Department of Natural Resources, Mines and Energy

# Guidance Note QGN 18
# Tipping near or over vertical edges in underground mining operations

*Mining and Quarrying Safety and Health Act 1999*

August 2010

Queensland Government

# Department of Employment, Economic Development and Innovation – Queensland Mines and Energy

# Tipping near or over vertical edges in underground mining operations

# Contents

# 1. Introduction

This guidance note has been issued by the Mines Inspectorate of the Department of Employment, Economic Development and Innovation. It is designed to assist underground mine operators, supervisors and management determine the safest options for tipping over vertical edges in underground mines where there is no permanent 'stop log' in place. The guidance note also provides information on the minimum expected requirement for underground anchor points for persons working in close proximity to vertical edges.

A guidance note is neither a guideline as defined in the *Mining and Quarrying Safety and Health Act 1999*, nor a Recognised Standard as defined in the *Coal Mining Safety and Health Act 1999*. In some circumstances, compliance with the guidance note may not be sufficient to ensure compliance with the requirements in the legislation.

Guidance notes may be updated from time to time. To ensure you have the latest version, either check the Department of Employment, Economic Development and Innovation website at www.dme.qld.gov.au/mines/guide_notes.cfm or contact your local inspector of mines.

# 2. Background

In May 2009, there was a fatal accident at a Queensland underground metalliferous mine in which a mineworker drove a LHD mucking unit into a stope while undertaking backfilling operations. An industry workshop was held in response to this incident.

At the vertical edge workshop the Mines Inspectorate and industry worked together to identify hazards and resultant risks associated with tipping over vertical edges.

Workshop participants also discussed the use and placement of underground anchor points to determine the safest practical anchor points for personal arrest/fall restraint for persons working underground in close proximity to vertical edges.

Information gathered at this workshop has been included in this guidance note.

# 3. Purpose and scope

Underground mining operations are commonly undertaken near voids, particularly when backfilling stopes and tipping into ore passes. In addition, mining operations can also operate equipment over filled voids. This guidance note provides information on the hazards associated with vertical edges to assist in controlling the resultant risks to an acceptable level and as low as reasonably achievable.

# 4. Management of vertical edges

The mine Site Safety and Health Management System should include the site's void management process, including monitoring and review of vertical edges.

Workers are exposed to the hazard of vertical edges in many aspects of underground mining as vertical edges are an integral part of the mining process.

Types of vertical edges may include:

- Mined void edges (stopes/benches/raise bored holes/winzes)
- Ore and mullock passes and finger raises

Types of activities at vertical edges may include:

- Workers inspecting or working near to a vertical edge (such as charging holes, drilling and cleaning holes, bringing down hang-ups in passes, taking surveys etc)
- Loaders/trucks tipping or ejecting material
- Supervisors conducting inspections
- Technical staff reviewing progress of stopes/raises etc

An effective risk assessment must be completed to determine appropriate controls for the hazards associated with persons and/or equipment working/operating at or near a vertical edge. Each of these activities will have their own hazards and resultant risks specific to the circumstances. The control measures implemented must address and manage these hazards in an effective manner.

When choosing controls to implement, the hierarchy of controls must be considered. Higher order controls such as elimination, engineering and design should be used in preference to lower order administrative controls such as procedures and training. However a combination of these controls will be necessary to ensure the risk to persons from going over a vertical edge while working at or near the vertical edge, or when tipping or pushing off, is at an acceptable level.

A pre-requisite to effective vertical edge management is the awareness of any vertical edge. The identification of all voids, including interaction of any levels into the void and any material including type and quantity used to fill the void, or to be/being extracted from the void, must be proactive and systematic, and be clearly communicated between management and the workforce. There have been incidents where persons have gone into vertical openings where material has been removed from voids and they were unaware of their location with respect to the overall void structure.

For example, incidents have occurred where persons thought they were at the base of a void when they were in fact at an intermediate level; or where material has been removed from lower parts of interconnected workings and unexpected voids appear higher up, causing greater than expected flows of materials.

Vertical edge management should also include a consistent method to mark permanent, temporary and waste stop logs.

