

## Safety – a Business Imperative

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**Abstract:** The safety performance in the South African mining industry has been a contentious issue for decades when compared to international benchmarks. Although mining safety has always been part of the mining business proposition, a step change was required as the unacceptable safety performance threatened the sustainability of mining. The South African mining industry has in recent times made significant inroads in improving safety as it is viewed as a business imperative to ensure long term sustainability. Fatalities reduced from 219 in 2007 to 73 in 2016, however, the industry recognises that much remains to be done as one fatality is one too many. Research was recently conducted to determine the emerging themes that resulted in the improved safety performance of six major South African gold and platinum deep level mines, between 2007 to 2016. It was concluded that the leadership of the mining companies followed a multi-tiered approach in order to reduce safety related incidents in mines. It is imperative to appreciate the element interdependencies of the ‘Zero Harm’ safety approach in order to sustain the safety culture that is evolving in the South African mining industry.

**Keywords:** advocacy, governance, safety, sustainability, systems, leadership, risk management

### 1 Introduction

Safety has always been part of mining world-wide, however, the importance of being safe differs historically between countries and different generations.

During the period 2007 to 2016, 1246 persons died in the South African mining industry. The fatalities reduced from 219 per annum in 2007 to 73 per annum in 2016 which is a 67% improvement.

Safety remains a very important part of the social license to mine in South Africa. Although the number of fatalities has decreased significantly in recent times, it still occurs too often to be acceptable by society.

The overriding question is what has had to change to realise this significant improvement? Was the answer in new leadership, technology, processes, systems, legislation or applying that was known before?

### 2 Background

The amount of deaths in the South African mining industry during the past 100 years exceeds 51 000 between 1917 and 2016, as shown in Figure 1. Although the number of deaths has been decreasing substantially during the past 30 years since 1987, it remains unacceptably high at 73 fatalities in 2016, as shown in Figure 2 and 3.

This reduction in fatalities has been partly as a consequence of the reduced number of employees up to about 2003 as shown in Figure 2. However, it can also be seen that subsequently there is no correlation between the

number of employees and fatalities as the risk exposure has been reduced.

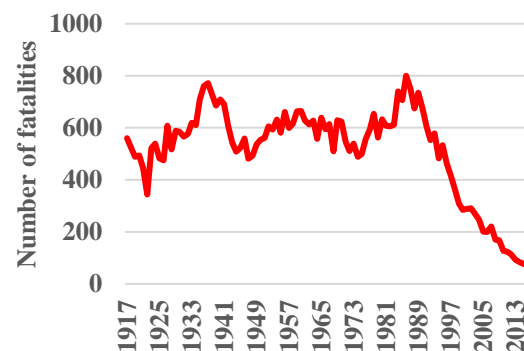


Figure 1 Fatalities of mining industry in South Africa between 1917 and 2016

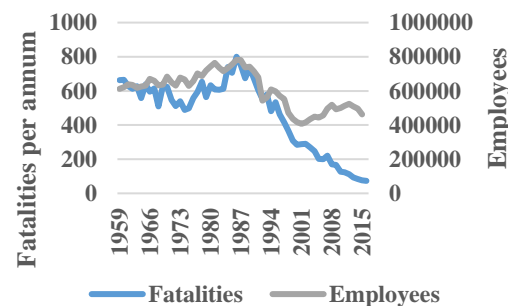


Figure 2 Fatalities and employees of mining industry in South Africa between 1959 and 2016

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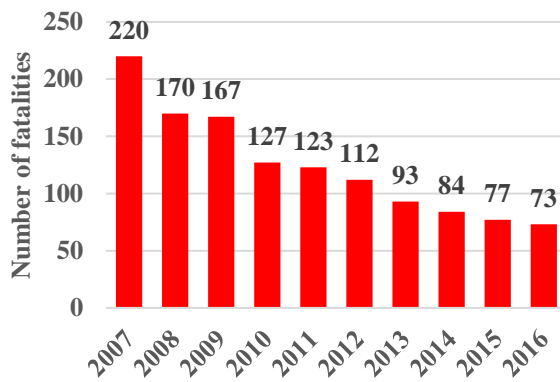


Figure 3 Fatalities of mining industry in South Africa between 2007 and 2016

In 1983 National Union of Mineworkers (NUM) was recognised by the South African Chamber of Mines as a representative union. In the same year Hlobane colliery methane explosion resulted in 68 fatalities. In 1985 NUM expressed concern over the mining industry safety record.

