EXPLOSIVE USE OPERATIONAL PLAN

BC Ministry of Transportation Avalanche and Weather Programs

OHS 21.85 Firm No. 4000-175

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## Definitions

**anchor**
The part of a fall protection system that connects to an anchorage.

**Avalanche Guard**
A remotely-fired avalanche control device that is comprised of towers mounted with magazines that contain mortar barrels with propellant and explosive charges.

**ALARP**
Engineering standard; As Low As Reasonably Practicable.

**blaster**
A person who holds a valid blaster’s certificate issued by WorkSafeBC.

**blaster of record**
The blaster who is designated to be in charge of a blasting operation.

**blasting area**
An area extending at least 50 m (165 feet) in every direction from a place where explosive materials are being prepared or fixed, or where an unexploded charge is known or believed to exist.

**blasting operation**
Work that involves preparing, placing and firing a charge, handling a misfire, and/or destroying or disposing of explosive materials.

**case charge**
The detonation of explosives, often multiple bags of ammonium nitrate/fuel oil (ANFO), which have been placed (as opposed to thrown or dropped) at the bottom of the targeted avalanche path.

**charge**
Explosive materials, which may or may not contain a primer, placed for the purpose of detonation.

**cornice control**
An avalanche control technique where personnel on the ground use mountain rope access techniques to safely place charges and/or detonate several charges at once with detonating cord.

**danger area**
An area in which there may be danger to persons or property from flying material or other hazardous conditions resulting from a blast. The danger area
includes the blasting area, all areas affected by the blast concussion and materials, and all terrain where avalanches could result from the use of the applied explosives.

**dangerous incident**
An accident or near miss resulting from the use of explosives, including an unexpected result or problem with explosive products.

**detonator or detonator products**
Explosives used to detonate commercial explosives, commonly called “blasting caps” or “electric caps,” or other similar devices.

**explosive**
A substance that is made, manufactured or used to produce an explosion or detonation, including but not limited to blasting explosives, pyrotechnic devices and accessories containing explosives.

**fall restraint system**
A system to prevent a worker from falling from a work position, or from travelling to an unguarded edge from which the worker could fall.

**hand charging**
A technique where personnel on the ground throw or place explosives into the avalanche path start zone. Often performed while wearing skis.

**helicopter deployment**
The dropping of explosives from a helicopter to perform avalanche control.

**misfire (mishole)**
A dangerous condition in which a charge or part of a charge fails to completely detonate or function on initiation.

**mislight**
A type of misfire where there is a failure or perceived failure of a pull-wire lighter to ignite the safety fuse assembly.

**lanyard**
A flexible line of webbing or synthetic or wire rope that is used to secure a safety belt or full body harness to a lifeline or anchor.

**primer**
An explosive to which a detonator or other initiating device has been attached.
**safety fuse assembly**

A manufactured blasting accessory consisting of a precut length of safety fuse, an igniter cord connector and a detonator.

**Wyssen Tower**

A remotely-fired avalanche control device that drops an explosive charge which remains hanging from a cord at a pre-set height above the snowpack. Two igniters are pulled and the explosion is set off after a delay.
I. GENERAL PROCEDURES

A. INTRODUCTION

The Avalanche and Weather Programs unit in the British Columbia Ministry of Transportation and Infrastructure administers an integrated avalanche risk management program along provincial highways in British Columbia. A key aspect of this program is the use of explosives to release unstable snow under controlled circumstances to mitigate a current or potential avalanche hazard. The ministry’s avalanche control programs also use explosives to analyze snowpack stability and evaluate the overall avalanche hazard.

The purpose of this Explosives Use Operational Plan is to define the personnel, competencies, procedures, specific safety measures, equipment and primary locations used by ministry staff in carrying out this important work.
B. GENERAL AVALANCHE CONTROL RATIONALE

The ministry artificially triggers avalanches in order to reduce the threat that naturally triggered avalanches could present to provincial highways.

Predicting where and when avalanches could occur requires a thorough understanding of the interaction between weather, terrain, and mountain snowpack. The ministry’s analysis draws on this expertise, supported by many observations and tests.

The decision to use an explosive control is based on a complex analysis of current and future weather and snowpack conditions and the effect these condition may have on the avalanche hazard.

Appendix A identifies the ministry’s avalanche explosives use program areas.
C. **REGULATING AUTHORITIES**

Explosive treatment for avalanche risk management is regulated by the Prevention Division of WorkSafeBC [OHS Part 21].

Regulations for the storage of explosives used by the ministry’s avalanche control programs are governed by the Explosives Regulatory Division of Natural Resources Canada.

The transportation of explosives for the ministry’s avalanche control programs operates in accordance with the Transportation of Dangerous Goods Act, governed by Transport Canada.

The ministry’s Manager of Avalanche and Weather Programs is responsible for the site specific procedures, review, approval and quality assurances of the Explosives Use Operational Plan.
D. PERSONNEL AND CERTIFICATION

All blasting operations and teams must have at least one blaster with a WorkSafeBC Code 1 blasting certificate and the appropriate endorsements for the control method being employed. When more than one certified blaster is present in a team, a blaster of record must be designated to oversee all aspects of the blasting operation [OHS 21.5 (1)(2)].

Blasting operations must have a minimum of two personnel: the blaster and an assistant. Exceptions may apply in helicopter control operations as specified in the respective procedural descriptions. If the assistant does not hold a valid blasting certificate (with required endorsements), the blaster is required to visually supervise the assistant and is responsible for their work during explosive priming, initiation and deployment [OHS 21.5(3)].

Blasters must be familiar with the manufacturer’s handling recommendations [OHS 21.36], as well as current legislation and regulations concerning all relevant aspects of explosive acquisition, transportation, storage, use and disposal. All blasters are required to review these procedures annually during a training session prior to the avalanche season.

Blasters are also responsible for immediately reporting any theft or attempted theft of explosives to the Chief Inspector of Explosives under Natural Resources Canada’s Explosives Regulatory Division.

Any dangerous incident involving explosives, whether or not there is personal injury, must be reported to WorkSafeBC [OHS 21.3]. Such incidents are also to be immediately reported to the Manager of Avalanche and Weather Programs.
E. HANDLING OF EXPLOSIVES

Specific explosive preparation procedures are contained in each respective avalanche control operation procedure. Explosive materials must be stored, transported, handled and used in a manner recommended by the manufacturer of the material [OHS 21.36].

The blaster of record will determine the most appropriate primer assembly location closest to the blasting site, while ensuring that explosives and detonators are only brought together at the last most practicable moment [OHS 21.85 (2)].

The blaster of record will select their crew for risk reduction treatments, capturing all opportunities within our integrated risk management plan.

A person operating a vehicle that is transporting explosives (a) must operate the vehicle in a safe manner, consistent with prevailing road and weather conditions, and (b) must not drive faster than 90 km/hr. [OHS 21.29].
F. **CLOSURES/SWEEPS**

The danger area includes the blasting area, all areas affected by the blast concussion and materials, and all terrain where avalanches could result from the use of the applied explosives.

The danger area must be cleared before the commencement of each avalanche control operation and confirmed clear by radio communication. Maintenance contractors or ministry personnel must execute road closures and perform sweeps prior to every ministry avalanche control operation. Where backcountry users are possible a visual sweep of the danger area will be performed.

Blasting signals for avalanche control are not necessary, as per WorkSafeBC regulation 21.69, provided the above measures are taken to ensure safety within the blast area.

Signs warning of expected avalanche control should be used whenever feasible at off-highway access points to the danger area to inform backcountry users of the ministry’s local avalanche control operations.

Traffic control persons with warning signs and physical barriers will be used at each highway end of the closure area. The sweep vehicle(s) is responsible for travelling the highway between the identified closure points to ensure that no traffic remains within the danger area and that it is safe to proceed with avalanche control operations. The sweep vehicle(s) will notify the blaster of record by radio once it has left the danger area.

Once avalanche control is complete, the blaster of record will notify the maintenance contractor personnel on site. Provided no further avalanche activity is expected, the maintenance contractor is responsible for clearing the highway of avalanche deposits and ensuring it is safe to reopen to the public.
G. RECORDS KEEPING

Standard avalanche observation records are to be kept for each explosive placed and its results. These records include the time, date, location, type and size of explosive, detonation status, avalanche characteristics and any resulting damage, as well as closure and sweep start and end times. Refer to the Canadian Avalanche Association’s *Observation Guidelines and Recording Standards for Weather, Snowpack and Avalanches* for further details.

Ministry avalanche programs will also record details of all explosive use in a blasting log. Blasters will also keep records of all blasting operations in their personal blasting log [OHS 21.4].

A copy of the ministry’s Avalanche and Weather Programs’ Explosive Use Operational Plan will be kept by the blaster of record on site and will be available for inspection by members of WorkSafeBC staff upon request.
H. MISFIRE DISPOSAL PROCEDURES

All misfires and suspected misfires are to be recorded in keeping with the standard records. Their location is to be marked as soon as possible and georeferenced to identify the area to be searched at a later date. Suspected misfires are explosions that may have detonated properly, but which may not have been heard or seen by the control team due to deep snowpacks, strong winds or poor visibility.