A site inspection and risk assessment should always be conducted for any activity that is associated with a vertical edge. The following should be considered:

- Elimination of vertical edges through changes to the mining methodology
- The type of activity that is planned to occur near the vertical edge
- Minimising personnel exposure at the vertical edge
- Minimizing the time the edge will be in use
- Equipment
    - Must be fit for purpose
    - Serviced and maintained so that it complies with Original Equipment Manufacture standards as a minimum, in particular vehicle brakes should be checked daily.
    - Equipment checks, such as pre-start checks, should be conducted and identified defects corrected effectively
- Engineering controls to remove people from the edge
    - Remote controlled equipment (eliminating persons operating close to the edge)
    - Extensions on equipment (which does not require the operation of equipment working in close proximity to the edge e.g. push off bars)
    - Reduced opening size to prevent falling into the excavation
        - For example, design additional opening for tipping into the stope, such as a long hole winze, to eliminate the need for going near a vertical edge
    - Design of openings so they are smaller than the size of the equipment working near them
    - Maintenance of openings, particularly pass wear at the collar or hidden below the collar
    - Ore pass rings or grizzlies (restricts the size of material that can be tipped and has the additional benefit of preventing machinery from going into the void)
- Stop logs / barriers
    - Permanent stop logs (designed and tested as safe)
    - Temporary steel stop logs
    - Temporary steel stop logs and waste stop logs combined
    - Waste material stop logs
- Use of suitable proximity detection equipment
- Use of edge warning devices. These warning devices must be consistent and specific to the task marks on the wall. They could include:
    - Laser trip switches
    - ‘Candy Cane’ poles
    - ‘Streamer’ tell tales on the backs
    - Flicker lights
    - Audible indicators
- Improved visibility
    - Lights
    - Whitewashing
    - Signage – cleanliness and consistency of signage must be ensured
- Check integrity and stability of the edge (such as undercutting) through
    - Survey pick ups
    - Visual inspection from a point of safety
    - Undercutting ‘tell tales’
- Mechanism for inspecting and maintaining the integrity and effectiveness of the barrier
- Written procedures and standard work instructions
- Operation of equipment when approaching barrier
- Personnel anchor points
- Use of spotters
- Training and competency of personnel
- Communication of job activity and work areas (including detailed use of plans)

- Process when leaving an open void area
    - Physical barricade and communication to warn personnel of the hazards (e.g. barricades and signs)
- Identification of location with respect to the void structure (e.g. clear identification of drawpoint versus intermediate level)
- Level of supervision to ensure effective implementation and maintenance of control measures
    - Closely monitor operations to verify the effectiveness of the control measures
- Emergency response

**Activities around vertical edges should be limited to essential personnel only.**

In addition, ground conditions regarding working near blasted areas should be considered, but are not included in the scope of this guidance note.

# 5. Barriers

Selection, construction and installation of the barrier type controls are important and should consider:

- Design of the barrier
- Fit for purpose nature of the barrier
- An assessment to determine the effectiveness of the barrier (based on size, power of the equipment and the materials used in the construction of the barrier)
- Mechanism for inspecting and maintaining the integrity and effectiveness of the barrier including potential ramping effects of material in front of the barrier

## 5.1 Engineered permanent stop logs

Where it is necessary to create and maintain a vertical edge the best means of managing the risk is to establish a permanent engineered stop log. It must be of a ‘fit for purpose’ nature that would stop equipment under normal operating conditions inadvertently going over the edge.

The following points should be considered for permanent stop logs:

- Designed to appropriate engineering standard
- Installed to an appropriate engineering design
- Anchor point location considering ground integrity if pinned to the floor or wall
- Maintenance, inspection and testing regime with well defined pass/fail criteria (including inspection of the edge and void, such as an ore pass)
- Nature and type of equipment that will access or come into contact with the stop log (considering management of change if new equipment is used on site)
- Potential ramping effect of material in front of the stop log
- Lighting, white washing surrounds, etc
- Signage and warning paraphernalia (streamers etc)

## 5.2 Engineered temporary stop logs

If it is not practical to establish a permanent stop log, due to the nature of the void or void cycle time, then a suitable temporary stop log should be established and maintained.


