Eliminating falls of ground in South African mines
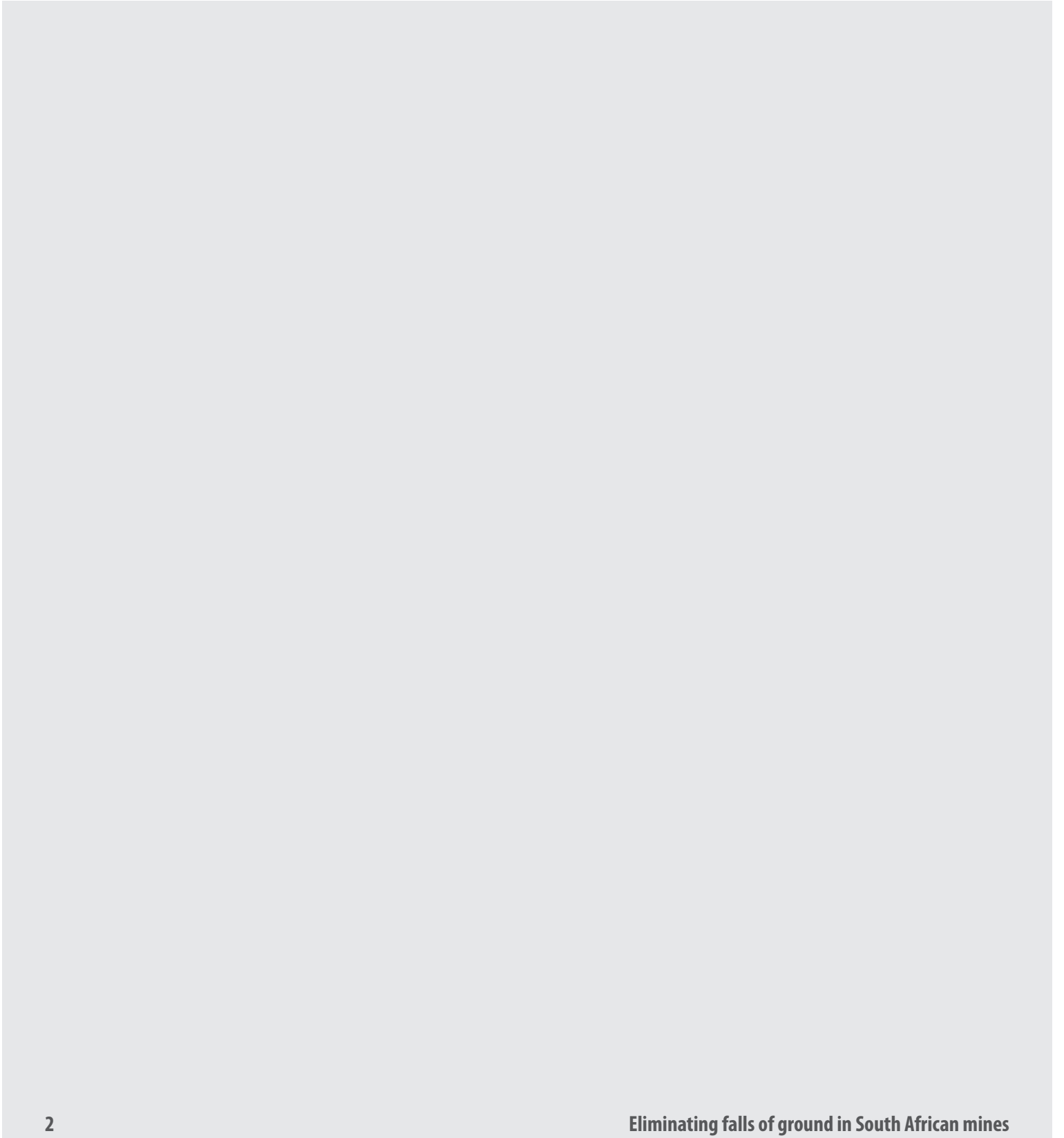
Leading Practice Adoption Guide for the "TARP" system for use in underground mining faces

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Chamber of Mines of South Africa
Putting South Africa First

PROUDLY SOUTH AFRICAN

CONTENTS

EXECUTIVE SUMMARY

Fall of ground fatalities made up approximately 30 % of all mining fatalities in the South African mining industry in 2011, 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 third leading practice to be identified and demonstrated for the reduction of fall of ground injuries and fatalities, addresses the risk in underground mining faces.

The Triggered Action Response plan consists of a set of documented and known hazards that need to be checked for in the working place continually. The level of risk is also pre-identified and the responsible person, doing the inspection has to react according to this plan. Once the risk is identified, then the remedial process is triggered. Based on the risk classification the situation is escalated to the level of responsibility that is required to deal with that risk in terms of the definition of the process. This Action Response Plan may be developed for any of the Major Hazard Areas within a mine, be it Transport, Stored Energy or Falls of Ground related. This particular leading practice looks just at the use of TARP related to Falls of Ground Hazards. At Joel Mine and in the wider Harmony group of companies the TARP plan is referred to as a TSM which stands for Team, Supervisor and Management respectively. These three hierarchal structures have been identified as the levels to which identified risks need to be elevated to and dealt with. As the risk escalates a higher level of management is required to be involved in assessing and making decisions regarding the action that should be taken.

The Programme in terms of combating Uncontrolled Falls of Ground is as follows:
1. The Rock Related Hazards are identified, photographed and documented.
2. A Reference Card System is produced depicting:
   a. A High Definition Photograph of the Hazard
   b. The Hazard is Named and Described
   c. The Hazard is coded in terms of the Risk it poses and the action it Triggers is attached.
      i. (Team) Green – Minor Risk, the "Workplace Team" can deal with the hazard
      ii. (Supervisor) Yellow – Moderate Risk, the affected area is "stopped" and barricaded off and the "Yellow Team" needs to be called for assistance. This Team may include the Shift boss, and Health and Safety Representative, which together with the Workplace Team should conduct an assessment of the situation and come up with a suitable remedial process. Actions are recorded in the Safe Declaration Document and communicated to the Rock Engineering Department.
      iii. (Management) Red – High Risk, the affected area is stopped and barricaded off and the Red Team is called for assistance. This Team may in addition to the Yellow Team include the Section Manager or Mine Overseer, Rock Engineer and Full Time Health and Safety Representative. An assessment of the situation is made and the recommendations are recorded. Only once the Mine Overseer has signed off that those recommendations have complied with, may work continue. Actions are recorded on the Safe Declaration Document and Communicated to the Rock Engineering Department.
3. All Mining Crews are trained in the contents and application of the TARP System and the Reference Cards are carried with the Team (Competent Persons and Health and Safety Representative) in the workings.
4. An E-learning System may be used to enhance the training and management processes attached to the system

PART 1
Strategic Context

The problem addressed

Rock-related hazards continue to be the single largest cause of injuries and fatalities in South African mines, making up close to 30 % of all fatalities(Figure 1) in recent years. While rock related fatalities 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) and in the access-ways to the mining faces. 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.
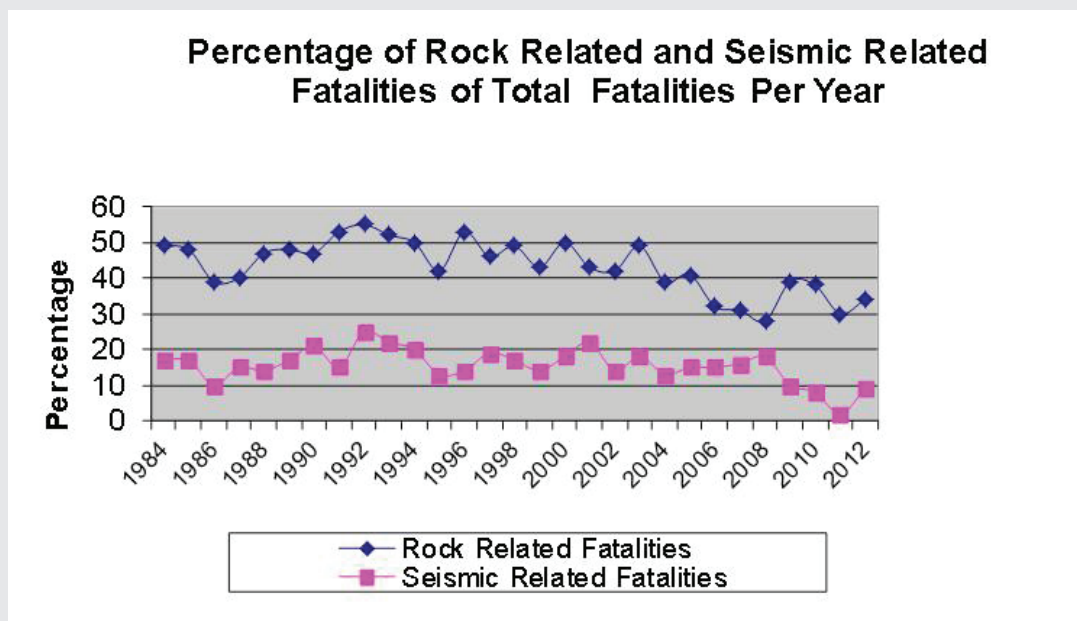
Figure 1: Contribution of rock related fatalities from 1984 to 2012

In 2011 the Mine Health and Safety Inspectorate (MHSI) reported 123 mining-related fatalities in the South African mining industry as illustrated in Table 1, with 38 fatalities or 31 % of cases being rock related.

