



MANDELA MINING PRECINCT
MINDS FOR MINES

Rapid Inclined Access Development

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FINAL REPORT			
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Executive summary

The aim of the project was to facilitate the development of rapid inclined access development equipment that is applicable to conventional narrow reef mining in South Africa. Rapid inclined development (inclines) is necessary to provide access to the ore body. Accessing the ore body timeously enables the availability of equipped “adequate faces” and “buffer faces” to mine all the time, allowing mining companies to mitigate against potential production losses due to unavailability of sufficient ground to mine. Thus, this project originated from the need for equipment that would function efficiently in local narrow reef hard rock mining environments to develop inclined access development infrastructure. A series of milestone deliverables were completed during the course of the project execution.

In Milestone 1 (Project initiation), a detailed project plan outlining the methodology, project milestones, activities for each milestone, project schedule and project budget was developed. The main stages of the methodology of the project included the development of Terms of Reference (ToR) to appoint three manufacturers that would participate in a challenge to develop rapid inclined development equipment. The subsequent stages were the call for concept designs, the evaluation of these designs and finally, the appointment of the three participant manufacturers. This phase of the project was also used to attain ethical clearance approval to conduct the project. The ethics clearance process delayed the commencement of engagements with mining industry stakeholders.

The aim of Milestone 2 (Development of ToR) was to develop draft ToR for use in the appointment of the three participant manufacturers. This involved conducting a desktop study to understand rapid inclined access development and the associated equipment and engaging mining industry subject matter experts through a survey and a questionnaire. The technical evaluation criteria, that was incorporated into the ToR, was developed using the information gathered from the desktop study, survey and workshop with the mining industry stakeholders.

Milestone 3 (Development of progress reporting templates for original equipment manufacturers (OEMS)) aimed to develop a progress reporting template that will be utilised for monitoring and evaluation of project (equipment design and development) progress, ensuring that the project is completed within the planned budget, brief (scope) and time. The developed monthly progress reporting template provides a number of project related details such as project name, project aim, project financials, project progress (planned versus the actual progress) and project risks.

The aim of Milestone 4 (Call for concept designs) was to request for proposals from manufacturers and other stakeholders with capability to design and manufacture rapid inclined access development equipment. The call for proposals (CFPs) was advertised in the Mining Weekly, on social media (specifically LinkedIn), and on the CSIR and Mandela Mining Precinct websites, on the 20th of May 2021 and the closing

date was the 18th of June 2021 at 16H00. Following the CFPs, Mining Equipment Manufacturers of South Africa (MEMSA) arranged a 30-minute online questions and answer session on the 1st of June 2021. During the session, the Mechanised Mining Systems (MMS) Programme Manager provided a brief introduction to the CFPs, its rationale and process as planned. MEMSA members were given an opportunity to ask any clarity seeking questions to enable them to respond to the CFPs. When the CFPs closed on the 18th of June 2021 at 16H00, only one proposal was received from a local equipment manufacturer. The low response rate could be due to a number of reasons including the following:

- Lack of funding by the manufacturers to co-fund the design and manufacture of rapid inclined access development equipment.
- Lack of capability and time to design and manufacture rapid inclined access development equipment as per the requirements of the CFPs.
- Lack of risk appetite to pursue the innovation challenge.

Participation of more equipment manufacturers could be improved by availing sufficient funding (budget) to cover costs required to design and manufacture the equipment.

Milestone 5 (Evaluation of concept designs) aimed to evaluate the proposals that were received from manufacturers and other stakeholders with capability to design and manufacture rapid inclined access development equipment. A two-phase evaluation process, based on administrative and technical equipment design criteria, was followed. The proposal met all the administrative criteria and thus qualified for technical evaluation. However, the proposal failed to meet all technical evaluation criteria, thus was eliminated for further evaluation. Consequently, (Milestone 6 - Appointment of three manufacturers) could not be executed as the proposal that was received did not meet all the required technical evaluation criteria.

It is recommended that similar future projects should consider availing sufficient funding to cover the costs required to design and manufacture the relevant equipment or technologies and aligning the duration of the challenge or competition to manufacturing processes, thus affording the manufacturers a realistic chance to participate. Additionally, collaboration between the various local manufacturers and continuous innovation should be promoted. Importantly, the scope of the challenge or competition should be clearly and concisely defined to facilitate timeous engagements with various stakeholders and avoiding delays that arise from ambiguities.