Figure 1: Example of a permanent stop log

The following points should be considered in the risk assessment for temporary stop logs:

- Designed to appropriate engineering standard
- Installed to an appropriate engineering design
- Appropriate maintenance, inspection and testing regime with well defined pass/fail criteria
- Nature and type of equipment that will access or come into contact with the stop log (considering management of change if new equipment is used on site)
- Anchor point location considering ground integrity if pinned to the floor or wall
- Backing board height, base plate length and suitable width for the machinery using it
- Potential ramping effect of material in front of the stop log
- Lighting, white washing surrounds, etc
- Signage and warning paraphernalia (streamers etc)

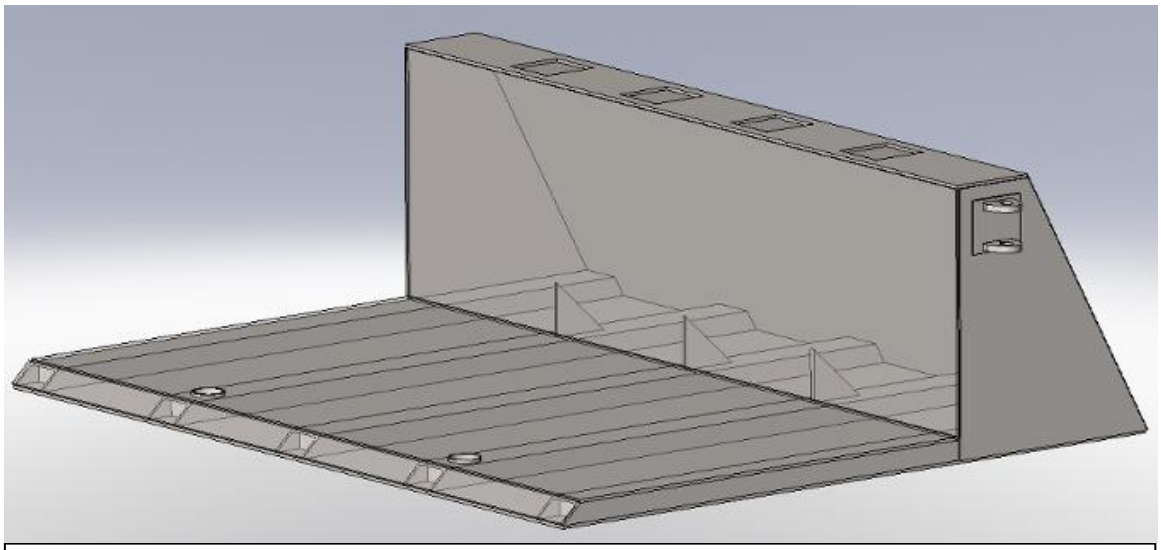


Figure 2: Example of a temporary stop log design

## 5.3 Waste stop logs

A waste stop log (i.e. a stop log made from rock material) should be considered a lower level control than a correctly designed, installed and maintained permanent or temporary stop log. A waste stop log may have less stopping capacity for equipment travelling towards it at speed. Variations may exist in a worker's judgement of what an 'adequate' waste stop log is.

The risk assessment involving a temporary waste stop log should consider the following:

- Height of stop log
- Quality of material used
- Variations in a worker's perception of the height of the stop log and the quality of material used
- Prone to erosion through inadvertent removal of material during use
- Prone to build-up over time which may cause a ramping effect
- Risks associated with cleaning build-up of material

# 6. Pushing off vertical edges

Pushing off is a high risk activity as personnel and equipment are placed in close proximity to an unguarded vertical edge while equipment is in a forward motion. The activity of pushing off should be avoided.

