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Sibanye Stillwater

STOPE MECHANISATION PROGRAMME

Fact sheet 2018

The ability to mechanise conventional tabular orebodies has been a key strategic driver of the Safe Technology and Innovation department (STID) since its inception in June 2014. While the programme is extensive with respect to dependencies, manoeuvrability was identified as the priority in terms of development.

The department embarked on the development of two primary moving platforms, the MT1000 and MT100, responsible for primary mining and secondary support activities respectively, which are capable of completing a number of different activities catered for through the use of different attachments.

2017 PROGRESS

2017 was a landmark year for the stope mechanisation programme as both the initial MT1000 multi-drill and MT100 sweeper and dozer prototypes were completed and deployed for testing.

MT1000 multi-drill during initial commissioning and sub-system testing

MT1000

The MT1000 is a multi-track, electrically-driven platform capable of operating in a minimum stoping width of 1,000mm. The four individual track assemblies are capable of three separate degrees of motion:

- track rotation (drive)
- track assembly rotation (lifting, lowering)
- lateral articulation (steering), which is facilitated by an on-board hydraulic power circuit

While a number of attachments have been designed for the MT1000, the initial unit design is equipped with a multi-drill attachment consisting of four hybrid, hydropower drills powered by a stationary hydropower pack. The combination of energy transfer mediums (electricity, electrohydraulic and hydropower) makes the MTT1000 unique in its complexity. However, its modular design is intended to allow for complex repairs to be done on site when required, ameliorating the effects of component failures and alleviating the dependence of the deploying operation on highly skilled labour.

One of the major contributing factors to lost blasts throughout the mining industry is the inability to adequately complete panel drilling within a shift. Furthermore, completed panels may not advance or fragment efficiently if the drilling is inaccurate. The MT1000 multi-drill is designed to eliminate both paradigms by providing fast, accurate drilling.

Prior to the start of the project, theoretical calculations show that the concept should be capable of manoeuvring, locating and drilling four holes in less than six minutes, meaning a panel could be completely and accurately drilled in 2.5 hours.

DEPLOYMENT AND TESTING PROTOCOL

The MT1000 was deployed in a trial site at Burnstone that was representative of conventional mining operations. The trial programme was designed to ensure rigorous testing of all aspects of the MT1000 against the original specification and included three major trial and assessment regimes.

- **Manoeuvrability**
  Assessing the geometric applicability and manoeuvrability of the MT1000, equipped with the multi-drill attachment, in a typical conventional mining layout. Assessing the unit's ability with respect to energy transfer mediums and associated trailing cable (medium voltage cable, and high-pressure water, low-pressure water piping).
- **Cycle assessment and refinement**
  Assessing and configuring the sequencing of positioning, stabilising and drilling processes. Refining the process and sub-processes to ensure that the drill-to-drill cycle is optimised.
- **Drilling capability assessment and refinement**
  Assessing the drilling performance of the multi-drill attachment against the original theoretical six minute per cycle target.

PERFORMANCE

The MT1000 exceeded expectations in many aspects of its trial phase.

All geometric and manoeuvrability targets were achieved and the MT1000 performed exceptionally well with respect to track speed, exceeding design criteria by 15%. Unfortunately, during the initial trial, a power failure resulted in a track rotation brake failure, highlighting a critical flaw in the brake application protocol. The unit was repaired on site and the team was able to reconfigure the emergency stop and power failure protocols to allow for brake engagement prior to disconnection of the drive motor, solving the problem.

MT1000 multi-drill commencing first drilling trial, accompanied by a delegation from the Technology Innovation Agency

A considerable amount of time was spent refining the location, stabilising and drilling cycles to ensuring stability before drilling in particular while reducing the cycle to under 90 seconds.

The MT1000 was configured when delivered with a cycle time of 150 seconds. Through continuous refinement, the team has managed to achieve a cycle time of under 80 seconds, exceeding the set target for testing.

Lastly, the multi-drill attachment was tested and continuously refined to achieve the optimal drilling rate. As the application is relatively new, a conservative target of 6 minutes per round was set. The time is inclusive of collaring, round completion and retraction of the drill steel from the hole. Initial testing proved significantly more difficult than anticipated as the drive cylinder pressure for the drill carriages was set too high resulting in bent drill steel and jamming in the hole. The configuration settings were update until the optimal pressure was realised and the assembly was able to complete a full round without fault. Further amendments were made to the drills in order to optimise the drilling further. The net result of the refinement was that the assembly was able to complete a full round in under 4 minutes, substantially quicker than anticipated.

To conclude, the MT1000 has achieved or surpassed many of the criteria set prior to the trials. In essence, the machine is able to manoeuvre as designed, the positioning stabilising and drilling cycle has been refined and the multi-drill assembly is able to complete a full round of four holes in under 4 minutes. When considering the entire cycle, the MT1000 multi-drill is capable of effectively and accurately drilling a single hole in 80 seconds. When compared to the time taken to complete a single manually drilled hole with a compressed air drill which, is approximately 7 minutes (collar to collar), the achievement represents a 525% improvement in drilling rates. It thus seems likely that the MT1000 multi-drill will be capable of replacing the current conventional panel drilling arrangement.

