

Low-profile Mechanized Mining

Leading local innovation at the heart of gold and PGM miner's mechanization drive



Sibanye Gold is using the equipment to mine panels at heights of 1 m, as opposed to the current 1.5 m, extracting significantly more gold-bearing ore while reducing waste-rock extraction, translating into increased yields and reduced waste-disposal costs. The MT1000 features a rock-breaker for non-explosive mining and a patented multidrill attachment, which allows four holes to be drilled quickly and accurately at the correct angles.

CMTI Group's state-of-the-art patented technology is a critical component of Sibanye Resources' drive to mechanize its South African gold and platinum-group metal (PGM) operations — a transition that will lead to safer mining, while extending the life of operations, bolstering productivity levels and unlocking significant value for shareholders.

The South African original equipment manufacturer's (OEM) cutting-edge MT 100 and MT 1000 ultra-low platforms (ULPs) are part of the mining house's Stope-Mechanization Program. Registered as a "quick-win" project at the Phakisa Innovation Hub, they are playing their part in helping the mining house extract a percentage of the 2.2-million ounces (oz) contained within the strike and dip pillars without inducing excessive seismicity, or dramatically impacting regional stability.

Part of Sibanye Resources' Advanced Transport Program, CMTI Group's hybrid locomotives have significantly improved transport efficiencies and are a proactive response to potential new legislative requirements that limit diesel burn in underground mining environments.

These technologies, as well as the CMTI-integrated brake-testing machine,

are being manufactured at the company's factory in Tshwane that is now being ramped-up to cater to the large demand for local innovation in mining mechanization.

Dr. Danie Burger, managing director of CMTI Group, said they are the outcome of a 12-yearlong development program. During this phase, the OEM worked in a joint venture with some of the world's largest platinum-group metal (PGM) and gold mining houses to develop technologies that are suited to the onerous demands of the South African deep-level gold and PGM-mining sectors. Prior to their commercial launch, the equipment was also subjected to three years of testing in South African underground environments.

"Our technology has its roots in the Goldfields' Innovation Program, for which we assumed management in the latter half. The program has also enjoyed support from government bodies, including the Technology Innovation Agency and the South African Department of Trade & Industry. There is a very high-demand for 'home-grown' innovation to help mechanize South African hard-rock, narrow-reef mines, considering the existing limitations of imported 'off-

the-shelf' technologies from the United States and Europe that have hampered this transition," Burger said.

The Need for Mechanization

Neil Froneman, Sibanye Gold CEO, is one of many captains of industry who has stressed the need to fast-track mechanization in the gold and PGM mining sectors.

Froneman, who also serves as the vice president of the Chamber of Mines, warns that output in the South African gold mining industry is expected to slump to only 50 metric tons (mt) from the current 150 mt and risks almost dying out completely by 2033 if it continues to rely on mining methods that are more than 100 years old.

More than 200,000 jobs are at stake in an industry that now only employs 480,000 people compared to some 600,000 people in the 1970s when the country's gold mining was at its peak and produced 1,000 mt annually.

Froneman is confident that mechanization will allow existing gold-mining output levels to persist to until at least 2025, or even 2045.

Semi-mechanized equipment will extend the life of a low-grade mine by up to 15 years, as opposed to only four years using conventional methods, while full-scale mechanization will prolong the lives of these operations by up to 25 years.

CMTI's ULPs were deployed to Burnstone gold mine in January 2017 and later to the mining house's PGM operations in Rustenburg.

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"In addition to mining at lower operating heights and at greater depths, our equipment is allowing mines to safely work previously inaccessible areas, such as remnant pillars and barred panels," Burger said.

"Old areas that were never cleaned properly and that still contain significant reserves can now be accessed safely. This

will unlock immense value considering that one shaft that was mined 20 years ago still has 7,000 hectares of fines with yields of between 12 g/mt. However, these panels cannot be reached safely using manual methods. Importantly, our technology can also be used to clean the back ends, where as much as 30% of daily production ends up in the PGM industry due to poor blasting practices. A local PGM mine is currently only cleaning a maximum of 80 m² per day using a crew comprising 30 people, as opposed to the required 200 m² per day at yields of typically 4.5 g/mt, according to mining production figures.”

CMTI Group's machines are currently being operated from the gully as part of the first phase of the development program. The second phase will entail operating the ULPs from the surface and eventually off-site. This supports the drive by the South African mining industry to remove workers from potentially harmful working environments, while substituting

low-skilled employment prospects with skilled jobs that are safer and secure.

