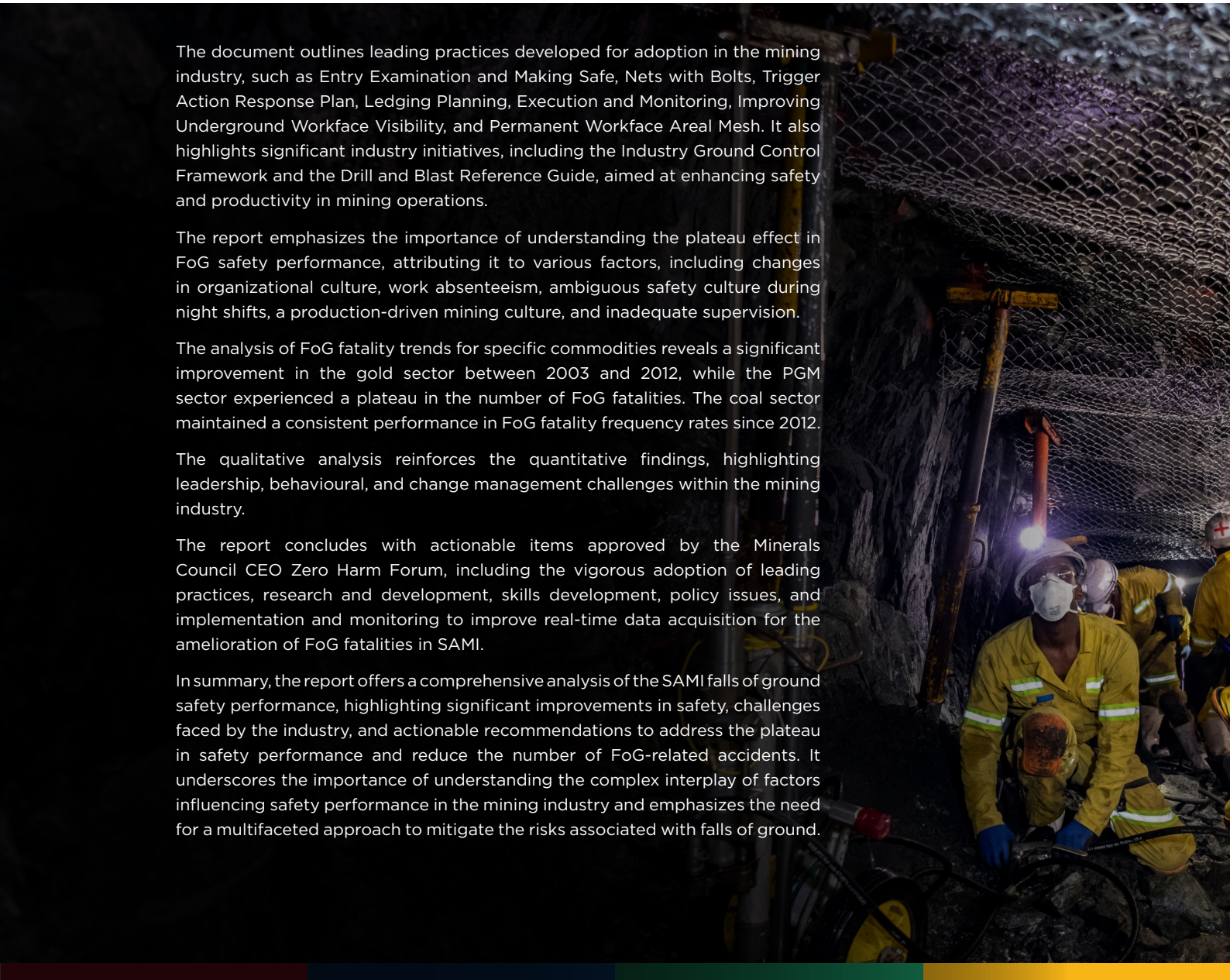
The State of Falls of Ground South African Mining Industry

MINING INDUST RY
OCCU PATIONAL
SAFETY & HEA LTH

MINERALS COUNCIL
SOUTH AFRICA

Executive Summary

This report provides a comprehensive review of the South African Mining Industry's (SAMI) Falls of Ground (FoG) safety performance from 2003 to 2023. The report aims to offer insights and recommendations to aid in reducing the number of FoG-related accidents. It begins with a quantitative analysis of the safety performance data, revealing a significant decrease in FoG accidents from 2003 to 2012. However, the industry reached a plateau in 2012, prompting a more detailed look at the years 2012 to 2023. The report also delves into safety performance statistics for the more recent years (2017 to 2023), identifying key issues such as the locations and activities where most FoG accidents occurred, as well as the job categories at the greatest risk. Additionally, the paper offers qualitative evaluations focusing on behavioural and human resources-related concerns such as production pressure, organizational culture, fatigue, and change management.



The document outlines leading practices developed for adoption in the mining industry, such as Entry Examination and Making Safe, Nets with Bolts, Trigger Action Response Plan, Ledging Planning, Execution and Monitoring, Improving Underground Workface Visibility, and Permanent Workface Areal Mesh. It also highlights significant industry initiatives, including the Industry Ground Control Framework and the Drill and Blast Reference Guide, aimed at enhancing safety and productivity in mining operations.

The report emphasizes the importance of understanding the plateau effect in FoG safety performance, attributing it to various factors, including changes in organizational culture, work absenteeism, ambiguous safety culture during night shifts, a production-driven mining culture, and inadequate supervision.

The analysis of FoG fatality trends for specific commodities reveals a significant improvement in the gold sector between 2003 and 2012, while the PGM sector experienced a plateau in the number of FoG fatalities. The coal sector maintained a consistent performance in FoG fatality frequency rates since 2012.

The qualitative analysis reinforces the quantitative findings, highlighting leadership, behavioural, and change management challenges within the mining industry.

The report concludes with actionable items approved by the Minerals Council CEO Zero Harm Forum, including the vigorous adoption of leading practices, research and development, skills development, policy issues, and implementation and monitoring to improve real-time data acquisition for the amelioration of FoG fatalities in SAMI.

In summary, the report offers a comprehensive analysis of the SAMI falls of ground safety performance, highlighting significant improvements in safety, challenges faced by the industry, and actionable recommendations to address the plateau in safety performance and reduce the number of FoG-related accidents. It underscores the importance of understanding the complex interplay of factors influencing safety performance in the mining industry and emphasizes the need for a multifaceted approach to mitigate the risks associated with falls of ground.

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List of Acronyms

CCM	Critical Control Management (CCM)
CEO ZHF	The South African Mining Industry Chief Executive Officers' Zero Harm Forum
COPA	Community of Practice for Adoption
CSIR	The Centre for Scientific and Industrial Research
DMRE	The Department of Minerals and Energy: South Africa
FFFR	FOG Fatality Frequency Rate
FGD	Focus Group Discussions
FOG	Fall of Ground
IGCF	The Industry Ground Control Framework
LP	Leading Practices (emanating from the Minerals Council)
MMP	Mandela Mining Precinct
MHSC	Mine Health and Safety Committee
Minerals Council	Minerals Council South Africa, previously known as the Chamber of Mines (COM)
MOSH	Mining Industry Occupational Safety and Health
OHS	Occupational Health and Safety
RETC	The Rock Engineering Technical Committee: Minerals Council South Africa
RTF	Regional Tri-partite Forum including members from government, employers and employees
SAMI	The South African Mining Industry
SAMRASS	South African Mines Reportable Accidents Statistics System
SANIRE	The South African Institute of Rock Engineers
SHERQ	Safety, Health, Environment, Risk and/or Quality

01 Introduction

In March 2021, the CEO Zero Harm Forum discussed the mining industry's 2020 fall of ground safety performance. There was agreement that there was an overall decline in safety performance from 2012 to 2020. Part of the debates and action required the MOSH Learning Hub FoG Team to examine, assess, and compile the South African Mining Industry (SAMI) FOG safety statistics from 2003. The process would include analysing historical fall of ground safety performance and comparing it to present FoG safety performance. Furthermore, it is expected that this study will provide substantial new insights and lessons to help in the development of mitigation measures to reduce the regression in FoG safety performance.

