain that produces avalanches is identified, only terrain that produces avalanches of interest to the Ministry is outlined. The avalanche path outlines are truncated at the highway and do not indicate runout distances beyond the highway. There is no indication of frequency or size implied by these maps.

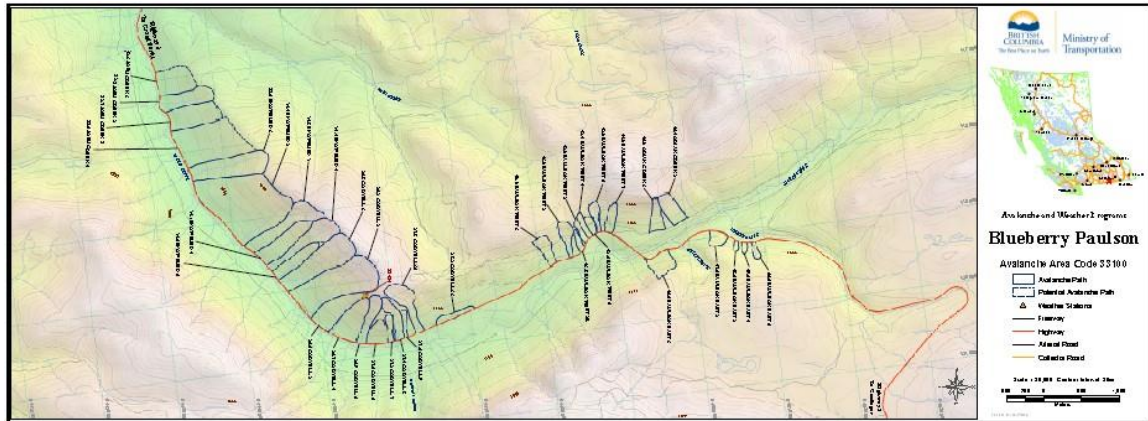


Figure 13 Avalanche Area Strip Map

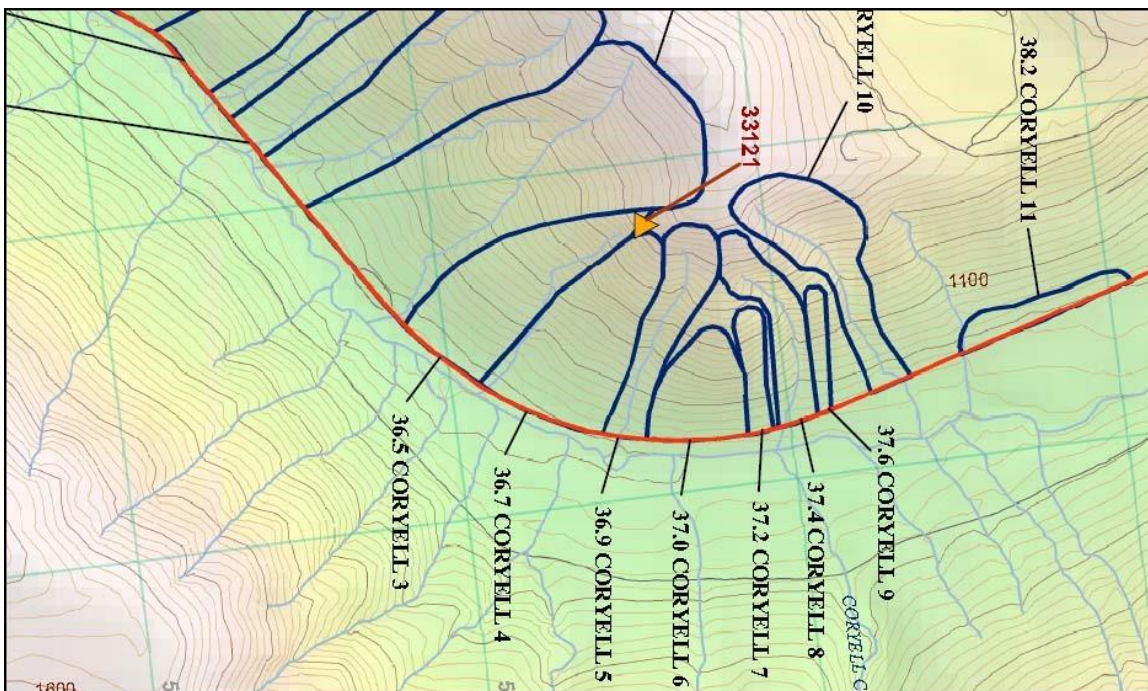


Figure 14 Detail of an avalanche strip map

Reference Materials

Appendix I – Introduction and Geographic Description

- *Listing of Avalanche Area Codes Atlases and Maps*
- *Map Views of Avalanche Area Locations by Name*

5.07. Vehicles

Ministry avalanche workers are supplied with vehicles that are equipped for the duties they perform. Full size trucks with four-wheel drive are required. These vehicles are equipped with Ministry radios, warning lights and avalanche rescue equipment.

Many of the vehicles are used for transporting explosives and when used for that purpose must have an enclosed cargo compartment. As noted in *Section 10* of this document, both Transport Canada and WorkSafeBC are involved with regulating the transportation of explosives. Workers should look to both of these bodies for information on the equipment and cargo compartment configurations that are required.

Vehicles that are carrying explosives also carry a copy of the Emergency Response Assistance Plan 2-0804.

5.08. Explosive Spill Kits

The Ministry is required to have and maintain an Emergency Response Assistance Plan (ERAP 2-0804) as a guide to recovery from an accidental release of explosive products during highway transport. Response equipment caches intended for use in the event of an explosives spill are required; the caches are referred to as Accident Site Equipment in the ERAP, and a detailed list of the required equipment is found in that document.

Accident Site Equipment is located with Avalanche Rescue Caches adjacent to routes used for transportation of explosives. Accident Site Equipment is maintained by the District Avalanche Supervisor in that area. The Accident Site Equipment cache can be transported to the accident site by the Maintenance Contractor or the ERAP technical advisor.

***Note:** The District Avalanche Supervisor will ensure prior to the avalanche season that all required Accident Site Equipment is present in the cache and in good condition. A record of the annual inspection will be kept by the District Avalanche Supervisor.*

Reference Materials

Appendix VIII – Explosives

- *Explosive Spill on Highway - Emergency Response Assistance Plan 2-0804*

Natural Resources Canada, Explosive Safety and Security Branch, Explosives Regulatory Division Regulation, Policy and Guidelines are found online at:
<https://www.nrcan.gc.ca/explosives>

WorkSafeBC Regulation, Policy and Guidelines are found online at:
<https://www.worksafebc.com/>

5.09. Fieldwork and Snow Science Equipment

The Ministry supplies avalanche workers with the equipment required to safely and effectively conduct fieldwork. This includes the equipment required to travel over snow as well as snow study equipment. Safety equipment appropriate for conditions is carried and used at all work sites.

When conducting fieldwork, a worker is likely to require the following equipment either individually or as part of the work group resources:

- avalanche transceiver
- collapsible probe
- snow shovel

- first aid kit
- backpack with the capacity to fit the equipment
- snow study kit with: snow thermometer, snow saw, crystal screen, magnifying loupe, ruler, field book, pencil, gloves, compass, altimeter, inclinometer, and any additional equipment required for snowpack tests
- portable Ministry radio and spare battery / InReach transponder
- clothing suitable for outdoor work in the variable conditions at the worksite
- headlamp
- eye protection with 100% UV filtering
- survival equipment appropriate to the potential exposures found at the site
- over-snow travel equipment such as skis, split-board, boots, bindings, poles, climbing skins, snowshoes
- wood saw, fire starter

***Note:** The District Avalanche Supervisor ensures that inventories of Ministry fieldwork and snow science equipment are maintained.*

Reference Materials

Canadian Avalanche Association, *Observation Guidelines and Recording Standards for Weather, Snowpack and Avalanches*

WorkSafeBC Regulation, Policy and Guidelines are found online at:

<http://www.worksafebc.com/>

6.0 Operational Procedures

6.01. Pre-Winter Meeting

An avalanche area specific meeting of Maintenance Contractor and Ministry personnel will be held prior to the start of the avalanche season as a venue to discuss all aspects of the shared responsibilities for avalanche safety and efficient winter operations. The meeting offers a venue to establish performance expectations as well as to ensure all avalanche-related duties and training requirements are understood.