Misfires are to be disposed of as soon as safely possible. Care shall be taken to ensure that a misfire is not disturbed. It should be detonated with a hand charge if possible; using a new primer that is placed in contact with the unexploded material [OHS Guideline 21.75]. Non-sparking shovels shall be used when digging for misfires within the snowpack.

A waiting period of at least one hour, as recommended by the manufacturer [OHS 21.36], must be observed before the control team approaches the misfire location. If a misfired charge contains a safety fuse and is re-blasted, workers must not return to the blast site until 30 minutes after detonation [OHS 21.36]. Locations requiring access to very steep or hazardous terrain must adhere to the OHS guidelines applicable to the techniques being employed.

In the event snow or avalanche conditions prevent access to the misfire, it must be left until conditions have reached an acceptable level. Due to the inaccessibility and inherent danger of travelling in avalanche start zones, misfires may be left until spring melt conditions enable safer access. At least two patrols throughout the spring and summer should be conducted in order to discover and dispose of misfires. These recovery missions are usually performed as soon as the snow melts and before significant vegetation growth.

Access points where recreationists could enter into areas affected by ministry avalanche control operations must have physical barriers with signs warning users of the dangers of misfires. If blocking access to the area is not feasible, prominent warning signs with a phone number to call for current information must be clearly visible at all access points.
I. STANDARD DISPOSAL OF EXPLOSIVE PRODUCTS

If it becomes necessary to dispose of any explosive products, the disposal of these explosive products must be conducted in accordance with the manufacturers’ recommendations using procedures as outlined in the WorkSafeBC Blasters’ Handbook.

The ministry no longer uses artillery rounds for avalanche control; however, dud projectiles or failure-to-fire rounds could be found. In this event, rounds must be disposed of by appropriately trained personnel from the RCMP or Department of National Defense.
J. EXPLOSIVE USE REVIEW AND REVISION PROTOCOLS

The Manager of Avalanche and Weather Programs will review these procedures annually [OHS 21.85 (4)].

Avalanche program personnel will regularly review the procedures to ensure they reflect current industry best practices. Amendments of this document will be subject to review by the Manager, prior to submission to WorkSafe BC for approval.
II. OPERATIONAL PROCEDURES

A. HELICOPTER DEPLOYMENT PROCEDURES

1. Equipment
   - Helicopter with radio set to highway closure frequency
   - Intercom headsets or flight helmets (preferred)
   - Fall restraint system, including approved harness or belt, anchor(s) and lanyard [Transport Canada TDG CAR 527]
   - Timing device(s)
   - Blasting log (notebook, tablet, etc.)
   - Explosives (ANFO, cast boosters, safety fuse assemblies, etc.)
   - Pull-wire lighters
   - Blasting tools and accessories (burlap, tape, zip ties, etc.)

2. Personnel
   The blasting team consists of a helicopter pilot and a blaster of record. Additional blasters or assistants may be used, with a maximum of four personnel on board during active control.
   i) **Pilot** is responsible for the following:
      a) Operation and safety of the aircraft and occupants
   ii) **Blaster of Record** is responsible for the following:
      a) Safety in the use of the explosives
      b) Directing the pilot to avalanche sites
      c) Ensuring that the area closure and sweep is complete
      d) Preparing, igniting and dropping explosives on to the slopes
      e) Recording the time of burning fuses
      f) Recording the placement of charges
      g) Recording the observations (detonation and results)
      h) Re-opening the road (or sections of the road) to workers for maintenance and deposit removal and/or to the travelling public.
   i) Ensuring all members of the team understand the blasting plan, their roles and responsibilities.

Any member of the blasting team has the responsibility and authority to call a halt to the avalanche control mission if they believe that worker safety is, or is likely to be, compromised.

*Note: When additional blasters or assistants are being used, the blaster of record is responsible to ensure that additional team members understand which parts of the blasting operation they are to perform. Blasters without a helicopter
endorsement may prepare and deploy charges; however, they must be under direct visual supervision of a qualified blaster [OHS regulation 21.5(3)].

3. **Preparation of Explosives**

Primed charges are to be made up prior to entering the aircraft, at the last practicable moment and as close to the helicopter landing zone as safety permits [OHS 21.85(2)]. Pull-wire lighters must be transported separate from charges.

A minimum of a one-meter safety fuse must be used [OHS 21.56(2)].

Ideally, all explosives carried by the helicopter will be used during a particular control mission. If primed explosives have not been used and the mission is complete, the fuse and explosive of the primed charge may only be separated if the primer is a cast booster. The products’ manufacturers must approve the procedure [OHS 21.36].

Primers shall be transported within the helicopter in a container that is made of an antistatic material (e.g. wood) and that is capable of being easily jettisoned.

Provisions:

- A minimum amount of fuse should be exposed outside of the bag (approximately 10-25cm);
- The helicopter staging area should be near target locations. Primed bags of ANFO should not be flown considerable distances [OHS 21.85(2)].
- If requested by the pilot, the sleeve of the ANFO bag where the primer is inserted can be securely taped shut to contain prills. Burlap covers or other means should also be considered to aid in containing prills and preventing ANFO bags from sliding on hard surfaces.
4. **Preflight Safety Check**

All persons involved in the blasting mission that will be working in or around the helicopter will discuss the procedures and processes for the mission. Topics will include:

- Working safely around the helicopter;
- Safe refueling, explosive assembly and helicopter loading areas;
- Experience levels of the blaster of record, pilot and assistants—both individual experience and experience working together as a team. Consider using dry run flights with limited weight on board to build experience as a team before conducting a live explosive mission;
- Weather conditions and any weather-related terrain access limitations;
- Fuel, personnel and explosive loads—consider the terrain, weather and elevations expected for the mission;
- Harness anchor points;
- Safety instructions for ground support personnel;
- Mission specific terrain considerations and a discussion of safe standoff distances (blade strikes) — see Safety Precautions 7 (a) (page 20);
- Seating arrangements and the limitations of pilot visibility when the blaster is seated side opposite from the pilot — see Safety Precautions 7 (c) (page 21);
- Radio call signs and channels/frequencies for support and closure personnel;
- Targeting, and how the blaster and/or assistant will guide the pilot to the targets;
- Blasting run commands;
- Methods for emergency jettison of explosives;
- Method the team will use for timing the 90 second period after the first fuse is lit;
- Safe standoff distance from the blast and the avalanche in motion (dust clouds, airborne debris);
- Mis-light procedures and predetermined placement locations;
- Ensuring that all members of the mission team understand they can abort the mission if they feel any unsafe condition is about to arise.
5. **Procedures – Pre-Flight**

   a) The pilot will arrange the helicopter in an appropriate manner to ensure that explosives can be safely dropped (e.g. remove the rear door and/or ski basket or racks as required).
   
b) The pilot and blaster will ensure that the intercom and radio on closure frequency are functioning correctly.
   
c) The blaster will attach a lanyard to two related anchor points in the helicopter that is approved by the pilot and check the lanyard for correct length.
   
d) The blaster will put on an approved harness or belt with a non-instantaneous release system and attach it to the helicopter via the anchor lanyard. The assistant(s) will be suitably restrained by standard safety belts.
   
e) A complete dry run will be instituted on the ground, including the use of the harness, intercom, stop watch, field notebook and bombing commands, to ensure all systems are operational and understood.
   
f) Closure and sweep are to be initiated at a time that is appropriate for the mission.
   
g) If required, primers will be loaded aboard the helicopter in a suitable container so that they can be easily jettisoned, if necessary.
   
f) The explosives will be loaded into the helicopter. Primed bags of ANFO may be used.
   
g) The pilot or additional team member will verbally or visually check the blaster’s tie in.

6. **Procedures – In-Flight**

   a) Ensure that the road closure and sweep of the highway is complete and any necessary visual sweep from the helicopter has been performed [OHS 21.66(2)(3)].
   
b) The blaster will ready the primer and lighter as the helicopter approaches the target area.
   
c) The blaster will trim the fuse no more than 10 centimeters and attach the lighter. Dialogue should be as follows:
      
      Blaster: "Lighter on"
      Pilot: "Lighter on"
   
e) The blaster will direct the pilot into the final position for shot placement.
f) The blaster will take approximately **five seconds** to confirm the burning fuse. Indications will include:
- visible grey smoke
- acrid smell of smoke
- discoloured fuse
- fuse droop

The blaster will take no more than **15 seconds** to confirm that the fuse is burning after using the pull-wire igniter.

If the blaster confirms that the fuse is NOT burning, he will announce to other team members "MIS-LIGHT." Confirmation from team member(s) and pilot is necessary.

