

THIS is GOLD

FACT SHEET JULY 2018

SAFETY

IN GOLD MINING



South Africa is known for having pioneered deep-level gold mining. Given the hazards endemic to deep-level mining, commitment and adherence to safety standards are non-negotiables.

The recent spate of fatal accidents in the gold sector has once again focused attention on the safety of its employees. This is particularly disappointing, given the significant strides in safety performance over the past two decades as a direct result of the increased and constructive collaboration among the industry and its tripartite partners including government, labour and industry working together to protect those underground.

A UNIQUE ENVIRONMENT

Aside from the depths now being reached and planned for – as much as 5,000m below surface in some cases – conditions in the gold mining environment are generally challenging. Mining is typically undertaken in narrow, often steeply dipping reef stopes and is still a largely labour-intensive process. Working places are increasingly distant from the shafts that serve them, involving longer underground travelling times at the start and end of each work shift. Virgin rock temperatures can reach up to 60°C at the depths mined. Sophisticated cooling methods and equipment, involving some of the

largest refrigeration plants in the world, use ice and chilled water to reduce ambient temperatures to reasonable working temperatures. Furthermore, to address the stresses to which rock faces are subject naturally at depth, a vast infrastructure of support mechanisms is in place, backed by world-leading seismic monitoring and research.

The industry is continually working to reduce risks in the workplace – injuries and fatalities are unacceptable. Ensuring the safety and health of all underground employees requires the active collaboration of management, employees and regulators, supported by extensive safety-related infrastructure, communication, risk management and auditing processes and, above all, training.

REGULATORY STRUCTURES

South Africa's Mine Health and Safety Act (MHSA) provides for an inclusive, tripartite approach to safety and health.

The Mine Health and Safety Inspectorate of the Department of Mineral Resources (DMR), established in terms of the MHSA, is responsible for overall regulation of the health and safety of mine employees, as well as communities affected by mining operations. The Chief Inspector of Mines has extensive authority, which includes the ability to impose directives prohibiting some or all work in some working areas or all working areas. This can be extended to entire mines, should the inspectorate have valid reason for such a decision.

As governed by the MHSA, individual companies and mines have agreements in place with their representative labour unions which regulate many aspects of safety and health in the workplace.



This also provides for joint planning, decision-making, training and auditing. Typically, each shaft has its own health and safety committee that comprises representatives from management and unions. These committees seek to ensure compliance with regulations and to monitor safety training for all employees, as well as provide for active collaboration in all matters relating to safety and health. Accidents and incidents are investigated and their outcomes are documented and shared.

An overarching tripartite Mine Health and Safety Council (MHSC) was set up in 1996 to direct safety in the mining industry and to respond to industry safety challenges. This body was built on the achievements of many years of fundamental research that was undertaken over decades and funded by the mining industry. The MHSC comprises a tripartite board represented by the state, employers and organised labour, under the chairmanship of the Chief Inspector of Mines. The MHSC is funded by public revenue and is accountable to Parliament. The MHSC's primary tasks are to advise the Minister of Mineral Resources on occupational health and safety legislation and research outcomes focused on improving and promoting occupational health and safety in South African mines.

The MHSC also works closely with the Mining Qualifications Authority (MQA), which plays a critical role in addressing skills shortages in the mining industry through capacity development and process improvement. The MQA is mandated to ensure that the mining and minerals sector has sufficient numbers of competent people who have been trained to improve health and safety standards and processes.



ADDRESSING RISK, ACHIEVING BUY-IN

Risk management is integral to the successful operation of a mining company, and the identification, mitigation and management of safety-related risks is a top priority. Industry members have frameworks in place for risks and hazards to be identified, assessed and ranked on a regular basis. Reporting structures ensure that risks identified in the workplace are communicated to management, which develops strategies to manage and mitigate risks.

The mining industry is the first in South Africa to develop industry and sector-level shared targets, objectives and action plans to improve health and safety. Although many milestones have been achieved, there is still some way to go in others. Of note, however, is that stakeholder co-operation has been a major contributor to achievements to date and it is further commitment by gold industry members that will advance the goal of achieving zero harm.

Safety is not simply an add-on for the gold mining industry. The bulk of all training hours in the industry is applied to safety training, both in specific training modules and on-the-job. All employees are exposed to safety training in induction and refresher training on at least an annual basis. Both full-time elected safety stewards and part-time safety representatives are allocated to each working area underground, with safety briefings at the beginning of every working shift. Critically, safety features as a primary motivator in respect of earnings. All production bonuses at every level in the organisation are strongly influenced by safety performance. Safety is also a critical key performance indicator for supervisors, managers and executives.