The District Avalanche Supervisor will convene and chair these meetings. Attendees should be asked to contribute agenda items. The District Avalanche Supervisor should ensure that once the agenda items have been defined the appropriate Ministry personnel that can address the agenda are invited to the meeting.

These meetings offer the opportunity to review the participation expected in response to a variety of events. Agenda items for review typically cover topics such as the following:

- Roles and responsibilities in the ERAP 2-0804 and a table top exercise
- Reporting of avalanche and weather observations
- Avalanche Hazard Levels and Specific Operational Procedures – Five Level Scale
- Requirements for check-in or tandem workers during elevated hazard
- Responding to an avalanche on an open highway

- Avalanche Search and Rescue
- Response to vehicle(s) stuck in an avalanche deposit
- Closure and sweep procedures
- Check-in procedures, local contacts for avalanche workers
- Avalanche Safety Plan and Snow Avalanche Safety Measures for Highways

***Note:** Meeting minutes will be kept and distributed by the District Avalanche Supervisor. In those minutes a specific and thorough reference should be made to the review/exercise of ERAP 2-0804 with the personnel identified in response roles by the ERAP. The minutes will be retained by the District Avalanche Supervisor.*

Reference Materials

Appendix II – Operational Objectives

- *Snow Avalanche Safety Measures for Highways Manual*

6.02. Avalanche Forecasts and Operational Procedures

The Ministry operates avalanche safety programs for areas of the provincial highway system where avalanches are expected to affect the highways. These are programs for monitoring weather, snow and avalanche conditions, for determining temporal fluctuations of avalanche conditions and for implementing safety measures to reduce avalanche risk.

Persons who perform work on behalf of the Ministry within these avalanche areas are trained to follow safe work procedures.

General Winter Operational Procedures

General Winter Operational Procedures are followed by all workers who have duties within the avalanche areas. These general procedures include the requirements for observations and communications as well as facility and equipment readiness as stated in the *Snow Avalanche Safety Measures for Highways Manual*.

Specific Operational Procedures

The *Snow Avalanche Safety Measures for Highways Manual* contains a matrix chart of a scale called Avalanche Hazard Levels and Specific Operational Procedures – in common usage, it is called the Five Level Scale. At each level, the scale identifies the nature of the expected avalanche activity alongside a set of Specific Operational Procedures to be followed by all workers in the avalanche area during the forecast period.

This Avalanche Hazard Levels and Specific Operational Procedures chart should be posted in areas where the current avalanche forecast is posted.

Avalanche Forecasts

Avalanche forecasts are created by Ministry Avalanche Technicians and issued through the SAWS system. The forecast form includes fields for current weather station data and weather forecast information. The system allows the Ministry Avalanche Technician to include information on weather, snowpack, snow stability, avalanche occurrences as well as the forecast of snow stability and the character of expected avalanche activity. There are areas for inserting comments and for identifying the persons/agencies that have been notified of the hazard level forecast.

The avalanche forecast is distributed to workers that have duties within the avalanche area. The avalanche forecasts:

- are produced when there is a change or update in the avalanche forecast as determined by the Ministry Avalanche Technician
- identify the area of concern, the expected duration of the forecast and the reason for the change in forecast level

- are provided to workers via Ministry radio system or telephone and /or posted electronically
- may cover a large geographic area or be specific to a small localized area
- reflect the highest hazard within the forecast area

The purpose of the avalanche hazard level forecast form is to inform highway workers of the current forecast level so they are able to follow the correct safety procedures. Each new forecast is posted at locations where workers muster so that workers coming on shift will be aware of the current avalanche forecast. Each change in forecast level is also conveyed to workers in the avalanche area via the Ministry radio system.

The Ministry Avalanche Technician should include detail and direction for workers to follow when operational requirements for specific times or locations vary from the specific operational procedures for a particular hazard level. One example of this is where workers are required to undertake avalanche deposit removal at safe areas within an avalanche area that is on an overall higher forecast level. Another example is where a worker is assigned to clear catchments at a specific avalanche path where the risk has been reduced to a Low hazard level even though there are other paths within the avalanche area at a higher hazard level.

Information on specific locations of heightened concern or on certain weather events that may cause the forecast level to change should be included in the information directed toward those working in the area. Documenting requests for weather and avalanche observations through the forecast period highlights the need for workers to supply information on changing conditions to the avalanche forecasters.

The avalanche forecast form is the primary location for Ministry Avalanche Technicians to record details of the contributing factors behind their decision to assign a specific forecast level. Successive avalanche forecasts should reflect the evolution of that reasoning alongside the details of the changes in snowpack, weather and avalanche activity in the forecast form. The avalanche forecast form is the document that allows the Ministry Avalanche Technicians to demonstrate a diligent process of assessing the fluctuations of avalanche conditions and for recording the appropriate implementation of safety measures.

Avalanche Forecast Distribution

The forecast is authored in SAWS and is automatically distributed via email or fax. The District Avalanche Supervisor creates recipient lists that are maintained by the Avalanche and Weather Systems Manager. There is at least one list for every avalanche area. Recipients include the Maintenance Contractor and Ministry offices responsible for that avalanche area. Other recipients vary from area to area but may include RCMP or other agencies with interests along the transportation corridor such as railways or electrical utilities.

The avalanche forecast is available to Ministry personnel across the province through SAWS, through direct inquiry to the TMCBC radio room, through inclusion on the email distribution lists or by visiting the Road Weather Information System mapping application.

Ministry avalanche programs subscribe to the Canadian Avalanche Association information exchange program called InfoEx.

Avalanche Forecast Short Form – “One-Liners”

Avalanche personnel are often required to issue avalanche forecasts while away from the Ministry computer network. When this situation arises the operators at the TMCBC will issue a short format avalanche forecast through SAWS at the direction of the Ministry Avalanche Technician. The Ministry Avalanche Technician can communicate the required information to the TMCBC operator via telephone or Ministry radio. These short format forecasts are typically referred to as “one-liners” as the primary purpose of the short form is to communicate the change in avalanche forecast level to workers in the avalanche area.

Use of the short format avalanche forecast form meets the need for rapid dissemination of changes to the current avalanche forecast level to workers but does not provide a complete record of the forecasting process. Following the issue of one or more short format forecasts (as required by the situation) the best practice is to issue a complete avalanche forecast form that includes details for the period of the short forms.

Hazard Level Signal Devices

At some Maintenance Contractor mustering points, the Ministry and the Maintenance Contractor have installed signalling devices to ensure that workers are aware of the current avalanche forecast level. These signals may be as simple as a painted pegboard with the forecast levels listed, or at some locations, a system of lights that correspond to the forecast levels is used. These devices are intended to increase worker awareness; they do not replace the requirement for worker access to the current avalanche hazard forecast form. The information displayed by the signal device is not intended for use by the travelling public.

The I-198-1 sign shown below is available for use in the maintenance yards and at mustering points to advise highway workers of the current avalanche hazard level. The sign should not be posted for public viewing.

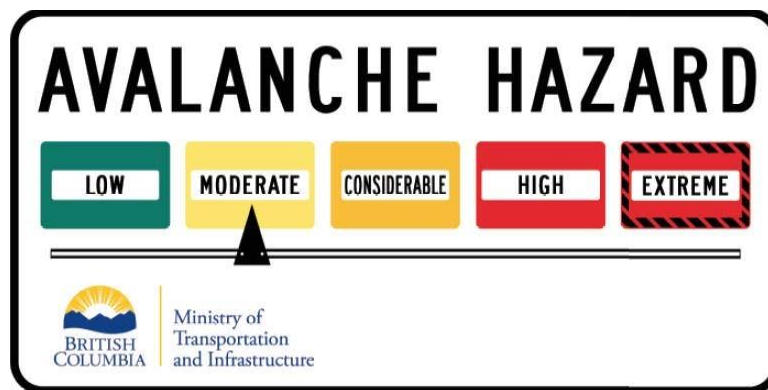


Figure 15 The I-198-1 Avalanche Hazard Level Sign

Reference Materials

Appendix II – Operational Objectives

- *Snow Avalanche Safety Measures for Highways Manual*

6.03. Avalanche-related Road Closures

Closures are primarily used to reduce the risk of highway users being involved in avalanches during periods of High and Extreme avalanche hazard. Road closures are also put into effect prior to the start of avalanche control missions. By closing off entry to the avalanche area and then evacuating the traffic and workers from within that avalanche area, the risk of avalanche involvement is removed for the duration of the elevated avalanche hazard. As the avalanche hazard abates, the Ministry Avalanche Technician will direct workers in a methodical re-entry into the avalanche area and, after the Maintenance Contractor has brought the road conditions back to an acceptable standard, the road is re-opened.