02 Purpose of the Document

This document's goals are to:

- Provide important insights, lessons learned, and discussions on the analyses of the FoG safety data for the period 2003 to 2023.
- Outline imperatives and recommendations for short-, medium-, and long-term discussions with SAMI CEOs, and garner their approval on the various aspects for SAMI's FOG safety improvement.
- Identify quick wins to pursue immediate improvements to address the FoG risk; and
- Create a paper that serves as SAMI's guide on the analyses that have been completed thus far.

03 Background

The analysis for this paper came from the database[1] of fatalities and injuries that is updated periodically by the Department of Minerals and Energy (DMRE).

The distribution of mineral wealth in South Africa is depicted in figure 1. The gold commodity has most of the deepest mines and the province of Gauteng is home to these mines. A significant portion of South Africa's mines are underground, even though there are several above-ground quarries and mines. As a result, FoG-related fatalities and injuries have afflicted the sector. The risk of FoG rises as mines get deeper—up to 3500 meters below the surface.

Since 2003, falls of ground have been the cause of more than thirty percent (30%) of all recorded fatalities in the South African Mining industry.

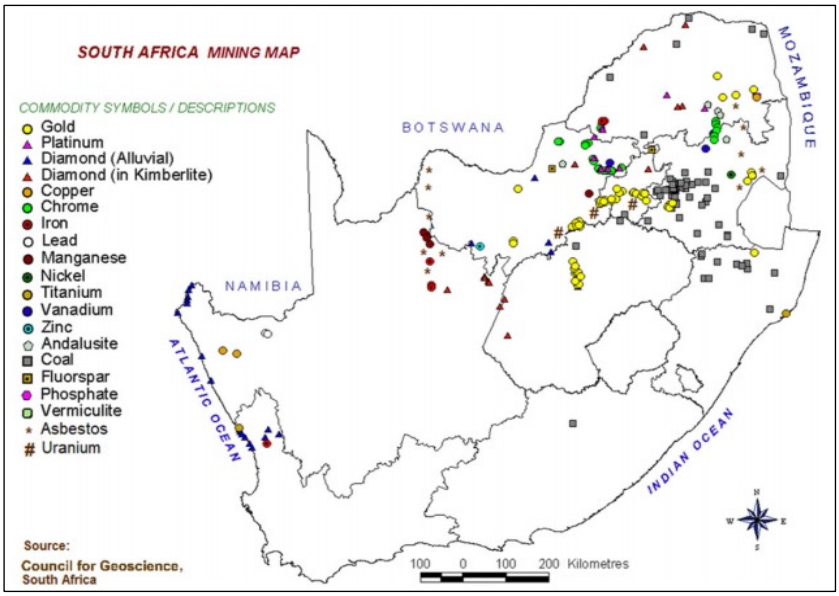


Figure 1 Mining areas in South Africa (Source: Utembe, et al, 2015.)

1. The detailed DMRE SAMRASS data for the period 2014 to 2016 is not available due to data collection constraints. The analysis for the period 2017 to 2023 is conducted based on the available data, acknowledging its incompleteness due to data collection constraints.

Through the MOSH Learning Hub, the Minerals Council South Africa has been identifying Leading Practices since 2008 with the goal of reducing the fall of ground risk in the mining sector. Figure 2 shows the chronology of the FoG Leading Practices (LPs) launch dates in relation to the injury and fatality figures.

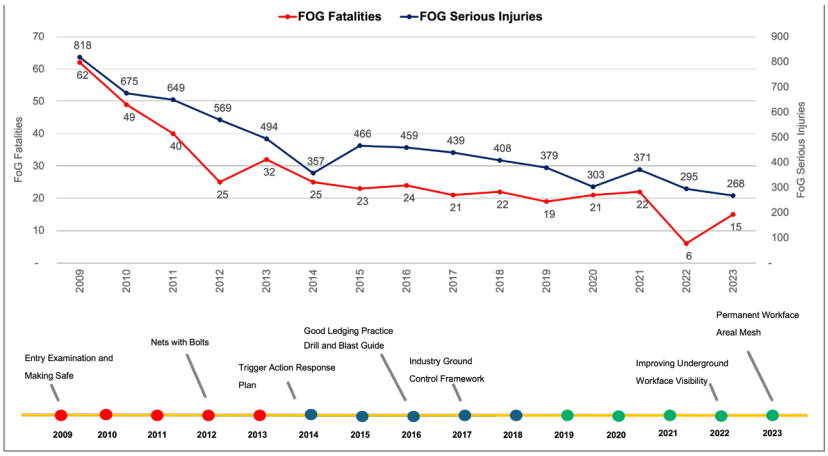


Figure 2: Approximate launch dates for FoG LPs in relation to the FoG injury and fatalities.

Numerous industry participants[2] identified the FoG leading practices that are described in the following sections. The mining industry appoint relevant individuals to serve on these committees and to support the initiatives.

2. These stakeholders include the Community of Practice for Adoption (COPA) members. FoG Industry Task Team and the Rock Engineering Technical Committee.

The following Leading Practices have been developed for adoption:

- Entry Examination and Making Safe – EEMS
- Nets with Bolts - NwB
- Trigger Action Response Plan - TARP
- Ledging Planning, Execution and Monitoring – LPEM
- Improving Underground Workplace Visibility – IUWV
- Permanent Workface Areal Mesh – PWAM

3.1.1 Entry Examination and Making Safe (EEMS)

Entry examination and making-safe procedure is the first Leading Practice developed through the MOSH process within the Learning Hub. This leading practice involves participation of the entire crew in examination of their working place and in taking measures to make it safe before any work begins in that area (https://www.mosh.co.za/falls-of-ground/leading-practices).

3.1.2 Nets with Bolts (NwB)

This leading practice encourages the installation of nets integrated with the roof support system. The practice is meant to enhance the areal support of the excavated areas and active mining stopes in underground mines and slopes in open pit or surface mines (https://www.mosh.co.za/falls-of-ground/leading-practices).

3.1.3 Trigger Action Response Program (TARP)

TARP is derived from a mine's Major Hazard Management Plan. TARP is a tool that was developed to enhance identification of hazards and decision-making during Early Entry Examination and Making Safe. It comprises documented and known workplace hazards that are continuously monitored. The purpose of TARP is to ensure that the areas in which crews travel or perform their work are thoroughly assessed before entry and where FoG hazards are identified, the situation will receive the appropriate attention at the appropriate level of management and expertise (https://www.mosh.co.za/falls-of-ground/leading-practices/tarp-summary).

3.1.4 Ledging Planning, Execution and Monitoring

This Leading Practice highlights the importance of prioritising thorough planning before engaging in ledging activities. The planning includes resource allocation, specialised crew training, and continuous monitoring. The Good Ledging Practice Guide provides a series of principles and leadership behaviours to ensure a safe, sustainable, and productive ledging process where ledging is practiced (https://www.mosh.co.za/falls-of-ground/leading-practices/ledging-planning).