**Important Notice** - Once the pull-wire has been activated, the pull-wire igniter manufacturer’s instructions dictate that the charge must be deployed and that there must be no further attempt to re-cut or re-light the fuse. There is 90 seconds from the time that the pull-wire igniter is activated to deploy the charge. Ideally, this will be in a location that can be easily accessed after the elapsed wait time for disposal. Where possible, locations for mis-lights and misfires should be discussed prior to the control mission.

h) After ensuring that the fuse is lit, the dialogue should be as follows:
   - Blaster: "Fuse lit"
   - Pilot: "Fuse lit"

i) **DROP** the charge down and away from the helicopter.
   - Blaster: "Shot is away"
   - Pilot: "Shot is away"

k) Record the time and location

j) If the charge slides away from the target, the blaster should communicate this to the team and, where practical, the helicopter should move to a location to observe the final resting place of the charge and/or primer.

l) When multiple primed charges are being deployed, placement of all charges will stop 90 seconds after lighting of the first fuse. The helicopter will then move to a safe location to observe the detonations and results.

m) Record the results (and any misfires).

n) Notify closure control personnel when blasting operations have been completed.

7. **Safety Precautions**

a) All blasting team members must be mindful of the need to always maintain sufficient standoff distance between the helicopter and the surrounding terrain.

b) The blaster should be seated on the same side of the machine as the pilot. This is the only seating arrangement that allows both the pilot and blaster to have
the same uncompromised view and perspective of the terrain and relative location of the rotor blades.

c) Explosive charges should be deployed with the blaster and pilot facing the uphill slope. If contrary winds prevent this orientation, it will be left to the discretion of the blaster and pilot to determine one of the following options:
   i. deploy shots on the downhill side;
   ii. deploy shots on the uphill side, with the blaster seated on the side opposite the pilot. If this option is selected, use greater standoff distances from the terrain to allow for the compromised pilot visibility of this seating configuration.

d) When using the “large” charge technique (multiple charges at the same placement), ANFO bags should be unprimed, with the exception of the final shot. The requirement for extended hover and accurate shot placements needs to be considered when assessing the feasibility of using a “large” charge.

e) When deploying hand charges from the helicopter, the blaster’s hand must be on top of the shot with the thumb facing down toward the ground. The charge should be pushed down and away from the aircraft when released.

f) The lighters are to be placed on the fuses at the last possible moment.

g) In the event of an emergency, the pilot must request or approve the jettison of explosives.

h) The blasting team will decide if weather conditions are safe; however, the pilot will make all flying decisions.

i) Extra personnel, other than those in training situations, shall not be on board the helicopter during any phase of the explosives control operation.

j) A minimum distance of one meter should be maintained between a landing helicopter and explosives to reduce the possibility of static discharge.

k) At no time shall a primer be assembled or dismantled in a helicopter.

8. **Misfires and Disposal**

   For mis-lights and misfires, refer to Section I: General Procedures (H), "Misfire Disposal Procedures" (page 13) and Section I: General Procedures (I), "Standard Disposal of Explosive Products" (page 14).

9. **Helicopter Loading Calculations and Considerations**

   The pilot is responsible for ensuring that the total weight of explosives, personnel and equipment inside the helicopter does not exceed the aircraft’s maximum gross weight limit. In addition, the pilot will determine the weight of 75 per cent of the Hover-Out of Ground Effect (HOGE) based on the highest altitude planned on the flight in order to calculate the maximum weight of explosives that may be loaded in the helicopter.
Department of Transport Regulations require helicopter operators to obtain approval to permit dispensing of explosives from rotorcraft and Transportation of Dangerous Goods certificate of training.

B. **CASE CHARGE PROCEDURES**

1. **Equipment**
   - Truck and portable radios set to the highway closure frequency
   - Timing device(s)
   - Blasting log (notebook, tablet, etc.)
   - Explosives (ANFO, cast boosters, safety fuse assemblies, etc.)
   - Pull-wire lighters
   - Blasting tools and accessories
   - Hearing protection

2. **Personnel**
   The blasting team consists of a minimum of a blaster of record and an assistant. Only personnel directly involved in the control work will be in the danger area.
   i) **Blaster of Record** - is responsible for the following:
      a) Safety of the entire blasting operation.
      b) Ensuring that all members of the team understand the blasting plan, their roles and responsibilities.
      c) Ensuring that the area closure and sweep is complete.
      d) Placement and location of charges.
      e) Record keeping (times, locations, results, etc.)
      f) Re-opening of the road (or sections of the road) to workers for maintenance and deposit removal and/or to the travelling public.

   Any member of the blasting team has the responsibility and authority to call a halt to the avalanche control mission if they believe that worker safety is, or is likely to be, compromised.

3. **Preparation of Explosives**
   a) Prepare primers at the most appropriate safe location closest to the blast site [OHS 21.85(2)].
   b) Assemble explosives according to manufacturers’ recommendations [OHS 21.36].
   c) Primers should be double fused when practical.
   d) No sparking materials should be present when transporting primers.
   e) Safety fuse igniters must be kept dry and should be transported separately from primers.
4. **Procedures**

   a) Ensure that the highway sweep/closure has been performed and that the danger area around the blasting site is clear.
   
   b) Park motor vehicle so that it can be quickly and directly driven away from the blasting site. Do not turn the engine off.
   
   c) Charges should be placed on a pillow of snow above the gravel shoulder. Care must be taken to place explosive charges in a fashion that will not result in damage to the road.
   
   d) Light the fuses and confirm burn. See 6(f) in Section II.A. “Procedures for Helicopter Deployment of Explosives” (page 16).
   
   e) After ensuring that the fuses are lit, immediately drive out of the danger area.
   
   f) Record the results.
   
   g) Notify closure control personnel when blasting operations have been completed.

5. **Safety Precautions**

   a) If natural avalanche activity is possible, the blasting plan should consider risk treatment options such as blasting into the avalanche area; placing the truck between the blaster and the slope for charge placement; and using a designated watchman with a signaling device.
   
   b) Every effort must be made not to work directly beneath the area of the avalanche path being controlled by the case charge.
   
   c) Hearing protection is to be used during detonation.
   
   d) Longer safety fuses may provide additional safety margins when case charging. Some examples of situations where their use should be considered include: the possibility of natural avalanche activity; multiple charges being deployed simultaneously; and the possibility of vehicles becoming stuck. It is the responsibility of the blaster of record to ensure that there is ample time for members of the team to clear the danger area, including situations where unforeseen events may occur.

6. **Misfires and Disposal**

   Refer to Section I: General Procedures (H), "Misfire Disposal Procedures" and Section I: General Procedures (I), "Standard Disposal of Explosive Products"
C. HAND CHARGE PROCEDURES

1. **Equipment**
   - Portable radios
   - Timing device(s)
   - Blasting log (notebook, tablet, etc.)
   - Explosives (cartridge primer, cast boosters, safety fuse assemblies, etc.)
   - Pull-wire lighters
   - Blasting tools and accessories (tape, rope, etc.)
   - Hearing protection

2. **Personnel**
   The blasting team should have a minimum of two members: one blaster of record and an assistant.
   
   **Blaster of Record** - is responsible for the following:
   
   a) Safety of the entire blasting operation.
   b) Ensuring all members of the team understand the blasting plan and their roles and responsibilities.
   c) Ensuring that the area closure is complete and danger area is clear.
   d) Placement and location of charges.
   e) Record keeping (times, locations, results, etc.)

   Any member of the blasting team has the responsibility and authority to call a halt to the avalanche control mission if they believe that worker safety is, or is likely to be, compromised.

3. **Preparation of Explosives**

   See Section II.B.3 - “Case Charge Procedures: Preparation of Explosives” (page 22).

4. **Procedures**

   a) Initiate danger area closure and sweep.
   b) Trim the fuse(s) no more than 10 centimeters immediately prior to attachment of the pull wire lighter. Announce: "Lighter on" so that the other team members hear, and ensure that they acknowledge it.
   c) Light the fuse and confirm the burn. See 6(f) in Section II.A. “Procedures for Helicopter Deployment of Explosives” (page 16).
   d) After confirmation, notify the other team members by announcing "Fuse Lit" and deploy charge.
   e) All team members move to a pre-determined safe location.
   f) Record the results.
   g) Notify closure control personnel when blasting is complete.
5. **Safety Precautions**

a) The blaster of record and assistant(s) must be in contact at all times.
b) Hearing protection is to be used during detonation.
c) Consider using longer length safety fuse assemblies if there is uncertainty about the length of time required to move to a safe location.
d) Rope or cord may be used to position charges and prevent them from sliding.

