

**Contributing to
reducing mining
health and safety
risks through a
nonexplosive
mining innovation.**

A S Macfarlane





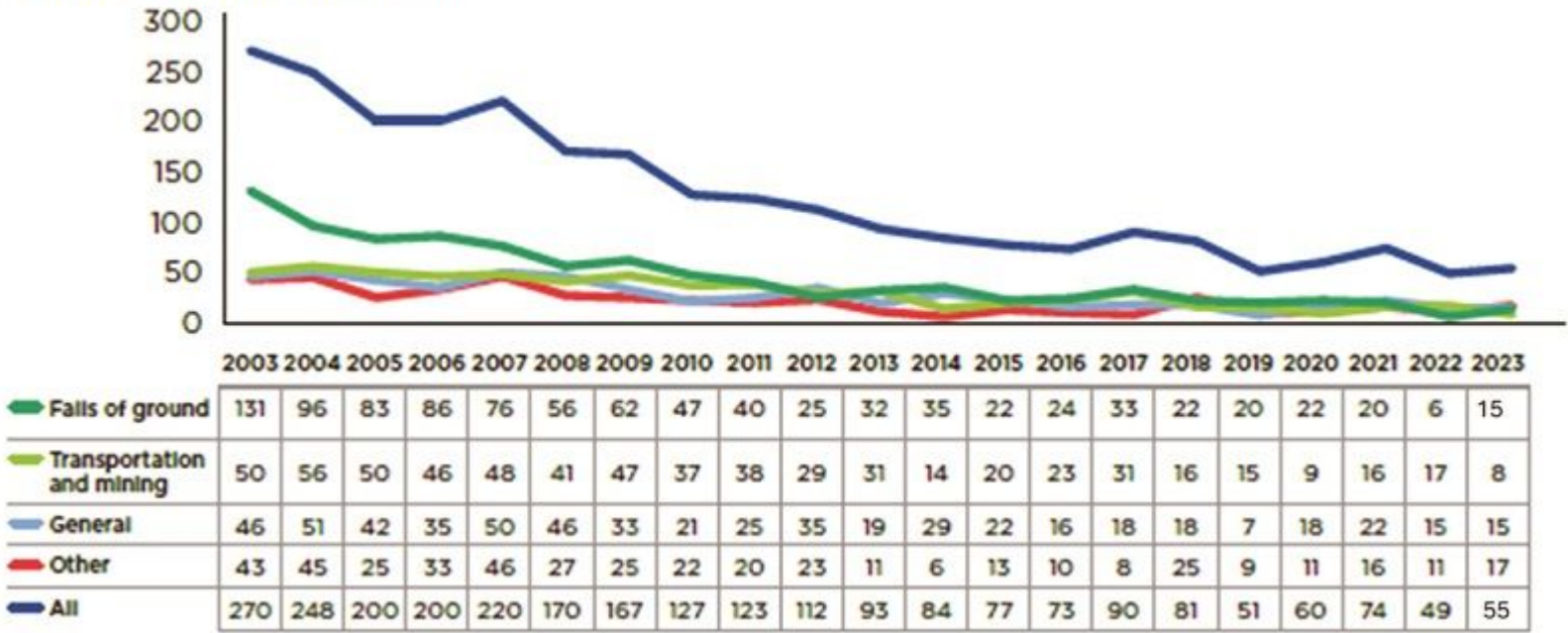
The story line

- Mine health and safety
 - Where we are
 - Where we want to be
- Milestones and aspirations
- Explosive mining
- Non-explosive mining
- An alternative : Controlled Foam Injection (CFI)
- Applications and configurations
- Progress and the way forward
- Circling back : benefits and opportunities
- Contact us!

The Health and Safety situation in mines



Fatalities per classification



Major improvements over the last 22 years, but despite the target of zero fatalities by 2034, there appears to be a flattening of the curve.

This will (and has been) achieved by intervention.

(If you don't change something, everything stays the same)

Can a nonex solution contribute to achieving these milestones?

South Africa's mining sector recorded **42 fatalities** in 2024, a 24% decline from 2023, achieving its lowest-ever annual fatality count. Occupational injuries dropped 16% year-over-year to 1,841 cases, with occupational diseases also declining by 17% due to focused health interventions.