Roles and Responsibilities

The personnel required, and the process followed, is similar for each type of closure. The decision to initiate a closure, or to re-open a road, is made by the Ministry Avalanche Technician however the authority to close a highway rests with the District Manager, Transportation. The Maintenance Contractor is responsible for establishing the closure and supplying the personnel to control the closure area as well as for the operation and maintenance of the necessary equipment such as signs, gates and radios. Procedures and requirements for conducting avalanche-related road closures are found in the *Snow Avalanche Safety Measures for Highways Manual*.

Closure procedures are also described in the Explosive Use Operational Plan employed by Ministry avalanche programs closure procedures stated in that document provide some additional comments on closure methods and reasoning specific to blasting operations. The procedures described there should be understood by all Ministry avalanche blasters in addition to the contracted roles and responsibilities for closures that are stated in the *Snow Avalanche Safety Measures for Highways Manual*.

Closure Phases

The closure of a highway does not occur instantaneously at a single point in time. The objective of the closure is to exclude people from a hazardous area. In order to meet that objective, there are three distinct phases of the closure process:

- Traffic is stopped at the designated traffic control points; closure time (duration) begins and is recorded.
- Sweep begins after closure personnel verify that no new traffic can enter the closure area. Beginning of sweep time is recorded.
- Sweep is complete when the person(s) conducting the sweep can verify that no highway users remain inside the closure. End of sweep time is recorded.

All of these activities are part of an avalanche-related road closure. It is the elapsed time where the public is blocked from entering the avalanche area until the time when the road is reopened for public traffic that constitutes the length of time of a road closure.

The Maintenance Contractor assigns a person to expedite the closure and records of the location and timing of the phases of the closure. The record required is:

- Location of closure points

- Reason for closure
- Date and Time of closure to the public
- Date and Time that sweep begins
- Date and Time that sweep is complete
- Date and Time that the road re-opens to the public

The Ministry District Avalanche Supervisor is responsible for ensuring this data is entered into SAWS and may wish to keep their own record of these events. In addition to the required records noted above, a record of the time when the closure transitions from closure for avalanche hazard or control, to maintenance and deposit removal may be recorded.

Communication Requirements for Closures

Communications are a critical component of avalanche-related road closures. All personnel working on or in a closure area must be equipped with Ministry frequency radio equipment. Requirements for communications are stated in the *Snow Avalanche Safety Measures for Highways Manual* and the Explosive Use Operational Plan.

Closure Locations

Closure locations are often associated with avalanche barrier gates, particularly in active avalanche areas, although there are also locations without gates. Closure locations are chosen to meet a number of traffic management needs. The first consideration is to ensure lineups of stopped traffic will not extend into areas affected by avalanches. Typically, the closure points are also chosen for attributes such as near level terrain, free from avalanche hazards, appropriate sight distance and where there is turning space for transport trucks. Areas signed with the No Stopping Avalanche Area (P-066-1) signs cannot be used for traffic management (stopping, pooling or parking) while the signs are displayed.

A list of standard closure locations is maintained by the District Avalanche Supervisors in the SAWS application. Data extracted from SAWS using the Road Closure Locations Report function is used to provide the current list of closure locations found in Appendix D, Closure Locations, of the *Snow Avalanche Safety Measures for Highways Manual*.

At times there will be requirements to control traffic or implement planned highway closures for events unrelated to avalanches such as construction projects. In these situations, the planning for traffic management must consider that areas signed with the No Stopping Avalanche Area (P-066-1) signs cannot be used for traffic management (stopping, pooling or parking) while the signs are displayed. Traffic must be controlled outside of the signed avalanche areas in order to prevent the loss of safe traffic management options that may occur when vehicles are stopped directly in avalanche paths as increased avalanche hazards may occur.

Personnel manning the closures do so in accordance with the *Traffic Management for Work on Roadways*, BC MoTI, Engineering Branch.

Note: District Avalanche Supervisors are responsible for ensuring that the closure location information in SAWS is complete and current.

Avalanche Closure Gates

Information on Avalanche Closure Gates is found in *Traffic Management for Work on Roadways*, BC MoTI, Engineering Branch.

<https://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/engineering-standards-guidelines/traffic-engineering-safety/trafficmanagementmanual>

Information on installation and maintenance of gates can be found in the *Snow Avalanche Safety Measures for Highways Manual*.

Public Notifications - DriveBC

DriveBC is the public internet and telephone portal for information on highway conditions across BC. The Ministry has developed a number of standardized statements relating to avalanche closures that are made available to the public through the DriveBC systems.

Ministry Avalanche Technicians use these statements to warn of upcoming highway closure. Once closures are in place, the statements include a time frame for updates to the information, possible opening times and a confidence rating for the timing of those events.

The Maintenance Contractor is responsible for providing road condition updates to the public. This includes, but is not limited to, Drive BC and Overhead message signs.

Reference Materials

Appendix II – Operational Objectives

- *Snow Avalanche Safety Measures for Highways Manual*

Appendix VIII – Explosives

- *Explosive Use Operational Plan*

BC Ministry of Transportation and Infrastructure, Engineering Branch, *Traffic Management for Work on Roadways*

<https://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/engineering-standards-guidelines/traffic-engineering-safety/trafficmanagementmanual>

6.04. Manual Data Acquisition and Management

Avalanche field programs acquire several types of data that are used for short term avalanche forecasting as well as for long term planning.

The District Avalanche Supervisor initially captures this data to meet program requirements for observation, consolidation and evaluation of relevant information for snow stability analysis and avalanche forecasting. An equally important use of this data is in the analysis of historical patterns in weather, snowpack, avalanche activity and the effects on the highway system.

Weather, snowpack and avalanche occurrence data are collected in accordance with the Observation Guidelines and Recording Standards for Weather, Snowpack and Avalanches (OGARS).

Avalanche Occurrences

Ministry Avalanche Technicians make observations of avalanches that occur on avalanche paths along the highway corridors. The initial objective of gathering this data is for communication of avalanche occurrence information among the avalanche forecasting team.

In avalanche areas where the District Avalanche Supervisor is responsible for a widely dispersed number of avalanche areas, it is common for the Maintenance Contractor to record avalanche observations and to pass the information on to the Ministry Avalanche Technicians in a timely manner. Maintenance Contractor personnel can record avalanche occurrences on the H-664 Avalanche Occurrence Report form and provide that record to the District Avalanche Supervisor.

The Ministry supplies avalanche occurrence field books that allow field staff to gather the information in a manner compatible with data entry into SAWS. Once gathered, the avalanche occurrence data is manually entered into the SAWS system and is available to avalanche personnel and others using that system.

The avalanche occurrence data has a high value when used as resource material during the design of avalanche risk treatment during highway improvement projects. The occurrence data is summarized in the Ministry avalanche atlases.

The District Avalanche Supervisor is responsible for ensuring the data is collected at a high quality, for reviewing the data entered into the SAWS system and for the quality of the data.

Snowpack

Information on the structure of the mountain snowpack, along with a record of tests performed to evaluate the strengths and weaknesses of the snowpack, are obtained through snow profile observations at various field locations. Snow profiles are taken at established study plots or at safe locations near the avalanche starting zones.

A record of the snow profile data is made in the field following CAA guidelines. In the office, this data is transferred into a graphical snow profile format. The record of the snow profile data is stored in the SAWS system.

