MOSH LEARNING HUB

Leading Practice Adoption System

Leading Practice Adoption Guide for the

Installation of Netting with Bolting in the Stope-Face Area

Rev 1

3 January 2013

Note: This draft guide is for use at the first of the adopter mines. It will be updated to take account of experience gained and input received while securing successful adoption at the first adopter mine.

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Executive Summary

Fall of ground fatalities make up approximately 40 % (fatalities in 2010) of all mining fatalities in the South African mining industry, with the majority of these occurring close to the working faces and particularly the stope faces. For this reason, the falls of ground hazard was selected as an area in which a significant impact could be made through the Leading Practice Adoption System. The second leading practice to be identified and demonstrated for the reduction of fall of ground injuries and fatalities, addresses the risk in the stope face.

Netting and Bolting was identified as a leading practice on Union Section Platinum Mine. The safety record and experience of Union Section suggests that netting and bolting, together with other initiatives, have played a significant role in limiting fall of ground injuries and fatalities. Due to the adoption of netting with bolting process still being rolled out at Kusasalethu, it was not possible to show improvements in safety directly due to the use of the netting and bolting practice at Kusasalethu Gold Mine. Measuring will continue and it is expected that significant improvements in rock related safety will be measurable as the procedure is fully adopted on the mine.

The objective of this document is for it to serve as a guide to decision makers and adopters to facilitate the adoption of the netting and bolting practice whilst addressing the 'people' issues that aid the process. The scope of the identified leading practice is clearly defined.

The guideline is presented in three parts, with the first part outlining the strategic context, the second part outlining the guidance on adoption of the leading practice at adoption mines and the third part providing the details of the leading practice that is to be adopted, including any reference or example material considered necessary, attached as appendices.

Leading practice adoption guide

List of Acronyms

CEO	Chief Executive Officer
COPA	Communities of Practice for Adoption
DMR	Department of Mineral Resources
EXCO	Executive Committee
FoG	Fall of Ground
H&S	Health and Safety
KPA	Key Performance Area
MHSA	Mine Health and Safety Act
MHSC	Mine Health and Safety Council
MHSI	Mine Health Safety Inspectorate
MOSH	Mining Industry Occupational Safety and Health
OH&S	Occupational Health and Safety
PPE	Personal Protective Equipment
SAMRASS	South African Mining Reportable Accidents Statistics System
SIMRAC	Safety In Mines Research Advisory Committee

Part 1 – Strategic Context

1.1 The problem addressed

Rock-related hazards continue to be the single largest cause of injuries and fatalities in South African mines, making up approximately 38 % of all fatalities(Figure 1). While they comprise a more serious issue in some mining sectors and commodities than in others, in general, their control and elimination is a crucial element in helping the industry reach its milestones in 2013 and the eventual target of zero harm. Most rock-related injuries and fatalities occur near the active mining face, whether this face is a tunnel or stope (Figure 2). These areas are where the rock is most unstable, as it has been recently exposed by blasting, is adjusting to new stress environments, is sometimes unsupported and is possibly even subject to dynamic conditions such as seismicity.

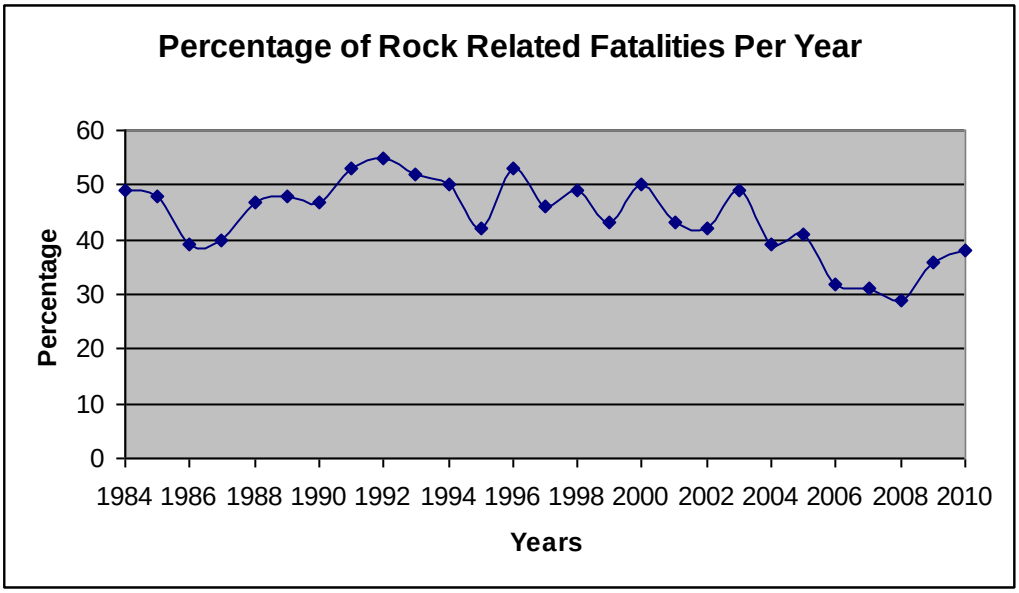


Figure 1. Contribution of rock related fatalities from 1984 to 2010

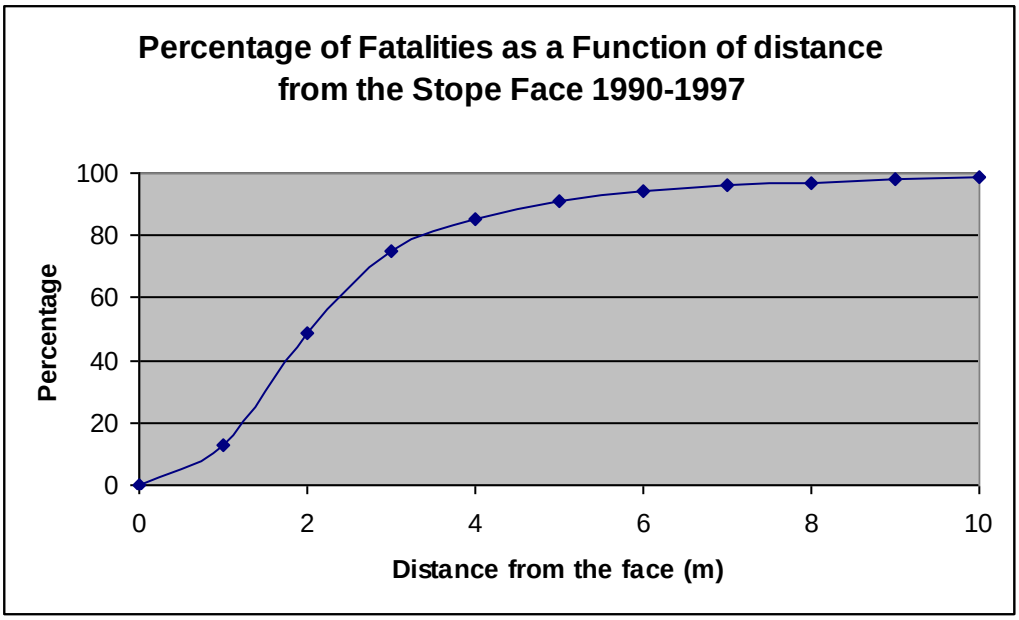


Figure 2. Cumulative percentage of fatalities as a function of the distance to the stope face

In 2010 the Mine Health and Safety Inspectorate (MHSI) reported 128 mining-related fatalities in the South African mining industry as illustrated in ***Table 1,*** with 49 fatalities or 38 % of cases being rock related.

Table 1: Rock-Related Fatalities and Total Fatalities in South African Mines for the Period 1/01/2010 – 31/12/2010. (Source: MHSI SAMRASS Data Base 2010)

	Rock related Fatalities	Total Fatalities
Gold	30	62
Platinum	14	34
Other	5	32
Total	**49**	**128**

Figure 3 shows the fatality rate for rockfalls and rockbursts from 1996 to 2010. A downward trend is evident but more can and needs to be done to improve this trend. In spite of the improvement in actual numbers and the rate of deaths per million hours

worked, the total deaths due to rock related incidents was unacceptably high at 49 deaths in 2010 as shown in ***Table 1 and Table 2***.

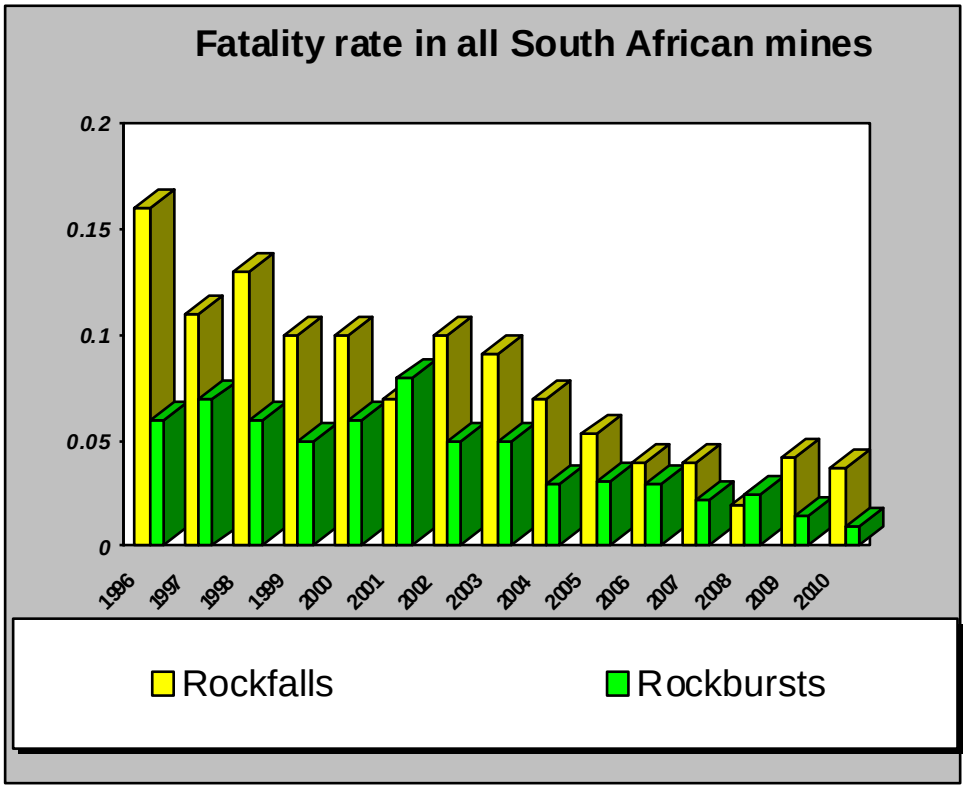


Figure 3: Rockfall and rockburst fatality rate for all mines 1996-2010.

Table 2. Rock related fatalities in all South African Mines from 1996 to 2010

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Rockfall Fatalities	180	115	118	94	91	59	84	83	65	52	55	49	26	48
Rockburst/ Strainburst Fatalities	67	77	63	43	51	64	40	48	31	31	30	27	30	17
Total Rock Related Fatalities	247	192	181	137	142	123	124	131	96	83	85	76	56	65

The purpose of netting with bolting is to ensure that the area in which stope crew members are working is protected against rockfalls. The quality of support in stopes has improved over time and support resistance levels have been set to cater for the fall-out thicknesses of rock anticipated. However, a weakness of even high support resistance support systems has been the lack of total area coverage. This has been addressed to some extent with the use of headboards on top of elongate supports. In spite of these additions, many rock related injuries, and even fatalities occur as rock dislodges between support members. Thin sprayed lining and netting with bolts have been applied in the industry, with limited success in the former case and considerable success in the latter case. Netting with bolts has therefore been identified as a leading practice and suitable for eager wide adoption by the industry.

Recent analysis of two and a half years of fatality data from the South African mining industry indicates that over this period, 21 fatal accidents may have been prevented with the introduction of nets with bolting in stope faces. This is not conclusive but rather indicative of the impact that nets with bolting could achieve. Figure 4 shows the information related to netting and bolting and other rock related leading practices in a graphical form.

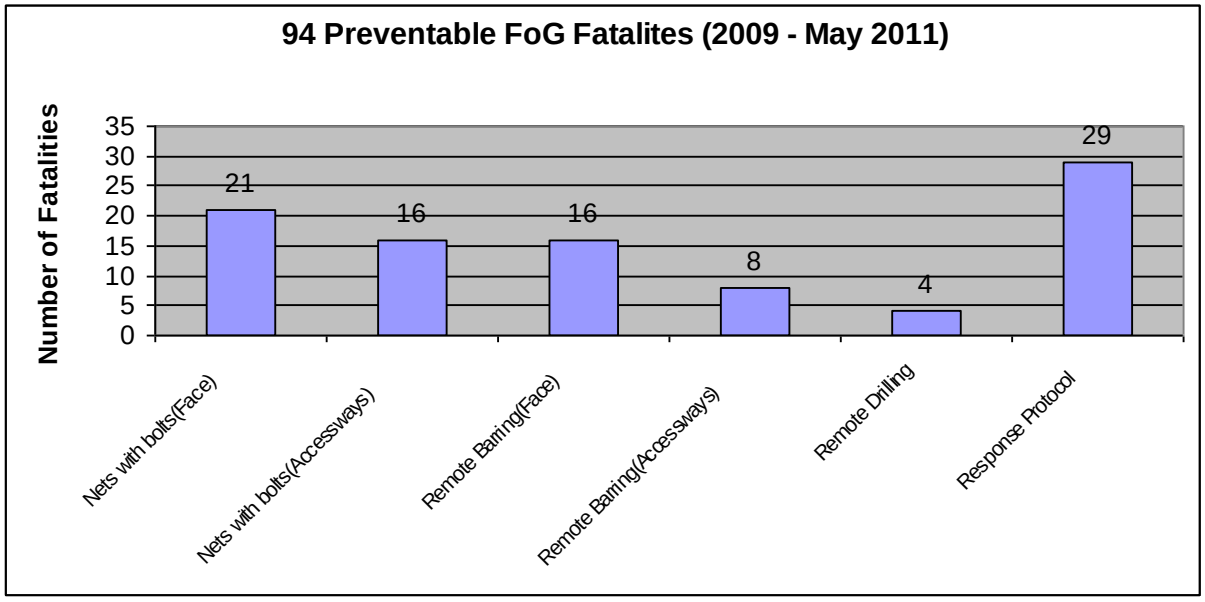


Figure 4. The possible impact of rock related leading practices over a two and a half year period in South African Mines

The selection of netting with bolting as an industry focus, combined with the widespread adoption of the practice, should result in significantly improved general safety figures for the mining industry and rock related safety figures in particular.

1.2 Summary description of the practice

The second identified leading practice for adoption to address falls of ground involves the installation of HPDE knotted nets as close to the working face as possible. The nets, together with hangingwall bolts, are designed to provide protection from rockfall from the hangingwall. This is intended to protect the crew who drill blast holes in the face, drill holes for the new rock bolts in the hangingwall and those who carryout the charging up of the face with explosives.

The practice is as follows:

- The crew enters the face and begins with the entry examination and making safe.
- The installation of the netting may only proceed once the entry examination and making safe procedure has been completed in the section of face in which nets are to be installed.
- As the crew proceeds down-dip, temporary mechanical jack support is installed as close to the face at approximately 1.5 m on strike from the last line of support at 2.0m dip spacings.
- The 6m x 2 m wide nets are rolled down the face beginning at the top of the panel.
- The net is first attached to a mechanical prop at the face. These mechanical props have special hooks on their headboard. The headboards are oriented at right angles to the face and the hooks are located on the part of the headboard closest to the face.
- The net should be pulled as tight as possible between the successive mechanical props along the face as the net is rolled out.
- The net is progressively attached and tensioned to the headboards on the permanent support as the net is rolled down the face
- The next net is attached in a similar way and attached to the first net with c-hooks.

- Once a net is in place, c-hooks are used to attach the net to the roofbolts. This minimizes the spans between attachment points, reduces slackness and stiffens the system in the event of a rockfall. The installation of the roofbolts is therefore critical.
- Members of the crew then commence the tasks set for the day.
- At the end of the shift before the shift leaves the face and before the blast occurs, the nets with c-hooks must be removed
- The removal of the net should begin with an inspection of the net to identify if there are any loose rocks located in the net. If there are loose rock in the net then special care need to be exercised when removing the net to avoid injury from the rocks as the net may be under additional tension. If the rock is very large then temporary support should be placed below it before the net is removed. The temporary support can be released remotely after the net is disconnected and the net freed from below the rock if possible. The net may need to be cut in exceptional circumstances.
- The net and attachment devices should be stored in a safe place where they will not be subjected to blast damage.

