# COAL INTERNATIONAL

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September-October 2021

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# New Komatsu D475A-8 mining dozer delivers more production and longer life

On mining sites, support machines, like dozers, can directly impact productivity by keeping blasting, loading and dump areas clean, enabling loading and hauling equipment to work more efficiently. If your operation needs a versatile mining dozer that can go from ripping solid rock to cleaning up around the dragline, take a look at the new Komatsu D475A-8.

## Built for years of reliable service

Using extensive customer feedback, Komatsu re-engineered the D475A-8 mainframe to target twice the life of previous models and withstand multiple rebuild/overhaul cycles. Its low center of gravity provides machine stability and long and consistent track on ground length offers more traction, pushing power, ripping efficiency and less shoe slippage. Track shoe slip control automatically controls engine speed and minimizes slip during ripping.

- Operating weight: 115,300 kg (254,193 lbs.)
- Net horsepower: Forward – 664 kW @ 2,000 rpm (890 HP @ 2,000 rpm)
- Net horsepower: Reverse – 722 kW @ 2,000 rpm (968 HP @ 2,000 rpm)
- Blade capacity: 27.2-45.0 $m^3$ (35.6-58.9 $yd^3$)

Additional horsepower can provide for faster ground speeds, shorter cycle times and more production tons per hour, when appropriate. The D475A-8's high horsepower in reverse means the lock-up converter stays engaged more frequently, allowing significantly higher levels of production, especially when pushing down slopes.

## Increased production; less fuel consumption

Engineered for exceptional production, the D475A-8 mining dozer is designed for power, stability and solid performance. Komatsu's lockup torque converter produces a more efficient transfer of power to the driveline, designed to help decrease cycle times and increase production. During long pushes, the automatic gearshift mode allows the system to automatically engage the torque converter lockup clutch. Locking up the torque converter transmits all the engine power directly to the transmission, increasing ground speed and thus achieving efficiencies equal to a direct drive, consuming less fuel.

- Up to 10% productivity increase over previous models
- 11.5% more engine power in reverse, compared to forward direction
- 10% reduction in fuel consumption with automatic transmission with lockup torque converter compared to manual gearshift operation

## Improved operating environment

Improvements to the operator's cab make the D475A-8 more comfortable to operate throughout long shifts. Ergonomically placed touch points and palm control joysticks make operation easier. Outstanding operator visibility to the ripper shank, a rear view monitoring system and a heated, ventilated, air-suspended seat help keep operators comfortable. The redesigned undercarriage of the D475A-8 drastically reduces shock and vibrations when the dozer travels over rough terrain.

## Doze with a blade built for efficiency

Operators can boost efficiency by working in blade auto-pitch mode, designed to increase dozing efficiency while reducing the amount of operator input required. The all-new blade support structure is designed to significantly reduce blade side sway. It also has fewer maintenance points and enhances operator visibility to the blade.

## Maintenance features

The D475A-8 is engineered to minimize planned downtime and make maintenance efficient with features such as centralized greasing points, ground-level fill/evac service center and battery and starter isolators with lockout tagout functionality.

For additional information about the D475-8, please visit the Komatsu website.

## Sibelco announce ambitious carbon-reduction target

GLOBAL minerals company Sibelco have unveiled their target to reduce Scope 1-2 emissions intensity (tonnes CO2/revenue) by 5% per year from 2021 to 2030 (37% cumulatively), in line with best practices promoted by the Science Based Targets initiative (SBTi). An additional target for Scope 3 emissions will be confirmed next year after further consultation with customers and suppliers.

The 5% per year Scope 1-2 intensity-reduction target is understood to be one of the toughest set to date by any business in the industrial minerals sector, and the company will be investing approximately €90 million in new technologies and operational excellence initiatives over the next nine years to support its goal.

Sibelco say that by setting this ambitious reduction target, they are demonstrating their commitment to the zero-carbon transition aligned with the Paris Agreement and its goal to limit global warming to well below 2°C compared with pre-industrial levels.

Commenting on the new target, Sibelco's chief executive officer, Hilmar Rode, said: 'We are committed to supporting the world's transition to a zero-carbon economy. The ambitious target we have set ourselves for Scope 1-2 emissions, and will next year set for Scope 3, is central to our overall sustainability strategy and we will work closely with all stakeholders to achieve our goal.'

Meanwhile, separately, Sibelco have announced half-year results that reflect a recovery in most of the sectors served by the company. Revenue and EBITDA were back above the levels of the equivalent period in 2019 and the company also generated positive cash flow and an improved return on capital employed.

For the first six months of 2021, Sibelco's continuing operations generated a 17% increase in revenue, which was up from €700 million to €816 million, driven primarily by higher sales volumes in most end-markets. EBITDA improved by 56% from €94 million to €147 million.

Commenting on the results, Mr Rode said Sibelco could be pleased with the rebound shown in the first half of 2021 but warned that this should be tempered with some caution. 'Most industries, particularly in Europe, are far from a return to long-term structural growth and competitive pressure and cost inflation remains intense,' he said.

## Coal India's 39 mining projects running behind schedule

State-owned CIL's 39 coal mining projects are running behind the schedule on account of delays in getting green clearances and issues related to rehabilitation and resettlement (R&R). This assumes significance in the wake of the country's power plants grappling with depleting stocks at their end.

"114 coal projects with a sanctioned capacity of 836.48 mty (million tonnes per year) and a sanctioned capital of Rs 1,19,580.62 crore are in different stages of implementation out of which 75 projects are on schedule and 39 projects are delayed,"

Coal India (CIL) said in its report, the major reasons for delays in implementation of these projects are delay in forest clearances and possession of land and issues related to R&R.

CIL's nine coal projects, with a sanctioned capacity of 27.60 million tonnes per year and a sanctioned capital of Rs 1,976.59 crores were completed with a total completion capital of Rs 1,958.89 crore during 2020-21.

Four of these projects belong to Western Coalfields (WCL), three of Central Coalfields (CCL) and two of Mahanadi Coalfields (MCL).

WCL,CCL and MCL are subsidiaries of Coal India.

One project with a sanctioned capacity of 1.4 million tonnes per year and a sanctioned capital of Rs 143.63 crore had started coal production during the year 2020-21, the report said.

CIL arm South Eastern Coalfields (SECL) is the mining project that started production during FY21, it said.

Coal India accounts for over 80% of domestic coal output.

Based on the demand projection in 'Vision 2024' for the coal sector in the country and subsequent demand projection on CIL, a road map has been prepared to project production plan in medium term. Under this, CIL has envisaged one billion tonne coal production in the year 2023-24 to meet the coal demand of the country.

To achieve this target, CIL has identified major projects and assessed their related issues.

## This mine would attract 1500 jobs

The company behind plans for a new coal mine in west Cumbria has set out its case for the project – attracting criticism from Green MP Caroline Lucas.

Just a week before a public inquiry into the Woodhouse Colliery plan started, West Cumbria Mining (WCM) published a detailed explanation of why it believes the mine is necessary and acceptable, claiming it will "directly" create 532 jobs.

It would also, claims the mine company, generate more than 1,600 jobs 'indirectly."

The company's claims were attacked by Ms Lucas, England's only Green Party MP. She described the proposal as a "backward step," saying it would tarnish the UK's standing in a world at a time when economies need to abandon fossil fuels.

Environmental activists have repeatedly spoken of the urgent need to tackle what they – and an international panel of experts – have described as a climate "emergency".

The debate is a foretaste of the arguments that are likely to be aired during the forthcoming public inquiry into the plan, which is likely to be keenly followed by campaigners from both sides of the debate.

The proposed mine aims to supply the British and European steel industry with metallurgical coal – considered 'essential" for the manufacture of steel, says the firm.

WCM says the coking coal it wants to supply was recently identified as a 'critical raw material' by EU Commission and is 'indispensable" for the steel industry's "transition to climate neutrality.'

The firm says British steelmakers currently import all their metallurgical coal for the UK's steel manufacturers at Scunthorpe and Port Talbot. As a result, metallurgical coal is being railed and shipped thousands of added miles from overseas mines to customers in the UK and EU.

Additional emissions connected with this long-distance production, handling and transportation are thus being 'off-shored', claims WCM.

In a statement, the firm today said that Woodhouse Colliery would be "net carbon zero" for all aspects of the mining process from day one.

The firm adds: "The Woodhouse Colliery project will create 532 direct and 1,618 indirect jobs and deliver new UK exports, which are forecast to reduce the UK balance of trade deficit by around 1.8% annually.

It will deliver £130 million in annual spend in Cumbria when the project is in full production.

"The project is fully compliant with Government climate change policies alongside its wider Industrial Strategy, as a vital part of the steel industry supply chain. The mine, it is claimed, would not be reliant upon any public funding and will represent a substantial post Brexit/ COVID-19 inward investment into the UK economy."

Mark Kirkbride, the Chief Executive of WCM, said: 'We have considered the climate impacts of the project in great detail and implemented significant and world leading techniques to demonstrate that the resources industry can also achieve net carbon zero operations."I believe this will become a core part of the social licence to operate resource projects and we fully comply with the Climate Change Committee carbon budgets and proposed net zero test."

Ms Lucas said: "However West Cumbria Mining tries to dress this up and greenwash it with claims of being 'net carbon zero', its coalmine is the wrong development at the wrong time.

"This mine wouldn't only take us in the opposite direction to where we need to be going on carbon emissions, it is also tarnishing what reputation the UK has on climate action and undermining the Government's chance of persuading other nations to cut their carbon emissions.

"It is a giant step backwards for the climate and for the local economy.

"Cumbria needs jobs, but they must be long-term sustainable jobs in the green economy, not a throw-back to a fossil fuel age we urgently need to leave behind."

Her comments were echoed by Green Party Eden district councillor Ali Ross, who said: "Of course, jobs are important – but not at any price. These jobs would be in such a carbon intensive field, producing the most carbon intensive form of fuel – fossil fuels.

"The price we'd pay for jobs such as this would be too high.

"There are so many jobs which are there to be done in reducing our carbon footprint – not just in Cumbria but across the whole of the country. That includes renewable energy, and retro-fitting homes which are not as energy efficient as they should be.

"The Government should be investing in green jobs, which west Cumbria would be well suited to."

Reacting to the claim that the new mine would be "carbon neutral," Ms Ross said: "That's a misrepresentation. They're only considering emissions from the operation of the mine.

"They're not considering the actual product, the coal, which would lead to huge levels of emissions.

Green Party MP Caroline Lucas

"And in terms of the production of steel, it is clearly a vital product – but there are now viable alternatives to using coking coal to produce it."

In an earlier statement, west Cumbrian Green Party activist Jill Perry highlighted Local Government Association had published research, Local Green Jobs – accelerating a sustainable economic recovery, which shows that 861 jobs could be created in Copeland, 1,170 in Allerdale and 1,802 in Barrow – far outweighing the 500 jobs promised by WCM.

"Given the uncertainty surrounding the jobs in mining, this seems an infinitely preferable option," she added.

Last month, The Intergovernmental Panel on Climate Change released its 6th Assessment Report on the Physical Science Basis of climate change – the most alarming report on the issue so far.

The report was described as a "Code Red" for humanity, highlighting the scale of the unfolding climate emergency and need for countries and governments to take rapid action to reduce emissions.

The report warned of increasingly extreme heatwaves, droughts and flooding, with key temperature limits being broken in just over a decade. "This is a code red for humanity", said a UN spokesman for the panel.

# ABEL supplies two HMQ pumps for International Mining Industry

ABEL continues to strengthen its global presence in the mining sector. The latest additions to this market are orders for two HMQ pumps (Hydraulic Quadruplex Diaphragm Pump) received the Northern German pump manufacturer from Peru and Macedonia.

One HMQ pump will be used to transport tailings in a mine in Peru at 4600 masl, which is a big challenge that ABEL will overcome. Our customer is planning on increasing production to achieve the market requirements and they have trusted on ABEL HMQ reliability for that purpose on the tailing management facility.

Our customer in Macedonia has decided to make a big step forward on the tailings management by constructing a new Paste Plant on site that will serve to avoid the usage of the tailing dam. With this process on duty (>75% solid content), natural environment is strictly respected and safe. ABEL HMQ will serve as a key partner of the paste plant to backfill the underground stopes while the mine keeps advancing at a faster pace.

These two orders specially reinforce ABEL image on the tailing management: thickened tailings transport, backfilling, and dry stacking.

The robust design, ease of operation, high availability and low maintenance, and proven track record of more than 110 installations worldwide for various combinations of highly concentrated ash slurry (fly ash + bottom ash, salt water) make ABEL reciprocating diaphragm pumps the preferred choice for pumping abrasive slurry in various industries.

## Australia and India take next step in mining partnership

Australia and India have discussed opportunities in coal technology, skills development, and business-to-business collaboration at a Joint Working Group (JWG) meeting on 'Coal and Mines'.

The forum was co-chaired by Australia's head of resources division Paul Trotman and India additional secretary, Ministry of Coal, Vinod Kumar Tiwari.

The delegates also discussed issues relating to India's coking coal import from Australia.

Australia made presentations on its Global Resources Strategy as well as ways of leveraging technologies and infrastructure to decarbonise energy and industry.

Tiwari provided an overview of the coal sector in India, outlining the country's current and future coal resources, while forecasting India's critical and strategic minerals demand and supply scenarios.

Tiwari also explained the coal and broader mining priority areas the two countries could capitalise on going forward.

Other specific conversations included India and Australia's collaboration on clean coal technology, surface coal gasification, coal bed methane, sharing of technology deployed for fire quenching, coal-based hydrogen, and carbon capture, utilisation and storage (CCUS).

An open house discussion was also held.

The JWG meeting was a precursor to the upcoming India-Australia Energy Dialogue – an annual meeting that will next take place on October 13.

The Energy Dialogue discusses the countries' bilateral engagement on energy and resources.

Coal and Mines is one of four working groups established to support the forum, which also includes Oil and Gas, Renewable Energy and Smart Grids, and Power and Energy Efficiency units.

In June 2020, Australia and India announced a Memorandum of Understanding (MoU) on critical minerals.

The MoU has seen Australia take a significant step towards establishing itself as a reliable supplier of critical minerals for India's growing manufacturing sector and its defence and space capabilities.

## Vitrinite gets green light for Vulcan coal mine

Vitrinite has received approval for its Vulcan mine complex, paving the way for the development of a $160 million metallurgical coal mine in Queensland's Bowen Basin.

The lease will unlock the first four years of an expected 15-years-plus mine life, opening the door for more than 150 full-time jobs whilst delivering a major economic boost to the region.

"Having the Vulcan mining lease approved for Vitrinite is a huge milestone for our company," Vitrinite founder and managing director Nick Williams said of the approval.

"Going from a greenfield to a producing mine is a huge feat for any company and to do it in the time we've done it is an amazing feat and we're very excited."

Vitrinite first acquired the asset in 2018, quickly accelerating the project into development soon thereafter.

Williams was buoyed by the opportunities that will come of the Vulcan mine once it begins producing two millions tonnes per annum.

"The Vitrinite family are looking forward to supplying 150 jobs to the local people," he said. "We're also excited about providing opportunities for local businesses."

With the sustainability of producing coal always in question, Williams said Vitrinite is conscious of the role it needs to play to maintain the environment.

"We take our environmental responsibilities very seriously. We are adopting world-class, innovative technologies to progressively rehabilitate our pit beyond our statutory requirements."

Queensland Resources Council (QRC) chief executive Ian Macfarlane echoed Williams' sentiments, highlighting the environmental considerations at play.

"Queensland is widely regarded as having the strictest environmental regulations in the world, which our industry is fully committed to complying with, along with our determination to lower carbon emissions and implement sustainable mining practices," Macfarlane said.

"The Vulcan complex mine project is also the first resources project in Queensland to have its progressive rehabilitation and closure plan (PRCP) approved under new legislation introduced in 2019.

"A PRCP commits mine operators to progressively rehabilitating land while the mine is operating and returning the land to its pre-mining use at the end of the project, which in this case is low-intensity cattle grazing."

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# 2022 Editorial Programme





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# Technology helps resource firms move towards sustainable mining

A new water-purification technology that uses solar energy to transform wastewater produced by the resource industry into re-usable distilled water has been shortlisted as a finalist in this year's innovation award organised by the Resource Industry Network (RIN).

The Flamingo concentrated solar distiller technology, offered by Brisbane-based JWA Oilfield Supplies, harnesses solar energy to extract moisture from the waste streams generated by oil and gas and mining industries through a multi-distiller system, which then delivers pure distilled water and dried slurry output.