Avalanche-related Road Closures

Information on all highway closures associated with avalanche programs is recorded by the Ministry Avalanche Technician. *Section 6.03 Avalanche-related Road Closures* of this plan has details regarding the highway closure information collected and stored in SAWS.

Reference Materials

Appendix IV – Operational Procedures

- *Form H-664 Avalanche Occurrence Report*

Canadian Avalanche Association, *Observation Guidelines and Recording Standards for Weather, Snowpack and Avalanches*.

6.05. Quality Assurance

Program Quality Assurance

The primary objective of a program review is to determine the status of avalanche programs with respect to their ability to safely and efficiently carry out their duties and responsibilities. In meeting those objectives, the renewed process strives to ensure that key roles and responsibilities for managing the avalanche programs are respected and that this review empowers the District managers to ensure that the avalanche program in their District is consistent with ministry policies, procedures, standards and guidelines as well as external regulatory requirements.

District Avalanche Program Reviews

Avalanche Program reviews will focus on numerous items to ensure safe, effective and efficient operations. An emphasis will be placed on technical training, operational safety and regulatory aspects of the programs with additional consideration given to program maintenance and development. The following list is intended to provide some examples of avalanche program functions. It is likely that, due to specific needs and situations, audits will include items not mentioned here.

- program preparedness
- training objectives and achievements
- operational procedures
- search and rescue capabilities
- fieldwork sites, objectives and preparedness
- safe field travel
- regulatory compliance
- equipment and infrastructure
- documentation and record keeping
- explosives safety, training and regulatory compliance
- field route atlas's

The purpose of the program review is not to evaluate all details of an avalanche program at any one time but rather to gauge the state of the program through the review of a range of items. The Avalanche Safety Plan along with the associated documents and appendices forms the basis for determining the topics covered during a review. There may be other items or issues introduced to the review as required; this may include requests by the participants for review of specific policies, procedures or work processes.

In a number of cases, the Avalanche Safety Plan identifies documentation expectations are intended to enable avalanche field crews to demonstrate diligence in meeting their responsibilities. This documentation of events and activities varies from simple notations in program logs or in field books, to documentation that is required by the maintenance contract. There are also instances of documentation that must be undertaken in order to comply with external regulatory requirements. Most reviews will include requests for a representative sample of some of the avalanche program records.

District Avalanche Program Review Frequency

Avalanche Program Reviews will be conducted on a regular basis and should be considered routine. The following guideline provides direction regarding the frequency of Avalanche Program Reviews.

- Specific Event or Incident
- At the request of the District Manager
- A minimum of two (2) Avalanche Programs reviews will be conducted by Senior Avalanche staff annually.

Process

The Senior Manager, Avalanche and Weather Programs will establish a review/training availability schedule for the Senior Avalanche Officers and provide the general schedule to the District. In turn, District managers may request that a review of a Ministry avalanche program be conducted in their avalanche area(s). In cases where District managers do not confirm a specific schedule or request a review, the Senior Manager, Avalanche and Weather Programs may assign a Senior Avalanche Officer to undertake a review at a specific time and notification will be provided to the District.

The Senior Avalanche Officer will generate a report shortly after the review and the Senior Manager, Avalanche and Weather Programs will provide the report to the District Manager. The report will indicate the areas of the program that were inspected and the status of each item. Recommendations may be made to assist the avalanche program personnel with reaching program goals. District Managers will be able to implement recommendations from the review. The reports and recommendations will be reviewed during subsequent reviews, and the status of any unresolved issues will be carried forward.

The primary goal of the avalanche program reviews and subsequent recommendations is to ensure safety to the avalanche crew, and that the avalanche program operates as effectively and efficiently as possible. This process will also ensure that all avalanche programs consistently apply avalanche risk hazard management principals in a method which complies with the Ministry's policies and standards.

The secondary objective is to identify future initiatives that will lead to the betterment of the avalanche risk management program.

Annual Reports

Reporting out from the field level to both management streams allows the District Avalanche Supervisor a venue for evaluation from within the program. The annual report provides an evaluation of the effects of weather and snowpack conditions on the outcomes of the avalanche season. Annual Reports to be submitted to the Manager, Avalanche and Weather Programs at end of each avalanche season.

This is also the venue to build support for improvements and projects. Information on work that is planned for the period leading to the next season, as well as general schedules for that work should be presented here.

Reference Materials

Appendix IV – Operational Procedures

- *Outline for Avalanche Program Annual Reports*

7.0 Avalanche on Highway Search and Rescue Incident Response Plan

7.01. Avalanche on Highway Search and Rescue Incident Response Plan

Ministry, Maintenance Contractor, and Regional Transportation Management Centre (TMCBC) staff are trained to participate in a response to an avalanche on the highway. There are three main components to the Avalanche Search and Rescue plans.

- **Avalanche Response Plan – Report of an Avalanche on Highway and Avalanche Search and Rescue** is in place at the TMCBC. Details of any report of an avalanche on an open highway are recorded and the TMCBC contacts the responsible avalanche program for further response.
- **Avalanche Search and Rescue Plan – Incident Commander** plan is in place for each avalanche area for the use of Ministry avalanche staff. This portion of the plan guides the overall rescue and provides current contact information for a wide variety of rescue resources.
- **Avalanche Search and Rescue Plan – Task Force Team** plan is in place for use by Ministry staff and Maintenance Contractor staff that may be called upon to direct rescue efforts at the site of the avalanche. This portion of the plan is identical throughout the province. It is typically distributed to Road Foremen, avalanche staff and Ministry Area Managers; copies are also available in the Avalanche Rescue Equipment Caches.

Not all reports of an avalanche on an open highway will result in a full rescue response. When an avalanche is reported to the TMCBC, the Avalanche Response Plan is initiated, and details of the avalanche report are recorded. The TMCBC then contacts the staff of the responsible avalanche program and relays the avalanche report to that person who then becomes the Incident Commander.

The Incident Commander decides how far to proceed into a rescue based on the report from TMCBC as well as other information that is available such as reports from maintenance personnel or Ministry employees at the scene. The Incident Commander may determine that there is no possibility of a burial and have all responders stand down or they may determine that a rescue is required and assign a Task Force Team to undertake the rescue. The duties of the Incident Commander may be handed off to another trained plan holder if it is determined that the originally assigned Incident Commander is in the best position to act as Task Force Team Leader.

The TMCBC, Incident Commander and Task Force Team Leaders should be careful to make notes of all communications, times and actions taken during the rescue. The rescue plan components are designed to accommodate the appropriate notes.

7.02. Plan Maintenance and Distribution

Section 5 of *Snow Avalanche Safety Measures for Highways Manual* contains some information regarding the maintenance and distribution of Avalanche on Highway Search and Rescue Incident Response Plan. Additional information on this topic is found on the Avalanche on Highway Search and Rescue Incident Response Plan electronic file share site that all Ministry avalanche programs have access to. That file share site also contains files that detail the process of updating and distributing the Avalanche on Highway Search and Rescue Incident Response Plan; all avalanche field programs are expected to be familiar with and follow those directions.

The **Avalanche Response Plan – Report of an Avalanche on Highway and Avalanche Search and Rescue** used by staff at the TMCBC is maintained by the Senior Avalanche Officers with updates provided by each avalanche program. Only persons who are Incident Commander plan holders are listed as contacts in the TMCBC plan.

Updates to this plan are **required** when there are changes to avalanche program staff or their contact information – this includes changes in phone numbers as well as notification of hire/layoff of staff. District Avalanche Supervisors provide this information to the Senior Avalanche Officers when the change occurs.

No distribution beyond the TMCBC is required for this portion of the plan.

The **Avalanche Search and Rescue Plan – Incident Commander** for each avalanche area is maintained and distributed by the avalanche program staff. Plan holders of the Incident Commander plan are typically restricted to the avalanche program responsible for the area, headquarters avalanche staff that may act as coordinator and, in some instances, a nearby neighbouring Ministry avalanche program.

This section of the rescue plans contains contact information for a variety of external rescue resources and internal Ministry contacts. It is typical to review, verify and update all contact information prior to the onset of winter. Additional changes are often required during the winter season. Once updated, an email distribution notice is sent to each plan holder to allow them to print updated copies of the plan from one central file share location. All plan holders acknowledge that they have updated their plans by signing off on a shared distribution list.