The intention is to also replace traditional underground mining jobs with higher paid positions in factories as mines gradually deploy more local innovation — a strategy that is endorsed by Dr. Paul Jordan, a resource-development strategist and staunch proponent of the urgent mechanization of South African mining. This narrative was also again given significant weight at the ruling party's national conference in December, where Minister of Trade & Industry Rob Davis emphasized the need for all economic sectors to embrace advanced technologies to boost South Africa's competitiveness on the global stage.

Drilling 2 Panels in a Shift

CMTI Group's MT100 has a maximum height of 420 mm and a battery life of seven hours, and can be equipped with any two attachments, such as a sweeper, scraper and dozer with an 850-kg dozing capacity.

Powered by a trailing cable, the MT1000 features a rock-breaker for non-explosive mining and a patented multidrill attachment, which allows four holes to be drilled quickly and accurately at the correct angles.

Both machines feature a multitrack concept. Four tracks are individually driven and are able to swing around a center point for the platforms to negate vertical obstacles as high as 400 mm.

The tracks on the MT1000 are also steerable and, at Burnstone, the machine aligns itself with the rock face, while driving parallel to it, and then drills a 46-mm diameter hole. It indexes the breaker to the hole's position and inserts it, before imparting lateral force to the rock.

Using the technology, two panels are being drilled in a single shift, and Burger said CMTI Group will improve on this stellar performance early this year. This is in stark contrast to the extended periods it currently takes up to five rock-drill operators to drill a 30-m panel using traditional mining methods.

Slamming the Brakes on Substandard Testing

Locally developed technologies are providing underground and surface mines with a safer, as well as more reliable and efficient means of testing the braking systems of their mechanized production and transportation equipment. CMTI Managing Director Dr. Danie Burger said the company is using its experience developing mining systems to design integrated brake-testing technologies.

“They are based on the suggestions of a workgroup, comprising all mining houses and OEMs in the South African mining industry,” Burger said. “Steered by Anglo Platinum's De Wet Strydom, the workgroup was tasked with assisting in the design of a solution that would address the many challenges facing both underground and surface-mining operations.”

For example, dynamic testing, used in underground mining environments, can cause unnecessary damage to trackless mobile mining (TMM) machines and only inspects the efficacy of the service-brake, as opposed to the entire system, including the park and emergency brakes, as well as accumulators.

The technology is also not suited to testing tractor-trailer combinations due to the risk of “jack-knifing” the vehicles.

He also noted the important findings of extensive studies undertaken by the Mine Health and Safety Council have shown that the technology can be up to 200% inaccurate when vehicles are tested at speeds of less than 12 km/h as is also mentioned in SANS 1589.

Burger added, “Mine personnel also do not realize that a 35% measurement reading on the service brakes of a vehicle on a decline with a gradient of 20% means that the vehicle has failed the test and is, therefore, non-compliant. It remains a serious concern that machines with brake efficiency levels of only 15% are being returned to service, despite the severe risk that they pose in already complex working environments.”

While causes of accidents, injuries and fatalities may vary, transport-related incidences remain one of the three main rea-



The semistatic pull-brake tester avoids damaging the brake system and is a safe means of testing the surface, neutral and park/emergency brakes.

sons for mine injuries in underground mining environments, according to the South African Chamber of Mines.

This includes the use of TMM machines, which are a critical component of the mechanization of South Africa's underground operations to ensure a safer working environment, in addition to their long-term sustainability by replacing outdated mining methods.

CMTI Group's pull-brake tester for underground vehicles is semistatic to avoid damaging the brake system and is a safe means of testing the service, neutral and park/emergency brakes. In addition, all tests are undertaken with a 10% overload to facilitate the trending of brake degradation, while wear data is recorded and measured against the OEM's standards.

All tests are photographed and a comprehensive report, including a time and date stamp, is generated for every test and can be used for legal purposes.

All TMMs are pre-loaded into the system, streamlining the testing process by allowing the operator to merely select the relevant model and enter the plant number, while an email notification is automatically sent directly to the relevant mine representatives in the event of a failure.

CMTI Group's technology meets the stringent requirements of the Mine Health & Safety Act. The new regulations for the static testing of TMMs were implemented in February 2015 and are undertaken according to the SANS/ISO1589 standard.

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Work in the field is being coordinated by Sibanye Resources' safe technology and innovation project engineer, Alex Fenn, who has noted the important part that CMTI Group's ULPs will play in helping the company do away with the use of explosives, paving the way forward for continuous mining practices.

