Workplace Safety North

ONTARIO MINE RESCUE

Recommended Practices for Working Safely Around Blasthole Stopes

705.474.7233
1.888.730.7821 (Toll free Ontario)
workplacesafetynorth.ca

Suggested Best Practices for Working Safely Around Blasthole Stopes

WSN Technical Advisory Committees
Ontario Mines

Workplace Safety North
ONTARIO MINE RESCUE

Preface

Workplace Safety North (WSN), working through its Technical Advisory Committees, has prepared this technical report to make mine operators aware of the hazards related to open stope mining.

The document is intended to assist companies in developing their own mining specifications. This is not intended to restrict research, impede innovation or hinder development of safe designs or practices.

The information contained in this material is provided as a guide only. WSN recognizes that individual companies must develop health and safety policies and programs which apply to their workplaces and comply with appropriate legislation. This material does not constitute legal advice. While the information provided, including references to legislation and established practice, is current at the time of printing, it may become out-of-date or incomplete with the passage of time.

No warranty, guarantee or representation is made by WSN as to the absolute correctness or sufficiency of any information contained in this material and WSN assumes no responsibility in connection therewith; nor can it be assumed that all acceptable safety measures are contained in this material, or that other or additional measures may not be required in particular or exceptional circumstances.

For additional copies of this material or for further information please contact:

Workplace Safety North
690 McKeown Avenue, P.O Box 2050 Station Main
North Bay, Ontario P1B 9P1
Toll free: 1-888-730-7821 (Ontario) Fax: 705-472-5800

Acknowledgment

Workplace Safety North (WSN) would like to thank Edward Pieterse and James Peters of Kidd Operations for providing guidance in the preparation of this technical report and review of its content. Our thanks also to WSN's Technical Advisory Committees (Safety and Loss Control, Ground Control, Mining Equipment and Workplace Environment) for their contributions to this document.

Table of Contents

1. Introduction

Incidents of working around big open holes in Ontario underground mines have resulted in serious injury and death, damage to equipment and loss of production. Blasthole or Long blasthole stope mining creates large openings that can range in height and width from a few meters to several hundred meters. These excavations pose specific hazards related to workers' and equipment interaction with the excavations or the openings.

This handbook does NOT discuss the excavation or filling design and processes but rather focuses solely on the hazards of this type of mining and the controls and practices that enable work to be conducted safely and efficiently. It is generic and contains information that underground mining operations can refer to on what are the hazards that are associated with this type of mining and ensure that controls and practices are implemented at the workplace to mitigate hazards. This document focuses only on "NON-ENTRY" blasthole production stopes where remote technology is used (i.e. remote controlled loaders such as Load-Haul-Dump or scoop). It does not include "entry" type stopes where remote technology is not used including "cut and fill" operations.

We recognize that individual companies must develop health and safety policies and programs which apply to their workplaces and comply with appropriate legislation. The information contained in this reference document is made available as a guide only to assist operations in developing those policies and programs.

2. Hazards Associated with Blasthole Stopes

There are specific hazards related to workers' and equipment interaction with the excavations or the openings created by blasthole stoping, while performing work. Appendices B and C summarizes the Past Occurrences Data, and Past Specific Incidents and Injuries, respectively. Workers should be particularly alert with hazards while performing work in these areas:

- Top of stope (overcut)
  - Fall from height or elevation or falling into open hole resulting from:
    - Edge peeling away, and drilling, dumping and construction at the edge of the overcut
    - Inappropriate or damaged barricade, or missing, mislabeled or deteriorated accesses warning signs
  - Falls of ground due to:
    - Loose ground in the back, ground movement, unusual seismic activity, ground support condition (corrosion, failed bolts, bagging of screen, etc.)
  - Exposure to airborne contaminants such as:
    - Dust and concentration of gases; after blast and diesel equipment exhaust gases, methane, radon, natural gas, etc., if unventilated

- Combustion resulting from oxidation of ore or tailings

- Bottom of stope (undercut)
  - Fall of ground from brow, within stope, and projected out of stope due to:
    - Loose ground inside the stope or the brow, ground movement, unusual seismic activity, ground support condition (corrosion, failed bolts, bagging of screen, etc.)
  - Driving or walking into open hole due to inappropriate or damaged barricade, or missing, mislabeled or deteriorated access warning signs
  - Exposure to airborne contaminants such as:
    - Dust, and concentration of gases; after blast and diesel equipment exhaust gases, methane, radon, natural gas, etc., if unventilated
  - Combustion resulting from oxidation of ore or tailings

- Stope backfilling
  - Falls of ground due to ground movement, unusual seismic activity, ground support condition (corrosion, failed bolts, bagging of screen, etc.) at construction site and travelway while:
    - Conditioning the stope brow
    - Building backfill fences, bulkheads or rockfill stoppage
  - Driving or walking into open hole due to inappropriate or damaged barricade, or missing, mislabeled or deteriorated access warning signs
  - Ventilation in the area could be compromised by the removal of ore and opening of the stope to the overcut
  - Build-up of the concentration of dust and gases; after blast and diesel equipment exhaust gases, methane, radon, natural gas, etc.
  - Chemical burns, dermatitis, or irritation due to exposure to cement mix, and buildup of dust concentration during shotcrete application
  - Backfill fence or bulkhead and rockfill stoppage failures, and backfill transport
    pipeline bursting (for paste and hydraulic fill) during backfilling operations

3. Top of Stope (Overcut or Sublevel)

A sublevel or overcut on top of a stope is created to provide access for drilling and blasting slices of ore during stoping operations. After the stope had been blasted and mucked out, the sublevel or overcut provides access for many activities including open stope inspection and monitoring (with CMS or other means), stope backfilling, dumping of waste rock, and for other ancillary activities. There are specific hazards related to workers' and equipment interaction with these headings while performing work near open stopes. Workers should be particularly alert with hazards while performing work in sublevels or overcuts near open stopes. **Figure 1** shows a view of the open stope from the overcut.

Figure 1 - A view of the open stope from the overcut.

3.1. Top of Stope Hazards

Hazards encountered when while performing work in a sublevel or overcut of an open stope includes:

- Fall from height or falling into open hole
- Falls of ground
- Exposure to airborne contaminants
- Combustion resulting from oxidation of ore or tailings

3.1.1. Fall from height or Falling into open hole

The dangers of workers and equipment falling from height or falling into open hole on top of the stope can be caused by many factors such as stope edge peeling off, drilling, dumping and performing construction work near or at the edge of the stope, and inappropriate or damaged barricade, or missing, mislabeled or deteriorated access warning signs.

3.1.1.1. Edge of stope peeling off

Cracks on the floor of the sublevel or overcut can develop as a post stope blast effect, or could be a result of ground movement, unusual seismic activity, contacts, faults or bad ground conditions. These can initiate a fall of ground into the stope while performing work. The floor should be cleared of any material using a remote operated LHD (preferably) prior to any other work being conducted. The remote LHD can also be used to pry any slabs of loose near the edge of the stope. Pre-shift and on-shift inspections are required to be performed. Indications of faults and contacts in the walls and back should be observed for coincidental movement. If uncertain and depending on the level of separation of the crack, the issue has to be reported to supervision and appropriate ground control personnel.

3.1.1.2. Drilling at the edge of the stope

Care must be followed when performing drilling near or at the edge of an open stope. Fall of worker and equipment into the open stope may happen if controls are not in place and standard operating procedures (SOPs) for drilling near or at the edge of an open stopes are not followed. A fall of ground can be initiated by the weight of the drilling equipment combined with the ground vibration caused by the drilling operation. Establishing a safe working distance from the edge of a stope will minimize potential harm due to peeling at the edge of the stope. A safe working distance from the edge of a stope should be established and a suitable barricade erected to limit exposure to any workers. Continuous monitoring of the work area including monitoring for loss of standing water or developing cracks will help predict if the edge of the stope may peel.

3.1.1.3. Dumping at the edge of the stope

Care must be followed when dumping material at the edge of an open stope with any equipment. Fall of worker and equipment into the open stope may happen if controls are not in place and SOPs for dumping in open stopes are not followed. A fall of ground can be initiated by the weight of the LHD combined with the ground vibration caused by the moving equipment. The likelihood of fall of ground can be amplified by the presence of cracks on the floor. The floor should be cleared of any material using a remote operated LHD (preferably) prior to any other work being conducted. The remote LHD can also be used to pry any slabs of loose, near the edge of the stope prior to setting up bumper blocks. Any dumping at an edge of a stope requires a suitable “bumper” of sufficient size and secured in a fashion to prevent equipment from falling over the edge.

3.1.1.4. Construction at the edge of the stope

Fall of worker and equipment into the open stope may happen when performing construction work at the edge of the stope. Fall of ground into the stope hazard also exist on the sublevel or overcut floor where work is being performed. The probability of fall of ground can be amplified by the presence of cracks on the floor. The floor should be cleared of any material using a remote operated LHD (preferably) prior to any other work being conducted. The remote LHD can also be used to pry any slabs of loose, near the edge of the stope prior to the start of the construction work. Any construction work at an edge of a stope shall be conducted using appropriate fall protection equipment.

3.1.1.5. Inappropriate or damaged barricade, or missing, mislabeled or deteriorated access warning sign

Barricades and warning signs are installed to avoid inadvertent access of workers and equipment beyond the barricade or warning sign. These should be maintained in proper condition to ensure that walking of workers or driving of equipment into open hole is avoided. This will also ensure that workers and equipment will not be exposed to a potential fall of ground.

3.1.2. Exposure to airborne contaminants

The ventilation system in the area could be compromised by the removal of ore and opening of the stope to the overcut, which can cause the build-up of the concentration of dust and gases such as after blast and diesel equipment exhaust gases, methane, radon, natural gas, etc. Short-circuiting between levels may result and require ventilation brattices or ventilation stoppages to ensure adequate ventilation design.

3.1.3. Combustion resulting from oxidation of ore or tailings

The oxidation of ore in stopes, or tailings used for backfilling stopes, with high sulfide content could result in an exothermic reaction of the material. These can cause the build-up of the concentration of unwanted gases and increased workplace temperature. **Figure 2** shows smoke resulting from oxidation of broken ore. There have been occasions where gas and smoke from oxidizing ore has interrupted production operations in underground mines.

Figure 2 - Oxidation of broken ore.

3.2. Top of Stope Hazards Controls

Hazards associated with performing work in a sublevel or overcut of an open stope can be prevented by implementing and maintaining controls along with following the appropriate SOP. Workers and equipment exposure to fall from height or falling into open hole, falls of ground, airborne contaminants, and combustion resulting from oxidation of ore or tailings can be prevented by implementing and maintaining controls such as edge of stope protection, bumper block design and installation, appropriate barricades and signs, and curtains to prevent air flow short circuiting.

3.2.1. Edge protection

Edge of open stope protection are required to ensure that workers and equipment are secured from being exposed to hazards such as fall from height or falling into open hole, and falls of ground. This includes the proper design and installation of appropriate controls such as bumper blocks, barricades and signage.