***Note:** notifications of updates to the **Avalanche on Highway Search and Rescue Incident Response Plan** are sent by email. Those emails and the shared distribution list are the records of changes to the plan.*

The **Avalanche Search and Rescue Plan – Task Force Team** is a generic plan used to guide the Task Force Team Leader at the scene of the avalanche rescue. There is no regular updating required as there are no contact numbers in this section of the plan. This section of the plan is distributed to all persons who are trained to direct an avalanche rescue in specific avalanche areas. This includes the trained Ministry and Maintenance Contractor employees that work in the avalanche areas as well as the managers that oversee the avalanche area. Copies of this section of the search and rescue plans are also included in the Avalanche Rescue Equipment Caches, usually in the Task Force Team packs.

Note: a record of the distribution locations of the Avalanche on Highway Search and Rescue Incident Response Plan will be kept by each avalanche program. The District Avalanche Supervisor will document an annual or more frequent audit that ensures all Avalanche on Highway Search and Rescue Incident Response Plans are in place for their avalanche areas.

7.03. Training

The type and amount of training for participating in an avalanche response or search and rescue varies with the role of the individual.

The highest level of training is required of the Ministry avalanche staff that may fill the roles of Incident Commander, Task Force Leader or Strike Team Leader. Training to fill these roles is acquired from the Canadian Avalanche Association training courses required for all Ministry avalanche workers. Additional training is conducted during local mock rescue practices and transceiver training sessions.

Persons who may be called upon to act as the Task Force Team Leaders are trained in accordance with the training requirements set out in *Section 3.0* of the *Snow Avalanche Safety Measures for Highways Manual*. Additional training is conducted during the annual one-day avalanche safety training courses as well as during local follow-up (mock rescue) practices and transceiver training sessions.

Note: The Maintenance Contractor must record and supply dates of avalanche training for Maintenance Contractor and sub-contractor personnel. These records will be supplied to the Ministry upon request. Ministry personnel must be able to demonstrate that they have completed the appropriate training.

TMCBC staff is trained by Ministry personnel to respond to a report of an avalanche on the highway during an annual pre-winter meeting and training session.

Note: the minutes of the TMCBC pre-winter meeting will constitute the training record.

Snow Avalanche Safety Measures for Highways Manual contains recommendations on the content and frequency of follow-up Avalanche Rescue Training for Ministry and Maintenance Contractor staff. The intention of these sessions is to focus on transceiver skills, terrain familiarity and mock rescue practices.

Note: The Maintenance Contractor must record and supply records indicating the avalanche follow up training dates of all avalanche training for Maintenance Contractor and sub-contractor personnel. These records will be supplied to the Ministry upon request. Ministry personnel must be able to demonstrate that they have completed the appropriate training.

7.04. Avalanche Rescue Equipment

The *Snow Avalanche Safety Measures for Highways Manual* describes requirements for avalanche rescue equipment in *Section 4.0*. The location and Level of Avalanche Rescue Equipment Caches are described in Appendix A and the contents of Avalanche Rescue Equipment Caches are listed in Appendix B of that document.

7.05. Backcountry Avalanche Risk Assessment Protocol

Ministry avalanche program staff may receive requests from outside agencies to participate in avalanche search and rescue missions that are unrelated to Ministry operations. The Ministry has established an agreement with Emergency Management British Columbia, RCMP, and the British Columbia Coroners Service that defines the conditions of participation.

The agreement, first and foremost, recognizes that responding to these unrelated avalanche rescues is not an employment requirement of any Ministry of Transportation and Infrastructure personnel. Ministry employees may refuse to participate in a non-highway rescue. The Ministry will allow an employee to participate in a rescue and receive full pay, benefits and coverage should injuries or death occur as a result of that participation.

Reference Materials

Appendix II – Operational Objectives

- *Snow Avalanche Safety Measures for Highways Manual*

Appendix V – Avalanche Search & Rescue Plans

- *Backcountry Avalanche Risk Assessment Protocol*
- *Avalanche on Highway Search and Rescue Incident Response Plan*
- *Field Work Search and Rescue Incident Response Plan*
- *Vehicle Inserts*

8.0 Incident Review

8.01. Ministry Incident Reporting and Investigation Policy

The general requirements for reporting and investigating incidents that occur during the course of Ministry work are described in the *Core Requirements* section of the *Ministry of Transportation and Infrastructure, Health and Safety Manual, 1.4: Incident Reporting and Investigations, Policy 1.4.1 Incident Reporting and Policy 1.4.2 Incident Investigations*.

8.02. Avalanche Incidents

Avalanches, like many occurrences in nature, can be unpredictable and unexpected. All persons involved in the delivery of an avalanche safety program must accept that there will always be a level of uncertainty when forecasting potential avalanche risks and can be influenced by numerous variables. Occasionally there will be avalanche events that exceed the operational risk band.

In the worst case, an avalanche occurrence may result in harm to highway users and/or damage to property. In other cases, an avalanche that exceeds the risk thresholds may affect an open highway with no vehicle involvement; yet this is still an incident which merits attention as a forced closure or near-miss occurrence.

In either case, reviewing events that fall outside of the operational risk band will offer insight into the possible reasons for the event. The review will also help to identify any improvements in current risk management policies and procedures which may point to preventive measures for the

future. A report on the event will serve as the basis for analyzing the causes of incidents and for recommending the appropriate change.

The formalization of a *process* for incident reporting is desirable but attempting to assign a single reporting *standard* to all unwanted events is problematic. The potential for avalanches to cause loss or damage ranges from minor to catastrophic and the resources committed to the review of an avalanche incident should reflect the potential of the event.

Incident Reporting Decisions

The Ministry relies on the skills and judgment of District Avalanche Supervisors to achieve the operational avalanche risk management goals of the Ministry. The simplest expression of those goals is stated in the primary objectives of the avalanche program:

- a) ensure the safety of highway users
- b) minimize the frequency and duration of avalanche-related road closures

These objectives can be applied as the upper and lower limits of an operational risk band, a concept that can be reviewed in *Section 2.0 Operational Objectives* of this document. In that section, there are three Ministry documents introduced, *Snow Avalanche Safety Measures for Highways Manual*, *Threshold Guidelines for Avalanche Safety*, and *Avalanche Forecasts and Specific Operational Procedures*. Those documents are not only used when establishing avalanche hazard levels, but they are also equally valuable when reflecting on events that fall outside of the operational risk band.

The Ministry relies on the District Avalanche Supervisor to demonstrate the same skills and judgment applied in avalanche forecasting to their evaluation of an incident. District Avalanche Supervisors are well-qualified to recognize conditions that fall outside of the operational risk band. Applying guidance from the documents mentioned above, the District Avalanche Supervisor is able to judge the potential or actual consequences of a specific event and reach a decision as to the nature and depth of incident review merited by the event.

Process

District Avalanche Supervisors are responsible for ensuring that appropriate steps are taken when incidents occur. The process for recording events and providing information to others in the Ministry is as follows:

- The District Avalanche Supervisor will record details, including photographs, of the event.
- The District Avalanche Supervisor will ensure the occurrence details are entered into SAWS and is labelled as an incident.
- The District Avalanche Supervisor will notify their District Manager of Transportation as well as headquarters Avalanche & Weather Programs as soon as is reasonable and fitting given the situation and the severity of the incident.
- If appropriate to the severity of the incident, the District Avalanche Supervisor will provide an initial report to the District Manager of Transportation as well as headquarters Avalanche & Weather Programs as soon as reasonably possible of the event;

- The District Avalanche Supervisor and Avalanche & Weather Programs staff will determine the appropriate level of detail for a review.
- The District Avalanche Supervisor will provide a report that examines the event and, if appropriate, make recommendations for consideration. When events have caused or had the potential to cause severe losses, a Senior Avalanche Officer will work in cooperation with the District Avalanche Supervisor (and others where appropriate), to produce this report and the recommendations for consideration.
- The District Manager of Transportation and the Senior Manager, Avalanche and Weather Programs will review and consider recommendations within their area of responsibility.
- Incident recording, tracking and any follow-up actions will be documented. It is the responsibility of the Headquarters Avalanche Program staff to maintain these records and ensure follow-up actions have been considered or taken.