TRIPARTITE ACTION PLAN FOR HEALTH AND SAFETY

There has been significant progress in health and safety performance over the past two decades. Many deep-level South African gold mines are achieving safety performances that compare favourably with international benchmarks set in countries such as Canada and Australia. But, to achieve the goal of zero harm requires further improvement in mining methods and technologies, including removing people from the working-face underground, as well as improving safety attitudes and practices. A great deal of attention is currently being focused by gold mining companies on the development of processes and technologies that will remove – as far as possible – individuals from the rockface so as to minimise the threat of injury. The introduction of mechanised operations at some mines, for example, has seen a radical improvement in safety performance.

SIGNIFICANT PROGRESS

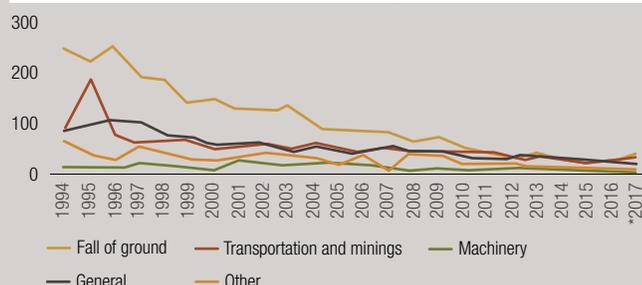
Significant safety progress has been made over the past decade, in South Africa's mining sector.

Between 1993 and 2016, the number of fatalities across the mining industry declined by around 88%, while fatalities as a result of fall of ground incidents dropped by 92% over the same period. Other safety indicators improved at similar rates. This improvement over 23 years is a direct outcome of the various safety initiatives adopted by the mining

industry in collaboration with its tripartite partners under the auspices of the MHSC. Indeed, this improvement illustrates that achieving the industry's ultimate goal of Zero Harm is possible.

However, the tide changed in 2017 when fatalities increased to 88 from 73 in 2016. In the first half of 2018, similarly, mine fatalities remained at unacceptably high level, with 47 fatalities reported in the first six months of the year. This is particularly disappointing given the consistent improvement over the past two decades. A particular concern in 2017 and 2018 was the number of accidents related to seismic activity and subsequent fall-of-ground incidents associated with rockbursts. Seismicity has been the main cause of falls of ground. This development has been noted and the industry has renewed its commitment to better understanding and addressing the issues. A Mining Industry Occupational Safety and Health (MOSH) Fall of Ground Team has been established to lead the development of leading practice, particularly with regard to rockbursts. The findings of the task team will be shared across the industry. The gold industry is fully committed to play its role in supporting this initiative.

Causes of fatality across the mining industry (1994 – *2017)



* Note that official safety statistics for 2017 have not yet been released by the DMR and the 2017 figures have not been confirmed

Source: Department of Minerals Resources

The term 'fall of ground' is used to classify those accidents that relate to unexpected movement of the rock mass and the uncontrolled release of debris and rock, as a result of gravity and/or pressure, strain burst and rock burst.

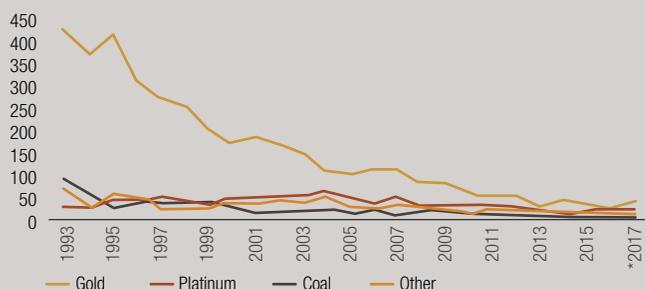
Joint industry efforts over several years have focused intensely on addressing fall-of-ground incidents, particularly in deep-level mines. This is reflected in the more than R150 million invested by the MHSC towards research to this end. In addition, through the MHSC, more than R250 million has been spent on research into seismicity associated with deep-level mines. Another R40 million has been spent on fundamental and applied research and technology transfer. Research outcomes have led to new mine designs and methods. As a result, the number of fatalities associated with seismicity fell from 48 in 2003 to 14 in 2017.

Safety is not simply an add-on for the gold mining industry

Transportation incidents tend to be associated with trackless mobile machines and rail-bound equipment, as well as collisions with people in confined areas or close to moving equipment. Progress has been made in the area of vehicle avoidance systems. Investigations are in place to find systems which will contribute to a further reduction of these types of incidents.