3.2.1.1. Bumper block design and installation

Design and installation or construction of adequate bumper blocks at specified distances from the overcut edge should be conducted based on design specifications and procedures. If waste materials are allowed to be dumped in open stopes, bumper blocks on the dump should be designed (engineered) and constructed based on mass and force expected to be applied and the wheel height of the largest truck or equipment allowed to dump in the open stope. Appropriate barricades with signage identifying the hazard should be installed ahead of the cement barriers or bumper blocks.

3.2.1.2. Barricades and signs

Barricading of dump area is required when it is not in use. Barricades should be installed at a specified distance from the opening of the open hole and should be accompanied by appropriate signs that alert workers of the hazards present. These signs include cautions about blasthole overcut, open hole, men working below, backfilling in progress, etc. Signage is required to be posted at eye level on the barricade.

Various types of barricades can be installed depending on the condition of the area being barricaded:

- *Barricades for no entry* - these are isolation barricades used to protect workers from immediate risk by preventing entry to a hazard such as open hole conditions or dangerous ground conditions that may be undetectable than can endanger life with no warning.

  Entry beyond this type of barricade requires entry permission. **Figure 3** shows examples of this type of barricade.

- *Restrictive warning barricades* - are used to isolate an area that has a known detectable hazard that is visible or is a potential hazard. Work can be conducted beyond this type of barricade by trained, competent and authorized workers.

  This type of barricade is a restricted entry barrier. **Figure 4** shows examples of this type of barricade.

Figure 3 - Examples of no entry type barricade.

Figure 4 - Examples of restrictive warning type barricade.

- *Cautionary barricades* - are notification barricades that are used in areas that have a recognizable hazard and provide an impediment that permits easy access to the area for various activities.

  This type of barricade limits entry to the area that has known hazard. **Figure 5** shows examples of this type of barricade.

Figure 5 - Example of cautionary type barricade.

3.2.2. Area control and control processes

Edge of open stope protection is required to ensure that workers and equipment are secured from being exposed to hazards such as fall from height or falling into open hole, and falls of ground. This protection includes the proper design and installation of appropriate controls such as bumper blocks, barricades and signage.

When a risk assessment has been conducted and hazards are recognized to pose injury workers or damage to equipment, controls need to be implemented. These controls should be designed by the mine engineering group and issued on prints with appropriate information and will dictate the appropriate controls to be installed such as bumper blocks, barricades and signage.

Various types of barricades can be installed depending on the condition of the area being barricaded as discussed in Sub-sections 3.2.1.1 and 3.2.1.2.

3.2.3. Ventilation control for stope short circuiting

When blasthole hole or long blasthole stopes are emptied, the ventilation system in the area can be affected by either change in ventilation direction of flow (reversed airflow), or air short circuiting. Controls should be in place to ensure that reversing or short-circuiting of airflow is avoided. This includes the proper design and installation of appropriate controls such as barricades and signage that informs workers of the needs.

Either the overcut or the undercut to the stope is required to be controlled through brattices or barricades to ensure that airflow will not be reversed or short-circuited when the stope is emptied. Various types of barricades can be installed depending on the condition of the area being barricaded and availability of material to be used:

- *Brattice or curtains* - this type of isolation barricade consists of a canvas that is installed tightly to the walls, back and floor.
- *Timber framed bulkhead* - fabrene wrapped timber frames can also be used for bulkheads.
- *Muckpile bulkhead* - consists of waste rock material pushed at some distance from either the brow of an open stope at the undercut or the top of the open stope at the overcut.
- *Shotcrete frame bulkhead* - this type of barricade consists of shotcrete sprayed over weld mesh screen, gabion basket frames or cable lacing.

3.3. Top of Stope - Other Considerations

3.3.1. Drilling From the Top and Mucking from the bottom simultaneously

Care must be followed when performing drilling near or at the edge of an open stope, while mucking of the stope is in progress. Fall of worker and equipment into the open stope may happen if controls are not in place and SOPs for drilling near or at the edge of an open stopes are not followed. A fall of ground can be initiated by the weight of the drilling equipment combined with the ground vibration caused by the drilling operation. This can cause damage not only to the drilling equipment but to the LHD or scoop in the stope, if the equipment happens to be in the stope when the fall of ground occurs. The fall of ground can also be initiated by the presence of cracks on the floor. The floor should be cleared of any material using a remote operated LHD (preferably) prior to any other work being conducted. The remote LHD can also be used to pry any slabs of loose, near the edge of the stope.
The drill string may contact the scoop in the stope below due to rods being dropped or pushed beyond the regular breakthrough location. The breakthrough holes and associated drilling vibration may cause muck to fall onto the scoop. The drill string may deviate from the anticipated direction due to ground conditions or operator error. The drilling activity may introduce water and cuttings into the stope.

Drilling into unexploded remnants of previous drill holes could result in an unplanned explosion. Thorough mapping of drill holes and consideration of potential deviation (not only of the original blast hole but deviation in any other holes to be drilled that could intersect a previously drilled hole) is required to indicate where potential remnants may be present.

3.3.2. Inspection of Open Cavity

Care must be followed when performing open cavity inspection near or at the edge of an open stope, either visually or using instruments such as Cavity Monitoring Systems (CMS). Fall of worker and instrument into the open stope may happen if controls are not in place and SOPs for cavity inspections near or at the edge of an open stopes are not followed. A fall of ground can be initiated by the presence of cracks on the floor. The floor should be cleared of any material using a remote operated LHD (preferably) prior to any other work being

conducted. The remote LHD can also be used to pry any slabs of loose, near the edge of the stope.

When performing a CMS from the bottom of the stope the instrument should be put in place using a remotely operated equipment, ensuring workers are at a safe distance from the brow.

3.3.3. Multilevel Accesses

Fall of worker and equipment into the open stope and falls of ground from stope brow, within stope, or projected out of stope at multilevel access may happen if controls are not in place and SOPs for working near or at the edge of open stopes are not followed. The SOP should specify a non-entry point and a non-entry barricade should be constructed.

3.3.4. Dust Control

The cascading of broken muck in a stope during mucking operations can release dust in the air. Depending on the direction of airflow, dusts can go up the overcut and affect workers. Dust control must be in place and SOPs for dust control must be developed, implemented and followed by workers. The most common dust control for this condition is the use of water sprays. Water cannons may also be used from the overcut to wet broken muck below the stope.

3.3.4.1. Water Cannons

Water cannons are used for dust control during mucking operations in stopes. Care must be followed when using water cannons to suppress dust in stopes. Excessive use of water can be a source of another hazard such as run-of- muck in stopes, which can place workers and equipment at risk when conducting mucking operations.

3.3.4.2. Too Much water (High Sulfide ores)

Too much use of water for dust control in high sulfide ores can cause sulfide oxidation that will not only produce acidic water but the oxidation process will cause the broken ore to fuse and harden. This can create an unpredictable hazard that can affect mucking operation. An SOP for dust control in high sulfide ores must be developed, implemented and followed by workers.

4. Bottom of Stope (Undercut)

An undercut of a stope to be mined is created to provide access primarily for mucking operations following a stope production blast. The undercut is also used for installing long ground support (cablebolting) to hold the hanging wall if the wall is determined to be weak and can crumble overtime. In some cases, it is also used for drilling and blasting slices of ore during stoping

operations. After the stope had been blasted and mucked out, the undercut provides access for installing backfill barricades or bulkheads prior to stope backfilling. There are specific hazards related to workers' and equipment interaction with these headings while performing work near open stopes. Workers should be particularly alert with hazards while performing work in undercuts especially at or near the brow of open stopes. **Figure 6** shows a view from the undercut of the bottom of the stope containing broken muck.

Figure 6 - A view of the bottom of the stope with muck.

4.1. Bottom of Stope - Hazards

Hazards encountered when performing work in the undercut of an open stope includes:

- Falls of ground
  - From stope brow
  - Within stope
  - Projected out of stope
- Muck can roll down the face of the muck pile
- Broken muck size could be inconsistent and relatively uncertain and if rolling down or out of the stope opening could exacerbate the harm
- LHD's could be overloaded which affects steering capabilities and the life of the vehicle
- Operators can trip while approaching an LHD when operating in a remote/manual mode
- Operators can fall while accessing the LHD or the remote platform / stand
- Operators outside of the operator's cab could be exposed to a collision with the LHD
- The LHD could strike the stand and potentially damage equipment or causing the operator to fall
- When operating on a radio signal, LHDs could be considered more difficult to control in precise situations and could strike the wall, safety stands or other pedestrians

- Ventilation in the area could be compromised by the removal of ore and opening of the stope to the overcut, or the refilling of the opening
- Exposure to airborne contaminants
- The sources of dust may be difficult to access and control which can cause difficulty in maintaining the ventilation system
- Combustion resulting from oxidation of ore or tailings creating, smoke, harmful gases or fire
- Stranded LHDs as a result of breakdown or entrapment occur and expose this vehicle and the recovery operations to additional loss

4.1.1. Fall of ground from stope brow

The dangers to workers and equipment during mucking operations, and block hole drilling and blasting (secondary breaking of boulders by drilling and blasting for oversized material) activities in the stope brow can be caused by fall of ground at the brow. Fall of ground from the brow in non-entry blasthole production stopes where remote technology is available, can pose risk to personnel and equipment, and impact the stability of the brow and nearby structures and pillars.

4.1.2. Fall of ground within stope

Workers and equipment performing mucking operations, and block hole drilling and blasting (secondary breaking of boulders by drilling and blasting) activities in the stope are at risk to fall of ground within the stope. Fall of ground inside non-entry blasthole production stopes where remote technology is available, can also pose risk to personnel, risk of damaging equipment, and impact on the stability of nearby structures and pillars.

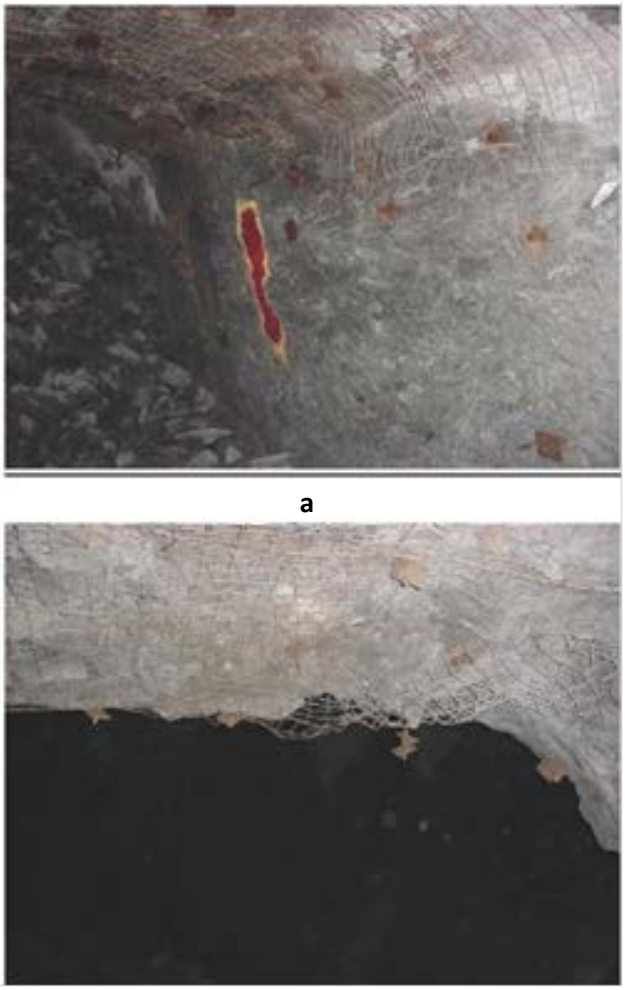
4.1.3. Fall of ground projected out of stope

Workers and equipment performing remote mucking operations outside the stope can be endangered by a fall of ground projected out of the stope. Workers in the remote or safety stand and the equipment can be hit by material projected out of the stope especially when the stope is partially mucked out and the brow is empty. Such fall of ground, regardless if it is a non-entry blasthole production stope where remote technology is available, can cause injury to workers and damage to equipment.