The breakthrough zero-carbon technology allows resource companies to not only reuse water for their own operations, but also to provide beneficial use of the treated water to the local communities, such as farming and irrigation, as well as rehabilitate ponds in water scarce environments – a major step towards creating a circular economy.

The capability to separate dry solids also presents many potential opportunities to close the loop and recycle minerals and resources that would otherwise be classified as waste.

The unique Flamingo water treatment technology is one of three finalists shortlisted for RIN's prestigious "Out of the Box Award", which celebrates innovation in new products or services.

"This technology will allow resource companies to view and tackle waste streams in a entirely new manner and progress further towards sustainable mining. Water is an increasingly precious commodity which we cannot afford to squander away," said Hensley Wee, business development manager at JWA.

Treating produced water is a key challenge faced by the oil and gas sector as it is the largest waste stream generated during hydrocarbon extraction, whereby large amounts of water are injected into the reservoir to counteract underground pressure and increase oil and gas recovery rates.

The fluid that resurfaces, referred to as "produced water" contains various organic and inorganic compounds at variable concentrations which can be difficult to treat for either re-use in mine operations or for discharge, while contaminated water from mining, such as tailings water from coal extraction, also requires costly treatment before it can be discharged.

As a result, resource and mining companies operating in arid areas often purchase and cart clean water from long distances to continually meet their operational needs, while the produced water is either put in large evaporation ponds or treated using reverse osmosis technology, which is expensive in part due to it being diesel powered.

Using the patented concentrated solar method for water treatment is both more efficient and economical than the current reverse osmosis technology. JWA has partnered with Bridgeport Energy (a subsidiary of New Hope Group) to trial the Flamingo concentrated solar treatment unit at one of its sites.

# Mechanical endeavours

The primary application of these giants is to extract large quantities of lignite brown coal in the eastern regions of Germany, however, their usefulness has expanded into several roles, as a soft rock overburden removal machine where blasting hasn't been deployed and the extension of their uses within the Heap Leaching process where removal of the heaps is an obvious application of stacking and reclaiming. '*Coal International* ' looks at BWE's and recent developments.

A bucket-wheel excavator is a large heavy equipment machine used in surface mining.

The primary function of BWEs is to act as a continuous digging machine in large-scale open pit mining operations, removing thousands of tons of overburden a day. What sets BWEs apart from other large-scale mining equipment, such as bucket chain excavators, is their use of a large wheel consisting of a continuous pattern of buckets used to scoop material as the wheel turns. They rank among the largest vehicles land or sea ever produced, and the largest of the bucket-wheel excavators the 14. 200 ton Bagger 293 still holds the Guinness World Record for the heaviest land-based vehicle ever constructed.

Bucket-wheel excavators have been used in mining for the past century, with some of the first being manufactured in the 1920s. They are used in conjunction with many other pieces of mining machinery to move and mine massive amounts of overburden waste. While the overall concepts that go into a BWE have not changed much, their size has grown drastically since the end of World War II.

In the 1950s two German mining firms ordered the world's first extremely large BWE's and had three BWEs built for mining lignite near Cologne, Germany. The German BWEs had a wheel of over 16 m 52 ft in diameter, weighed 5.500 short tons 5.000 t and was over 180 m 600 ft long, with eighteen crawler units for movement and could cut a swath of over 180 m 600 ft at one time BWEs built since the 1990s, such as the Bagger 293, have reached sizes as large as 96 m 315 ft tall, 225 m 738 ft long, and as heavy as 14.200 t 31.300.000 lb. The bucket-wheel itself can be over 21 m 70 ft in diameter with as many as 20 buckets, each of which can hold over 15 m 3 20 cu yd of material. BWEs have also advanced with respect to the extreme conditions in which they are now capable of operating. Many BWEs have been designed to operate in climates with temperatures as low as −45°C −49°F. Developers are now moving their focus toward automation and the use of electrical power.

The BWEs used in the United States tend to be smaller than those constructed in Germany.

A brief look at the size of the 'Bagger 288' in comparison to other structures and machines highlights the enormity of this

mining giant. It overshadows structures and buildings like the Statue of Liberty and taller than the Eiffel Tower, A German made bucket wheel consisting of 18 buckets that can remove more than 8 million cubic feet within a continuous 24-hour period.

With a total of four conveyor belts of over 10metres wide this machine surprisingly only needs four or five people to maintain its operation. A grand total of 13,000 tons and a speed of 0.4 mph creates a major headache when being transported from one site to another and can indeed take more than three weeks to travel a grand total of 22km, the sheer enormity of this mining beast crushes everything it traverses over including highways, leaving the highway to be totally rebuilt.

It is a common misconception that the majority of the BWE's are all similar in design wether larger or smaller, however, this has never been the case as each unit is bespoke, ensuring that their longevity is maintained, one could refer to this as 'horses for courses' as geological conditions change from one site to another.Referring back to the Bagger 288 which was built in 1978 was last seen in commision at Garzweiller in North Rhine-Westphalia, Germany, which prooves these giants, when built, are here to stay for quite a few decades.

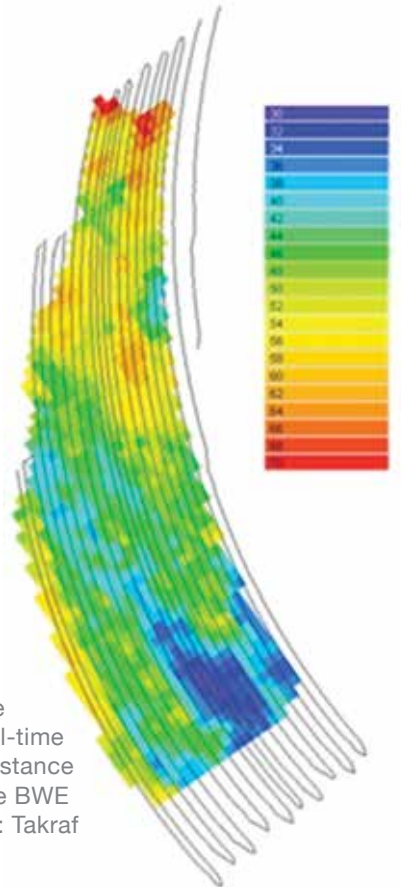
These gigantic machines represent a true mechanical endeavor and boast a long history dating back a number of years to the early 1920s. There has been a ninety-year evolution of BWE's, which reached its peak in the 1980s. However, BWE technology has also been successfully introduced in various countries around the world, ranging from other mines in Central and South-Eastern Europe, to Asia and Australia. TAKRAF, a Tenova company and leader in the global mining, bulk handling and minerals processing industries, is one of the world's major players within this technology space and boasts a long tradition of delivering BWEs for specific material conditions.

In the 1970s and early 1980s, TAKRAF delivered thirteen BWEs, type SRs (K) 2000, for the unique hard coal deposits of the Ekibastuz region in Kazakhstan. Almost all these machines were designed for hard overburden, interburden and hard coal, with uniquely designed bucket-wheels, with 32 buckets on an 11-meter wheel, suitable for material up to UCS 40 MPa. By using an extremely high number of buckets combined with a maximized cutting speed, TAKRAF managed to create a smooth operation under hard coal conditions. These machines – boasting a distinctive TAKRAF bucket-wheel design – have been operating with continued success for more than three decades. Continuously excavating, conveying, and dumping/ stockpiling, wherever feasibly possible and suited to prevailing conditions, BWEs consistently boast the potential to be the mining solution with the lowest lifecycle cost. This is one of the principal reasons why many of these systems continue to operate to this day, and why they are still the preferred solution for many mining operations, despite higher initial investment costs. New systems continue to be developed and installed globally with various pieces of equipment, but the principal remains the same.

In fact, TAKRAF has developed a toolbox of operator assistance and operation planning and control features


One of two TAKRAF bucket-wheel excavators, SRs 6300, in the "Lusatian coal district" in Germany. ***Source***: Takraf

TAKRAF bucket-wheel excavator, SRs (K) 2000, in Kazakhstan. ***Source***: Takraf



Trace line (grey) of the bucket-wheel and real-time measured cutting resistance (N/cm²) within a single BWE mining block. ***Source***: Takraf

for BWE operations, based on the real-time analysis of the cutting resistance.

The understanding of the instantaneous value of the cutting resistance provides invaluable information regarding the geo-mechanical properties of the native rock, state of tool wear, process efficiency and much more. This information enables the visualization and modelling of geological structures, the monitoring of the wear state of cutting tools, as well as the automation of slewing speed control. The goal is to maximize production rates in compliance with stress limitations for equipment and tools. Thanks to this solution, operators can finally take advantage of the available drive capacity due to the natural heterogeneity of the rock, and the risk of overload and shutdown of the slew drives caused by local solidifications cause is minimized and/or avoided.

## IN CONCLUSION

Wherever large amounts of material need to be moved efficiently and effectively, BWEs and Bucket Chain Excavators (BCEs) should always be considered as an option - and not only for pure mining operations as both technologies can be successfully employed in construction and stockpiling, as well as inland reclamation projects.

TAKRAF bucket-wheel excavator, SRs (K) 2000, in Inner Mongolia, PR China. This is also the largest ECS (Excavator – Conveyor – Spreader) system in Asia. ***Source***: Takraf

# Research shows coal is still king

Coal citadel: 21 of the 30 proposed new mines are based in Mpumalanga province, which already accounts for 83% of South Africa's coal production. Photo: Mark Olalde / MineAlert

While the world is shifting away from fossil fuels to renewable energy sources, data on planned new mines indicates the global coal mining industry might not be winding down any time soon.

At the 47th summit of the Group of Seven (G7) nations in June, global leaders pledged to end government support for international thermal coal power generation by the end of 2021, and to eliminate inefficient fossil fuel subsidies by 2025.

"We have committed to rapidly scale up technologies and policies that further accelerate the transition away from unabated coal capacity, consistent with our 2030 Nationally Determined Contributions and net zero commitments," the G7 leaders said in a communiqué.

The leaders, representing the world's seven largest "advanced" economies, called on other countries to adopt such commitments and to join them in their efforts to phase out the most polluting energy sources.

Despite these global efforts to do away with fossil fuels and reduce carbon emissions caused by the burning of fossil fuels, coal production does not seem to be winding down.

In a report titled *Deep Trouble: Tracking Global Coal Mine Proposals* released recently, the Global Energy Monitor revealed that at least 432 new coal mines, each with a proposed capacity of 1 million tonnes per annum (mtpa) or greater, are currently planned across the world. These are coal mines that have been announced, explored, permitted, or are under construction, and which have shown activity in the past two years.

According to the report, "2,277 mtpa of new coal mining capacity is currently under development, while 1,663 mtpa of proposed coal mine capacity is in the early stages of planning and 614 mtpa of proposed mine capacity is already under construction".

## WORLD RANKINGS

Most proposed new mine developments are clustered in China (609 mtpa), Australia (466 mtpa), India (376 mtpa), and Russia (299 mtpa). These countries make up 77% (1,750

On the road: As large coal mine producers leave the South African coal industry, there is growing concern their operations will land in the hands of companies that may not comply with environmental, social and governance requirements for listed companies. Photo: Daylin Paul / Life After Coal

mtpa) of all global mine development projects, according to the report.

Large coal operations usually draw attention and opposition from climate activists, but the report points out that midsize operations with lower public profiles are primarily relied upon to boost coal supply. The median size for a new coal proposal is 3.5 mtpa.

## IS COAL REALLY ON ITS WAY OUT IN SOUTH AFRICA?

A MineAlert data investigation published in February 2021, reported that divestment by larger coal mining companies in South Africa has resulted in coal mines being taken over by smaller operators and some big companies that are not listed on the Johannesburg Stock Exchange. As large coal mine producers continue to leave the South African coal industry, there is growing concern that their operations will land in the hands of companies that may not comply with environmental, social and governance requirements for listed companies.

The investigation showed that coal is not on its way out in South Africa despite the decline in investments and export markets, as well as opposition from climate activists. Data analysed for the investigation showed that there were a number of new coal projects in exploration, feasibility study and/or construction phase.

If these were to go into operation, coal reserves which are projected to last for the next 50 years will continue to be dug up even as the rest of the world disinvests from coal mining.

"These new coal proposals are out of line with needed action. We need to be moving away from new coal rather than opening up dozens of new coal mines," said climate justice activist at 350 Africa, Alex Lenferna.

"Reduction needs to start happening now. If we take the needed climate action, many of those coal reserves and infrastructure will end up being what is called stranded assets: they will lose their economic value and end up being losses to those who own them."

South Africa's coal production and consumption is ranked seventh in the world, with reported production at 258 mt in 2019 and carbon dioxide emissions of the proposed new coal mines reaching 296.5 mt of carbon dioxide.

## COAL FOR POWER GENERATION

The Global Energy Monitor report says the country has 30 proposed coal mines, with a projected output of 129.5 mtpa. Of these 30 proposed projects, 21 are based in Mpumalanga province, which already accounts for 83% of South Africa's coal production.

Seven of the remaining nine projects are located in Limpopo, which according to the Department of Mineral Resources and Energy (DMRE) contains about 40% of the country's remaining coal resources and is regarded as a point of interest for future development projects. KwaZulu-Natal and Gauteng have one proposed coal mine each.

According to the DMRE, more than 70% of South Africa's primary energy needs are still heavily dependent on coal and the country currently has 18 coal-fired power stations run by electricity utility Eskom. Twenty of the 30 new coal mine proposals identified by the Global Energy Monitor are for thermal coal used in electricity generation, and the remainder are for metallurgical coal and thermal coal used in steelmaking and other industries.

Five of the proposed thermal coal mines mentioned in the report will supply coal to two existing coal power stations – the 2,352 MW Arnot power station and the 3,600 MW Matla power station. The other three will supply coal to the 1,200 MW Thabametsi coal plant outside Lephalale in Limpopo, and the 300 MW Khanyisa coal plant and 4,800 MW Kusile Power Station in Emalahleni, Mpumalanga.

Power paradox: South Africa plans to generate more than 17 gigawatts of renewable energy by 2030, but If the proposed coal projects outlined in the report proceed for the next decade, they could increase greenhouse gas emissions by up to four times. Photo: Mark Olalde /MineAlert

## CLIMATE CRISIS

In order to limit global warming to 1.5°C and to realise the targets of the Paris climate agreement, coal producers need to reduce their output by at least 11% annually through 2030, and to halt all new mining plans and extensions, the Global Energy Monitor report states.

If the proposed coal projects outlined in the report proceed for the next decade, they could increase the 1.5°C limit by up to four times.

The Paris climate agreement was adopted by 196 parties in 2015 at the United Nations Climate Change Conference (COP21) and entered into in 2016, setting the global framework for countries to reduce their greenhouse gas emissions and limit the increase of global warming.

South Africa, considered a midsize industry producer, accounts for 65% (130 mtpa) of proposed coal capacity in Africa and the Middle East. If all proposed mines went into operation, the industry would see a 51% increase in current production, according to the report.

President Cyril Ramaphosa announced at the Leaders' Summit on Climate Change in April 2021 that South Africa plans to generate more than 17 gigawatts of renewable energy by 2030 and that the country's emissions will begin to decline from 2025.

Two months later the president announced a major move to reform South Africa's energy sector. In a national address on June 10, Ramaphosa said the cap on the self-generation of electricity without a licence would be raised from 1MW to 100MW. This means companies and independent power producers will be able to produce their own electricity by adhering to new regulations that require them to register with the National Energy Regulator instead of obtaining a generation licence.

"There is a lot of pent-up demand by companies and corporations to build out renewable energy, reduce energy costs and also have more reliable energy, so increasing the threshold will greatly increase renewable energy [infrastructure] being built," said Lenferna.

However, he worries that this may also provide an opportunity for other polluting energy projects such as gas. "By liberalising the market and opening it up, there is the worry that there may be polluting projects that are built under that 100MW," he said.

Lenferna said Eskom should be leading the transition to renewable energy, but the power utility is "still constrained by regulation that prevents it from building out at the speed that it wants to in terms of renewable energy ambitions. There is a need for more than just liberalising small energy production, but allowing the likes of Eskom to move forward with a rampant transition to renewable energy."

# Coal still a lifeline for SA as transition begins

While the global focus on environmental, social and governance (ESG) issues looks to phase out coal as an energy resource, the prospects for South African coal production remain strong for coming decades.

Following the 3rd Coal Industry Day, held online in July, SRK Consulting principal coal geologist Lesley Jeffrey said coal remains a key contributor to the country's economy – both in terms of energy production and mineral export revenues. Coal was only recently overtaken by platinum group metals as the country's leading commodity by sales, but it remains the most significant component of the country's mining in terms of value added – accounting for 25%[1].