3.1.5 Improving Underground Workface Visibility

This leading practice was launched in 2022 and forms part of Pillar 1 of The Elimination of Falls of Ground Fatalities Action Plan (FOGAP)[3]. The leading practice focuses on workface illumination in underground mining for better hazard identification, safety performance, and working efficiency. Although cap lamps provide enough illumination for one to navigate through a stope or working face, the lighting is not sufficient for hazard identification. The benefits of adequate in-stope lighting include improved working conditions, reduced risks, increased employee morale, and productivity (https://www.mosh.co.za/falls-of-ground/leading-practices).

3. The Minerals Council's CEO Zero Harm Leadership Forum collaboratively devised a comprehensive Fall of Ground Action Plan (FOGAP) in partnership with professional mining associations. This six-pillar plan aims to address incidents related to ground collapses. Notably, the plan was approved in July 2021 and involves a significant financial commitment of R46 million over five years.

3.1.6 Permanent Workface Areal Mesh (PWAM)

In 2023, Permanent Workface Areal Mesh was launched as a leading practice that stemmed from of Pillar 1 of FOGAP. This leading practice is an evolution from the nets with bolts leading practice. Building on such success, the permanent workface areal mesh can bring about the much-needed step change in reducing the FOG related accidents in the industry. The recent fall of ground safety performance may be attributed to this leading practice, as many mines have adopted (https://www.mosh.co.za/falls-of-ground/leading-practices).

3.2 Other significant initiatives

3.2.1 Industry Ground Control Framework

Against the backdrop of a continued regression in fall of ground related fatalities in the SAMI, the CEO Zero Harm Leadership Forum (CEOZHLF) commissioned a review of the Fall of Ground Management (FOGM) systems in 2017. Initially, the project sought to identify, document, and disseminate pockets of excellence in the management of falls of ground. However, the process culminated in the Industry Ground Control Framework (IGCF), developed (2017-2018) by the SAMI Rock Engineering, SHERQ and Mining Engineering disciplines.

Initially comprising seven (7) rock engineering technical elements, the IGCF (Figure 3) also seeks to identify, understand, and embody the so-called "soft

skills" described as creating an Enabling Environment, providing for Operational Excellence and, inculcating a Just Culture that promotes safety thinking. In addition, the framework necessitates that the Leadership of the organisation take a central role in actuating the model.

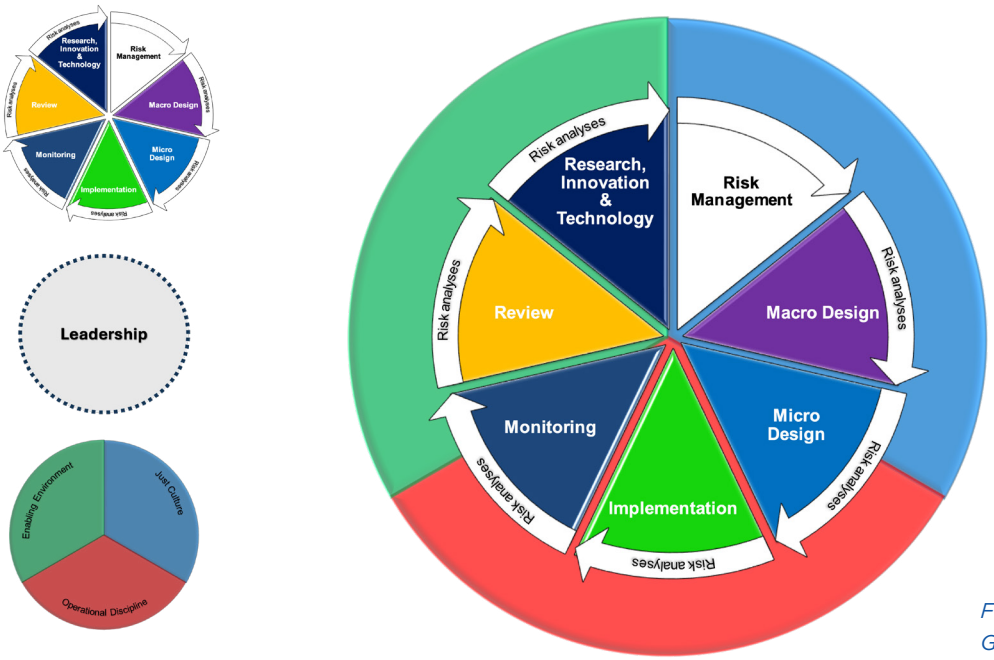


Figure 3: The Industry Ground Control Framework (IGCF)

The IGCF, enacted for various tasks, flows from the Risk Management (technical) element, through to the Research Innovation and Technology element whilst considering the "soft skills" throughout the process. At the various stages, when the element is actuated, the user should assess the element and evaluate it through the risk analysis process detailed in figure 3 (https://www.mosh.co.za/falls-of-ground/initiatives).

3.2.2 Drill and Blast Reference Guide

The Drill and Blast Refence Guide provides a comprehensive overview of initiatives to enhance the efficiency, productivity, and safety of the drill and blast cycle in mines, particularly in conventional narrow tabular orebodies. The document emphasizes the need to understand the key elements within the mining cycle, the timeframe and resource allocation for each element, and the consequences of poor execution. It also discusses the importance of blast design and technologies to improve the training, technical, and quality components of the drill and blast cycle.

The primary aim of the work is to provide drill and blast guide for stoping in conventional narrow tabular mines. The scope of the document is to:

- Outline the safety trends underlying drill and blast processes.
- Analyse data, procured from industry, that shows the extent of deviations from the standards, norms and procedures for drill and blast.
- Show why improving drilling and blasting will contribute to both production and safety initiatives.

- Provide techniques on how to improve the processes.
- Define the key elements that constitute an ideal drill and blast cycle.
- Show how efficiency and productivity gains can be made within the cycle.
- Provide a suite of available products and technologies that can be used to improve the training of personnel, as well as contribute to efficiencies within the drill and blast cycle.

For more information, see https://www.mosh.co.za/falls-of-ground/documents.

3.3 Fall of Ground Research, Innovation, and Development

The Centre for Scientific and Industrial Research, the Chamber of Mines Research Organisation (COMRO), Mining Tek (Mintek) and mining academic institutions, have contributed to significant, ground-breaking, and innovative mining solutions to the fall of ground risk in South Africa and globally.

To this end, McFarlane (2018) reported that at its peak in 1989, the Chamber of Mines Research Organisation (COMRO) had conducted research to the value of R481 million (equivalent to R581 million in 2018), and that according to Webber-Youngman (2018), funding by 2003 had dropped to R100 million (equivalent to R255 million in 2018). He further reports that after the demise of COMRO, mining companies funded their own research, and this amounted to R635 million for the period 2007-2015. Unfortunately, at the time of compiling this report, there had been no accurate record of spending in FoG research.

04
SAMI FOG Data Analyses

This section of the document represents the core of the analyses and considers the FoG fatalities and injuries data since 2003.

4.1 Methodology

The following methodology was followed to provide insight and information for discussion:

- A literature search of key aspects for the report.
- A review of the FoG fatality trends for the period 2003 to 2023.
- An intensive review and analyses of the DMRE SAMRASS fatality data for the period 2017 to 2023.
- Presentation of aspects and experiential evidence that emanated from the MOSH FOG Team interactions with the mines through the process of adopting Leading Practices.

Presentation of insights gained from specific behavioural discussions/ interventions such as Focus Group Discussions at mines where specific leading practices were adopted.