Alternatives:

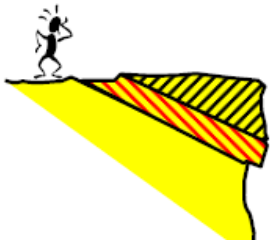
- Eliminate the need to push off (e.g. manually blowing off)
- Use remote controlled equipment (this approach eliminates the need for a spotter and keeps the operator away from the hazard of the vertical edge)
- Make changes to the mine design through stope design and firing practices that will eliminate the need for pushing off
- Use engineering extensions to further remove the operator from the edge

# 7. Personal anchor points

Activities around vertical edges should be limited to essential personnel only.

Where it is essential that persons work in close proximity to a vertical edge, an appropriate means of fall restraint/arrest and anchoring must be determined.

All types of anchor points used underground should be engineer designed and tested as fit for purpose. The intent is not to have each anchor point tested, but that the design and installation process should be to a known standard with appropriate quality control and quality assurance processes. The standard should be reviewed regularly and have an appropriate factor of safety to account for error in installation and use.



There are two types of personal restraint: fall arrest and fall restraint. A fall restraint system prevents workers from reaching a hazard, while a fall arrest system allows workers to reach a hazard and then protects them if they should fall.

## 7.1 Fall arrest

A fall arrest system provides maximum freedom of movement for workers to conduct their duties. It allows them to reach the point where a fall could occur, such as when charging holes close to an edge. In the event of a fall, the fall will be arrested. However, wherever possible, a person should not be placed in a situation where they could fall over an edge.

## 7.2 Fall restraint

Fall restraint systems allow a person access to conduct their duties but prevent them from reaching a point where a fall could occur. Restraint systems are generally suitable if the person needs to work at the edge of a hazard.

## 7.3 Risk assessment considerations

The most effective means of ensuring an acceptable level of risk to persons working in close proximity to vertical edges underground is through comprehensive risk management strategies. This may include the use of ‘fit for purpose’ anchor points. It may be difficult to achieve certification to an Australian Standard for all anchor points in rock; however, the design and installation process in given rock types can be tested.

Additional information is available in the Australian Standard is AS/NZS 1891.4, Industrial fall-arrest systems and devices – Selection, use and maintenance for the selection of an appropriate fall-arrest system.

The following points should be considered in risk assessments involving anchor points:

- No activity should be carried out where falling into an open void could be possible

- Eliminating the need to access vertical edges by determining the activities requiring access and challenging if the activities are in fact required.
- Analysing the purpose of being in close proximity to the edge and determining anchor point required (fall arrest versus fall restraint systems)
- Edge integrity
    - Determine whether the activity can be performed at a barrier or from a stand off distance
    - Determine if the condition of the edge could change, consider fall arrest if the edge gave way
- Anchorage
    - Type based on determined selection criteria; ensure the anchorage type and method is suitable for the task and fit for purpose
    - Use within its design limitations with compatible components (consider and review restraint requirements, e.g. >15kN of breaking force comply with AS1891)
    - Maintenance of anchorage
    - The direction of the load applied, fixing anchors directly overhead or along strong bedding/joint planes may not be suitable
    - If an anchor point is fitted to a vehicle it should be exclusively used for that purpose and should be engineer designed and installed. Bull bars and towing points on vehicles may not be appropriate as anchor because they are used for other purposes
- Testing requirements
    - Load testing for a given rock type. It is advisable to test every anchor in a mining environment due to the variance in the fixing surface
    - Load testing on an appropriate regime (when permanent)
    - Attachments and components are tested and certified as fit for purpose
    - Competent persons conduct testing to ensure their fit for purpose nature
- Appropriate competencies of persons using anchor points to ensure they are able to determine the correct attachments that are used within their design limitations
- Consider the breaking limit of the restraint equipment, particularly when working in an abrasive or sharp rock environment
- When working on fill, e.g. working within a backfilled ore pass, personnel should be wearing fall arrest equipment

In some cases, such as an emergency situation, it may not always be possible to have an engineered designed anchor point. In these cases all reasonably achievable controls should be implemented.

# 8. Monitoring and review of vertical edges

All processes associated with vertical edges must be reviewed regularly and continually improved. These processes should include a way of measuring monitoring and evaluating void management.