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1. Milestone 1 - Project initiation

1.1 Introduction

The South African narrow reef underground gold and platinum group metals (PGM) mines have been struggling to remain profitable against the backdrop of a number of challenges such as increasing mining depth, low commodity prices, increasing operational costs and declining productivity. The goal of the Mechanised Mining System (MMS) programme is to improve extraction efficiencies, improve occupational health and safety (OHS) performance and reduce operational costs of current conventional mining operations. This will be achieved through the development and implementation of sustainable mechanised mining solutions to execute the different production and development activities.

During the 2017/2018 financial year (Year 1), the LoCM programme commissioned some work to understand the bottlenecks in conventional narrow reef underground gold and PGM mines. Unavailability of “adequate faces” and lack of “buffer faces” to mine was identified as one of the major constraints that is preventing some mines from attaining daily conformant blasts. A conformant blast is one which meets the quality (advance, tonnage, grade, etc.) and safety objectives (worker safety e.g., strata control parameters) of the mine. The conformant blast will also enable subsequent mining cycle activities to be carried out safely without any constraints. Woodhall (2002) defined flexibility as “the provision of sufficient equipped mining face to make alternative, profitable workplaces available to sustain a planned production level”. Flexibility and availability of equipped faces to mine (ore reserve availability) are critical enablers of attainment of planned conformant blasts. Musingwini et al. (2006) suggested that 18 months should be the minimum ore availability period. In the absence of alternative equipped faces to mine, some bottlenecks within the mining cycle could easily result in lost blasts. Examples of bottlenecks within the mine production system include failure to complete cleaning, drilling or supporting of a panel, strata control challenges, fluctuating grades and geological features (potholes, dykes, faults, etc.).

The rapid construction of inclined access development infrastructure enables mining to commence quicker and at a lower cost thus, leading to benefits such as quicker rate of return, improved productivity and improved profitability. The rapid development of inclined access infrastructure will significantly increase the chances of attaining planned conformant blasts, through improved availability of additional “adequate faces” and “buffer faces” to mine all the time. There is, therefore, an opportunity to develop equipment that will enable rapid inclined access development in South African mining conditions. However, the use of incline shafts is also associated with a number of disadvantages such as labour intensiveness, low operational efficiency, health and safety challenges and difficulties in cleaning broken rock during shaft sinking.

The aim of the project was to facilitate the development of rapid inclined access development equipment that can be used to accelerate development of inclined shafts in narrow reef hard rock mines. For the

purpose of the current project, the term “inclined development” refers to on-reef raise development (inclines). The project methodology consisted of the following sequence of activities:

- Project Initiation.
- Development of a terms of reference (ToR) to assist in appointing a service provider.
- Development of progress reporting templates for original equipment manufacturers (OEMs).
- Call for concept designs.
- Evaluation of the concept designs.
- Appointment of three manufacturers based on the criteria specified in the ToR.
- Submission of a draft final report.

The aim of Milestone 1 of the project was to deliver on the following key activities:

- A start-up presentation detailing project intent.
- Detailed project plan outlining the project milestones, activities for each milestone, project schedule and project budget (see Section 3).

Table 1 provides details of the actual events and occurrences that were conducted to initiate the project in fulfilment of milestone 1 deliverables.

Table 1: Key events and activities for milestone 1

Date	Event	Outcome(s)
22nd of October 2020	Introduction presentation detailing project intent, methodology, stakeholder mapping, project plan, project risks and roles and responsibilities of the project team	Project team’s inputs into key projects aspects including research methodology, stakeholder mapping, project plan, project risks and roles and responsibilities of the project team
22nd to 27th of October 2020	Preparation of milestone 1 report	Draft milestone 1 report
28th to 29th of October 2020	Review of milestone 1 report	Draft final milestone 1 report
30th of October 2020	Sign-off of draft final milestone 1 report and submission to Mandela Mining Precinct	Signed-off draft final milestone 1 report submitted to Mandela Mining Precinct

1.2 Project schedule and expenditure

Table 2 shows a summary of project milestones, activities and expenditure. Of the total available project funding (R499 973.33), only R436 912.20 was utilised, and the total unutilised funding was R63 061.13. The unutilised budget was for Milestone 6 (Appointment of three manufacturers), which could not be completed as the proposal that was received did not meet all the required technical evaluation criteria.