4.2 Quantitative Analyses

Figure 4 shows the number of FoG fatalities and serious injuries. The FoG fatality data for the same period, broken down into the sub-agencies of Seismic/ Rockburst[4] and Gravity/Rockfall, are displayed in figure 5.

4. Note that any strain burst data is included in the rockburst statistics.

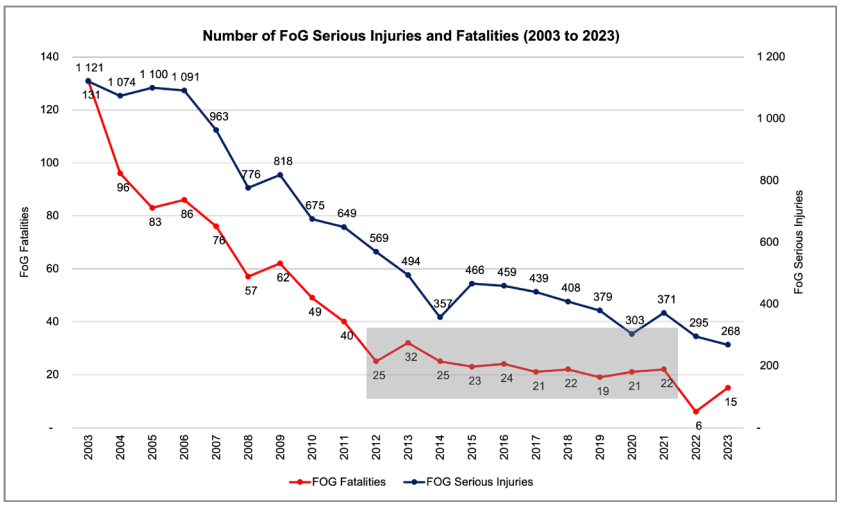


Figure 4: FOG injuries and fatalities (2003 to 2023)

The insights in figure 4 are as follows:

- Since 2003, fewer FoG injuries have occurred.
- There was a significant decline in FoG fatalities between 2003 and 2012. Nevertheless, this indicator has plateaued since 2012. The plateau is reflected in the range 25 to 20.

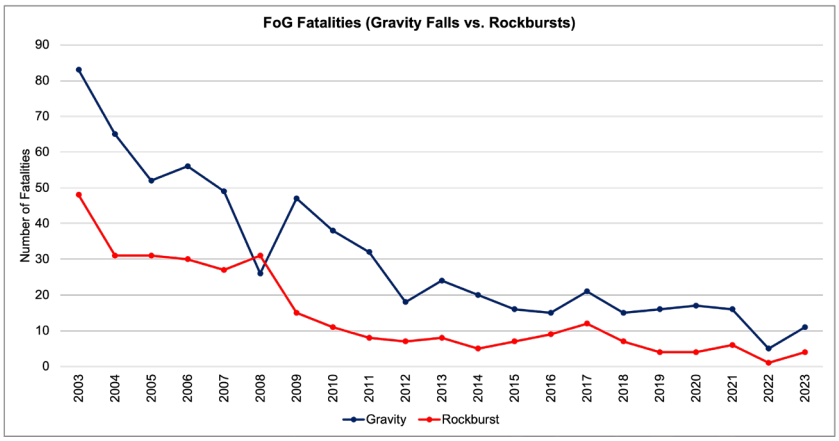


Figure 5: Number of FoG Fatalities (Gravity Rock vs. Rockbursts) – 2003 to 2023

The salient points in figure 5 are as follows:

- The number of FOG fatalities related to Rockfall and Rockburst have reduced since 2003.
- In 2008, the number of gravity-driven fall of ground fatalities were lower than the number of rockburst fatalities.
- The number of gravity-driven fall of ground fatalities reduced drastically from 2003 to 2012. However, since 2013, there is a plateauing of this indicator. This plateau is reflected in the range, 83 to 32 (2003 to 2011) and 24 to18 (2013 to 2021).
- The number of FoG fatalities related to rockbursts indicate a similar trend. From 2003 to 2008, there was a significant reduction. However, since 2009, there is a plateauing of this indicator, reflected in the following range, 48 to 8 (2003 to 2011), and 14 to 2 (2012-2023).

The analysis conducted in figures 4 and 5 show a steep decline in FoG fatalities for the period 2003 to 2011, followed by a plateau in the same indicator for the period 2012 to 2023. There is a reduction in the rate at which the FoG fatalities reduce over time. A slower rate works against the timelines set by the CEO ZHTT to achieve zero FoG fatalities.

The industry initiatives have significantly improved the FoG safety performance as can be seen by the steady decline in FoG accidents. It should be noted that since 2022, the industry has recorded fatalities below twenty, with a record achievement of six fatalities in 2022.

4.2.1 Analysis of Industry Fall of Ground Safety Trends

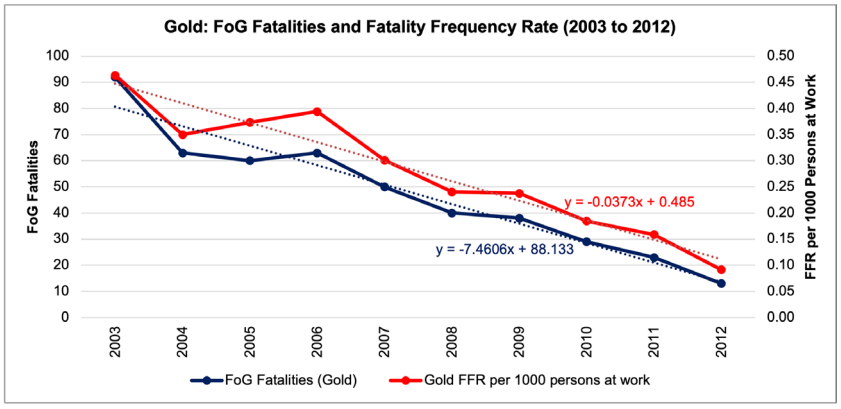
The absolute FoG fatality data as well as the fatality frequency rates (FFR) per thousand (1000) persons at work were analysed to normalize the statistics. Four commodities were analysed: Gold, Platinum Group Metals (PGMs), Coal and Other[5] for the periods 2003 to 2012 and 2013 to 2023.

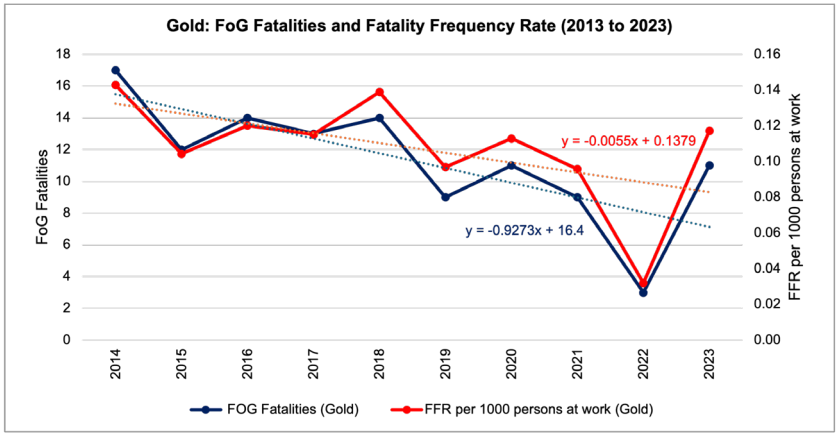
5. Includes Iron ore, Manganese and Chrome.

a) Gold

Figure 6 illustrates that the gold industry saw a reduction in fall of ground related harm from 2003 and 2012, as well as 2013 to 2023. The FoG Fatality Frequency Rate, or normalised data, shows a slower plateauing effect after 2012 compared to the prior decade. This represents an estimated 90% reduction in FoG fatality improvement.