In 1986 the Kinross fire resulted in 177 fatalities followed in 1987 by a methane explosion in the Ermelo coal mine which resulted in 34 fatalities. In the same year St Helena mine had a shaft explosion causing the cage to fall down the shaft resulting in 67 fatalities. NUM had a National strike for 3 weeks in 1987 (Leon Commission of Inquiry report 1995).

In 1988, the Association of Mine Managers Council decided that safety would be at the top of all agendas and AMMSA organised a safety symposium (Hocking 1997).

The safety improvement in the South African mining industry basically commenced in 1987, as shown in Figure 1. At the time there was significant company restructuring and refocusing as some mature shafts were closed, some shafts were sold to 2<sup>nd</sup> and 3<sup>rd</sup> tier companies and NUM's presence was felt in the mining industry.

In 1993, yet another Commission of Inquiry, the Leon Commission, was launched into safety and health in the mining industry with wide terms of reference to inquire into all aspects of the Regulation of OHS. The findings built on previous Inquiries done in 1911, 1925, 1960.

In 2007, the then CEO of Anglo American, closed two platinum shafts in South Africa following a number of fatalities until the workforce received more safety training. This level of consequence management was unheard of in South Africa at the time.

The DMR has subsequently been stopping shafts or part of the operations at regular intervals for transgressions, despite lacking consistency in the approach.

In 2008 the Presidential Mine Health and Safety Audit was commissioned, and recurring themes were again recognised as was the case in the 1960 Marais Commission. (Leon Commission 1995).

A Tripartite Safety Summit was held in 2008 with union, government and industry representatives to address safety concerns in the mining industry.

Why were some of these recommendations not implemented at the time? The compelling answer is

probably that the mining industry at large was not held accountable for their actions and non-compliance had insignificant consequences for the individual companies in the past.

The mining industry response to safety has changed significantly in the past two decades and the historical prerogative to 'ignore' safety issues is no longer an option as mining companies are being held accountable for their actions.

### 3 Theoretical Approach to Achieve 'Zero Harm'

It is imperative that leaders involved in safety and health holistically understand the interdependencies of various safety aspects in dealing with the concept of 'zero harm' and how to achieve it. It has been experienced that that in large organisations, very few individuals actually understood the interdependencies of the overall safety management 'system' as a whole.

It's critical to recognise that safety success isn't an 'or' issue (one strategy or another), but rather an 'and' issue (one strategy and another). Safety excellence isn't the result of a singular strategy. There are no universal answers.

In a complex environment or a very large organisation, it is conceivable that only a few people, if any at all, understands the overall interdependencies of all the aspects of the 'Safety Management System'. There should therefore be a consistent, simplified safety storyline available so that the majority of the staff understands how the various components fit together as a whole in order to achieve 'zero harm'.

As a start, the Leadership of a company must have 'zero harm' as a non-negotiable value for the company. However, it should be understood that 'zero harm' is a reactive mindset in that it implies that an incident is expected to occur, but that the consequences should result in 'zero harm'. The next desirable pro-active mindset is that of 'zero incidents', meaning that all risk management controls are appropriate and applied.

Genuine caring for people creates an environment conducive for 'zero harm'. 'Values' on a wall poster that are not being applied, especially by leadership, have significant negative consequences on the safety culture in the longer term. Management must be seen to live the values and lead by example.

The company's safety efforts should be documented and contained in a Safety Management System (SMS), agreed to by all and applied by all stakeholders in the company. Participative management is important to the success of the 'zero harm' concept.

The SMS must be underpinned by a credible dynamic Risk Management process. Risks at all levels of the organization must be identified and controls instituted. Controls must be applied by all so as to ensure that activities are within the company's residual risk tolerances.

Safety is a result of pro-active risk management and is a concurrent activity to ensure that controls are in place before and during the execution of any task and not something that is done subsequently. For every task to be performed there

should be an agreed safety procedure available and all staff should agree to work to it.

What gets measured gets done. The safety information system must be appropriate for the company with leading and lagging indicators which are relevant, accurate and available timeously. More importantly, appropriate action should be taken should indicators trend negatively.

