



GOLD FIELDS

TECHNOLOGY THAT PROTECTS

**New Mining Technologies and
Mechanisation: Emerging Health
and Safety Risks**

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The argument in four moves



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Technology has enabled safety
Fatalities down 91% since 1994.
Machinery fatalities down 67%
in a single year.

The hazard moved, it did not disappear
We took people off the rock face. The machine became the dominant hazard.

New technology, new failure modes
Interference, unproven adoption, and work we changed without redesigning it.

The discipline decides the outcome
Management of change and change management are now the binding constraint.

PEOPLE PROTECTED • RISK ENGINEERED OUT • CHANGE MANAGED

SAFETY FIRST

Everyone home,
every shift

EXPOSURE REMOVED

People out of the line
of fire

RISK RE-ASSESSED

New technology, new
failure modes

PEOPLE CARRIED

Skills, roles and
dignity of work

ZERO HARM

The only acceptable
destination

Before we talk about technology, we talk about people



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41 colleagues did not come home in 2025.

It was the lowest annual figure in the recorded history of South African mining. It is also 41 families, 41 crews, and 41 funerals.

This summit commemorates the colleagues we have lost. Everything that follows in this presentation — every system, every roadmap, every business case — is only worth presenting if it moves that number toward zero.

One goal. Everyone home. Every shift.

OUR COMMITMENT

Stop

If it is not safe, we do not do it.
Production never buys a shortcut.

Think

Assess the risk in front of you, not
the one in the procedure.

Act

Raise it, fix it, or withdraw. Silence
is a decision too.

We go beyond compliance. We look out for each other.

Before we talk about technology, we talk about people



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Killed in South African mining in 1994, the year our democracy began.

Minerals Council South Africa

42

in 2024, down 24% from 2023, with no disaster-type accidents at all.

DMPR, 23 January 2025

41

Killed in 2025 — a 91% reduction, and the lowest figure on record.

Minerals Council SA, provisional

1 693

serious injuries in 2025, down 12% on the year and 80% since 1994.

Minerals Council South Africa

THE HAZARD DID NOT DISAPPEAR. IT MOVED.

Fall of ground averaged 111 deaths a year, 2001–2005

Fatalities concentrated at the rock face, in conventional stopes

The control was a support standard and a person's judgement



Fall of ground: 15 fatalities in 2025 — an 86% reduction



Fatalities concentrated around machines, in trackless environments



The control is increasingly an engineered system on the machine

Transport and mining machinery is now roughly one in five fatalities and one in five serious injuries.

South Deep's journey at a glance



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We are evolving

Who is South Deep?

- Custodians of one of the world's largest and deep known gold orebodies with a **70+ years** LOM
- **Our reality:** Seismically active mine. **Last Fatal Injury from Seismic activity was in 2019**
- **2006:** Shift from conventional to fully mechanised mining
- **Mindset:** Transformed how we work and the skills we need
- **Inclusion:** Increased female representation from 1% (below the Mining Charter baseline) to **30% in today**
- Digital control centre - real-time decisions

We are evolving:

- **Mechanisation** - Helping remove historical physical barriers to participation
- **Digitalisation**- Enabling real-time operational decisions
- **Advanced analytics** - Supporting safer, more efficient and sustainable mining
- **Future capabilities** - Digital, technical and leadership skills

We are becoming a safer mine:

2008:

14 fatalities and
43 serious injuries

2026:

0 fatalities and
0 serious injuries

4 fatality-free
years

Mechanisation and automation have made South Deep safer, more inclusive and future-ready.

Where technology took the person out of the line of fire



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Section 11 of the Act sets the order: eliminate, control at source, minimise, then PPE. Technology is how we finally reach the top of it.

Collision prevention, Level 9

South Africa is the only country in the world to legally require a machine to detect a person, warn, and then brake itself without human intervention — since 21 December 2022.

Teleremote and autonomous operation

The operator is not protected from the hazard. The operator is not there. For that task, exposure is eliminated rather than reduced.

Real-time location of people

Continuous visibility turns emergency response from a search into a rescue, and makes zone-based exclusion enforceable.