Entire production cycles are still founded on these instantaneous blasting procedures that result in extended periods of inactivity while shafts are evacuated due to the noxious gases that are generated and the seismicity that is induced.

CMTI Group's ULP 1000 rock-breaker imparts a suitable amount of energy into the rock, and is compact enough to fit into congested spaces to avoid increasing material dilution. It is also able to negotiate the prolific support structures at South Africa's deep-level gold mines, while the MT 100 allows mines to complete stope cleaning within 24 hours, which is usually restricted to a short three-hour window at Sibanye Resources' mines.

These machines also facilitate the adjustment of shift cycles. Four eight-hour overlapping shifts could be implemented

at mines to help address worker fatigue, while improving rock fragmentation, translating into significantly less gold being lost and better mine call factors.

Because there is no significant energy imparted to the hanging wall using this technology, mines could even reconsider support installations, while improving standard shaft infrastructure availability from as low as 27% to almost 100%.

In addition, fleet size and infrastructure that is needed to transport material can be significantly reduced.

Efficiencies achieved in the transport component of underground mining operations are complemented by CMTI Group's 10-mt underground hybrid diesel-electric locomotive.

"The locomotive uses a low-emission diesel generator, coupled to an advanced battery system and very efficient asynchronous permanent magnet motors that are capable of regeneration. Its overall efficiency is between 85% and 90%, which is a vast improvement on existing standard battery, electric, or diesel equipment used in gold and PGM mines in the country. The mining house's convention-

al mines use a combination of battery, electric and diesel-powered locomotives, and are currently only achieving average efficiencies of between 45% and 55%. Meanwhile, trackless mines have large fleets of equipment that consume significant amounts of diesel with similar efficiencies," Burger said.

Other stand-out features of the front-driven locomotive include self-steering bogeys, a fully enclosed cab and triple-laminated windscreen, as well as infrared-assisted cameras with video displays, strategically positioned throughout. It can also be remotely operated and features a pedestrian-monitoring system.

Importantly, the technology is the basis of further research and development under way in the drivetrains of the future, and the outcome of the research will also guide CMTI Group in the development of future trackless equipment that burns significantly less quantities of fuel in the transportation of ore, men and material.

Burger concludes that CMTI Group is proud to be part of the many successes achieved at Sibanye Resources as its transitions into new era of gold and PGM mining.

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(Slamming the Brakes on Sub-standard Testing - from p. 61)

They stipulate that the employer must take reasonable practical measures to ensure that people are not injured as a result of brake failure. These include ensuring that TMMs are operated with adequate and effective braking systems; and that all braking systems are adequately and routinely tested for intended functionality and are regularly maintained. Where a combined braking system is used, it needs to comply with the requirements for the separate systems and be fail-safe.

Meanwhile, the mandatory code of practice stipulates that conformity of production (COP) must describe the procedures for testing of braking systems to ensure functionality, in terms of brake-design specifications. This is relevant for static testing, dynamic-type or other testing methods for the recording and safe keeping of test results for a period specified by the COP.

The code also mandates the provision of brake descriptions, as well as the test procedures. These need to be supplied in table format. Accumulator systems need to be tested for a number of applications and hold time.

SANS/ISO3450 is the standard by which testing of surface operated equipment is undertaken. However, Burger highlights that there are also glaring pitfalls in the standard ramp-testing system used to test the braking systems of large-surface mining machines. Many of the ramps for testing purposes have been built at incorrect angles, despite the SANS 1589 also specifying that they must be at least 4° steeper than the steepest gradient at a mine. The correct ramp procedures are also seldom followed in the test-

ing of the service and neutral brake.

Standards are also not adhered to in the testing of the park/emergency brake. Here, the test needs to be undertaken while the engine is off and the vehicle without an operator to ensure that the inspection is not being aided by the service brake.




Meanwhile, the very accurate values in the gradient hold test stipulated by ISO3450 are seldom in line with the OEM's specifications. For example, the service and park/emergency brake-testing specifications for a 100-mt rigid-dump truck are to be undertaken at 20% and 15% slope gradients, respectively. However, some OEMs specify that testing of park brakes need to be undertaken on gradients of up to 15%. This means that the vehicle cannot be tested according to the standard as it will fail and even result in costly warranty-related issues with the manufacturer.

CMTI has developed the SBT500 slab-brake tester for vehicles exceeding 50 mt. This allows the vehicle to be tested on a moving platform that is hydraulically actuated and equipped with the necessary load cells to record the testing data.



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