Human factors, which include the theory of behaviour as well as human errors, should be well understood, including human limitations. This will include the behavior of leadership as well as the individual who is in the line of fire. Behaviour turns systems and procedures into reality.

Benchmarking of relative industry performance should be undertaken, and system audits should be done regularly to ensure compliance of the company's Safety Policy. The company should strive for continual improvement of their safety performance (de Jager 2015).

#### 4 Safety is a Business Imperative

The safety expectations by individuals, society-at-large as well as companies, matured over time. What was acceptable in the past is no longer acceptable and will evolve further in future.

In the past the majority employees in the mining industry were illiterate and was required to do manual labour underground in challenging conditions. The mineworkers were largely recruited from remote labour sending areas and neighbouring countries and were housed on the mine in hostels, away from their families. They had an expectation to earn a wage to support their families and irked out a living. At the same time, they expected to potentially contract phthisis and lose hearing over time due to their exposure to dust and noise. Additionally, they could get injured, be maimed or die as a result of the nature of their work. Such was life.

However, over time, the individual's expectations matured and now expects a decent wage and benefits, living with their families in houses as well as not to be injured at all or exposed to other occupational diseases.

Company and other stakeholders' expectations have increased dramatically over time resulting in increased complexity and effort to have a sustainable business. Making adequate returns on investments is paramount to ensure business success but it cannot be done at the expense of society expectations. Mining companies cannot operate in isolation and society creates an enabling environment if expectations are met and the opposite if it is not met.

Exposure to occupational risks that results in diseases, injuries and fatalities are not acceptable and some investors and clients are no longer willing to deal with mining companies that has unacceptable safety performance. Times have changed and if companies do not adapt, how long will they survive?

##### 4.1 Society's view on accidents

Society has different views about public commuting deaths versus a similar incident in a mine and the reactions are vastly different.

A hypothetical example of a taxi commuting accident versus an underground people transportation accident is used to illustrate the different potential consequence.

If the public use cars, taxis, trucks and buses on public roads, there are common rules applicable with respect to road safety. Adhering to the rules of the road seems to be optional in many cases in South Africa. In the case of speeding, as an example, the adherence to road rules are randomly checked by the traffic officers and violations are dealt with, largely in the form of fines, which are to be paid subsequently.

Pro-active collision avoidance driver competencies such as advanced driver training is dependent on the attitude and requirements of the individual driver, unless prescribed by company rules. Collision avoidance technology in a vehicle, such as park distance control, cameras, ABS, EBD, lane change assist are vehicle manufacturer's self-imposed requirements, which maybe a requirement by some countries. In some countries, failure to produce a safe car could result in class action suits against the manufacturers, which could have a significant negative impact of a brand. Just about none of these controls are available in the taxi industry in South Africa.

Consequence controls in a car such as airbags and crumple zones are requirements set by manufacturing bodies and it has different requirements throughout the world. Vehicles used on public roads are supposed to be roadworthy and from a safety perspective, only the wearing of seatbelts in certain types of vehicles are prescribed by law in South Africa.

In the case of an accident by a taxi in South Africa, which results in multiple injuries and fatalities, which happens too regularly, it becomes news, not headline news. These accidents invariably happen when an over tired driver, pushed for turnover, drives an un-roadworthy vehicle, probably disregarding the rules of the road, takes another chance and this time it fails.

The victims are buried, the families are distressed, bread winners may be lost, some passengers may be maimed, and others are lucky to escape unhurt. The driver may get a fine, but it is not inconceivable that he or she would be back on the road in due course carrying on with the same old habits.

There may even be an outcry by the local authorities and at times even an outcry by the government which fades fast. If the locals complain about a driver's recklessness, they won't have a lift the next day.

Other than sharing the intent that all drivers must comply with the traffic rules, there is no government requirement that subsequent to taxi fatality that all drivers must be retrained, all taxi services be stopped to facilitate the retraining, all un-roadworthy taxis be scrapped, new on-board technology for collision avoidance be introduced etc. The same old just continues and it is business as usual.

Therefore, the society has come to accept that riding a taxi is just part of life and the potential negative consequences has become part of the South African culture.

In 2016 there were 14 071 road accident related fatalities in South Africa. (RTMC 2016) The equivalent

number in Australia was 1290 fatalities during 2016 (Bitre 2017).