8.03. Non-highway Incidents

Ministry avalanche workers may be involved in a wide variety of work activities that expose them to avalanche risks. Some examples include attending to non-highway avalanche incidents, incidents that occur during work, or around aircraft, or an untoward event that occurs during fieldwork. Avalanche workers have a responsibility to examine the event and consider the possible need for informing others in the Ministry and for reviewing the events. Workers should evaluate the event in a manner similar to that described above in order to reach the appropriate decision on whether to report and review a particular event.

8.04. Regulatory Requirements to Report Incidents

Where there is an external regulatory requirement to report an incident the Ministry staff involved will ensure that those requirements are met. For example, agencies that may be involved are Transport Canada, WorkSafeBC or Natural Resources Canada Explosive Regulatory Division. Avalanche workers should be familiar with these regulations. Incidents and associated reports which occur under Regulatory compliance must meet specific agency standards.

Reference Materials

Appendix VI - Incident Review

excerpts from *Ministry of Transportation and Infrastructure, Health and Safety Manual, Core Requirements, Incident Reporting and Investigation:*

- *Policy 1.4.1 Incident Reporting*
- *Policy 1.4.2 Incident Investigations*

WorkSafeBC Regulation, Policy and Guidelines are found online at:

<http://www.worksafebc.com/>

9.0 Fieldwork Sites and Working Alone or in Isolation

Ministry Avalanche and Weather Network (AWP) workers are required to travel to remote fieldwork locations during the course of their work. The purpose of travelling in mountainous terrain to these sites is to gather weather, snowpack and avalanche observations as well as to ensure the continued functioning of remote installations such as weather monitoring equipment

and avalanche control installations. These activities are in direct support of, and a component of, the Ministry highway avalanche safety program.

Work sites with permanent equipment installations such as weather stations are typically sited outside of terrain affected by avalanches. Some equipment for avalanche control, such as the GazEx exploders are permanently mounted in avalanche start zones where visiting workers may be exposed to avalanche hazards.

Ministry AWP workers are required to gather snowpack, weather, and avalanche occurrence information from worksites located throughout the mountains that form the highway avalanche areas. Workers travel to and from specific work sites by various means including helicopter, over-snow vehicles, ski, snowshoe, on foot or in a motor vehicle. The greatest degree of vulnerability to avalanche hazards for Ministry AWP workers is found during over snow travel to, from and at these work sites. These travel routes are the largest component of the fieldwork sites. When moving through mountainous terrain, the travel routes and activity locations must be determined by qualified persons.

The Ministry follows the CAA avalanche risk guidelines related to transportation corridors and the public user. Ministry avalanche workers travelling in the field follow CAA commercial backcountry operation guidelines.

Those risk management controls recommend various planning measures, safety measures, risk assessments and typical mapping and terrain documentation based on avalanche destructive potential and return period. The basic premise is that potential hazards to workers will be identified with safety plans put in place to manage the risks.

9.01. Fieldwork Atlases – Workplace and Risk Identification

Fieldwork atlases describe Ministry workplace locations of facilities, field observation sites and areas where workers travel in mountainous terrain.

The avalanche worker constantly monitors and reviews avalanche hazards and chooses terrain accordingly to reduce all risks and remain within acceptable risk tolerances.

The Parks Canada Avalanche Terrain Exposure Scale (ATES) technical model has been adapted and applied to the avalanche workers fieldwork atlas (AWP Mountain Travel Matrix) providing consistency in evaluating avalanche terrain.

The worksite descriptions in the atlases supply the connection between the check-in procedures and a search and rescue effort. The Fieldwork Atlas will provide the persons overseeing check-ins with clearly identifiable locations which can be relayed to responders in the event a response is required.

If a staff member is planning to do work in a new area where there is not an existing check-in procedure, atlas entry and hazard review, the staff member will evaluate and document the terrain in their atlas, define the check-in procedure and submit it to the appropriate locations prior to the commencement of work.

In general, the atlas will contain an entry for each workplace. Each entry consists of a map, a workplace data sheet describing the worksite with the avalanche exposure and an annotated

photograph of the area. Appendix VII, Fieldwork Atlas Format, shows the required mapping and worksite summary format.

Note: The District Avalanche Supervisor will prepare an atlas of fieldwork sites following the standards in Appendix VII and ensure that the content is current. Current copies of the atlas will be available to all fieldworkers and provided to the applicable local check-in contacts, TMCBC and Senior Avalanche Officers. In the case of developing a fieldwork atlas for the Environmental Electronics Technicians, a Senior Avalanche Officer will assess the terrain that access's the work site using the ATES scale and develop a Fieldwork Atlas and safe work procedures for that specific work area

Avalanche Risk
Travel Controls for MOTI workers

	ATES Simple Terrain		ATES Challenging Terrain			ATES Complex Terrain		
Competency Training	Hazard Low-Moderate	Hazard Considerable and Higher	Hazard Low-Moderate	Hazard Considerable	Hazard High to Extreme	Hazard Low-Moderate	Hazard Considerable	Hazard High to Extreme
Professional Forecaster	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
Avalanche Worker	Allowed	Allowed	Allowed	Forecaster Consult	Forecaster Consult	Forecaster Consult	Forecaster Consult	Forecaster Consult
Backcountry Worker	Allowed	Forecaster Consult	Restricted	Restricted	Restricted	Restricted	Restricted	Restricted
Assistant Backcountry Worker	Allowed	Forecaster Consult	Restricted	Restricted	Restricted	Restricted	Restricted	Restricted

Professional Forecaster

District Avalanche Supervisor- District Avalanche Technician

CAA Level III or equivalency

Avalanche Worker

District Avalanche Assistant

CAA Level II

Backcountry Worker

Environmental Electronics Technici; / Assistant EETS

CAA Level 1

Assistant Backcountry Worker

Assistant Environmental Electronics Technician

RTAM

Figure 16 AWP Mountain Travel Risk Matrix for Workers (Appendix VII)

Table 2. Avalanche Terrain Exposure Scale

Terrain characteristic	Simple	Challenging	Complex
Slope angle	Angles generally < 30°	<i>Mostly low angle, isolated slopes >35°</i>	<i>Variable with large % >35°</i>
Slope shape	Uniform	Some convexities	Convuluted
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	<i>Many depressions, gullies, cliffs, hidden slopes above gullies, cornices</i>
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	<i>Numerous and overlapping paths</i>
Route options	Numerous, terrain allows multiple choices	A selection of choices of varying exposure, options to avoid avalanche paths.	<i>Limited chances to reduce exposure, avoidance not possible.</i>
Exposure time	None, or limited exposure crossing runouts only	<i>Isolated exposure to start zones and tracks</i>	<i>Frequent exposure to start zones and tracks</i>
Glaciation	None	<i>Generally smooth with isolated bands of crevasses</i>	<i>Broken or steep sections of crevasses, icefalls or serac exposure</i>

* Recently harvested cutblocks are included in the definition of open terrain.

** Terrain that qualified under an italicized bold descriptor automatically defaults to that terrain class or a higher terrain class.

Figure 17 Avalanche Terrain Exposure Scale (Appendix VII)

9.02. Pre-trip Plan

When Ministry AWP workers travel through areas that have been identified and assessed in the fieldwork atlas they are likely to be exposed to residual avalanche risks that cannot be eliminated entirely by terrain choice. Skill and training are required to make reliable assessments of the current snow conditions in those workplaces.

An objective assessment of overall avalanche risk for a particular work site is made prior to going into the field. While this assessment may change as new information becomes available during a field trip, a pre-trip plan is a valuable tool for screening out currently hazardous areas, identifying locations where conditions are suitable for work to take place, and discussion of options that may be followed if existing conditions force a change in the work plan.