Bulk mechanised mining

Drilling, bolting and cleaning done by machine rather than by hand. Fall of ground fatalities fell 86% as conventional stoping declined.

Battery-electric and low-emission fleets

Diesel particulate is a Group 1 carcinogen and underground workers see over a hundred times ambient levels. Ventilation dilutes it; electrification removes it.

Continuous environmental monitoring

Gas, dust, noise and seismicity measured continuously rather than sampled, so an exposure becomes an alarm instead of an annual statistic.

Each of these removes the hazard or controls it at its source. That is why they belong in a health and safety conversation, not only a productivity one.

The evidence, and what we cannot claim



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0.27

collision near-misses per million truck hours at autonomous sites, against 2.76 at manual sites.

Rio Tinto data, via NIOSH, 2023

–67%

fall in machinery-related fatalities in South African mining in a single year, 2023 to 2024.

DMPR, 23 January 2025

–80%

reduction in both tuberculosis and silicosis in the industry between 2008 and 2023.

Minerals Council South Africa

–55%

reduction in noise-induced hearing loss — far behind the other two, and now our priority health risk.

Minerals Council South Africa

WHAT WE CAN AND CANNOT CLAIM

The government has said it on record
Minister Mantashe attributed the 2024 fall in transport accidents to collision avoidance brought about by the new trackless machinery regulations.

But hearing loss is going backwards
Standard threshold shift incidents above 25 dB rose from 4 in 2023 to 67 in 2024. Noise remains a risk that technology has not yet fully removed.

No South African study
There is no published national figure quantifying what collision prevention has done to collision fatalities. We should commission one.

Five risks we have actually experienced



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1

Technologies that interfere with each other

Safety systems that degrade or disable other safety systems.

2

Unproven technology adopted at scale

Readiness in a controlled trial is not readiness on an ageing fleet.

3

Underestimating the impact on people's jobs

We plan the machine in detail and the role in a paragraph.

4

New exposures replacing old ones

Strain, cognitive overload, fatigue, and risk moved to the artisans.

5

The operational technology attack surface

Once the mine is connected, a cyber incident is a safety incident.

WHY I CAN SPEAK TO THESE

South Deep is one of the deepest bulk-mechanised mines in the world. We are not speculating about mechanisation — we live in it. On 2 January 2024 we lost a colleague in an underground incident involving trackless mining equipment.

At one of the world's most mechanised mines, the type of machine introduced to improve safety was involved in a fatal incident.

Interference, and technology adopted before it is proven



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01 · TECHNOLOGIES THAT INTERFERE

We certify devices one at a time, then install them on the same machine, in the same tunnel, on the same spectrum.

A dust monitor that disabled a proximity system

NIOSH found a personal dust monitor interfered with proximity detection below 15 cm — at 7 cm, in three of four orientations tested. A miner could approach a continuous miner without being detected.

A regulator's formal warning

MSHA notified underground coal operators in 2016 that gas detectors, radios, dust samplers, laser range finders, trailing cables and variable frequency drives all cause interference with proximity detection.

Our own interoperability finding

The Minerals Council's CPS work found vendors use different communication standards of their own choice, that 76–81 GHz radars risk masking true targets, and that stopping a loaded haul truck above 30 km/h has not been demonstrated.

02 · ADOPTED BEFORE IT IS PROVEN

Two failures that look like opposites, and happen at the same time.

Most pilots never reach the people they were meant to protect
85% of companies spend more than a year in pilot mode. Only 30% of pilots ever scale across the organisation.

And when we do commit, we commit at scale

Technology readiness is not operational readiness. A controlled trial says nothing about a mixed, ageing fleet on a wet decline at three in the morning.

Our own example: the Level 9 gap

Three and a half years after the regulation commenced, many operations remain in the process of verification. The diagnosis in the trade press is blunt: the gap is one of practice rather than of technology.

Underestimating what technology does to people's jobs



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We plan the machine in detail and the role in a paragraph. Every behavioural failure on this slide begins in that asymmetry.