2018 PLAN

The MT1000 has completed initial trials, warranting the progression to phase two, the production trials. The machine will be put into an operating stope and will function as if in a commercial application. The intention of the trial will be to determine the operating capabilities as well as refine secondary processes such as maintenance intervals, system, subsystem and component wear rates and performance, operational ergonomics, emergency preparedness (recovery protocols) as well as the MT1000's remote operating and data acquisition abilities.

Production trials are expected to take 12 months from implementation in January 2018. To expedite deployment should the production trials be successful, the STID is to initiate a production section identification process. The process will identify areas in which the MT1000 may be deployed without significant change to the current layout such as Beatrix 3 shaft or at Driefontein's Main Reef, which is flatly dipping in nature. In addition, operational plans will be assessed to identify areas that are yet to be developed in which the machinery can be applied. The department plans to identify at least 15 operating sections for deployment by the end of 2018.

MT100

Similar to the MT1000, the MT100 is a multi-track, battery-driven unit with similar track assemblies. However, lateral articulation has been excluded as the unit length enables it to steer itself effectively. A limited rotational joint has been included in the body to allow the machine to traverse rough environments. While intended to satisfy a number of smaller applications, the current unit design incorporates a detachable dozer blade and sweeping tool.

The MT100 was originally designed as a replacement to scraper winches, however, vamping of old areas was identified as a significant opportunity, specifically at Bathopele where there is an abundance of partially cleaned back areas. In theory, the MT100 is capable of cleaning approximately 400m^2 a shift, matching current efficiencies of labour crews completing the same function.

DEPLOYMENT AND TESTING PROTOCOL

Given the MT100's potential vamping capability, this feature was trialled at Sibanye-Stillwater's Bathopele shaft. While the trial is a departure from the original specification, the testing protocol was designed to test the equipment in a vamping environment but against the original specification for which the unit was designed. The MT100 trail protocol also consisted of three major themes:

- **Manoeuvrability**
  As per the MT1000
- **Attachment functionalities**
  Testing the manipulation and articulation of the sweeper and dozer attachments as well as blade and brush wear rates
- **Tractive effort and ability**
  Determining the MT100's tractive capacity and associated dozing capacity

A preliminary target of cleaning 200m^2 a shift was set for the MT100.

PERFORMANCE

It is important to note that the MT100 was originally designed as a sweeping tool, before the design was amended to include the dozing functionality. Consequently, the initial prototype was specified and manufactured with 515kg of tractive effort, and is thus able to move half a ton of material before exceeding the available torque.

Given this fact, the MT100 trial was considered a success with respect to manoeuvrability and attachment functionality. However, the unit was decidedly underpowered for the dozing application, resulting in the MT100 not achieving the set target of 200m^2 a shift. The problem has been resolved in design and future units will be supplied with 950kg of tractive effort by increasing the capacity and voltage of the battery pack.

As the machine weighs approximately 1,000kg, this is on the frictional limit of the machine, in essence, the maximum allowable power before the tracks begin to slip. In the interim, the prototype has also been modified to supply the same power however, due to the battery pack size, it has reduced the operating time per charge from 8 hours (a full shift) to approximately 3.5 hours, a problem that will not be present in future units. The modification was completed at the end of November 2017 and the unit will be returned to Bathopele in 2018 for further testing.

2018 PLAN

Considering the power revision of the MT100, the unit has not yet been operationally qualified as envisioned however, in order to expedite the approval of the unit for operation, the department will re-deploy the modified unit in a production setting where it will compete with conventional cleaning crews with a set target of 400m^2 cleaned per shift.

Should the unit prove to match or exceed the efficiencies of a conventional vamping crew by end June 2018, the unit will be considered as a replacement technology and implemented.

MT100 sweeper performing sweeping operations at Rustenburg operations' Bathopele shaft

TECHNOLOGY INNOVATION AGENCY FUNDING UPDATE

Mining manufacturer, CMTI, with support from Sibanye-Stillwater, applied for support funding from the South African Technology Innovation Agency (TIA) in 2016. In total, TIA committed to R17 million for the redesign and manufacture of two more MT1000 multi-drills and MT100 sweeper and dozers, to be deployed in a representative platinum mining environment.

The funding was provided on condition that CMTI and Sibanye-Stillwater satisfy a number of milestones, the latest of which was proof of concept in a representative environment. Sibanye-Stillwater hosted a delegation from TIA in November 2017 to view the MT1000 in operation. The delegation was pleased with progress to date and released the next round of funding for the design review and manufacture of machinery. The STID has identified a suitable trial site at Bathopele, representative of a conventional platinum mining layout and will be implementing the next two sets of machinery by the end of September2018.

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