While this support solution has demonstrated effectiveness and efficiency in improving rock-related safety in underground mine workings, its success as a leading practice depends on people – people at all levels of employment and their leaders at all levels.

Formal research supporting development of the Leading Practice Adoption System showed that decades of emphasis and effort on technology transfer to improve safety and health performance has, in fact, produced little true transfer of technology or significant improvement in performance. Research also showed that the need was to realise adoption – not transfer – of technology and leading practice.

Adoption is a human activity and the two most powerful influences on adoption are leadership behaviour (i.e. the actions and inactions of leaders) and behavioural communication (i.e. modes of communication appropriate to different levels of employees and situations) as these have a significant influence on people's decision-making, judgment and behaviour. Communications and leaders' behaviour occur continuously every day in mines in various forms and combinations.

Recognising the importance of these two features (i.e. the need to introduce behavioural communication to achieve the desired behaviours and a leadership behaviour strategy to evoke and re-enforce the desired behaviours of leaders) distinguishes the Leading Practice Adoption System from past approaches. Therefore, as the appropriate leadership behaviour and behavioural communication expedite the adoption of a leading practice, these 'people' aspects, together with the practice, comprise the 'leading practice' that is being recommended for adoption across industry, as depicted in ***Figure 5***.

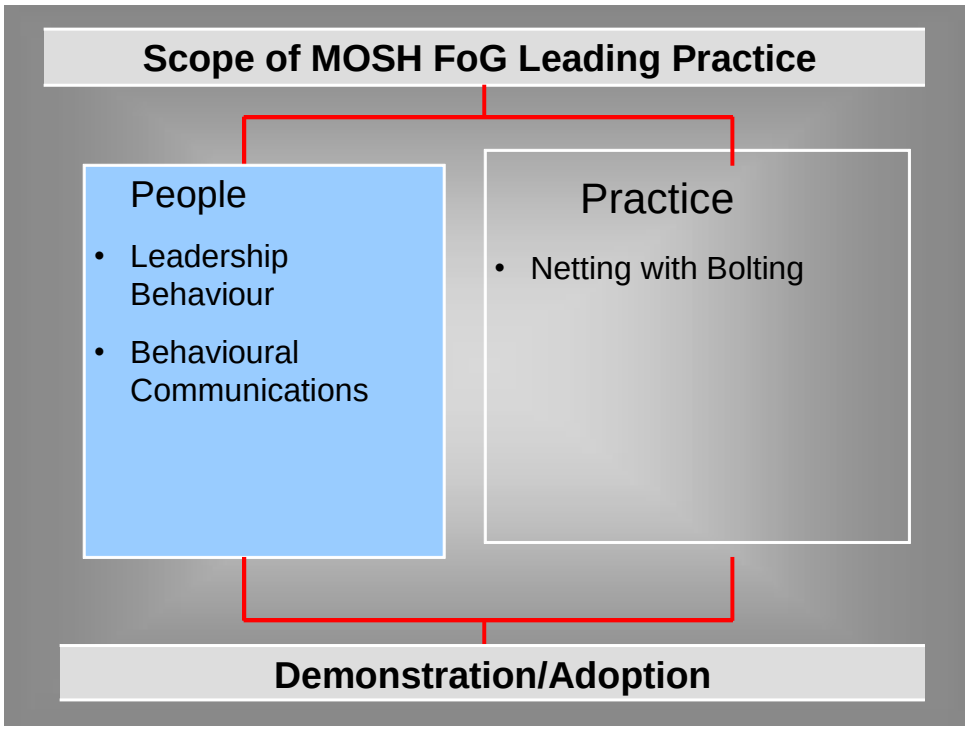


Figure 5: Scope of leading practice.

1.3 Summary of documented performance and impacts

The source mine, Union Platinum, had tried, tested and modified the use of netting with bolting since 2003 following a concerted effort to improve safety and particularly rock-related safety.

Subsequently, the leading practice was demonstrated at Kusasalethu Gold Mine, both in terms of the efficiency of the procedure in assisting in ensuring that the installation of nets with bolting was correctly carried out, and in terms of the effectiveness of a

behavioural communication and leadership behaviour strategy. This strategy was aimed at key stakeholders and adopters to address leadership and communication gaps in order to facilitate the adoption of the system.

Monitoring of the effectiveness of the nets with bolts covered the following:

Leading indicators – Quality of support
Distance of backfill from face
Distance of support to the face
Distance between support members
Equipment present to carry-out installation of nets with bolts
Panel shape and layout
Personal testimony

Lagging indicators - Lost Time Days
Injuries (Treat and return to work)
Anecdotal evidence from mining staff

Table 3: Summary of the parameters measured before and after the leading practice was introduced.

Measure	Without Leading Practice	With Leading Practice
Dip Roofbolt Support spacing (m)	>1.5	<1.5
Strike Roofbolt Support Spacing (m)	>2	<0.8
Minimum Support distance to face (m)	0.5	0
Maximum Support distance to face (m)	1.0	<0.5
Time taken to carry out installation of nets(hours)	n/a	10 minutes of 15m panel
Time taken to remove the nets and store	n/a	10 minutes
Personal Experience	“Expect rock related damage and injury at the face”	“Evidence of rock being caught by the nets. These have not been large rocks but enough to cause injury”

1.4 The generic value case

The value case for adopting technological and people solutions to eliminate fatal and serious injuries is not only a business consideration but a moral, reputational and ethical one.

Substantial research has been carried out in South African mines to determine the fall of ground thicknesses for particular ground control districts. The average thickness of falls of ground has been found to be less than 0.5 m, and 95 % of all falls have been found to be less than 1.4 m for one ground control district[1]. However, half a metre of quartzite weighs approximately 1,380 kg per square metre of hangingwall. This is more than sufficient to cause serious injury and even loss of life in the event of such rocks detaching from the hangingwall.

However, this represents a small, controllable risk if, firstly, correct early examination and making safe procedures are carried out and, secondly, adequate support is installed to reinforce the rock, providing support through tendons and timber. However, there still remains a risk from the exposed rock between the supports and the final barrier to substantially reducing the risk is area support offered by nets. The injuries and fatalities caused by falling rock in the face area could be reduced and even eliminated with such a support approach.

Many mines have experienced closure of sections, shafts or even the mine itself through Section 54 notifications issued by the Department of Mineral Resources (DMR). This often results in considerable loss in production and profit for a mine, threatening sometimes its very existence, with social repercussions such as loss of jobs. It is conservatively estimated that one fatal accident costs a company about R2.7m[2]. This is an expense that comes directly from the profits of a company. With the many fatalities currently caused by falls of ground in mining (49 out of 128 fatalities in 2010), the annual cost of these accidents to the industry is enormous. More recent work by Joughin[3] indicates that losses of R 500 000 or more per day may be suffered by mines for stoppages for any reasons and that mines have been stopped by the DMR for as much

[1] Jager and Ryder, 1999. A handbook on Rock Engineering Practice. pp148

[2] Adams, 2005. Strategic versus Tactical approaches in Mining. pp148

[3] Joughin, 2011Rock Engineering for managers in hard rock tabular mines. pp156

as 5 to 10 days. These stoppages inevitably follow fatalities, including rock related fatalities. The use of nets with bolting should reduce the possibility of unexpected falls of rock that could lead to injury or death of workers, with all the emotional and psychological scarring to mine personnel, damage to equipment, heightened health and hygiene risks such as dust and poor ventilation, and unscheduled stoppages. With the installation of nets with bolts, working places will be safer, with less stoppages for injuries to workers. there will be less falls of rock that will need to be cleared, worker moral should improve, together with improved productivity. There is therefore a large incentive, morally and financially, to use the leading practice of netting with bolting..

Additional benefits reaped by a mine implementing the nets with bolts that includes workers in making decisions about safety and training supervisors to listen to workers will have a further positive impact on morale.

The return on investment in occupational safety spending is difficult to accurately quantify, as is the true cost of the burden of fatal or serious injuries on the individual, families, communities, social services, health services and the employer, both from an economic and a human, ethical and moral point of view. However, every effort must be made to do everything possible, consistently and well, to achieve zero harm from rock-related hazards.

Part 2 – Adoption Guide

2.1 Ensure existence of a clear implementation decision by mine manager

On Kusasalethu the endorsement to adopt the netting with bolting was given by the General Manager of the mine who indicated his desire and willingness to have the leading practice demonstrated on his mine.

- He wanted the leading practice in the long term strategic/mine and budget plans.
- He was prepared to commit the resources required to implement the leading practice by signing off the budget and plan summary.

- He nominated a project champion and team to drive the process. Included in the formation of the team was an understanding that the Unions would be included as full members.

Adoption of the netting with bolting leading practice was presented to the General Manager as a major occupational safety priority that has the potential to significantly improve the occupational safety performance of the company. The motivation thereof was driven by a strong value case which extends beyond the financial costs.

2.2 Clarify potential for the mine to benefit – develop the value/business case for the mine

Key components of the value case:

- Occupational health and safety performance improvements

– *With a large enough roll out of netting with bolting on a mine and sufficient time, the lagging rock related indicators will show an improvement in the safety of the operation*

– *It is estimated that the installation of nets with bolts will prevent rock related injuries and even fatalities in the stope face area which is traditionally the area with greatest risk.*

– *Key leading indicators will be indicative of the benefit that is likely to be achieved. With the installation of nets with bolts it is expected that with time the support standard will be more rigidly adhered to because the nets fit into the stope more easily when the support is to standard.*

– *Kusasalethu Mine has a high support resistance in the stope face area. In spite of this, there is the possibility of rock detaching from the hangingwall between the current support contact points on the hangingwall. The installation of nets with the other supports and particularly the roofbolts should be the final protective barrier to eliminating gravity rock related and even seismic rock related incidents in the stope face area.*

- Financial benefit of occupational health and safety improvements

Although it is too soon to show any actual financial savings from the implementation of this leading practice it is clear that any injury prevented or life saved will result in financial savings.

- *Hospitalisation and other medical costs. Joughin[3] estimates that the average medical costs for a lost time injury or a major injury is R10 018-00. For a fatality this cost is R1 465-00.*
- *Time off work. When an individual is booked off work due to an injury, the rest of the crew has to achieve the same output without that person's presence. This leads to frustration, fatigue and often neglect of safety in the work-place. Even minor injuries caused by falls of ground may mean that the crews are under compliment as a crew member may leave the work place for attention to their injury.*
- *Risk premiums. RMA provides insurance for the industry and increase risk results in increased premiums for the mine.*
- *SIMRAC levies. Joughin[4] presents these costs for a lost time injury of 7 days as R25.00, for a major injury of 138 days as R494.00 and a fatality, deemed to be 6000 days lost as R21 480.00(This figure is paid three times over a three year period).*
- *Management time devoted to enquiries, reporting and other communication. If an injury occurs, whether serious or fatal, there will need to be an investigation which involves members of staff from the mine at all levels. Usually the more senior and costly members of staff are involved for longer periods of time.*
- *Lawyers. Fatal accidents and serious injuries have the potential to result in litigation and possible prosecution. All parties retain legal representation which is very costly to the mine and the union to which the individual was affiliated.*

- Initial cost to implement the new practice

- *Capital costs of purchasing and installing new equipment.* The netting with bolting practice is relatively inexpensive to implement. The nets are the largest item that needs to be purchased. However, the nets are reusable and should last a couple of months. In the case of Kusasalethu, the bolting was already being carried out and mechanical props were being installed on the face. An additional crew member had already been added to each crew to cover the additional work involved in the drilling of hangingwall roofbolt holes and installation of the roofbolts. The main supports for attaching the net were therefore already present. The only additional items to be purchased with the nets are c-hooks, s-hooks and saddle hooks which go over the headboard of the mechanical props.

3 Joughin, 2011Rock Engineering for managers in hard rock tabular mines. pp155

Table 4. Estimated monthly costs for installing netting with bolts

	Cost (Rands)	Number of Units/People	Total Cost per Item
Labour	**R 10 000.00**	**1**	**R 10 000.00**
Netting	**493.14**	**5**	**R 616.43**
Bolts	**49.85**	**300**	**R 14 955.00**
Drill Modification	**R 1 421.00**	**1**	**R 118.42**
Drill Steel	**R 127.11**	**5**	**R 635.55**
Camlocks	**R 743.47**	**11**	**R 4 089.09**
Resin			**R 0.00**
Tensioners(if needed)	**R 85.00**	**11**	**R 467.50**
C-hooks/S-hooks/Saddle Hooks	**R 2.00**	**200**	**R 400.00**
Direct Monthly Expenses for Netting with Bolting			R 31 281.98

– *Creation of new infrastructure (physical facilities, training and communication aids, etc.)* At Kusasalethu Mine a surface mock-up was built to demonstrate the installation of the nets in the stope face. This was constructed simply and inexpensively. It is close to the shaft so that crews can either visit it when exiting the shaft or if they are in training sessions on surface. Nets have also been installed at the crush to remind personnel about them and their use.

– *Initial training of management, supervisory staff and workers* At the start of the MOSH demonstration at Kusasalethu Mine, the General Manager gave a brief talk on the MOSH system to all the middle and senior officials at their weekly safety meeting. He then allowed the adoption team managers to address the group on the process that would be followed. Following on from this sessions with small groups of miners were arranged to explain the MOSH principles to them. More detailed, one-on-one sessions were arranged with each Mine Overseer. The crews are introduced to the netting with bolting leading

practice at the time that they attend the Qaphelangozi training on surface. Qaphelangozi is a management change initiative that aligns with the MOSH behavioural aspects. During their training the teams visit the surface mock-up and have an opportunity to install and remove the nets and to have discussions about problems they may have with the system. The teams are then given further training by a specialist underground at the working panel. The specialist does not install the net but assists with the installation. Multiple visits occur to each panel to give ongoing coaching so that he quality of netting installation occurs.

- Direct impact of the new practice on operational costs

– *Human resource costs*

A decision has been taken by the management of the mine that no additional labour will be given to install the nets. All the support members that are required for good attachment of the nets are already installed by the crew and the net is simply to be attached to the existing support. If the support is installed to standard then the attachment of the net should not require much physical effort and should be accomplished within 5 minutes per net. A net is 5 m long so a 30 m panel would require 6 nets and the installation time for the whole panel should be about 30 minutes.

– *Routine training costs*

– On Kusasalethu the training required for netting installation with bolts was incorporated into the Qaphelangozi training so that very little additional time was required. However, a dedicated experienced middle management person was assigned to the roll out of the netting with bolting in the crews and this cost is approximately R0.5m per annum.

– *Equipment maintenance costs*

– The equipment is very basic and it does not require maintenance. The nets do break and if too many strands are cut the net is discarded. Nets should last indefinitely if they are not cut but on average they are expected to last 2 months.

– *Outsourced service providers*

– The Qaphelangozi initiative is run by independent contractors and the additional work that is involved in the netting with bolting programme is minimal.

- Indirect operational impacts of the new practice

– *Productivity, both positive and negative effects*

– The installation of nets initially takes a long time and does impact on other production tasks. Production crews have expressed frustration on some occasions because of the time taken to install nets. During initial attempts to install the nets, more than an hour was taken and this delayed the drilling and charging-up operations. More recently with the shorter nets and once the crew has some practice the installation for a full panel (30m) takes between 10 and 20 minutes.

- Other valued business impacts

– *Improved stakeholder relationships internally and externally*
– *Reduced pressure to compel change by rule-makers and other key players*
– *Buy-in and collaboration from all stakeholders*
– *More positive relationship between all operational levels on mines*

In addition to the anticipated occupational safety improvements, the value case for the use of netting with bolting can be supported on a strong foundation of potentially significant financial savings if their presence reduces stoppages for a variety of reasons (see 1.4).

2.3 Identify gaps and alignments (Mental Models)

The adopters should be ready for and receptive to the behaviour modification that will be expected from them. This readiness must be assessed and addressed before adoption, to identify the knowledge, attitudes and perceptions that will operate as aids or as barriers to adoption of the leading practice.