Source: DMPR

ELIMINATION OF MINING FATALITIES
Objective: Achieve zero fatalities in mining operations. Key Commitment: Every fatality is one too many. Mining companies are striving to reach a target of zero fatalities industry-wide

ELIMINATION OF REPORTABLE ACCIDENTS
Falls of Ground (FOG) Accidents: Targeting a 20% annual reduction. Transportation and Machinery Accidents: Targeting a 20% annual reduction. General-Type Accidents: Targeting a 20% annual reduction.

Respirable Crystalline Silica Dust: By 2034, 95% of exposure measurements will be below 0.03mg/m³. Review in 2029.

Respirable Coal Dust: By 2034, 95% of exposure measurements will be below 1.25mg/m³. Review in 2029

Respirable Platinum Mine Dust: By 2034, 95% of exposure measurements will be below 1.0mg/m³. Review in 2029

Noise emissions from equipment must not exceed 104dB(A) by 2034. By December 2034, no novice cases of noise-induced hearing loss will occur among individuals entering the industry post-2024.

Thresholds and limits : occupational health milestones 2034 (Minerals Council)



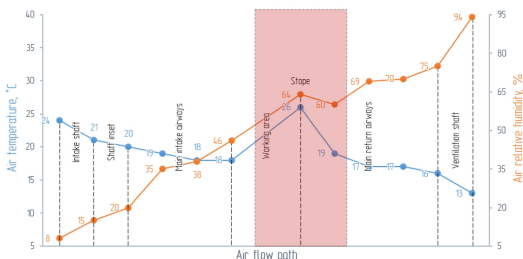
Noise

- Industry wide Buy and Maintain Quiet
- Focus on noise elimination
- Eliminate NIHL
- Maximum emission 104 dB(A) from equipment by 2034
- Semi-remote operation
- Noise abatement



Dust

- 95% of all exposure milestone of respirable silica $< 0.05 \text{ mg/m}^3$
- Dust suppression
- Reduction at source of generation (especially from blasting)
- Re-entry periods

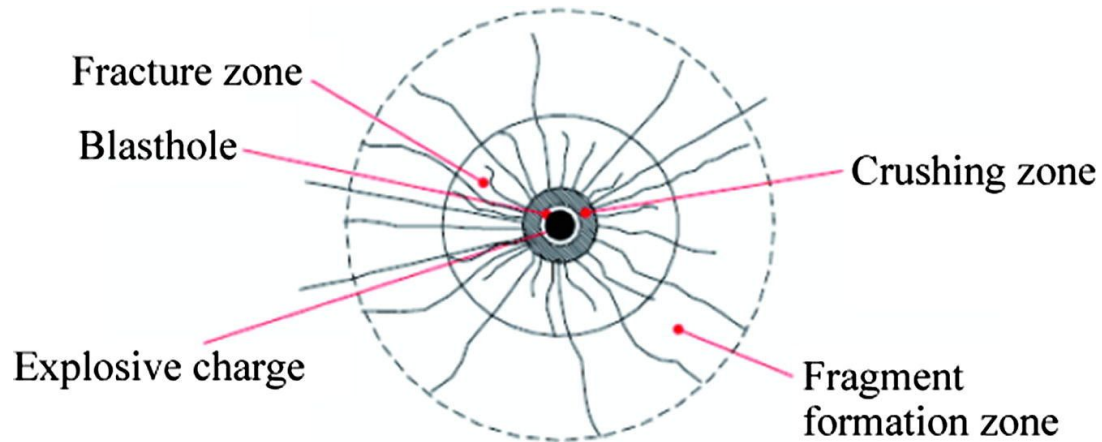


Heat

- Definition of hot environment : DB $> 37^{\circ}$, WB $> 32^{\circ}$
- CoP when DB $> 32^{\circ}$, WB $> 25^{\circ}$
- Refrigeration, cooling all at a cost
- Heat sources : explosives, diesel equipment

H&S risks associated with explosives

Modern mining systems frequently use drill and blast techniques for rock excavation. Rock blasting not only fragments rock but also creates overbreak in the rock surrounding the excavation. The unwanted damage often results in higher mining costs and severe safety concerns.