4.2. Bottom of Stope - Controls

4.2.1. Definition of brow

For this document, a brow refers to the accessible edge of the stope, either at the top overcut (sublevel) or bottom undercut. This document centers mainly on mechanized stoping but may pertain to mucking out of or into raises and shaft bottoms. **Figures 7 a** and **b** show a closed brow and an open brow.



a

b

Figure 7 - Brow photo: **a** - shows a closed brow and **b** - shows an open brow.

4.2.2. Access to the brow

It is critical that draw points be designed long enough to accommodate the safety stands or cut outs and provide a safe distance from the brow for the operators to mount and dismount the LHD equipment or scoop.

The mine design should indicate a standard distance between the haulage drift and the brow or ore contact. In cases where a level is under “geology control” and during the development of the undercuts, engineering should be constantly advised by operations when they make contact with the ore so that a safe and consistent distance between the haulage drift and the brow or ore contact is maintained.

Most mines specify a minimum distance to which the stand can be placed from the brow. A standard brow marker should be developed and a procedure should be in place for the

installation of the marker including where and when brow markers are to be installed. A “no personnel entry” signage or marker is also required when remote mucking is conducted at the undercut as per company policy. The signage and marker include warning of no entry of personnel beyond that point.

4.2.3. Mucking Control Zone

The preferred method is to provide a safety stand that is located on the same side as the operator’s cab on the LHD. In most cases this is the left hand side of the draw point. The most preferred method of a mucking installation is in the following order:

- Remote operated LHD from control room removed from the active mining area
- Secured remote or safety stand with a fixed transmitter, with the addition of remote cameras where good line of site to the LHD is not available
- A fixed transmitter in a cut-out
- Any use of a portable transmitter with a shoulder harness should be conducted under strict protocols to avoid LHD to operator contact. This method of operation is typically avoided due to the added risk.

Refer to the Ministry of Labour (MOL) Hazard Alert on “*Safe Areas for Remote Control Operation of LHD Machines*”. Studies have shown that operators using a harness and portable transmitter have moved into positions of vulnerability and the hazard of falling rock or contact with the vehicle. The operator should be required to remain stationary (not allowed to walk) while operating the LHD.

4.2.3.1. Pedestrian control and “approach” control

When other personnel enter a remote mucking area, they are required to make their presence known to the LHD operator. Once the operator is aware of their presence, the mucking process should stop and allow the pedestrians safe passage or retreat to a safe location such as a muck bay. While remote mucking is in progress, no workers should be allowed to enter the remote mucking area without receiving permission from the remote LHD operator. LHD’s are not ever allowed to transport people other than the operator, and no other work is to be done in the same general area while LHDs are mucking.

4.2.3.2. Barricades and signs

Mines require a variety of signs to be used, including “Caution Remote Mucking Area” during mucking, “Danger Open Stope” sign and barricade when mucking is not in progress, and "Restricted Pedestrian Access”. Some employers use warning lights to alert pedestrians to a remote mucking operation. Barricade materials are required to be available at the haulage way entrance to prevent inadvertent entry of pedestrians prior to contacting an operator or entering an unused draw point.

4.2.4. Remote Mucking

LHDs or scoops are designed to load trucks or in some cases haul the ore or development waste to a dump point, typically an ore or waste pass. These vehicles can be equipped to operate remotely, without an operator in the cab, in areas where the ground is unsupported, such as in blasthole stopes. Typically, the LHD is switched to remote control mode by the operator when the equipment reaches the remote or safety stand. The operator dismounts from the equipment and steps on to the remote stand and operates the equipment with a remote control transmitter. The equipment is driven beyond the stand and into the muck pile by the operator remotely to load and return to the remote or safety stand where the operator can switch the LHD back to manual control and steps back onto the equipment. The operator manually drives the LHD to the orepass to dump. Appendix D shows example checklists for remote mucking setup, Appendix E shows a checklist for developing procedures for the design and operation of remote mucking, and Appendix F shows actual sample procedures, respectively.

4.2.4.1. Remote mucking - transmitters and receivers

Transmitters and receivers shall be checked and inventoried to ensure the frequencies used are different for other radio devices on the site and do not cause any form of interference.

All remote control functions should be tested prior to use and after any repairs are made to the transmitter, receiver or actuators on the vehicles. Testing is done in a safe location with respect to workers and other equipment. Testing of the brakes, steering and bucket control is done in manual mode with the operator seated in the operator's cab. Only one remote control unit should be tested in the heading or test area at the same time.

Malfunction of any remote function should result in an immediate stop to the mucking or operating process in order to have the remote unit replaced or repaired. If there is connector damage or other breakdown the defects can quickly manifest to complete failure of the radio link. Transporting of transmitters can be handled by securing them to the vehicle in a fashion that would prevent damage. When operating the LHDs manually, the radio remote units should be put in a secure location and typically on charge.

4.2.4.1.1. Tilt switches

Tilt switches in remote mucking technology are devices that are embedded in transmitters to stop and shutdown the remote controlled LHD in the event the transmitter is upset and essentially out of control. The device receives a signal from the tilt sensor for changes in motion or orientation and turns on or off. It does this by generating an artificial horizon and measuring angular tilt with respect to this horizon. Tilt switch alarms and trigger audible or visual responses to notify the operator that the LHD is out of alignment.

4.2.4.2. Remote mucking stands - design and installation

4.2.4.2.1. Remote mucking stand design

Most mines require an operator's remote or safety stand to be engineered and physically secured in a cut out along the left side of the draw point. Consideration should be given to the access to specific loader used so that the exposure of the operator to harm is limited. A properly installed and secured remote stand is required where LHDs are to be driven beside the stand with the operator on the stand. The stand should be designed to withstand a glancing blow that directs the vehicle away from the stand in the event of an impact. Some sites require a concrete steel reinforced wedge placed ahead of the stand for this purpose.

It is critical that draw points be designed long enough to accommodate the remote or safety stands or cut outs and provide a safe distance from the brow for the operators to mount and dismount the LHD. During development of the undercuts the mining team should be constantly advising the engineering group when they make contact with the ore so that a standard distance between the haulage drift and the brow or ore contact is maintained. Most mines specify a minimum distance to which the stand can be placed from the brow.

4.2.4.2.2. Remote mucking stand installation

It is required that stand location decisions consider the drift height, width and arch, and provide adequate clearance for an LHD to pass the remote stand. The arch of the drift is important for determining clear line of site for the operator. The placement of the stand must provide adequate operator head clearance as well as protection from the largest remote controlled vehicle.

The stand is to be placed as tight to the rock wall as possible. Care should be taken so that protrusions of the wall do not cause the stand to extend too far into the drift and possibly be caught by the passing LHD. There should be ample room for the safe operation of the remote LHD beside stand. The floor should be level in the proposed installation area and building up of the roadbed may be required.

Remote or safety stands should be secured to the wall with reinforced rod or an appropriately designed slinging arrangement (except in backfilled areas). Securing the stand into backfill may require prior mark up of rebar holes to match the stand. Installation of a remote mucking stand should be completed as per the requirements of the engineered print or drawing.

No edges, slings or attachments should stick out from the remote or safety stand that would allow the LHD to hook onto it. If the stand contains water ballast, then it is required to be full of water when mucking. Other requirements include water spray systems to be installed and operational, stope lights installed as close to the brow as is safe to do so and operational, housekeeping in good order, tripping hazards removed, radio communication established, ventilation established and adequate for operating equipment, ground conditions checked, scaling bars available, fly muck

removed from haulage way, the area washed down and any services properly hung so as not to be in contact with the LHD.

The remote or safety stand installation should be inspected by competent staff and Supervision should see that the proximity to the brow and all installation features of the stand are as per company standards and engineering design. Procedures often require the completion of a checklist and log entry.

Figures 8 a and **b** show examples of a remote mucking stand installation. **Figure 9** shows a view of the LHD or scoop with the remote stand besides it.

a

b

Figures 8 a and b - Examples of remote mucking stand installation.

Figures 9 - A view of the LHD or scoop with the remote stand beside it.

4.2.4.2.3. Line of sight

Mucking should be done in a straight line from the entry point where possible. Workers should not approach a brow in order to gain a better view.

4.2.5. Video Remote

Video remote control is a component of a video electronic device used to operate the LHD remotely from a distance such as a remote or safety stand or a remote control station.

Cameras can be mounted on the LHD for the operator to see the muckpile or the orientation of the equipment (mucking blind) in non-entry blasthole production stopes.

When mounting fixed cameras in a draw point, considerations are required for the potential of fly muck from the stope if the brow is not completely full, and placed in a location where it is accessible should it require repair.

4.2.6. Tele-Remote

A tele-remote control system allows tele-operation of heavy machinery (e.g., rock breakers, drills, excavators, LHDs, wheel loaders, dozers) at a distance such as from a remote or safety stand or control station. It is a Wifi or radio-frequency based system but are now commonly Wifi based system.

Remote transmitters are to be turned off and left in a safe location when hauling to the dump.

4.2.7. Transmitter / Receiver maintenance and checks

Transmitters and receivers should be checked and inventoried to ensure that the frequencies used are different from other radio devices on the site and do not cause any form of interference.

All remote control functions should be tested prior to use and after any repairs are made to the transmitter, receiver or actuators on the vehicles. Testing is done in a safe location with respect to workers and other equipment. Testing of the brakes, steering and bucket should be done with the operator seated in the operator's cab so that in the case of malfunction, the system can be quickly overridden by the operator. Only one remote control unit should be tested in the heading or garage at the same time.

Malfunction of any remote system should result in an immediate stop to the mucking or operating process in order to have the remote unit replaced or repaired. If there is connector damage or other breakdown, the defects can quickly manifest to complete failure of the radio link. Transporting of transmitters can be handled by securing them to the vehicle in a fashion that would prevent damage. When operating the LHD manually, the radio remote unit should be put in a secure location and typically on charge.