Identification of the gaps and alignments is achieved most effectively though a direct enquiry process, outlined in section 2.7 and detailed in ***Appendix 2***, which includes templates for the interview process.

This identification of the unmet needs (gaps and alignments) is an important first step in the process to arrive at a customised leadership and behavioural communication strategy that identifies the objectives, key messages of communication and the choice of communication modalities that translate into the required actions. The customisation process is outlined in ***Appendix 5***.

Appendix 2 provides the questionnaire that was used by the Kusasalethu to identify the mental models of the adopters prior to developing the leadership and behavioural communications strategy. The main gaps and alignment at the operation are given below.

Gaps:

- Communication at all levels of employment is lacking.
- Leadership behaviours do not consistently promote a transformative culture in the workplace.
- Supervisors do not give enough time to their subordinates. There appear to be very few opportunities for individuals to interact one-on-one with their supervisors.
- Supervisors are not trusted.
- Misunderstanding exists on the cause and effects of falls of ground, both gravity and seismic induced failures.
- Misunderstandings exist on the role of the net to trap people if there is a rockfall

Alignments:

- Top level executives are taking a firm stand.
- Employees at all levels are eager and willing to be involved in improving safety.

It follows that these unmet needs must be addressed in any behavioural communication and leadership behaviour strategy.

The behavioural communication and leadership behaviour plans developed (sections 2.11 and 2.12), and attached as ***Appendices 3 and 4,*** aligns with and responds to the research findings of the unmet needs of the stakeholders and adopters of the demonstration mine.

2.4 Evaluate fit with mine's safety strategy

The introduction of the leading practice of netting with bolting involves behavioural and cultural change, and without these aspects the leading practice is not being applied. In Kusasalethu Gold Mine's case, the culture change required for application of the leading practice was aligned with the mine's Qaphelangozi programme, emphasising the rights and responsibilities of all employees in respect of their own safety.

2.5 Identify project champion and team for implementation

A condition for adopting the leading practice should be that the mine will identify and appoint a person to champion application of the leading practice technology and people components. The mine should adequately free the appointed person from his/her operational responsibilities so that the role can be optimally fulfilled. The primary purpose of appointing champions is to energise and spearhead the progressive growth in the adoption of the leading practice that they are championing. In essence, the mechanism of championship involves leadership to overcome implementation difficulties, as well as effective communication of relevant information to enable other operations to decide to adopt the leading practice.

A project champion should be appointed for the duration of the project. At Kusasalethu the project champion and the mine adoption team leader were the same person for some period of time. A summary of the key points on championship is given in ***Figure 6.***

2.5.1 Role profile of project champion[2]

Credibility: An essential requirement for success is that the champion should be credible. This individual should preferably be someone linked directly to the Occupational Safety discipline and should be at a high level in the organisation. He/she should have good levels of knowledge, energy, leadership, communication skills and personal credibility.

Involvement: Having selected an individual with the right potential, it is essential that he/she be sufficiently released from normal operational responsibilities to adequately perform the function of championship. To do this, the person needs to become deeply involved in the details of the technology and people components of the leading practice, to appreciate the issues and problems, and to assist in, or be knowledgeable about their solution.

Leadership: An important role of the champion will be that of providing leadership in overcoming implementation problems that arise, and in particular to energise lagging aspects of the process. The champion should also provide input into the development of strategies and plans for the progressive adoption of the technology and or leading practice at both the mine and across industry.

Communication: Perhaps the most important role that the champion needs to play is that of being an effective spokesperson for the leading practice being championed. To do this,

the champion would accumulate key data and prepare appropriate documents and presentations to communicate such performance and technical data to interested parties. The champion would seek out opportunities to present such information, including workshops, conferences, technical journals, meetings of professional societies, internal meetings, and so on.

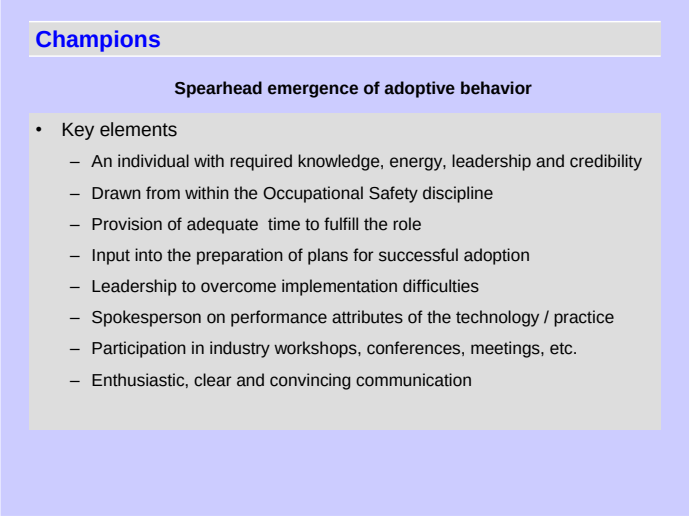


Figure 6: Summary of key points on championship.

2.5.2 Project management team

The adoption mine should appoint a project management team to plan and oversee the detailed execution of the project. The leader of the project team could be the champion, but this should not be a requirement. Unfortunately, due to staff turnover, and the resulting production pressures the mine adoption team leader changed three times at Kusasalethu. This is a pattern that should be avoided.

The champion should however be responsible for reporting progress on the project to all parties that have expressed an interest in receiving such information, particularly key people on the mine.

It follows that the project team must be multidisciplinary with line management, safety specialists, rock engineers, behavioural specialists, communication experts, training practitioners and labour representatives, as was the experience at Kusasalethu Gold

Mine.

The following members made up the adoption team on Kusasalethu.

The Mine Manager

The Safety Officer

The Rock Engineering Manager

Union Representative

Training Officer

Mine Overseer

A Chamber of Mine Representative

2.6 Identify adopters (supervisors/workers) and stakeholders (management/OHS Committee/Unions/Safety Reps)

In keeping with the principles of the leading practice adoption system, it is critical that people are involved at all levels of the adoption process whether they are adopters or key stakeholders.

The adopters of the technology in the case of netting with bolting are mine overseers, production supervisors and workers. This category incorporates:

- those who have a primary or shared role in designing and implementing, and/or approving the design and implementation, of the implementation project, and
- those who will be most affected by the system and could be responsible for the operational functionality of the technology or process.

The key stakeholders have a stake in the issue but are not directly involved, typically include the Senior Mine Management, the unions, Safety and Health Committees and Safety Representatives and even the DMR.

It is imperative that particularly adopters and mine stakeholders are identified early in the process as it is these people and groups who will be the focus of the behavioural communication and leadership behaviour efforts, and from whom commitment is required for the successful adoption of the leading practice.

The procedure for identifying adopters and stakeholders is the first step (see Figure below) in an eight step process developed for customising a behavioural and leadership

communications strategy for implementation as part of the Leading Practice Adoption System. .

Step	What	Check – go/no-go decision question
1	**Identify adopters and key stakeholders at the mine**	Do we have a good understanding and complete identification of potential adopters and stakeholders?
2	**Select people to be interviewed**	Have we chosen the appropriate people to interview?
3	**Identify and brief the interviewers**	Are the interviewers ready to interview?
4	**Conduct the interviews**	Have all the interviews been done and full worksheets completed and returned for processing?
5	**Summarise the interview results**	Have the interview results been systematically assessed and significant new findings clearly identified?
6	**Use the findings to customise the behavioural communication plan**	Are the customised plans coherent and properly understood by the mine team and can they be implemented and effectively monitored in behavioural terms?
7	**Use the findings to customise the leadership behaviour communication plan**	Are the customised plans coherent and properly understood by the mine team and can they be implemented and effectively monitored in behavioural terms?
8	**Integrate the customised plans into the implementation plan at the mine**	Is the overall implementation plan coherent and properly understood by the mine project team?

Figure 7 Eight step process developed for customising a behavioural and leadership communications strategy. The first step - identifying adopters and stakeholders - is highlighted.

Key points for identifying adopters and stakeholders are as follows:
The Mine Adoption Team should review the Risk Summary provided by the MOSH FOG Adoption Team (see Appendix 9) and confirm or elaborate on the description of adopters and stakeholders.

A list specifying the adopters and stakeholders that will be the focus of behavioural communication and leadership behaviour efforts in the adoption mine should be prepared by the Mine Adoption Team based on ***Figure 7***.

2.7 Direct enquiry process

Once the stakeholders and adopters in ***Figure 7,*** have been identified, a shared understanding of their perceptions, attitudes and unmet needs regarding safety management, and more particularly netting with bolting, should then be gained. This

forms the basis for customising and implementing the leadership and behavioural communications strategy.

The only way to accurately understand people's thinking is to directly enquire into it. A detailed description of how to conduct the enquiry process is provided in ***Appendix 2*** with key points highlighted below.

The interview process should consist of two parts which seek to establish the stakeholders/ adopters beliefs about the causes and outcomes of [the risk/hazard], about the best ways to protect people from [the risk/hazard], and about key leader behaviours and behavioural communication needs.

An appropriate type and number of persons should be interviewed using the final list of adopters and stakeholders at the adoption mine. The types of people selected should ensure good representation of those most likely to be most involved in accomplishing adoption of leading practice. The number of persons to be interviewed should be between 25 and 30 to obtain useful interview results. At Kusasalethu 33 people were interviewed.

Interviews with the selected adopters and stakeholders should be done confidentially and one-on-one with individuals. All interviews should be carried out in the interviewees mother tongue. At Kusasalethu, one of the consultants running the Qaphelangozi initiative was multi-lingual and was able to conduct all interviews in the person's mother tongue. As a consultant he had the advantage of being outside the mine structures and was able provide a 'safe' base for asking questions and receiving answers.

In general, mine adoption teams should chose as interviewers those people whom interviewees are most likely to feel comfortable with in an interview setting. Interviewers should be briefed or trained in the interview to be conducted.

The questions to be asked in the interview are provided in the example Worksheet #1 provided in ***Appendix 2***. Interview responses should be carefully documented at the time of the interview onto the Interview worksheet using the interviewee's own words.

A simple analysis outlined in ***Appendix 2*** for summarising the interview results will allow the Adoption Mine Team to better understand the thinking of their stakeholders and adopters and to compare the thinking at their mine with the most informed understanding of the hazard, as summarised in the Risk Summary (see ***Appendix 9***), and the thinking of stakeholders at the demonstration mine. The analysis worksheet is attached in ***Appendix 2,*** together with a recommended analysis procedure.

Members of the adoption mine team could be selected as analysts, or the task may be assigned to two or more individuals associated with the team and adoption effort, and who have a sound understanding of the Risk Summary.

Step	What	Check – go/no-go decision question
1	**Identify adopters and key stakeholders at the mine**	Do we have a good understanding and complete identification of potential adopters and stakeholders?
2	**Select people to be interviewed**	Have we chosen the appropriate people to interview?
3	**Identify and brief the interviewers**	Are the interviewers ready to interview?
4	**Conduct the interviews**	Have all the interviews been done and full worksheets completed and returned for processing?
5	**Summarise the interview results**	Have the interview results been systematically assessed and significant new findings clearly identified?
6	**Use the findings to customise the behavioural communication plan**	Are the customised plans coherent and properly understood by the mine team and can they be implemented and effectively monitored in behavioural terms?
7	**Use the findings to customise the leadership behaviour communication plan**	Are the customised plans coherent and properly understood by the mine team and can they be implemented and effectively monitored in behavioural terms?
8	**Integrate the customised plans into the implementation plan at the mine**	Is the overall implementation plan coherent and properly understood by the mine project team?

Figure 8 Eight step process developed for customising a behavioural and leadership communications strategy. Steps 2 to 5 – the interview steps - are highlighted.

2.8 Customisation of behavioural communication plan

Behavioural communications enables people to make more informed decisions and take appropriate actions to reduce risks. The methods (modalities) of communication selected should focus on addressing people's 'mental models' or their rationale for behaving in a specific way in order to effect the required change in behaviour that focuses more on safety seeking .

A detailed behavioural communication plan developed for and refined at the demonstration mine is attached as **Appendix 3** to serve as the base plan to be customised by an adoption mine. The appropriate communication vehicles at each level have been identified. Many of the communication methods already in use at Kusasalethu Gold Mine were used, but a number of new initiatives were put in place to complement the mine's Qaphelangozi change management and safety initiative. These communication models were selected to address the stakeholders' and adopters' unmet needs and were either sourced or developed by the team.

Given the information, gaps and alignments and for purposes of fast tracking adoption, the behavioural communication strategy focuses initially on the short term objective of understanding:

- The implications of installing nets with bolts well or poorly.
- The additional benefits of installing nets with bolts properly.

The plan should be customised by each adoption mine based on the unique organisational culture and existing communication strategies at each operation. However, the Adoption Mine Team should first ensure that they fully understand the plan developed for the demonstration mine, before proceeding with the process of customising the plan to suit their mine specific circumstances.

Step	What	Check – go/no-go decision question
1	**Identify adopters and key stakeholders at the mine**	Do we have a good understanding and complete identification of potential adopters and stakeholders?
2	**Select people to be interviewed**	Have we chosen the appropriate people to interview?
3	**Identify and brief the interviewers**	Are the interviewers ready to interview?
4	**Conduct the interviews**	Have all the interviews been done and full worksheets completed and returned for processing?
5	**Summarise the interview results**	Have the interview results been systematically assessed and significant new findings clearly identified?
6	**Use the findings to customise the behavioural communication plan**	Are the customised plans coherent and properly understood by the mine team and can they be implemented and effectively monitored in behavioural terms?
7	**Use the findings to customise the leadership behaviour communication plan**	Are the customised plans coherent and properly understood by the mine team and can they be implemented and effectively monitored in behavioural terms?
8	**Integrate the customised plans into the implementation plan at the mine**	Is the overall implementation plan coherent and properly understood by the mine project team?

Figure 9 Eight step process developed for customising a behavioural and leadership communications strategy. Step 6 – customising the behavioural communication plan - is highlighted.

2.9 Customisation of leadership behavioural plan

The objectives of the leadership behaviour strategy are:

- Building trust between supervisors and the workforce.
- Developing listening skills particularly amongst the supervisors.
- Communicating the message that mining should not occur if it cannot be carried out safely.
- Communicating the importance of the installation of nets with bolts for improving safety.
- Developing the understanding of, particularly seismicity as a component of Falls of Ground, so that the workforce can be prepared for such an eventuality.

In a manner similar to that for customising the behavioural communication plan, a leadership behaviour plan developed for and refined at the demonstration mine is attached as ***Appendix 4*** to serve as the base plan to be customised by the adoption mine. The plan sets out the required antecedents, key leader behaviours and re-enforcing consequences for those behaviours.

Step	What	Check – go/no-go decision question
1	**Identify adopters and key stakeholders at the mine**	Do we have a good understanding and complete identification of potential adopters and stakeholders?
2	**Select people to be interviewed**	Have we chosen the appropriate people to interview?
3	**Identify and brief the interviewers**	Are the interviewers ready to interview?
4	**Conduct the interviews**	Have all the interviews been done and full worksheets completed and returned for processing?
5	**Summarise the interview results**	Have the interview results been systematically assessed and significant new findings clearly identified?
6	**Use the findings to customise the behavioural communication plan**	Are the customised plans coherent and properly understood by the mine team and can they be implemented and effectively monitored in behavioural terms?
7	**Use the findings to customise the leadership behaviour communication plan**	Are the customised plans coherent and properly understood by the mine team and can they be implemented and effectively monitored in behavioural terms?
8	**Integrate the customised plans into the implementation plan at the mine**	Is the overall implementation plan coherent and properly understood by the mine project team?

Figure10 Eight step process developed for customising a behavioural and leadership communications strategy. Step 7 – customising the leadership behaviour communication plan - is highlighted.

2.10 Integration of behavioural communication and leadership behaviour plans into the implementation plan at the adoption mine.

Based on the experience gained, Kusasalethu customized their behavioural communication and leadership behaviour plans into the overall implementation plan at the mine.

A component of the integrated implementation plan should be a monitoring programme that includes appropriate checking and reporting on the occurrence of the desired observable behaviours, as well checking and reporting on provision of the necessary antecedents and re-enforcing consequences.