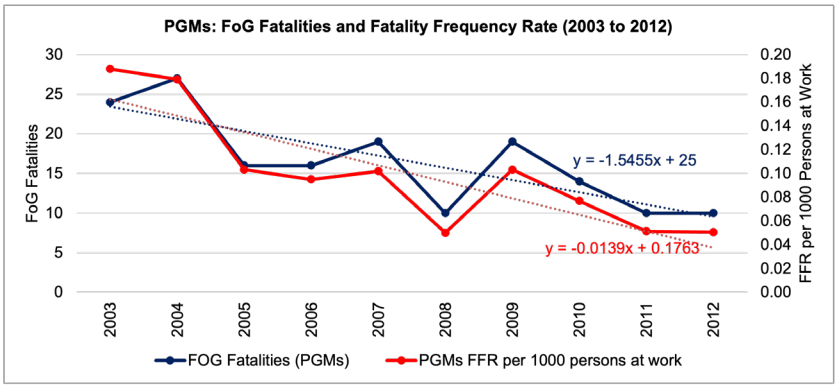
Figure 6: Analysis of plateau in gold sector.





b) Platinum Group Metals (PGMs)

Figure 7 depicts a decrease in the number of FoG deaths in the PGM sector, as well as the drop in the fatality rate across the elected periods. The modest fifty percentage (50%) reduction of FoG fatalities in the PGM sector is significant in comparison to the ninety percent (90%) reduction in the gold sector.



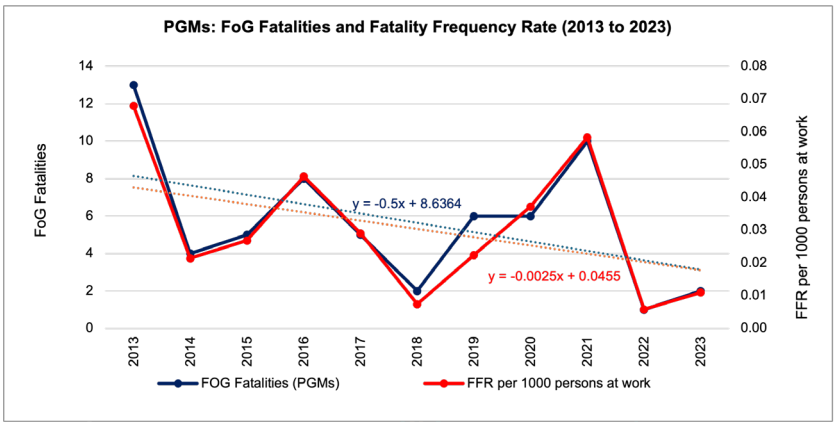


Figure 7: Analysis of plateau in the PGMs sector.

c) Coal

Analysis of Figure 8, the Coal sector, shows that FoG fatality frequency rates (FFR) went down for the period 2003 to 2012, but since 2012, the rate has shown upward momentum, in sharp contrast to the other sectors under scrutiny.

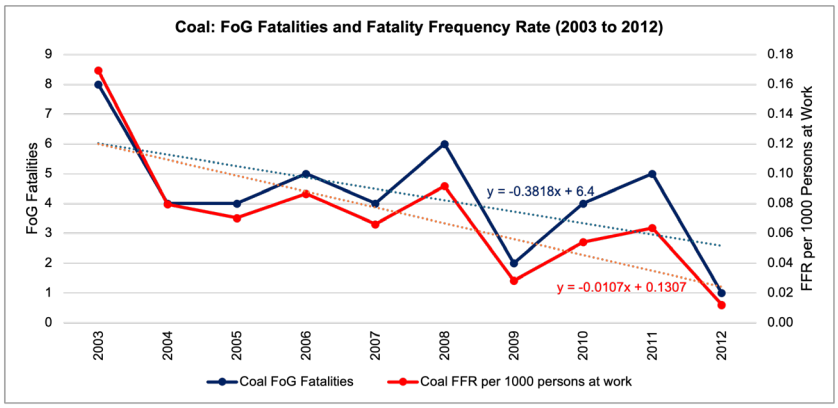
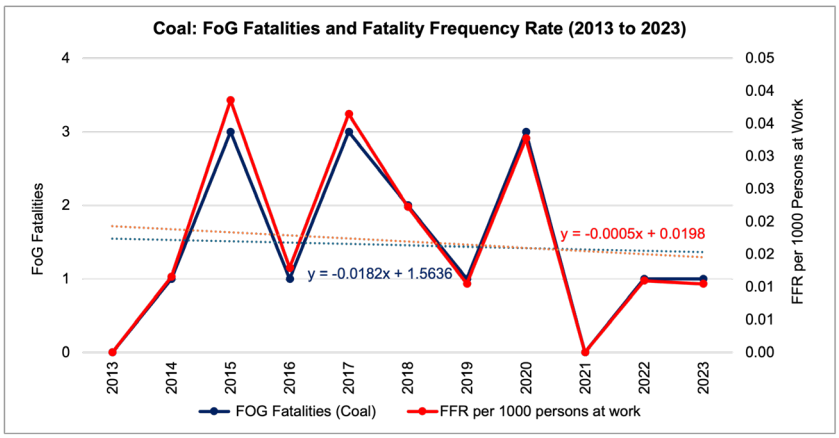


Figure 8: Analysis of plateau in the Coal sector.



d) Other commodities

"Other" commodity refers to base metals such as iron ore, manganese, and chrome. Figure 9 shows that there was a downward trajectory for both periods. However, the plateau effect is visible for the later period.

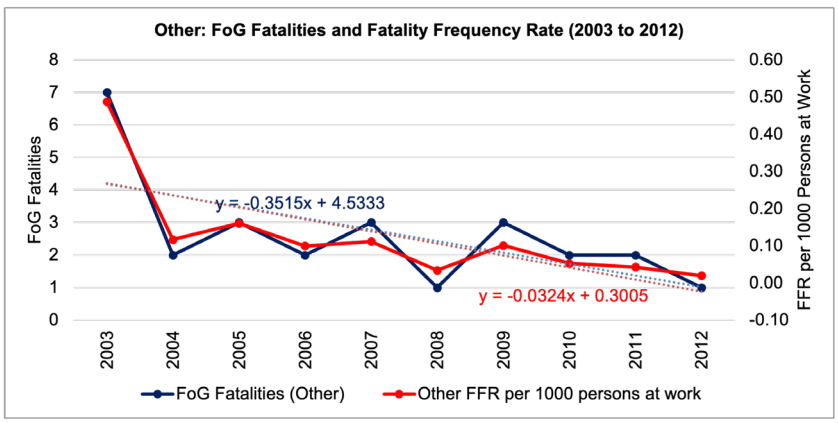
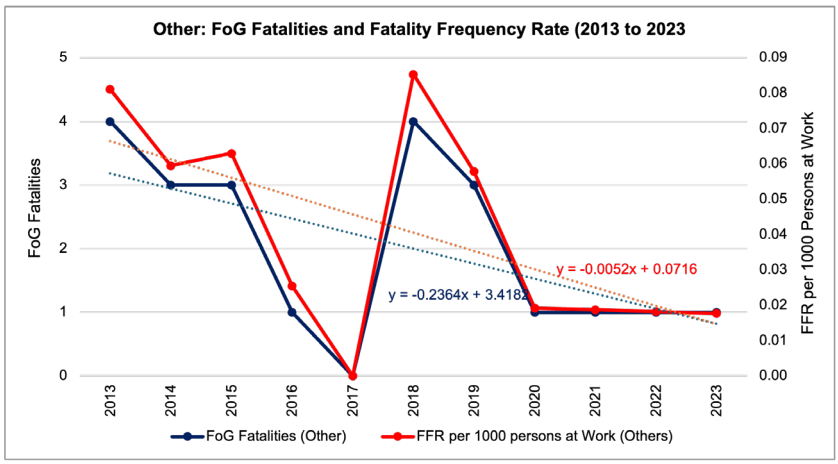


Figure 9: Analysis of the plateau in other commodities.