6. **Misfires and Disposal**

Refer to Section I: General Procedures (H), "Misfire Disposal Procedures" (page 13) and Section I: General Procedures (I), "Standard Disposal of Explosive Products" (page 14).
D. AVALANCHE GUARD PROCEDURES

1. Equipment for Loading
   - Explosives
   - Safety-fuse assemblies
   - Avalanche Guard pull-wire lighters
   - Propellant cup assemblies
   - Replacement lanyards and twin connector hooks
   - Fire control computer and communication equipment
   - Portable radios
   - Blasting tools to cut fuses and crimp pull-wire lighters
   - Keys for Avalanche Guard controls and magazines

   Additional Equipment for Unloading
   - Container for safety fuse/detonator
   - Container for safety fuse/pull-wire lighters
   - Container for explosives
   - Container for propellant cups

2. Personnel

   The blasting team for loading and unloading consists of a blaster of record and assistant(s).
   i) Blaster of Record - is responsible for the following:
      a) Safety of the entire operation
      b) Lock-out of Avalanche Guard system
      c) Supervision of the assembly (or disassembly) of the charges
      d) Supervision of the destruction of disassembled pull-wires, fuses and detonators
      e) Ending of the lockout, returning the system to service
      f) Post-loading function and communication tests
   ii) Assistant - is responsible for the following:
      a) Assisting in the assembly (or disassembly) of the charges
      b) Assisting in the destruction of disassembled pull-wires, fuses and detonators
      c) Observing for anomalies during assembly and loading

   Any member of the blasting team has the responsibility and authority to call a halt to the procedures if they believe that worker safety is, or is likely to be, compromised.
3. Avalanche Guard Loading Procedures

3.1 Preparing the Avalanche Guard for Loading

On arrival at the launching device, proceed as follows:

a) Place the lower service platform, handrails and ladder into position.

b) The blaster of record unlocks the control cabinet.

c) Turn the switch in the control cabinet to the SERVICE position using the secure control box key. The complete firing control system is now LOCKED OUT while the switch is in the SERVICE mode. Remove the key from the service switch.

d) Place the upper service platform, handrail and ladder into working position.

e) Unlock and open the terminal access panel.

f) Remove the launching squib leg wires from the contact panel. Shunt each pair of leg wires as they are removed by twisting the bared ends together.

g) Use the secure control box key to turn the key switch on the bottom of the launching box to the DOOR OPEN position. The door of the launching box will swing open. Remove the key from the switch. The blaster of record must now retain this key in his or her possession to ensure LOCK-OUT for the duration of the procedure.

h) Check the launching device housing, including the door for icing and soiling. Clean as required.

i) Remove all used launching cups and leg wires. Check to ensure the wing nut on the bottom outside of the barrel is backed out so as not to disrupt loading of the charge.

j) Check the barrels for icing and soiling. Clean as required.

k) Inspect the lanyards and twin connector hooks, and replace if worn or damaged. Tuck the lanyards into operational position.

l) Ensure the barrel retention wing nut is tight on all barrels.
3.2 Procedure for Loading - Charging the Barrels

a) Remove a propellant cup from the packaging and test for continuity using an approved galvanometer. Shunt the leg wires by twisting the bared ends together.

b) Run the leg wires up the side of the charge in the 9 o’clock position.

c) Insert the charge into the barrel, propellant end first. Leg wires remain in the 9 o’clock position and the fuse tie down strap in the 12 o’clock position. Lower the propellant cup and charge into the barrel until the top end is flush with or below the upper rim of the barrel.

d) Hand-tighten the wing nut at the bottom of the barrel to secure the propellant cup.

e) Pass the leg wires down the conduit and through the numbered hole in the top of the connection panel that corresponds to the number of the barrel being loaded.

f) Repeat this procedure for each barrel that is being loaded.

3.3 Procedure for Loading - Fusing the Explosive

a) Remove a one-meter fuse assembly from the packaging and insert the detonator into the cap well of the first charge. Ensure the detonator is at the bottom of the 10 cm deep cap well. Secure the fuse by hand-tightening the screw-down fuse holder at the top of the cap well. Repeat this step with a second one-meter fuse in the second cap well of the same charge.

b) Cut both fuses to the correct length using an approved fuse cutter.

c) Crimp a pull-wire lighter onto each fuse using an approved crimping tool. DO NOT remove the protective cap from the pull-wire lighter.

d) Pass both fuses through the fuse tie down strap attached to the explosive charge and loosely tighten the tie down strap. Do not tighten the fuse tie down strap all the way at this time.

e) Repeat these steps for each barrel that is being loaded.

3.4 Procedure for Loading - Attach Lanyards

a) Remove the protective caps from both pull-wire lighters of one charge.

b) Attach the twin hooks on the end of the lanyard to the eye-hooks on the pull-wire lighters.

c) Tighten the fuse tie down strap onto the pull-wire lighters until the fuses are held securely.

d) Replace the lanyard cover.
e) Cover the end of the barrel with a plastic bag and use a rubber band to secure.
f) Repeat this procedure for each barrel being loaded.
g) The assistant inspects each charge to ensure all lanyards are connected and all barrels are covered.

3.5 Returning Avalanche Guard to Operating Mode

a) The blaster of record turns the secure control box key to the DOOR CLOSED position and removes the key after the door is fully closed.
b) Connect the leg wires to the terminals starting with the leg wire for barrel number one. Repeat this for each barrel that is loaded, connecting the wires to the terminal of the same number as the barrel number.
c) Close and lock the terminal access panel.
d) Fold away the upper service platform, ladder and handrails.
e) Insert the secure control box key into the key switch in the control cabinet and switch from the SERVICE (locked out) position to the AUTOMATIC position. The firing system is NO LONGER LOCKED OUT. The key cannot be removed in this position.
f) Lock the control cabinet and remove the key.
g) Fold away the lower service platform, ladder and handrails.
h) Use the fire control computer to confirm system readiness.
4. **Avalanche Guard Unloading Procedures**

4.1 **Preparing the Avalanche Guard for Unloading**

On arrival at the launching device, proceed as follows:

a) Place the lower service platform, handrails and ladder into position.

b) The blaster of record unlocks the control cabinet.

c) Turn the switch in the control cabinet to the SERVICE position using the secure control box key. The complete firing control system is NOW LOCKED OUT while the switch is in the SERVICE mode. Remove the key from the SERVICE switch.

d) Place the upper service platform, handrail and ladder into working position.

e) Unlock and open the terminal access door.

f) Remove the launching squib leg wires from the contact panel. Shunt each pair of leg wires as they are removed.

g) Use the secure control box key to turn the key switch on the bottom of the launching box to the DOOR OPEN position. The door of the launching box will swing open. Remove the key from the switch. The blaster of record must now retain this key in his or her possession to ensure LOCK-OUT for the duration of the procedure.

4.2 **Procedure for Unloading - Detonator Removal**

a) Using an approved fuse cutting device, cut a section approximately 15 cm in length out of each fuse between the fuse tie down strap and the detonator.

b) Loosen the screw-down fuse holder at the top of the cap well, gently pull the fuse and detonator out of the mortar and place them in the detonator container. Repeat this for all fuses in each mortar that is being unloaded.

c) Cut the fuse tie down strap. Detach the twin lanyard hooks from the eye-hooks on the pull-wire lighters and put them in the used pull-wires container.

d) Repeat this procedure for each barrel being unloaded.

e) Remove the detonator container and the pull-wire lighter container to a safe location off the service platforms.

4.3 **Procedure for Unloading - Remove Explosive and Propellant**

a) Loosen the propellant cup clamping screws, then extract the explosive charge, propellant cup and leg wires.

b) Place the explosive in the explosives container.

c) Place the propellant cup in the propellant cup container.
d) Repeat this procedure for each barrel being unloaded.
e) Remove the explosives container and the propellant cup container to a safe location off the service platforms.

4.4 Securing Avalanche Guard after Unloading

a) Close and lock the terminal access panel.
b) The blaster of record turns the secure control box key to the DOOR CLOSED position and removes the key after the door is fully closed.
c) Fold away the upper service platform, ladder and handrails.
d) Insert the secure control box key into the key switch in the control cabinet and switch from the SERVICE (locked out) position to the AUTOMATIC or OFF position. The firing system is NO LONGER LOCKED OUT. The key cannot be removed in this position.
e) Lock the control cabinet and remove the key.
f) Fold away the lower service platform, ladder and handrails.

5. Procedures for Remote Firing of the Avalanche Guard System

a) Initiate area closure.
b) Proceed to the safe firing location.
c) Ensure that the closure is effective and the area is clear.
d) Use the firing control computer to fire the selected Avalanche Guard on the selected target.
e) Detonation will be confirmed by the firing computer through the geophone.
f) Check for misfire and fall out procedures. Refer to Section I: General Procedures (H), "Misfire Disposal Procedures" (page 13).
g) Record the results.
h) Repeat steps (d) through (g) for the next target(s).
i) Notify closure control personnel that blasting is complete.

6. Safety Precautions

a) The blaster of record and assistant(s) must be in contact at all times.
b) No flammable or sparking materials may be carried in the same containers as the explosives, detonator assemblies, pull-wire lighters or propellant cups.
c) Only cast explosive primers made for the Avalanche Guard may be used.
7. **Misfires and Disposal**

Refer to Section I: General Procedures (H), "Misfire Disposal Procedures" (page 13) and Section I: General Procedures (I), "Standard Disposal of Explosive Products" (page 14).
E. CORNICE CONTROL – BURIED CHARGE PROCEDURES

1. **Equipment**
   - Portable radios
   - Timing device
   - Blasting log (notebook, tablet, etc.)
   - Explosives (ANFO, cast boosters, safety fuse assemblies, detonating cord, etc.)
   - Pull-wire lighters
   - Blasting tools and accessories
   - Hearing protection
   - Appropriate mountaineering equipment

2. **Personnel**
   The blasting team consists of a blaster of record and an assistant(s).
   i) **Blaster of Record** - is responsible for the following:
      a) Safety of the entire operation
      b) Determining appropriate primer assembly location closest to blasting site
      c) Supervision of the construction of the explosive network
      d) Ensuring that the area closure is complete
      e) Designating the cornice charge placement locations
      f) Ensuring that all team members are aware of the blasting plan, routes and safe alternative routes and rope techniques being employed

   Any member of the blasting team has the responsibility and authority to call a halt to the avalanche control mission if they believe that worker safety is, or is likely to be, compromised.