"Strong international coal prices of around $130 per tonne have raised the attractiveness of exports, with most of South Africa's export coal going to Pakistan," said Jeffrey. "China is also opening up opportunities for imports from SA following its trade wrangling with Australia, previously an important coal source for them."

Although there has been less coal demand from India due to a surge in local production there, South African coal still remains better suited to India's production of sponge iron, she noted. This suggests that the recent dip in exports to that country may only be temporary; the added advantage is that this market takes relatively low-grade product from South Africa. Coal Industry Day presenter Xavier Prévost confirmed that coal remained the largest single source of power generation globally. Prévost also said the coal sector expected a strong recovery in 2021 – a reminder of coal's central role in fuelling some of the world's largest economies.

Jeffrey highlighted that coal-fired power stations are still being built on a large scale in developing regions like south-east Asia – as this provides an affordable route to powering broader economic development. While South Africa has mined out much of its traditional export quality coal, there remained a long horizon of demand abroad for our lower grade coal.

"Unreliable rail services to the Richards Bay Coal Terminal continue to constrain SA's coal exports, and this has been exacerbated by a recent hacking event and the spate of looting in parts of the country," she said. The export market was vital to sustain, she emphasised, as it created the economic balance that keeps coal producers profitable while they continue to supply Eskom at low margins. Without the higher-value exports, local electricity prices would likely have to rise even faster to meet the full cost of mining.

Looking further ahead, there was a level of consensus among Coal Industry Day speakers that South Africa could still expect another 20 to 30 years of reliance on coal.

"Between now and 2050, we have few options apart from coal for most of our energy generation," she said. "Of course, there will have to be a change toward less carbon-intensive energy sources – and it is constructive that work has been initiated on charting a just transition towards renewables."

The coal industry's employment of about 90,000 workers[2] – nearly a fifth of mining's head-count – means that as many as half a million people are directly reliant on coal mining. These are among those who will be affected as the country moves toward a lower-carbon future, said Jeffrey. Eskom has recently completed comprehensive social impact studies for its Komati, Hendrina, Grootvlei and Camden power stations to assess

the local impact of closure. Closing these plants could have devastating effects on direct and indirect employment in these areas.

"While power stations like Komati are relatively small, it is a good place to start," she said. "It is vitally important that practical ways are found to transition away from coal while not leaving communities stranded."

The challenge, she pointed out, was that the pace of South Africa's transition was going to be slower than the climate change deadlines being pursued by developed countries. It was to be expected that developing countries will be looking for more time to make the necessary changes in line with global commitments.

## ABOUT LESLEY JEFFREY

Lesley has over 35 years' experience in coal geology. She specialises in all aspects of geology related to coal; this ranges from exploration and greenfield studies to the initiation of mining and has been involved in the design, implementation and management of coal exploration programmes, the geological assessment of coal deposits, computer modelling of tabular ore bodies, particularly coal, coal quality assessments and coal resource/reserve estimation. Lesley has carried out coal feasibility and due diligence studies and compiled Competent Person Reports; she has undertaken coal model and resource estimation audits, as well as geological assessments. She is a registered professional natural scientist with SACNASP and recognised as a Competent Person (coal). She is a Fellow of the GSSA and served on the editing committee for the second edition of SANS10320, the South African guide to the systematic evaluation of coal exploration results, coal resources and coal reserves.

## ABOUT SRK

SRK is an independent, global network of over 45 consulting practices on six continents. Its experienced engineers and scientists work with clients in multi-disciplinary teams to deliver integrated, sustainable technical solutions across a range of sectors – mining, water, environment, infrastructure and energy. For more information, visit www.srk.co.za

SRK Consulting principal coal geologist, Lesley Jeffrey.

## REFERENCES


1. Source: Stats SA http://www.statssa.gov.za/?p=14225
   In South Africa, the PGM sector is the largest contributor to mining in terms of sales. In contrast, coal is the most significant component of mining in terms of value added, accounting for 25%. For the first time in the last decade, PGM sales overtook those of coal to become the most significant contributor to total mining-industry sales, reaching R190 billion in 2020. This was more than the value of iron ore and gold sales combined."
2. Source: SA coal producers' website Coal Mining Matters: http://www.coalminingmatters.co.za/what-matters/employment
3. One miner supports about five dependants ... Source: https://coaltech.co.za/wp-content/uploads/2019/10/Task-7.8.5-Socio-economically-Sustainable-Communities-Post-Mine-Closure-Phase-1-2006.pdf

# Mechanised and automated transport operations

**Over several decades underground transportation has been developed in line with advancing technology and has been as critically important as the mining operation itself. The transportation system of ores, materials, equipment, and persons can also be seen as being developed from a variety of engineering backgrounds, from the primitive hand operation to the mechanized and automated operation, utilising the rapid progress of technology in production equipment and methods of extraction, all of this has the aim to raise productivity and production. It is also important to note that any transport system must be designed, considering the many other elements of the mining operation, and must consider the number of possible steps from the extraction site (stope/face) to the shaft or ramp portal. *Coal International* takes a detailed look at a variety of systems being used today.**

## FROM SURFACE TO UNDERGROUND AND VICE VERSA

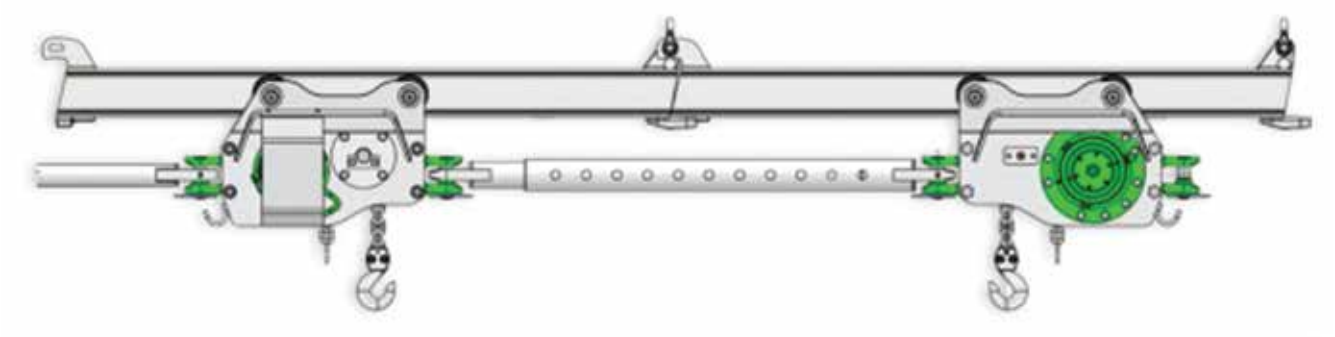
Moving materials in and around a coal mine can range from light transport sets to sophisticated systems.

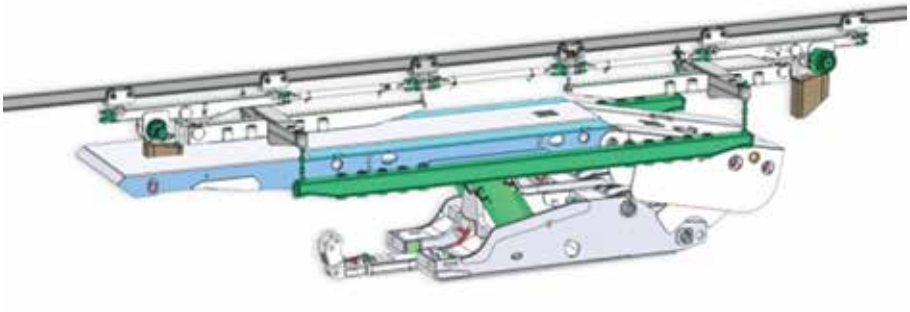
Light transport sets can be designed bespoke for the mines needs and a typical example of this is the one shown from Famur which is designed for transportation via the use of ropes and a self-propelled monorail system. It is equipped with a winch chain (hydraulically or manually driven). The light transport set can be combined into various transport configurations transporting loads of weight up to 8 tonnes.

The WJ-S light transport set (Famur) is compliant with the requirements of the European Parliament and Council Directives 94/9/EC and 2006/42/EC. It may be used in underground mines, in methane and non-methane fields of headings classified as „a", „b" or „c" degree of methane explosion risk as well as in headings classified as „A" or „B" of coal dust explosion hazard.

The PIOMA ZNMw transport set is designed for transportation of materials by rope-driven and self-propelled monorail systems. The modular design of the set allows customer to adapt its capacity and size exactly for transport task while maintaining the full ability to customize it for other different tasks. As with previous light transport systems this is also compliant with European Parliament and Council Directives.

Considering transport systems from the surface to underground, mines may be classified into two basic categories: shallow mines with roadways of level or shallow gradients, and deep mines with vertical shafts or long





inclined drifts. Deep mines require some form of specific transport system between the surface and the underground level. On the other hand, shallow mines generally require a direct and simple transport system.

However, in any underground mining operation the challenge is to ensure that operators are kept safe. With today's technology extending from Load haul dump trucks (LHD's) both diesel and electric generated as well as wirelessly remotely operated, the challenge still remains and is presented on a daily basis due to the nature of mine roadways.

Development of underground coal mines is reflected in increasing lengths of transport routes between shafts and workplaces. This is not an issue in terms of transportation of materials or groups of people, because suspended railways are efficient, safe, and a fast means of transport. However, transportation of individual people or small loads is an issue because of the lack of a means of individual transport and the high cost of transport using suspended railways.

## TRANSPORTATION OF MATERIALS

One of the most widely adopted materials transport system in coal mines comprises diesel/electric powered tractors towing trailers, the most common type of tractor being an articulated load/haul/dump ("LHD") machine, normally fitted with a "quick attach" scoop bucket with the "quick attach" system allowing the bucket to be easily removed and replaced with other purpose designed attachments when not towing trailers. Such attachments include forks for pallet handling, work platforms for high work, cable, or conveyor belt reelers, stone dusters, roof bolters, etc. Most mining companies such as Caterpillar, Famur, Komatsu and Epiroc to name a few all manufacture this type of equipment.

Originally trailers used in such systems were general purpose flatbed trays, but increasingly use is being made of specialised purpose designed trailers built for specific purposes or materials. While removing some of the flexibility of the earlier systems it significantly improves safety and efficiency in materials handling.

An alternative transport system is available where articulated diesel prime movers fitted with U-shaped ends (or "tuning forks") enable pods to be attached and transported throughout the mine in the fork attachment - the pods replace the trailers in the system described. The prime movers lack the flexibility of being utilised for other functions when not transporting materials, but the pods are considerably cheaper than trailers and the prime movers less expensive than LHD's.

Increasing use is being made of palletizing or containerising supplies where suitable, to facilitate handling of bulk materials (e.g., loading all supplies needed for a set distance of mining roadways into a purpose designed pod or container; stone dust in 1 tonne capacity bulk bags instead of 25kg small bags) or packaging items previously supplied loose (e.g., supply of road ballast in 1 tonne capacity bags).

While all these initiatives are aimed at improving overall efficiency, it is important to ensure that they are designed to fit in with available equipment or that suitable equipment is provided before they are introduced into an existing operation.

It is noted that while rubber tyred equipment is extensively used throughout the industry,

caterpillar tracked vehicles are also being used, particularly for handling large equipment such as longwall shearers and supports.

Until the mid-1990's, all diesel vehicles used underground were required to have exhaust "scrubbers" (essentially a water tank that exhaust gases pass through before being released into the atmosphere) and protective devices fitted to prevent the engine from potentially igniting gas. Trials have been underway since that time to introduce standard diesel vehicles, as used on the surface for use underground, provided such vehicles are restricted to locations where gas should not be found (essentially in intake airways up to a set distance from the face area) and they are fitted with devices to prevent them being used in a non-approved manner.

### HAND TRAMMING AND HAULING

Hand tramming is still widely used in small mines, in prospecting operations, and as an adjunct to mechanical haulage systems. For tramming small tonnages of material short distances on the main levels, for short transfers on sublevels, and in some types of stopes it is the obvious method to employ, although, if power is available, scrapers may be more economical for some of these purposes and small storage-battery locomotives for others, provided the tonnage to be handled warrants the capital outlay involved.

Hand tramming requires a minimum capital investment for equipment and for this reason, among others, is particularly adapted to small-scale operations such as those conducted by many “leasers”.

Small cars of 12-, 16-, or 20-cubic-foot capacity are usually employed, the 16- and 20-cubic-foot sizes being the most popular, although cars holding 2 to 2½ tons sometimes are used. In the Tri-State lead and zinc district, “cans” of 1,200 to 1,400 pounds capacity were used almost exclusively for many years, but more recently these have been superseded by cars in some of the mines. The cans are buckets that are run to the face on a flat truck and, after they have been loaded, are returned to the shaft, and hoisted directly to the surface.

Cars are usually of either the end- or side-dumping type, with the end or one side forming a swinging door suspended from a rod at the top of the car and latched at the bottom. In the end-dump type the car body or box often is mounted on a turntable on top of the truck frame, so that the car may be turned for dumping into a chute at either side of the track.

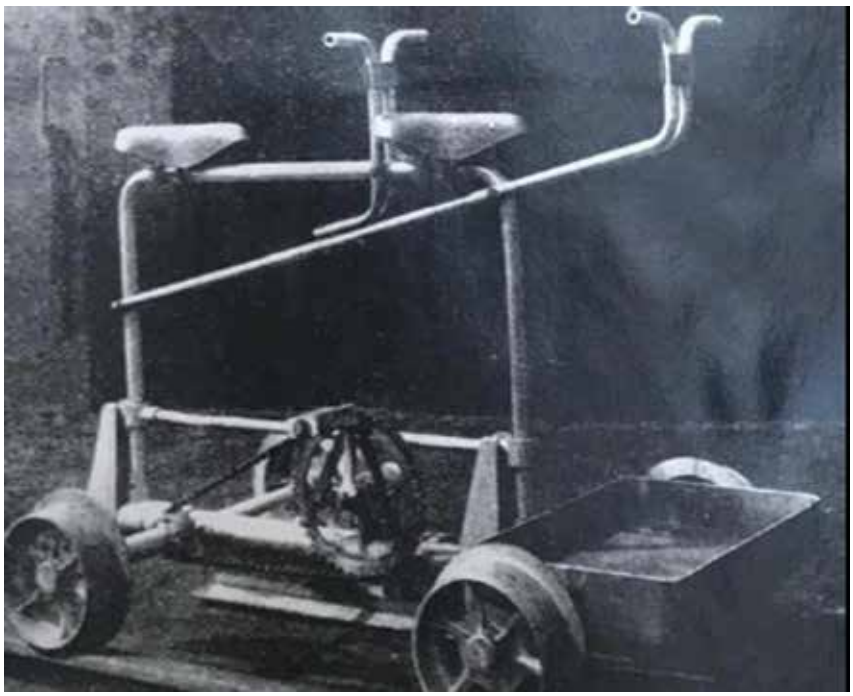
Car bodies and truck frames may be of either wood or steel construction, though few wood cars have been employed in recent years. One advantage of the wood-box car is that if a board becomes broken it can readily be removed and replaced, whereas a damaged steel box requires considerable work in the shop.

For tramming ore and filling material in cut-and-fill stopes, a car with a scoop-shaped box open at the front end may be used to advantage.

Tracks for hand tramming usually are laid with light rail (weighing 8, 12, or 16 pounds per yard) on wood ties. The heavier rails are preferable if they are to be used for an appreciable time, since once they are well-laid, they are less likely to become bent and out of alignment and thus will require less attention.