To the contrary, if an accident which results in multiple fatalities occurs underground, while transporting employees, the mine will be stopped; the driver probably be relieved of his duties and lose his or her job; the manager and the company may be fined; significant retraining to be done by all the drivers and new technology expected to be introduced to prevent a reoccurrence.

The original equipment manufacturers could be bought in and in a tripartite process be established to find a solution. It would probably become an industry strategic safety thrust; case studies will be done, and papers written about the remedial measures. Significant cost will be associated with this mishap; the company and mining industry image will be tarnished; the unions could even strike, and investors could become reluctant to be further associated with the company concerned.

#### 4.2 Safety is a business imperative

This exaggerated rendition of similar accidents in a different context and varying society and government expectations, points out that the consequences of mishaps for the mining industry is enormous.

The Chamber of Mines of South Africa (COM) estimated that the Department of Mineral Resources (DMR) Section 54 instructions to stop mines or part thereof, as a consequence of safety related transgressions, cost the industry some R13.6 billion between 2013 to 2015. (Moneyweb 2017)

There are therefore compelling reasons for a company to mine safely and to regard it as a moral and business imperative to ensure sustainability.

### 5 Is 'Zero Harm' Possible?

The society at large is increasingly expecting that for mining to be sustainable, the safety performance must improve dramatically. It has never been acceptable to kill somebody in the course of their work. Society's expectations and the mining industry's response has moved closer over time the mutual vision of 'zero harm' was adopted although it has not been achieved as yet.

Will 'zero harm' ultimately be reached? Probably not as mining is inherently dangerous, and people make mistakes. The focus of the mining industry is to make the mining process safer and for people to make fewer mistakes.

#### 5.1 Mining context

Mining is not a steady state operation and is very dynamic as the environment is constantly changing and it is therefore an abnormal normal environment. The mining method employed such as conventional drilling and blasting, mechanisation and automation largely dictates the potential safety outcome. This outcome is fine-tuned by the interface between humans, machinery and the environment created.

In the South African mining industry, there are a significant number of elements that creates the context within which miners are expected to operate. It includes

mature mines, pillar mining, mining at depth, heat, significant underground travelling distances, and seismicity, amongst others.

The mining method, taking into consideration the inherent characteristics of the orebody, is the singular most important predictor of the safety outcomes as everybody working in the resultant environment will be exposed to the risks created by design.

There is a direct relationship between energy used to mine and the potential consequences of it used in a positive or negative manner. In mining the amount of energy used is invariably significant to turn ore reserves ultimately into a saleable product.

Mining involves intruding into an inherently high-energy space and environment. The very rocks surrounding the excavated openings are charged with latent energy. The way how to manage this latent or potential energy has a lot to do with safety.

The laws of thermodynamics and entropy mean that latent energy stored in the rocks surrounding any excavation is looking for a way of release. The very environment in which mining takes place is charged with energy and any irresponsible behaviours could result in an unwelcome release of that energy. It is therefore no surprise to conclude that the safest mining is no mining at all.

#### 5.2 Risk management

There is no single answer to achieve 'zero harm' as the overall efforts necessary to ensure that the residual risks created by deep level, hard rock mining is enormous and complicated. Continuous improvement is required in order to move closer to achieving 'zero harm'.

The South African mining companies in general have put in significant efforts to reduce the residual risks. The mining industry has renewed their efforts to apply known solutions better in the prevailing circumstances.

Certain practices were stopped, such as mining in seismically active areas and new ones introduced such collision avoidance technology in horizontal transport underground. This has resulted in improved safety results. However, more of the same can only do so much and something new is required to create the step change in safety performance.

Risk management processes has not changed in the past 80 or so years. The application methodology and monitoring thereof has become more sophisticated over time. Unfortunately, if the collective wisdom by all stakeholders fails to identify the risk, nothing else matters. What will be will be.

Paper solutions are patient, but the reality is that the mining environment is dynamic, and conditions changes continuously. The company leadership should cater for the possibility that the requirements to achieve 'zero harm' will not always be executed perfectly. This resultant gap is where incidents occur that can cause harm.

If a risk is not identified upfront, the rest of the available potential controls are all irrelevant. However, if the risk has been identified and the controls are inadequate,

the correct application thereof could still result in an incident.

People are exposed to the real environment and will have to take these dynamics into consideration to make informed decisions on the spot. The result of these decisions will determine whether 'zero harm' is achieved, or not. The perfect human being has not been found as yet and the rest of society is still fallible and has the potential to make mistakes.