Alarm fatigue, then circumvention

Frequent or non-critical alarms erode trust, and an operator who stops believing a system looks for ways around it. Habituation has already led to an operator failing to react to a critical alarm.

The control room is not the easy job

One controller supervising an average of 25 trucks. Researchers observed controllers taking no break, including no toilet break, for up to six hours. Several had expected automation to make work easier.

Over-trust, in the other direction

A documented case of a light vehicle deliberately crossing ahead of an autonomous truck, assuming the system would stop. Automation changes behaviour both ways.

The risk moves to the maintainers

In an analysis of 432 driverless haul truck incidents, maintenance personnel were the workers at greatest risk of injury. The operator came off the machine; the artisan went under it.

Loss of skills and awareness over time

People lose manual skills if they do not use them regularly— precisely where emergency operation demands manual reversion. No single operator holds the whole picture any more.

Impact on jobs and skills

39% of workers' core skills are expected to change by 2030, and 63% of employers name skills gaps as the biggest barrier to transformation. A workforce that fears a technology will not surface its defects.

People comply with technology they feel is imposed on them. They improve technology they feel they own.

The numbers that should stop all of us



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33 ▶ 36 ▶ 42

Fatalities at ICMM member operations in 2022, 2023 and 2024. Two consecutive years of increase — across the companies with the most technology, the most capital and the most mature safety systems in the world.

83%

of those 2024 fatalities were linked to a failure to implement effective critical controls.

ICMM, July 2025

26%

of member fatalities from 2021 to 2024 involved mobile equipment — the single largest cause.

ICMM, July 2025

15

of the 42 were in South Africa, 14 of them underground.

ICMM, July 2025

45%

of the 2024 fatalities were contractors, not employees.

ICMM, July 2025

The technology was in place. The controls were in place. The failure was in how they were applied in practice.

Two disciplines, one failure mode and now a legal duty



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MANAGEMENT OF CHANGE

The technical discipline

A management system to identify, review and approve every modification to equipment, procedures, materials and operating conditions — other than replacement in kind — before it is implemented.

It asks: what is the technical basis, what is the impact on health and safety, which procedures must change, and who must be retrained before start-up.

Owner: the operation

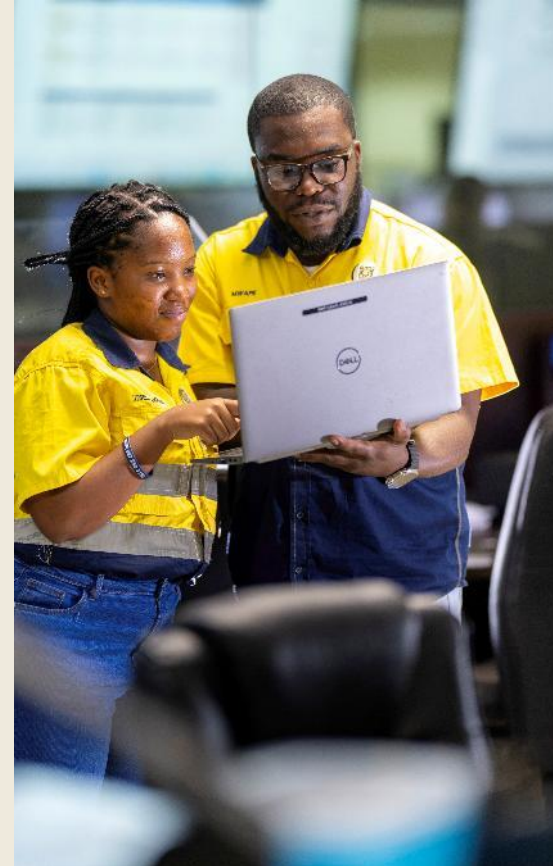
CHANGE MANAGEMENT

The people discipline

A structured approach to moving individuals, teams and the organisation from a current state to a desired future state, focused on the human side of change.

It asks: does the crew know why, do they want it, do they know how, can they actually do it, and what reinforces it when the project team leaves.

Owner: line leadership, human resources, the unions and our people.