3. **Preparation of Explosives**
   See Section II.B.3 - “Case Charge Procedures: Preparation of Explosives” (page 22).

4. **Procedures**
   a) Identify the work area and proper belay locations and techniques.
   b) Lay out a section of detonating cord along the length of the area to be blasted. Include enough extra cord to have the end of the detonating cord well off the cornice area. Cut the detonating cord from the roll. Secure both ends with ski poles.
   c) Dig or punch holes in the snow at the required spacing and depth.
   d) Bury an explosive charge with detonating cord assembly.
   e) Extend detonating cord branch line back to a safe area.
   f) Once all charges are placed, properly connect the detonating cord branch lines from the charge to the main trunk line.
   g) Move everyone out of the blasting area and remove ski poles from the ends of the detonating cord.
h) Ensure the highway sweep/closure has been performed and that the danger area around the blast area is clear.

i) Properly attach two safety-fuse assemblies to one end of the detonating cord and notify the team.

j) Trim the fuses immediately prior to the attachment of the pull-wire lighters. Say "Lighter on" and get confirmation from other team members.

k) Light the fuses and confirm burn. See 6(f) in Section II.A. “Procedures for Helicopter Deployment of Explosives” (page 16).

l) After ensuring that the fuse is lit, notify team members by saying "Fuse lit."

m) Move to a pre-determined safe location to await detonation.

n) Check for misfire and fall out procedures. Refer to Section I: General Procedures (H), "Misfire Disposal Procedures" (page 13).

o) Notify closure control personnel that blasting is complete.

p) Tape detonating cord section ends before storage to prevent magazine contamination.

6. **Safety Precautions**

   a) The team members must be in contact at all times.

   b) Safety fuse assemblies must be carried separately from detonating cord and other explosive products, and should be attached to the trunk line immediately prior to performing the blast.

   c) Hearing protection is to be used during detonation.

   d) If the travel time to safety precludes any of the above, then longer sections of either detonating cord or safety-fuse shall be used to activate the explosives.

   e) Personnel must comply with WSBC Part 34.4 Training and Certification

      (1) Before allowing a person to perform rope access, the employer must ensure and document that the person (a) has received training in the safe use of rope access systems, as appropriate to the work being done, the safe work practices, skills and practical experience hours described in the following Groups: (i) RATA, (ii) SPRAT, (iii) ACMG.

   f) Blasters must ensure that det cord is compatible with the primer being used.

7. **Misfires and Disposal**

   Refer to Section I: General Procedures (H), "Misfire Disposal Procedures," and Section I: General Procedures (I), "Standard Disposal of Explosive Products."
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1.0 Introduction

Wyssen Avalanche Towers (WAT) will be used for avalanche control on the Trans-Canada Highway (TCH) at Three Valley Gap (3VG). A WAT is a remote avalanche control system (RACS) that an avalanche technician uses to deploy explosives into an avalanche starting zone. The system is operated from a safe location on the highway by means of a digital interface (e.g. tablet or laptop computer) connected to an encrypted communication system (e.g. radio, GSM). Explosives are dropped by remote mechanism from a removable deployment box installed at the top of a tower, and are suspended several metres above the snow surface. The deployment box holds up to twelve explosive charges (up to 4.5 kg) that are detonated individually.

Prior to the installation of the WAT, avalanche control in Three Valley Gap was conducted at these avalanche paths by helicopter, which is limited to flying during daylight hours and during sufficiently good weather. The WAT installation will result in a significant decrease in highway closure time due to the ability to operate the system at any time of day and during any weather.

These procedures describe blasting equipment used with the WAT, personnel training, the assembly and loading of explosives in the tower deployment box, flight operations for transport of the tower deployment box by helicopter, deployment of the explosives using the remote system, and misfires. Procedures are in accordance with WorkSafe BC (WSBC) Occupational Health and Safety Regulations (OHS) Part 21 – Blasting Operations and Part 29 - Aerial Operations, Natural Resources Canada Explosive Regulations, Transportation of Dangerous Goods Regulations Part 12.12 – Aerial Work and the Wyssen Avalanche Tower LS12-5 G3 Instruction Manual (v 3.6, June 2016).

1.1 Location

The TCH crosses Three Valley Gap 19 km west of Revelstoke, BC, and is subject to significant avalanche hazard. Avalanche paths are located on north facing, steep forested slopes that have no runout prior to reaching the highway. Small snowfall amounts can result in avalanches large enough to reach the highway and affect vehicles, thus frequent avalanche control is required. The TCH has an average daily traffic volume of approximately 3200 vehicles per day, with commercial vehicles representing a significant portion of this traffic. Traffic volume can be substantially higher during weekends and holidays.
2.0 Equipment for Blasting

The WAT system components and the equipment used for the assembly, loading and transport of the explosives and tower deployment box are listed below. Further detail of the system components can be found in the WAT Instruction Manual, Wyssen Avalanche Control (2016).

2.1 System Components

- Wyssen Avalanche Tower LS12-5 G3;
  - The tower deployment box (Figure 1);
  - The complete Wyssen Avalanche Tower (Figure 2);
- Wyssen Helicopter Latch HK-02 (Figure 3);
- Web-enabled device (PC, notebook, tablet, smartphone)
- WAC.3 base for radio communication with avalanche tower

2.2 Explosive Charge Components (Materials Per Charge)

- Explosives: Dyno TX, 50 mm x 400 mm (0.96 kg), 4 units (total 3.84 kg);
- Safety fuse assemblies, 30 cm (variance, October 2016), 2 units;
- Wyssen percussion fuse lighters, 2 units;
- Wyssen charge container, 1 unit;
- Cord, 3 mm, approx. 7.5 m in cord sack for charge suspension, 1 unit;
- Wire hooks for connecting pull wire lighters to cord, 2 units;
- Retaining ring to connect suspension line to the cable dropper, 1 unit;
- RECCO reflector, 1 unit.

2.3 Accessory Tools

- Fuse cutters;
- Punch tool;
- Electrical tape;
- Eye protection;
- Gloves

2.4 Other

- Portable radio(s)
- Keys for WAT deployment boxes and control unit.
- Locks for WAT deployment boxes
- Container for safety fuse assemblies
Figure 1. Components of the tower deployment box.
Figure 2. Components of the complete Wyssen Avalanche Tower system.

Figure 3. Wyssen Helicopter Latch HK-02.
3.0 Documentation

Inspection, testing, maintenance, loading, and use of the Wyssen Avalanche Towers will be carried out in accordance with the manufacturer’s recommendations and following the standard procedures outlined in the WAT Instruction Manual, including recommendations for:

- Charge construction;
- Loading and unloading the deployment box with explosive charges;
- Transport of the deployment box by helicopter;
- Seasonal recommissioning and decommissioning; and
- Maintenance.

The maintenance section of the manual includes inspection and maintenance instructions, maintenance schedule, and procedures in case of a malfunction. The supplier provides a 24-hour telephone service in the case of a system malfunction.

Records of inspections, pre-season and post-season maintenance, and testing will be maintained. A copy of the Avalanche Safety Plan, WAT Instruction Manual, and Explosive Use Procedures will be kept at the work site and made available to technicians using the system.

4.0 Personnel Roles and Responsibilities

4.1 Training and Certification

Personnel performing charge assembly will also be trained in:

- Site orientation;
- WHMIS training;
- TDG certification;
- WorkSafe BC blasting certificate for avalanche control;
- Wyssen Avalanche Tower specific training provided by an authorized Wyssen representative, covering the following topics:
  - System components, including maintenance and function tests;
  - Communication system operation and tests;
  - Pre-season maintenance requirements;
  - Charge assembly and loading;
  - Aerial transport operations;
  - Misfire procedures; and
  - Post-season decommissioning.
5.0 Operational Procedures

The operational procedures are presented in three sections for each of the following periods of use: recommissioning the system at the start of the season, operational use, and decommissioning the system at the end of the winter season. Personnel performing the tasks described below will meet the training and certification requirements list in Section 4.1 of the procedures. A Blaster of Record will be designated for explosive charge assembly, loading, helicopter transport of the deployment box, testing and operations.

5.1 Pre-Season Commissioning

Prior to the start of each winter season, several tasks are required to prepare the system for use. This includes inspecting all system components, assembling the explosive charges, loading the deployment boxes, and transporting the deployment boxes to the towers.

The charge assembly and loading area will be at least 400 m from inhabited areas and publicly travelled roads. This area will be secured during arming of the system to prevent unauthorized access.