Step	What	Check – go/no-go decision question
1	**Identify adopters and key stakeholders at the mine**	Do we have a good understanding and complete identification of potential adopters and stakeholders?
2	**Select people to be interviewed**	Have we chosen the appropriate people to interview?
3	**Identify and brief the interviewers**	Are the interviewers ready to interview?
4	**Conduct the interviews**	Have all the interviews been done and full worksheets completed and returned for processing?
5	**Summarise the interview results**	Have the interview results been systematically assessed and significant new findings clearly identified?
6	**Use the findings to customise the behavioural communication plan**	Are the customised plans coherent and properly understood by the mine team and can they be implemented and effectively monitored in behavioural terms?
7	**Use the findings to customise the leadership behaviour communication plan**	Are the customised plans coherent and properly understood by the mine team and can they be implemented and effectively monitored in behavioural terms?
8	**Integrate the customised plans into the implementation plan at the mine**	Is the overall implementation plan coherent and properly understood by the mine project team?

Figure 11 Eight step process developed for customising a behavioural and leadership communications strategy. Step 8 – integrating the customised plans - is highlighted.

2.11 Identify initial implementation site

The selection of the initial implementation site is important. The decision for the initial stope to implement the netting with bolting was based a stope

- that has a reasonable length of time still to mine,

- that has a grade that is not marginal,
- that has relatively uncomplicated mining conditions,
- that is not too difficult to mine; but
- that has the possibility of demonstrating an improvement in safety with the implementation of netting with bolting.

While it is feasible to gain operating experience on the procedural aspects at this scale, a broader based implementation at Mine Overseer section level at least, and preferably at shaft level, needs to be mapped out to achieve the required shift in workplace culture. This is the route that was followed at Kusasalethu.

2.12 Briefing of adopters and stakeholders

At the start of the programme the General Manager addressed the senior officials(Shift boss and senior) of the mine regarding the MOSH initiative at the weekly safety meeting. He then gave the MOSH Adoption Team Managers an opportunity to introduce themselves and the leading practice.

Briefing of stakeholders and adopters must be part of the customised behavioural and leadership plan and as such should be based on insights gained from the mental models. These models will have been derived from the direct enquiry research to identify potential problems, attitudes, knowledge gaps and alignments and to acquire a shared understanding of what safety and, particularly, netting with bolting mean to employees.

2.13 Visits to and or discussions with source and demonstration mines

The Adoption team from Kusasalethu Gold Mine, visited the source mine, Union Platinum Mine, to obtain a full understanding and address any knowledge gapsd in the adoption of the new technology. The visit enabled the project team to view the process in situ and discuss key success criteria and share learning points. This experience enabled the demonstration mine team to redesign the process to suit the conditions of deep, steeper, backfilled panels at the demonstration mine.

2.14 Arrangements for special assistance considered necessary

The communities of practice for adoption (COPAs) mechanism should be utilised as an important network through which experience and knowledge can be shared in supporting adoption and project teams into the future. The COPA mechanism has been established with the objective that members adopt a generous approach to sharing their experience and expertise in the area of occupational health and safety, on the grounds that such sharing will impact positively not only on overall industry performance, but also on their own performance through feedback and reciprocal sharing. In the case of the Netting with bolting COPA it is envisaged that the COPA will provide an opportunity for many mines who have been early adopters of netting with bolting to apply the MOSH principles of Leadership behaviour and behavioural communications to their practice to make it the leading practice and therefore help to ensure its sustainability.

The COPA is a key mechanism though which special assistance and learning can be obtained. Other methods through which assistance and expertise can be acquired via the COPA mechanism include the following:

- Direct communication with other members: a readily accessible register of member's contact details, special expertise and interests is available to help direct an enquiry for assistance that a member may have.
- Visits to successfully operating sites to observe effective practices and for problem solving discussions: visits are and can be coordinated through the COPA
- Expert input: in some cases the problems encountered by mines may require expert input beyond that available at mines that have successfully adopted the practice and the COPA may provide appropriate expert assistance.

2.15 Identification of any special training considered necessary

Interviewer skills training for conducting the mental models interviews may be required as the questionnaires are not self administered. In addition individuals selected to conduct the interviews should be familiar with the language, culture and literacy levels of the employees, in addition to being knowledgeable on the subject matter outlined in ***Appendices 3 and 4***. At Kusasalethu the Qaphelangozi initiative and the consultants involved with it provided ideal candidates to assist in this role.

2.16 Identification of key success factors

To facilitate the widespread adoption and success of the leading practice, the following critical success factors should be addressed:

- Addressing the importance of improving safety and the role that falls of ground play in serious accident and injuries.
- Simple and clear messaging in communications.
- Sense of ownership by all stakeholders.

Some key success indicators should be:

- Leading practice, the netting with bolting procedure, and behavioural communication and leadership behaviour strategy, adopted successfully.
- Longer term (12 months) a 50 % reduction in lost day injuries on all crews that have implemented the process.
- Effective participation in community of practice for adoption (COPA).

2.17 Design of a monitoring programme

A monitoring programme was established to monitor performance of the practice at Kusasalethu. This task was given to the rock engineering department who provided an independent and objective way of measuring the progress.

They recorded:

- Leading indicators such as support spacings, distance of different support types from the face, the presence of temporary support, the spacing of roofbolts, the distance of backfill from the face and the use of preconditioning. The face shape and leads and lags of panels were measured.
- The number of hazards and general rock mass conditions recorded in the panels during audits which may also indicate the impact that the process is having on ground conditions.
- Lagging indicators which may in the longer term indicate the effect and benefit of the use of netting with bolts include lost time days or rock-related injuries.

2.18 Development of the implementation plan for the mine

The implementation plan was developed by the project team. Involvement from the unions was encouraged but not always obtained. The presence of the Union (NUM) was

regarded as critical to ensure buy-in from all stakeholders and prepare everybody on the tasks and target dates. Responsibilities were assigned to a responsible person. Microsoft Projects, was used to update and track the progress of the project.

2.19 Implementation at the selected pilot site

Implementation at the selected pilot site should be done strictly in accordance with the implementation plan. At Kusasalethu each Mine Overseers section was given a plan to roll out nets with bolts over a three to four month period. The end date for full implementation of the netting with bolts was November 2011. Crews were introduced to the procedure during a training session in Qaphelangozi. This included a visit to a surface mock-up that had been constructed to show how the nets were to be installed. There was an opportunity to install and remove the nets in this surface mock-up. An individual with vast mining experience was appointed to visit each section to explain the installation underground and to assist with the first net installation. Follow-up visits by this individual is taking place on a rotational basis. The various levels in the mining hierarchy were briefed separately. Each mine overseer was individually given an overview of the MOSH system with particular reference to the leadership behaviour and the behavioural communications. They were coached in applying the leadership behaviour and understanding the behavioural communication requirements. A presentation explaining these principles was given to each mine overseer to share with his shift bosses.

2.20 Identification and documenting of any customisation needed prior to extension across the mine

During the piloting phase, some customisation of the practice was introduced. At Kusasalethu there are breast, up-dip and down-dip panels that required netting with bolting. Minor adaptations had to be made to the up-dip and down-dip installations as the initial installations were carried-out and proved on breast panels. The lesson plan for installation of nets with bolting is a guideline and fairly generic due to the different scenarios on Kusasalethu. However, there are some principles that apply to all installations.

2.21 Implementation of customisation

Once the customisation had been applied to the practice, it was tested and continues to be tested. All operating procedures, mine standards and training material had to be

updated. It is strongly recommended that the behavioural communications framework be included as an integral element of the standard since the most critical feature of the leading practice is the emphasis on full participation and team involvement.

2.22 Managing extension of the practice across the mine

One of the major components of extending the practice across the mine is the training of the crews prior to implementation.

Crew behaviour training with a particular emphasis on sensitising the stope crews towards the roll-out process for netting with bolts should be conducted.

Involvement of all stakeholders and effective communication is required.

2.23 Completion of checklist to confirm adequate consideration of critical elements

Before the roll out can commence, it is necessary to determine whether the mine is "ready" for roll out and implementation and the checklist in ***Appendix 8*** is an example of the relevant questions that should be answered.

Part 3 – Details of the leading practice

3.1 Overview

The following basic requirements have been established for the successful adoption of the installation of netting with bolting leading practice:

- Mine leadership support and involvement in the project,
- Involvement of the labour union in the process
- Appropriate leadership behaviour,
- Appropriate behavioural communications, and
- Sensitisation and training of mine staff at all levels involved in the process.

With the netting with bolting as its core element, the procedure contains three main components:

- the task of installing and removing nets to be a team effort

- nets should be tensioned as tightly as possible
- the installation of bolts is critical,
- the mechanical props are installed against the face
- the drilling of the next line of hangingwall holes is drilled under the cover of the net, and
- the nets are attached to all possible attachment points by means of S, C or saddle hooks and not twine or string.

3.2 Site Selection for initial adoption

The installation of nets with bolts is applicable for most underground mining operations and sites, including stopes and development ends, although the focus in the MOSH project has been on the installation of nets with bolts in stopes. Exceptions to the use of nets with bolting may be stoping widths are very small < 800 mm, steep stopes and where roofbolts are difficult to install or should not be installed.

The selection of the initial adoption site may be guided by the specific area having a poor safety record, particularly in terms of rockfalls. However, an area struggling to maintain production targets may not be suitable. Similarly it may not be ideal to initially select a stope that has a reputation of being a key producer, in case, during the introduction of the practice, delays occur which may tarnish the image of the leading practice for the rest of the mine.

3.3 Equipment

The netting with bolting leading practice requires minimal additional equipment. The purchase of appropriate nets, and various hooks are the only new equipment that is necessary. Modification of the current mechanical props to include a hook or a hole through which a hook may be attached needs to arranged. Holes were also drilled through the steel frame of the headboards to provide an additional attachment point and the washers on the resin grouted roofbolts already have a hole in them for hook attachments.

3.4 Necessary supporting physical infrastructure

A suitable place to store the nets needs to be arranged. This position should not be too far from the face but away from the effects of blasting and out of the way of scrapper

activity.

3.5 Training

Each crew is introduced to the procedure on surface during a Qaphelangozi training programme. This includes a visit to the mock-up where the installation and removal of nets is demonstrated and then carried out by crew members. The crew is then visited underground by a special projects official who gives coaching in the installation techniques. The shift supervisor is present with the special projects person.

3.6 Instruction documentation

The netting with bolting procedure of installation has been adapted from the source mine's procedure and as a result of numerous attempts on Kusasalethu to find a netting installation that worked for the mines support layout. A lesson plan that gives general principles and guidelines for netting with bolting installation was written for Kusaslethu. ***Appendix 1.***

3.7 Signage

At Kusasalethu Gold Mine, the Qaphelangozi change management and safety initiative, is in place and incorporate a major communication campaign. Therefore, only minimal additions were made to the existing communications strategy, but nets were installed in the accessway from the shaft and a mockup of the netting with bolts was constructed on surface. Crews were taken to the mock-up for an explaination of the installation procedure and to encourage discussions between members.

3.8 Incentive arrangements

The netting with bolting should not have any long term negative impact on the production performance of the mine. The leading practice relies on the installation of resin roofbolts, which should already be in place as a non-negotiable of Kusasalethu, and the correct spacing of other permanent and temporary support as per the mine standard. There fore the additional work required simply involves "hanging" the net on and between the existing support. Therefore the anticipated additional work for the crews should be negligible. The correct adoption of the system should enhance safety and result in fewer losses and stoppages, resulting in a more profitable mine. It is expected that no

incentives in terms of production should be necessary for the introduction of the process. However, the mine may consider encouraging those who have been introduced to the new procedure by offering them a certificate or T-shirt.

The improvement in safety due to the implementation of the netting with bolting procedure should also be encouraged by including installation of nets with bolts in management's key performance indicators (KPI's). A relevant KPI may be the number of crews successfully adopting the procedure in their section of the mine.

3.9 Operational procedures

Operational procedures for netting with bolting, based on a procedure developed by the demonstration mine in cooperation with the MOSH Adoption Team, is given in ***Appendix 1.***

3.10 Relevant mine standards

All relevant mine standards need to be updated to reflect the changes made to the installation of nets with bolts. In the case of the nets with bolts it concerned the attachment of the nets and the strength of attachment hooks and attachment points, and the removal of the nets, particularly if they have rocks in them.

3.11 Monitoring and reporting arrangements

In the longer term, the mine's safety records are the major source to indicate whether a significant improvement in safety and more particularly in rock-related safety has been achieved. These records should be available to the adoption team to analyse.

In the short term, improvements such as support spacing and support distance to face should be used to indicate whether improvements in general stope conditions and therefore safety have been obtained. These measurements should be taken regularly (weekly) by trained production staff or specifically identified personnel such as the rock engineering staff, as was the case on Kusasalethu Gold Mine. These measurements should be recorded in a spreadsheet or database and analysed by a competent person such as a rock engineer.

A measurement programme should be initiated with frequent readings. The frequency will depend on the extent of the sites at which the procedure is being implemented. However, the objective is to collect enough data to perform meaningful analysis as the procedure is introduced to a mine or section. However, the frequency of measurement may be reduced as the procedure is adopted in the mine or section. At Kusasalethu, weekly measurements at a number of designated sites are being taken.

3.12 Performance measures

In terms of assessing the success of the netting with bolting procedure, this will be indicated by the ongoing improvement in the mine's safety performance as the procedure is rolled out to all crews on a mine. The number of crews that are trained in the installation of netting with bolting is a leading indicator that should be recorded. How effectively the trained crews are adopting the practice should be measured. This can be achieved by monitoring the support spacing on dip and strike, minimum and maximum distances of support from the stope face and the availability of equipment for installation. Planned Task Observations(PTO) of the crews carrying-out the installation should be made. This would document whether the process was followed correctly. Frequency of measurements of physical and behavioural data will depend on the size of the roll-out of the process. Two aspects should be considered: 1. The need for enough data to draw significant conclusions and 2. Whether the data is valid if it comes from many different sites implementing the process, compared to collecting the data from one site. If there are many sites then once a month measurements may be enough whereas if data is only collected from one site than at least weekly and perhaps more frequent measurements if possible are recommended.

3.13 Management of leading practice

No changes to the management structure should be necessary as the procedure is essentially hanging a net onto existing support units. If the other supports are installed correctly then the task of installing a net is made extremely easy.

Typically, the roles and responsibilities of the key players in the adoption and operation of the system are as follows:

Mine/General Manager

— Holds overall legal responsibility for the health and safety of his workforce and makes legal appointment of senior management to carry out appropriate occupational safety strategies.

— Motivates the capital expenditure and business plan, co-ordinated by the Project Manager, for phasing in the system across the mine.

— Approves purchase order for purchasing any equipment.

— Monitors performance of the system via monthly reports submitted to him.

Section Mine Overseer/Shift Supervisor

— Responsible for providing on-going supervision for the process.

— Monitors the performance of the system through spot checks.

— The shift supervisor is the pivotal person in ensuring that the netting and bolting practice is adopted. At Kusasalethu experience has shown that shift supervisors with personnel power have a greater chance of being successful than those that simply rely on positional power. Hence the importance of training and coaching in leadership behaviour and the use of behavioural communications.

3.14 Risk Management in implementing the system

A risk assessment on the netting and bolting procedure has been carried out. A few issues were raised. These were:

- Workers being trapped by the net in the case of a rockfall
- Handling the removal of rock in the net if such rockfalls occur
- Removal of the nets at the end of the shift

The risk of being trapped by rock is thought to be low. The net is relatively soft and easily cut. Without a net and the same fall of ground, the person would have been offered no protection. At least the net may prevent or cushion the fall.

The removal of rocks from the nets should be handled by a competent person and persons removed from the immediate area of the nets with rocks.

At the end of the shift care needs to be exercised to check for rocks in the nets and to visually re-examine the hangingwall before removing the net. The nets should be removed at the same time as the mechanical props. The mechanical props are required

to be removed remotely and this would ensure that any rocks that are in the nets or come down with the nets do not pose a danger to people.
To minimise the risk, crews should undergo training in the procedure.

3.15 Proprietary knowledge or technology

Both the source mine and demonstration mine management have agreed that any relevant information on the netting with bolting procedure at their mines will be freely available. This is available both directly with the mine and through the COPA mechanism.