Figures 6 to 9 highlight the following:

- Before 2012, there was a noticeable decline in the number of FoG fatalities as well as the fatality frequency rate (FFR) across all commodities.
- Prior to 2012, the gold sector saw the biggest decline as seen by the steep trend in figure 6.
- Both the FFR and the number FoG fatalities have plateaued in the Gold, PGM, and Other sectors since 2012.
- The coal sector performed consistently in FFR and the number of fatalities since 2013.

e) Percentage Contribution to FoG Fatalities per Commodity

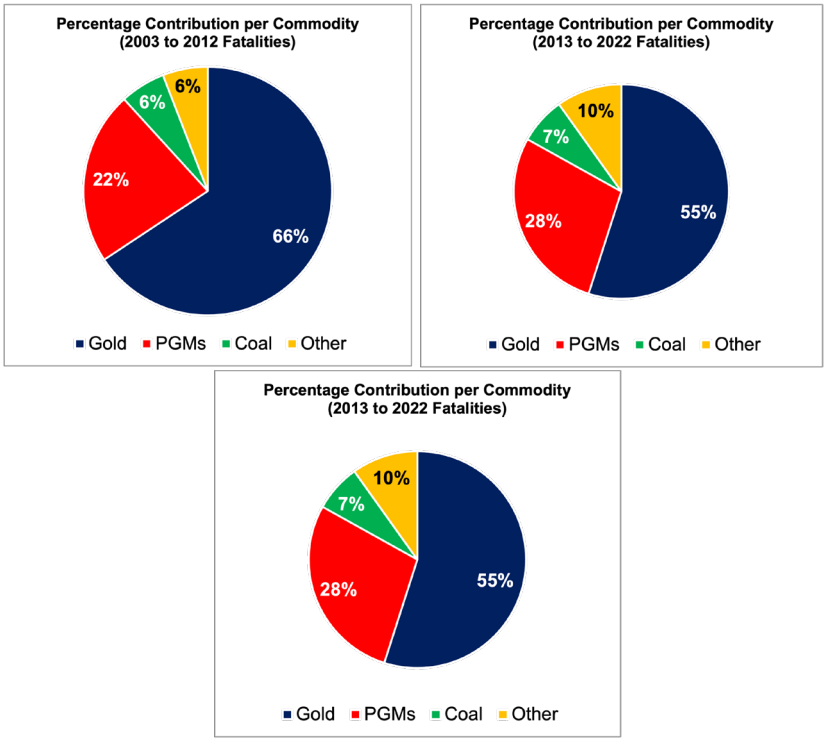


Figure 10: Analysis of the percentage contribution to FoG fatalities by commodities.

4.2.2 The Plateau Effect

What happened after 2012 to cause the plateau effect in the safety performance? Given the multiple variables at play, as well as the differences in organisational cultures, values, and individual beliefs, finding absolute solutions to this question is difficult. However, the authors have gained some significant insights into what could have caused the plateau effect, and what follows are a series of possibilities that will require additional investigation and evaluation.

The MOSH adoption system allows for engagement with various stakeholders in the mining community. Some of the information gathered during these engagements show that when there is a change of culture i.e., a merger or acquisition by another company, “the way things were done” changes. The feedback was obtained from engagement with the industry employees. The participants referred to changes in company and safety culture, work, and procurement systems, as well as employee structures and numbers, which might have led to a disconnect. Although the mining companies may have had change management systems in place to ensure smooth transitions, big changes naturally and inevitably come with consequences which are bound to affect the mining operations and therefore the industry. Big changes are also known to affect employee behaviour which is an important factor in work safety.

According to studies conducted by Honeybourne, Hill, & Moors (2000) and Nitti & Nitti, (2001), the plateau effect occurs when the effectivensess of measures which were once very effective lessen over a period of time. In these studies, the plateau effect is also described as a force of nature which can be paralleled to the concept of diminishing returns. It simply describes a period when an initiative sees no decrease in numbers over a certain period of time. The plateau effect also represents an autonomous stage when a task is belived to be mastered, and it runs on autopilot. Thompson & Sullivan (2013) explain that this is a scientific theory that has been studied and applied by scientists, athletes, therapists and companies to help break through stagnancy. These authours further describe it as a powerful law of nature that affects everybody. In the FoG team’s opinon, this point is very important and also relevant to mining because the industry relies largely on people, and the lack of progress or a reduction in progress is part of human nature. In addition to this, plateaus are inherent to any company’s development and they can sometimes occur in other spheres of the company such as in productivity figures.

It is difficult to try to identify solutions that can assit the mining industy to overcome the plateau effect, partly because the theory has not been applied to the mining industy, and more specifically, to mine safety. It is, therefore, very important for the mining industy to understand the workings of the plateau effect and the potential causes in the FoG fatality and FFR space. In working towards a solution, one can also draw learnings from other fields and apply them to the mining indistry. An example can be extracted from a book titled “The Plateau Effect: Getting from Stuck to Success” written by Thomas and Sullivan (2013). In order to curb the plataeu effect (from a psycological perspective) one needs to turn off the forces that cause people to become too comfortable with systems, tasks and practices, and eliminate the “get used to” mentality. From a buisness perspective there would be a reqirement to create, rethink or re-energize strategies that adress the problem (Thomas and Sullivan, 2013).

Based on the 2022 and 2023 data, there is a hopeful indicator that the industry may be nearing the end of the plateau, with the psychological barrier of 20 fatalities broken.

4.2.3 Analysis of DMRE SAMRASS Data

Figures 11 to 14 represent detailed analyses of the DMRE fall of ground database. The main points for discussion are provided after each graph.

The following two (2) graphs indicate the physical location whereby the FoG fatality occurred, and what activity was being performed at the time of the accident respectively. Please be cognisant of the fact that the entire data set was not populated by the locality and activity data.

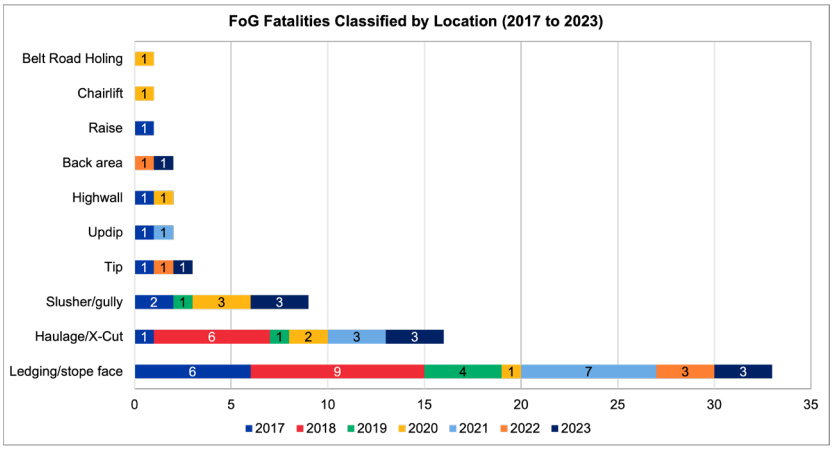


Figure 11: FoG Fatalities (2017-2023) as a function of physical location in the working environment.