4.3. Upset Conditions

4.3.1. Stranded LHDs

If a LHD shuts down and cannot be driven from beyond the brow markers, the operator must call or arrange for assistance immediately. No worker is allowed past the brow markers for any reason. The retrieval hooks on the back bumpers of remote LHDs must be maintained so as to allow retrieval while on remote. Retrieval of a disabled LHD in a stope is done in several ways depending on the location of the scoop:

a. Reaching in with a pole to place a cable eye on the LHD's rear hook
b. Pushing in a set of bicycle wheels to attach the cable eye to the hook on the back of the LHD
c. Using a second piece of equipment operated by remote with a camera can be driven into the stope to attach a tow cable to the hook on the disabled LHD
d. Using a robot to attach a tow cable to the disabled unit

The stranded unit can be pulled out using a second vehicle or tugger of sufficient power

For a visible stranded LHD or scoop, the procedure can entail attaching a sling onto two clevises on the bucket lip of the towing vehicle or LHD which then approaches the up-turned hook on the rear bumper of the stranded scoop and drops the cable over it. For more difficult, less-visible situations, a similarly looped cable with a camera mounted on the

retrieving LHD can be used. Pull on the prepared tow hook also releases the brakes providing there is pressure in the hydraulic system.

4.3.2. Buried LHDs

This refers to a remotely operated LHD buried and rendered non-functional or inoperable inside a non-entry blasthole stope which could be due to fall of ground or run of muck. A procedure should be available for retrieving the disabled equipment inside a non-entry blasthole stope. A non-routine hazardous task may be necessary for the retrieval of fully autonomous LHD buried and rendered non-functional or inoperable inside a non-entry blasthole stope. Another remotely operated LHD may be needed to remove excess material around the buried LHD prior to an attempted removal.

4.3.3. Oversize Muck (boulder)

Oversize muck or boulder in a non-entry blasthole stope that cannot be handled by the LHD should be reduced in size by either a remote block hole drilling and blasting or a remote rockbreaker. A procedure should be available for reducing oversize muck in a non-entry blasthole stope.

4.3.3.1. Remote block hole drilling and blasting (blockholing)

Remote block hole drilling and blasting is the process of reducing the size of oversize muck inside a non-entry blasthole stope by drilling a hole to the boulder, loading the hole with explosive, and then blasting. The process is done remotely. **Figure 10** shows a remote controlled drill for blockholing purposes.

When performing blockholing with remote equipment, the following must be considered:

- Check that muck inside stope is not hung up or unstable
- Blast hang ups, not use the scoop bucket to bring them down
- The operator should stay behind brow lines, the knuckle of the drill boom should not pass the brow line unless on remote control
- Wash the rock to be drilled with water before commencing drilling so as to detect misholes

Figure 10 - A remote controlled drill for blockholing.

4.3.3.2. Remote Rockbreaker

A process of reducing the size of an oversize boulder using a remote controlled rockbreaker.

4.3.4. Pealing Brows

Depending on the ground conditions and other issues such as effects of secondary blasting of oversize muck or boulders, pealing or deterioration of the stope brow can occur. Fall of ground from the brow in non-entry blasthole production stopes where remote technology is available, can pose higher risk to personnel, increased risk of damaging equipment, and impact the stability of the brow and nearby structures and pillars.

Pealing or a fall of ground in stope brow can be controlled by the installation of ground support designed to hold the brow considering the factors that affect the stability of the brow.

4.4. Filling Preparation and Stope Backfilling

Mine backfill is any material or combination of materials used to fill underground voids created by mining. The voids are filled with backfill primarily to provide ground support to allow for the adjacent pillar mining. If mine or mill waste materials are used for backfilling, this provides opportunity to dispose of these materials. Three types of backfill are primary used in Ontario underground mines: hydraulic (or slurry) backfill, paste backfill and rockfill (RF) cemented rockfill (CRF). Mine backfilling can be divided into four steps; surface operation (aggregate raw materials and binders, and surface delivery), backfill plant operation (backfill preparation), underground distribution, and stope placement operations.

4.4.1. Filling preparation and stope backfilling hazards

Each of the fours steps in mine backfilling may contain one or any combination of the following hazards:

4.4.1.1. Surface and backfill plant operations

- inhalation or contact hazards with corrosive binder agent materials (cement, etc.) and additives
- slips and falls
- inadequate lighting
- exposure to moving parts (equipment, conveyors, pumps, etc.)

4.4.1.2. Underground distribution

- inhalation or contact hazards with corrosive binder agent materials (cement, etc.) and additives
- slips and falls
- inadequate lighting
- plugged delivery pipeline causing pipeline to burst
- runs of material

4.4.1.3. Stope placement operation

- inhalation or contact hazards with corrosive binder agent materials (cement, etc.) and additives
- slips and falls
- inadequate lighting
- plugged placement pipeline causing pipeline to burst
- runs of material
- Bulkhead/fill fence failure

4.4.1.4. Backfill types used in Ontario underground mines

There are three primary types of backfill that are used in Ontario underground mines:

- *Hydraulic (or slurry) backfill* - generally consists of mill tailings that are screened or size segregated to include aggregate particles ranging from sand sized to very fine. These fill materials are mixed with water and binding agents to create a slurry mixture of solids (up to 65% by weight of the entire mix) and water that are hydraulically pumped from surface to underground. A large percentage of the water in the mix will decant from the placed backfill mass and must be collected and pumped back to surface.

- *Paste backfill* - is a blend of very fine tailings or other aggregates (at least 15% by weight finer than 20 micrometers diameter) that are blended with binding agents and water to create a “paste-like” backfill material from which water does not bleed if transport stops or material is placed into stopes. Typically, paste backfill mixes contain up to 20% water by weight. This blended product can make use of some or all of the mine tailings produced when ore is concentrated.

- *Rock Fills or cemented Rock Fills* - generally constituted from waste rock materials, rock fill materials are often free-placed ((dropped by gravity into open stopes or if the material is coming from surface, dropped through waste chutes from surface to levels and into stopes). Rock Fills consist of generally unclassified product (all product sizes used, with no oversize or undersize being removed prior to transport). They may be placed either dry or containing some fraction of adsorbed surface moisture. Cemented rock fills are often mixed with cement slurries in order to improve the placed bond strength between rock fragments. Different methods have been used to mix the waste with cement, including i) percolating a cement slurry (at approximately 50% by weight water) over the placed mass of waste solids in the stope, or ii) mixing both the waste solids and cement slurry in hoppers prior to dumping them both into stopes. As before, materials are all free- placed and no size segregation or sorting of the waste materials is performed prior to placement.

4.4.2. Brow conditioning

Prior to installation of a fill bulkhead, Ground Control in consultation with the mine supervision (Mine Captain, Mine General Foreman, Mine Superintendent, Front-line Supervisor), are required to assess the brow and mark a restricted access line in yellow or orange paint. The fill bulkhead must be constructed entirely outside the restricted access line. Crews must install a barricade across the heading at or before the yellow or orange line to prevent personnel from getting too close to the stope. Warning or danger signage such as “No Personnel Allowed - Open Stope” should be installed on the barricade.

4.4.3. Building Filling Stoppage

Fill fences or bulkheads are walls or embankments for holding back backfill. A bulkhead is defined in Section 1 of Regulation 854 as a structure for the impoundment of backfill and should be designed to hold a potential pressure against the structure in excess of 100 kPa (14.5 psi). Bulkheads should be installed at a specified distance from the opening brow. The construction of a fill bulkhead may contain one or any combination of the following hazards:

- loose ground, ground movement, unusual seismic activity, ground support condition (corrosion, failed bolts, bagging of screen, etc.) at construction site and travelway
- driving or walking into open hole due to inappropriate or damaged barricade, or missing, mislabeled or deteriorated access warning signs
- concentration of gases; after blast and diesel equipment exhaust gases, methane, radon, natural gas, etc.
- ventilation in the area could be compromised by the removal of ore and opening of the stope to the overcut
- chemical burns, dermatitis, or irritation due to exposure to cement mix
- dust concentration during shotcrete application
- combustion resulting from oxidation of ore or tailings

4.4.3.1. Paste Bulkheads

Retaining structures for this type of backfill consist of shotcrete sprayed over arched steel frames, weld mesh screen, gabion basket frames or cable lacing. In only limited cases are traditional fabrene wrapped timber frames still used for bulkheads. An innovative procedure includes the placement of a pre-fabricated frame that is assembled some safe distance away from the brow and moved by scoop into position close to the brow, outside the restricted access line. The frame is then secured to the wall, back and floor with dowels, and shotcreted into place with either a robotic shotcreting unit or manual application. **Figure 11** shows an example of the construction of a pre-fabricated frame and **Figure 12** shows an example of a shotcreted arched fill fence.

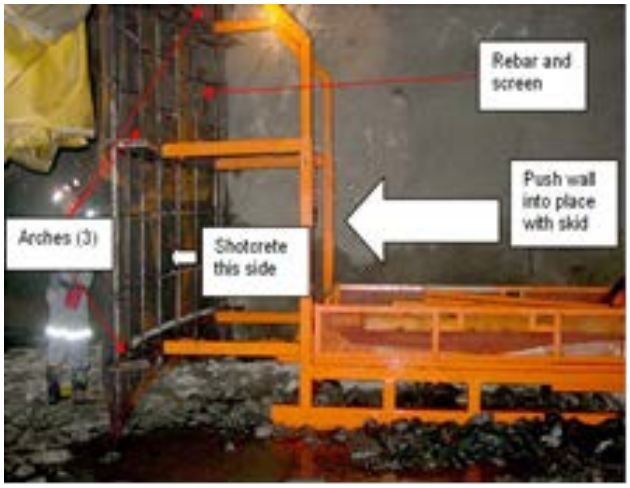


Figure 11 - Example of a pre-fabricated frame for a shotcrete fill fence (source: Kidd mine, Timmins, Ontario, Canada)

Figure 12 - Example of a shotcrete fill fence (source: Brunswick Mine, New Brunswick, Canada).

4.4.3.2. Hydraulic fill bulkheads

Bulkhead designs typically consist of weld mesh or gabion baskets that are oversprayed using shotcrete at thicknesses ranging between 20 and 35 cm (**Figure 12**). Some bulkheads feature arched configurations, while others exhibit flat surfaces that are reinforced using 1 m (3 ft) high waste rock berms at their bases. For these bulkheads, top drains, bottom-mounted drainage pipe or combinations are mounted in bulkheads to accommodate water drainage after hydraulic backfill placement. **Figures 13** and **12** show examples of this type of bulkhead.