	Rock related Fatalities	Total Fatalities
Gold	21	51
Platinum	10	37
Other	7	35
Total	38	123

Table 1: Rock-Related Fatalities and Total Fatalities in South African Mines for the Period 1/01/2011 – 31/12/2011. (Source: MHSI SAMRASS Data Base 2011)

Percentage of Fatalities as a Function of distance from the Stope Face 1990-1997
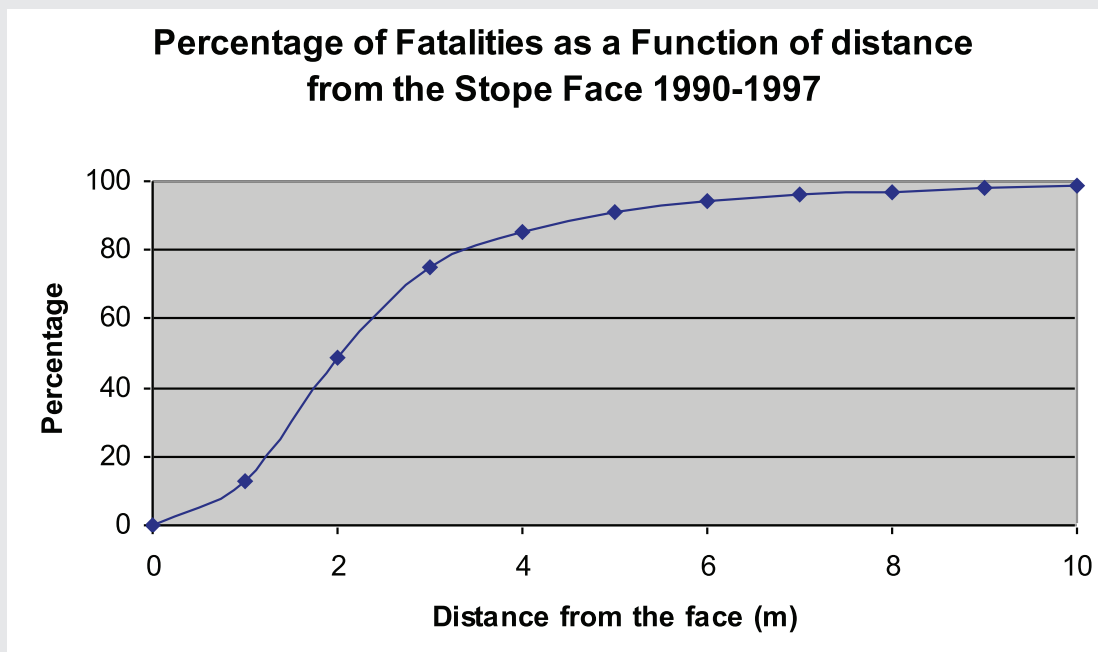
Figure 2: Cumulative percentage of fatalities as a function of the distance to the stope face

Figure 3 shows the fatality rate for rockfalls and rockbursts from 1996 to 2011. 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 38 deaths in 2011 as shown in Table 1 and Table 2.
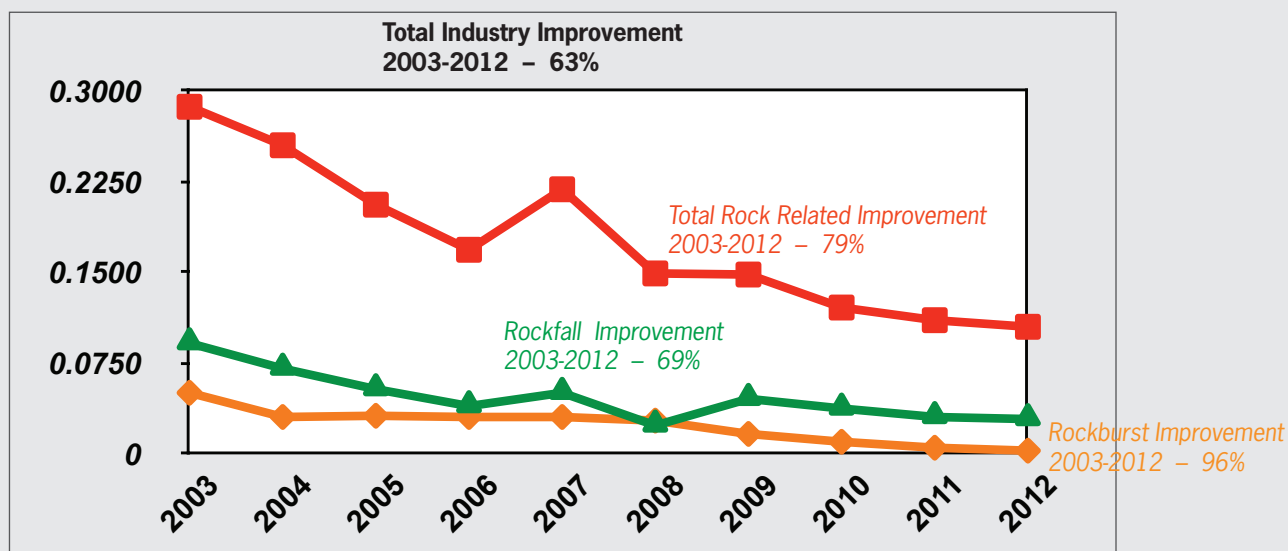
Figure 3: Fatality rate in all South African mines

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Rockfall Fatalities	84	83	65	52	55	49	26	48	39	30
Rockburst/ Strainburst Fatalities	40	48	31	31	30	27	30	17	10	8
Total Rock Related Fatalities	124	131	96	83	85	76	56	65	49	38

Table 2: Rock related fatalities in all South African Mines from 2002 to 2011

The purpose of TARP is to ensure that the area in which stope crew members are using as accessways or performing most of their work are thoroughly assessed before entry and that if falls of ground hazards are identified, the situation will receive the appropriate attention at the right level of management and expertise.

94 Preventable FoG Fatalites (2009 - May 2011)

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

Summary description of the practice

The Triggered Action Response Plan is derived from the Mine's Major Hazard Management Plan. It consists of a set of documented and known hazards that need to be checked for i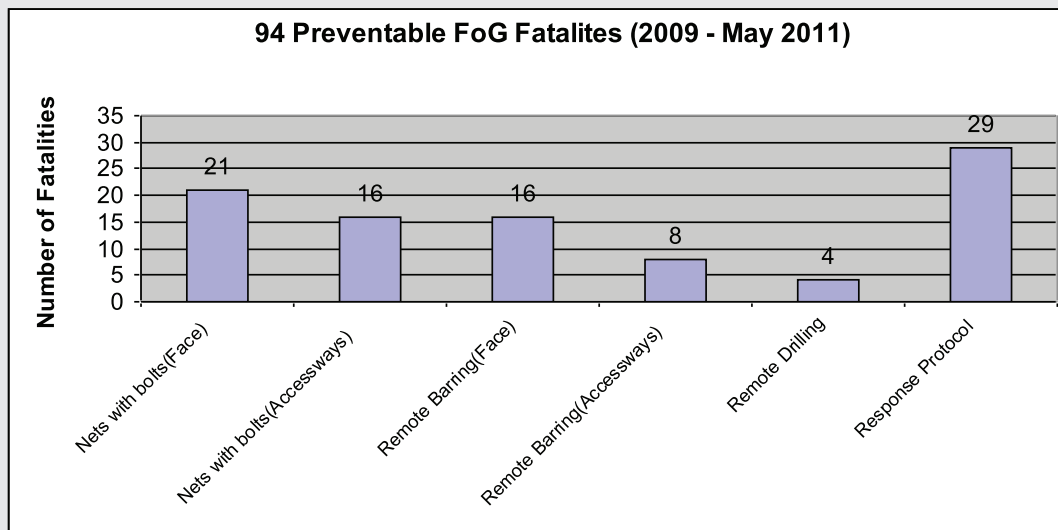n the working place continuously. The level of risk is also pre-classified and the responsible person, doing the inspection has to react according to this plan. Once the risk is is identified , this triggers remedial process which will escalate the problem to the level of responsibility that is required to deal with that risk in terms of the definition of the process. This Action Response Plan may be developed for any of the Major Hazard Areas within a mine, be it Transport , Rock, Stored Energy, or Falls of Ground related.

The programme in terms of combating uncontrolled falls of ground.

1. The Major Hazard Management Plan for the Mine is reviewed.
2. The Rock Related Hazards are identified, Photographed and Documented.
3. A Reference Card System is produced depicting:
   a. A High Definition Photograph of the Hazard (Fault, Brow, Dyke, Blast Induced Fracture etc.)
   b. The Hazard is Named and Described
   c. The Hazard is coded in terms of the Risk it poses and the action it Triggers is attached.
      i. Green – Minor Risk, the "Workplace Team" can deal with the hazard and rectify as per Mine Standard and then continue with their normal activities. Actions are recorded on the Safe Declaration document
      ii. Yellow – Moderate Risk, the affected area is "stopped" and barricaded off and the "Yellow Team" needs to be called for assistance. This Team may include the Shift boss, and Health and Safety Representative, which together with the Workplace Team should conduct an assessment of the situation and come up with a suitable remedial process. Once the conditions have been met with and signed off, normal work may commence / resume. If not possible, they can escalate to a Red coding. Actions are recorded in the Safe Declaration Document and communicated to the Rock Engineering Department.
      iii. Red – High Risk, the affected area is stopped and barricaded off and the Red Team is called for assistance. This Team may in addition to the Yellow Team include the Section Manager or Mine Overseer, Rock Engineer and Full Time Health and Safety Representative. An assessment of the situation is made and the recommendations are recorded. Only once the Mine Overseer has signed off that those recommendations have complied with, may work continue. Actions are recorded on the Safe Declaration Document and Communicated to the Rock Engineering Department.

iv. All Mining Crews are trained in the contents and application of the TARP System and the Reference Cards are carried with the Team (Competent Persons and Health and Safety Representative) in the workings.

v. An E-learning System may be used to enhance the training and management processes attached to the system

vi. All instances of a Yellow or Red nature are communicated to the Rock Engineering Department for further recording, data analysis, review and recommendations. This could include the review of Standards, Codes of Practice, revised inputs at Planning Meetings and the issuing of Special Instructions if needed.

vii. A documented, common name base and understanding exists with respect to each identified hazard, the level of risk associated therewith and the remedial actions to be taken.

viii. The relative persons have been given authority by Management to prevent exposure to the relative hazards and to call for the appropriate assistance.

ix. Management affirms that the safety of the employees overrules other priorities.

x. The TARP system enhances the Examination and Making Safe process.