Appendix 1: The Kusasalethu Procedure For Installing Nets with Bolts

Course Title: Installing Nets in Stope Faces	
Lesson Title: 1. Introduction	
Knowledge, Skills, Techniques(The What, How, When, How Well)	**Purpose (Why) Health and Safety (Hazards, Risks, Consequences and Prevention)**
1. Introduction Netting is a form of support that provides area coverage to the hangingwall of the stope face area. It forms a barrier to any loose or unidentified rock hazards from dislodging during the drilling and charging-up operations in the stope face area. **1.1 Interest** All competent A and B workers should be aware of how to install and remove the netting before and after the shift respectively. This lesson is designed to assist and train in installing and removing nets safely, efficiently and effectively. **1.2 Need** The most dangerous part of any tabular mining operation is the area adjacent to the	

stope face. It is here that many serious and even fatal injuries occur. The nets are installed to provide an area support barrier to rockfalls between the individual permanent and temporary supports.

1.3 Title

Installation of nets with bolts

1.4 Range

1. Introduction
2. Tools and equipment
3. Transport, storage and care of nets
4. General rules of installation
5. General rules of removal

1.5 Objective:

The trainee must be able to install and remove the nets safely in a stoping panel face, adhering to the mine standards and legal requirements. The trainee must demonstrate the multiple attachment of the net to the previously installed bolts and to other permanent and temporary

supports. The stiffness of the net is paramount and should be evident after installation. Trainees should be able to join nets together and negotiate the installation of the nets around existing support.	

Course Title: Installing Nets in Stope Faces	
Lesson Title: 2. Tools and Equipment	
Knowledge, Skills, Techniques(The What, How, When, How Well)	**Purpose (Why) Health and Safety (Hazards, Risks, Consequences and Prevention)**
2. Tools and Equipment: It is essential to be familiar with the nets and accessories for attachment. There is a module in this lesson that deals with the effective installation of the nets with bolts. You should be able to identify defective nets, mechanical props, c-hooks and s-hooks. 1. HDPE nets 5m x 1.4m with 75mm aperture 2. Mechanical props with welded or attached hooks 3. Headboards with attachment points 4. C-hooks and S-hooks 5. Roof bolts with washers containing a hole for hooks	**Why?:** In order that nets are installed so that they can catch rock falls and prevent serious injuries or even deaths. **Hazard?:** The nets provide a barrier between the detached rock from the hangingwall and people working in the stope face. **Risk?:**

Normal PPE for mining are required when installing the nets **2.1 The Net** The nets are easily cut by sharp objects and therefore care needs to be taken in their handling. Therefore the nets need to be examined regularly for broken strands and if two adjacent strands are broken then the net should not be used. The net can be repaired or discarded if it is old with multiple repairs and cannot be repaired. The nets should be installed after entry examination and making safe and taken out at the end of each shift before blasting takes place.	Falls of rocks is the single biggest cause of injury and death on the mines. **Prevention:** Ensure that the nets are installed correctly so that they can perform when required to do so. **Why?:** The aperture of the net is critical as this dimension restricts the size of rock that is caught or passes through the net.
Course Title: Installing Nets in Stope Faces	
Lesson Title: 2. Tools and Equipment	
Knowledge, Skills, Techniques(The What, How, When, How Well)	**Purpose (Why) Health and Safety (Hazards, Risks, Consequences and Prevention)**

2.2 Mechanical Props with welded or attached hooks The mechanical props provide the edge for attachment close to the face. The props themselves need to be in excellent working order to ensure that they do not fall out if a rock falls into the net. The props need to be installed as the crew move down the face with the entry examination and making safe. **2.3 Headboards with attachment points** The permanent timber support has timber headboards to increase the area coverage. The headboards have carrying handles or hooks to which the net can be attached. Attachment in this case is usually by C-hooks or S-hooks. **2.4 C-Hooks and S-Hooks** The means of attachment of the net to other support units is primarily by C-hooks or S-hooks. These hooks are stronger than the net and as long as they are securely hooked will provide the necessary support. **2.5 Roofbolts with washers containing a hole for hooks** The roofbolts provide intermediate attachment points for the net. The washer provides the	**Why?:** There has to be secure attachment points on these units so that the nets can be tensioned.

attachment point through which a C-hook or an S-Hook can be placed. The row of roofbolts closest to the face should be drilled from the cover of the installed net. Therefore the positions of the roofbolts should be marked on the hangingwall before the net is installed.	**Why?:** Multiple attachment points keep the net tight and minimises the span of net that is required to hold any dislodged rock. This reduces the distance the rock will move down from the hangingwall.

Course Title: Installing Nets in Stope Faces	
Lesson Title: 3. Transport, Storage and care of Nets	
Knowledge, Skills, Techniques(The What, How, When, How Well)	**Purpose (Why) Health and Safety (Hazards, Risks, Consequences and Prevention)**
3. Transport, Storage and Care of Nets Nets are the main part of the support system and if they are sub-standard then no matter what condition the rest of the equipment is in, the system will not work optimally. **3.1 Transport**	

The nets can easily be cut by sharp objects. Therefore when transporting them care should be taken to first roll them up and carry them rather than dragging them. Before installing them they should be rolled out so that if they do snag on anything the problem can be identified and the net detached without undue force being applied to the net. **3.2 Storage** The nets should be stored away from any influence from the blast and the possible fly rock that may be associated with the blast. They should be folded or rolled up before storing them and if possible stored away from other equipment. They should also be stored in a place away from the possible path of scrappers and ropes. **3.3 Care** Nets should be inspected before each installation and if the strands of two adjacent cells in the net are broken then the net should not be used unless it can be repaired or hooked in such a way as to close the hole.	
Course Title: Installing Nets in Stope Faces	
Lesson Title: 4. Installation of Nets	

Knowledge, Skills, Techniques(The What, How, When, How Well)	Purpose (Why) Health and Safety (Hazards, Risks, Consequences and Prevention)
4. Installation of Nets Nets will be most effective if installed properly. The presence of a net does not necessarily mean that the conditions are safer. In fact a poorly installed net may give workers a false sense of security and therefore be more dangerous than not having a net at all. The installation of nets should only occur after entry examination and making safe is completed and concurrently with face preparation. **4.1 Mark positions of new roofbolt holes** The line for the next line of roofbolts and the bolt positions should be indicated before the net is installed. **4.2 Attachment of the net to the mechanical props at the face** The mechanical props should be no more than 0.5m from the face and therefore if the nets is attached to these it will be in the required position to protect workers at the face. **4.3 Attachment of the net on the side away from the face** The nets should be pulled as tight as possible to arrest any rocks that fall in the minimum	**Why?:** Nets are not to replace good entry examination and making safe but to provide an additional barrier against rockfalls **Why?:** Once the net is up it is difficult to mark the hangingwall and it may not be done.

distance. These attachments should be onto permanent support such as timber prop's headboards or older roofbolts. C-hooks and S-hooks should be used. **4.4 Attachment of the net to roofbolts** Once the nets are attached along their long sides, the net should be attached to any roofbolts washers that are above it. This is by means of C-hooks or S-hooks.	

Course Title: Installing Nets in Stope Faces	
Lesson Title: 5. Removal of Nets	
Knowledge, Skills, Techniques(The What, How, When, How Well)	**Purpose (Why) Health and Safety (Hazards, Risks, Consequences and Prevention)**
5. Removal of Nets During the shift rock conditions may have changed. Rocks may have fallen or been barred into the net. Care should be taken when removing the nets with rock in them. **5.1 Releasing the nets**	**Why?:**

The general approach to removal of the nets should always be from the top of the stope to the bottom. This should always definitely be the case if rocks have accumulated in the nets. The procedure for removal of the nets is to remotely release the mechanical props one by one starting at the top of the panel. Once the front edge of the net is on the ground the back edge can be detached from its attachment points. Care should be taken to identify any parts of the net under tension during releasing these attachment points. **5.2 Dealing with the released Nets** Once the net is on the ground any rock should be removed from the net, the nets separated from one another and the mechanical props and rolled up individually. In the event of the rock being too large to remove the net can be cut around the rock and removed and discarded.	The nets provide all of the crew protection for the whole shift and should only be removed at the end of the shift when the last crew member is ready to leave. **Why?**: A net under tension may create a whip action when released which may injure personnel

Appendix 2: Mental models questionnaire

Falls of Ground
Mental Models Interview Protocol

Interview Purpose: To identify the need / value / priority and risks associated with adapting the proposed leading practice in a specific mine – Netting with bolting Practice – and what is required to make adoption successful.

Introduction

Introduce yourself and your purpose

Hello, I'm << name and company / organization>>. I am conducting interviews on behalf of the Falls of Ground Team. I'd like to give an overview of the work that the Falls of Ground Team is doing, and then ask you for your thoughts on the specific challenges you face with falls of ground in your mine and how our team's proposed best practice might work at your mine. I'd like to thank you, on behalf of our team, for taking the time to help us with this important initiative.

I have some questions to help guide our discussion, but please feel free to raise any topic that comes to mind as we go along. There are no right or wrong answers, and all of the comments you provide will add value to the team's research. I assure you that what you say will be kept confidential to our research team. No personally identifying information will be passed along to any one associated with your company, other companies or the Chamber of Mines.

Before we start, I'd like your permission to have <<name>> take notes throughout the interview. Please be assured that we will not attribute any specific answers to you. We will only report the results back to the team in aggregate, that is, all of the interviews will be summarised. May we proceed on that basis? Thank you.

Opening

Share your agenda

Our conversation will cover two topics. First, I'm going to ask you about the risk of falls of ground at your mine, and then I'm going to ask you about how the Adoption Team's proposed leading practice for falls of ground might be adapted for your mine.

Provide background

The Falls of Ground Adoption team is working to significantly reduce falls of ground in mining operations. Our goal as an industry is to reduce falls of ground by 20% each year from 2003 to 2013

Researcher: If Interviewee thinks that he or she does not know enough to answer the question, please use follow-ups, however, don't press if the Interviewee still does not want to answer a question.

- I'm just interested in hearing what you think. Again, there are no right or wrong answers.
- Based on what you know, what are your thoughts on this topic?

Perceived Risk of Falls of Ground at their Mine

Perceived Risks – Questions for revealing thinking and the need and priority for addressing falls of ground in this mine and also context.

To start, perhaps you could tell me a bit about your role in the mine. What is your position?

- **1** Do you have people reporting to you?
- **2** What is your interest in falls of ground at your mine?

Now, let's talk a bit about the potential for falls of ground at your mine

- **3** What are the likely causes of rock falling from the hanging or side walls in your operations?
    - **4** Of the causes you mentioned, what is the most likely cause?
        - Is this also the most harmful to people?
        - If no, which one that you mentioned would be?
    - **5** Thinking about the most harmful cause to people, to what extent is this repetitive?

- **6** Thinking about the most harmful cause << name it>> is there anything that is not understood about why it happens

- **7** From your perspective, what is the single most important thing that can reduce << this cause>> of falls of ground on your mine?
    - **8** Please explain your answer?

- **9** Thinking about current operations at the mine, what is being done well to prevent << this cause>> of falls of ground?

- **10** And what still needs to be improved?

Thank you. Now I'd like to move on and talk about leading practices.

Adoption of Technology or Leading Practice

Provide scenario:

The Falls of Ground Team is considering a Netting with Bolting leading practice for mines like yours. It would entail making sure that all checks are made, before people enter a working area, by a competent person. It would also ensure everyone implements all procedures for making a working area safe before they enter and while working in it.

Note to interviewers: By leading practice we mean a procedure or set of procedures that are routinely used in practice by one or more operations as a particularly good and effective way of doing things to achieve improves OH&S performance.

Best practices would include a procedures, or set of procedures used by an operating mine or group of mines to achieve particularly good performance in the area under consideration. It could be a particular way of using technology, achieving a desired behaviour, or more generally, of arranging for things to be done. It would usually be identified through a benchmarking, or other review, or information sharing process.

Focus on the critical influences on successful adoption

Value and Priority

- **11** So, having heard a bit about the best practice the team is considering, what do you think would be the greatest benefits of adopting this at your mine?
    - **12** Would there be any downsides of adoption?
- **13** What do you think it would take for the adoption of this leading practice to be seen as a top priority in your mine?
    - **14** Please explain your answer?

Aids and Barriers to Adoption

Broad Mental Models questions to prompt thinking about aids and barriers.

- **15** When you think about adopting this netting and bolting leading practice at your mine, what will be the most important things to enable successful adoption?
    - **16** Tell me why that would be important?
    - **17** If they do not mention it, prompt:
        - **18** What functional requirements would be most important? By that I mean the equipment or the people would mean to do the best practice?
        - **19** What leadership behaviours would be most important? By that I mean, the actions that employees can observe leaders doing or not doing?
        - **20** And what behavioural communications requirements would be most important? By that I mean, communications that enable people to act in a new way?
- **21** When you think about people who will be primarily responsible for implementing this netting and bolting leading practice, what things would be particularly important for them to have in order to implement it successfully?
    - **22** And why would that be important?
    - If they don't mention it, prompt:

- **23** How important would training be?
- **24** How about proper tools?
- **25** How about leadership by their supervisors?
- **26** How about behavioural communications?
- **27** Does anything else come to mind that would be important?

- **28** What barriers might prevent successful adoption?
    - **29** How might <<take the ones mentioned one at a time>> be addressed?

Specific questions about two major areas of focus that will be aids or barriers to adoption

Leadership behaviours

Thinking about leadership now…

- **30** What will be important for you to <u>see</u> your supervisor <u>do</u> to demonstrate support for adoption of this best practice?
    - **31** Why would this be particularly important?
    - **32** Is there anything your supervisor <u>should not</u> do?

- **33** When you think about the adoption of leading practice, what should the supervisors in your mine do that they are not doing right now?
    - **34** Why would that be particularly important?

Behavioural Communications

Now I'd like to discuss communications about the netting and bolting leading practice.

- **35** Which leaders in your mine would be most trusted by teams working to ensure safety related to falls of ground?

  Falls of Ground - Mental Models Interview Protocol – Reply Sheet

    - **36** Please explain why that leader << if more than one, take them one at a time>> is most trusted?

- **37** For the most trusted leader, what messages will be important for << this leader>> to stress in their communications when they introduce this best practice to the mine workforce?
    - **38** Why might those things be really important?

- **39** What messages will be important for direct supervisors to stress in their communications when they introduce this best practice to the teams working to ensure that mine hanging and sidewalls are kept safe?

    - **40** Why might those things be really important?

- **41** What sorts of messages must be avoided by the direct supervisors?

    - **42** Why?

- **43** What forms of communications would be most effective for introducing this best practice to the teams?

    - **44** Why those
    - **45** Any forms of communications that should be avoided?
    - **46** Why?

Close: Wrap up

You have been very helpful\. I really appreciate the time you have taken to speak with me. In closing:

- **47** Is there anything else that came to mind while we were talking that you would like to be sure the team considers?

- **48** If you could offer one piece of advice to the Falls of Ground Adoption team, what would it be?

That now concludes this interview. Your comments have been very interesting and valuable. On behalf of the Adoption team, and the Chamber of Mines, I'd like to thank you for your time.

Worksheet #1: Questions for use in conducting interviews

Name of Leading Practice:			
Instructions: Indicate any particular instructions that need to be followed			
Unique Interview reference number	**Interview Date**	**Name of Mine**	**Name of Worker Position**
[example: *FOG 1*]	[example: *25 July 2009*]	[example: *Impala Plats*]	[example: *Mine Overseer* [

Part A: Adopter/Stakeholder beliefs about [the hazard] (Causes and outcomes)		
1	Please describe your role and responsibilities at the mine.	
2	Please describe [the risk/hazard] in your own words. • How may [the risk/hazard] occur? • What are the possible causes of [the risk/hazard]?	
3	What happens as a result of [the hazard]? • How might you be affected by [the risk/hazard]? • Who else may be most affected by [the risk/hazard]? • What may happen to people who are affected by [the risk/hazard]?	
4	How important do you think it is to find a way to better protect people [the risk/hazard]? • Why do you say that?	
Part B: Adopter/Stakeholder Beliefs about Leading Practices		
5	What do you think could be done to better protect people from [the risk/hazard]? Why?	
Interviewer say: This mine is currently working to bring about leading practices to better protect people from [the risk/hazard]. Describe the proposed leading practice of netting with bolting in simple neutral terms.		
6	What should leaders and supervisors in the mine do to help make sure that these practices are successful? Why should they do this?	
7	What should leaders not do in order to make sure that these practices are successful? Why should they not do this?	
8	What other kinds of things might stand in the way of the leading practice being successful at this mine? How should these things be addressed?	
9	What information would be important for people like you to know about how people can be affected by the risk and what is being done to protect them? Why is this important?	
10	What is the best way for people like you to receive this information? Why is this the best way?	