Track grades for most efficient hand tramming should be considerably steeper than for locomotive haulage. The ideal grade would probably be that on which the effort required to push a loaded car downgrade would equal that required to push the empty car up, although some prefer a somewhat steeper grade, so that the loaded car, when once started, will almost if not quite run by itself. The exact grade requiring a minimum of effort will vary with the size

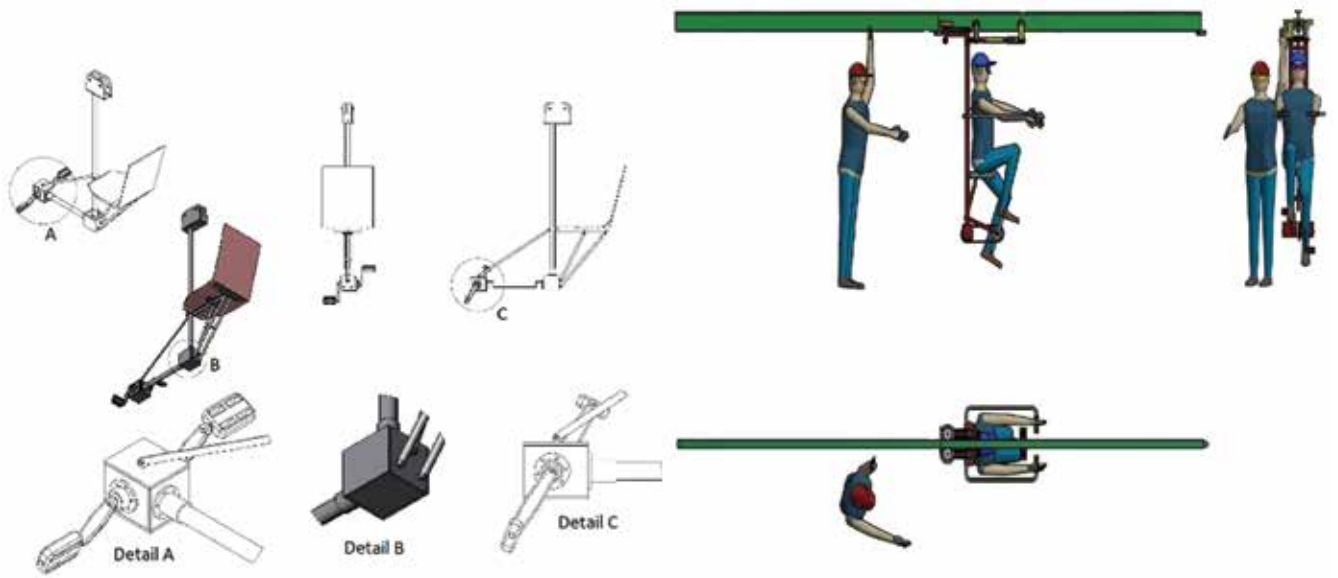
and weight of the car and the load carried, the type of bearings, lubrication, and the general condition of the equipment and track. Ordinarily, grades of 1 to 1½ percent in favour of the loaded cars will be found satisfactory for hand tramming.



## PEOPLE CARRIERS

The development of individual means of transport, based on historical solutions, utilizes existing equipment of mine workings. However, there are some instances where the stages of development of an underground bike, from the original idea to tests and analysis have been trialled. The development process consists of simulations of different parameters of the bike using Working Model software and real-life tests conducted in an underground mine.

The development of coal mines has been observed for several decades. Rapid industrial development at the turn of the 19th and 20th centuries caused significant growth in coal demand because coal was the principal energy resource at that time. Growing coal production enforced mine expansion and, in turn, lengthening of roadways. At present, the main cause of longer distances in coal mines is the need to develop mining areas that are distant from shafts in exploited deposits. Numerous means of transport have been developed to improve communication between distant excavations and mine shafts. Due to the many advantages of railway, this form of transport became the most popular in underground mines, particularly combustion and electric floor railways. These have now been replaced in most cases by friction-gear-driven suspended railways, on which mine transport systems are based. Suspended railways are efficient and relatively fast means of transport. Thus, transportation of people and materials is safe and easy, even in the case of distant mine areas However, despite the development of means of mass transport, the problem of individual transport remains unsolved. Furthermore, due to the specific requirements of large groups of mine employees, significant distances are travelled between different mine workings, potentially several times per day. The desire to increase effectiveness and facilitate work has resulted in extensive development of improvised means of transport. Mine employees have readily adapted devices used on the surface to the conditions of underground workings. Due to the popularity of bicycles in urban spaces, their modified construction is common in underground mines, especially in Germany and Netherlands. Initially, underground bicycles were self-made creations, manufactured in mine workshops. In 1954, Scharf GmbH from Hamm, Germany introduced and sold the first miners' bike, named Grubenflitzer. During the years of the market presence of Grubenflitzer, numerous models of the bike were constructed. The basic model is presented above.

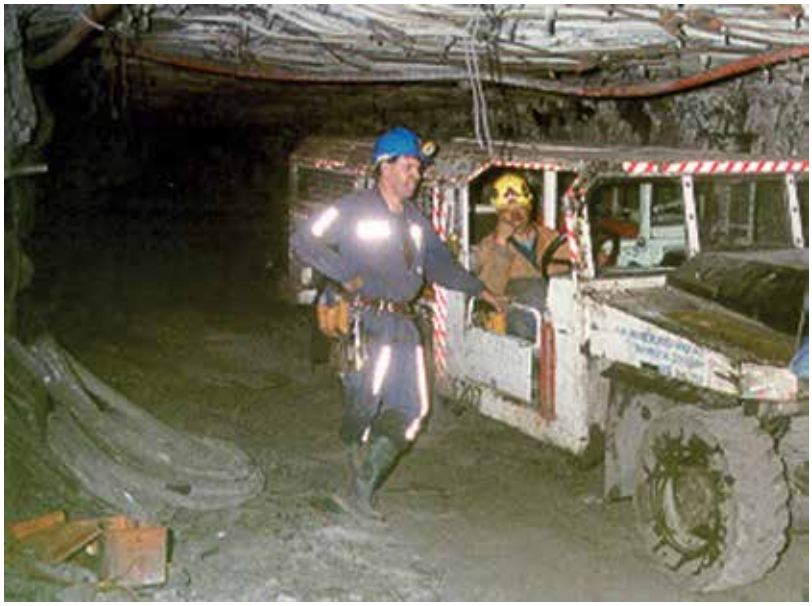


Based on the features shown, the idea of a miners' bike utilising suspended railway was developed. It was assumed that this new means of individual transport should be light enough to be assembled or disassembled by one person. It was necessary to consider safety of user and environment. The result of conceptual work on this means of individual underground transport was the patent PL 418208, which was a basis for further construction development and necessary research and testing.

The specified requirements were the basis for several new miners' bike construction proposals, which differ in terms of drive solution, placement of the drive and seat, and assembly of the elements. Examples of different miners' bike solutions are shown.

Where access to a mine is by a drift or inclined shaft and rail is installed, personnel transport typically utilises a vehicle permanently attached to a winding rope with provision for seating passengers. Again, this vehicle is typically used as a means of attaching other rolling stock to the winding rope and, whether set-up to carry passengers or not is usually referred to as a "dolly car". A dolly car can be automatic (push button control by the passenger) or operated by an

on-board operator, particularly where the dolly car is utilized to haul other rolling stock into and out of the mine.



Dolly cars typically have limited capacity for passengers and additional personnel carriage(s) are attached at shift changeovers to enable the full shift to be transported in one load or lift.

For vertical shafts, personnel transport may be in a large shaft vehicle, or "cage" with the cage being used to transport materials at other times or may be in a special permanent personnel winder which operates more like a building lift. Most shaft conveyances are fully automated, requiring only a start button to be pressed.

There may be benefits in separating personnel and material transport systems, particularly in relation to the greater efficiency then possible of material transport. With shared systems, it is normal to suspend material transport if passengers are to be conveyed in the system. Such suspensions can be extremely disruptive, particularly in large mines where the material transport system is fully utilized.

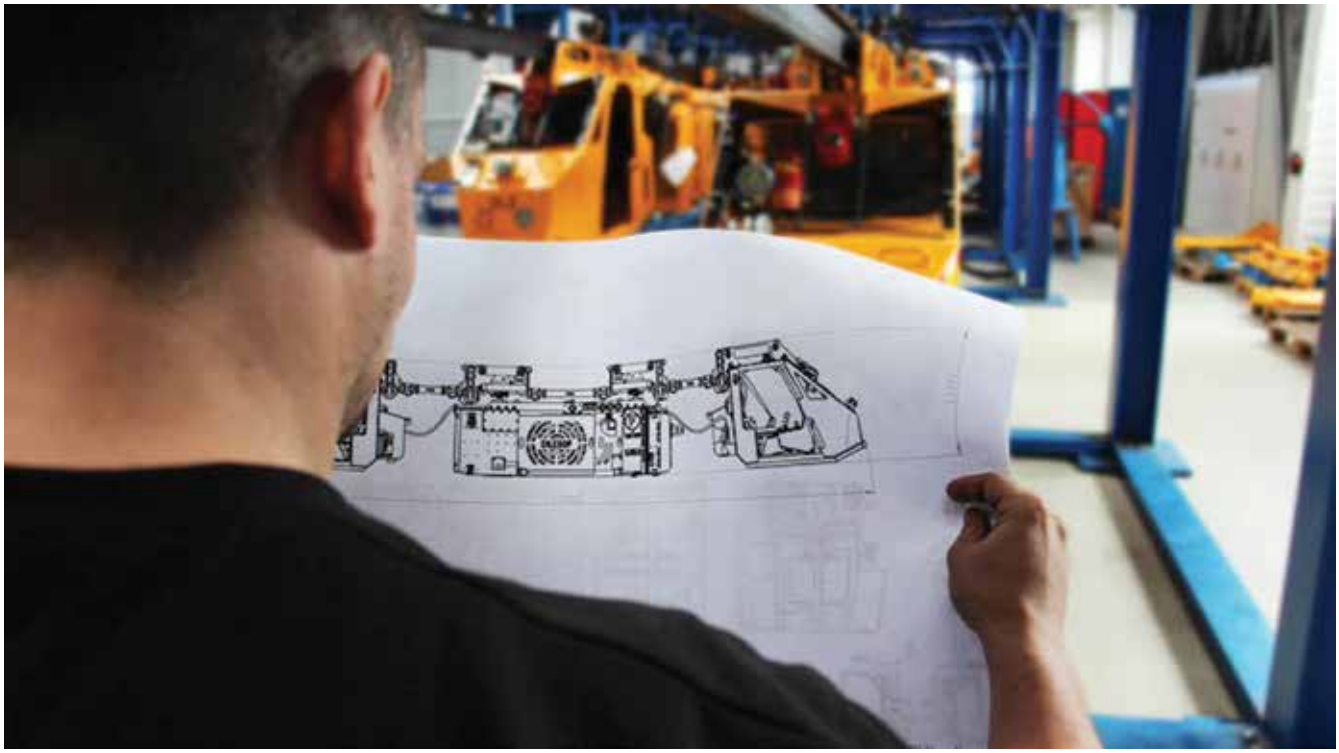
With rubber tyred systems various types of personnel transports have been developed to fit in with the materials transport (e.g., trailers or pods fitted out for personnel transport but handled by the normal materials handling prime movers). There have also been convertible vehicles developed where seating for personnel could be folded away leaving the vehicle suitable for materials. Most of these vehicles operated successfully, but interference with the materials transport system when personnel transport was required led to inefficiency, especially if some personnel transport was required for the full shift.

Purpose designed vehicles are now typically used for personnel transport such vehicles essentially being modified "land cruisers" or "troop carriers". These vehicles offer considerable flexibility as they can be used throughout the shift to carry staff, inspection personnel, tradesmen, etc who do not work in a single location and can also be quickly adapted for use as an ambulance if required. The development of the land cruiser style vehicles with improved seating and ergonomics has generally led to the demise of other types. Though several of these older vehicles are still in use they are generally being replaced by the land cruiser type when the reach the end of their economic life, if not before.

Many mines also utilize multi-purpose vehicles which can carry a limited number of people as well as materials (e.g., utility vehicles to carry tradesmen and equipment, special pipe handling vehicles, etc).

A recent development in personnel transport is the use of "non flameproof" vehicles for personnel transport in restricted areas (being intake airways). Their use in areas likely to contain gas (hazardous zones) is prevented at least by mine rules but also by attaching automatic cut-out devices operated by a radio signal from devices attached to the roadway ribs or roof. Such vehicles are much cheaper to purchase and maintain, essentially being standard off-road vehicles.

Underground transportation has developed significantly over recent decades, but monorail transport remains one



Ferrit designers

of the most widely used haulage solutions for materials and equipment, as well as personnel, in coal and ore mines.

Many sites use conveyors, trams, and trucks to move coal but often find that this is only effective for short distance haulage, so what does monorail do differently?

Before operations even begin, the benefits of monorail transportation become clear. Whether a mine is best suited to suspended or track locomotives, monorails are easy to install and have low maintenance requirements, saving both time and money. As a modular system, it is much easier to implement a monorail solution to the exact accordance of a mining site's needs.

Every mining project is different, so this customizability is important. The volume of material that needs to be transported and at what incline angle is going to affect what a mine demands from its haulage system.

Having a monorail system that is designed with specific needs in mind means that monorail transport is more efficient, safe, reliable, and cost effective compared to alternative solutions. If a mining site relied entirely on vehicles for transport, it could take an extensive fleet to do the work of one monorail, requiring much more work-power and intensive collision avoidance systems.

Ferrit has a long history in mining equipment manufacturing and has become one of the leading producers of transport systems for both materials and people. Key levers to ensure their success in this section of the mining market are: Efficiency, economic viability and safety, ensuring the best way to transport people, materials and varying loads. History shows that in varying parts of a mine that loads were transported by ropes and winches and the method used was neither efficient nor safe with accidents being recorded quite frequently.

Ferrit's suspended monorail system occurs mainly in smaller sections of the mine where tunnels and roadways are narrower, and inclines are greater than ten degrees. The monorail system consists of a track suspended from the roof of a mine, either with bolts or on the mines arch reinforcement. The track

itself uses a system of sections connected by switches and anchoring elements and exist in two basic forms, monorail locomotives and monorail manipulators.

## WHAT ARE THE ADVANTAGES OF A MONORAIL SYSTEM OF TRANSPORTATION?

There are several significant advantages to using suspended monorail transport systems in underground mines. Firstly, unlike conventional ground transport systems, monorail systems can be used in mines with inclinations up to 40 degrees depending on the type of suspended track used.

In addition, the cross-section of a mine can be significantly smaller when using a monorail system than when using other types of mine transport, while footwalls within a mine remain available for alternative use once suspended transport is installed.

Because of its efficiency and low operating costs, monorail systems are used increasingly widely in coal mining, as well as in ore mines. Indeed, monorail systems are fast becoming the key components in all mining projects where steps have been taken to optimise transport systems, and where it's possible to combine wheel and rail transport.

Suspension systems are suitable for both vertical and inclined mine shafts. In the case of an inclined shaft, the mine's depots can be located at either end of the shaft while the monorail system connects workspaces within the mine, both at the top and bottom of the mine shaft.

Famur continuous transport system.

Famur continuous transport system.

## HOW THE MONORAIL SYSTEM WORKS

The key component of suspended monorail transport systems is the track. This consists of a single rail with a load-bearing rail profile of I155, including suspension elements, railroad switches, bends and other accessories. The track itself consists of individual rail segments anchored to the roof of a mine shaft.

The way the track fits together means that monorail systems can be installed either horizontally or vertically, depending on the requirements of a particular mine. With the additional use of traction and handling equipment, it is possible to transport loads up to 100t using monorail systems. However, when operating in high humidity where adhesion conditions within a mine are deteriorating, or in inclinations up to 40 degrees, rack and pinion systems would be the more appropriate choice.

The movement of locomotives or manipulators in monorail systems is provided by a set of drive units. These convert electrical or hydraulic power into motion, driving the monorail's mechanical actuation system. Traction force to the track is transmitted by hydraulic engines. Downward pressure on the track is provided by a cylinder, which replaces the adhesive weight and provides force for braking. The number of drive units required depends on the inclination of the mine and the weight of the loads needing to be transported.

## TAILORED TRANSPORT FOR ANY MINE

There are two basic types of traction unit for suspended transport systems: mining suspended locomotives and mining suspended manipulators. Mining suspended locomotives are like suspended trains. They ensure the transport of people and material in larger quantities and over longer distances. Mining suspended manipulators are used more to ensure material handling in the vicinity of specific mining workplaces.

Suspended transport systems are simple and modular, meaning that each system can be tailored to the specific requirements and conditions of a mine. If required, hydraulic lifting units (with a load capacity ranging from 8t to 40t) can be attached to the suspended transport system. These can then be used to suspend containers for carrying material or a cabin for transporting personnel.

Suspended systems are also used to transport individual machine parts, such as mining shearers, powered roof supports and other important mining equipment. The big advantage of suspended transport systems is that more lifting units can be attached and integrated behind one another, providing a greater load capacity overall.

Locomotives and manipulators can be manufactured according to various specifications and are powered either by diesel engines or by electric cable or battery. All equipment in suspended transport systems is non-explosive and can therefore be used safely in mining environments where there are risks of explosion from things like gas and coal dust.

## MONITORING PERFORMANCE

The suspended monorail locomotive consists of the following parts: the engine, the auxiliary section, the propulsion units, and the cabins (for operating the locomotive), which are located at both ends of the set.