GOVERNMENT NOTICE 6328

A mandatory code of practice for change management

Gazette 52883, 20 June 2025.
Issued by the Chief Inspector of Mines under section 49(6) of the Act.

- Risk assessment under section 11
- Consultation with H&S reps and unions
- A named senior leader accountable
- Competency demonstrated, not attendance

Do the first without the second and the system is compliant and ignored. Do the second without the first and the crew is enthusiastic about an unassessed hazard. Every mine must now have a code — the question is whether ours covers technology.

Three horizons, in the right order



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Each horizon is only safe to enter once the one before it is stable. Automation multiplies the operating model underneath it — including its defects.

NOW · 2026–2027

Foundation

Assure what we have already bought

- Close the Level 9 verification gap on every trackless machine
- Interoperability and interference testing across the installed fleet
- A change management code of practice that explicitly covers technology
- Alarm, override and availability reporting in the monthly safety pack
- Role redesign for control room, remote operator and maintenance crews

NEXT · 2028–2030

Integration

Connect the systems and the people

- Network-enabled mine as the assured backbone for safety-critical systems
- Continuous real-time location of every person underground
- Battery-electric transition, planned deliberately for noise and DPM
- Operational technology security inside the section 11 risk register
- Reskilling pipeline delivering the roles the technology already created

FUTURE · 2031 ONWARD

Transformation

People out of the line of fire

- Teleremote and autonomous operation in the highest-risk working places
- Predictive seismic and ground-condition management at production scale
- Integrated mine operating centre as the accountable point of control
- Human systems integration required of every OEM at tender stage
- Zero fatalities, sustained — not achieved once and reported

AND FOUR GATES

PROVE

Does it work here?



ASSURE

Is it safe to rely on?



ADOPT

Will people use it as intended?



SCALE

Does it hold without the project team?

What I would ask of each of us



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The state

Regulate the system, not the device

Extend assurance from device certification to interoperability on the installed fleet, with ICASA on spectrum and a common standard.

Commission the evidence we do not have

No published South African study quantifies what collision prevention has done to collision fatalities, or how often it trips unnecessarily.

Make change management visible in inspection

Ask for the June 2025 code of practice — and ask whether it covers technology introduction.

Organised labour

Be in the design, not the communication plan

Health and safety representatives in the technology risk assessment, while the decision is still open.

Bring us the workarounds

Your members know which system gets bypassed and why. That is a leading indicator and none of us are collecting it.

Hold us to the reskilling, in writing

There is no public tripartite agreement on modernisation and jobs. There should be, and this is the forum to start one.

Employers

Fund the change, not only the capital

Budget role redesign, competency and post-handover support as part of the technology, not as overhead.

Report adoption, not installation

Alarm rates, override rates, availability and trust in the monthly safety pack, alongside fatalities and injuries.

Put the duty on the supplier

Section 21 already makes the manufacturer responsible for a safe article. We have not been pulling that lever.

Technology is neutral. The way we introduce it is not.



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THANK YOU

QUESTIONS?

Working together for a safer, smarter
and more sustainable industry.

Benford Mokoatle

Executive Vice President: South Africa / Gold Fields

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Get to know the presenter

Mr Benford Mokoatle

is the Executive Vice President: Gold Fields South Africa.

He holds a BSc (Hons) Geology, from the University of Cape Town; a Graduate Diploma in Engineering from Wits University; an MBA from Wits University; and a Sustainable Business Strategy qualification from Harvard University.

Mr Mokoatle is a geologist with over 30 years' experience in the mining industry. He joined Gold Fields in October 2017 as General Manager for South Deep and became Executive Vice President for the Gold Fields South Africa on 1 June 2023 after serving as acting EVP since 1 July 2022.

Prior to joining Gold Fields, Mr Mokoatle spent seven years with AngloGold Ashanti and 15 years with De Beers, where he was the Head of MRM and Technical Services before taking on the role as a General Manager for the Voorspoed and Venetia mines.

He is a trustee for the South Deep Education Trust, South Deep Community Trust and the South Deep Joint Venture Rehabilitation Trust.



Every mine worker returning from work unharmed every day. Striving for zero harm in our lifetime.