Triggered Action Response Plan
Workplace Application
(Team – Supervisor - Management)
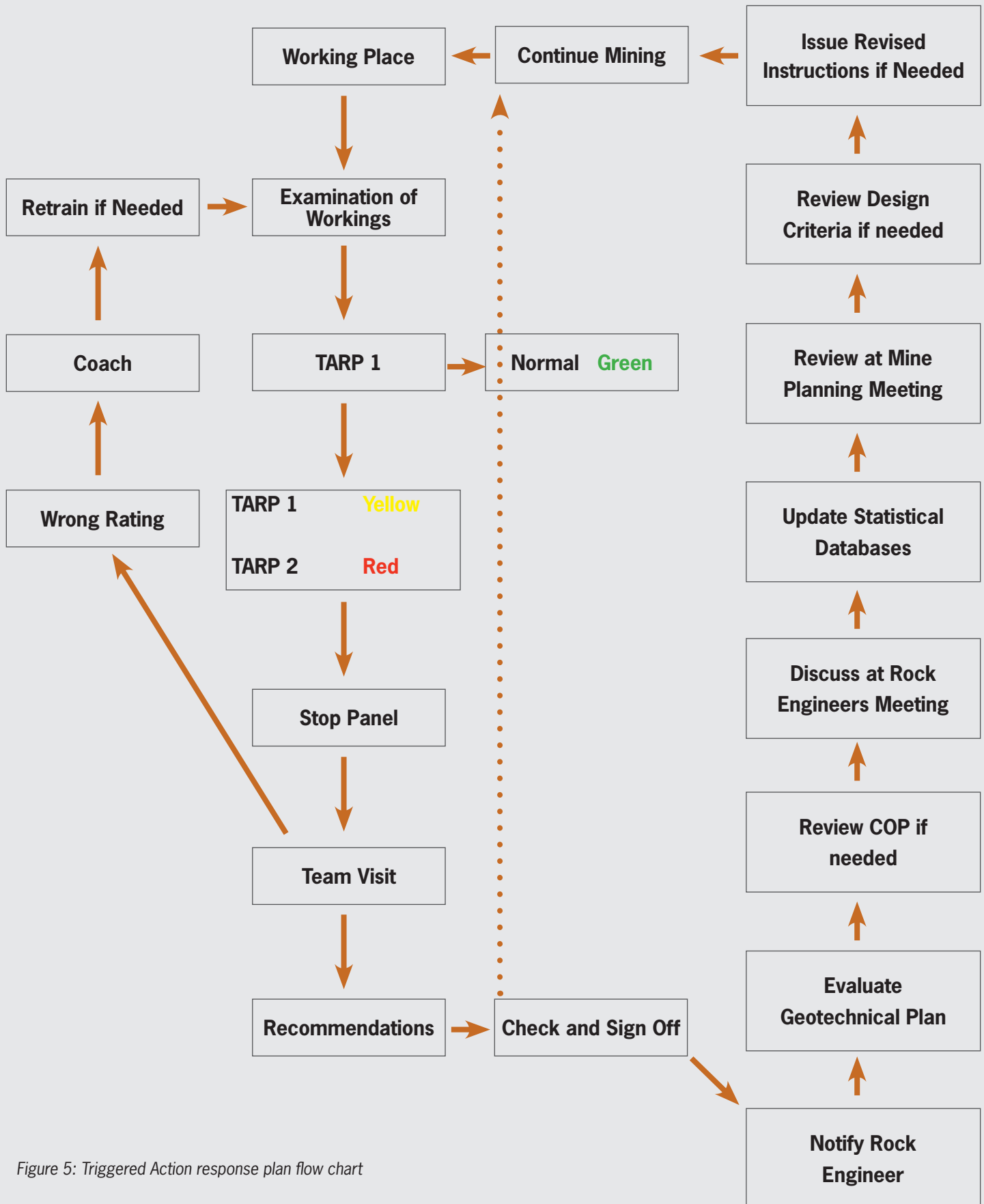
Figure 5: Triggered Action response plan flow chart

Working Place → (from) Continue Mining → (from) Issue Revised Instructions if Needed

Retrain if Needed → Examination of Workings

Coach

Wrong Rating

Examination of Workings → TARP 1 → Normal Green

TARP 1 Yellow

TARP 2 Red

Stop Panel

Team Visit

Recommendations → Check and Sign Off

Review Design Criteria if needed

Review at Mine Planning Meeting

Update Statistical Databases

Discuss at Rock Engineers Meeting

Review COP if needed

Evaluate Geotechnical Plan

Notify Rock Engineer

Scope of MOSH FoG Leading Practice

People

- TARP System
- Leadership Behaviour
- Behavioural Communications

Practice

- TARP System

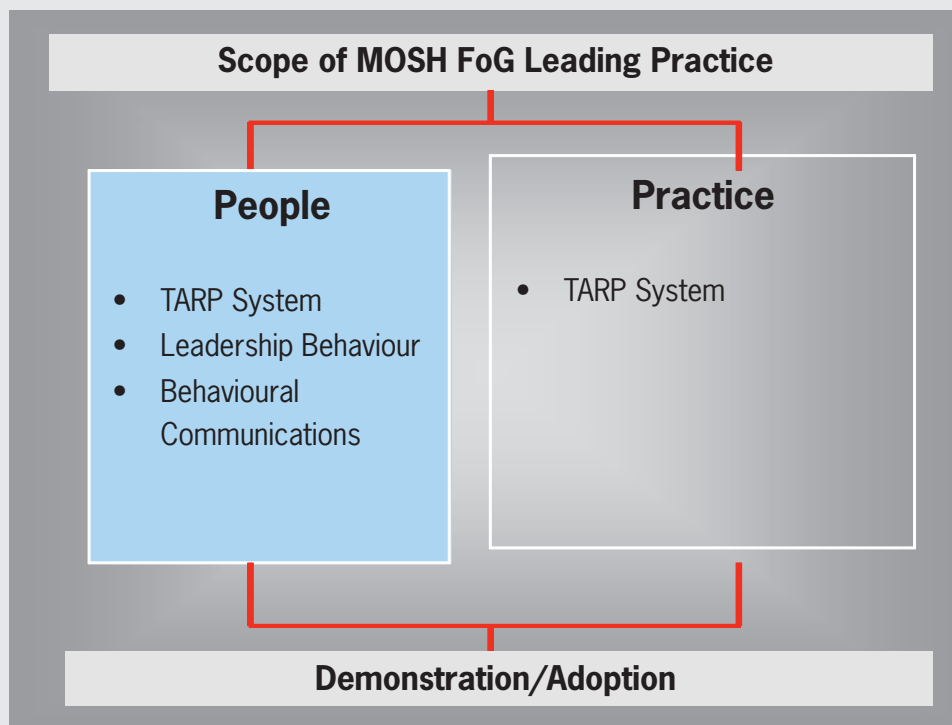**Demonstration/Adoption**

Figure 6: Scope of leading practice.

Summary of documented performance and impacts

Xstrata Kroondal Chrome was selected as the Source Mine. It was on this operation that the practice was observed to be working effectively and resulting in safety benefits for the mine. A Source Mine Report was written to document the Leading Practice on Kroondal Mine (Appendix 1).

Subsequently, the leading practice was demonstrated at Joel Gold Mine, both in terms of the adoption of the procedure and the impact on improved safety that occurred or may be expected in the longer term.

Monitoring of the effectiveness of the TARP system covered the following as indicated more fully in Table 3 below:

Leading indicators:

1. Quality of support
2. Distance of support to the face
3. Distance between support members
4. Personal testimonyLagging indicators -
5. Lost Time Days
6. Injuries (Treat and return to work)
7. Anecdotal evidence from mining staff

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 district1. 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.

Working Place Name:	Team Leader:	Mine Overseer:
Date:	Miner:	Date of Adoption of TARP:
Number of crew members:	Shiftboss:	Other:

Measure	Without Leading Practice	With Leading Practice
Number of Yellow stoppages		
Number of Red stoppages		
Number of incorrect stoppages		
Average Maximum and Minimum Support distance to face (m)		
Average Dip and strike Support Spacing (m)		
Rock related LTIs		
Rock related Serious and Fatal Injuries		
White Flag Days		
Time taken to conduct TARP procedure		
Condition of stopes/tunnels hangingwall		
General Housekeeping (good/moderate/Bad)		
Section 54/55s		
Absenteeism in crews (Total days per week for crew)		
Evidence of team work (good/moderate/bad)		
Mental model changes(y/n, if y what?)		
Tons per person per month		
Area mines (m2) per crew		
Personal Observations/ Experience/ Feedback/ Input		

Table 3: Template used for recording the parameters measured before and after the leading practice

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 R2.7m2. 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 (38 out of 123 fatalities in 2011), the annual cost of these accidents to the industry is enormous. More recent work by Joughin3 indicates that losses of R 500 000 or more per day may be suffered by mines for stoppages for any reasons and

[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*

that mines have been stopped by the DMR for as much as 5 to 10 days. These stoppages inevitably follow fatalities, including rock related fatalities. The use of TARP 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 application of "TARP", 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.