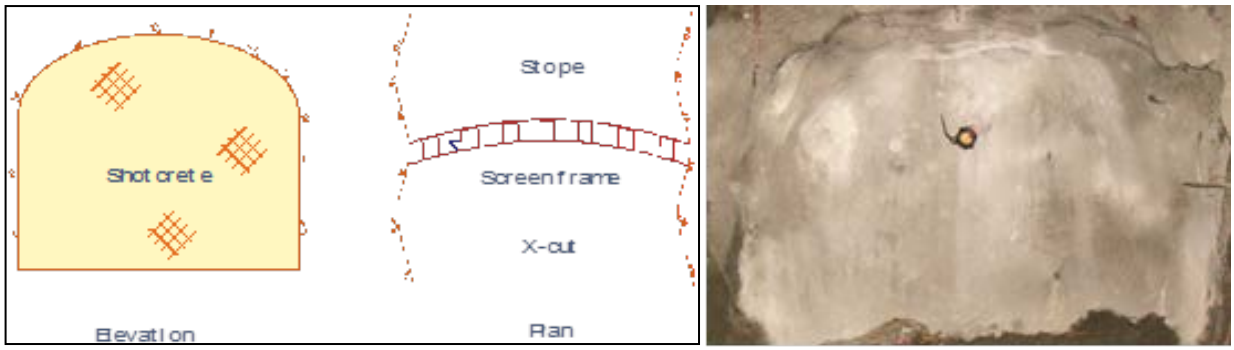


Figure 13 - Examples of arched configuration shotcrete fence type bulkhead.

4.4.3.3. Rockfill or cemented rockfill stoppages

Normally require muckpile (rammer jammed pile) bulkhead. Rammer jammed piles are waste rock material pushed at the brow of an open stope. **Figure 14** shows example of a muckpile bulkhead and a rammer equipment.

Muckpile bulkhead | Scoop with rammer

Figure 14 - Example of muckpile bulkhead.

4.4.4. Backfilling (backfill placement in the stope)

The use of backfill for filling open stopes is an essential control, primarily: (i) to provide ground support; (ii) to provide fill strength for vertical wall stability during pillar recovery; (iii) to provide working platform capability; and (iv) to provide for waste disposal (if tailings are used).

Prior to backfilling, appropriate fill bulkhead (depending on the type of backfill used) must be first installed. Engineering or Ground Control in consultation with the mine supervision (Mine Captain, Mine General Foreman, Mine Superintendent, Front-line Supervisor), are required to determine the approximate volume of backfill material needed for the stope to be backfilled, and the backfill recipe, if required. Essential controls for safe backfilling operation vary by type of backfill used; consolidated backfill prepared from surface such as paste and hydraulic backfill, and rockfill using waste rock material from development heading and dumped directly into open stopes. Prior to backfilling, Crews must install a "snow fence" across the heading at or before the yellow or orange line to prevent personnel from getting too close to the stope. Warning or danger signage such as "No Personnel Allowed - Open Stope" should be installed on the snow fence.

4.4.4.1. Paste or hydraulic backfill stope placement operation

For paste or hydraulic backfill prepared from surface, the volume of backfill required and recipe must be noted in a "fill letter" which is submitted to the backfill crew on surface. Essential controls for these types of backfill must cover the following steps: surface operation (aggregate raw materials and binders, and surface delivery) and backfill plant operation (backfill preparation); underground distribution; and stope placement operations. For the purpose of this document, only the step in stope placement operation is discussed.

1. At all stope pouring sites, appropriate barricades and bulkheads must be provided. Essential controls for stope barricades and fill bulkhead construction are discussed in Section 4.4.3. of this document.
2. In hydraulic backfill operations, drain pipes and weeping tiles provide water drainage to reduce backfill pressures on bulkheads.
3. Excessive bulkhead pressures or water seepage developing during placement is often a result of too rapid a rate of backfilling or poor drainage in hydraulic backfill operations, backfilling operations must be slowed or stopped until backfill pressures have been reduced to meet bulkhead design requirements.
4. Strict water management accounting practices must be maintained, especially when pipeline flushings are conducted at pre-determined intervals.
5. In paste backfill operations, to minimize potential bulkhead failures, plug pour heights must be limited (to reduce incidents of overfilling), longer pour curing intervals must be implemented, and reduce the rates of backfilling of both plug and bulk paste pours.
6. Pressure monitors and other types of probes, such as stand pipe monitors that can be used to indicate conductivity in the presence of water, can be remotely monitored to provide continuous warning of potential problems that may develop at backfill pour

sites. They do not require manual reading, and thus can provide real-time indication of potential site instability conditions.
7. For incidents of stope delivery pipes become blocked, written standard operating procedures for the safe removal of pipe blockages should be available and followed by mine crews to replace or drill out and flush blocked sections to restore backfill flow.
8. Standard operating procedure for regular pipeline water flushing during backfill transport and remove blockages.

4.4.4.2. Rockfill or consolidated rockfill stope placement operation

For rockfill or consolidated rockfill, the essential controls for this type of backfill must cover the following steps: For rockfill material coming from surface; surface operation (aggregate raw materials and surface delivery); underground distribution; and stope placement operations. For rockfill material coming underground waste; stope placement.

1. For filling of a stope where the fill material is no longer running freely in the stope, due to the stope becoming full, the bumper block should be removed and a remote block should be installed to allow material to be pushed into the cavity using a remote operated LHD. If dump trucks are used for rockfilling of stopes, trucks must deposit materials at a safe distance from the crest of the stope. The material is pushed into the cavity using a remote operated LHD.
2. Scooptrams and loaders must always approach the crest at 90 degrees to the edge of the open hole.
3. Dump locations must be inspected daily for signs of instability in the back of the heading and cracks on the crest of the stope. Dump areas must be barricaded with proper signage when LHDs' are not actively working in the stope.

4.5. Top and bottom of Stope - Other Considerations

4.5.1. Dust Control

Dust is a concern during mucking operations in stopes not only in the undercut but also in the overcut, where workers could be performing work from drilling to cavity inspections and others. The cascading of broken muck in stope during mucking operations can release dust in the air. Depending on the direction of airflow, dusts can go up the overcut and affect workers. Dust control must be in place for both undercut and overcut, and SOPs for dust control must be developed, implemented and followed by workers. The most common dust control for this condition is the use of water sprays. Water cannons may also be used to wet the broken muck in a stope from the overcut. Care must be followed when using water cannons to suppress dust in stopes. Excessive use of water may can be a source other hazard such as run-of-muck in stopes, which can place workers and equipment at risk, when conducting mucking operations.

The use of excessive water for dust control in high sulfide ores can also be a concern as sulfide oxidation can occur that will not only produce acidic water but the oxidation process causes

the broken ore to fuse and harden. This can affect mucking operation. An SOP for dust control in high sulfide ores must be developed implemented and followed by workers.

Appendix A - Definition of Terms

[This is a description of the terms used in this document; they are not legal definitions, they are included for consistent understanding by the readers]

Barricade - means to restrict workers from dangerous areas

Brow - for this discussion it refers to the accessible edge of the stope, either at the top overcut or bottom undercut. This document centers mainly on mechanized stoping but may pertain to mucking out of or into raises and shaft bottoms.

Bumper Block - engineered barrier, prevents scoops or trucks from falling into open hole when dumping, prescribed by Mining Regulations Section 118

Cavity Monitoring - surveying of inside of stope done without personnel entering the stope

Fill Bulkhead - wall built to contain backfill at the undercut of the mined out stope

Hanging wall - the underside of the wall or the upper wall rock overlying a vein or orebody, or a stope

Hang-up - where broken ore is stuck and will not flow downward, could be in stope or raise

Longhole (Blasthole) Stope - stopes mined by drilling and blasting of larger and longer holes.

Mucking Wedge - A triangular or wedge shaped barrier that is intended to sit in front of the remote stand in order to deflect a runaway scoop from hitting the operator's stand

Open Brow - an undercut brow that the muckpile does not touch, allowing muck to slide or roll down into the access drift

Overcut - Top access to longhole (blasthole) stope, typically (not always) where drilling & loading is done

Pipe flushing - cleaning or clearing of a slurry transport pipeline (for backfill or cement slurry transport) using high pressure water

Pre-Op - pre-operational check of vehicle functions prior to using it for the shift

Raise - an inclined opening, built to allow muck flow downward by gravity

Recess - cut-out in a drift for safe operation of scoop on remote control, similar to safety bay

Remote control - means of operating scoop without being on the vehicle, may be pedestal-mounted or worn on person (harness), allows operator to stay safely out of non-entry stope

Remote Stands - a fabricated structure from where operator runs scoop on remote control

Scoop - load haul dump vehicle used to remove blasted muck from stope, may be manually or remotely controlled

Scoop recovery - efforts to get a scoop back that is disabled inside a stope where personnel are not allowed. Scoop may have mechanical or electronic malfunction, or be buried by muck.

Stope - the larger openings created by mining out ore, as opposed to drifts

Undercut - Bottom access cross-cut or access to a stope, where mucking of ore is done

Appendix B - Past Occurrences Data Synopsis

A Review of Unusual Occurrences reported to the Ministry of Labour from 1999 to 2008

General Conclusions:
- Ninety events were reported involving workers and open Blasthole / Longhole Stopes
- There were no injuries reported from these events
- There was a variety of types of hazards affecting a number of different activities
- Most of the hazards were related to unstable rock or backfill
- There were also many mechanical issues with vehicles reported, including loss of braking
- LHD retrievals from within the no entry area of open stopes were required occasionally

Stranded LHD recoveries:
- Usually required preparation of a retrieval procedure or review of existing procedure
- Common approach is to wait until ground conditions stabilize
- Very awkward and difficult when LHD covered by hundreds of tonnes of muck
- The value of the unit prompts serious recovery efforts, scoops were not readily abandoned
- Other large vehicles are required, tight cables, workers in close proximity, many hazards

LHD mechanical problems:
- Several incidents of free-wheeling after hitting E-stop on LHD
- Several service brake failures when on remote, needed E-stop on transmitter to stop LHD
- One vehicle fire while LHD on remote
- Incident of loss of control while LHD on remote, unit bumped remote stand

Other Hazards not related to mucking:
- Blasthole loading crews noticed fall of ground under their working floor
- While loading with remote control blockholer unit, muck fell on explosives
- Fill slough of an old stope created an unexpected open hole where operator was mucking
- Part of stope sloughed off where drill was cleaning holes near ring of open stope

Ground Problems and practices:
- Mining plans and sequences often reviewed and changed if conditions deteriorate at the stope being mined
- Changing plans often requires meeting & discussion by many different parties & departments
- Ground support requirements may be reviewed and “beefed up” in the access drift if conditions deteriorate
- Remote stands can be considerable distances from the brow, depending on conditions
- Falls of ground or rockbursts can occur after production blasts in a stope
- Frequently a fall or burst requires personal close inspection by a number of different parties, often including a

Cavity Monitoring System (CMS) survey of the new void – this is a time when there is elevated risk from instability:

- Problems often include deterioration of brows, sloughing within the stope,
- LHD's have gone over the edge of the stope when dumping material into the stope
- LHD operator reaction to leave area due to working ground has limited exposure to unsafe conditions
- Stopes that are mucked empty and not filled may easily destabilize

Appendix C - Past Specific Incidents and Injuries

October 1, 1987 - Worker was fatally injured when the ST-2B scooptram he was operating fell 50 feet down a 62 degree mill hole. A berm of crushed rock which was placed around the mill hole was found breached where the scooptram had entered.