Figure 11 indicate the following:

a. An estimated sixty percent (60%) of all FoG fatalities occur in the stope face (slusher/gully and ledging/stope face combined),

b. Twenty- three percent (23%) of the FoG fatalities occurred in haulages, crosscuts, flat development.

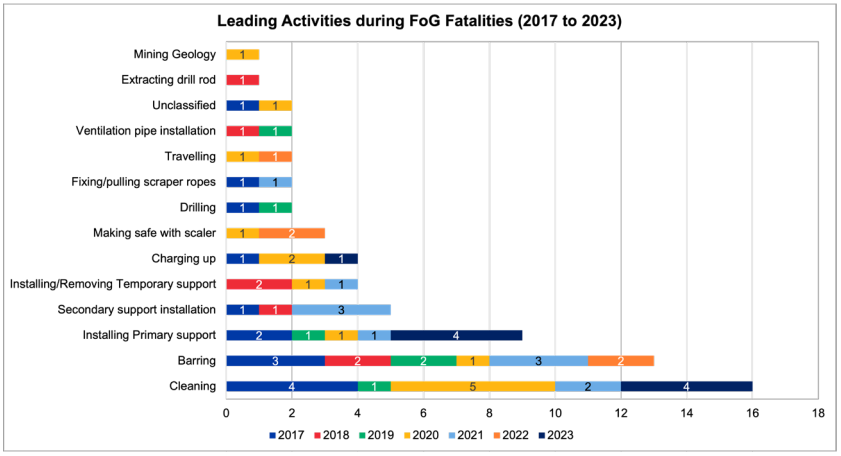


Figure 12: FoG Fatalities as a function of activity performed when the fatality occurred.

Figure 12 indicates the following:

a. A significant number of FoG fatalities occur during the cleaning shift. Anecdotal evidence indicates that many mines do not have as many supervisory staff, as well as service department staff on nightshift, which is primarily when most of the cleaning activity occurs, other than the normal day shift.

b. The cleaning shift occurs after the blast and before the support activity occurs. Challenges that may be faced by personnel during the cleaning shift could include the fact that:

   i. Some areas of the working face may be unsupported,

   ii. It is often difficult to install temporary support on broken ore,

   iii. There may be damage to existing support units which may result in the efficacy and loading ability being compromised. It is incumbent on the cleaning crew to assess whether the support system after the blast satisfies the Entry Examination and Making Safe (EEMS) procedure,

   iv. It may be difficult to bar due to the broken ore and the muck pile location,

   v. Rigging units may not be sited in areas where adequate support has been installed, and,

   vi. The EEMS procedure, as well as the TARP strategy, may not be followed diligently.

c. Although there no baring-related fatalities in 2023, the process of Barring remains a significant risk as this activity may expose employees to unsupported ground.

d. The installation of primary and secondary support, as well as the removal of support also pose significant risk due to the increased exposure to unsupported ground.

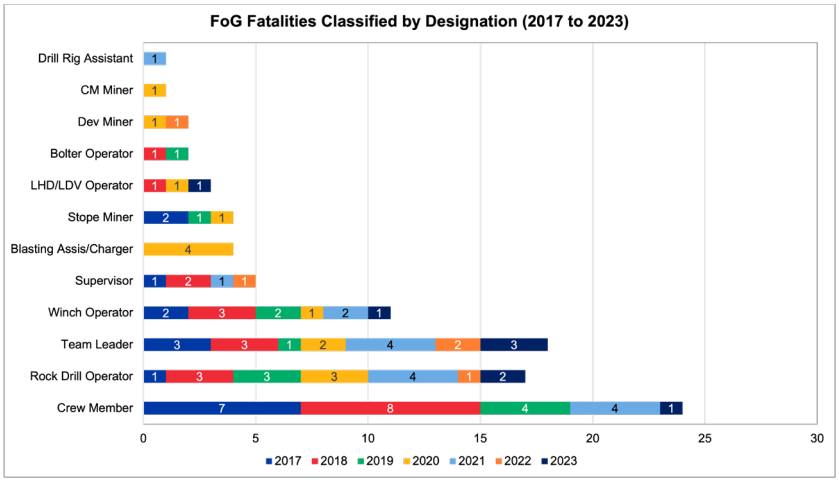


Figure 13: FoG Fatalities as a function of designation.

Figure 13 shows the following:

a. Majority of all FoG fatalities have work designations primarily linked to a stope.

b. Crew members[6] succumb mostly in FoG accidents.

c. A small portion of FoG fatalities are from the miner, production supervisor discipline.

d. Team Leaders are the second most affected designation to FOG fatalities.

6. For the purpose of this analysis, Crew members excludes Team Leaders, RDO's and winch Operators.

4.3 Qualitative Analyses

Table 1 shows the consolidation of various sources that emanated from the MOSH FOG Team's Focus Group Discussions (FGD), ad-hoc interviews with mining personnel, bi-lateral engagements with mining organisations, specific mine's FOG Data Analyses, and interactions with senior leaders at mining companies.

Table 1: Summary of feedback on interactions with various role-players

Aspect	Discussion
Work Absenteeism	Many of the mining operations that were interviewed believe that work absenteeism contributes to FoG accidents. In several cases people become absent from towards significant public holidays such as easter causing labour shortages. The crews resolve the shortages by overstretching themselves and putting more tasks on fewer people, for example the Team Leader will take on the responsibilities of the absent team members and the team will shortcut safety procedures to achieve the production target. FoG statistics support this observation.
The application of safety training	The feedback also showed that challenges related to the application of safety training in the industry. Many of the focus groups highlighted that the issue was not really with training but with the application of the training. In many cases line supervisors discourage people from applying the safety principles they have learnt in pursuit of higher production tonnages. People are often told that they are not in the training centre and they are underground to work. This discourages them to apply safety training or sections 22 and 23.

The application of safety training

During the focus group discussions many employees expressed a belief that there is a high focus on safety and production efficiency during the morning shift cycle. However, the night shift does not share the same privilege. People believe that there is a reduction in safety supervision during the night shift, causing people to cut corners. The safety principles enforced in the morning shifts are not enforced during night shift. Which is why many night shift operators fail to apply Leading Practices such as EEMS and TARP. In addition to this, the lack of effective supervision results in night shift crews often "making a plan" to meet production targets.

Production driven mining culture

The issue of a production driven mining culture recurred throughout all the operations that were involved in the interviews. Many people expressed that they believe that their mines consider production to be more important than safety. This is because of the pressure they are placed under which overrides the culture of safety most of the time. They expressed that this attitude, as well as the frustrations of their line supervisor's cascades down to the crew members. Production often surpasses safety which causes disagreements between the shift supervisors, miners, team leaders and crew members. The crew members constantly expressed that they consider their safety to be of a higher priority.

Inadequate or poor supervision

The issue of inadequate supervision was also recurring during the focus group discussions. This was mostly attributed to supervisors being unable to spend enough time with their crews because they must visit many excavations.