If the risk was identified and the controls are adequate, behavioural safety can make the difference between success and failure when the individual decides to apply the intended risk controls or not.

### 5.3 Inadequate risk controls

Fatalities will not occur if the risk controls in place were adequate and applied perfectly. If one considers the 73 fatalities that occurred in the South African mining industry during 2016, how many of the fatalities were due to inadequate controls being in place?

Some generalities are bandied about by the individual companies that 70-80% of accidents are due to human behaviour, which normally refers to the behaviour of the individual that was injured. This means that the risk controls were in place but not adequately applied which resulted in harm.

The converse must then be true that 20-30% of incidents had inadequate risk controls in place, designed by the company leadership. That being the case, is this oversight due to mistake or is it a violation? Ignorance is bliss, but unacceptable in mining.

The residual risk is the interface by the individual to this environment by a prescribed working methodology using prescribed equipment. The onus of ensuring that this interface can conceptually be safe rests with the company's leadership to determine policies that will create an enabling environment to achieve the lowest possible anticipated residual risk. It is only by the perfect application of this strategic intent that the real residual risk will equate to the planned residual risk.

### 5.4 Seismicity

If mining takes place in seismic areas, as an example, and the industry acknowledge that further research is necessary to manage the risks better, it means that inadequate knowledge is currently available.

If mining in seismic areas is continued in the meantime, it is done knowingly that the controls in place are probably inadequate. In this instance, the leadership behaviour could be classified as a wilful violation as it is a known unknown. This in turn becomes a moral debate and no longer a technical debate.

### 5.5 Safety by design

The conceptual level the focus of the South African mining industry is to remove people from risk by changing mining methods and by introducing new technology. This approach has had some success, but its full potential is still to be

achieved. The primary reason for this is that most of the current mines operate mainly using conventional methods which continuously to expose people to risk.

Mining is dangerous, and it is not possible to eliminate all risks completely, as ultimately there is a dependence on human behaviour. Humans are not perfect, and mistakes do happen. However, 'zero harm' is an important mindset and goal that should be relentlessly pursued, and the safety culture be enhanced continually.

The law makers, mine designers, process and procedure designers, equipment manufacturers, trainers and individuals regard safety as a priority and a non-negotiable. There are probably no individuals who has the wilful intention to design unsafe conditions. At worst, in isolated cases it is possible to make a mistake, primarily due to insufficient knowledge, that a design is inadequate.

Can it be true that if there is an accident, that in most cases, the response at company level is that the individual concerned has erred? It comes down to a perceived wilful violation by the individual as he or she was trained to do the job properly but did not do what he or she was supposed to do, for whatever reason.

Is it possible that the prevailing conditions was such that the individual concerned made a mistake in that what was trained was not quite applicable to the situation encountered? How many people would wilfully violate an agreed process and specifically have the desire to be injured or killed?

### 5.6 The residual risk is still too high

When risk controls are devised, it is envisaged that when it is perfectly applied, the residual risk will be acceptable. The tolerance for non-adherence of the control requirements is minimal in the instances where the potential energy that the individual is exposed to is beyond human tolerance.

The unintended release of energy such as a fall of rock, blasting, fall from height, in the way of equipment, misuse of energy normally exceeds human tolerance and results in harm. These releases of energy, where an individual could potentially be exposed to, invariably does not fail to safe, as would normally be the case with electricity that has a trip switch.

Maybe the consequence of a 'small' non-adherence to agreed procedures is such that the consequences are disastrous. Surely one must then query whether adequate controls are in place to deal with such situations.

It can therefore be concluded that the residual risk could be too high and should be engineered such that the consequences of potential mishaps are minimised. It is inappropriate to place such a significant dependence on the behaviour of individuals in the cases of accidental energy releases beyond human threshold.

### 5.7 Behavioural safety

When risk controls are formulated, it caters for a broad range of possible eventualities and it is perceived that the residual risk will be within the acceptable risk tolerances. This will only be achieved by the perfect application of the prescribed rules.



Danger is real, but it is the individual's interpretation of the perceived future residual risk that will determine his or her actions. It is possible that an individual could find him or herself in a situation where there is no ready-made solution available and that an on the spot solution needs to be made to deal adequately with the risk at hand. If the outcome is misinterpreted, the risk mitigation will be inappropriate which could result in harm.