Additional benefits reaped by a mine implementing the practice includes workers being involved in making decisions about safety and training supervisors to listen to workers, which 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

Selection of the demonstration site

The Mining Manager and the Rock Engineer represent Harmony on the MOSH FOG team. They attended a workshop where the TARP leading practice was identified. Following the workshop on the TARP, Joel Mine offered to act as the demonstration mine.

Joel mine satisfied all the criteria for a successful demonstration mine as set out in the MOSH Adoption Handbook.

Development of the initial value case for the mine

Measurements and evaluation of performance factors in the stoping panels and related crews that were identified for adopting the leading practice were made "pre adoption" and "post adoption' While the time scale is short, measurements will be continued for a considerable time still, after the adoption process has been instilled. However, Joel is a mine where "Safe Production" and "Safe Achievement" of targets has become a way of life. To this effect, Joel Mine has already chalked up over 81 consecutive "White Flag" days and their production targets have been superseded during much of the project time, bar the period relating to the Shaft Repairs that had to be made. During the course of this implementation phase, no falls of ground injuries have been recorded nor have any panels been stopped due to adverse rock hazards as contained in the TARP/TSM programme. A significant change in Geotechnical conditions are expected within the next two years as Joel Mine will be rolling out its deepening project and this was also seen as one of the major motivators in bringing the TARP / TSM system to this mine.

As far as the value case is concerned, we have had no negative impacts in terms of Safety / Injury or in terms of lost production. The only impact to date has been the cost of getting the E-learning facility up and running but this is also offset against the broader application of the E-learning programme being instituted by the mine. A positive effect has been noted in acceptance by the workforce and an added advantage lies in proving "competence" within workers for them to detect and manage rock related hazards in a more pro-active manner.

Clear implementation decision by the manager

The Chief Operation Officer, Mr Tom Smith was approached and the idea of being a demonstration mine was motivated to him. The General Manager of Joel Mine, Mr Kennedy Moagi was very keen to implement the new technology to make his safe miner even safer.

Capital had to be approved to establish an E-learning facility on site. STS Harmonize was the company selected to assist with the 3D simulations to Joel's standards.

Setting up the project team – the mine adoption team

Since Joel has a smaller workforce, it was not difficult to select a team. There is only one stoping Mine Overseer, so he was automatically on the team. The HR leader was also approached to join the team. The training manager, as well as the Joel training officer were also co-opted into the team. The Full time safety representatives were used to convey the message to the rest of the work force, through mass meetings. The Rock engineers played a part in compiling a list of hazards, and their possible causes.

The Joel team involved all the Role players from the start, and that made it a success story.

Selection of the appropriate demonstration site at the mine

There are 4 working raise lines, in which the 20 crews work. It was decided to start with the best performing crew, and then to roll out the Leading Practice to the rest of the crews. It was decided that the miner would attend the surface learning with his crew.

Identifying adopters and stakeholders

There are 20 stoping crews on Joel Mine and they will all be adopters to the practice. The Miner, Shiftboss, Mine Overseer and Rock Mechanics Officer are also adopters as they may be called on regularly to help in making decisions regarding underground rock conditions and how to address a particular situation. The stakeholders in the adoption of the Leading practice are the Mine General Manager and the Mining Manager, together with the service department representatives.

Securing support of regional and mine level union representatives

The Mining Manager met with the Unions and explained that safety is to be a way of life for the mining industry and Joel Mine in particular. The Mining Manager conveyed the message to the Unions that there is serious pressure from government level for the mining industry to improve on their safety. The Unions accepted the idea that crews needed to be empowered to stop if they are not happy about the condition of the work place. They appreciated that the TARP leading Practice offered a formalised approach to identifying and then stopping working places that were unsafe.

Who is to be kept informed of the adoption progress on the mine ?

The mining manager is the chairman of the Mine Adoption Team. He has the responsibility of keeping the General Manager informed of the adoption progress and the schedule. They meet informally on a weekly basis and the General Manager is updated on the program as well as the way forward.

Who is tasked with overseeing the BC & LB plans on the mine?

The Leading practice is very dependent on achieving the correct balance between the practical process, procedure or practice and the behavioural aspects. Without the behavioural aspects the leading practice is not present. Therefore on Joel the behavioural aspects of the leading practice were given to the specialists on the mine who were most likely to have training and knowledge of human behaviour. These were the Human Resource personnel who had access to the Chamber of Mines Behavioural Specialist.

Identify persons to do direct enquiry and analysis

The Behavioural Specialist at the Chamber of Mines visited the mine and was given three individuals with Human Resource responsibilities to train in the interview process. The interviews were conducted and written and audio records of these interviews were made. The audio interviews were translated at Wits University from which the draft Behavioural Communication plans and the Leadership Behaviour Plans were developed. These plans were then presented back to the mine and they performed the customisation of the plans.

Preparation for and conducting the direct enquiry interviews

The direct inquiry interviews were conducted on 20 members of the Joel mine staff across all levels of the team responsible for mining. Individuals from different employee bands were identified, and then interviewed . There were more people from the lower employee bands interviewed that the top bands. The following is the breakdown of those interviewed.

1. General Manager
2. Mining Manager
3. HR Leader
4. Chief Safety Officer
5. Mine Overseer
6. Senior Surveyor

7.   Shift Boss (*2)
8.   Miner (*2)
9.   Health and Safety Steward
10. Transport supervisor
11. Team Leader (*2)
12. Team member (*3)
13. Rock Drill Operator (*3)

Analysis of the direct enquiry interviews

Once the direct enquiry interviews had been completed, the responses were analysed by the MOSH Behavioural Specialist at the Chamber of Mines Learning HUB. Where direct enquiry interviews had been conducted in languages other than English or Afrikaans, these interviews were translated into English by Wits University.   From the responses the Behavioural Specialist developed Leadership Behaviour and Behavioural Communication plans which were then sent to the mine for finalization by the Human Resources Department.

Identification of any special training needs

It was decided that the use of e-learning and visual reality would assist greatly in the adoption of the leading practice at Joel. The training material was designed by the service provider and was satisfactory. Joel's management is positive of its acceptance by all those involved in the TARP process. At each session with a new crew the mining manager or section Mine Overseer gives an introductory lecture on the TARP system with its MOSH elements briefly explained. A pocket booklet with all the major FoG hazards has been prepared and laminated and is given to all supervisors to take with them underground. Each Team trains together and includes the shiftboss down to the crew with the Mine Overseer sometimes attending. They spend the first day of training on surface followed by underground training, putting into practice their training. The Mine Overseer or Shiftboss does an early shift with the crew. The process still involves Entry Examination and making safe, application of the Fogis system with the TSM plan. There is an on-going coaching for the crew in the work-place and follow-up from the safety department at regular intervals. The shiftboss is able to see each of his crews every day given the location of panels. Therefore if during mid-shift barring problems are identified it is possible to get the correct team together to the site fairly quickly.

Customising LB & BC plans

The Mine received the draft versions of the Leadership Behaviour and Behavioural Communication plans from the MOSH Behavioural specialist and then customised them for their mine building the information from the interviews into the training, general lesson plans and ultimately into the implementation plan.

Permission by management to implement Behavioural-based plans

The behavioural plans for the mine where agreed to by the Senior Management team of the mine after consideration by the Human resources department and the mine adoption team.

Visits to or discussions with Source mine

Senior members of Joel Mine and Harmony Gold Mining Company visited the Source mine, Kroondal Xstrata Chrome .

Special training of project leadership in behaviour based techniques

Throughout the process of meeting with the mine adoption team at Joel, the principles of the MOSH leading Practice adoption system were explained and shared. The leadership of the mine was represented at the meeting from both the management and the organised labour, so the differentiators between simply applying a new practice and a MOSH Leading Practice viz. the leadership behaviour particularly but also the behavioural communications were made clear.

Communicating updates to future adopter mines and own mine. Briefing stakeholders

The General Manager of Joel meets with his employees from Miners upwards every Thursday. This is used as an opportunity to brief the mine on the progress on the TARP plan and the progress that is being made. On a Tuesday, team leaders are communicated with and the opportunity is used to update these members of progress with the Leading Practice.

Harmonising the practice with mine standards/mine circumstances

Joel Mine has its own mine standards and an auditing checklist exists to assist the mine in fulfilling these. With the TSM plan, the particular geological condition is identified. If the condition is classified as green then the crew is in a position to respond to the condition. If the colour is yellow or red then the area is barricaded off and the appropriate level of expertise is summoned to assist.

Identification of key success factors

The main success factor that the Joel Mine is monitoring as the TARP plan is implemented is that of continuing their legacy of excellent safety and to even improve it. Clearly another key success factor is to maintain and improve production as a result of the leading practice. The behavioural aspects of the MOSH Adoption system will be essential to sustain the leading practice on the mine and to derive the cultural changes that will help all aspects of the mining process on the mine.

Identify criteria and time scale for project completion

The Criteria and timescale was decided on by the Mine's Adoption team as facilitated by MOSH Adoption team manager and using the example of an adoption schedule as contained in the MOSH Leading Practice Adoption Handbook. A project schedule was drawn up and making use of past experience and the local conditions at Joel, such as the number of teams to be trained, what sections would be involved, the state of the current practice regarding rock related hazard recognition, the progress that was made in terms of having adopted the leading practice for the Entry Examination and Making Safe of their working places and their Major Hazard Management Plans, the schedule was drawn up and progress evaluated at each phase of the programme and at each progress meeting. While many Management related topics had to be included, the major emphasis was in the practical implementation and involvement of the workforce in the process.