5.1.1 Preparation of the Deployment Box

1. The docking system spike on the tower is to be cleaned and greased. Smooth out any irregularities, burrs, or edges with a coarse file. Apply a thick layer of waterproof and low temperature grease to the spike (grease brand/properties approved by Wyssen).
2. The battery (ies) on the deployment box are charged with a voltage of 12.8 V.
3. Position the deployment box to ensure that there is not more than 30 cm of free height below the bottom of the deployment box (deployment hole).
4. Prior to loading, each deployment box is located such that it is moved less than 50 m to the helicopter attachment point.
5. Open all padlocks on the cover and turn the locking level through 90°.
6. Lift the cover using handles provided until the safety catch engages. This is a two-person task due to the heavy weight.
7. Set all sliders of the cable droppers into the rear position.
8. Unfasten the hand screws of the tube holder cover and remove the cover.
9. Remove cable droppers from their notches.
5.1.2 Explosive Charge Construction

1. Preparation of the charge container:
   a. Place a RECCO reflector on the inside of one of the plastic half shells, between the ribs.
   b. Insert the explosive cartridge(s) into one half of the plastic shell. Ensure the cartridge(s) sits at the bottom end of the plastic shell.
   c. Snap the second half of the plastic shell together with the first one, starting with the tabs at the bottom of the shell working upwards.

2. Preparation of the retaining cord:
   a. Guide the retaining cord through the four holes on the top end of the plastic shell join the two ends with a Flemish bend (Figure 8 Knot).
   b. Release the cord attached to the back of the pre-assembled cord sack and then fasten the sack with a girth hitch to the retaining cord.
   c. Clip the spring hooks into the eyelets of the percussion fuse ignitor and insert the cord sack with the end (ring) on top.
   d. Place the foam stopper on the top of the cord sack to protect and secure the inserted retaining cord and percussion fuse ignitor.

3. Preparation of the safety fuse:
   a. Prepare the safety fuse assemblies with approved tools by cutting the fuse to a length of 30 cm.

4. Priming of the charge:
   a. Loosen the screw sleeves at the bottom of the percussion fuse ignitors by approximately 1 turn and remove the plug. Do not unscrew completely. Hold the ignitor at the top with one hand to prevent twisting. **NOTE: If the ignitor should be completely unscrewed, do not reassemble; this ignitor must not be used.**
   b. Push the free end of the safety fuse assembly fully up into the ignitor and firmly tighten the screw sleeve (compression fitting). Hold the ignitor by the lug with one hand while tightening the screw sleeve in order to prevent twisting. Repeat for the second safety fuse assembly.
   c. Pierce explosive cartridge(s) with the punch tool through the side holes in the plastic shell and insert the detonator on the safety fuse assembly securely into the cartridge. Repeat for the second safety fuse assembly.
   d. Clip the safety fuse assemblies into the plastic clips on the inside of the plastic shell.

5. Securing the primed charge:
   a. The primed charge is placed and secured in the temporary storage rack.
   b. A quality control inspection is conducted for each charge by a second trained person, completely independent of the construction process. This inspection will confirm the charge is assembled correctly following the procedure described above.
5.1.3 Loading the Deployment Box with Explosive Charges

1. Bring the prepared explosive charge to the deployment box and set it down on the surface next to the flashing light. The prepared charges should never be handled or transported one-handed.
2. Carefully remove the foam stopper from the charge while ensuring the retaining cord stays in place.
3. Take hold of the explosive charge on the inside of the plastic shell through the holes at the upper edge of the tube and carefully insert the charge into the tube holder, beginning with Tube #12 and working in descending order.
4. Attach the ring on the end of the retaining cord to the cable dropper by inserting the ring into the center slot on cable dropper and push the slider to the front extended position, which holds the ring. The slider goes into the front position by pressing the metal pin at the bottom of the cable dropper.
5. Lay the cable dropper into the notches of the tube holder so that the ball bearings point to the center of the deployment box. Both recesses in the cable dropper must lie within the tube holder to prevent the cable dropper from shifting.
6. Ensure the retaining ring is correctly mounted in the cable dropper. After this check, avoid touching the cable dropper.
7. Replace the tube holder cover and tighten the hand screws.
8. Conduct a test run with the switches on the control system (per section 5.1.4).

5.1.4 Test run with Operating Buttons

Prior to transporting the unit, a test run is carried out using the operating switches on the control system. The display serves to indicate important information about the system.

1. Pull out the emergency stop master switch until the yellow marking is visible.
2. Press the test button until the hourglass on the display switches off again (5 seconds). The flashing warning triangle signals test operation.
3. Press the start button until the hourglass on the display turns off again (2 seconds).
4. The test run now proceeds automatically and lasts about 8 minutes, depending on the number of charges.
5. When the warning triangle switches off, the test run has been successfully concluded. **Do not switch off the control system or carry out another test run prior to transportation.**
6. Once the system test is completed, close the deployment box, attach the padlocks, and prepare for transportation.

5.2 Transportation of the Deployment Box by Helicopter

The transportation of the deployment box by air is regulated by Transport Canada and the Transportation of Dangerous Goods Directorate. Personnel performing the tasks
described below will meet the training and certification requirements list in Section 4.1 of the procedures.

The Wyssen deployment box is a small means of containment designed and secured to prevent the accidental release and detonation of the explosives during transport. Further safety measures are described in the procedures below to minimize risk to workers and the public.

The helicopter loading area and flight corridor will be least 400 m from inhabited areas and publicly travelled roads. This area will be secured to prevent unauthorized access during the arming process. If the flight path requires that a publicly travelled road be crossed, specific procedures must be developed in accordance with WSBC OHS Part 18

5.2.1 Pre-planning for Helicopter Transportation

1. The pilot-in-command is provided with written information for each of the dangerous goods being transported, including:
   a. The shipping name, UN number and class; and
   b. The net explosive quantity (NEQ).
2. The pilot-in-command and ground crew review the operational procedures, operation of the load-carrying equipment, the flight plan, dangers when flying external loads, and emergency procedures in addition to the standard pre-work tailboard (safety) meeting.
3. A long-line with an automatic electrical latch is used for transporting the deployment box. The helicopter company is responsible for ensuring good working condition of all load-bearing elements. The elements must be designed to carry loads of at least 700 kg.
4. No passengers are allowed in the helicopter during transportation of the deployment box.

5.2.2 Helicopter Attachment

1. In addition to the 400 m distance requirement, the staging area/receiving point of the loaded deployment box must be suitable for helicopter operations with appropriate approach and departure corridors.
2. Ensure weather conditions are suitable for helicopter operations.
3. The ground staff must wear an approved helmet or hardhat with chin strap, safety glasses, high visibility vest, gloves, suitable clothing and solid footwear.
4. No use of the Wyssen Avalanche Control Centre software is allowed during transportation of the deployment boxes. Use of the software is only permitted after the deployment box has been placed on the tower and the helicopter has left the danger area.
5. The Blaster of Record is responsible for a final check of each deployment box prior to transport to ensure the charge-dropping mechanism is on stand-by and the latch, padlocks and dropping hole are closed and secure.
6. During the approach to the receiving point, the pilot must establish contact with the ground staff as a communication check. If this attempt fails, the helicopter must land and the malfunction rectified prior to transportation.

7. The electric latch is connected directly to the transport hanger of the deployment box.

8. After attaching the deployment box to the helicopter, no persons are allowed to be under the suspended load.

5.2.3 Placement of the Deployment box on the Tower

1. The pilot brings the insertion funnel directly over the docking spike on the top of the tower, following the range of permitted approach angle in Figure 4.

2. As the deployment box is lowered onto the docking spike, the deployment box will automatically turn into the correct alignment. A flashing light on top of the deployment box blinks for 1 minute as soon as it is correctly positioned.

3. If during the positioning manoeuvre, the deployment box hits the tower heavily or is positioned roughly, the internal mechanism may be damaged and the pilot should not release the latch and must return the deployment box to the staging area for a test run.

4. One the pilot confirms the deployment box sits firmly on the docking spike and is correctly positioned, the latch can then be released.

a. In the case the deployment box is released but not positioned correctly (i.e. no flashing light), the deployment box must be retrieved using the HK-02 latch and returned to the staging area.

5. After positioning of the deployment box, a test run is conducted. The test must only be started after the helicopter has left the danger area around the avalanche tower.

6. Once all deployment boxes have been placed, a flight with a second trained person will be done to confirm each deployment box is placed on the correct tower.
5.3 Live Testing and Operational Use

5.3.1 Area Closure

An area closure will be implemented as described in Section 3.2 Closures of the Dynamic Avalanche Consulting Ltd. General Explosive Use Procedures for Avalanche Control. For publicly travelled roads, the closure will also be in accordance with WSBC OHSR Part 18 and the managing agency of the roadway (e.g. BC Ministry of Transportation).