Other risks include:

- Nitrates in groundwater
- Silica dust
- Sulphide dust
- Storage and handling
- Drilling into misfires
- Premature detonation
- Coal dust explosions

Mitigation

- Threshold blasting
- Smoothwall blasting
- Suitable non-explosive methods and technologies such as CFI



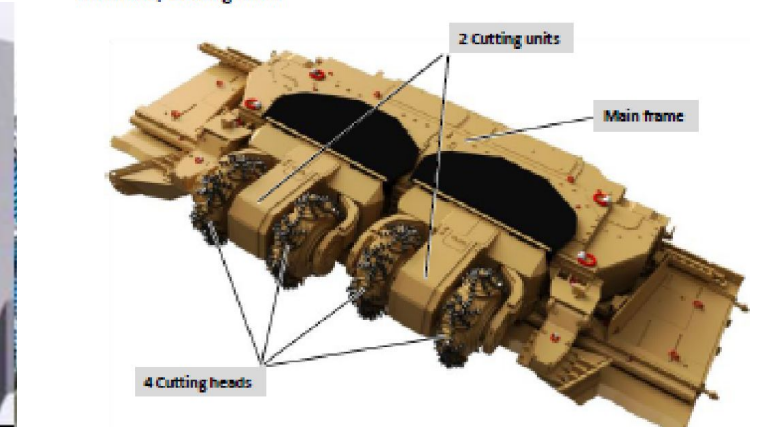
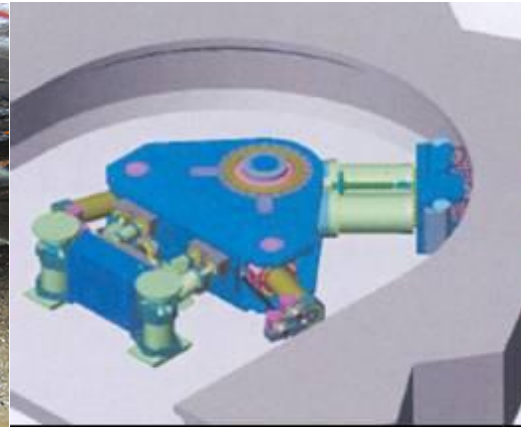
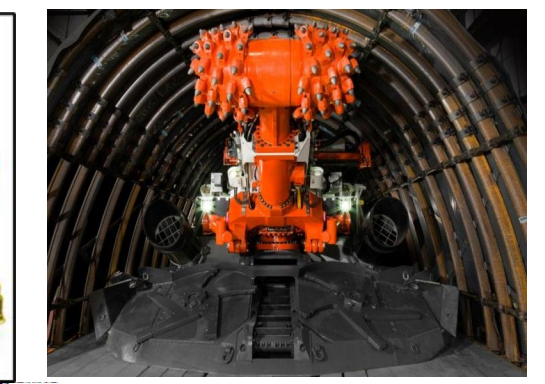
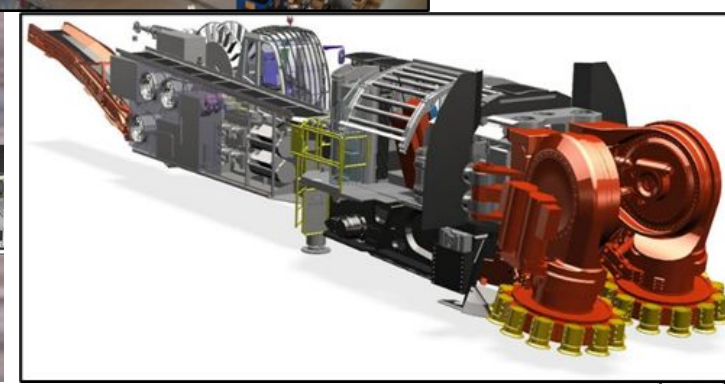
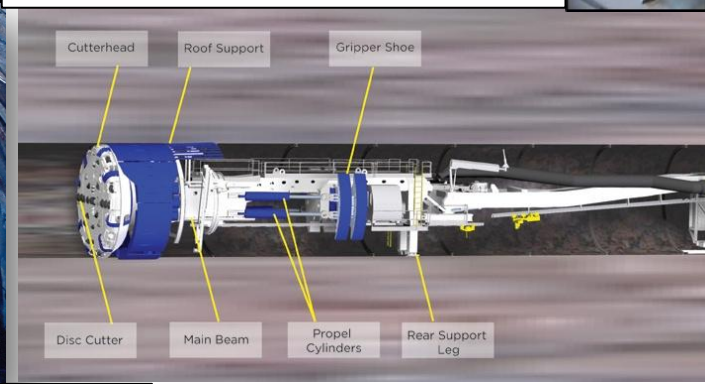
(a)