Identifying project risks and mitigation plans

Late delivery of e-learning equipment and the provision of the learning facility were seen as risks to the success of the project. There was no suitable room to accommodate the equipment and a new room had to be created. This in fact did delay the progress on the project.

Acquisition of equipment and IP issues

Harmony Gold had already embarked on an e-learning approach as their FOGIS system necessitated this. Since the introduction of the TARP Leading Practice, the shaft population and the size of the training facility at each mine has been considered. At Joel Mine a room was prepared in the current training facility to accommodate the computer consoles which are connected to a master computer in the room . A licence agreement has been established with the provider of Virtual Reality software on a fee per learner. The learner may use the programme as many times as he or she wishes. . The facility will be used for review and refresher training once initial training is completed. In making the decisions pertaining to software Joel visited Union Mine to see their e-learning facility. Discussions with computer software and hardware vendors were held and tenders submitted for their supply.

The software programmes are not confined to rendering only Falls of Ground scenarios but may later be programmed to visually display other major hazards.

Training of workers involved in the implementation of practice

Once the e-learning facility was established, the first people who went through the training were the Adoption

team including the General Manager. At the training centre assessors run the training and evaluate each person's performance. The competency of the trained members is assessed underground by the supervisors.

Preparation of key training documentation

The main document for training in the TARP plan for falls of ground is a list of all the rock related hazards in Harmony Gold Mine, South operations. This information was then categorised and photographed with simple descriptions of each hazard attached. The information was then condensed into pocket booklet size, laminated and distributed to all Team leaders and above. It is intended that these persons will carry these booklets with them at all times underground. The other important part of the training is that the information in the booklet was captured into graphic virtual reality sequences depicting the hazard and the consequences of not identifying and dealing with the hazard correctly.

Setting up the required equipment maintenance arrangements

A private vendor was used to provide the software for the rendering of the Virtual Reality scenarios. A cost per learner was agreed to irrespective how many times the learner used the facility.

The hardware necessary for the e-learning centre was acquired through the tender process and the normal warranties and guarantees governing the purchase of equipment are in place.

Design of monitoring programme

The mine adoption team considered the factors that were important in assessing whether the TARP/TSM initiative was having any impact. These included safety, production and behavioural factors. A number of drafts were considered and revised. Once the final list of factors was decided on a one-page recording sheet for shiftbosses was designed. At the same time provision was made for the individual daily inputs from the shiftbosses to be captured on a central Excel database. In a separate survey conducted by the MOSH Behavioural Adoption Specialist, the culture change will be assessed from pre to post adoption of the Leading Practice at Joel.

Initial test implementation of the practice

The approach is familiar to the workers. The TARP plan was formalised and will preserve organisational memory. In addition, the behavioural aspects of the MOSH system have been added to the practice so that all stakeholders in the process understand the reasons for following the plan, give correct leadership and receive communications that will influence their behaviour positively. Therefore, the initial test ran without difficulty.

Impact on production

During the training period of all the crews on Joel, 20 blasts were lost which represents about 600 m2. However, the mine was still able to make up this lost production following the training.

Documentation of the performance and impact of the practice (Value case)

Measurements and evaluation of performance factors in the stoping panels and related crews that were identified for adopting the leading practice were made "pre adoption" and "post adoption' While the time scale is short, measurements will be continued for a considerable time still, after the adoption process has been instilled. However, Joel is a mine where "Safe Production" and "Safe Achievement" of targets has become a way of life. To this effect, Joel Mine has already chalked up over 81 consecutive "White Flag" days and their production targets have been superseded during much of the project time, bar the period relating to the Shaft Repairs that had to be made.

During the course of this implementation phase, no falls of ground injuries have been recorded nor have any panels been stopped due to adverse rock hazards as contained in the TSM programme. A significant change in Geotechnical conditions are expected within the next two years as Joel Mine will be rolling out its deepening project and this was also seen as one of the major motivators in bringing the TARP / TSM system to this mine.

As far as the value case is concerned, we have had no negative impacts in terms of Safety / Injury or in terms of lost production. The only impact to date has been the cost of getting the E-learning facility up and running but this is also offset against the broader application of the E-learning programme being instituted by the mine. A positive

effect has been noted in acceptance by the workforce and an added advantage lies in proving "competence" within workers to for them detect and manage rock related hazards in a more pro-active manner.

Due to the training in preparation for the implementation of the leading practice meant that 20 production blasts were lost. This represents about 600 m2. Following the training and the roll-out on the mine, there have been no stoppages. Yellow panels have all been resolved on the same day of classification and blasted.

Refinement to practice prior to full roll out

After the first crew had been trained and implemented the practice underground there were no changes necessary to the practice prior to the full roll out on the mine.

Implementation plan for mine

A schedule of the 20 crews was drawn up and training dates and the roll out dates were set.

PART 3
Details of the Leading Practice

Overview

The following basic requirements have been established for the successful adoption of the TARP leading practice:

1. Commitment from the most senior manager on a particular mine
2. Involvement and buy-in to the leading practice by the organized labour on the mine and in the region
3. Formation of an effective mine adoption team
4. Commitment of the mine adoption team to the MOSH process
5. Classification of all the significant rock related rockfall hazards on the mine
6. Photographing, describing and documenting the hazards
7. E-learning facility to train personnel in the identification of each hazard and consequences of taking incorrect decisions
8. Regular follow-up on the adoption by crews

Site selection for initial adoption

1. Joel has 20 stoping crews under one production Mineoverseer so the selection of the first crew to be trained and the site at which it was first implemented was simple and decided by the Mine overseer with the Mining Manager.

Equipment

1. A document which describes all the significant potential rockfall hazards photographically and literally is essential
2. A laminated pocket sized book with all the significant hazards
3. The e-learning centre is key but not critical to the adoption of this Leading Practice

Necessary supporting physical infrastructure

1. The e-learning centre is key but not critical. If an e-learning centre is established then the correct investment in computer hardware is necessary.

Training

1. Crews received training at the e-learning centre. The software is designed to teach and check on knowledge retention.
2. The crews are trained further underground with their supervisors
3. Further on-going couching and assessments are carried-out by safety personnel at regular intervals

Instruction documentation

1. The e-learning has documentation built into the software. Instructions are given for the candidates to follow

Incentive arrangements

1. Safety was agreed on Joel to be the first priority and therefore the Leading Practice was accepted as an initiative to maintain and improve safety. Therefore no incentives were offered or requested.

Operational procedures

1. The TSM system had already been operating before the adoption of the MOSH Leading Practice. Therefore

this practice has continued but with the addition of the e-learning and the inclusion of the behavioural aspects derived from the direct enquiry interviews. It fits in well with the required entry examination and making safe practice.

Relevant mine standards and Risks

1. The new TARP/TSM Leading Practice was assessed to determine if new risks had been introduced through its adoption. There were some minor changes but not significant to exclude the practice being adopted. The necessary changes were made.

Monitoring and reporting arrangements

1. The shiftbosses were tasked with collecting the measurements which were identified by the Mine Adoption Team. These measurements are carried out each day in each panel. The data is recorded into electronic format every day by the Shiftboss. The Mine Overseer has the responsibility of combining the data into a master spreadsheet and reporting the findings to the Mine Adoption Team at monthly meetings.

Performance measures

1. The summary performance measures from before and after the adoption of the Leading Practice are contained in Appendix 9. The main findings are:
2. The support was installed closer to the face
3. Support spacings on strike decreased slightly
4. Production targets are still met
5. Behavioural Culture on the mine may be improving
6. House-keeping may be improving

Management of leading practice

1. The General Manager of Joel gave his full support to the MOSH Adoption process. The Mining Manager was appointed as the Mine Adoption Team leader to lead the process. The Mine Overseer and Shift Supervisor were tasked with managing the adoption of the Leading Practice in the production areas.

Proprietary knowledge or technology

1. The software vendor owns the IP for the basic programmes on which Joel's own unique conditions are built. The Joel additions are the IP of Joel Mine.

APPENDIX 1
The Joel Procedure for implementing TARP

The TARP programme in terms of combating uncontrolled falls of ground

1. The Major Hazard Management Plan for the Mine is reviewed.
2. The Rock Related Hazards are identified, Photographed and Documented.
3. A Reference Card System is produced depicting:
   a. A High Definition Photograph of the Hazard (Fault, Brow, Dyke, Blast Induced Fracture etc.)
   b. The Hazard is Named and Described
   c. The Hazard is coded in terms of the Risk it poses and the action it Triggers is attached.
   d. Green – Minor Risk, the "Workplace Team" can deal with the hazard and rectify as per Mine Standard and then continue with their normal activities. Actions are recorded on the Safe Declaration document
   e. Yellow – Moderate Risk, the affected area is "stopped" and barricaded off and the "Yellow Team" needs to be called for assistance. This Team may include the Shift boss, and Health and Safety Representative, which together with the Workplace Team should conduct an assessment of the situation and come up with a suitable remedial process. Once the conditions have been met with and signed off, normal work may commence / resume. If not possible, they can escalate to a Red coding. Actions are recorded in the Safe Declaration Document and communicated to the Rock Engineering Department.
   f. Red – High Risk, the affected area is stopped and barricaded off and the Red Team is called for assistance. This Team may in addition to the Yellow Team include the Section Manager or Mine Overseer, Rock Engineer and Full Time Health and Safety Representative. An assessment of the situation is made and the recommendations are recorded. Only once the Mine Overseer has signed off that those recommendations have complied with, may work continue. Actions are recorded on the Safe Declaration Document and Communicated to the Rock Engineering Department.
   g. All Mining Crews are trained in the contents and application of the TARP System and the Reference Cards are carried with the Team (Competent Persons and Health and Safety Representative) in the workings.
   h. An E-learning System may be used to enhance the training and management processes attached to the system
   i. All instances of a Yellow or Red nature are communicated to the Rock Engineering Department for further recording, data analysis, review and recommendations. This could include the review of Standards, Codes of Practice, revised inputs at Planning Meetings and the issuing of Special Instructions if needed.
   j. A documented, common name base and understanding exists with respect to each identified hazard, the level of risk associated therewith and the remedial actions to be taken.
   k. The relative persons have been given authority by Management to prevent exposure to the relative hazards and to call for the appropriate assistance.
   l. Management affirms that the safety of the employees overrules other priorities.
   m. The TARP system enhances the Examination and Making Safe process.