August 29, 1993 - Worker was instructed to dump a scrap 8 1/2 ton LHD bogie (the front chassis portion of an articulating LHD) into a mined out stope using his 8-yard scoop on dump radio remote control. For some unknown reason he drove into the open stope falling approximately 24 m (80 ft.). The scoop landed up-side down and burned for about 9 hours.

2001 - A ST-8B -operated on remote plunged down 122 - 152 m (400 - 500 ft.) of stope when the stop block (berm) failed. The 475 liter (125 gal) fuel tank separated, ruptured and exploded, causing extensive damage on two levels. No workers were injured.

December 29, 1996 - Worker died when he was buried under a mixture of backfill and rock. He was mucking a drawpoint when he drove the manually operated scoop into the stope. The scoop tram he was operating was found partially buried and still running. The Coroner's Jury recommended that the industry adopt a zero tolerance policy to all workers who go into an open stope.

November 14, 1989 - Worker was crushed when a large piece of muck rolled over the bucket arms and pushed him into the control panel of the 3.5 yard scoop his was operating. When his supervisor first visited the drawpoint at 0930 hours the brow was open approximately 4-feet. Around 1210 hours a 4 ton block of rock came out of the drawpoint, and struck him.

October 14, 1987 - Worker was run over by a 3.5 yard scoop. The scoop operator had made approximately 80 trips from the drawpoint to the ore pass. The form that the worker was constructing was in a section of drift where the scoop travelled to the ore pass. The Coroner's Jury recommended that when workers enter or work in trackless haulage areas the working area should be marked and they should make their presence known to the operator.

July 30, 1996 – A worker drove his scoop 30 meters into an open stope and was killed. On the day he returned from a week's vacation he was assigned to backfill the east stope. The regular entrance he had been familiar with was blocked by surveyors and he proceeded to the west stope, drove through a warning gate and drove into the open stope.

February 9, 1998 - A miner was killed when a 5-yard LHD squeezed him between the LHD bucket and the back of a tractor. He and a co-worker had gone to a storage area located on a ramp with a tractor to pick up supplies. They parked the tractor in a curved section of the ramp next to the storage area. They were in the process of loading screen onto the tractor when the LHD came around the curve.

March 28, 1989 - A remote controlled scoop pushed a worker over the edge of a 25 meter open stope. He and his partner were preparing to load a drilled off ring of the stope with explosives while mechanics were working on a scoop approximately 17 ft. behind him. An operator with an identical radio transmitter started his scoop below. This second transmitter took over the operation of the scoop that was being repaired on the top sill.

A scoop freewheeled away from the remote stand after the operator hit the E-stop on his remote unit. An electrician tested the unit to diagnose the fault. When the E-stop was used again, the engine shut down but the scoop freewheeled into the electrician's Toyota. It was found that the radio remote brake release module was damaged and saturated with water and grease. The fault released the brakes when the scoop was switched into remote mode.

April 11, 2002 - Scoop operator was killed when struck by a large rock inside the stope. He had been assigned to muck on remote. It was speculated that he manually operated the scoop to have a better view. The Coroner's Jury recommendation was to install cameras on remote scoops.

March 6, 2006 - The operator was killed while mucking on remote control when he somehow became pinned underneath the water filled remote stand. It is believed that the ST8B caught a tow sling that was overhanging the remote stand.

January 12, 2006 - A miner operating a remote controlled scoop pinned himself against the wall. His left leg was amputated just above the knee and his pelvis had to be plated. The safety bay from where the miner was to operate was small and visibility of the operation was poor. The operator reported he left the protection of the safety bay in order to perform his job.

July 23, 2007 - A miner was killed when the scoop he was using to dump scrap with, drove off the overcut brow of a blasthole stope and fell 45 m (150 ft.) to the bottom floor.

November 17, 2007 - An experienced miner was killed when he was struck by a scoop at the bottom of a development ramp where the LHD and operator were mucking.

Appendix D - Checklists

1 - Remote Mucking Commissioning Report

This is one example of a pre-operational check form for a remote mucking setup.

Checklists are used to ensure the remote mucking set up is up to the site standard. The forms are initiated by the Mine Captain / General Foreman before remote mucking activities begin in longhole / blasthole stopes. The forms are completed and signed off by both the Front Line Supervisor and his supervisor. The forms are then kept on file in the second line supervisor's office for the duration of the set up. If the set-up is moved or modified, a new commissioning form is completed.

Remote Mucking Location:_____
Inspected By: (Supervisor/STS/OGF/Captain) _____
Date Inspected: _____

5 m Brow Offset" No Go Zone" marked on wall	Yes / No
Stand secured minimum 12 m from brow on level ground	Yes / No
Stand condition checked for damage	Yes / No
Stand placed as tight to the rock wall as possible	Yes / No
Transportation rigging gear removed - chains, slings, etc.	Yes / No
Concrete steel reinforced deflector wedge installed as per design	Yes / No
Water spray system installed and operational	Yes / No
Stope lights installed and operational	Yes / No
"Remote Mucking In Progress" signs posted	Yes / No
"Restricted Pedestrian Access" signs posted	Yes / No
Barricade fencing available at stope entrance	Yes / No
Housekeeping in good order	Yes / No
Tripping hazards removed.	Yes / No
Radio communication established.	Yes / No
Ventilation established, adequate for operating equipment	Yes / No
Ground Conditions Inspected	Yes / No
Scaling Bars Readily Available	Yes / No
Fly Muck Removed From Haulage way	Yes / No
Remote Stand To Muck Pile Washed Down	Yes / No
Electrical Cables- Out Of Water - In Good Condition- Hung Tight To Screen	Yes / No
Approved For Use By OGF, Mine Captain or designate	Yes / No

Date:

2 - Radio Remote Scoop Pre-shift Checklist

This is an example of a pre-operational check form for a remote control for mucking.

This is checklist is to be completed during a regular initial check. Each item is checked off as completed. MACHINES ARE NOT OPERATED ON REMOTE WITHOUT SUCCESSFULLY PASSING EACH TEST BELOW. (Exception: Transmitter Battery Test)

1) General condition of the transmitter
2) (Transmitter battery test)
3) Remote/manual selector switch
4) Transmitter tilt test
5) Transmitter emergency button
6) Functional Tests a)Half throttle b) Full throttle c) Forward d)Reverse e) Steer right f)Steer left g) Boom up h) Boom down I)Bucket roll back j) Bucket dump

Radio Remote Scoop Testing Procedure

This test is performed prior to each remote mucking shift, or if any apparent malfunction occurs while in use. Under no circumstances is a scoop operated on remote if it has failed any of these tests! (Exception: Transmitter Battery Check) Having performed all normal initial checks, inspections, brake tests, etc., the remote test is to be performed in an area where failure of tests should not endanger the operator or other workers.

1) **General Condition of Transmitter**: Visually check the transmitter for damage. Be sure the joysticks return to the neutral position when released.
2) **Transmitter Battery Check**: Turn on the transmitter and check the low battery indicator.
3) **Remote / Manual Selector Switch & Indicators**: Operate the remote / manual selector switch on the scoop to see that it stays in position.
4) **Transmitter Tilt Test**: Using the remote, release the emergency park brake. Tip the transmitter forward 30 degrees or more. The brakes should come on within 3 seconds and the engine should shut down in 20 - 30 seconds.
5) **Transmitter Emergency Button**: Re-start the scoop and release the park brake. Press the emergency button down. In this case, the brake should come on immediately, followed by the 20 ¬30 second engine shut down.
6) **Function Tests**: Test all functions on the transmitter. Make sure that each control corresponds with the markings on the faceplate of the remote transmitter. Each item should correspond without abnormal delays to operate or when released.

Appendix E - Do your procedures measure up?

PROCEDURE CONTENT (Do Present Procedures Address the Following):

- **Design and Setting**
  - Is the location adequate for remote mucking (can the vehicle be positioned near the remote stand easily?)
  - Is mucking to be done on an incline?
  - Are there any unusual conditions affecting remote mucking set-up?
  - Has a site hazard assessment been done?
  - Has a site risk management plan been developed?
  - Do workers understand what an “Open Brow” is? Do procedures address open brow hazards?
  - Has the minimum ventilation requirements been established for the equipment in use in the remote mucking area?

- **Remote Vehicle Operation**
  - Does Remote Control Mucking begin when the brow is open?
  - Does the Pre-Op include Radio Remote Testing?
  - Does the Pre-Op include Testing the vehicle including brakes & lights?
  - Where is the operator located when mucking on Remote?
  - Where does operator switch from manual to remote control
  - Where does operator switch from remote control to manual operation
  - Are conditions for parking and / leaving LHD unattended addressed?

- **Remote Stands, Cut-Outs or Remote Harness**
  - Has the remote stand been engineered?
  - Does the remote stand have manufacturer installation specifications?
  - Have mine site installation standards been developed for remote stands?
  - What are the specifications and standards for operator recesses?
  - It the mucking recess narrower that the remote unit being operated and at least six feet deep?
  - Is the mucking recess located on the same side as the operator’s position on the remote unit (in most cases this is the left hand side of the drawpoint)?
  - If operating on an inclined grade, has the mucking recess (safety bay, cut-out) been created?
  - Are mucking recesses appropriately located and do they prevent equipment contact with the operator?
  - Has the specified ground support been installed in the mucking recess?
  - Does the remote harness utilize proximity detecting technology (i.e. Buddy System)?

- **Remote Control Transmitter Unit**
  - Does remote control transmitter operate on its own unique radio frequency?

- Has the Electrical Department confirmed this for each transmitter before the unit is installed?
- Has a Remote Control Transmitter Unit Pre-shift Checklist been developed?
- Has a Pre-shift Radio Remote Scoop Testing Procedure been developed?
- Has a procedure been developed detailing at what locations the remote control transmitter unit can be operated, and where the transmitter is to be securely stored when the remote unit is operated manually?
- Do the remote control stop and tilt sensor stop the vehicle while in motion

- **Line of Sight Issues**
  - When are cameras required to be used?
  - Are cameras available and understood?
  - Can the Remote operator clearly see the travel route, brow, brow markers, and stope from the location where the remote control transmitter unit is being operated?
  - Will visibility issues arise as mucking progresses?
  - Do procedures say to stop remote mucking when the muckpile is not visible?
  - Do established measures exist to address not seeing the muckpile (i.e. camera)?

- **Lighting Issues**
  - Have standardized lighting requirement for remote mucking been developed?
  - How are variations in site layouts and conditions to be addressed and who is responsible for ensuring there is sufficient lighting to undertake remote mucking?

- **Remote Camera Technology**
  - Is remote camera technology required to enable effective remote mucking?
  - Is this technology available for immediate use?
  - Do established procedures exist as to when remote mucking is to be accomplished with remote camera technology?