Individual parts of the locomotive are connected to each other with special connecting rods. The locomotive's control system monitors and determines its operating parameters. Using a mine's central communication system, data about the locomotive's location and performance can be transferred to the mine's operations department, otherwise known as central dispatching.

Locomotives are equipped with a camera monitoring system that allows the driver to monitor what is happening at the other end of the set. All types of suspended locomotives can be controlled using the REM-CON remote control.

## SIMPLE, MODULAR SYSTEMS

As previously outlined, the suspended monorail transport system is a modular system that allows customers to tailor sets according to their specific requirements, and to specific mining conditions. Ferrit have a large portfolio of options in the suspended transport category which means that they can work with customers to create an almost infinite number of sets.

A perfectly functioning transport system requires a tailor-made solution. And, just as there are indefinite numbers of mineral deposits around the world – all different types and shapes – to which mining methods and technologies must adapt, so must the transport systems and facilities that enable it.

With decades of collaboration with customers, Ferrit has built a wide portfolio of mining transport equipment options. Each transport set is unique, and with the experience they have they can optimise the system in any underground mine for both coal and ore. customers.

# BHP, Cat combine for sustainable mining trucks

BHP and Caterpillar have partnered to develop zero-emissions mining trucks, following months of collaboration on how to sustainably tackle the miner's energy demands.

As the equipment becomes available, Caterpillar will give BHP first look at it while facilitating training and development for its workforce.

BHP's chief commercial officer Vandita Pant said this partnership was vital to both company's goals.

"We are pleased to announce our partnership with Caterpillar to develop and deploy zero-emissions mining trucks at BHP," Pant said.

"Climate change is a critical global challenge, and we know that partnering with others will help accelerate the transition to a low carbon future."

Pant also said the collaboration would allow for more tailored solutions of the mining industry.

"The opportunity for our teams to input into the design process also gives us confidence that the trucks will be safer and easier to operate for a workforce that's more diverse than ever," she said.

Caterpillar Group president Denise Johnson said collaborations of this nature were important for the future development of the industry and the environment.

"Caterpillar is pleased to work with BHP on the next generation of large mining trucks and mine site technology," Johnson said.

"Deeply integrating our teams and timelines will allow for faster deployment to deliver zero-emissions solutions."

The companies will also work together over the coming years to encourage workplace inclusivity to enable the machines to be accessible for a broader slice of the workforce.

Frontline operators will be involved in the design, development and implementation of the machines to ensure they are best suited to those who will keep them running.

## Montem Resources increases at Chinook to 172 million tonnes

The results from the 2021 Chinook Project resource update further confirms that the project has the geology, resource base and coal quality to support open-cut development.

Montem's plans are to continue to explore and define the Chinook Project with its main focus on the Chinook Vicary area

Montem Resources Ltd has increased its coal resources at the Chinook Project in Alberta, Canada to 172 million tonnes with 108 million tonnes in the indicated category and 64 million tonnes in the inferred category.

The Chinook Project also contains an exploration target, which has been upgraded from 125 million tonnes to 450 million tonnes.

Plans to drill out remaining areas

Montem managing director and CEO Peter Doyle said: "We are very pleased with the significant increase of the JORC resource estimate for the Chinook Project.

"This upgrade of the resource is the result of new information from the 2020 exploration which led to a re-interpretation of the geological model for Chinook and follows announcements detailing the excellent coal quality results received from the 2020 drilling program, as well as the positive scoping study we completed for the Chinook Project in early 2021.

"The next step is to drill out the remaining areas included in the Scoping Study mine plan and progress to a Pre-Feasibility Study.

"As the entire Chinook Project lies within Alberta 1976 Coal Development Policy Category 4 land, we are able to continue exploration and project planning.

"We are excited by Chinook and look forward to the next phase of development."

Background and next steps

The Chinook Project is made up of two areas – Chinook Vicary and Chinook South.

Montem's resource update is in the Vicary Domain, which makes up the central portion of the Chinook Vicary area.

The Vicary Domain was the target of Montem's 2020 exploration drilling program, which confirmed the occurrence of near surface, structurally thickened coal seams suitable for future open-cut extraction.

Montem will continue to explore areas of Chinook Vicary identified in the scoping study mine plan, aiming to define an open-cut project at preliminary feasibility level.

## TerraCom to extend Blair Athol

TerraCom has extended the life of its Blair Athol coal mine in Queensland's Bowen Basin by approximately 10 years.

The announcement comes after TerraCom engaged Deswik Mining Consultants to complete an updated assessment of the Clermont operation.

As of 30 June, 2021, the Blair Athol marketable reserves totalled 19.5 metric tonnes, and with a two-million-tonne sales profile, it's estimated there's another 10 years of life in the mine.

TerraCom executive chairman Craig Ransley is excited by what's to come of Blair Athol.

"This latest JORC reserve result means that the Blair Athol operation will effectively be able to operate for 14 years under TerraCom ownership," he said.

"Blair Athol has already contributed significantly to the TerraCom group and we look forward to a further 10 years contribution from the operation."

TerraCom acquired the thermal coal mine from Rio Tinto in 2017 via the former's subsidiary Orion Mining after Rio had closed the mine and placed it under care and maintenance since 2012.

In April, TerraCom was forced to defend the authenticity of the coal at Blair Athol, denying allegations the company was involved in a fake coal sampling investigation.

The investigation and subsequent 2020 court case centred on allegations that lab testing and certification company ALS had helped TerraCom to falsify its coal quality results to increase the coal's worth.

On 10 August, TerraCom advised July 2021 operating EBITDA results of $13.6 million for Blair Athol. This represented a cash margin of $58 per tonne.

The Blair Athol site. Image: TerraCom

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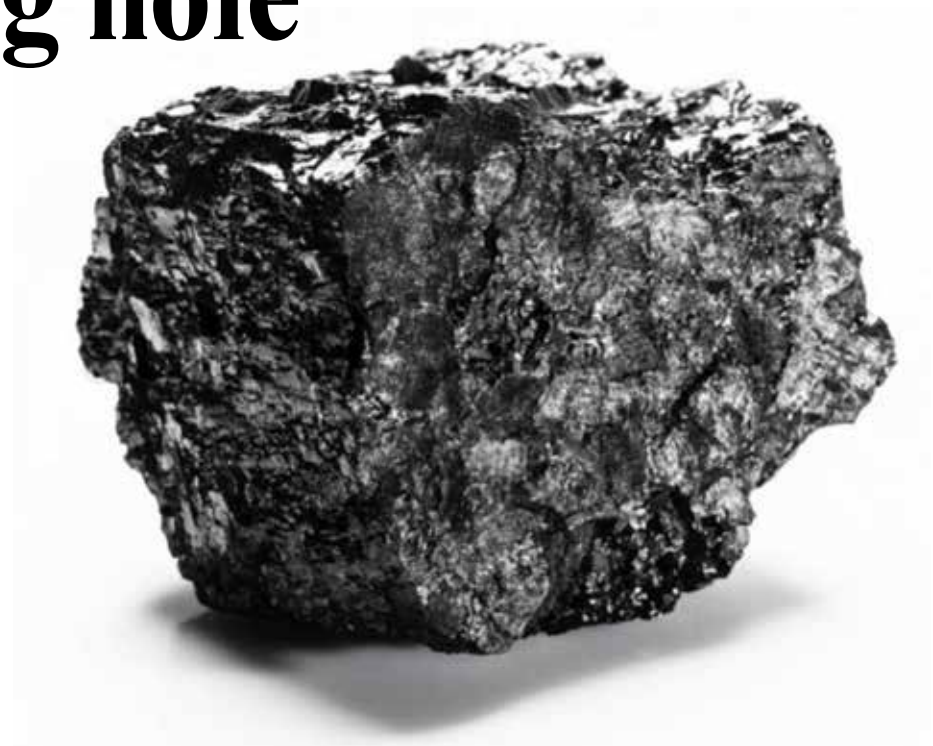
# Australia's coal sector looks to dig itself out of a funding hole



Coal is an increasingly dirty word in much of the world today and those in the industry must dig deeper to find funding for it.

Australia is the second largest coal exporter so the sector's decline will have credit implications across the value chain, in our view. Australia is also one of the world's biggest emitters on a per capita basis, according to the United Nations (UN). The UN recently called for Organization for Economic and Development countries, which includes Australia, to phase out coal by 2030.

Sources of funding will continue to change. The pool of capital available to fund the coal sector is shrinking, which is increasing the cost of that capital.

S&P Global Ratings believes these market forces will increase liquidity and refinancing risks for companies as debts mature. They could also pressure ratings if the cost of debt continues to rise and issuers do not respond by reducing leverage.

We also believe rising capital costs will cause asset owners along the coal chain to reduce investment in upgrading or enhancing physical assets to extend their operating life.

## TIMEFRAMES ARE SHORTENING

A primary issue for businesses that rely on coal is funding. Who will continue to fund them and on what terms and at what pricing?

Financial markets are working toward their own agendas and timelines. These timelines are contracting and companies, governments and policymakers know it. What were once 10-year time horizon considerations for investors are now more like five years. Adding to the pressure are the ongoing trade tensions between Australia and China.

Another risk for some entities is the potential for "financial stranding," whereby the pool of capital becomes shallower as investors exit the sector.

## TO INVEST OR NOT TO INVEST

Some financial organizations now exclude coal-related investment. But the question of funding is not black and white.

Many investors have a timeline for when they will exit coal-related assets. Some are shunning the relatively more polluting thermal coal used for energy but maintaining an interest in metallurgical or coking coal, a key ingredient in steelmaking. Others still have policies allowing them to invest in companies with plans to support them through the transition.

The burgeoning market for "transition bonds" is one way investors are responding to energy transition. This approach is understandable, given strong near-term cash generation. And established infrastructure should help fund the shift to more environmentally friendly activities over the medium to long term.

It also remains unclear to what extent private capital will step in to support the sector, and at what cost. Private debt capital will be attracted by the increasing returns and is less exposed to public scrutiny than public capital market and bank lenders. Even still, lower aggregate demand for these coal-related assets will mean that elevated debt costs are likely to persist.

Credit conditions are tightening. Over the past 12 months, spreads on bond issues for coal-related businesses have moved out by 50-100 basis points depending on the type of asset. Various market developments reflect both the decline in the investor demand for the sector and the requirements for a risk premium to invest. For example:

For Australian assets on the debt side, Asian and U.S. markets are stronger sources of funding because of lower demand locally and from Europe. Environmental, social and governance (ESG) considerations are featuring in more and more investor mandates. So the question is how long Asian and U.S. markets will retain their current appetite for coal exposure.

The big four Australian banks and most European banks now rule out investing in new coal assets and aim to exit the sector over planned timeframes. Some Asian banks are following suit.

For the Australian coal export terminals accessing debt capital markets, the U.S. remains the primary source of capital markets funding as other debt capital markets shun coal assets. This increases the cost of debt and heightens refinancing risk.

## FUNDING DRIVERS

The Northern Australia Infrastructure Facility (NAIF) recently approved a A$175 million loan to Pembroke Resources for its new coking coal mine, Olive Downs, in central Queensland. The NAIF, which is funded by the Australian government, offers concessional funding terms and seeks to fill gaps where the private sector won't fully fund transactions. This transaction would suggest the project had difficulty securing private sector finance at attractive rates.

Coal export terminals such as Dalrymple Bay (Dalrymple Bay Finance Pty Ltd.

BBB/Stable/--), in Queensland, and the Newcastle Coal Infrastructure Group Pty Ltd

(BBB/Stable/--), in New South Wales, have been accessing U.S. capital markets over the past 12 months, raising medium to long term debt at rates of between 4.5% – 5.0%. In contrast, North Queensland Export Terminal Pty Ltd (BB-/Negative/--) was unable to raise debt in the bank or capital markets and so relied on shareholders' funding to repay recent maturities.

The recent recapitalization of Coronado Global Resources Inc. (B-/Stable/--) involved an equity raising to reduce debt and included a US$350 million tranche of senior secured five-year notes priced at 10.75% and a US$100 million asset-based loan facility.

UniSuper recently sold equity positions in New Hope and Whitehaven Coal and IFM Investors plans to exit thermal coal-reliant assets by 2030.

## STRANDED ASSETS AND PRICING PAIN

The coal sector increasingly faces the problem of stranded assets. Market economics are forcing the early closure of deteriorating, inefficient or unprofitable power plants and mines.

In general, significant new capital is unlikely to go toward upgrading or enhancing older physical assets to extend their operating capability.

The most prominent example is the case of coal-fired power stations. Over the past few years, most have become unprofitable as an influx of renewable energy generation lowers the price of electricity.

Similarly, older high-cost coal mines are vulnerable to pricing cycles. They may be profitable during periods of high coal prices but suffer when prices fall. This vulnerability may make companies reluctant to continue to operate such assets or to contribute funding. On the other hand, those that stand to benefit are operators with efficient cost bases and "cleaner" coal.

## FORCED TO CLEAN UP THEIR ACT

AGL Energy Ltd.'s coal-fired Liddell power station in NSW's Hunter Valley will close in 2023 to be replaced by a renewable solar-hydro energy power plant.
The scheduled closure of Energy Australia's 1,480-megawatt brown coal power station at Yallourn, east of Melbourne, has been brought forward to mid-2028.

Whitehaven Coal's extension to its Vickery mine in northeastern NSW is facing approval uncertainty.

A proposed underground coal mine of Hume Coal (a wholly owned subsidiary of Korea-based POSCO, BBB+/Positive/--) has been rejected by the NSW Independent Planning Commission.

## COSTS ADD TO RATINGS RISK

Any new material and permanent cost increases will heighten rating transition risk for the sector. Both local and global signs are emerging of various extraneous costs. All the larger local insurers have enacted climate change policies. The conditions and timelines of these policies vary but in most instances they have exclusions in relation to underwriting and investing in coal.

A prominent public example is the Adani Carmichael coal mine in central Queensland, which local insurers are declining to insure. In response, the coal industry is investigating opportunities for self-insurance.

The Australian coal supply chain also faces growing costs at an international level. The European Union is set to introduce the world's first carbon border tax. As proposed, the EU Carbon Border Adjustment Mechanism will be rolled out in 2023 at

the earliest before becoming fully operational in 2026. Such a mechanism, if replicated elsewhere, could impose costs on Australian coal exports in the absence of any carbon pricing mechanism on coal here.

## COMPANIES LOOK TO DIVERSIFICATION TO EASE THE STRAIN

Increasingly companies are examining ways to either diversify away from coal or to manage the impact of energy transition. This is taking many forms, including mergers and acquisitions, demergers, and new business lines.

In many cases, a company's ESG considerations govern decisions on diversification. Nevertheless, it is difficult to separate those decisions from the influence of investor preferences and capital flows.

## LOOKING AT OTHER OPTIONS

The rapidly evolving landscape is forcing numerous businesses to reduce their coal dependency by diversifying into other areas. Examples include:

- BHP Group Ltd. (A/Watch Neg/A-1) has begun to exit coal-mining activities.
- South32 Ltd (BBB+/Stable/A-2) divested its interest in South Africa Energy Coal and decided not to proceed with the Eagle Downs project.
- Aurizon Holdings Ltd. diversified into nonvolume-linked bulk service contracts, including leasing of rolling stock and crew, and recently expanded into non-container port services;
- The Port of Newcastle (Port of Newcastle Investments (Financing) Pty Ltd
- BBB-/Stable/--), the world's largest coal export port, has for several years been examining options for a container terminal within the port and is looking at developing other bulk trade over the next decade.
- Dalrymple Bay Coal Terminal is reportedly interested in how it might facilitate the transport of hydrogen.
- AGL is pursuing a demerger into two entities: one will contain energy generation assets; the other will contain its more environmentally friendly retail business activities.

## HOW THESE ISSUES AFFECT OUR RATINGS

Our rating analysis considers present and emerging credit implications in several key areas:

### *Cost of debt*

Interest margins for coal-related assets and business have risen over the past one to two years. In assessing future credit metrics we reference current and expected margins to understand and incorporate the impact of higher costs of debt in our analysis. This includes instances for coal export terminals where the current full cost of debt may exceed the cost that can be passed through to the terminal's customers.

### *Refinancing*

Liquidity risk is a primary concern for corporates with concentrated debt maturity profiles and project financings with bullet maturities. The risks of replacing debt include the cost and degree of market appetite. And time is increasingly a factor because some debt issuances are taking longer to implement. For corporate credits we consider, among other things, an issuer's track record and relationship with banks – especially in the case of liquidity risk. We also consider to what extent new ESG related bank policies may affect future bank support. For project financings, we typically expect to see bullet maturities refinanced nine to 12 months ahead of maturity for investment-grade credits.