APPENDIX 2
Mental Models Interview Protocol used at Joel Mine (demo mine for the TARP leading practice

Opening

1. What is your position or designation?
2. What are your most important responsibilities?
3. What is your main interest or involvement in TARP at your mine?

Perceived risks associated with underground FOG

4. Why do you think FOG accidents happen:
   a. Work procedures – are they appropriate and always followed? Examples?
   b. Training and skills – sufficient to avoid FOG accidents? Examples?
   c. Health or fitness for work – Problems?
   d. Attitudes?
   e. Risk perceptions?
   f. Other matters not properly understood?
5. Of all the things about FOG that you have mentioned, what do you think is the number one issue that should be addressed? Why?

Leading Practice being considered

The MOSH Falls of Ground Adoption Team is considering a "Triggered Action Response Plan" practice for mines like yours. It would entail making sure that all checks are made, by a competent person assisted by experienced members of the team, and that the Falls of Ground Hazards are correctly identified and classified, in line with a pre-set standard and in terms of the risk it poses, and that the correct level of attention would be given to treat that hazard before the area can be declared safe to work in.

6. So, having heard a bit about the leading practice the team is considering, what do you think would be the greatest benefits of adopting (or making this practice your own) this at your mine?
7. Would there be any downsides of adoption?
8. What do you think it would take for the adoption of this leading practice to be seen as a top priority in your mine? Please explain your answer.

Aids and barriers to adoption

9. What about this system do you think might be a problem at your or other mines? Why?
   a. What would you need to get full buy-in from your management team / subordinates?
   b. What information and data would you need?
   c. How would you prefer to get such information and from what source?
   d. Who else would you need to convince?
10. What do you think are the most important things to do to achieve success?
    a. Training –special training?
    b. Access to resources – availability money for equipment and people?
    c. Motivation - Special incentives?

d. Leadership – any special qualities / or behaviours considered necessary?

e. Communication – what would be important to communicate? By whom?

11. Of all the things mentioned, which do you think would be the number one issue? Why?

12. Are there things that could prevent successful adoption of TARP at a mine? Why?

13. Who at your mine, (worker / supervisor level), have the greatest influence on the adoption of TARP? Why?

Leadership

14. What would be the most important thing that a superior should do to support subordinates in implementing TARP? Why would this be important?

15. What should he not do? Why do you say this?

16. What do you think senior mine leaders should do to support adoption of TARP? Why?

17. What do you think operational level supervisors need to do to ensure successful adoption of TARP?

18. Which of these things would be most important and why?

Communication

19. Thinking of the leaders at your mine who you really trust, without naming anybody, what is it that they do that makes you trust them?

20. Thinking of leaders who you do not trust, without naming anybody, what is it that they do that makes you distrust them?

21. What do you think would be most important for trusted leaders to say or explain regarding TARP? Why?

22. And what ways would be most effective in communicating information regarding TARP?

23. What ways would be least effective – and why would they be so ineffective?

Wrap up and Closure

24. Is there anything else that you think will be important to know about TARP?

APPENDIX 3
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 done?
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 arise?
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 4
Risk Summary

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

Part A – Description of the causal chain

Nature of the hazard	Exposure to the hazard	Outcomes of exposure
No **Description**	**No** **Description**	**No** **Description**
1. Mining operations are designed to extract the maximum amount of ore possible 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 3. Large mining spans result in higher abutment stress levels and stope closure increasing the risk of rock falls 4. The rockmass around deep-level excavations is fractured due to the high virgin rock stress and the stress concentrations induced by mining 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 6. Unsupported pieces of fractured rock may fall due to gravity without warning 7. Loss of a key block in a fractured hanging wall beam can result in many rocks falling as the fractured roackmass unravels 8. Installed support does not provide full area coverage 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 10. The time dependent response of timber support to imposed loads results in lower levels of support resistance being provided 11. Poor control of mining operations may 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	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 2. The examination and making safe procedure requires workers to come into close proximity with rocks that have the potential to fall 3. Workers responsible for cleaning blasted rock from the working stope face must do so before a new line of support is installed 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 5. Setting up the cleaning operation may involve some workers being exposed to unsupported hanging wall - setting up the scrapper ropes 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 7. Drilling for the installation of bolted support exposes drillers to situations involving temporary support only 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 9. Miners and other supervisors are also exposed to the rockfall hazard but for shorter periods 10. Persons from mining service departments such as surveyors, geologists, samplers, ventilation 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	1. Death due to being crushed or other traumatic injury from falling rocks. 2. Serious injury that results in partial or total disability 3. Injuries that result in work absence 4. Injuries that result in work time stoppage to attend to the injured persons 5. Rockfalls that result in persons being trapped or buried for extended periods, to the point where persons may die before being released 6. Time delay before expert medical care (equipment and expertise) is available 7. Disabled persons returning to home care may not cope or be accepted 8. Persons may need to undergo extended periods of rehabilitation 9. Disabled persons may need to be trained to undertake different occupations on returning to work. 10. Persons may need to undergo special counselling prior to being reintegrated into their work team 11. Sharp edged falling rock may cause cuts that bleed profusely resulting in shock or death due to a loss of blood 11. Injured workers may be HIV positive and pose a health risk to those who treat them both underground and on surface 12. Rockfall accidents due to poor control measures may give rise to regulatory action that results in work stoppage for prolonged periods

Part A – Description of the causal chain (continued)					
Nature of the hazard		**Exposure to the hazard**		**Outcomes of exposure**	
No	**Description**	**No**	**Description**	**No**	**Description**
12.	Rocks that fall vary in size from small fragments to large rocks of many tons	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.	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				
14.	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				
15.	High temperature conditions impair the ability of workers to recognise hazardous situations				
16.	High rockstress in the mining face causes fractured rock in the mining face to be violently expelled into the excavation				
17.	Mining towards unknown geological features				
18.	Mining faces approaching each other result in increased rock stress levels that increase the risk of rockfalls				
19.	Unplanned pillars due to geological features result in high stress conditions that increase the risk of rockfalls				
20.	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.				
21.	Exposed rock weathers and losses strength with time				
22.	The length of the fractured hanging wall section (beam) that is self-supporting decreases with time and previously clamped rocks may fall				
23.	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				
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				

Part A – Description of the causal chain (continued)		
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**
No Description	**No Description**	**No Description**
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	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 2. Support standards implemented by the mine may not meet the requirements of the area being mined 3. Pieces of rock that may easily fall may not be detected and barred down during the examination and making safe procedure	1. Partial vigilance of all underground workers 2. Lack of sustainability of any systems put in place to address the risk of falls of ground 3. Lack of use of the provided PPE	1. Rapid medical care to injured workers at the site of the accident 2. Possibility of the transmission of the HI virus 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 2. Expert planning 3. Exposure to and adherence to the RE leading practices locally and internationally	1. Seismic sounding of the hanging wall above the place where a person is going to work 2. Infrared survey of the rock above the place that a person is going to work 3. Design work to be carried out as much as possible remotely by modifying machines	1. Dedicated medical team on standby to reach accident sites within 30 minutes 2. Improved training and preparedness of workers to handle blood injuries 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

APPENDIX 5
Mental models report derived from the demonstration mine

Major theme	Sub theme	Description of theme	Summary of research findings
Cause of FOG	Non compliance	Non compliance to standards: poor support, poor entry examination.	Interviewees were almost unanimous on this point citing negligence, short cuts, focus on targets and complacency as reasons
Barriers or Challenges to Address	Attitudes	People will come up with invalid reasons not to enter working places	This was mentioned by a Mine Overseer, but it is probably a wider concern.
	Need	People don't perceive the need for new interventions	One interviewee felt that people may say they don't need it because they achieve their safety and production targets already. Another said that such campaigns only happen after a problem has occurred.
	Effort	The LP may be seen as causing more work	People may resist this on the basis that they will have extra work to do for which they are not remunerated
	Production pressure	The LP may retard production	One interviewee believed that the miner may be expected to continue work despite the fact that a hazard has been escalated. A MO cited production pressure as a barrier
	Remuneration	People want to be compensated if the system involves more work	'The most important thing to the workers is money, they must be satisfied' 'There must not be changes to people's conditions' 'Recognise people by uplifting their wages'
	Discipline	Punishing people for using the system	'People must be made aware that they are not going to be charged' 'Management must not threaten the people about their performance of the day'
	Poor Leadership	Leadership behaviour that is de-motivating	'Belittle' 'Undermine' 'They think they don't need to talk to you because they are on a higher level' 'Do not attend to my interests' Care came up a few times. A good example: 'When you were off sick and you return to work, they will not ask you how you are and if you are able to work. They will say look how much work have you left here' 'Dishonesty' 'Shouting at us' 'Have outbursts' 'Never listens'