The following points should be considered in the review of vertical edges:

- An audit of all voids to include
    - Interaction of any levels into the void
    - Material including type and quantity used to fill the void
    - The amount of expected and actually extracted material from a void
    - Potential of undercutting
- Review effectiveness of current engineering controls existing at vertical edges

- Written procedures and standard work instructions associated with working near vertical edges. No activity should be carried out where falling into an open void could be possible
- When working on fill, e.g. working within a backfilled ore pass, personnel should be wearing fall arrest equipment
- Mine design practices to minimise working near void edges
- Refresher training of personnel involved in activities associated with working at or near vertical edges

# 9. Relevant legislation

## *9.1 Mining and Quarrying Safety and Health Act 1999*

### 9.1.1 Risk management

**27 Risk management**
(1) Risk is effectively managed when all persons individually and as part of their respective workgroups and organisations take action to keep risk at an acceptable level.
(2) In particular, effective risk management is achieved when persons apply risk management procedures and practices that are appropriate for the nature of the risk, operation or task being performed.
(3) Risk management is the systematic application of policies, procedures and practices to

(a) identify, analyse, and assess risk; and
(b) avoid or remove unacceptable risk; and
(c) monitor levels of risk and the adverse consequences of retained residual risk; and
(d) investigate and analyse the causes of serious accidents and high potential incidents with a view to preventing their recurrence; and
(e) review the effectiveness of risk control measures, and take appropriate corrective and preventive action; and
(f) mitigate the potential adverse effects arising from retained residual risk.

## *9.2 Mining and Quarrying Safety and Health Regulation 2001*

### 9.2.1 Risk management process

**6 Hazard identification**
(1) A person who has an obligation under the Act to manage risk at a mine must identify hazards in the person's own work and activities at the mine.
(2) The operator must ensure hazard identification for the mine's operations is done during the operation's planning and design.
(3) The site senior executive must ensure hazard identification is done –

(a) when operations start at the mine; and
(b) during the operations; and
(c) when the operations change in size, nature, complexity or another way; and
(d) for a hazard caused by a hazardous substance or dangerous good — periodically, at intervals not exceeding 5 years.

(4) For hazards caused by hazardous substances or dangerous goods, the site senior executive must ensure the identification includes the following —

(a) hazardous substances or dangerous goods being processed or used for processing;

(b) hazardous substances or dangerous goods that are a product, by-product or waste product of operations;
(c) hazardous substances or dangerous goods occurring in —
(i) the natural environment; or
(ii) plant or facilities; or
(iii) energy sources.

**7 Risk analysis**

(1) A person who has an obligation under the Act to manage risk at a mine must analyse risk in the person's own work and activities to decide whether the risk is at an acceptable level.

(2) The person must have regard to the following in analysing the risk—
(a) the results of hazard identification, risk monitoring and incident investigations carried out for the mine;
(b) the work environment and work methods for the mine's operations;
(c) the interaction of hazards present at the mine;
(d) the effectiveness and reliability of hazard controls in use at the mine;
(e) other reasonably available relevant information and data from, and practices in, other industries and mining operations.

**8 Risk reduction**

(1) A person who has an obligation under the Act to manage risk at a mine must, as far as reasonably practicable, apply hazard controls in the following order —
(a) elimination of the hazard;
(b) substitution with a lesser hazard;
(c) separation of persons from the hazard;
(d) engineering controls;
(e) administrative controls;
(f) personal protective equipment.

(2) The site senior executive must ensure hazard controls used to reduce risk in the mine's work and local environments are appropriate having regard to the following —
(a) the interaction of hazards present in the environments;
(b) the effectiveness and reliability of the controls;
(c) other reasonably available relevant information and data from, and practices in, other industries and mining operations.

**9 Risk monitoring**

(1) A person who has an obligation under the Act to manage risk at a mine must monitor risk in the person's own work and activities at the mine.

(2) The site senior executive must ensure risk in the mine's work and local environments caused by the mine's operations is monitored —
(a) when the operations start; and
(b) at appropriate intervals or stages during operations at the mine; and
(c) when the mine's risk management practices or procedures change significantly.