### *Leverage*

To manage end-market volatility and refinancing risks, companies are reassessing what is appropriate for a through-the-cycle capital structure. Accordingly, we look to assess a company's current and future capital management plans as they adapt to their evolving operating environment.

### *Asset values*

Written-down asset values decrease balance sheet ratios, particularly debt-to-asset ratios, which may affect adherence to debt covenants. Balance sheet covenants are generally less prevalent than cash flow/leverage covenants for our rated issuers, but we continually assess current and likely future compliance with all covenants.

### *Operating costs*

We include in our forecast increased direct costs, where known, such as rising insurance premiums. We will also consider the impact of any material future cost changes in the industry. Carbon taxes or government subsidies, for instance, may increase the cost position of our rated issuers relative to more environmentally friendly technologies.

### *Rehabilitation/remediation costs*

We consider various costs involved with the closure or retirement of assets at the end of their useful life or, as in increasingly the case, voluntary earlier closure. These costs can be meaningful and difficult to quantify (and hence easy to underestimate).

### *Business risk and competitive position*

We closely consider a company's future strategy and recognize the need for corporate strategy to pivot and invest to address the long-term viability of its business model.

ESG factors are increasingly important for investors. The pace of change is faster than ever. This means challenges for business and less time to deal with them. Consequently, rating transition risk is heightened because the rate of change may defy our expectations.

Australia's highly profitable coal export sector is unlikely to dissolve overnight. However, failure to attract new capital amid rising ESG concerns will likely end the relative ease of doing business within the Australian coal sector.

As 2030 approaches, the industry will face growing scrutiny and the impact of capital market behaviour is likely to add to the uncertainty.

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# Online conveyor training content for learning management systems

New online content has been introduced by the world's most experienced conveyor training provider, specifically designed to integrate with Learning Management Systems (LMSs) so users can assign, monitor and certify progress of all participants. The new offering from Martin Engineering includes eight self-paced modules that address methods to identify, understand and correct common bulk conveying issues to improve safety on powerful and potentially dangerous systems, while complying with regulations, maximizing production efficiency and achieving the lowest operating costs.

"Online conveyor training is delivering critical knowledge to companies around the world, and that's never been more important than in these pandemic-restricted times," explained Training Manager Jerad Heitzler. "But even as the popularity of these programs continues to rise, larger firms face challenges integrating the content into their Learning Management Systems so they can ensure thorough and convenient training for all employees – at all levels – across multiple sites. These modules create a verifiable record of employee training, so customers can track and confirm the participation of individuals company-wide." Organized into 90-120 minute segments, the virtual classes cover topics such as best practices for safety, fugitive material control and belt tracking.

The modules deliver topic-specific, non-commercial content that can be put to immediate use.

With the training modules easily accessible and conveniently located in company-wide LMSs, the new Martin content gives customers complete control over scheduling and tracking. “This is the type of training that everyone should have, and companies no longer need to rely on an outside vendor to schedule individual or group sessions,” Heitzler continued. “It delivers an in-depth and consistent understanding of conveyors and their hazards, ensuring that personnel at all levels can work safely and efficiently around these powerful systems.”

Martin Engineering has been providing expert training for much of its 75+ year history, helping customers better control bulk material flows while reducing the risks to personnel. Designed to maximize employee engagement, the modules deliver topic-specific, non-commercial content that can be put to immediate use, and the new format allows even the most remote locations to take advantage.

The eight modules cover essential subjects that include an introduction to the concept of Total Material Control, with content on transfer points, belting and splices, as well as belt cleaning, alignment and dust management. “This system is created using a SCORM 1.2-compliant format, so it will integrate seamlessly with most existing LMSs,” Heitzler added.

SCORM is a widely used set of technical standards that provides the communication method and data models that allow eLearning content and LMSs to work together. All eight modules are currently available in English, Spanish and Portuguese, and can be provided in a variety of formats to meet the requirements of specific customers and their LMSs.

“Seven of the eight modules have a test at the end, requiring a minimum score of 70% to move on to the next module,” he said. “SCORM allows the content to interact with the LMS and leverage any features that a customer’s system has, which could include tracking the progress of each learner, providing reports or issuing certificates of completion.”

“With this new effort in place, Martin has taken another step forward in global conveyor training,” Heitzler concluded. “We’ve emerged as an LMS content provider to deliver greater flexibility and control over employee learning, helping customers attain the highest levels of efficiency and safety.” The training content is available in a variety of packages, with options to suit a wide range of industries and company sizes. Interested parties can obtain details by contacting their regional Martin Engineering locations, which can be identified at https://www.martin-eng.com/content/find_rep.

**Martin Engineering** is a global innovator in the bulk material handling industry, developing new solutions to common problems and participating in industry organizations to improve safety and productivity. The company’s series of Foundations books is an internationally-recognized resource for safety, maintenance and operations training – with more than 20,000 print copies in circulation around the world. The entire 500+ page volumes can also be downloaded as free PDFs from the Martin web site. Martin Engineering products, sales, service and training are available from 19 factory-owned facilities worldwide, with wholly-owned business units in Australia, Brazil, Chile, China, Colombia, France, Germany, India, Indonesia, Italy, Japan, Mexico, Peru, Russia, Spain, South Africa, Turkey, the USA and UK. The firm employs more than 1,000 people, approximately 400 of whom hold advanced degrees. For more information, contact info@martin-eng.com, visit www.martin-eng.com, or call (800) 544-2947.

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# Taking effective measures

The fact that fires occur with an alarming regularity in the mining industry reinforces the importance of recognizing and eliminating the potential hazards in both underground and surface operations, power plants and monitoring of all mining equipment. The overall need for fire control and suppression technology should ensure the best possible outcome during a mine fire. Mine fires remain a serious threat to the health and safety of miners in metal and nonmetal (M/NM) operations. For example, a few years ago, three mobile equipment fires were reported with one miner dying and another one injured. The subsequent Mine Safety and Health Administration (MSHA) identified that the likely cause of the fire leading to the fatality was a steering hose rupture on the haul truck, causing hydraulic fluid under high pressure to spray onto the hot surface of the engine, resulting in a fast-growing fire. Most of the reportable mine equipment fires involve similar circumstances.

To reduce the number of equipment fires, it is necessary to develop effective measures to limit or prevent hot surface ignitions on mine equipment. To reduce the number of fire-related injuries, it is important to improve the equipment fire suppression techniques to protect the equipment operators. Although some mine equipment includes a fire suppression system, the efficacy of the system can be compromised by poor design, ineffective installation, and fire damage to the system if not activated in time. It is also important to provide mine operators with an effective mine ventilation diagnostic tool to make appropriate ventilation adjustments to protect underground mineworkers from smoke and toxic gases generated from an equipment fire.

Dust build-up in the underground mining area is another major cause of coal mine explosions. The inhalation of silica and coal dust also poses serious health hazards for the miners. The use of air ventilators and water sprays, and the regular cleaning of coal dust lying on the surface are some of the basic techniques to prevent coal dust explosions. An array of dust-buster agents including binders, foams and antioxidants are also being developed to mitigate the chances of coal dust related disasters.

Mining is one of the most profitable businesses, however to what cost? The risks and dangers of working in an underground mine are quite well known. The processes and possible exposure to the miners, poses a mental, physical, and psychological risk. If the appropriate health and safety measures are not implemented, it can result in long lasting physical and psychological damage to the miners and their families. The Department of Justice has a document that specifically focuses on targeting all risks and implementing counter measures to ensure the safety of the miners in the workspace. The primary risks for any miner are:

**Gas Concentrations** – ventilation officers are required to always be available onsite, with regular testing of areas where miners are working as well as any stockpiles that may be on site. As the miners excavate the ore, there is possibility of natural occurring gases to seep in, such as Methane, and accumulate in the underground mine site. The routine checks, and ongoing live monitoring, limits

the probability of risks posed by accidentally tapping into unforeseen gas chambers.

**Blasting** – the explosive nature of this process causes suspension of a range of toxic fumes and gases, which can cause fatal lung tissue damage to any miners exposed. These gases include Carbon Dioxide, Oxides of Sulphur, Carbon Monoxide, Oxides of Nitrogen, and other carcinogenic gases. Hence, why there are extensive and stringent guidelines to mitigate against any risks of exposure.

**Integrity of the support structures within the mine** – underground mining processes are destructive, which causes consistent vibrations, blasting and drilling. The rock that is constantly exposed to such processes may become weakened, and if not monitored consistently may easily jeopardise the integrity of the mine. Hence, why routine inspections of the infrastructure that is supporting the mine are undertaken frequently.

**Dust** – is the most toxic pollutants that affects Australia's miner's health. Dust is generated from a wide range of sources that are utilised within the industry. Multiple studies across the globe have recognised dust inhalation as one of the primary factors responsible for black lung. The threat, of course, is long term exposure when in a confined environment, such as those conditions found in underground mines.

## SOME GUIDELINES FOR THE CONTROL AND MONITORING OF GAS CONCENTRATIONS

Until the early 1980s, mine face ventilation systems were designed for ventilating cutting depths up to 20 feet. Since that time, use of remotely operated mining machines have allowed cutting depths to increase to more than 40 ft, increasing concerns about the effects on methane levels at the mine face area. The principles for efficient methane control during deeper cutting remained the same, namely:

- Move enough intake air from the end of the tubing or curtain to the face.
- Mix intake air with methane gas liberated at the face.
- Move methane contaminated air away from the face.

However, when cutting to depths greater than 20 ft (known as deep-cut mining), airflow quantities reaching the face area often decreased because it was difficult to maintain tubing or brattice setback distances. Earlier researchers showed that use of machine-mounted scrubbers and water sprays increased airflow at the face area during deep cutting.

Without additional controls, only a small percentage of the air delivered to the end of the tubing or curtain reached the face area.

Operation of a machine-mounted scrubber increased airflow and reduced methane levels at the face area if the quantity of intake air delivered to the end of the curtain or tubing was not reduced.

Operation of water sprays did not significantly increase the volume of air reaching the face but did improve mixing of methane and intake air at the face. Methane monitoring requirements remained the same for deep cutting, but the possibility of rapidly changing conditions at the face increases the need for accurate estimates of face methane concentration.

At the time research examined currently available instrumentation and sampling methods for monitoring methane at the face. The results from this NIOSH research program demonstrated how existing and new engineering controls can be used to reduce face methane levels and the sampling methods that were investigated can provide better ways to measure methane levels near the front or face of the where the machines are being used. the continuous mining machine.

From the report there are several practical guidelines that can be adhered to for controlling and monitoring methane levels in the face areas of underground coal mines. Most of the recommendations were based on studies conducted in the NIOSH ventilation test gallery.

Free-standing fans can be used to ventilate empty headings in coal mines.

The fan nozzle should be designed to provide maximum throw distance.

Recirculation should be minimized by proper placement of fan inlet and or by placing curtains partway across the entry.

With blowing systems, the single most important factor on face methane dilution is the velocity of the air directed toward the face.

For the same airflows, use of tubing rather than a curtain usually provides better control of face methane, especially at longer setback distances.

With blowing and exhausting systems, and with the mining machine at the face, use of scrubbers increases the amount of intake airflow reaching the mining face.

Scrubber and spray systems should be designed to achieve efficient face ventilation for the effective removal of gas from the face.

Measurement of airflow speed and direction between the curtain and the face helps to predict methane concentrations in the face area

In empty entries, airflow velocity is much lower in narrower entries. More airflow should be provided during box cuts to prevent higher methane levels.

Regardless of intake flow quantity, increasing scrubber flow will reduce face methane levels if recirculation is controlled. Recirculation can be controlled by:-

Minimizing leakage around the ventilation curtain.

Directing scrubber exhaust away from the blowing curtain. With exhaust systems the mouth of the curtain should always be outby the scrubber exhaust.

Water sprays on the mining machine should be directed to provide the best airflow across the entire face.

Methanometer response times can be measured using either of two techniques developed by NIOSH. Instruments with shorter response times more accurately measure current methane levels. Dust cap design has the greatest effect on response times.

When selecting a methanometer the dust cap design should be examined. The cap should protect the methane sensor from dust and water but not significantly increase the response time.

Alternative methane sampling locations on the mining machine should be compared and selected based on the relative protection provided to the face workers.

Mine personnel should be provided with methane monitors that can be worn while working in areas that cannot be regularly monitored. Audible, visual, and vibratory alarms for the monitors should be evaluated based on the environment in which the instruments are used.

Miners must be safely removed from a mine without exposure to excessive methane following stoppage of a main fan

Mines should be evaluated for the most likely area where methane gas can accumulate following stoppage of a main mine fan.

In areas between the mouth of the ventilation curtain and the face, airflow direction is constantly changing, and it is difficult to accurately measure flow velocity with a single axis anemometer (e.g., a vane anemometer).

Following approval for underground use, multi-axis anemometers should be used to monitor airflow direction and velocity between the mouth of the ventilation curtain or tubing and the face. Multi-axis instruments should also be used to monitor flow at locations outby the mining face.

During roof bolting, if it is not practical to monitor methane levels at the mining face, methane levels should be measured with a bolter machine-mounted monitor and a detector held 16 ft in by the last row of bolts using an extensible pole.

However, in today's mines we see a plethora of gas monitors that can be used and as such there are many manufacturers of gas monitoring equipment available. One such manufacturer is Dräger which provides explosion proof and intrinsically safe gas monitors to measure noxious gases such as CO, $CO_2$ , NO, $H_2S$, $SO_2$ as well as $O_2$ and N.

These instruments typically provide a 4-20mA analogue output or a Modbus output which can be read by Neon Remote Terminal routinely, perhaps every 1, 5 or 10 minutes to be logged, alarm limit checked and then transmitted via a communication channel to a Neon Server on a regular schedule, perhaps every 5 minutes.

Underground mines typically have one or more mine shafts, many tunnels leading from those mine shafts and one or more ventilation shafts. Neon Remote Terminal Gas Monitor


Stations can be set up at many different locations within the mine to monitor gas and other local conditions, such as temperature, humidity and perhaps dust and sound.

Underground mines generally have an existing communications system within the mine. Old mines had wired systems, like a telephone. Modern mines have wireless communications systems either cell phone based or standard 802. WiFi based, with a leaky feeder / leaky coax antenna throughout the mine, and WiFi access points.

The Neon Remote Terminal / WiFi can be used in this application with data being transferred from the Neon Remote Terminals via the existing WiFi system to a Neon Server within the Mine Administration building on the surface.

The Neon Server can be used to check gas and other ambient parameters at each measuring station / at each Neon Remote Terminal and display information on a standard web browser and on a schematic diagram of the overall mine to highlight any out of limit ambient or gas parameters.

The Neon Remote Terminal can also be programmed to increase or decrease ventilation in the mine based on the current measurements. The Neon Server can be set up to check incoming data for any out of limit conditions and activate an alarm. Alarm actions can be set up to activate visual or audible alarm indicators. Alarm actions can also be set up to email and text mine staff and mine safety officers to alert them of any out of limit / any dangerous conditions.

## ULTRASONIC TECHNOLOGY HOLDS THE KEY

Mine fires and explosions traditionally have ranked among the most devastating industrial disasters. The prevention and control of fire and explosion in mines is fundamental. On a mine site, fire hazards may occur in and around process plants, underground conveyors, static and mobile plants, draglines, workshops, substations, monitored control rooms and switch rooms. All mines have highly expensive and mission critical equipment that typically operate day and night under extreme hostile conditions, in vast, remote, and difficult to access environments, especially on underground equipment. In many cases non-gaseous and gaseous fire suppression systems are the preferred systems installed to protect the high value assets, safeguard operators and processes to guarantee business continuity. However, it can be argued that the competitive nature of the free marketplaces great pressure on the fire industry to deliver systems which minimally comply with, rather than exceed, the regulations. Too often fire protection is seen as a cost – not a vital investment for business continuity. High value assets such as critical mining infrastructure, may have catastrophic results in the event of downtime or shutdown due to fire. The risk far exceeds the risk of choosing minimal compliance, instead of advanced real-time monitoring systems. The cost or damage to reputational integrity because of this downtime far exceeds the cost of integrating a real-time monitoring system.

resistant construction. This is particularly important for mines with intended for use longer than 6 months. If such an arrangement is not possible, then the area should be protected throughout by an automatic fire suppression

system. In coal mines it is critical to minimise any potential fire source. In many underground mines, mobile equipment is typically diesel-powered, and a large percentage of the fires involve the fuel used by these machines. These fire hazards are compounded by the presence of coal, coal dust and methane.