During the pre-trip planning session, it is important to consider the skills of the group as part of the decision process. Most Ministry avalanche workers are trained and experienced at a level that allows them to maintain professional level membership in the CAA. Where workers have a lower level of training the exposure to avalanche hazards should be limited to times and terrain appropriate to their skill level. AWP have developed a mountain travel matrix intended to match worker skill with the appropriate terrain and avalanche risk conditions. The AWP Mountain Travel Risk Matrix was developed based on Parks Canada's Mountain Travel Risk Matrix. The *AWP Mountain Travel Risk Matrix* can be found in Appendix VII.

WNP employees are restricted to simple terrain unless accompanied by a Professional Avalanche Worker (Professional member of the CAA). When avalanche forecaster consultations are required, (see *AWP Mountain Travel Risk Matrix* Appendix VII) WNP Backcountry Workers

will contact the local Ministry Avalanche Technicians for any pertinent avalanche risk information prior to trip departure. In conjunction with *Section 9.03 Check-in Procedures* of the Avalanche Safety Plan, all WNP employees will submit the appropriate details to TMCBC for the “*Check-in Procedures*”. This will include using the local Ministry Avalanche Technician as their local point of contact in the case of an emergency. If required, any backcountry emergency rescue involving a WNP employee will be initiated either by the worker themselves or the local point of contact identified in the *Check-in Procedures*.

Appendix VII also contains an example of a pre-trip evaluation worksheet that allows AWP workers to document their evaluation of current conditions found at worksites they are proposing to use; a similar practice is followed in commercial backcountry operations. This practice also finds a parallel in the WorkSafeBC concept of holding a Toolbox Meeting where specific hazards and risks have been identified and associated with a type of work activity and need to be discussed and evaluated for the current situation at the worksite. In the development of the Ministry’s pre-trip plan, all workers should be included in the discussion and review. The pre-trip plan documents work goals, evaluation of all hazards, and the methods of mitigating those hazards. A post-trip evaluation of the field activities is useful as a learning tool and in preparing for additional fieldwork operations.

Environmental Electronic Technicians (EET) will use the latest Avalanche Canada public bulletin for their region to initially assess the current avalanche hazard, as well as consult with the local highways District Avalanche Supervisor regarding an avalanche risk assessment. The EET’s will then apply that information to the AWP Mountain Travel Risk Assessment Matrix to determine if there are able, under current conditions, to access certain work sites.

***Note:** AWP workers document and save their pre-trip planning for fieldwork.*

9.03. Check-in Procedures

All Ministry avalanche workers are required to use the check-in procedures when undertaking fieldwork. Ministry avalanche workers must be trained in the use of the procedures. The check-in procedures rely on the Ministry radio system as the primary means of communication. Every employee must have ready access to a Ministry radio.

The procedures require that a local contact person must be established prior to undertaking fieldwork; the local contact must be trained in the use of Ministry radio systems and have ready access to a compatible radio. The person must also be trained to fulfill the duties of the local contact as stated in the check-in procedures.

The Environmental Electronic Technicians will always use a Ministry Avalanche Technician for a local contact.

***Note:** The Ministry District Avalanche Supervisor will review the check-in procedures annually with all avalanche workers and all local contacts. A record of that training will be retained by the District Avalanche Supervisor.*

Training of TMCBC staff occurs annually at a pre-winter meeting; meeting minutes will contain a record of attendance and training. TMCBC keeps a log of all fieldwork check-ins.

Emergency Preparedness and Response

In the event that Ministry avalanche workers fail to meet a scheduled check-in, the TMCBC will follow the written procedures. The stages of response include further attempts to contact the workers, instructing the local contact to undertake a preliminary search, contacting the nearest Ministry Avalanche Technician and the Senior Manager of the Avalanche and Weather Programs.

Summary:

- Ministry worksites are identified, hazards are analysed (atlases)
- Check-in procedures are established and personnel are trained in the procedures
- Workers review the identified hazards and assess all aggregated risks prior to conducting fieldwork (pre-trip plan)
- Check-in procedures are followed in the field
- Conditions presented in the field are constantly re-evaluated
- Missed Check-In Procedures; plan is in place for a missed check-in or if assistance is required

Reference Materials

Appendix V – Avalanche Search & Rescue Plans

- *Backcountry Avalanche Risk Assessment Protocol*

Appendix VII – Fieldwork or Working Alone or in Isolation

- Check-in Procedures
- Fieldwork Atlas Format
- Fieldwork Pre-Trip Plan
- Avalanche Terrain Exposure Scale
- AWP Mountain Travel Risk Matrix

10.0 Explosives

Ministry workers are required to purchase, handle, store, transport and fire explosives; this is done in accordance with federal and provincial statutes and regulations. The government bodies that are responsible for the acts and regulations include:

- **Transportation of Explosives** - Transport Canada, Transportation of Dangerous Goods Directorate is the federal body responsible for the Transportation of Dangerous Goods Regulation.
- **Storage of Explosives** - Natural Resources Canada, Explosive Safety and Security Branch, is responsible for administering the federal Explosives Act and regulations. Through the Explosives Regulatory Division (ERD), the Branch provides services and support to the explosives industry.
- **Explosive Use** - WorkSafeBC regulation dictates how explosives are used in BC. They also examine and certify individual blasters for specific types of blasting operations.

WorkSafeBC regulation also describes the conditions under which explosives are transported or stored.

10.01. Transporting Explosives

All Ministry workers that transport explosives will be trained and certified in accordance with the Transportation of Dangerous Goods Regulation. That training may be obtained in-house or from an external provider; a record of that training that has been endorsed by the employer must be carried when transporting explosives.

Ministry employees that transport explosives will be required to respond in the event of an explosive spill occurring during transportation. The employee must carry, and be trained in the use of, Emergency Response Assistance Plan (ERAP) 2-0804. This plan is reviewed and accepted by Transport Canada. Annual training for all personnel in this response plan is a requirement. Ministry avalanche personnel are responsible for ensuring that all Ministry and contractor personnel may be required to use the ERAP in their area and receive this annual training. Copies of the ERAP can be obtained from HQ for distribution by the district avalanche staff.

The TMCBC plays a key role in the ERAP. Annual training for TMCBC staff is typically conducted and documented during the pre-winter avalanche meeting.

***Note:** The District Avalanche Supervisor maintains a training record for personnel that are required to have the annual ERAP 2-0804 training.*

All dangerous goods shipping documents must be retained for two years.

10.02. Storage of Explosives

All explosives are stored in magazines licensed by the Explosive Regulatory Division. There is no specific training course or certification required for magazine license holders or users. Magazine construction and operation standards are published by the ERD. The ERD issues directive letters to magazine licensees when changes are made to the standards.

In general, magazines are kept in a clean and orderly condition at a site that has been found acceptable by the ERD. Magazine capacity is determined by the ERD and is documented on the license.

Magazine inventories are kept in a log stored inside each magazine. The log must show the current quantity of each type of explosive in the magazine, the date of any change in quantity or of an inventory count along with the signature of the person making the log entry. The Ministry keeps an external log of explosive inventories for each magazine in a shared electronic file.

Magazine door locks require a key type that may only be purchased from the magazine door manufacturer. Magazine keys must be stored in a secure, locked, location and when not in storage must be under the direct control of a responsible person. Keys are never left unattended when not in locked storage. If any magazine key is lost or stolen the lock must be replaced immediately.

Magazines must have a security surveillance program in place in order to be in compliance with the regulation set out in Directive Letter 61 of December 2007. There are two options for

surveillance, a daily visit to inspect the magazine or an electronic monitoring system that reports to the licensee.

Storage of explosives during the operational avalanche season is both necessary and unavoidable. Magazines should be emptied between avalanche seasons. The risk and liability reduction attained by emptying the magazines outstrips the costs of returning explosives to the vendor. Artillery projectiles must be stored year-round and are generally subject to storage in magazines of a higher security standard.

WSBC 4.17 asks that local fire departments be informed of explosive storage locations.

Note: The District Avalanche Supervisor maintains a copy of each magazine license on file and one copy posted inside each magazine.

10.03. Explosive Use

Ministry avalanche personnel are certified by WorkSafeBC to carry out blasting operations for the purpose of avalanche control. All blasting operations are conducted under the direction of a Blaster of Record in accordance with the Explosive Use Operational Plan.