(b)



Non explosive mining developments



Impacts of these technologies on H&S



- ✓ • Reduced blast damage
- ✓ • People (operators) out of harm's way : remote operation
- ✗ • High noise levels
- ✗ • Potential for high dust levels
- ✗ • High heat levels
- ✗ • High power requirement
- ✗ • High capital cost
- ✓ • Low flexibility

Is there an alternative?



Note:

- The barrel is not subject to the shock damage associated with explosives.
- Rock is liberated from the face with low velocity
- Relatively little fly rock
- No shock wave
- Relatively quiet
- Can be operated remotely
- Can be powered by any power source
- Rock is broken out in tension (low energy)

The Mining Cycle
Hole depth less than 1 m
Full cycle (drill, index, insert,
break) 3-4 minutes
Breakout per hole up to 0,5m³



CFI OPERATION

**APPLICABLE FOR ALL TYPES OF MINING
FROM UNDER SEA TO OUTER SPACE**

- Drill a hole
- Index the CFI breaker to the hole
- Insert the breaker barrel into the hole
- Placement of seal
- Inject high pressure foam, fracturing and liberating the rock



The foam:



Environmentally safe foam

- Non-Toxic
- Biodegradable



- Breaks rock in tension
- Continuously pressurizes fractures
- Tailored viscosity to RMI
- Sufficient stored energy to break rock
- Fume and dust free
- No chemicals to cause downstream impacts
- Minimum fly-rock
- No vibration
- Minimum rockwall damage

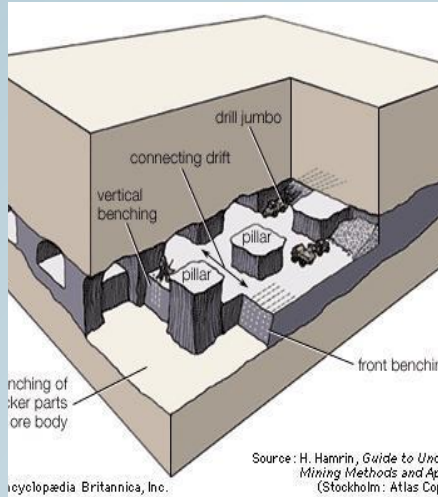
Applications

Multiple applications in surface and underground operations



Tunnelling

- Flat, inclined or vertical
- Any size or shape
- Minimal sidewall damage



R&P mining

- Improves productivity by improved cycling
- Minimal pillar damage
- Improved extraction ratio



Stonework

- Nonex dyke mining
- Eliminate the need to move out CMs
- Reduced possibility of gas explosions



Interburden removal

- Improved productivity
- Minimal interference with coaling ops



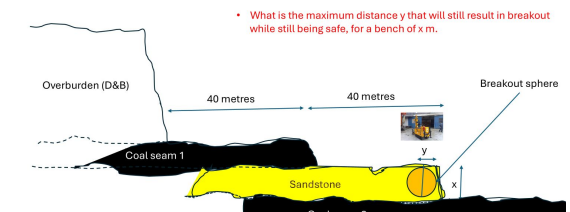
Civil engineering

- Road cuttings, civil excavations near infrastructure : minimal disruption

Other specialist applications include Boulder Breaking, mining near infrastructure (within 500m radius) and environmentally sensitive areas, Pillar reclamation etc.