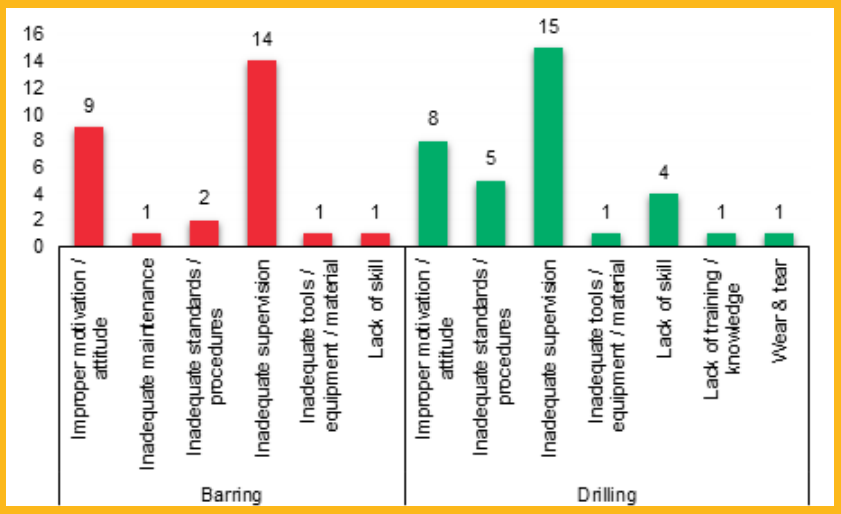


Figure 20: Factors contributing towards FOG accidents - Case study.

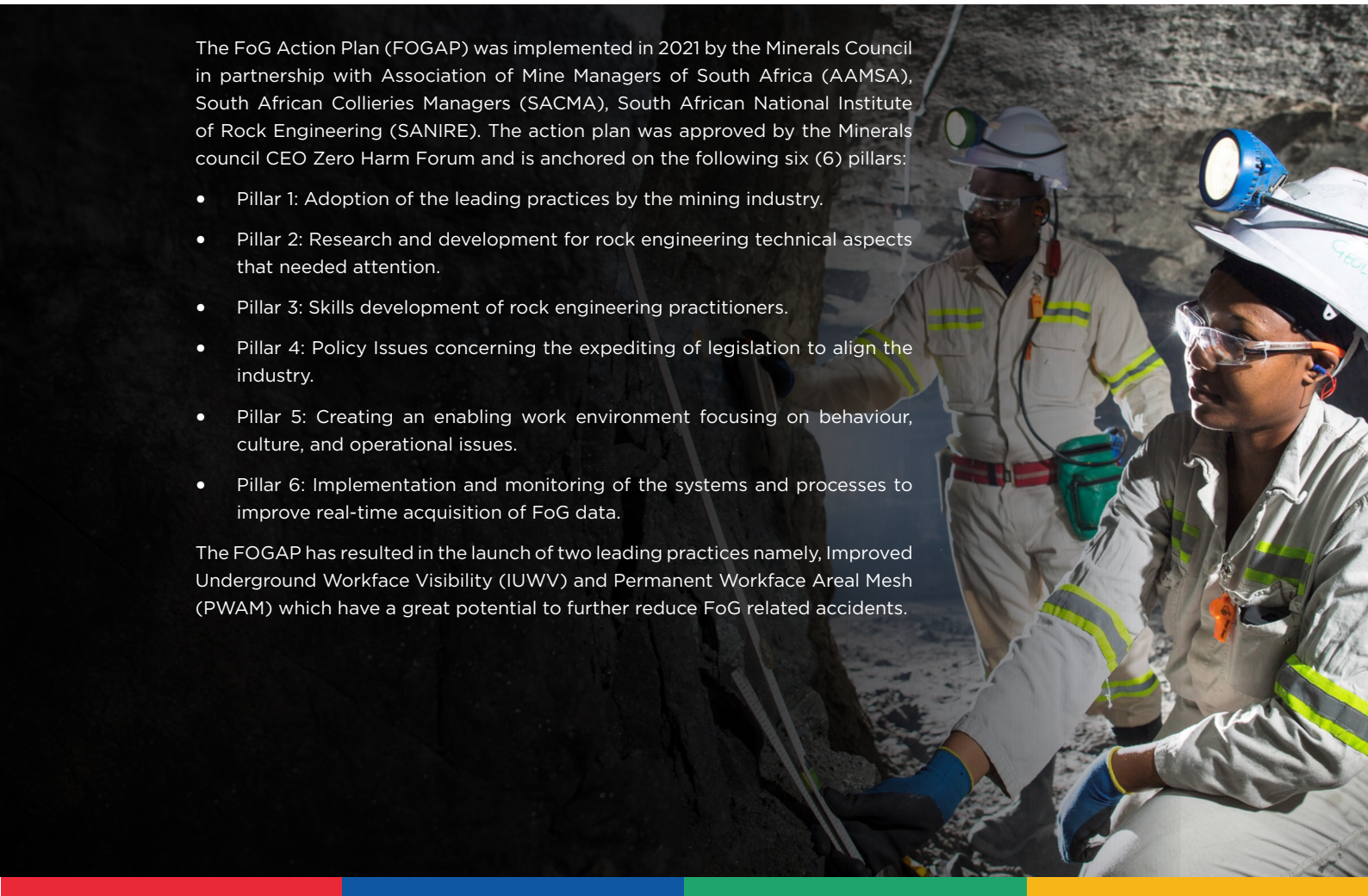
Issues of transparency (the lack of transparency) and mistrust between supervisors and employees were also frequently mentioned during the interviews.

05 Conclusions

The quantitative information derived from this analysis shows marked improvement in Falls of Ground safety performance between the years 2003 and 2012. It further shows that this downward trend decreases after the year 2012. During this period the industry entered a plateau which saw minimal improvement from all commodities except for the coal sector which experiences a regression. The gold sector has been a majority contributor to FoG fatalities from 2003 to 2013 and the PGM sector for the past ten years. This can be attributed to the shrinking of the gold sector relative to the platinum sector.

The general improvement over the years can be attributed to several safety initiatives that the industry embarked on since 2003. Examples of these initiatives include investment in training and skills development, research and development (R&D) initiatives, and the adoption of MOSH FoG leading practices. The development and enactment of new legislation to regulate safety in the mining industry has also helped in the safety improvements.

The analysis of the data between 2017 and 2023 shows that most of the FoG accidents occur on the stope face, followed by active development ends. It also reveals that most accidents occur during cleaning, barring and support installation. The job categories at the highest risk of FoG accidents during these years were crew members, winch operators, rock drill operators (RDOs) and team leaders. The qualitative analysis highlights the leadership, behavioural and change management challenges that the industry is facing. It also corroborates the information produced by the quantitative analysis. This is seen in the focus group discussion feedback which shows that the job category of team leaders is exposed to FoG hazards at a disproportionately high rate compared to other job categories. This is because team leaders are expected to perform multiple functions of other team members who are absent.



The FoG Action Plan (FOGAP) was implemented in 2021 by the Minerals Council in partnership with Association of Mine Managers of South Africa (AAMSA), South African Collieries Managers (SACMA), South African National Institute of Rock Engineering (SANIRE). The action plan was approved by the Minerals council CEO Zero Harm Forum and is anchored on the following six (6) pillars:

- Pillar 1: Adoption of the leading practices by the mining industry.
- Pillar 2: Research and development for rock engineering technical aspects that needed attention.
- Pillar 3: Skills development of rock engineering practitioners.
- Pillar 4: Policy Issues concerning the expediting of legislation to align the industry.
- Pillar 5: Creating an enabling work environment focusing on behaviour, culture, and operational issues.
- Pillar 6: Implementation and monitoring of the systems and processes to improve real-time acquisition of FoG data.

The FOGAP has resulted in the launch of two leading practices namely, Improved Underground Workface Visibility (IUWV) and Permanent Workface Areal Mesh (PWAM) which have a great potential to further reduce FoG related accidents.

06
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