Worksheet #2: Analysis of results from interviews

Name of Leading Practice		
Instructions: To be used to summarize results of individual interviews from the Interview Worksheet – Worksheet #1. See guidance provided in the guidance note.		
Part A: Adopter/Stakeholder beliefs about [the risk/hazard] (Causes and impacts)		
1	List and tabulate Interviewees' roles and responsibilities.	
2	List and tabulate mentioned *causes* of [the risk/hazard]	• Which, if any, of these causes agree with the Risk Summary? • List any causes that disagree with the Risk Summary. Describe how people who were interviewed may be wrong in their thinking about the hazard and risk.
	List any information on causes that Interviewees say they want to know.	
3	• List and tabulate mentioned *impacts* of [the risk/hazard]. Include description of *who* may be affected.	• Which, if any, of these impacts agree with the Risk Summary? • List impacts that may disagree with the Risk Summary? Describe any areas where people who were interviewed may be wrong in their thinking about possible impacts.
	• List any information on impacts that Interviewees say they want to know.	
4	• Summarize Interviewees' comments on the importance and value of better protecting people from [the risk/hazard]?	
Summary of Part A. Compare the results above to the mental models results of the demonstration mine project.		
What, if any, are the <u>key similarities</u> between the results in Part A and those of the demonstration mine that should be emphasized in behavioural communications and leadership behaviour plans?		• What, if any, are the <u>key differences</u> between the results in Part A and those of the demonstration mine that should be emphasized behavioural communications and leadership behaviour plans?

Worksheet #2 Continued

Part B: Adopter/Stakeholder Beliefs about Leading Practices		
5	List and tabulate mentioned opportunities to better protect people from the hazard. Describe why, in the Interviewees' words.	• Which, if any, of these ways agree with the features of the leading practice? • Are there any ways mentioned that differ from the features of the leading practice? Explain the possible reasons this disagreement.
6	List and tabulate mentioned leadership behaviors that should be done to ensure the success of leading practice. Describe why, in the Interviewees' words.	• Which, if any, of these ways agree with the features of the leading practice? • Are there any ways mentioned that differ from the features of the leading practice? Explain the possible reasons this disagreement.
7	List and tabulate mentioned leadership behaviors that should not be performed to ensure the success of leading practice. Describe why, in the Interviewees' words.	• Which, if any, of these ways agree with the features of the leading practice? • Describe any ways mentioned that differ from the features of the leading practice? Explain the possible reasons f this disagreement.
8	List and tabulate mentioned potential barriers to the success the leading practice at this mine? Describe Interviewees' perceptions on how should these things be addressed?	• Which, if any, of these ways barriers and possible solutions agree with the features of the leading practice? • Describe any these ways barriers and possible solutions differ from the features of the leading practice? Explain possible reasons for this disagreement.
9	List and tabulate the information people need. Describe why, in the Interviewees' words.	• Which, if any, of these ways agree with the features of the leading practice? • Describe any ways mentioned that differ from the features of the leading practice? Explain the possible reasons f this disagreement.
10	List and tabulate the mentioned best ways communicate to people. Describe why, in the Interviewees' words.	• Which, if any, of these ways agree with the features of the leading practice? • Describe any ways mentioned that differ from the features of the leading practice? Explain the possible reasons f this disagreement.
Summary of Part B. Compare the results above to the mental models results of the demonstration mine project.		
• What, if any, are the key similarities between the results in Part B and those of the demonstration mine that should be emphasized in behavioural communications and leadership behaviour plans?		• What, if any, are the key differences between the results in Part B and those of the demonstration mine that should be emphasized in behavioural communications and leadership behaviour plans?

Worksheet #3: Customisation of behavioural communication and leadership behaviour plans

Name of Leading Practice

Instructions: To be used to customise the behavioural communication and leadership behaviour plans. See guidance provided in the guidance note. Provide adequate space for responding to the various questions and any other instructions that should be followed.

Guiding questions for customisation of the behavioural communication plan

- What, if any, of the modes of communication in the demonstration project's behavioural communication plan should be included in this mine's plan? Can any be removed without affecting the overall quality of the plan?
- What, if any, of the content or key messages in the different modes in demonstration project's behavioural communication plan should be kept in this mine's plan?
- What, if any, new content or key messages should be added to the behavioural communication plan for this mine?
- Will these changes best match with the modes that should be used and key messages that should be conveyed in the adoption mine as revealed through the interview results?
- What is the best way to go about implementing the behavioural communication plan?

Guiding questions for customisation of the leadership behaviour plan:

- With respect to the stakeholders and adopters involved, who are considered to be the key leaders involved in accomplishing adoption of the leading practice?
- For each leader or type of leader, what key behaviours or actions must they perform to appropriately influence the decisions and actions of the stakeholders and adopters. (The set of Behaviours) Why?
- What must the leaders to provided to enable them to perform these behaviours? (The set of Antecedents). Why?
- What consequences – positive, immediate and certain – must follow performance of the key behaviours that will encourage them to be repeated and sustained? (The set of Consequences). Why?
- What, if any, of the key behaviours, antecedents and consequences in the demonstration mine's leadership behaviour plan should be included in this mine's leadership behaviour plan? Why?
- What, if any, of the key behaviours, antecedents and consequences in the demonstration mine's leadership behaviour plan should be omitted from this mine's leadership behaviour plan? Why?
- What is the best way to go about implementing the leadership behaviour plan?

	What could be done to protect people?	What should leaders do?	What should leaders not do?	What could stop a leading practice being successful?	What information would be important to you?	What is the best way for you to receive information?
Mine Overseer	Strict Adherance	Follow-up Proper communication Conduct safety meetings Measure quality and quantity	Not take chances Work sub-standard	Lack of discipline and accountability	More info from geology and RE	Briefing meetings Face to face meetings Posters, photos, reports
Shift Supervisor	Conduct PTOs Leaders must lead Train people to identify faults and dykes	Enforce practices Visit working places(x2) Follow-up Use logbooks to record EE&MS	Do not take shortcuts Avoid being negative Allow blasting without implementation of practice Be inconsistent	Lack of discipline Shortage of material and labour	What are other mines doing to tackle FoGs What are best practices Refresher courses on FoG	Stategic planning with the manager Regular safety meetings Training centre Waiting place meetings Posters Videos at crush
Miner	Improve training for team members Everyone must take ownership for safety	Give rewards for excellent work Not interfere with authority of miners but rather support Right material always available Follow-up	Avoid being negative(x2) Allow blasting without implementation of practice	Lack of time No prior training No consultation on practices	Alert before FoG occurs Training on support standards	Training centre(x2) Waiting place meetings(x2)
Team Leader	Adhere to five non-negotiables Continuous use of proper support	Lead by example and give guidance Coach the teams Join in the work Provide training for all using the practices Rewards for success Trust the team Follow-up	Be inconsistent Not just instruct verbally Assume the practice will be implemented	No follow-up and daily monitoring Material not ordered on time	How FoGs occur Visual material on the impact of FoGs Higher level FoG training	Training centre Posters Videos at crush Training Courses
Stope Team Member	Right support – Better roofbolts and backfill Innovative ways to prevent FoGs Adhere to standards(x2) Ask questions to see if people understand about FoGs Availability of material Training people	Supervision Charge persons that do not comply Leaders such as SB should go underground every day Hands on approach Follow-up Lead by example(x3) Be honest Keep promises Explain reason for change Get agreement from the team Provide training	No compromise on use of practice(x2) Leaders should not stay on surface Not allow work to proceed without practice in place Strict and not too friendly with workers They should not swear and shout at us when giving instructions(x2) They should not force people to work in unsafe areas	Negative attitude(x3) Shortage of labour(leave rosters) Divisions in the team Poor communications between supervisor and team. No bonuses if overtime is worked Longer hours Poor relationships between team and supervisor	Employ expert to teach on FoGs Impact of FoGs on all mines in SA Motivation by MO and SB during u/g visits to discuss safety Inform of safety results constantly(x2) Kept in loop about everything that happens on mine including accidents and action plans to stop these (x2)	Training centre(x3) Waiting place notice board Meetings with supervisors Waiting place meeting with supervisor(x5) Team building such as qhaphelangozi

APPENDIX 3 Behavioural Communications

Behavioural communication plan to facilitate operational adoption of Leading Practice on Bolting and Netting For implementation by Mine Adoption Team										
No.	**Stakeholders / Adopters (recipients)**	**Desired behaviour & issue addressed**	**Messages . Communication content**	**Mode**	**Tools / means**	**When**	**Responsible for delivery**	**Who to ensure**	**Evaluation / control measure**	Ref. Row No.
1	Team Member	Desired behaviour: Nets are understood to be a barrier to stop serious and minor FoG accidents and are always installed to standard in all stope faces requiring them before any drilling and charging-up begins Belief, knowledge gap, lack of understanding, or misperception: The support density and support resistance is sufficient. It is a waste of time to put in nets as well. The net will result in workers being trapped if a FoG occurs . Nets delay the work and therefore we need to start drilling as soon as we enter the stope.	Even small rockfalls may cause serious injury and even death. The entry examination and making safe process may not eliminate all potential FoGs. The rock is fractured and gravity and/or seismicity may cause rocks to dislodge. The nets have been designed to catch the anticipated maximum fallout. Therefore the nets should arrest the rock before it seriously impacts a team member. Do not start work in the panel before the net is installed. It is unlikely that the team member will be trapped below the rock and net but if this happens the net is soft and easy to cut.	Training of crew	Training outlines	Annual On the job	TL/Miner	Shiftboss	Mine Overseer /Underground follow-ups /Rock Engineering reports	1
		Desired behaviour: Make sure that the roofbolts are installed to mine standard. Belief, knowledge gap, lack of understanding, or misperception: As long as the net is in, then that is all that is required. It need only be attached at the edges to whatever attachment point that can be found. Even twine can be used to tie the net to an attachment point.	What is a good netting with bolting installation?The nets are flexible and are very difficult to tension over their entire length. Therefore, the net needs to have multiple attachment points at its edges as well as over the area of the net. The net should be tight between each attachment. This will also ensure that the net follows the contours of the hangingwall and that there are no large gaps between the net and the hangingwall. C-hooks and tensioning chains should be used to attach the net and the attachment points should be the roofbolts, mechanical props and special strong attachment points on the permanent support headboards. Attachment with materials weaker than the net will lead to failure of the net.	Traing course at training centre (surface)	Practical demonstration	Before crew adopts	Training coordinator	Mining Manager	Record number of crew and people in each crew trained	4

		Desired behaviour: In order to get proper installations the crew must work as a team. Belief, knowledge gap, lack of understanding, or misperception: Every member of the team wants to get his job completed as soon as he can in order to leave the stope. Completing his job everyday is important to getting his bonus and installing nets may mean he cannot complete his task. Each team member already has a job- someone else must install the nets. As soon as team member has finished his task he wants to pack up and leave. He does not want to wait to help with taking down the net. The team needs to install and un-install the nets but many don't want to help with these additional jobs.	The team members depend on each other for safety. Drilling of the face and hangingwall should only start after the net is in place and the net should only be removed once the charging up of the face is completed. Therefore the team needs to exercise restraint in starting with drilling and should not leave as soon as the drilling is completed. The nets need to be removed and stored safely only after charging up of the face is completed	Team meetings	Tasks that demonstrate team work	At surface training	Shiftboss	Mine Overseer	Recorded in Shiftboss notebook	6
		Desired Behaviour: Always work under nets. Belief, knowledge gap, lack of understanding, or misperception: Nets don't really work. It is a nuisanace to always stay under the net when moving up and down the panel. Sometimes the net restricts may movement further by reducing the stoping width. (Observation: Having installed the nets, workers often travel and work in areas that are not beneath the net).	The nets do not cover the entire stope face area but cover the most dangerous part of the stope face.Nets can save people from injury and death. Nets are not a cosmetic addition. They are there to protect workers. Therefore the crew should always do their work under the protection of a well installed net. They should not work on drilling of the face or hangingwall or charge-up the face unless they are below a secure net.	Team Meetings	Photos of successes	When new material becomes available	Safety Department	Safety Manager	Compile a record of all photos showing bolting and netting benefits and record of which sections were given photos	7

2	Team Leader	Desired behaviour: Make sure that the roofbolts are installed to mine standard. Belief, knowledge gap, lack of understanding, or misperception: As long as the net is in, then that is all that is required. It need only be attached at the edges to whatever attachment point that can be found. Even twine can be used to tie the net to an attachment point.	What is a good netting with bolting installation?The nets are flexible and are very difficult to tension over their entire length. Therefore, the net needs to have multiple attachment points at its edges as well as over the area of the net. The net should be tight between each attachment. This will also ensure that the net follows the contours of the hangingwall and that there are no large gaps between the net and the hangingwall. C-hooks and tensioning chains should be used to attach the net and the attachment points should be the roofbolts, mechanical props and special strong attachment points on the permanent support headboards. Attachment with materials weaker than the net will lead to failure of the net.	Traing course at training centre(surface)	Practical demonstration	Before crew adopts	Training coordinator	Mining Manager	Record number of crew and people in each crew trained	8
			The benefit of an integrated support system. Nets provide area coverage that the other support cannot give. Areas of net between attachment points are small, limiting the size of FoG that has to be caught by the net.	Underground demonstration	Action checklists	First day of adoption	Mine Overseer	Mining Manager	Record number of crew and people in each crew orientated	9
		Desired behaviour: The team leader needs to give leadership to the crew Belief, knowledge gap, lack of understanding, or misperception: Team members indicate a lack of communications from the team leader. They want to discuss problems with their supervisor and and get advice.	The team leader should be expert at installing the nets and assist the teams as they install the nets. The team leader needs to learn how to coach the members on good or poor installations, complimenting good work and giving corrective advice for poor installations. He should be able to dialogue with his team, discussing rather than just telling.	Dialogue from observation of key behaviours	Talking points	Monthly	Miner	Shiftboss	Scorecard	10

3	Miner	Desired behaviour: Understanding the role of support and support standards Belief, knowledge gap, lack of understanding, or misperception: Production pressures sometimes forces supervisors to take short cuts. Adherence to mine standards is ignored. There is a belief that nothing will necessarily happen by occasionally not following the standard.	Basic Rock Engineering and support theory. The miner should not take short cuts to getting the production from a particular panel. Support, including the nets, should be installed before any drilling tasks begin. The installation of the permanent support, especially the roofbolts must be installed to mine standard to ensure proper installation of the nets.	Training session	Training outlines	Regularly at miner meeting with SB	Shiftboss	Mine Overseer	Interactions logged in Shiftboss logbook	11
		Desired behaviour: The miner needs to be present and able to correctly and early identify potential FoGs Belief, knowledge gap, lack of understanding, or misperception: Lack of presence and confidence on the part of miners to appreciate dangerous or changing rock conditions	Instill in the miner the importance of his presence during the installation of nets. Early identification of potential rockfalls. The miner should be proficient at identifying different geological features and man-made features. The miner should be familiar with his working area and spend most of his working shift in the panel face area. The miner should be at hand during installation of nets to give advice and assistance to the crew and their team leader. He should be familiar with the conditions of the hangingwall and should be able to advise if sufficient barring and making safe has taken place before nets are installed.	One on one coaching	On job inspecti on	Regularly with EE&MS during early shift	Shiftboss	Mine Overseer	Recorded in Shiftboss notebook	12
		Desired behaviour: Supply of all equipment in good condition. Belief, knowledge gap, lack of understanding, or misperception: There is often a lack of the proper equipment at the face. The equipment is often lost or broken.	The bolts with nets are part of a support system that is as weak as the weakest part. Nets need to be installed and removed on a daily basis and used repeatedly. Therefore the miner needs to be the custodian of the nets ensuring that they are stored away from the influence of the blast. He needs to ensure that the team remember to collect the c-hooks for attachment and that the mechanical jack are protected when not in use.	Training to familiarise with equipment and the condition it should be in.	Talking points	Monthly	Shiftboss	Mine Overseer	Scorecard	13
4	Shiftboss									