Smoke inhalation happens when an underground fire occurs and the ventilation infrastructure is unable to clear the working areas. All employees have at their disposal self-contained self-rescue equipment – essentially a breathing apparatus – that can be donned and which provides at least 30 minutes of oxygen, while the individual makes his/her way to a place of refuge. All underground working places are equipped with refuge bays, which are protected chambers located within 30 minutes of all working places, and which are equipped with fresh air, water and communication devices.

Mining fatalities per commodity (1993 – *2017)



* Note that official safety statistics for 2017 have not yet been released by the DMR and the 2017 figures have not been confirmed

Source: Department of Minerals Resources

Injuries in 2017

Commodity	2016	2017**	% change
Total	2,785	2,534	(9)
Gold	1,167	955	(18)
Coal	184	193	5
Platinum	1,120	1,204	1
Other*	314	282	(10)

* Other includes diamonds, chrome, copper, iron ore and all others not specified above

** 2017 figures to be confirmed

IDENTIFYING AND MITIGATING SAFETY RISKS

Although the causes of accidents, injuries and fatalities vary, there are three primary causes that are responsible for most mine injuries, namely falls of ground and accidents relating to transport and machinery.

TECHNOLOGY FOR SAFER WORK

Central to curbing underground accidents is, where possible, the removal of miners from working-face dangers and in-stope health hazards. Where that is not possible, technology is directed at protecting workers.

Some of the more conventional mining techniques start at the stope face. Before drilling or cleaning occurs, roofs or hanging walls are secured with rope netting fixed to roof bolts. Should a rock break away, it will be retained by the net. It is a simple technique that adds to the mining cycle time and to costs – but its efficacy comes from its simplicity.

Hydro-powered rock drills are faster and quieter than older ones powered by compressed air. Drillers need to spend less time at the stope face while, in development ends, wholly-mechanised drills can do the hard work.

Holes are blasted with new water-based emulsions which can be loaded quickly and safely into blast holes, to be detonated electronically from surface at a set time throughout the mine. This is followed by a four-hour period to settle dust and post-blast micro-seismicity.

Latest developments in hauling broken rock rely on an electronic control system which incorporates remote sensing built into the underground trains that transport the rock.

These are all incremental improvements – but they add up to making mines safer places to work.

COLLABORATION FOR GOOD

A collaborative effort between mining companies, government and various other stakeholders, has resulted in the establishment of the Mandela Mining Precinct in Johannesburg. The core function of the

precinct is to advance the mining cluster through a number of research and development programmes.

The programmes seek to develop new technologies that will enable safer, more efficient and more sustainable mining practices, as well as supporting South African manufacturers through their involvement in the process.

While the programme is inclusive of all commodity producers that wish to take part, many of the programmes focus entirely on deep level tabular mining.

South African mining companies have for years co-operated with one another and with equipment manufacturers in devising better and safer working methods and technology. Sibanye-Stillwater continues to seek ways of extracting deep, narrow-vein gold in secondary reefs and underground pillars.

At Gold Fields' South Deep mine, the only bulk mechanised underground gold mine in South Africa, the challenges are different to those of more conventional mines as the miner is normally some distance away from the rock face. In addition, the high-profile destress mining methodology being used has reduced the seismic energy per event since it was introduced three years ago.

A VISION OF ZERO HARM

The gold mining sector is committed to a vision of zero harm, where every miner returns from work each day, sound in health and body. Policies, programmes and campaigns are in place at all mining companies, particularly to heighten individuals' awareness of the need to avoid injuries, to promote health and well-being, and to provide safety training and awareness campaigns. Many mines extend these campaigns, where appropriate, to the communities surrounding their operations.

INDUSTRY INITIATIVES

The gold industry fully supports the various initiatives that have been developed at industry level in collaboration with its tripartite stakeholders, the trade unions and the DMR. These include the following:

In November 2014, MHSC principal tripartite stakeholders launched a Centre of Excellence to conduct world-class research, build research capacity and facilitate the implementation of research outcomes.

In 2009, the Minerals Council established the MOSH Learning Hub, to help companies learn improved safety methods from one another. Among the success stories of this work are:

- Various improvements in underground support methods that have resulted in fewer fatalities attributable to fall of ground incidents.
- Through the MHSC, more than R250 million has been spent on research into seismicity associated with deep-level mines. In addition, R40 million has been spent on fundamental and applied research and technology transfer. The research outcomes led to new mine designs and methods. The number of fatalities associated with seismicity has fallen from 48 in 2003 to 14 in 2017.

- In line with the Culture Transformation Framework developed by the MHSC, the industry is improving its accident investigation methods, modifying bonus systems to further prioritise safety and is intensifying visible leadership approaches which have already had positive impacts.