(continued)			
Major theme	**Sub theme**	**Description of theme**	**Summary of research findings**
Aids that will facilitate implementation	Participation	Involve all stakeholders in the process, most importantly, Management must listen to and respond to worker needs and views	This view was held by the vast majority of interviewees. Examples of what was said are: 'Involve employees and their union in the process' 'People must have 'freedom of speech' 'People must work as a team' 'We must work as co-workers' 'People must 'own' the project' The manager 'must not do this thing on his own and afterwards tell us' 'He must hear our opinions 'Listen to the complaints of the workers' 'Work together with the people' 'Listen to what we bring to them, give full attention' About supervisors: 'they are workers as well' 'They must know what the workers need' 'Managers must have ways to have meetings with us so that they can hear what our complaints are' 'We must feel free to discuss issues' 'Listen to our complaints and we will be able to work together in the right way'
	Values	Piggyback on the mines existing values	Interviewees at all levels made reference to "our values" Examples: 'motivate people using the values of the mine' 'Communication, commitment, respect, honesty and recognition'
	Accountability	People at the appropriate level will be accountable to declare a workplace safe	'People at the lowest level will not be unnecessarily punished; the 'people in charge' will bear the responsibility'
	Communi-cation	People must be properly informed and constantly reminded	Literally all interviewees mentioned the importance of communication: 'Frequent meetings' 'Explain it properly' 'Explain the benefits' 'Create a common understanding' 'Explain fully' 'Be understood clearly' 'Be demonstrated practically' 'Explain to people why' 'Keep reminding the people' 'Do it continuously until it is entrenched' 'Up and down – not telling, rather sharing and getting a common idea' Face to face down the line by far the most preferred method of communication - in team context Written communication not preferred.
	Training	People must be able to work according to the system	A substantial number of interviewees expressed the need for proper training.

Mental models report derived from the for the demonstration mine (continued)			
Major theme	**Sub theme**	**Description of theme**	**Summary of research findings**
Aids that will facilitate implementation	Management commitment	Leaders at all levels must show their commitment to the project.	Most interviewees agreed that the project must be driven from the top. 'They must practice what they preach' 'Management must be patient' 'The top management must not say it's too expensive, safety comes first' 'Management must not preach safety but only be concerned about production'
	Leadership	Effective leadership to motivate the people	'Supervisors must be approachable' 'They must listen to the workers' They must be visible' Supervisors 'must not speak rudely or in an unpleasant manner to the people. They must talk nicely' 'Management must be visible, talk to the people' 'Lots of interaction, talk to the people' 'Work together with the people' 'Physical visits to the working places' Management 'must understand what it is about before explaining it to the people' 'The leader must know what he talks about' 'Honesty is important, tell them if you don't know' 'Clear instructions'

APPENDIX 6
The customised behavioural communication plan developed for the mine

Draft (Generic) Behavioural Communication Plan: TARP Leading Practice: Joel (Demonstration Mine)

It is important that the leaders be trained as per the plan below before the introduction of the LP. Upon introduction of the LP, workers and team leaders will expect certain behaviours from their leaders as per the messages communicated to them in terms of the plan below (e.g. that they will not suffer negative consequences for using TARP). If there is incongruence between what they are told and what actually happens, there will be conflict.

The phrase used below (What is TARP, How does it work, why is it adopted, how it will approve safety) needs to be expanded upon significantly by technical TARP experts

The tables below are done for three groupings: Workers, Team leaders Miners; Miners, Shift overseers; Mine overseers; and Managers. Note that there are numerous behaviours/messages that overlap between the groups.

This is a generic plan to be customised by the mine. For this reason, only the first two columns have been completed and should not be changed. The other columns (Mode, Tools, Timing, etc.) is for the mine to decide and to be completed by them.

Behavioural Communication Plan: TARP Leading Practice: Joel (Demonstration Mine)

Workers, Team leaders, Miners

Issue addressed & Desired Behaviour	Messages Communication Content	Mode	Tools / means	When	Responsibility for delivery	Who to ensure	Evaluation / control measure
Issue addressed: Draw attention to FOG as hazard and explain the need to introduce TARP correctly and how to apply TARP correctly.	What is TARP, How does it work, why is it adopted, how it will approve safety	Training Team meetings One-on-0	Lesson plans Dialogues Coaching				
Desired behaviour: Apply support standards correctly, consistently	What the support standards are	Training Team meetings One-on-one	Lesson plans Dialogues Coaching				
Identify triggers at every entry examination: consistently, correctly.	Why it is important to work to standards (very basic rock engineering principles)	Training Team meetings One-on-one	Computer based training Trigger chart Dialogues Coaching				
Follow rules unconditionally (do not enter red or yellow panel) When in doubt, rather escalate.	What the triggers are	Training Team meetings One-on-one	Lesson plans Dialogues Coaching				
	What the triggers look like	Training Team meetings One-on-one	Lesson plans Dialogues Coaching				
	The importance of the rules						
	The consequences of not following the rules						
	When in doubt, don't take a change						

Behavioural Communication Plan: TARP Leading Practice: Joel (Demonstration Mine)

Workers, Team leaders, Miners

Issue addressed & Desired Behaviour	Messages Communication Content	Mode	Tools / means	When	Responsibility for delivery	Who to ensure	Evaluation / control measure
Issue addressed: Explain the consequences of introducing TARP, i.e. what can workers expect and how must they react	You will not be blamed or victimised if panels are stopped with the TARP process. If it happens, report it to management						
Desired behaviour: Workers must adopt and persevere with TARP	You will sometimes wrongly classify panels, that's OK						
	Panels will sometimes stand because of TARP, that's OK						
	Leadership may sometimes complain, tolerate that						
	If you do not stop and fix and there is an accident, the panel will stand for longer than when you stop it						
	Safety is more important than anything else						
	TARP the only way to mine, there is no other way						
	Remember: "It is better to lose the production than a person"						
	The introduction of TARP will not entail extra work						
Issue addressed: Workers concerns regarding TARP	The introduction of TARP will not entail extra work						
Desired behaviour: Workers must adopt TARP							

Behavioural Communication Plan: TARP Leading Practice: Joel (Demonstration Mine)

Miners, Shift Overseers, Mine Overseers

Issue addressed & Desired Behaviour	Messages Communication Content	Mode	Tools / means	When	Responsibility for delivery	Who to ensure	Evaluation / control measure
Issue addressed: Draw attention to FOG as hazard and explain the need to introduce TARP correctly and how to apply TARP correctly.	What is TARP, How does it work, why is it adopted, how it will approve safety						
Desired behaviour: Apply support standards correctly, consistently	What the support standards are	Training Team meetings One-on-one	Lesson plans Dialogues Coaching				
Identify triggers at every entry examination: consistently, correctly.	Why it is important to work to standards (very basic rock engineering principles)	Training Team meetings One-on-one	Computer based training				
Follow rules unconditionally (do not enter red or yellow panel)	What the triggers are	Training Team meetings One-on-one	Trigger chart Dialogues Coaching				
When in doubt, rather escalate.	What the triggers look like	Training Team meetings One-on-one	Lesson plans Dialogues Coaching				
	The importance of the rules		Lesson plans Dialogues Coaching				
	The consequences of not following the rules						
	When in doubt, don't take a change						

Behavioural Communication Plan: TARP Leading Practice: Joel (Demonstration Mine)

Miners, Shift Overseers, Mine Overseers

Issue addressed & Desired Behaviour	Messages Communication Content	Mode	Tools / means	When	Responsibility for delivery	Who to ensure	Evaluation / control measure
Issue addressed: Ensuring adoption by subordinates	Do not react negatively when workers escalate a hazard, even if they do it unnecessarily						
Desired behaviour: Leaders must behave in a way that will facilitate adoption by positive re- Enforcing the desired behaviour of their subordinates	When you observe people applying TARP correctly, react: positively, immediately, every time						
	When you observe people applying TARP incorrectly, coach them: positively, immediately, every time						
	MO and Shiftboss are key drivers of the process: Talk about TARP every time you meet the crew.						
	You will find doing TARP very difficult in the beginning						
	Always show unconditional support for TARP						
	Communicate with the people through dialogue – it involves listening						
	Show respect and care						

Behavioural Communication Plan: TARP Leading Practice: Joel (Demonstration Mine)

Miners, Shift Overseers, Mine Overseers

Issue addressed & Desired Behaviour	Messages Communication Content	Mode	Tools / means	When	Responsibility for delivery	Who to ensure	Evaluation / control measure
Issue addressed: Meeting the expectations of the workers in relation to the behaviour of the leadership	Strictly no blame if panels are stopped with the TARP process						
Desired behaviour: React and communicate appropriately	Panels will be wrongly classified red, that's OK						
	Panels will stand because of TARP, that's OK						
	Your actions must demonstrate that safety is more important than anything else						
	Demonstrate your belief that TARP the only way to mine, there is no other way						
	TARP requires a drastic culture change – production orientation to safety above else						
	Advocate the point that it is better to lose the production than a person						
	If you are going to drive production above safety, TARP will fail						

Behavioural Communication Plan: TARP Leading Practice: Joel (Demonstration Mine)