## WHAT IS A GASEOUS SUPPRESSION SYSTEM?

Gaseous fire suppression systems typically encompass extinguishing agent stored in pressurised cylinders that are connected to a network of discharge pipework and nozzles that deliver the extinguishing agent to an enclosure to be protected.

Among the commonly used gaseous fire suppression systems are Carbon Dioxide (CO2) and Clean Agent systems which are both non-conducting fire extinguishants safe for use when dealing with delicate electrical and electronic equipment unlike water-based systems. Both CO2 and Clean Agent systems vaporise easily and do not leave a residue upon evaporation.

Clean Agents consist of two types which are halocarbons that are stored as liquefied gases and inert gases that are stored as non-liquefied gases. Halocarbon is a name given to compounds containing both carbon and at least one of the halogens (fluorine, chlorine, iodine, or bromine). In the case of Halon 1301 and Halon 1211 which contain bromine, they possess strong ozone depletion potential that has been banned under the Montreal Protocol in 1989.

Replacement halocarbons has since been developed using safer halogens such as fluorine and among the popular ones are NOVEC™ 1230 by 3M™ and FM-200™ by The Chemours Company. On the other hand, inert gases are clean agents that consist purely of inert gas such as Nitrogen, or a combination of gases in the case of Inergen which contains CO2, Nitrogen and Argon.

## HOW GASEOUS SYSTEMS COMBAT THE FIRE TRIANGLE

At the heart of clean agent extinguishing properties is the commonly used “Fire Triangle” that represents the three components required to start a fire which are oxygen, heat, and fuel. When one or more of these components are missing, the fire will be extinguished. Halocarbon clean agents such as NOVEC™ 1230 and FM-200™ remove the heat component which effectively prevents the material from reaching its ignition temperature. CO2 and inert gases work differently by removing the oxygen component but equally as effective to extinguish a fire.

The clean agent systems function on a total flooding principle and are highly relied on due to their quick detection of a fire event, rapid suppression, and extinguishment capabilities. Typical applications include chemical storage areas, clean rooms, communications facilities, robotics, emergency power facilities and in mining sites as well. Depending on the site, the installed clean agent systems are in or around the fire risk areas such as control rooms, data centres, electrical switch rooms, and process control rooms. All fire equipment and systems including gaseous fire suppression systems need to be regularly tested, serviced, and maintained to help ensure that they will be ready to operate as intended at the event of a fire.

## WHY SHOULD WE MONITOR THEM?

Clean agent fire extinguishing systems of this type are governed by BS EN ISO 14520 Gaseous Fire Extinguishing Systems. They are designed to provide a supply of gaseous extinguishing medium for the extinction of fire. It is essential that gaseous extinguishing systems are carefully maintained to ensure instant readiness when required. Routine maintenance is liable to be overlooked or given insufficient attention by the owner of the system. These are very highly pressurised systems often stored at pressures of 725 psi (50 bar) and above. In engineering terms, they are "dynamic" systems, not passive ones. Inspection preferably by a third party, should include an evaluation that the extinguishing system continues to provide adequate protection for the risk (protected zones, as well rooms built for room integrity, can change over time as they age or are modified). There exist very few engineers in our industry who fully understand the design, installation, testing, maintenance, and safety of gaseous firefighting systems in buildings, plants or other structures, and the characteristics of the various extinguishants and types of fire for which they are a suitable extinguishing medium.

The HSE states that, in mines, continuous monitoring and protection of machinery and equipment can significantly reduce the likelihood of a fire occurring by detecting abnormal operating conditions and generating a warning and/or stopping the machinery or equipment before it becomes a hazard. The same should therefore go for the gaseous systems.

Gaseous extinguishing systems are pressurised, and therefore exist in a dynamic state and can leak. As supported by the BS EN ISO 14520 regulation, if clean agent cylinders leak beyond 5% of contents or 10% of pressure, they will not extinguish a fire event, as they will be below their design concentration. As the "gold standard" of clean agent systems – BS EN ISO 14520 highlights the asset owner's responsibility to check that the clean agents contents exist; that the protected space can be sealed; that the pipework used to discharge the clean agents are clear of particulates that can clog up the nozzles which reduces the amount of clean agent to the point where it cannot deal with the fire event.

## ANECDOTES OF BAD PRACTICE ACROSS ALL SAFETY CRITICAL INDUSTRIES

- Low labour rate servicing crews being unskilled, unreliable, and untrained
- Disreputable companies randomly checking a few cylinders and placing "tested stickers" on the rest of the untested ones
- 20% of CO2 cylinders installed have leaked or partially discharged during their lifetime

These anecdotes represent observations across multiple industries and could very highly be applied across the mining industry. These issues would risk the integrity of mining operations, because in the event of fire, there may be insufficient agent to extinguish it. For such safety critical operations, leaving fire safety systems unsupervised and unmonitored 364 days a year until their annual certification check is just too risky.

## INDUSTRY TREND TO GOVERN "THE UNGOVERNED SPACE"

Safety is an area which must no longer be overlooked. The industry is beginning to opt for more regular inspections and even, continuous 365/24/7 monitoring.

The ability to monitor autonomously, with remote diagnostics and remote relay which provide an alarm to the Fire Safety Officer or Facilities Manager, provides confidence in the integrity of the system. Minimising the risk of fire in the long run can improve business continuity. It also saves downtime and saves the potential costly pay-out which fire damage entails. Carl Hunter, having coined the term "the ungoverned space" as CEO of Coltraco Ultrasonics is proud to be at the forefront of the industry trend towards increased safety.

## WHAT METHODS ARE AVAILABLE NOW?

Ultrasonic technology holds the key. Coltraco Ultrasonics have developed a system capable of constant monitoring fire extinguishing cylinders with their Permalevel™ Multiplex.

Currently, protecting similarly high value and critical infrastructure, such as electricity sub-stations, power generating stations and data centres, Permalevel™ Multiplex will provide the asset owner with complete 24/7 visibility of their system's contents. This Safe site® solution enables mining sites to go above and beyond minimal regulatory compliance to develop their own best practice safety management system that may lead to better protection of asset and human life, as well as show their insurers their commitment to safety.

## IS BAD ENGINEERING BEING REWARDED?

Despite the technological advances in monitoring systems, the industry still approaches the installation of a dynamic and pressurised fixed gaseous extinguishing system as if it needs no integration into a Building Management System (BMS)/Safety Management System (SMS), except alerting on actuation. Nor does it think it needs constant monitoring,

lest it reveals the underlying engineering risk of them. Can this be because good engineering is left unrewarded in fire safety matters? Or might it be that the fire industry is more concerned to negate customer awareness of its need lest it reveals that pressurised systems do discharge and leak? These are needless concerns. All good engineering demands the monitoring of dynamic structures, and a highly pressurised cylinder is a dynamic structure. It is designed to protect a critical infrastructure or asset. Without constant monitoring a risk is generated in the very environment for which it is designed to reduce risk. The risk is not only to the asset, but to the people who work in the asset and their ability to enable business continuity in the high value asset under risk.

## WHAT IS ULTRASOUND?

Ultrasound is merely sound beyond our audible range. Dolphins and whales can communicate at sea over long ranges as sound travels more efficiently through liquids than air. We use this principle to identify that difference in a cylinder containing liquefied agent. Consider ones ears as ”the receiver” and ones mouth as the “transmitter”. Sound will arrive at ones ears at different times. The reason though that we hear a unitary sound is that our brain processes it to one. This is what we do by processing the returning ultrasound. In the air bats navigate by airborne ultrasound. We can do the same for contents and room integrity monitoring in the fire industry.

By utilising a sensor which acts as a transceiver, an ultrasonic measuring device can detect liquid levels within any single-skinned container through transmitting an ultrasonic pulse and analysing the strength of the returned signal to determine the level of contents. As sound behaves differently in air and liquid, so will the strength of the returned signal be different in the liquid allowing us to identify the level of contents accurately. Similarly, leaks can be effectively detected through an ultrasound generator placed in an enclosure and an ultrasound receiver outside of the enclosure to measure the amount of ultrasound that leaks from the seals and cracks which has the potential to affect the ability for a clean agent to extinguish fires due to the retention time it needs upon discharge to function at its best. Taking these collected data and transmitting them wirelessly over TCP/IP, true remote monitoring of your fire suppression systems is possible anywhere around the world.

## CASE STUDY: ULTRASONIC TECHNOLOGY OFFERS QUICK, SAFE & RELIABLE SOLUTIONS

The importance of ultrasonic technology to the mining industry has been demonstrated by its use thus far. NRG Energy have been using the Porta level™ Max since 2015 at the Morgan Town Generation Plant in Morgantown, Charles County in Maryland, US. The Morgan Town Plant is a coal powered power station based in Maryland. NRG own the USA’s largest and more diverse power generation competitive portfolio. NRG are dedicated to smart and reliable energy sourcing, and emission reductions although coal is a significant part of the electricity generation. The Porta level™ Max is an example of the technologically advanced techniques that the company are implementing to lead the way in safe and sustainable coal sourcing. After witnessing fire service experts undertaking ultrasonic liquid level indication in just minutes, they were keen to change from their previous method of weighing. As a safety critical asset, the Morgan Town Plant saw the necessity in investing into their fire safety. This was the same as at the Vales Point Power Station at Delta, Australia. The power station is at the southern end of lake Macquarie. This power station was built in the 1960’s as a four-unit station, but now operates two 660 MW generating units. The Power Station is owned and operated by Power International, with the capacity of around 1,320 megawatts, providing 24 hours electricity. In 2013 they bought Coltraco Ultrasonics’ Porta gauge® 3 thickness gauge for testing normal structure and stainless steel.

## HOW TO INSPECT LIQUEFIED GASEOUS SYSTEMS WITH EASE AND SPEED

Utilising ultrasound technology, Coltraco Ultrasonics have been manufacturing a range of ultrasonic portable liquid level indicators known as the Portalevel®. The Portalevel® MAX is the latest generation of the Portalevel® line and is designed to provide enhanced speed, operation, and performance, especially for high intensity testing requirements and works brilliantly for testing cylinder contents of fixed fire extinguishing systems like CO2, NOVEC™ 1230, FM-200™ and other clean agents. The device has UL, RINA and ABS Type Approval, building further on their history of over 27 years manufacturing this equipment and showcasing the commitment to the marine and shipping industry. The Coltraco Safesite™ technology suite includes Portalevel® MAX; a “world leading handheld ultrasonic liquid level indicator for testing most common extinguishing agents”; the Portasteele™ Calculator tablet based app converting the liquid level into agent weight/mass with ease, simplicity and ability to log the results; and the Permalevel® Multiplex for 24/7, 365 autonomous, continuous monitoring of fire suppression systems, with remote relay, remote diagnostics and alarm capability to alert in case of agent leak/discharge.

## HOW TO CONSTANTLY MONITOR LIQUEFIED GASEOUS EXTINGUISHING SYSTEMS 24/7

Permalevel® Multiplex is the first system worldwide that can monitor the liquid level of critical fire suppression cylinder systems on a constant basis. It gives a facility total visibility on the real-time status of all their critical fire systems. Modern fire suppression systems have transformed industry safety across all sectors. However, the development of their servicing and monitoring equipment has remained stagnant, with many very advanced systems relying totally on annual inspections, or on unreliable mechanical pressure gauges.

These methods leave the status of fire suppression systems completely vulnerable between annual checks.

The Permalevel Multiplex® is designed to ensure that fire suppression systems are always fully operational and that no accidental discharge has occurred, which could affect the effectiveness of the overall fire protection system if it is required for use 24/7 remote access to system status


– enables the operator to monitor each cylinder point in real time. The ability to retrofit into existing systems which eliminates downtime as the system does not have to be disconnected/deactivated provides ease and simplicity to be installed across hundreds of cylinders present in a particular site.

## HOW TO TEST ROOM INTEGRITY

Where Portalevel® and Pemalevel® deals with the clean agent contents, Coltraco Ultrasonics has also designed and manufactured a device to monitor the enclosure integrity at which the clean agent discharges into. Prior to the installation of a clean agent extinguishing system, fire installers are required to determine the enclosure's "hold time" to comply with regulations such as BS EN ISO 14520 and to ensure the enclosure can contain the released clean agent for a sufficient period to extinguish fires. This relies on the identification of leak sites within an enclosure and subsequently sealing them to improve the "hold time" when necessary. Coltraco Ultrasonics manufactures the Portascanner™ 520 which comprises of an ultrasound generator and ultrasound receiver whereby the ultrasound generator is left in an enclosure and the receiver is used to scan the enclosure seals to identify leak sites. This allows effective identification of leak sites and overall contribute to an increased reliability of a clean agent fire suppression system. A semi-permanent option is also available to monitor leak sites continuously, typically in old, grade listed buildings whereby protection from fire is of absolute importance.

## CONCLUSION: SAFESITE® FIRE SAFETY SOLUTIONS

Coltraco Ultrasonics is a company that demonstrates their commitment to developing and supporting safety systems and test equipment with their customer and the end application in mind, founded on science and pursuit of mathematical justification such as their practice to precisely cite accuracy i.e., they achieve +/-1.5mm level of contents accuracy and identify leak sites as small as 0.06mm +/-0.02mm. This is a key contribution the company makes to the industry over their competitors, backed up by 30 years' experience, operating in 108 countries and life-time customer care.

## CHALLENGES IN COAL DUST MANAGEMENT

Prevention is better than a cure. In coal mining, these words offer particularly good guidance. Underground mining presents numerous hazards ranging from structural collapses, flooding and explosions. The tremendous amount of dust generated by activities in a coal mine creates breathing-related problems for workers as well as maintenance issues for machinery. Dust can also create a potentially explosive environment. Injuries and deaths occur every year either from accidents or health issues caused by exposure to coal dust. Mining companies can dramatically reduce these risks by applying rigorous dust suppression safety measures

Coal dust is generated from numerous processes of production, including shearing, or loading, drill and blast, coal stockpiling, mining, processing and utilization, and transportation. There is also coal dust that is generated from conveyor transport driven by coal particles colliding and falling at subsurface points of transfer and through ventilation air flow in coal mines and the natural wind from outdoor environments.

Coal has different physical chemistry characteristics with different metamorphic stages. This affects wettability. The degree of metamorphism of coal varies in different areas which affect the wettability of the coal dust.

The largest source of inhalable and respirable dust at continuous mining operations are generated from two sources which are the continuous mining machine and the roof bolter. The continuous miner and the roof bolter operators are often exposed to elevated silica levels because of cutting and drilling into the rock. Dust generated by the continuous miner has the potential to expose the miner operator and anyone working downwind of the active mining. Water spray systems, flooded-bed scrubbers and face ventilation are used as best practice methods for dust control in continuous mining operations. Continuous mining dust control can be achieved using the following best practice techniques:

**Water spray systems:** hollow-cone for small to medium droplet sizes, full-cone for medium to large droplet sizes, solid-stream for uniformity in wetting of the material to be cut, flat-fan for small to medium droplet sizes in narrow and enclosed spaces and air-atomizing for fine mist droplet sizes which are the smallest droplets of all sprays.

**Flood-bed scrubbers:** capture dust from the cutting face through the ductwork on the miner and pass through a filter panel that is wetted with water sprays or use of surfactants. To improve the efficiency of the scrubber the best practice methods include scrubber maintenance, airflow measurement and adjustment of the filter panel thickness to specifications that suit quantity of airflow through the scrubber.

**Face ventilation:** blowing face ventilation in which intake air is delivered to the face of the working entry by blowing it from behind tubing. Exhausting face ventilation in which intake air is delivered to the face in the working entry.

**Dust control for roof bolters** is achieved using these 12 best practices methods: (1) maintaining the dust collector system, (2) cleaning the dust box (3) using dust collector bags (4) removing and replacing the canister filter (5) cleaning and discharge side of the collector (6) installing a sock on pre-cleaners (7) using dust hog bit (8) positioning to avoid working downwind of the continuous miner (9) wet drilling or mist drilling (10) using a canopy air curtain (11) routing miner-generated dust to the return and (12) working of the bolter.