WorkSafeBC requires that, prior to any avalanche blasting operation occurring, an approved Explosive Use Operational Plan must be in place. The *Ministry Explosive Use Operational Plan* is found in the Appendix VIII of this document. Updates to the plan are made periodically at the suggestion of Ministry blasters. Suggestions for change should be forwarded to the Senior Avalanche Officer.

Copies of the Explosive Operational Use Plan and WSBC (or recognized equivalent) Blasting certificate must be present at each blasting operation.

The Explosives Use Operational Plan must be reviewed by all avalanche personnel prior to the start of the avalanche season. Annual hands-on training sessions are highly recommended.

Where possible, live fire training and skills review should be undertaken by all crew members.

The avalanche program is required to make and retain a record of each blasting operation; this is called the Blasting Log.

- Each blaster (or blaster trainee) is required by regulation to maintain their own Blasters Log where they document their operational blasting experience and preseason training sessions.
- A record of the Avalanche occurrence results from avalanche control operations is recorded and entered into the SAWS system.
- Misfires are recorded in the Blasting Log and their location is marked on an oblique photograph. Records of misfire searches and the destruction of found misfired explosives are kept.
- The District Avalanche Supervisor maintains a record of the annual review of the Explosive Use Operational Plan and all dry fire and live fire training sessions.

Reference Materials

Appendix VIII - Explosives

- *Explosive Use Operational Plan*
- *Explosive Spill on Highway - Emergency Response Assistance Plan 2-0804*

Natural Resources Canada, Explosive Safety and Security Branch, Explosives Regulatory Division Regulation, Policy and Guidelines are found online at:

<https://www.nrcan.gc.ca/explosives>

WorkSafeBC Regulation, Policy and Guidelines are found online at:

<http://www.worksafebc.com/>

Common Acronyms and Abbreviations

ATES – Avalanche Terrain Exposure Scale

AWP – the Ministry Avalanche and Weather Programs

CAA - the Canadian Avalanche Association

FBSYS – the Forecast Broadcast System

Ministry - BC Ministry of Transportation and Infrastructure

MoTI – BC Ministry of Transportation and Infrastructure

TMCBC – Transportation Management Center British Columbia

RAWS – Remote Automated Weather Station

RWIS – Road Weather Information System

RWS – Roadside Weather Station

SAWS – Snow Avalanche Weather System

EET – Environmental Electronic Technician

WMP – Weather Network Program

EMBC – Emergency Management British Columbia

Definitions

Avalanche: Specifically refers to snow avalanche.

Snow avalanche: A volume of snow, usually more than several cubic meters, moved by gravity at perceptible speed. Snow avalanche may contain rock, broken trees, ice or other material.

Ministry avalanche areas: A set of geographically associated avalanche paths. These may affect a specific element at risk, or multiple elements at risk.

Avalanche path: A fixed locality within which avalanches start, run and stop. Paths consist of a starting zone, a track and a runout zone and sometimes an air blast zone.

Avalanche terrain: The area and topography within the physical boundary of the potential formation, movement and effect of an avalanche.

Avalanche forecasting: The prediction, over a specified scale of terrain, of current and/or future avalanche hazard/risk based on the expected likelihood of triggering, avalanche size and runout extent.

Avalanche size: A reporting system for observed avalanches based on the estimated potential destructive effects (McClung and Schaerer, 2006).

Avalanche frequency: The expected (average) number of avalanches per unit of time reaching or exceeding a location. Normally it has units of avalanche(s) per year(s) and is expressed as a ratio (eg 1:1, 1:3, 1:10, 1:30 etc.) This is determined from empirical evidence in the field, avalanche occurrence records.

Avalanche risk: Avalanche Risk is the probability or chance of harm resulting from interactions between avalanche hazard and specific element(s) at risk. Avalanche risk is determined by the exposure of that element, and its vulnerability to the avalanche hazard.

Avalanche hazard: A source of potential harm or loss. The potential for an avalanche(s) to cause damage to something of value. It is a function of the likelihood of triggering or frequency, and the avalanche size or magnitude.

Avalanche hazard assessment: A process that includes the steps of avalanche hazard identification, analysis and evaluation.

Avalanche hazard analysis: The data collection and study of environmental condition that contribute to the hazard. In planning, it includes an estimation of the probabilities and the dimensions of the physical impact of potential avalanches. In operations, it involves the systematic observation, monitoring, and investigation of avalanche activity, snowpack and weather conditions.

Avalanche season: The snowpack depth within an avalanche area reaches threshold. The avalanche season generally starts in early November and ends in late April. The District Avalanche Supervisor will make the determination of when the avalanche season begins and

when the season ends based on the avalanche risk for a particular avalanche area or avalanche path.

Avalanche threshold: When the snowpack within avalanche areas becomes deep enough to create an avalanche risk to the highway user.

Avalanche hazard identification: A process that includes the identification of avalanche terrain, recognition of avalanche potential, and recording and representing its location.

Avalanche hazard evaluation: Entails comparing the results of the analysis against evaluation criteria that rate or rank the hazard

Ministry avalanche technicians: Manager, Avalanche and Weather Programs, Senior Avalanche Officer(s), District Avalanche Supervisor, District Avalanche Technicians and Assistant Avalanche Technicians.

Risk owner: Person or entity with the accountability and/or authority to manage a risk.

Avalanche rescue cache: A location proximal to a Ministry avalanche area where avalanche rescue equipment is stored.

Qualified supervisor / Supervision of workers: The Ministry's **One Day Avalanche Safety Training** course is a minimum requirement for persons who supervise workers operating in Ministry avalanche areas as well as those who make decisions directly affecting the safety of employees and the public.

List of Appendices

Link to Appendices

<https://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/contracting-to-transportation/highway-bridge-maintenance/highway-maintenance/avalanche-safety-plan>

I. Introduction & Geographic Description

- Listing of Avalanche Area Codes Atlases and Maps
- Map Views of Avalanche Area Locations by Name

II. Operational Objectives

- District of Stewart - Mount Rainey Avalanche Program - Avalanche Safety Recommendations
- Threshold Guidelines for Avalanche Safety Measures

Winter Maintenance Specifications for 3.04 (2018)

- Highway Maintenance Agreement, Schedule 1, Section 6 - 3.04 Snow Avalanche Response (2018)
- Snow Avalanche Safety Measures for Highways Manual (2019)

Winter Maintenance Specifications for 7-790 (2015)

- Highway Maintenance Contracts, Maintenance Specifications Chapter 7-790 Snow Avalanche Response (2003)
- Snow Avalanche Safety Measures for Highways Manual (2015)

III. Personnel

- Memorandum Re: Ministry Avalanche and Weather Programs Overview

Ministry of Transportation & Infrastructure Job Descriptions

- District Avalanche Supervisor
- District Avalanche Technician
- District Avalanche Assistant
- Central Avalanche Program and WNP Construction and Installation Supervisor
- Manager, Avalanche and Weather Programs
- Senior Avalanche Officer
- Manager, Weather Network Program
- Weather and Climate Specialist

IV. Operational Procedures

- Form H-664 Avalanche Occurrence Report
- Guidelines for Conducting Avalanche Program Reviews
- Outline for Avalanche Program Annual Reports

V. Avalanche Search & Rescue Plans

- Backcountry Avalanche Risk Assessment Protocol
- Avalanche on Highway Search and Rescue Incident Response Plan
- Field Work Search and Rescue Incident Response Plan

VI. Incident Review

excerpts from Ministry of Transportation and Infrastructure, Health and Safety Manual, Core Requirements, Incident Reporting and Investigation:

- Policy 1.4.1 Incident Reporting
- Policy 1.4.2 Incident Investigations

VII. Fieldwork Sites & Working Alone or in Isolation

- Check-in Procedures
- Fieldwork Atlas Format
- Fieldwork Pre-Trip Plan
- Avalanche Terrain Exposure Scale
- AWP Mountain Travel Risk Matrix

VIII. Explosives

- Explosive Spill on Highway - Emergency Response Assistance Plan 2-0804
- Explosive Spill on Highway - Emergency Response Assistance Poster 2-0804
- Explosive Use Operational Plan