In 2012, the Minerals Council established the CEO Zero Harm Forum (formerly called the CEO Elimination of Fatalities Team) to acknowledge the value of leading by example. The first focus area was on fall of ground – the greatest contributor to fatalities at the time.

The objectives of the CEO Zero Harm Forum are to:

- Develop a model for industry leadership at CEO level.
- Model leadership behaviour to demonstrate commitment and expectations.
- Share experiences and help each other deal with and solve key challenges.
- Establish working protocols with industry stakeholders and communities.
- Monitor and agree adjustments to industry models to suit specific needs.

A place of refuge

Underground refuge bays are a South African innovation. They have been developed into permanent and well-designed features in deep-level South African gold mines – large enough to provide rest and shelter for miners until they can escape or be brought safely to surface – and designed to serve this purpose.

Eight survivors of the Doornkop mine tragedy in 2014 owe their lives to making it to a refuge bay. These are fireproof and strongly built to withstand falling rock, and are equipped with compressed air and potable water, voice communications via radio or telephone, and recharge facilities for self-rescue equipment. Their doors open inwards so that they may be sealed from within against noxious gases by the maintenance of a positive atmospheric pressure within.

A FOCUS ON SEISMICITY

Seismicity, a naturally occurring phenomenon, is also associated with deep-level mining. As the depth of mining increases, the stresses associated with the overhead rock mass intensify, with energy building up and having to be released, frequently violently.

All seismic activity in South Africa is monitored and recorded by the Council for Geoscience, which is part of a global seismic monitoring network. Internationally, seismologists concur that the timing, magnitude and exact location of a seismic event cannot be predicted with any certainty. Seismic events have for years been one of the main causes of fatalities and injuries in deep-level mines.

Most gold mines employ seismologists and members of staff are trained in basic seismology and seismic processing. Most of the mines also rely on the expertise of the Institute of Seismology for more in-depth knowledge of the energies and pressures which occur. The application of centralised blasting (which ensures that the blast is set off simultaneously across the mine), reduces the post-blasting intervals in which seismic activity normally occurs. It also contains the time of exposure to dust, post-blast noxious fumes and gases, which are released by the blast.

Seismic events differ in intensity and only a minority of them are significant enough to cause injury to mineworkers or damage to equipment. At Gold Fields' South Deep mine, for example, 78,200 events occurred in 2016-2017 of which only 44 were intense enough to cause damage to infrastructure.

The Centre of Excellence (launched in November 2014 by the principal stakeholders of the MHSC) has been proactive in conducting world-class research, has built research capacity and has facilitated the implementation of research outcomes. R40 million has been spent on fundamental and applied research and technology transfer, while R250 million has been spent to date on research about seismicity associated with deep-level mining. Years of research have contributed to a far greater understanding of the risks of seismicity and, in this way, leading to better ways of mitigating and avoiding occurrences.

This is Gold is an industry initiative started by South African gold producers to provide insight into the gold industry, its processes and its contribution. We aim to provide honest, balanced information that can be used to understand the history of gold mining in South Africa, the work being done by the industry now and the plans in place for the industry's future.



KEY DEFINITIONS AND ACRONYMS

Deep-level mining

Mining ore at significant depths below the earth's surface (typically below 1,500m). It requires support structures, ventilation and cooling to cope with high rock temperatures and transport to/from surface for people, materials, mined ore and waste.

MHSA

The Mine Health and Safety Act 29 of 1996, as amended, which is the primary legislation governing health and safety in the mining industry.

Falls of ground

Sudden and often unexpected movements of the underground rock mass accompanied by uncontrolled releases of debris and rock. May or may not be induced by seismicity.

MHSC

The Mine Health and Safety Council is a national public entity established in terms of the MHSA and comprises a tri-partite board represented by state, employers and labour members under the chairmanship of the Chief Inspector of Mines. The MHSC is funded by public revenue and is accountable to Parliament. Its primary task is to advise the Minister of Mineral Resources on occupational health and safety legislation as well as research outcomes focused on improving and promoting occupational health and safety at South African mines. The Council also oversees the activities of its committees; promotes a culture of health and safety in the mining industry; arranges a summit every two years to review the state of occupational health and safety at mines; and liaises with the Mining Qualifications Authority (MQA) and other statutory bodies about mining health and safety.

Mining Charter

The Broad-based Socio-economic Empowerment Charter for the South African Mining and Minerals Industry, which was amended in 2010. The charter is intended to facilitate the sustainable transformation and development of the mining industry.

DMR

Department of Mineral Resources.



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