It is for this reason that a significant amount of technical training is imparted to the individual as an enabler to envisage potential solutions of unanticipated situations. This training is augmented by behavioural safety training to equip the individual with the necessary emotional intelligence to make informed decisions to avoid harm.

## 6 Towards Achieving 'Zero Harm'

Research was done to determine what actions were taken to improve safety in six South African deep level mines using publically available information for the period 2007-16. All the mines were GRI compliant.

The conclusion was that the acceptance of global and national societal expectations; the embracing of these requirements; the creation of an enabling environment; the real reduction of risk in most cases and being held accountable, resulted in the reduction of fatalities in the South African mining industry over the past decade.

Emerging themes were observed which enabled the companies to create sustainable safety outcomes. This high-level approach could be adopted by the relevant companies and organisation in a country to improve the safety performance.

Most importantly, society norms and expectations need to be articulated consistently through various institutions, organisations and actions to enable the mining industry leaders to clearly understand what is expected from them. Other major themes include:

(1) The country/ company's leadership to take heed of the broader society's expectation that mining must take place safely;

(2) The country/company leadership to institutionalise the approach to 'zero harm' by articulating the strategic intent and to create an enabling environment to achieve 'zero harm';

(3) Systemise all the activities required to achieve 'zero harm';

(4) Humanise the systems to transfer relevant knowledge and establish behaviours of all individuals throughout the organisation to enable the achievement of 'zero harm';

(5) Operationalise the safety management system by removing or reducing the risk to acceptable levels in the workplace;

(6) Monitor and manage the company safety outcomes;

(7) Embrace continual improvement.

## 7 Summary

There is no one specific action that improved the safety

performance in a mature mining industry in South Africa. It requires a combined effort by all stakeholders including, companies, government, organised labour, relevant organisations and employees, aspiring to achieve 'zero harm', to turn the vision into action.

National and international society expectations were acknowledged and turned into actions by the mining industry to improve the safety performance. It included:

(1) A tripartite mining industry safety game plan facilitated by the Mine Health and Safety Council of South Africa was developed and re-focused bi-annually, where necessary;

(2) Measureable industry safety goals was determined and agreed to by the tripartite alliance which includes, government, organised labour and mining companies;

(3) The mining industry is being held accountable for their safety performance by shareholders, organised labour, the Department of Mineral Resources and by the company boards;

(3) The Chamber of Mines of South Africa is acting as a collective enabler for industry's safety initiatives;

(4) Guidance safety principles and processes provided by the International Council on Mining and Metallurgy is used;

(5) The mining industry established a co-operative Chief Executive Officer's working group to reduce fatalities by initially focusing on specific initiatives such as fall of ground and underground horizontal transport. The results were highly successful;

(6) Believing that 'zero harm' is possible, despite it being business in progress;

(7) Commitment by company boards, leadership and employees to achieving 'zero harm';

(8) Consistently articulating the strategic intent to achieve 'zero harm';

(9) Institutionalise 'zero harm' as an outcome through company values, policies, procedures and governance processes and definite plans to achieve it;

(10) Manage the interdependencies of all requirements to achieve 'zero harm' by systemising it. (Plan, do, check, act.) It includes all aspects of the zero-harm approach including enhanced risk management methodologies, international certification, audits, reviews, investigations, critical control measures, information systems, contractor management, etc;

(11) Spend significant efforts on enabling employees to achieve 'zero harm' by creating a safety culture focused on 'zero harm'. Some of the aspects included involvement by all relevant parties; safety culture transformation, wellness of the workforce; significant training; enhanced behavioural safety programmes; fatigue management; campaigns, leadership training programmes, stakeholder relationships, women in mining, absenteeism, incentives, disciplinary processes, etc;

(12) Operationalise the collective efforts by the 'real' reduction or elimination of risk. It includes reviewing and changing mining methods, technology introduction, mechanisation and automation, seismicity, rock bolting, netting, collision avoidance in horizontal transport, fire

prevention, maintenance of infrastructure, enhanced secondary support, amongst others;

(13) Measure and manage the safety performance at company and industry level;

(14) Aspiring to continual improvement.

## 8 Conclusion

It is acknowledged that the South African mining industry has still got significant room for improvement in its safety performance. However, the South African mining industry has a collective know how which can assist other countries to improve their safety performance.

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