- **Brow Markers**
  - Is there a standard type of brow marker for the site?
  - Do procedures say where and when brow markers are to be installed?

- **Signage Requirements**
  - How will other persons be warned that remote mucking is in progress?
  - How will inadvertent access into the remote mucking area be managed?
  - Does an established standard exist specifying the construction of “barrier” used to manage inadvertent access?
  - What signage is required to be posted at the entrance to the remote mucking area?
  - Does an established standard exist specifying what signage (content) needs to be installed before remote mucking begins?
  - Who is responsible for ensuring the installation of signage and “barriers”?

- Is there signage to indicate where the remote control transmitter unit is to be stored when the remote unit is on manual operation?

- **Entry of Other Personnel**
  - How do visitors make their presence known to the remote operator?
  - How do other personnel know the operator is aware of their presence?
  - When can the other person enter into the remote area and are there any restrictions on the manner in which the other person travels through the remote area?
  - How does the other person confirm their exit with the operator of the remote equipment?
  - Does an established procedure exist for the entry of other personnel into the remote mucking area?

- **Electric LHD Units**
  - Does an established standard exist for the specifications for the power cable anchor block?
  - Does a procedure exist for the installation of the power cable anchor block?
  - Who is responsible for ensuring the installation of the power cable anchor block?

- **Ventilation**
  - Is the required ventilation infrastructure (Auxiliary fans, ducting, etc.) installed to operate on remote?
  - When the brow is opened, what affect does this have on the ventilation and what must be done to maintain adequate ventilation?

- **Dust Control**
  - Does one past brow markers to install this?
  - What equipment is used and how is it secured?
  - Is it mandatory?

- **Training and Authorization of Operators**
  - Are operators trained and competent?
  - Are the Operator's training records on site?
  - Has the Operator been registered with MTCU and are MTCU's records of training up to date with the Operator's training records on site?

- **Documentation**
  - Has a remote mucking commissioning report or checklist been developed to ensure that remote mucking setup's conform to established policies, and standards
  - Who is responsible for completing the remote mucking commissioning report?
  - Where is the commissioning report to be kept?

- **Auditing**
  - Has a standardized methodology been developed for the purpose of auditing the remote mucking setup to ensure that while in use it is remains comparable to the remote mucking commissioning report?
  - Does an established program for job task evaluations of remote mucking operations exist and what is the frequency of this evaluation?

Appendix F - Actual Sample Procedures

Note: These are each a collection of pertinent elements taken from a variety of actual operating mine procedures, and are not a set of complete procedures. These are intended to provide insights and approaches to doing things your site may not have yet considered. It is necessary for each site to decide and include whatever is required to keep their workers safe in their circumstances.

--Please note that the wording of these excerpts is modified to avoid a mandatory sense (using words like "should" instead of "must"). It is advised to write your procedures in a mandatory manner.

1. MUCKING OPERATION

Pre-Op Checks, Repairs:
-- The remote operator needs to be currently qualified and authorized to use the remote control equipment
-- An initial check of all remote functions needs to be performed and recorded in the operator's pre-check list prior to use of the unit.
-- All testing of remote control functions prior to use or after repair needs to be done in a safe location having regards for workers and other equipment in the area. Testing of functions should be done by the operator while seated in the operator's compartment.
-- Function indicator lights, on remote control receivers or transmitters, if so equipped, should operate as designed. If the lights are not operating properly, the unit should be repaired prior to operating on remote control.
-- Remote transmitter/receivers should be adjusted / repaired at approved radio repair shops
-- Only one remote control unit should be operated / tested in the same heading or test area at the same time.
-- No one should be allowed to be on a LHD that is being operated on remote control except when an operator or a mechanic is doing pre-operational tests.
-- When transporting transmitters ensure they are secured on the LHD to prevent damage. -- A complete initial check of the workplace and remote station is to be performed and should be logged in appropriate check forms prior to remote operation. Damage to a remote station should be communicated to a Supervisor and assessed prior to start of remote operation. --If there is a failure of any remote function mucking should stop and the remote unit replaced or repaired.
-- One should shut down the remote controls and LHD if it is not working properly to failure in the open stope.

Remote Mucking
--All mobile activity, beyond established brow markers, should be done on remote-control
--No person should pass beyond established brow markers. A non-routine hazardous task should be completed if there is a need to conduct a task beyond the brow marker (i.e. water

sprays, loading, blasting, explosives removal from a muckpile or geological grading) to ensure that proper ground support is in place and measures are taken to protect the worker(s).
--The remote operator should be currently qualified and authorized to use the remote control equipment.
-- A complete initial check of the workplace and remote station should be performed and logged in appropriate check forms prior to remote operation. Damage to a remote station should be communicated to a Supervisor and assessed prior to start of remote operation
--While remote mucking is in progress, no worker should enter the remote mucking area without receiving permission from the remote LHD operator.
--A dust suppression system (water sprays etc.) should be installed, maintained and used while remote mucking is in progress.
--No edges, slings or attachments should protrude from the remote stand that would allow the LHD to hook onto it.
--The remote stand should be located a minimum of 12 m (40 ft.) from the brow of the stope.
--Where using a remote stand, and bringing the LHD alongside the remote stand, an approved engineered stand should be provided and used by all remote operators. There should be no variance to this rule where the LHD is driven alongside the remote stand
--Where an LHD is NOT brought alongside the remote stand, the use of any other remote stand needs a Manager's approval.
--An operator should have visual contact of the LHD at all times when mucking on remote.
--The width of the drift should be at least three feet wider than the combined width of the remote stand and largest LHD being used.
--Remote operators should ensure that the power on the transmitter is turned off prior to leaving the unit unattended.
--Remote control operations should be performed from the operator's side of an LHD.
--An operator should engage the park brake, put the vehicle into neutral and switch the selector to remote prior to disembarking the vehicle.
-- When dismounting an LHD, 3-point contact should be maintained at all times.
-- While on remote, the operator's compartment of the LHD should not go past the access point of the remote stand.
-- When entering a heading containing an active remote station, the operator should proceed forward manually making sure that the bucket has passed the remote station prior to dismounting the LHD.
-- Steep faces of muck should be left to flow to their natural angle of repose...
-- An individual field level risk assessment should be carried out prior to any remote mucking operation...the preferred method of mucking is in the following order: remote stand with permanent location, remote stand with use of remote cameras where good line of site is not available, or as last resort where a stand cannot be used, a remote-harness with a "Buddy System" (proximity detector).
-- Where a harness is used, the remote control operator should remain stationary (NOT ALLOWED TO WALK) while operating the LHD (scoop) ***Workplace Safety North does not condone the use of a body harness and movable transmitter.***

-- The remote scoop should remain visible to the operator... a camera may be mounted on scoop for mucking blind (where operator cannot see the muckpile)
-- Do not use scoop on remote to transport people...no other work is to be done in the same general area.
-- The remote transmitter should be left on the stand when hauling to dump and secured to the stand provided...mucking should be done in a straight line from the entry point where possible...park the scoop in a safe area---one should stay well clear of the open stope.
--Remote control electric scoops should only be operated from the mucking wedge or concrete stand (remote stand) to minimize the risk of an operator being struck by the electric trailing cable.
--Remote scoop operation should be used when advancing the bucket beyond the brow of the drawpoint. To assist in identifying the location of the brow while mucking, paint markings should be placed on both sides of the drawpoint. Consult the supervisor to determine brow location if necessary.
--Safe operator position should be available and the preferred method is to provide a safety bay that is located on the same side as the operator's position on the scoop. In most cases this is the left hand side of the drawpoint. The operator should ensure that he is in a position where he cannot inadvertently be struck by the scoop.
--When operating the scoop manually, the radio remote unit should be placed in a secure location. Proper signs are to be placed in all applicable workplaces indicating the secure location to place the remote. Use common sense and ensure the unit is supported off the ground, so that it cannot be inadvertently dropped, struck by the scoop, or damaged during the blasting process. When blasting during or at the end of shift, the remote control should be placed in the Refuge Station or lunch room, so that it is in a dry area and protected from being damaged by the blast. The radio remote units are quite fragile and damage to these units can result in costly delays.

Signage, Barricades

-- "**Caution Remote Mucking Area**" sign should be used during mucking.
-- "**Danger Open Stope**" sign and single guardrail should be installed when mucking is not in progress.
-- Warning lights /signs / barricades should be used to alert visitors to mucking
-- "**Remote Mucking In Progress**" signs to be posted... "**Restricted Pedestrian Access**" signs to be posted... barricade fencing should be available at the stope entrance

Getting On & Off Stands

-- Remote operators should ensure that the power on the transmitter is turned off prior to leaving the unit unattended... When entering a heading containing an active remote station, the operator is to proceed forward manually making sure that the bucket has passed the remote station prior to dismounting the LHD... While on remote, the operator's compartment of the LHD should not go past the access point of the remote stand.
--Take care getting on and off the machine...be certain that the brakes are set before leaving or approaching the machine

--An operator should engage the park brake, put the vehicle into neutral and switch the selector to remote prior to getting off the vehicle...When dismounting an LHD 3-point contact should be maintained at all times.

Visitors

--When other personnel enter a remote mucking area, they should make their presence known to the scoop operator....once the operator is aware of their presence, they should stop and allow them safe passage or retreat to a safe location such as a muck bay

-- While remote mucking is in progress, no worker should enter the remote mucking area without receiving permission from the remote LHD operator...Use the "**Caution Remote Mucking Area**" sign during mucking...The "**Danger Open Stope**" sign and single guardrail should be installed when mucking is not in progress.

Stranded Scoops

--In the event that the unit shuts down and cannot be retrieved from beyond the brow markers, the Supervisor should be contacted immediately. No worker should go beyond brow markers for any reason

-- In the event that the unit shuts down and cannot be retrieved from beyond the brow markers, one should contact the Supervisor immediately.

--One should not in any way, cover or block access to the hook on the back bumper of the scoop. All scoops operated on remote should be outfitted with a retrieval hook. Retrieval of a disabled scoop in a stope can be done several ways depending on the location of the scoop. However at no time should a person go beyond the brow of the drawpoint. Retrieval is possible by:

A - reaching in with a pole to place a cable for the pikrose hoist on the hook at the back of the scoop.

B - pushing in a set of bicycle wheels to attach the cable of the pikrose hoist to the hook on the back of the scoop

C - if possible a second scoop operated by remote control, can be driven into the stope to attach a tow cable to the hook on the disabled scoop and it can be pulled out by the second unit or the pikrose hoist can be used.

D - a robot can also be used to attach a tow cable to the disabled unit

--For somewhat easier visible stranded scoop retrieval, hook a sling onto two clevises attached to the bucket lip of another remote scoop and approach the up-turned hook on the rear bumper of the stranded scoop, and drop the cable over it...keep the bucket elevated to better see the operation...For more difficult, less-visible situations, use the similarly looped cable with a camera mounted on the retrieving scoop.