The general sequence of events from initiating the closure to re-opening the area following explosive control will be as follows:

1. Initiate the area closure.
2. Proceed to a safe firing location.
3. Ensure that the closure is effective and the danger area is clear.
4. Use the firing control system (Section 5.3.2) to control the selected WAT on the selected target.
5. Confirm detonation of the WAT using one or more of the following means: system detection by geophone, acoustically, visually.
6. Misfire check.
7. Record the results.
8. Repeat steps 4 through 7 for the next target(s).
9. Notify closure control personnel that blasting has been completed.
5.3.2 Firing the System

The Wyssen avalanche towers are controlled using a web application (control.wyssenavalanche.com) to access the firing system. Individual login credentials and a code list are used in order to maintain a high standard of safety and security. The entry of login credentials and a single-use numeric code from the code list is required prior to accessing the firing system. The firing system communicates with the towers via an encrypted radio communication system.

To fire the system:
1. Load the web application and enter your login credentials.
2. Enter the 8-digit numerical code.
3. The firing system is now activated until a charge is deployed, or until the time-out limit of 15 minutes is reached.
4. After deploying the charge, detonation must be confirmed. Detonation can be confirmed in three ways:
   a. Automatic detection by the geophone and displayed in the firing system.
   b. Acoustically.
   c. Visually.
5. The firing system will display a “Closed and Secure” status for the tower, indicating that dropping hole is sealed and the firing system connection is terminated.

5.3.3 System Malfunctions

If a fault occurs during the firing sequence, it is treated as a misfire the misfire procedures in Section 5.3.4 are followed. The Wyssen Avalanche Control 24-hour support line should be contacted immediately.

5.3.4 Misfire Procedure

If a misfire has occurred and is not recovered or disposed of before another shot is used to reduce the avalanche hazard, all misfire protocols must be followed before snow removal along the highway can take place. As per the WSBC Variance VR201600107 in Appendixes.

A misfire occurs when detonation cannot be confirmed by any of the three methods described in Section 5.3.2. Four types of misfires can occur (Type A1, A2, B1 and B2). Type A misfires are those which are hanging on the cord and Type B misfires are those which are lying in the snow. All types of misfires will be handled using the following procedures:

1. Maintain the area closure.
2. Observe the minimum waiting period of 30 minutes before approaching the danger, either by foot or in a helicopter.
3. Locate and visualize the misfire. This may require the use of a helicopter for towers that are difficult to access. Consider that misfires could potentially slide away from the tower and may have the potential to trigger an avalanche and be carried downslope to highway elevation.

4. Under no circumstances may a deployment box be transported beneath a helicopter with a suspended misfire.

5. If a cord is found in the area of a misfire, it must not be pulled since this can activate the percussion fuse lighter and detonate the charge.

6. A misfire must not be moved. If the charge contains a safety fuse and is re-blasted, the workers must not return to the blast site for 30 minutes after detonation.

7. For both Type A and B misfires, confirm the wire hooks are evident on the cord, which confirms the percussion fuse lighter was activated. If the wire hooks are not evident (i.e. still attached to the percussion fuse lighter), the percussion fuse lighter may not have been activated and extra caution is required.

8. For Type A misfires, remotely release the charge retaining cord from the deployment box.

9. Once the misfire is on the snow surface (Type B) or already on the surface (Type B), deploy a conventional explosive to detonate or destroy the misfire, as per the helicopter control or hand charging misfire procedure.

10. Confirm the detonation and perform a post-blast inspection to confirm the misfire was destroyed.

5.4 Post-Season Decommissioning

During the summer, it is preferable to house to the deployment boxes in secure, dry storage. Explosive charges that have not been used are preferably detonated prior to deployment box removal, but if this is not possible (e.g. malfunction of the deployment box), the charges must be removed from the deployment box and destroyed as the safety fuse must not be disassembled.

5.4.1 Return Transportation of the Deployment box by Helicopter

The Wyssen helicopter latch is attached to the automatic electrical latch on the long line to retrieve the deployment box.

The Wyssen helicopter latch must be regularly inspected and tested for proper functioning and damage prior to each transport of the deployment box as follows:

- The latch must be free to move upwards as far as the stop;
- The latch must drop and close independently through its own weight;
- In the closed state, the notch of the latch must lie on top of the supporting bolt;
- No cracks shall be visible on the latch or handle; and
- The latch and the handle must not be deformed.
If any defects are found or if there are any uncertainties, the helicopter latch in question must not be used.

The Wyssen helicopter latch is used for the return transport of the deployment box only. This allows the attachment of the deployment box to the helicopter longline without the assistance of ground personnel. Under no circumstance may the latch be used for the lifting of other loads. During the lifting of the deployment box, no personnel are permitted to be on or near the tower.

The following procedure is used to retrieve the deployment box from the tower.

1. The pilot then flies over the deployment box and lowers the Wyssen helicopter latch over the fork of the transport hanger on the deployment box. Once lowered far enough, the latch on the Wyssen helicopter hanger will catch the transport hanger and secure the deployment box to the helicopter longline.
2. As the pilot lifts the deployment box off the tower, they must ensure that they are lifting vertically to ensure that they do not cause damage to the tower.
3. As soon as the deployment box is lifted off the tower, the monitoring switch automatically deactivates the power supply in order to prevent an accidental release of a charge, should charges remain in the deployment box.
4. The deployment box is transported to the staging area and set down carefully.
5. The deployment box must be resting on the ground and the helicopter longline not under tension prior to uncoupling. The latch must only be opened by the black lever on the Wyssen helicopter hanger by ground staff.
6. Once the deployment box is released, the pilot is signalled so they can depart.

5.4.2 Unloading Explosive Charges from the Deployment box

If the deployment box is returned to the staging area with explosive charges still inside, the following steps are followed when unloading:

1. Open all padlocks on the cover and turn the locking level through 90°.
2. Lift the cover using handles provided until the safety catch engages. This is a two-person task due to the heavy weight.
3. Press the emergency stop master switch to ensure the system is deactivated and to protect the batteries during summer storage.
4. Activate all sliders on the cable dropper by pressing the side of the ball bearings toward the back.
5. Ensure the retaining ring is disengaged from the cable dropper.
6. Remove the cable dropper from the tube holder.
7. Take hold of the charge through the holes at the top of the plastic shell and lift out of the tube holder.
8. The primed charge is placed and secured in the temporary storage rack until the blaster is prepared to destroy or disassemble the charge.
9. Close the deployment box.

5.4.3 Charge Disassembly

1. Loosen the screw sleeves at the bottom of the percussion fuse ignitor by one turn.
2. Remove the both safety fuse assemblies from the percussion fuse ignitors through the openings on the side of the plastic shell.
3. With a slow, smooth and even pressure, remove both safety fuse assemblies from the charges. If resistance is encountered, the charge should not be disabled and must be destroyed in an appropriate safe location using the misfire procedure.
4. The safety fuse assemblies may not be reused if disassembled.
5. If the explosive charges are going to be stored in the plastic shells for future use, the plugs must be inserted into the bottom of the percussion fuse ignitors to protect them from moisture.
6. If the explosives are being stored for future use, the expiration date should be noted and must not be exceeded during subsequent use.

5.4.4 Preparing the Deployment box for Storage

In order to ensure that the battery survives the summer without any damage, it should be completely charged prior to being placed in storage. Connect the battery to the charger for at least 24 hours. The battery must only be charged with a designated battery charger which has temperature-controlled charging voltage. Battery chargers such as those used for car batteries are not suitable and damage the battery.

5.5 Emergency Procedure - Dropped Deployment box

In the unlikely event the deployment box is dropped during helicopter transport, it will be known to the Blaster of Record whether or not the deployment box contains explosives. If it does not, then a plan can be put in place to safely recover the deployment box. If the deployment box does contain explosives, the following procedure is followed by the Blaster of Record:

1. Dial 911 to activate required emergency services (police, fire and/or ambulance).
2. Begin evacuation of the area around the deployment box to a distance of 1600 m in all directions.
3. Contact the following:
   a. Local RCMP Detachment (detachment listings can be found here: [http://www.rcmp-grc.gc.ca/detach/index-eng.htm](http://www.rcmp-grc.gc.ca/detach/index-eng.htm));
   b. Emergency Management British Columbia (PEP) 1-800-663-3456 (24 hours)
   c. Regional Transportation Management Centre 1-866-706-7862 (24 hours)
   d. Explosive technical advisors as necessary (Dyno Nobel Inc.).
   e. Wyssen Avalanche Control Inc. (Switzerland) +41 79 628 10 83
4. Assist the Emergency Response Personnel (Incident Commander and/or Accident Site Commander) in the role of Technical Advisor in order to safely and efficiently recover and disposed of explosive products.
   a. Assess explosive division type(s), quantity and conditions at the accident site to determine minimum evacuation distance.
   b. Arrange for the delivery of explosives clean up materials and equipment as necessary for the severity and extent of spilled explosives.
   c. Confirm with Incident Commander and/or Accident Site Commander that assistance from outside agencies (e.g. RCMP, EMBC and CANUTEC) has been requested and dispatched as necessary. Ensure that essential personnel only are involved in the transfer and clean-up of spilled explosive products in order to minimize risk.
   d. In consultation with external expertise (e.g. Wyssen, Dyno Nobel, WorkSafe BC), advise the Incident Commander and/or Accident Site Commander of the most appropriate actions to ensure safety of all personnel involved.
   e. Liaise closely with the Incident Commander and/or Accident Site Commander and outside agencies at the accident site (e.g. RCMP) to ensure that all decisions made reflect the utmost concern for safety of involved personnel.
   f. Ensure that the area has been thoroughly searched to confirm that all spilled explosive materials have been removed prior to re-opening the evacuated area.