## DUST CONTROL IN SURFACE/OPEN-CUT MINES

Surface mining operations present dynamic and highly variable silica dust sources. The bulk of the dust generated at surface mines is produced by mobile earth-moving equipment such as drills, bulldozers, trucks, and front-end loaders excavating silica-bearing rock and minerals. Drill dust collection systems, enclosed cab filtration systems, controlling dust on unpaved haul roads and dust control at the primary hopper dump are best practice techniques used for dust control in surface mines. Silica dust is carcinogenic, it causes silicosis, and it kills. Exposure to airborne inhalable and respirable crystalline silica leads to fatal lung disease. There is no small amount of silica dust that must be overlooked as acceptable because cumulatively that results in silicosis with its severity varying from acute, accelerated, and chronic silicosis. The best practice methods for dust control in surface mines are described more in-depth as follows:

**Drill dust collection systems:** drill dust is generated by compressed air flushing the drill cuttings from the hole. Dry or water-based dust collection systems are used to control drill dust. For dry dust collector systems, a tight drill deck shroud enclosure with the ground must be maintained. The collector-to-bailing airflow ratio of at least 3:1 is key which should be coupled with a good drill stem seal with the drill table and maintaining the dust collector per manufacturers specifications. For wet dust suppression, some best practice techniques include the addition of small amounts of water into the balling air to reduce visible dust and minimizing water flow to a rolling cutter bit to increase bit life.

**Enclosed cab filtration systems:** one of the main engineering controls for reducing mobile equipment operators' exposure to airborne dust at surface mines. Enclosed cabs with heating, ventilation, and air conditioning (HVAC) systems are integrated into the drills and mobile equipment to protect the operator from the outside environment. It is important to ensure good cab enclosure integrity to achieve positive pressurization against wind penetration into the enclosure. Use high-efficiency respirable dust filters on the intake air supply into the cab and use an efficient respirable dust recirculation filter. Minimize dust sources in the cab and keep doors closed during equipment operation.

**Haul road dust control:** off-road haul trucks used in surface mining contribute most of the total dust emissions

at a mine site. Treatment of unpaved road surfaces using hygroscopic salts, surfactants, soil cements and polymers can be used for haul road dust control. Increase the distance between vehicles travelling the haul for road dust dissipation and dilution which provides opportunity to use administrative and mine planning control to reduce work dust exposure.

**Primary hopper dump dust control:** Mined product is normally loaded into the haul trucks from the surface mine pit and driven to the primary crusher location. The product is either dumped directly from the haul truck into the primary hopper feeding a crusher or dumped into a stockpile. Best practice for dust control includes enclosing the primary hopper dump, use of water sprays to suppress the dust in the enclosure and dust liberated due to rollback under the dumping mechanism of the dump vehicle.

## DUST SUPPRESSION METHODS

There are a variety of ways to suppress dust in coal mines that offer a varying degree of effectiveness and efficiency. The most common methods are:

- Bag filter system
- Dry fog system
- Use of water

**Bag filter system** uses fans to circulate the air and trap the solids in a bag. However, this type of system is maintenance-intensive and requires bag filter change-outs – which is not conducive to work in an underground mine.

**Dry fog system** requires electricity, making it impractical for work below ground level.

**Water** is an ideal solution because it takes advantage of the mine's existing water supply, forming it into a spray to suppress the dust as soon as it is generated at the coal extraction point and all other areas where dust is generated.

## PREVENTATIVE VS. CORRECTIVE DUST SUPPRESSION USING WATER

### *Preventative dust suppression*

Logically, if a problem can be prevented from happening, then the time and cost of fixing it can be saved. Preventing dust from becoming airborne is critical in dust suppression. Three important elements to successful preventative suppression using water include:

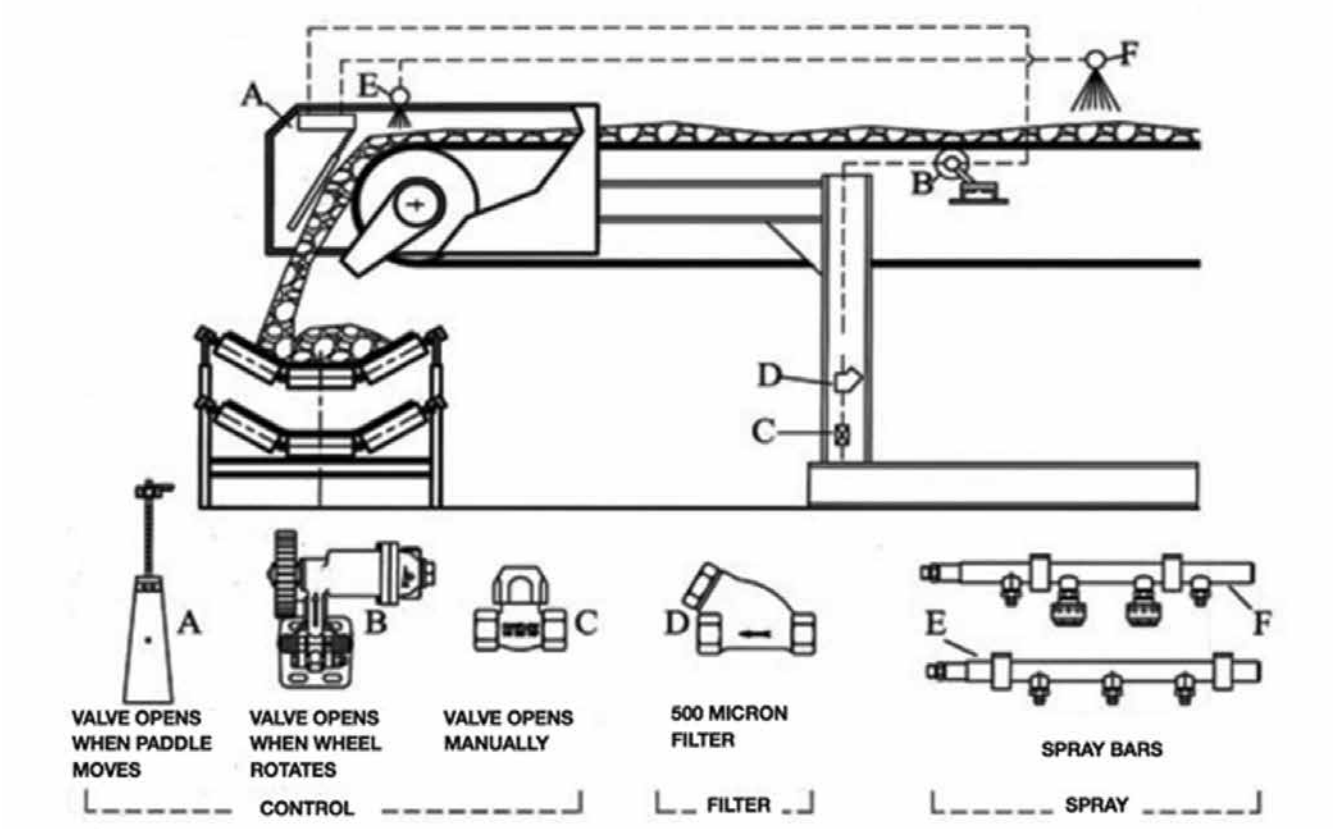
- Control
- Filter
- Spray

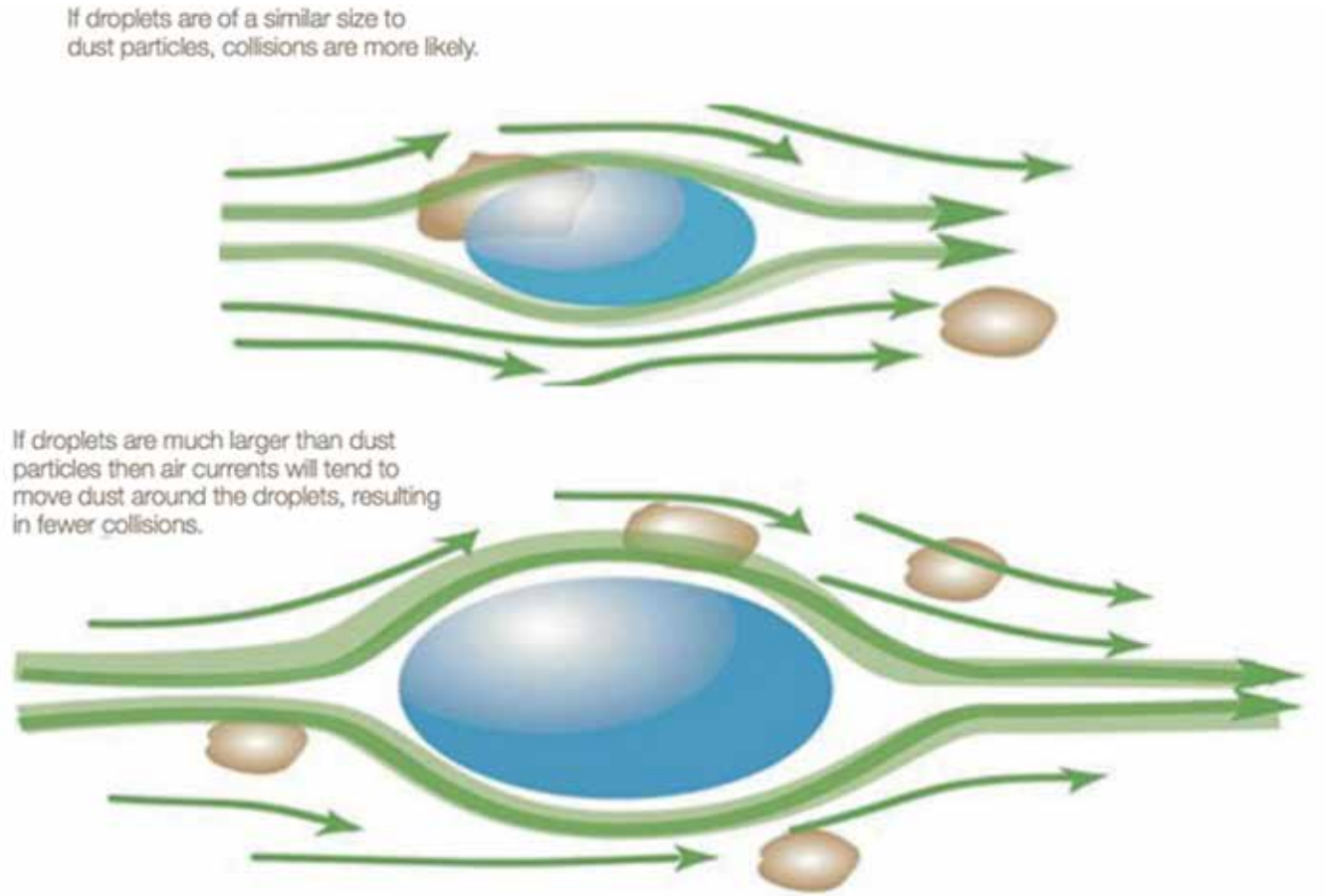
**Control** pertains to how the water is controlled. It may be controlled by the presence of coal on the conveyor or by the belt's motion. In either case, the water is isolated before entering the system.

**Filter technology** is used to remove contaminants from the water to assure reliable system operation.

**Spray** refers to a predetermined volume and pattern in which the water is delivered to the coal before the dust is generated.

The figure below shows a typical belt conveyor transfer point dust suppression system has two options: paddle valve (A) or belt-driven valve (B). Both are designed to operate only when there is coal on the conveyor.






## CORRECTIVE DUST SUPPRESSION

Corrective or symptomatic dust control is implemented after the dust is created and is more challenging than preventative dust control. Dust particles come in a range of sizes with some as small as 10 µm which is invisible to the human eye. These small particles are the most dangerous to workers and equipment because they can remain airborne for long periods of time and eventually find their way into miners' lungs, onto and into machinery as well as outside of the mine itself. Small particles are also the most difficult to remove from the atmosphere. Airborne coal dust can be addressed correctively using sprays. The principal is that the dust agglomerates with the water, causing it to fall under gravity. However, if the water droplets are too large, then the airborne dust particles are just moved around, resulting in very little dust being removed. To effectively remove the dust, the water droplets and dust particles must be the same size. Hence, the design of the spray head is of great importance. With preventative suppression, the size of the particle is less important.

## CASE STUDY: DUST

The property that makes dust so dangerous is its size. Dust particles are extremely small, making them easily disturbed and suspended. The dust particles are on average between 2.5um to 10um in size. The smaller the particle, the more dangerous as it's able to be absorbed into the capillaries in the lungs. For context, 2.5um is 1/7th the size of a strand of human hair. The slightest of disturbances or vibrations can cause these dust particles to become suspended and become a serious health hazard. The main sources of dust suspension in an underground mine are:

## MACHINERY

In an active underground mine, traffic is consistent with transport trucks, civil trucks, cars, and other machinery constantly moving in and out of the mine. The larger the vehicle, the larger the disturbance. The large transport vehicles that are utilised to transport the mined ore out of the mine, even when empty, weigh approximately 80 tonnes, and when full can weigh over 300 tonnes. The rotation of the large tires can suspend a large amount of dust, this combined with vibrations of their diesel engines and heavy load can suspend a large quantity of dust extremely quickly. Even though there are ventilation systems in place, dust quantities can accumulate in extremely high concentrations, very quickly, especially in a confined space.

To further mitigate the risk, according to the Department of Justice there are protocols that assist in reducing risk that are deemed sufficient. This includes:

- Providing adequate rescue equipment and always breathing apparatuses on all persons in the mine, and those miners that are trained in the use of this equipment are always available or on call at the mine while people are working.
- Any idle stockpiles are covered to ensure no dust suspension.
- It also must be ensured that if ventilation systems are switched off, or not working, no personnel are able to enter the underground mine.

## WET DUST CONTROL — A QUICK OVERVIEW

Broadly speaking there are two types of wet dust control systems:

- Dust Prevention - Low pressure and high volume of water
- Dust Suppression - High pressure and low volume of water

As with most things, there are reasons for/against these two dust control strategies, depending on the situation and application.In fact, many mining operations employ both systems in combination to produce the desired result.

## LOOKING AT DUST PREVENTION SYSTEMS

Low pressure systems use large volumes of water to pre-wet the material and increase the moisture/humidity content. This is usually implemented close to the source such as the beginning of the transfer point so that during handling there should not be dust emitted.

However, while there is often a real need to soak material thoroughly with a low-pressure system, there can be significant downsides for the site, including:

- Increased water usage (and its associated costs)
- Dealing with runoff all over the plant
- Excessive water pooling leading to health and safety risks
- Increased corrosion of conveyors and other infrastructure as water is carried through the entire plant
- Clogged up chutes, and
- Clogged up conveyors

Putting these problems aside, one must think about the harmful dust that is not visible to the naked eye including airborne and ultra-fine dust.

This creates an opportunity for dust suppression systems.

## LOOKING AT DUST SUPPRESSION SYSTEMS

These systems use lower volumes of water at high pressure (more than 50 bar) to add a fine atomised mist to dust that is already airborne increasing the particle size causing it to settle due to gravity. this type of dust is more deadly as it lodges in the lower respiratory tract. Depending on the type of material handled, it can either clog or scar the lung tissues resulting in pneumoconiosis (i.e., black lung for coal and in some instances, silicosis depending on the silica content available in the ore handled)

There are many other reasons why the high-pressure dust suppression methodology is a preferred option for dust control, particularly when it is not possible or practical to pre-wet material.

One of the reasons is that the overall water usage is decreased, because moisture is added to the air when suppressing dust and not to the material itself
This means that high pressure dust suppression systems have fewer short and long-term peripheral problems.

This type of dust control during material handling reduces the likelihood of blockages in the downstream materials handling processes caused by cloggy, wet material.

With dust suppression systems tailor made to suit their specific needs, clients can process and handle material at any point, confident that dust will not be a concern.

## DUST SUPPRESSION FOR COAL AND OTHER FINE ORES

Some hydrophobic materials such as coal and other fine ores bring specific challenges. In these situations, the effectiveness of a high-pressure dust suppression system can be enhanced by products such as Hydroplus, a concentrated surfactant specially formulated by Dust-A-Side to improve the wetting ability of water.

HydroPlus lowers the surface tension of water particles, which in turn enables the water particles to attract dust particles to them, through a process of agglomeration.

For effective dust suppression with coal and other fine ores, the selection of spray nozzles is another important issue.

For effective dust suppression, it is important that the water droplets are equivalent in size to the dust particles leading to smaller water droplets (between 5 and 10 microns); if the droplets are too large, the fast-moving airborne dust will simply flow around them.

The correct nozzles, when combined with HydroPlus will ensure that much higher levels of dust suppression can be achieved, with greatly reduced use of water on site.

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# China Coal & Mining Expo 2021

## China's 19th International Technology Exchange & Equipment Exhibition on Coal & Mining

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China National Coal Association

**Co-host:**
China National Coal Group Corp.

**Organizers:**
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