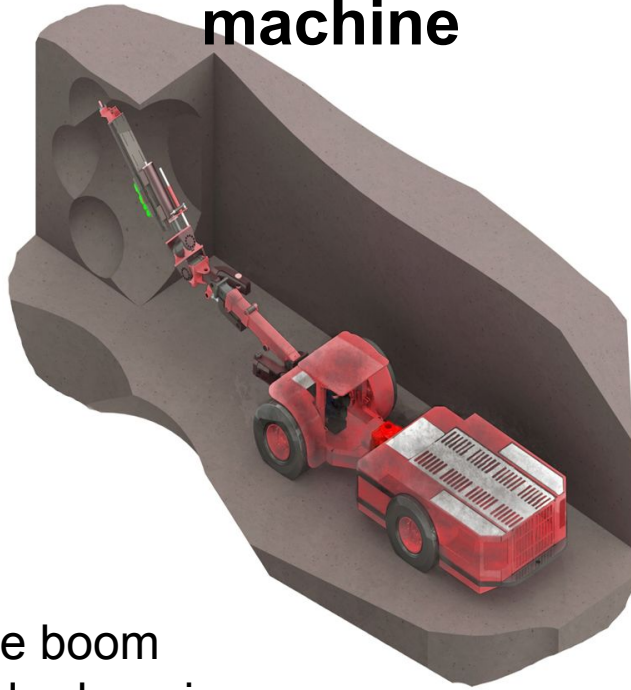


Safe positioning at edge



CFI configurations

Type 1 machine



- Single boom
- Standard carrier
- Breaking only
- Needs LHD or loader
- Easily operated remotely
- Any power source : diesel, electro-hydraulic, battery

Type 2 machine



- Addition of gathering arm loading
- Load-out by conveyor into truck or belt line

Type 3 Machine

- Support mounted on side
- Performs all activities continuously : breaking, cleaning and support



Power and Pressure



Power requirement:

- Carrier, compressor and drill
- Any power source : diesel, electric, battery, hydropower,

Pressure

1/10th the rock strength
350 to 700 bar

Testing parameters for compliance to milestones and enhancement



Safety

- Condition of sidewalls and hangingwall
- Depth of fracturing
- Fragmentation
- Level of fly rock
- Exposure to unsupported ground
- No need to go to connect up
- Reduction in moving machinery

Health

- Noise levels
- Vibration
- Dust levels
- Heat generation
- Ergonomics

All to be assessed against the milestones
and
Regulatory requirements

Technical Progress Report



- Carrier transported to Elinem workshops.
- Housed in cover area

2



Test conditions: where we are now

Progres

- Initial unit under assembly
- Due for completion at end of October
- Commissioning in November
- Testing and demonstration at an operating mine

Interactions

- Mining Companies
- Civil Engineering companies
- DMPR
- Universities (Wits, UP)
- MMP, CSIR
- MEMSA, local and international OEMs
- Dtic / IDC



Benefits offered by CFI

Health and Safety

- Non-explosive:
 - No re-entry
 - No gasses
 - Improved ground conditions
- Reduced noise
- Reduced heat (low energy)
- Reduced vibration
- Reduced flyrock
- Reduced need for licencing

Productivity

- Continuous operations
- Improved advance rates (based on modelling)
- Reduced unit costs (up to 40%)
- Ancilliary operations alongside primary development
- Opportunities for continuous stoping and development
- Benefits accruing from other applications : boulder busting, ancillary excavations, and many more

Business

- Improved productivity
- Reduced costs
- Improved output
- Improved H&S
- Competitive edge



Other considerations for CFI applications

- Level 8 and Level 9 collision avoidance easily fitted to level 1,2 & 3 machines
- Flameproofing can be applied if required without affecting performance
- Compatible with mine traffic management plans
- Semi remote operation is applicable
- Simultaneous scanning for profiling, next hole location and fragmentation is an enhancement
- CFI can be offered as a service by Rock Eater
- Rock Eater will identify skills needs and training
- Dust suppression, noise abatement, armouring all possible, if needed

Interested? Want to know more?

Contact us at:

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*Quod erat
demonstrandum*