6.0 Closure

These procedures have been developed for use by Dynamic Avalanche Consulting Ltd. with the Wyssen Avalanche Tower (WAT).

They describe blasting equipment used with the WAT, personnel training, the assembly and loading of explosives in the tower deployment box, flight operations for the helicopter transport of the tower deployment box, deployment of the explosives using the remote system and misfires. Procedures are in accordance with WorkSafe BC (WSBC) Occupational Health and Safety Regulations (OHS Part 21 – Blasting Operations and Part 29 - Aerial Operations, Natural Resources Canada Explosive Regulations, Transportation of Dangerous Goods Regulations Part 12.12 – Aerial Work and the Wyssen Avalanche Tower LS12-5 G3 Instruction Manual (v 3.6, June 2016).

These procedures will be reviewed annually and if any changes are made they must be approved in writing by WorkSafe BC.
### APPENDIX A - AVALANCHE AREA LOCATIONS BY PROGRAM

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January 26, 2017

Ministry of Transportation and Highways
4th Floor, 310 Ward Street
Nelson, BC V1L 5S4

Attention: Robb Andersen

Dear Mr. Andersen:

Re: Explosive Avalanche Control Procedures for Firm No. 4000-175

Thank you for submitting your Explosive Avalanche Control Procedures dated August 23, 2016. These procedures have been reviewed and accepted by WorkSafeBC under Section 21.85(1) of the Occupational Health and Safety Regulation (OHSR). This acceptance is subject to the following conditions:

1. This acceptance is in effect until July 31, 2021.

2. You are authorized to conduct the following control measures:
   - Helicopter Deployment
   - Hand Charging
   - Cornice Control
   - Case Charging
   - Avalanche Guard
   - Wyssen Tower

3. Before operations take place, the blaster of record must ensure that they have considered the entire scope of the danger area that may result from the blast. The blaster of record must ensure that guarding of the danger area is in accordance with Section 21.66 of the OHSR. The information contained in the Avalanche Atlas and the Avalanche Safety Plan for the specific avalanche area must be considered prior to designating the danger area and guarding of the area for the duration of the blasting operation. Furthermore; for industrial settings the blaster is to ensure consideration is taken in regards to protecting structures and equipment which may be exposed to the effects of the blast.

4. Emergency procedures, including a rescue and evacuation response plan, must be in place for all avalanche control work. All workers must have adequate and appropriate rescue equipment available for use.

5. All explosive materials must be stored, handled and used in the manner recommended by the manufacturer and required by the OHSR. All applicable
manufacturers' information must be available on site for reference and training by all blasters/workers involved in your control program.

6. This acceptance is conditional on the employer acquiring the appropriate authorizations and having satisfied the requirements of all other applicable regulatory agencies including, but not limited to, Transport Canada, British Columbia Safety Authority, and Natural Resources Canada. The granting of this acceptance does not constitute a finding by WorkSafeBC that those requirements have been met.

7. All misfires must be effectively guarded and the zone affected closed until such time as the misfire is located and disposed of. Due to the possibility of movement of misfired explosives by natural or planned avalanches, persons must be educated to identify explosive products, what the potential hazards associated with a misfire are and who to contact if an explosive product is found. Location of found misfires must be communicated in a timely fashion to the blaster of record.

8. Transport of primed charges by vehicles is strictly for case charging operations and is restricted solely to the specific safe area assigned to the blast site. Primed charges must be secured and effectively separated from all other explosives and must not be stored in the passenger compartment of any vehicle. Whenever possible primed charges should be transported separately from other explosives.

9. If misfires are suspected in an avalanche debris deposit, and machinery is required to clear the debris, the blaster of record must be on site. The blaster of record is to maintain a minimum number of workers required to clear the debris and must be in direct control and supervise all work. Any misfires located or suspected will be handled as required by the OHSR.

10. The granting of this acceptance does not constitute a finding by WorkSafeBC that the employer's procedures or equipment used for belay, or anchoring for belaying, when conducting cornice or avalanche control meet the requirements of Part 34 of the OHSR for Rope Access.

11. Section 21.85(4) of the OHSR requires that your procedures be reviewed annually and that any proposed changes be submitted to WorkSafeBC for approval prior to implementation. WorkSafeBC's acceptance of your procedures does not relieve the employer (and the contractor) from its obligation to ensure worker health and safety in accordance with Section 115 of the Workers' Compensation Act (Act) or any other obligation under the Act or OHSR.

WorkSafeBC accepts no liability for any loss or damage caused by the employer's avalanche control activities, including, but not limited to, the employers use of or failure to use these work procedures. (This information can be found on our website at www.worksafebc.com.)

12. Please keep a copy of this letter available with the procedures for inspection by a WorkSafeBC officer.
You may be asked to re-submit your procedures, regardless of changes, at any time. WorkSafeBC may, at its discretion, review and reconsider this acceptance at any time. Reasons that might cause a review of your procedures include, but are not limited to:

a) WorkSafeBC’s receipt of new information or the determination that there has been an error relating to this acceptance and;
b) Changes to the OHSR, OHS Policies, OHS Guidelines, or other laws affecting occupational blasting or avalanche control best practice.

If you have any questions on the content of this letter, please contact Certification Services at 1-604-276-3090 or toll free 1-888-621-7233 or email Certification@WorkSafeBC.com.

Yours truly,

Dan Westerby
Manager, Certification Services
Worker & Employer Services

DW/ve

Copy to: Alan Brose, Senior Manager, Prevention Strategic Issues
Warren Fulton, Certification Officer
Mark Harper, Occupational Safety Officer, Kamloops
Firm Avalanche Control Procedures File
Employer File WSE
The *Workers Compensation Act* requires that the employer must post a copy of this report in a conspicuous place at or near the workplace inspected for at least seven days, or until compliance has been achieved, whichever is the longer period. A copy of this report must also be given to the joint committee or worker health and safety representative, as applicable.

### Inspection Report #201715820002A

<table>
<thead>
<tr>
<th>Employer Name</th>
<th>Jobsite Inspected</th>
<th>Scope of Inspection</th>
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<td>PROVINCIAL GOVERNMENT (WORKERS'COMP CO-ORDINATOR)</td>
<td>KRYSTA GROENEWEGEN VAN DER WEIDEN PO BOX 9850 STN PROV GOVT VICTORIA BC V8W 3E7</td>
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**THERE ARE ZERO (0) ORDERS OR OTHER ITEMS OUTSTANDING**

**ACTION MAY STILL BE NECESSARY TO ENSURE COMPLIANCE**

**PLEASE READ FULL REPORT**
INSPECTION NOTES

This report is being generated to document the letter of acceptance this employer Explosive Avalanche Control Procedures.

The employer may contact Diving/Blasting Certification Officer Warren Fulton at 250-881-3420 for further details or clarification of this report. Additional information concerning The Workers Compensation Act, The Occupational Health and Safety Regulation and health and safety general information can be found by visiting the WorkSafeBC website at www.worksafebc.com.
REFERENCES

In addition to any orders, or other items, and the information provided in the Inspection Notes section in this Inspection Report, the officer may discuss other health and safety issues with the employer arising out of the inspection. The information below sets out the health and safety requirements discussed with the employer, and unless otherwise noted, violations of these requirements were not observed.

<table>
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<tr>
<td>OHS21.85(1)</td>
<td>Review of Explosive Avalanche Control Procedures</td>
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Explosive charges must not be placed manually on site by workers or projected by any means for the purpose of avalanche control, until the proposed work procedures have been submitted to and accepted by the Board.
**INSPECTION REPORT**

**Worker and Employer Services Division**

**201715820002A**

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**Lab Samples Taken** | **Direct Readings** | **Results Presented** | **Sampling Inspection(s)** | **Workers onsite during Inspection** | **Notice of Project Number**
---|---|---|---|---|---
N | N | N | | |

**Inspection Report Delivered To** | **Employer Representative Present During Inspection** | **Worker Representative Present During Inspection** | **Labour Organization & Local**
---|---|---|---
Robb Anderson | Robb Anderson | N A | |

**WorkSafeBC Officer Conducting Inspection**

Warren Fulton

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*The time recorded above reflects the inspection time and travel time associated with this inspection report and includes time spent on pre and post-inspection activities. Additional time may be added for subsequent activity.*

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**Right to Review**

Any employer, worker, owner, supplier, union, or a member of a deceased worker's family directly affected may, within 45 calendar days of the delivery date of this report, in writing, request the Review Division of WorkSafeBC to conduct a review of an order, or the non-issuance of an order, by contacting the Review Division. Employers requiring assistance may contact the Employers' Advisers at 1-800-925-2233.

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WorkSafeBC values your feedback. To obtain that feedback, an external market research provider may be contacting you to complete a survey.