(3) Monitoring must include —
(a) the occurrence of incidents, injuries and ill health; and
(b) the level of hazards present in the mine's work environment; and
(c) for monitoring under subsection (2) — the level of hazards from the mine's operations present in the mine's local environment.

(4) If it is appropriate, having regard to the nature and level of a hazard present in the work environment, the monitoring must include 1 or more of the following —
(a) personal monitoring to decide a worker's level of exposure to the hazard;
(b) self-monitoring to detect effects of the hazard;
(c) biological monitoring to decide a worker's level of exposure to the hazard;

(d) health surveillance under section 138.

## 9.2.2 Procedures and standard work instructions

**114 Procedures and standard work instructions for particular operations**
(1) This section applies to operations at a mine if, having regard to the nature and level of risk from the operations, it is necessary for managing the risk for the operations to be —
(a) uniform and consistent in their performance or results; or
(b) compatible with other operations at the mine.
(2) The site senior executive must ensure the mine has a written procedure or standard work instruction for carrying out the operations.

## 9.2.3 Training

**93 Training**
(1) The site senior executive must ensure each worker at the mine is trained, if necessary, and periodically assessed, to ensure the worker has adequate—
(a) knowledge and understanding of the processes to be carried out, and the materials and plant to be used, for the worker's duties at the mine; and
(b) skill to carry out the processes, handle the materials and operate the plant; and
(c) ability to access and understand the procedures and standard work instructions for the worker's duties.
(2) The training must be carried out in an appropriate way, including, for example, by formal training courses or informal on-the-job instruction.
(3) The assessment must be carried out in an appropriate way, including, for example, by examination, test or proof of relevant prior learning.
(4) The site senior executive must ensure a person being trained or assessed does not carry out work at the mine unless the person is adequately supervised to prevent creating an unacceptable level of risk.
(5) Subsection (4) does not apply to work carried out by the person in an emergency.

## 9.2.4 Time and resources for carrying out tasks

**95 Time and resources for carrying out tasks**
(1) The site senior executive must ensure time is allocated, and the mine's resources are distributed, to enable each worker at the mine to carry out the worker's tasks without creating an unacceptable level of risk.
(2) Without limiting subsection (1), the site senior executive must ensure the worker is given the supervision, and assistance from other competent persons, necessary to achieve an acceptable level of risk.
(3) In this section— ***resources*** includes the following—
(a) access and transport;
(b) communication methods;
(c) facilities, materials and plant;
(d) leadership, guidance and training;
(e) procedures, including procedures for coordinating activities, and standard work instructions and other relevant information.

## 9.2.5 Supervising workers

**96 Supervising workers**

(1) Without limiting section 95(2), the site senior executive must ensure the mine's activities and workers are supervised to the extent necessary to ensure each worker—

(a) is not likely to be exposed to conditions beyond the worker's capabilities; and

(b) is not likely to be affected by the conditions in which the worker is working in a way that adversely affects the worker's fitness to perform critical tasks; and

(c) has the resources necessary to carry out the worker's tasks without being exposed to an unacceptable level of risk; and

(d) is working within the limits of the worker's fitness and competence; and

(e) complies with the worker's safety and health obligations.

(2) The supervision must include communication, including direct contact, at appropriate intervals by the worker's supervisor.

## 9.2.6 Mobile plant selection and design

**100 Plant selection and design**

(1) A person who has an obligation under the Act to manage risk at a mine in relation to the selection and design of plant must ensure—

(a) the plant—

(i) is fit for its intended use and use in its intended work environment, including, for example, a hazardous area; and

(ii) is ergonomically compatible with persons operating or maintaining it; and

(iii) has appropriate provision for safe access, egress and maintenance; and

(b) if it is necessary for managing risk from the plant and it is reasonably practicable, the plant—

(i) fails to safety; and

(ii) does not fail catastrophically or by common mode or cascade failure; and

(iii) incorporates appropriate engineering controls to protect the plant operator and other persons; and

(iv) incorporates appropriate backup systems to ensure plant remains under control if its primary system fails; and

(v) is designed so its condition and performance can be monitored and incipient failures detected.

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