Managers

Issue addressed & Desired Behaviour	Messages Communication Content	Mode	Tools / means	When	Responsibility for delivery	Who to ensure	Evaluation / control measure
Issue addressed: Managers must ensure the adoption of TARP	Do not react negatively when workers escalate a hazard, even if they do it unnecessarily						
	When you observe people applying TARP correctly, react: positively, immediately, every time						
Desired behaviour: Create a conducive climate for adoption by behaving (doing and saying) appropriately.	When you observe people applying TARP incorrectly, coach them: positively, immediately, every time						
	Talk about TARP in every meeting and during every visit to workplaces.						
	You will find doing TARP very difficult in the beginning						
	Always show unconditional support for TARP						
	Communicate with the people through dialogue – it involves listening						
	Show respect and care						
	Strictly no blame if panels are stopped with the TARP process						
	Panels will be wrongly classified red, that's OK						
	Mine overseers and shift overseers will complain about impact on production, they need to be re-assured						
	Constantly communicate the notion that safety is more important than anything else						
	Make it clear that TARP is the only way to mine, there is no other way						
	TARP requires a drastic culture change – production orientation to safety above else						
	Sell the notion that TARP is the best weapon to give a miner in the fight against FOG						
	Success is due to drive behind it from the very top						
	If you are going to be seen to drive production over safety, TARP will fail						

APPENDIX 7

Leadership Behavioural Plan for Joel Team Supervisor Management Intervention (TSM)

Team Members	
Antecedents	**Desired Behaviour**
People trained and competent in applying support stndards People trained and competent in hazard (trigger) Identification People empowered to activate a trigger with their team People have thorough understanding of the triggers (causes, results and remedies) Give everybody a TSM card Address people's concerns: • Err on the caution but do not misuse the system not to work • Why is it necessary to introduce TSM • Is TSM an additional work and if so what about compensation? • TSM will initially affect production and how is the issue going to be handled? • Employees will not be victimized for using the system and what are the remedies and are they empowered to do so?	Compliance to the standard Training for the team in order to implement the system Training centre to update their training in order to achieve competency of TSM card users Training manual to include triggers (cause, results and remedies) Make TSM cards available for all who are expected to utilise it. Employees to be assured that if they err on identification of hazard, they will be coach in order to do proper identification. Management Representative to explain the rational of TSM Management to assure employees that there won't be an additional work. Employees are encouraged to report incidents in order come up with proper remedies. Make guarantees that employees will not be victimized and put a system in place of reporting victimization by superiors
Supervisors	
Trained and competent in hazards (trigger) identification Empowered to activate a trigger with their team Have a thorough understanding of the triggers (causes, results and remedies) Always have a TSM card Have the resources to do his job Be competent in leadership and coaching	Give proper feedback on incorrect and correct application of TSM (apply Joel values i.e. recognise good behaviour and reward it) Encourage and coach the team when the apply wrong identification methods Stop blaming but be part of the solution Demonstrate positive attitude towards TSM, because people do what they see Be patient with the process of implementation Be respectful and caring Analyse the process on a weekly basis, in order to put interventions "Play the ball not the man" Treat people equally Do not overrule the team without proper consultation with them. Use the TSM book all the time and if not sure invite the next line supervisor Be aware of those who will come with excuses not to enter the workplace Put progressive mechanism of TSM and not being reactive Avoid putting too much pressure on both the team and miners with regard to the production target Give assurance that employees will not be charged for the wrong identification of the triggers Encourage people not to see this system as extra work but as safeguard of their life, and discuss the benefits of TSM Caring and listening skills to be offered to both supervisors and management

Management

Antecedents	Desired Behaviour
Be competent on leadership and coaching Be an expert in TSM	Management to be visible and accessible to employees Management to apply Joel values (Respect, communication, honesty, commitment and recognition) Management to be consistent in application of the TSM Caring and listening skills to be offered to both supervisors and management Management to involve all stakeholders on implementation of the system Listen to the input of supervisors, employees and stakeholders on improvement of TSM system. Implement suggestion from employees. Management to create time to listen to workers concerns Ensures that responsible people are accountable Continuous communication to be applied Demonstration to be conducted before full implementation of the system The approach should be multi faceted and not "top down approach" Face to face communication to be a preferred method of communication Training department to be geared for implementation of the system Practice what you preach Management must understand the cost implication of the system and the return in future. Management to preach safety first and not production only Clarity of instruction is paramount

Working Place Name: All	Team Leader:	Mine Overseer: Frans Saunders
Date: 31 May 2012	Miner: 20	Date of Adoption of TARP: 31 MAY 2012
Number of crew members: 20	Shiftboss: 6	Other:
Measure	**Without Leading Practice**	**With Leading Practice**
Number of Yellow stoppages	n/a	(16) June / July 2012
Number of Red stoppages	n/a	0
Number of incorrect stoppages	n/a	0
Average Support distance to face (m) After The Blast.	Sticks 3.9 m Avr Hydra bolts 1.4 Avr.	Sticks 3.1 m Avr Hydra bolts 1.3 Avr.
Average Dip and strike Support Spacing (m) (Permanent)	Dip – 1.5M Strike – 2.8M	Dip – 1.5M Strike – 2.7M
Rock related LTIs (From 2009)	5	0
Rock related Serious and Fatal Injuries	5	0
White Flag Days	78	88
Time taken to conduct TARP procedure	n/a	90 Min on entry examination (Continuation during the shift)
Condition of stopes / tunnels hanging wall	Good	Good
General Housekeeping (good/moderate/Bad)	Moderate	Good
Section 54/55s	2 (Two)	None
Absenteeism in crews (Total days per week for crew)	± 15 Shifts per gang per week (2 Persons)	± 15 Shifts per gang per week (2 Persons
Evidence of team work (good/moderate/bad)	moderate	Good
Mental model changes(y/n, if y what?)	No	No
Tons per person per month	90 Tons	90 Tons
Area mines (m2) per crew	420m²	420m²
Personal Observations/ Experience/ Feedback/ Input	None	Management behavior change
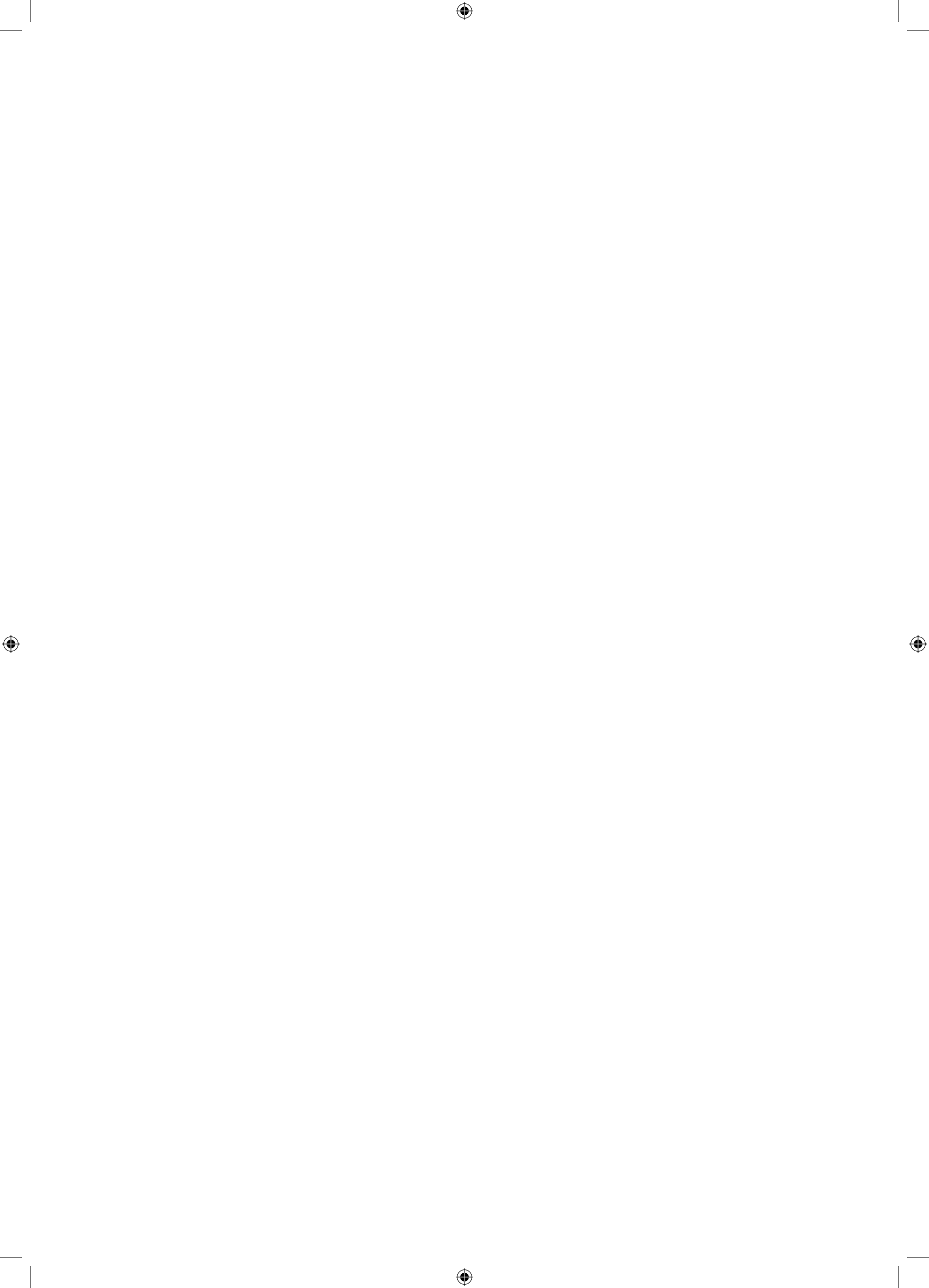
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