2. REMOTE STAND INSTALLATION

SAMPLE EXCERPTS of PROCEDURES

Selection of Location:
-- A remote stand (porta- pad) is a preferred choice, using a safety bay is the alternative -- stand should be placed at a minimum distance from brow as specified by company procedure on level ground... stand placed as tight to the rock wall as possible... undulation of the wall may cause the bumper form extend into the drift more than required. This may also cause the stand to move out from the wall getting it closer to the outside edge of the bumper
-- The remote stand is to be located a minimum distance from brow as specified by company procedure ...where using a remote stand, and bringing the LHD alongside the remote stand, an approved engineered stand will be provided for and used by all remote operators. There is no variance allowed to this rule where the LHD is driven alongside the remote stand...Where an LHD is NOT brought alongside the remote stand, the use of any other remote stand requires a Manager's approval...Remote control operations should be performed from the operator's side of an LHD.
-- Stand should be set up in a secure place, positioned flat and level for easy mounting...should be far enough away from the distance from brow as specified by company procedure for safe mounting and dismounting...should be ample room for safe operation of the remote scoop beside stand... remote stand to be positioned towards the wall in such a way that it cannot be hit on the pointed end. The stands are designed to withstand a glancing blow that directs the vehicle away from the pad in the event an impact occurs
-- Considerations for the proposed location should include the drift height, width and arch... should provide adequate clearance for scoop to pass the remote station...the arch of the drift is important for determining clear line of site for the operator...the base of the stand is limited so as to not interfere with the operators' headroom clearance

Ground Conditions in anchoring area:
-- Forming dowels are needed in competent ground (should be installed in rock or ore but not sandfill) to meet company design standards. The floor should be level in proposed installation area. Roadbed may be required. The procedure entails marking up the centerline of the remote station with paint, then marking up the dowel holes for the bumper as per the company design print.

Site Preparation:
-- No edges, slings or attachments should protrude from the remote stand that would allow the LHD to hook onto it.
-- The water holding tank in the stand should be full of water when mucking.
-- Protruding objects (bolts) may interfere with securing stand to the wall. One should ensure existing bolts don't line up with form anchoring holes for ease of installation.
-- Operating from a large vehicle (operator's compartment of substantial piece of equipment such as haul truck, scissor lift, or boom truck) is an alternative while moving in & out of

stope. -- Stand condition should be checked for damage...transportation rigging gear removed (chains, slings)... concrete steel reinforced wedge installed as per design...water spray system installed and operational...stope lights installed and operational... housekeeping in good order...tripping hazards removed...radio communication established...ventilation established and adequate for operating equipment...ground conditions inspected...scaling bars readily available...fly muck removed from Haulage way...remote stand to muckpile washed down...electrical cables not lying in puddles of water, in good condition and hung tight to screen...each installation approved for use by General Foreman, Mine Captain or designate, form signed & dated...copies to be sent to Safety / Training Supervisor, Operating General Foreman's Binder

Stand Installation:
- Prior to releasing the site, use the Remote Scooptram Operators Checklist form for remote station pre-op...Complete pre-op to ensure the final product meets all requirements as per form
-- One should clean area of debris/tools and equipment prior to leaving the job site and install portable transmitter tray.

3. BARRICADES FOR STOPES

SAMPLE EXCERPTS of PROCEDURES

-- One should cover or barricade the dump area when it is not in use...the dump door or tire plug should be closed or lowered before leaving the dump.
-- Barricades should be reinstalled when not mucking....appropriate signs should be in place.
-- Barricades should alert workers of a hazard beyond and prevent initial entry. Barricades may identify the following: men working above, below or beyond, entrance to BH/LH stopes and remote mucking stopes or areas where remote mucking may occur, ANFO loader parking area. Signage to be posted at eye level on the fencing indicating the hazard beyond and the barricade placed not greater than distance from brow as specified by company procedure.
-- Barricades should alert workers of a hazards and prevent inadvertent entry of mobile equipment to the area. Barricades may identify the following: Blasthole overcut or open hole area, explosive, or fuel storage area. The design should include cement bumper blocks installed at distance from brow as specified by company procedure from the hazard across the approach to the area to be barricaded in close enough proximity to each other to prevent passage of the smallest piece of mobile equipment in the mine. Orange fencing above should be complete with signage (identifying the hazard) installed ahead of the cement blocks.

4. DUMPING INTO STOPES

SAMPLE EXCERPTS of PROCEDURES

-- One should check overcut for loose, obstructions, ensure roadbed and dumping barrier are in good order, ensure adequate ventilation and water sprays are in place.
-- One should drive scoop into overcut and dump bucket load over the barrier, ensuring the scoop does not hit the barrier with the bucket or tires.
-- One should return barricade and reflective poles to closed position when finished working at this location for that shift, and also report the status of the workplace to the supervisor.
-- One should cover or barricade the dump area when it is not in use, and the dump door or tire plug should be closed / lowered before leaving the dump
-- The overcut should be prepared in such a manner that: The entrance to O/C clearly identified with the appropriate signs...Three reflective poles and orange fencing in place across the entrance. Reflective cable is weaved through fencing...two reflective poles hang at dumping location hanging from back...."Danger-Open Hole" signs in place...Two safety lanyards in place near barrier and adjusted to proper length.

5. BLOCKHOLING WITH REMOTE JUMBO

SAMPLE EXCERPTS of PROCEDURES

-- One should check that muck inside stope is not hung up or unstable.
-- One should blast hang-ups, not use the scoop bucket to bring them down.
-- The operator should stay behind brow lines, the knuckle of the drill boom should not pass the brow line unless on remote control.
-- Refer to procedures for frozen cuts. One should wash the rock to be drilled with water before commencing drilling so as to detect misholes.

6. INSTALLING FILL BULKHEADS

SAMPLE EXCERPTS of PROCEDURES

-- Pre-fabricating the fence away from the brow: One should construct the prefab frame nearby but in a safe place...put in place near the brow with scoop... and then shotcrete it into place with remote controlled robotic arm on a shotcreting unit.
-- Fill fences should not be constructed closer than 5 meters from the brow. Both Ground Control and the Mine Captain should approve any exception to this. No fill fence or shotcrete wall should be constructed closer than 5 meters from the brow. Ground Control and the Mine Captain should make an assessment of the ground conditions and approve the location of any fill fence or shotcrete wall before work on them proceeds. Muck fences should be placed by remote control scoop only.
-- If a fill fence is to be constructed within 6 m of the brow a risk assessment and

subsequent control should be required. A note should be placed on the fill print indicating that fence construction is not to proceed until a risk assessment has been completed. The Mine Captain should be responsible for organizing the risk assessment. Ground Control in consultation with the Mine Captain should reassess the brow and mark a restricted access line in yellow. The fence should be constructed entirely outside this line. Depending on the width of the opening and the type of fence used this could mean that where the fence anchors against the wall is 1.5 m (arch design, 11m span) in front of the yellow line. Crews should place a "snow fence" across the heading at the yellow line to prevent inadvertent movement closer to the stope. A note should be placed on the fill prep print to advise as to which line to respect.

7. ACCESSING BROWS

SAMPLE EXCERPTS of PROCEDURES

-- No person should pass beyond established brow markers. A non-routine hazardous task should be completed if there is a need to conduct a task beyond the brow marker (i.e. water sprays, loading, blasting, explosives removal from a muckpile or geological grading) to ensure that worker(s) is(are) protect.
-- Cautionary Note: This procedure describes the minimum conditions for brow access under normal ground conditions and support. In the event that conditions or ground support is not normal, additional restrictions should be communicated. In the case of an uphole blast or slot that misfires, it is expected that this should be treated as "not normal". An assessment of the brow should be done before work around the brow / slot to reload or re-blast any holes is begun.
-- There should be no access within the first 5 meters from the brow for all personnel. This includes hanging of all lights, water sprays for secondary blasting, scoop retrieval, cavity monitoring, construction of all fences or mining up holes (i.e.: capping and wiring of "up holes" that have been preloaded). Each exception should be assessed and approved by both Ground Control and the Mine Captain before any access within 5 meters is allowed.
-- The remote control stand should be at least 12 meters back from the brow at all times. Access beyond the remote stand should be restricted to those individuals that have to go beyond this point to do a specific task (i.e.: hanging lights, water sprays) and at no time within 5m of the brow unless approved by both the Mine Captain and Ground Control.
-- Ground Control should assess each new brow and then determine the "mucking no access" point that should be painted on the walls using white paint. This should be at minimum 5 m from the brow to account for muck roll and should allow Ground Control to monitor the performance of the brow.
-- Mucking with the 8 and 9 yard scoops on manual should be allowed if the brow is entirely full of muck. This puts the operator at least 5+ meters back from the brow. Once the brow is opened up at any spot, all mucking should be done on remote from this point on. All mucking with 2-1/2 yd. scoops should be done on remote control at all times

whether brow is full or not. -- The remote control stand should be at least 12 meters back from the brow at all times in typical areas, 7 meters in narrow vein areas . Access beyond the remote stand should be restricted to those individuals that have to go beyond this point to do a specific task (i.e. hanging lights, water sprays, cavity monitoring) and at no time within the specified Ground Control parameter (white line) unless approved by the Mine Captain and Ground Control. -- For LH/uphole blasts where it is required to load the next line of holes adjacent to the brow Ground Control in consultation with the Mine Captain should reassess the brow and mark a restricted access line in yellow. Crews should load from behind the line using the proper LH loading procedure.
-- For Open stope brows: check operation of remote functions before sending the scoop into open stope.. .put stope lights in the overcut for visibility, (optional) after the cap (crown) is blasted.. .at no time while remote mucking should scoop be able to touch remote stand.. . safety bay to be 19 m from design foot wall contact during development stage. (This is to allow deterioration of the foot wall brow and still have enough distance to safely operate from the porta-pad during production mucking.)
-- Limitations on personnel proximity to open stope: supervisor should mark limit lines on both walls.. .lines should be in plain sight and 6 m from the brow providing the brow does not exceed 4 meters in height.. .if brow exceeds 4 m height, lines should be 1.5 times brow height back from brow ...no one should be permitted to enter beyond these limit lines when the brow is open.

8. HANGUPS OF ORE

SAMPLE EXCERPTS of PROCEDURES

-- Workers should not expose themselves beyond the brow for any purpose.
-- Poking down box holes or drawpoints hung-up beyond the brow is very unsafe.
-- Hang-ups are commonly blasted using pneumatic or other approved equipment to place the shot. Persons placing the shot need to make every effort to avoid exposure to runs of muck. Where practical, large chunks can be placed to afford protection during blasting operations.
-- The use of the bucket of scoop to bring down hang-ups is not recommended.
-- All drawpoints being pulled by scoops should be clearly marked to indicate the farthest point of advance beyond which the operator should not be exposed (brow markers). Marking should be done according to the system approved at each mine and should be maintained so that the marking device used is clearly visible to the operator.

690 McKeown Avenue, North Bay ON, P1B 9P1 TF: 1 888 730 7821 (Ontario) F: 705 472 5800 workplacesafetynorth.ca