		Desired behaviour: The Shiftboss needs to possess basic Rock Engineering knowledge Belief, knowledge gap, lack of understanding, or misperception: Shiftbosses often lack a good understanding of basic rock engineering principles and practice	Basic Rock Engineering theory. A basic understanding of rock mechanics and strata control are an important part of a shiftbosses training.	Training session	Training outlines	Annually	Mine Overseer	Section Manager	Assessments of RE knowledge	14
		Desired behaviour: The Shiftboss needs to exercise organisational skills Belief, knowledge gap, lack of understanding, or misperception: Basic skills in organising necessary material is lacking. Nets are not able to be installed because the stope has not been cleaned properly.	The timely arrival of material and equipment is crucial to the smooth running of the stope. Without the permanent support in the form of elongates and roofbolts the nets will be ineffective. The shiftboss needs to be equipped with skills to schedule the ordering and delivery of equipment on time. The scheduling of blasting and cleaning so that the panel can be accessed and the nets installed is essential. Supply chain training would be helpful to this level.	Information sharing	Printed Informati on	Annually	Mine Overseer	Section Manager	Record shortages of material	15
		Desired behaviour: The Shiftboss needs to be able to listen and discuss mining and support isssues with his team Belief, knowledge gap, lack of understanding, or misperception: The view is that the best way to get the teams to implement nets with bolts is to tell them to do it and take disciplinary action if it is not carried-out. The teams understand what they have to do but are too lazy to carry-out instructions	Personal Mastery. The shiftboss needs to learn to discuss with his subordinates any issues regarding the support in the panel and the importance of the support to good netting with bolting installations. He must be able to coach his subordinates on good installations and provide corrective instruction on poor installations.	Dialogue from observation of key behaviours	Talking points	Twice annually but before adoption of LP	Mine Overseer	Mine Overseer	Recorded as KRA in performance contract	16
			Communication skills. Training in listening skills in order to understand others point of view	Training session	Key behavio urs	Annually	Training manager	Mining Manager	Set dates for training	17

5	Mine Overseer	Desired behaviour: The Shiftboss needs to be able to listen and discuss mining and support isssues with his team Belief, knowledge gap, lack of understanding, or misperception: The view is that the senior person knows what is best for any situation. There is not enough interaction between supervisors and staff. People are told what to do without enough explanation and opportunity to discuss reasons and alternatives. There is not enough visible felt leadership.	Personal Mastery. The mine overseer needs to learn to discuss with his shiftbosses any issues regarding the support in the panel and the importance of the support to good netting with bolting installations. He must be able to coach his shiftbosses on good installations and provide corrective instruction on poor installations. He needs to understand the importance of leadership behaviour and behavioural communications	Dialogue from observation of key behaviours	Talking points	Twice annually but before adoption of LP	Section Manager	Adoption Team	Recorded as KRA in performance contract	18
			Communication skills. Training in listening skills in order to understand others point of view	Training session	Key behaviours	Annually	Training manager	Mining Manager	Set dates for training	19
6	Section Manager	Desired behaviour: Dialogue skills Belief, knowledge gap, lack of understanding, or misperception: There is a view that a mine is a tough environment where people respond best to being told what to do. It is unwise to engage in discussion between supervisors and staff to get all views. People are told what to do without enough explanation and opportunity to discuss reasons	Personal Mastery. The section manager needs to learn to to discuss with his subordinates any issues regarding the support in the panel and the importance of the support to good netting with bolting installations. He must be able to coach his mine overseers on good installations and provide corrective instruction on poor installations. He will understand the importance of leadership behaviour and behavioural communications	Dialogue from observation of key behaviours	Talking points	Twice annually but before adoption of LP	Mining Manager	Adoption Team	Recorded as KRA in performance contract	20

		and alternatives. There is not enough visible felt leadership.	Communication skills. Training in listening skills in order to understand others point of view	Training session	Key behaviours	Annually	Training manager	Mining Manager	Set dates for training	21
7	Safety Representative	Desired behaviour: Safety comes before production. Belief, knowledge gap, lack of understanding, or misperception: Too much attention to safety may make the mine unprofitable.	Safety is the first priority on the mine and ways of monitoring to track safety inprovements to ensure improvements are being achieved. Understanding of how safety helps to make a mine more profitable and therefore sustainable. Understanding how the rock related safety is linked to achieving the 2013 milestones:	Notice boards	Safety Bulletins	Monthly	Safety Manager	Mining manager	Safety representatives to discuss with each team at working place and give feedback to safety manager who will compile a monthly synoptic report	22

Appendix 4

Leadership Behaviour Plans for Team Members, Team Leaders, Miners, Production Supervisors, Shift Bosses, Mine Overseers and Managers concerned with the Leading Practice for Netting and Bolting.

Team Workers [and or "Competent B persons"]

	Antecedents (Required inputs or "prompts" for desired behaviour)	Desired Behaviour	Consequences (Encouraging, timely, important and highly probable experiences occurring after the behaviour)
1	Clear understanding and acceptance that nets and bolts do not replace good entry examination and making safe	Participate in entry examination and making safe prior to installing nets and bolts	Members of the crew will not proceed with net installation unless area is made safe
2	Explanation of the role of bolts and washer to secure the nets	Installation of bolts at the right spacing as close to vertical and with a washer with a hole for a c-hook	The supervisor inspects the installation and expresses satisfaction with the crew and individuals when installations are good and corrective action when necessary
3	Training on required installation, Supply of equipment and demonstration underground of installation.	Diligent installation of nets	The supervisor complements the crew and individuals on good installations and shares and celebrates the FoG safety improvement with them. Shares success stories with crew where installations were successful
4	Mindset needs to be that work will only take place below a well installed net.	Always Working under nets	Individuals are praised when working under the nets, those working without nets are corrected and helped to install and shown the benefit of working under nets
5	Teaching on correct method for taking nets down, handling and transport to and from the	Care of nets at all times	The supervisor notes the age of the nets and compliments the team and individuals on the condition of

	face area and storage during non use.		the net when the expected life is extended. The supervisor inspects the storage of nets and compliments proper care.
General consequences or desired results from performance of behaviours include:			
• Each person understands his role in deciding on his own safety • Valued inclusion of team members in the team decision • Team performances and rewards are self identified and applied from within the team • Injury and loss avoidance		• Eliminate “Short Cuts” • Positive feed-back on communications and effectiveness of the process.	

“Competent A persons” – Team Leaders and Miners

No	**Antecedents** **(Required inputs or “prompts” for desired behaviour)**	**Desired Behaviour**	**Consequences** **(Encouraging, timely, important and highly probable experiences occurring after the behaviour)**
1	Understanding the importance of the entry examination and making safe	Signs off the declaration that the working place is safe before allowing bolting and netting to proceed	The team understands that no short-cuts are allowed and that nets are not a fix for all FoG problems
2	Understanding that bolting and netting is designed to primarily address the FoG problem during face work such as face	Champions the installation of nets before drilling of face begins	No short cut behaviours is tolerated by leadership. Leaders have the safety of the crew as a priority. Crew adopts the nets as a necessity.

	preparation and drilling for blasting		
3	Good understanding of the reason for the bolts and nets	Coaches the crew on good installation of bolts and nets and checks installations	Safety and production targets are met and celebrated. Crews morale improves as they feel safer. Shiftboss praises the effort of the crew
4	Good understanding of the condition od nets and how they should be protected underground	Provides and protects the equipment used for netting and bolting from installation to removal and storage	Shiftboss compliments the team leader/miner on no wastage. Spot inspections by the shiftboss reveal no defective bits of equipment and praises the effort.

General consequences or desired results from performance of the behaviours:	
• Positive support and feedback from the team • Safe conditions and Safe Activities – (FOG Incident free days) • Improved work organization, productivity and safe quality shifts	• Achievement of meaningful team goals. • No uncontrolled falls of ground

“Shift Bosses”

	Antecedents **(Required inputs or “prompts” for desired behaviour)**	**Desired Behaviour**	**Consequences** **(Encouraging, timely, important and highly probable experiences occurring after the behaviour)**
1	Understanding of the role of bolts and nets	Encourages all work to be under bolts and nets in the face and enforces no blast without bolts and nets.	Recognition of safe production by MO and Section Manager

2	Training in communication skills Set KPAs for Team Leaders	Conducts regular dialogue conversations with team members and others to provide pin-pointed feedback on their performance relative to bolt and net installations	Feedback from teams that behaviour is seen to be respectful, fair and non-discriminatory.
3	Trained in strata control and the installation of nets and bolts	Regularly tests the quality of installations of bolts and nets (PTOs). Applies corrective action to sub-standard installations	Recognition by Mine Overseer and Section Manager of safety achievements. Applies discipline where necessary.
4	Understanding of supply chain and budget Has a budget allocation	Assumes full accountability for sufficient availability of fit for purpose materials and equipment for use by the teams in bolting and netting	MO's acknowledgement/praise of Shiftboss's ability to manager section Correct equipment and necessary material supplied, available and systems functioning properly

General consequences or desired results from performance of the behaviours:

• Positive support and feed-back from work teams • Team values are strengthened and developed • Team knowledge is maintained at optimum levels • Teams can perform to the required output standards.	• Work outputs are delivered as required and short cuts are eliminated • Ensure standards and procedures are kept up to date and current with conditional / situational requirements

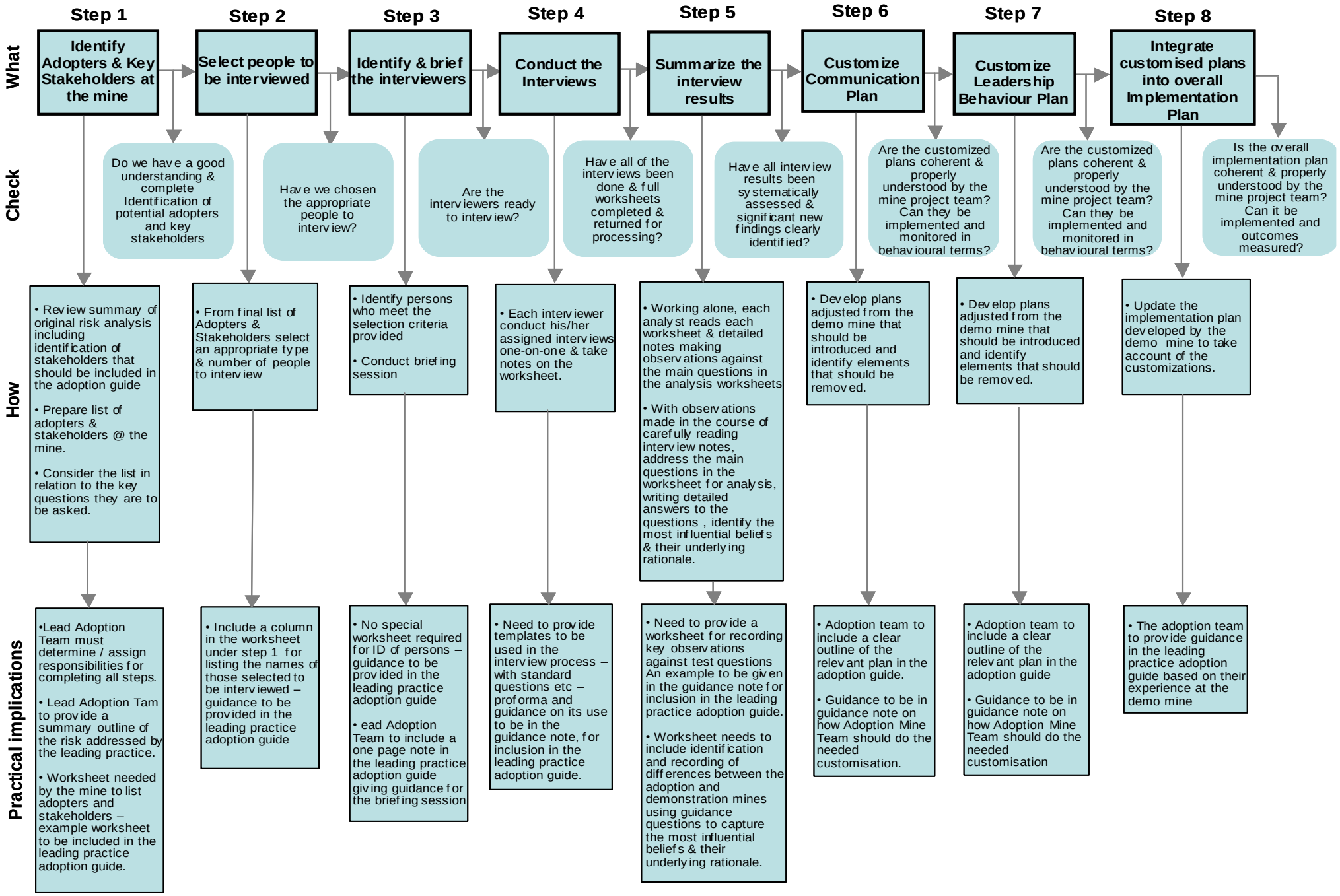
“Mine Overseers and Management”

	Antecedents (Required inputs or “prompts” for desired behaviour)	Desired Behaviour	Consequences (Encouraging, timely, important and highly probable experiences occurring after the behaviour)
	Buy in to the benefits of netting and bolting	Adopts the netting and bolting practice as a non-negotiable practice	Leading by example
1	A learning and supportive culture characterizes the working place Key behaviours required for safe conditions and performance in K.P.A.s are known to all	In-person audits, coaching and dialogue with members of his section to assess and encourage levels of training and preparedness for and the use of bolting and netting	Positive re-enforcement from Senior leaders. Senior leaders have a clear understanding of the state of bolting and netting and are able to give pin-point feedback and good and correct behavioutr that is poor.
2	Shared understanding of the safety requirements	Relates the use of bolts and nets to safety and good production	Recognition by MO/Section manager when safety targets are met
3	Regular underground visits	Positively motivates the installation of bolting and netting during underground visits	Trust grows in the team. Learning culture is enhanced
4	Correct knowledge of organization and	Gives 360 degree feedback through meetings	Roles of all stakeholders are made clear and

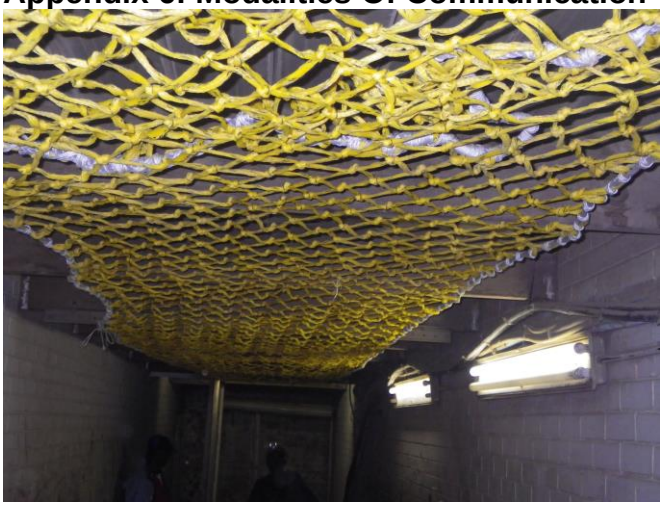
	relationships		dependence on the team grows
General consequences or desired results from performance of behaviours:			
• Team members support each other to live up to their value requirements. • People do not take short cuts because they know the correct procedures and are aware of the risks • Safety systems are applied uniformly and safe quality shifts are achieved		• Bolting and netting processes are on the agenda of all. • Willing compliance to installation of bolts with nets.	

APPENDIX 5

Procedure for customising behavioural communication and leadership behaviour plans



Appendix 6: Modalities Of Communication



HARMONY

The Basic Risk Story

Why use nets with bolts at Kusasalethu Gold Mine?

Appendix 8: Documenting The Performance Of A Demonstrated Practice

Data to be collected at Kusasalethu Demonstrator Site

Measurements:

Issue	How Often	How many measurements	Accuracy of measurements	Where are measurements taken	By Whom	Data Storage
Stoping width	Every shift	6	Tape measure	Top, middle and bottom of panel. At face and at last line of support	Production Supervisor	Photocopy of Shiftboss notebook filed. Excel spreadsheet with backed up copy(Rock Eng).
Face Advance	After blast	7	Tape measure	Seven evenly spaced positions along face. Every 5m on a 30 meter panel. Measure from last row of support before blast to face position.	Production Supervisor	Photocopy of Shiftboss notebook filed. Excel spreadsheet with backed up copy(Rock Eng). Record face advance and distances of face to support before and after blast. Determine monthly advance.
Support Spacing/density Roofbolts, Mechanical props and permanent support	After new row of support installed	6 strike measurements plus all dip distances between new supports	Tape measure	Top, middle and bottom of panel. From face to new support and from new support to previous support row	RE	Excel spreadsheet. Calculation of m^2 per support. Tributary Area Theory(TAT)
Backfill distance to face after blast	After blast	6	Tape measure	Three positions along face	Miner	Recorded in Miner note book. Photocopies of noteook stored.Entered into Excel Spreadsheet

Issue	How Often	How many measurements	Accuracy of measurements	Where are measurements taken	By Whom	Data Storage
Face shape	After each blast	1	Qualitative assessment	Observation of face	RE department	Excel Spreadsheet
Production delays	When they occur	List reasons	n/a	n/a	Miner / Mine Overseer	Copy of Miners Notebook/Excel spreadsheet.
m^2 per stope worker	Monthly	n/a	n/a	n/a	RE	Calculated from face advance spreadsheet
No. of non injuring FOGs & rockbursts	When they occur	Estimated height, width & breadth	Clino-rule/tape measure	n/a	Miner	Photocopy of team leaders notebbok. Excel spreadsheet wih backed-up copy (RE)
No. of Treat and returns	Past year Duration of demonstration	n/a	n/a	Mine safety records	Section Manager/ Safety Officer	Excel spreadsheet/graphs
LDIs for section	Past year Duration of demonstration	n/a	n/a	Mine safety records	Section Manager/ Safety Officer	Excel spreadsheet/graphs
FIFR for section	Past year Duration of demonstration	n/a	n/a	Mine safety records	Section Manager/Safety Officer	Excel spreadsheet/graphs
Rock LDIs for section (seismic & FOG)	Past year Duration of demonstration	n/a	n/a	Mine safety records	RE/Safety Officer	Excel spreadsheet/graphs
Rock FIFR for section (seismic & FOG)	Past year Duration of demonstration	n/a	n/a	Mine safety records	RE/Safety Officer	Excel spreadsheet/graphs

Issue	How Often	How many measurements	Accuracy of measurements	Where are measurements taken	By Whom	Data Storage
No. of incident free days	Daily / progressive	n/a	n/a	n/a	Mine Overseer	Excel spreadsheet
Transfer of persons into and out of section	Monthly	n/a	n/a	Crew compliment documents	Mine Overseer	Excel spreadsheet.
Leave roster	Once off	Last leave dates for crew	n/a	Employment records	Tme office	Bar graph Summary
Training	Once off	Completed courses and dates	n/a	Mine training records	Training Centre	Bar graph Summary

Appendix 8: Implementation Project Checklist

Implementation Project Factors and Factors Checklist	
1	Is there still a need for the new technology or practice?
2	Is the technology, practice or knowledge ready for transfer and Adoption?
3	Is further development required to arrive at a commercially and practically viable technology or practice?
4	Has the equipment to be tested (technology to be Adapted) been adequately designed to withstand the harsh underground environment?
5	Has the operation of the technology or practice been adequately simplified for mine application?
6	Is a trial installation warranted or will a desktop study provide adequate performance information?
7	Which parts of the mine would benefit most from Adoption of the technology or practice?
8	Which persons on the have the incentive and attributes necessary for championing the technology or practice?
9	Has (will) the mine appointed an appropriate champion?
10	Which persons at the mine need to be brought into the planning of the project at the earliest stage possible, and has this been don
11	Which persons should be invited to join an oversight group to assist in spreading the Adoption experience?
12	Has the mine staff responsible for the Project been provided with adequate time and resources to successfully undertake the Project?
13	Who will take responsibility for documenting and writing up the outcome of the Project for communication to others?
14	What technical support is needed to assist mine staff with the Adoption Process?
15	Are new skills or organisational structures needed to achieve successful Adoption?
16	Will the equipment supplier be able to meet the mine's needs in the event of a successful implementation?
17	Can or should the technology and/or leading practice be implemented as part of a larger, more beneficial system?
18	What are the possible unintended consequences of the technology and/or best practice and how will they be addressed if they aris
19	Do the risks warrant consideration being given to setting up arrangements to underwrite the Implementation Project?
20	Has adequate time been allowed for the Implementation Project to be undertaken to its proper conclusion?
21	What are the criteria for the Implementation Project to be considered complete and successful?
22	What are the criteria for the technology and/or best practice to be considered a success once adopted?
23	Which persons or mines are going to be most affected by Adoption of the technology and/or leading practice?
24	What steps need to be taken to ensure proper communication about the new technology or practice in regard to its application and its positive and negative impacts?
25	What special training is necessary for mine staff to facilitate successful Adoption?
26	Which persons on the mine could make or break the project and how have they been accommodated?
27	What will be the benefits to the various people on the mine who are or will be affected by Adoption of the technology and/or best practice, in particular the workers and first line supervisors?
28	What measures, in addition to training, need to be adopted to gain support of the workforce for the technology and/or leading practice?
29	Which persons will be negatively affected and how have their concerns been taken into account to secure their support?
30	Good and constructive union participation?
31	Strong and constructive Health and Safety Committee?

Appendix 9: Risk Summary

Risk Summary: Table of related factors – causal chain for FOG

Part A – Description of the causal chain

No	Nature of the hazard	No	Exposure to the hazard	No	Outcomes of exposure
	Description		**Description**		**Description**
1.	Mining operations are designed to extract the maximum amount of ore possible	1.	All persons involved in the underground mining process are exposed to overhead rock that has the potential to fall and cause injury or death	1.	Death due to being crushed or other traumatic injury from falling rocks.
2.	Virgin rock stress increases with the depth of mining to the point where mining induced stress-levels exceed the strength of the rock causing the rock to fracture	2.	The examination and making safe procedure requires workers to come into close proximity with rocks that have the potential to fall	2.	Serious injury that results in partial or total disability
3.	Large mining spans result in higher abutment stress levels and stope closure increasing the risk of rock falls	3.	Workers responsible for cleaning blasted rock from the working stope face must do so before a new line of support is installed	3.	Injuries that result in work absence
4.	The rockmass around deep-level excavations is fractured due to the high virgin rock stress and the stress concentrations induced by mining	4.	The drill and blast cycle of hard rock mining requires large numbers of people to work in close proximity to the face of advancing excavations	4.	Injuries that result in work time stoppage to attend to the injured persons
5.	Horizontal clamping forces created as the rock fractures tends to hold fractured rock in place but rocks at the hanging wall surface may readily fall, depending on the orientation and geometry of the fractures	5.	Setting up the cleaning operation may involve some workers being exposed to unsupported hanging wall - setting up the scrapper ropes	5.	Rockfalls that result in persons being trapped or buried for extended periods, to the point where persons may die before being released
6.	Unsupported pieces of fractured rock may fall due to gravity without warning	6.	Workers responsible for installing new support may at times be exposed to the unsupported zone between the last line of support and the newly exposed face	6.	Time delay before expert medical care (equipment and expertise) is available
7.	Loss of a key block in a fractured hanging wall beam can result in many rocks falling as the fractured roackmass unravels	7.	Drilling for the installation of bolted support exposes drillers to situations involving temporary support only	7.	Disabled persons returning to home care may not cope or be accepted
8.	Installed support does not provide full area coverage	8.	Rockdrill operators, persons installing support, (packs, elongates, backfill, netting) and crew team leaders are exposed to the rockfall hazard for most of the working shift	8.	Persons may need to undergo extended periods of rehabilitation
9.	Some installed support becomes ineffective due to weathering or the corrosive action of acidic mine water, particularly in long term support situations such as strike gulleys, travelling ways, tunnels and service excavations	9.	Miners and other supervisors are also exposed to the rockfall hazard but for shorter periods	9.	Disabled persons may need to be trained to undertake different occupations on returning to work.
10.	The time dependent response of timber support to imposed loads results in lower levels of support resistance being provided	10.	Persons from mining service departments such as surveyors, geologists, samplers, ventilation	10.	Persons may need to undergo special counselling prior to being reintegrated into their work team
11.	Poor control of mining operations may			11.	Sharp edged falling rock may cause cuts that bleed profusely resulting in shock or death due to a loss of blood
				12.	Injured workers may be HIV positive and pose a health risk to those who treat them both underground and on surface
				13.	Rockfall accidents due to poor control measures may give rise to regulatory action that results in work stoppage for prolonged periods
				14.	

result in excavation geometries that create local stress concentrations and increased risk of rock falls 12. Unknown geological discontinuities in the rock mass are encountered as mining advances and they increase the risk of rock falls 13. Each mining blast advances the mining face, creates new stresses and exposes a new area of unsupported rock 14. Removal of blasted rock needs to occur before support can be installed in the newly mined area 15. Rocks that fall vary in size from small fragments to large rocks of many tons 16. Blasting causes damage to the hanging wall rock - it makes new fractures and increases the size of existing fractures, increasing the risk of rocks falling 17. Continual movement of the rock mass due to the nature of its time dependent response to the mining induced stress causes the stability of the hanging wall to be subject to continual change 18. High temperature conditions impair the ability of workers to recognise hazardous situations 19. High rockstress in the mining face causes fractured rock in the mining face to be violently expelled into the excavation 20. Mining towards unknown geological features 21. Mining faces approaching each other result in increased rock stress levels that increase the risk of rockfalls 22. Unplanned pillars due to geological features result in high stress conditions that increase the risk of rockfalls 23. High mining induced rock stress results in seismic events and a release of energy that may forceably expel otherwise stable rocks from the fractured rockmass into the mining excavation. 24. Exposed rock weathers and losses strength with time 25. The length of the fractured hanging wall section (beam) that is self-supporting decreases with time and previously clamped rocks may fall 26. Delays in the installation of support allows the rockmass to move and unravel 27. Certain types of rock exhibit creep behaviour adding to the problems associated with the time-dependent behaviour of the rock mass 28. Barring down potentially unstable rocks during the making safe procedure may cause dangerous rockfalls	officers etc are also exposed but usually for shorter periods 11. Persons who work in tunnels and other excavations housing equipment and services that support the mining operation experience low levels of rockfall risk 12. Persons working in deep level excavations are exposed to higher levels of rockfall risk (gravity falls, seismic induced falls, rockface expulsions and massive stope closures) than those working in shallow excavations 13.	

29. Seismic events may cause may cause sudden and dangerous levels of stope closure that may extend over a relatively large (panel size) working area 30. Mining occurs on many fronts resulting in logistical supply problems, dilution of supervisory control, and high stress levels as mining faces approach each other 31. Unfavourable fracture patterns occur where the excavation face changes direction sharply, such as at the stope face strike gully intersection 32. The thickness of the zone of fractured rock around excavations increases with time increasing the loading on support units and increasing the size of a potential rockfall 33. In high stopes or tunnels effective barring and making safe may not be possible 34. In steeply dipping stopes rocks may detach from the side or hanging wall and roll down the stope causing injury to workers		
Data / Knowledge Gaps - Identify gaps that need to be investigated	**Data / Knowledge Gaps - Identify gaps that need to be investigated**	**Data / Knowledge Gaps - Identify gaps that need to be investigated**
1. Accurate determination of grade for mine planning purposes 2. Accurate determination of geological discontinuities for mine planning purposes 3. The time dependent movement of the fractured rockmass cannot be accurately characterised and predicted. 4. A well determined life of mine plan that minimises the need for ad hoc decision making	1. The extent of time that various categories of worker perform tasks in areas that are not adequately supported 2. A quantitative assessment of rockfall risk associated with individual working panels 3. A quantitative assessment of seismicity induced rockfall risk associated with individual working panels 4.	1. The extent of trauma and fear in individuals that work underground who have experienced or been in a mine FOG accident. The effect of the trauma on productivity 2. The preparedness of each mine to get medical help to injured workers within the "golden hour" 3. First aid training of all workers which includes dealing with possible HIV positive workers and the risks involved
Summary of major risks - Create a summary list of the major risks identified	**Summary of major risks - Create a summary list of the major risks identified**	**Summary of major risks - Create a summary list of the major risks identified**
1. High stress and Seismicity 2. Fracturing 3. Geological features 4. Lack of geological information 5. Poor layouts 6. Ineffective support 7. Rock falls 8. Rock bursts 9. Lack of qualified RE staff	1. Tasks that are carried out after the blast such as entry examination, establishing scraper rope paths and cleaning 2. Working under temporary support 3. Workers installing support 4. Workers drilling the face for blast holes or the hanging wall for support holes	1. Death from falling rocks that can crush, asphyxiate, amputate or cause severe bleeding 2. Lack of timely expert medical care 3. Transmission of HI virus

Risk Summary: Table of related factors – causal chain for FOG

Part B – Current risk mitigation controls and strategies – identify and describe

No	Nature of the hazard	No	Exposure to the hazard	No	Outcomes of exposure
	Mitigation controls and strategies		**Mitigation controls and strategies**		**Mitigation controls and strategies**
	1. Extraction ratios and mining operations are designed to ensure that the mining induced stress levels are kept to acceptable levels 2. Mining spans and pillar sizes are designed to ensure that the stress levels on mining faces and in abutments are kept to acceptable levels. 3. Backfilling is used in some mines to provide local and regional support capable of reducing stope closure and elevated stresses around excavations 4. Local support strategies are designed to prevent all likely falls of ground and to absorb the energy likely to be imparted to the supported rock due to a seismic event 5. Yielding tendons with mesh and lacing are used in tunnels to prevent all likely falls of ground and to absorb the energy likely to be imparted to the supported rock due to a seismic event 6. Meshing and lacing is used in tunnels to prevent all likely falls of ground 7. Preconditioning of mining faces is undertaken to reduce the risk of face bursting 8. All workers are specifically trained to identify and take the necessary action to address potential rockfalls 9. All working areas must be examined and made safe and declared safe by a competent person prior to starting work in the area concerned		1. The safety (including support) of all excavations are examined at least once every 10 working days. 2. Operational rule that no person shall perform work more than one metre from installed support 3. All persons underground must wear a protective hard hat and boots 4. Some mines require workers to wear arm guards or long sleeved shirts as protection against injury from falling rock 5. Gloves are provided to help prevent hand and finger injuries		1. Every underground worker does receive basic first aid training 2. Gloves and breathing pieces are supplied to all miners to minimise blood contact 3. Medical staff do go to the scene of serious accidents but may take longer than an hour to arrive due to logistical arrangements

	Weaknesses – Identify and list the major weaknesses		Weaknesses – Identify and list the major weaknesses		Weaknesses – Identify and list the major weaknesses
1.	Safety procedures and mine standards may not always be followed	1.	Partial vigilance of all underground workers	1.	Rapid medical care to injured workers at the site of the accident
2.	Support standards implemented by the mine may not meet the requirements of the area being mined	2.	Lack of sustainability of any systems put in place to address the risk of falls of ground	2.	Possibility of the transmission of the HI virus
3.	Pieces of rock that may easily fall may not be detected and barred down during the examination and making safe procedure	3.	Lack of use of the provided PPE	3.	Limited protection from falling rock

Risk Summary: Table of related factors – causal chain for FOG

Part C – Possible improvements in risk mitigation controls and strategies – identify and describe

No	Nature of the hazard	No	Exposure to the hazard	No	Outcomes of exposure
1.	Area hanging wall support in any place that workers move or work	1.	Seismic sounding of the hanging wall above the place where a person is going to work	1.	Dedicated medical team on standby to reach accident sites within 30 minutes
1.	Expert planning	2.	Infrared survey of the rock above the place that a person is going to work	2.	Improved training and preparedness of workers to handle blood injuries
2.	Exposure to and adherence to the RE leading practices locally and internationally	3.	Design work to be carried out as much as possible remotely by modifying machines	3.	State of the art rescue equipment available on each level of the mine close to the workings

Summary tabulation of major risks	
Description	**Priority Rating High / Moderate / Low**
Gravity induced falls of Ground	**High**
Shake down rockfalls due to seismicity	**Moderate**
Dynamic failure of exposed rock – rockbursts and strainbursts	**High**
Poor mine design	**High**
Insufficient support – deteriorating support	**Moderate**