Table 2: Summary of project milestones, activities and expenditure

No.	Milestone	Activities	Milestone Cost/R (excl. VAT)	Status
1.	Project initiation	- Contracting - A start-up presentation detailing project intent and project plan	38 044.44	Paid
2.	Development of terms of reference (ToR)	Development of draft ToR Workshop to solicit inputs into draft ToR from industry subject matter experts Incorporate inputs from the industry into the draft final ToR Approval of the draft ToR	150 933.33	Paid
3.	Development of progress reporting templates	Development of progress reporting templates Approval of progress reporting templates by MMP	32 000.00	Paid
4.	Call for concept designs	Call for concept designs from manufacturers and other stakeholders with equipment manufacturing capabilities, which includes scheduled prototype development and cost estimations	32 361.11	To be paid upon approval of the draft final report
5.	Evaluation of concept designs	Establish selection team and signing of non-disclosure agreements (NDA) Evaluate concept designs and select three concept designs which best meet the defined selection criteria Approval of recommended three manufacturers with the capability to develop rapid inclined access development equipment for narrow reef hard rock mines	150 933.33	To be paid upon approval of the draft final report
6.	Appointment of three manufacturers	- Contracting with appointed three manufacturers - Announcement of appointed three manufacturers by MMP	63 061.13	Unutilised
7.	Draft final report (submission)	Compilation of draft final report	32 639.99	To be paid upon approval of the draft final report
Total available funding (R)			499 973.33	
Less total unutilised project funding (R)			63 061.13	
Total utilised project funding (R)			436 912.20	

Table 3 depicts the baseline project schedule against the revised project schedule. The delays on the project were mainly due to the following:

- Milestone 2 (Development of ToR) was delayed due to delays from obtaining the ethics clearance certificate from the CSIR research ethics committee (REC). Further delays were caused by challenges in obtaining the required information from mining industry stakeholders, including securing the availability of the stakeholders to attend the workshop that was planned to solicit for inputs into the draft technical evaluation criteria.
- Milestone 4 (Call for concept designs) was delayed because of delays in obtaining guidance from the CSIR procurement and legal personnel regarding the correct process to follow for the drafting of CFPs.

Table 3: Schedule of milestones

Legend	
	Baseline project schedule
	Revised project schedule

No.	Milestone	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	July 21
1.	Project initiation										
2.	Development of terms of reference (ToR)										
3.	Development of progress reporting templates										
4.	Call for concept designs										
5.	Evaluation of concept designs										
6.	Appointment of three manufacturers										
7.	Draft final report (submission)										

1.3 Research methodology

The objective of the project was to facilitate the development of equipment that could be used to accelerate development of inclined access infrastructure for narrow reef hard rock mines. In the process of attaining the project objective, the following key milestones (summarised in Figure 1) were established:

- Development of ToR to appoint three locally based manufacturers with the capability to develop rapid inclined access development equipment for narrow reef hard rock mines.
- Call for concept designs from manufacturers with the capability to develop rapid inclined access development equipment for narrow reef hard rock mines.
- Evaluation of concept designs and selection of three concept designs which best meet the defined selection criteria.
- Appointment of three manufacturers with the capability to develop rapid inclined access development equipment for narrow reef hard rock mines.

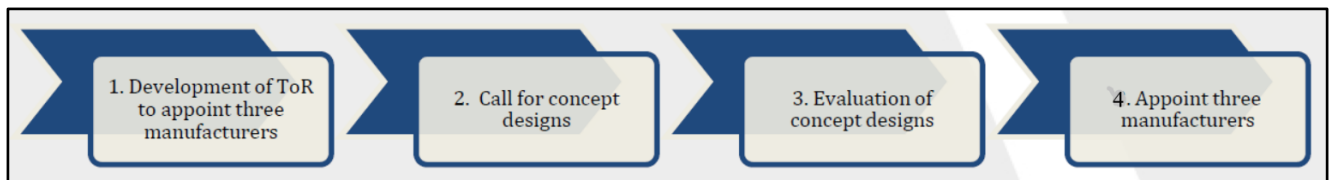


Figure 1: Methodology to be followed for the development of inclined rapid-access development equipment

It is noteworthy that the process is aligned to the “Terms and Conditions for projects related to product/prototype development challenges” that was developed and approved by the Mandela Mining Precinct (Annexure 1: Terms and Conditions for projects related to product/prototype development challenges)

- Annexure 2: Ethics approval to conduct the study
- Annexure 3: Questionnaire on requirements for the design of rapid inclined and inclined access development equipment
- Annexure 4: Terms of reference / CFPs to identify organisations to participate in the design and development of rapid inclined access development equipment for hard rock underground mines
- Annexure 5: Rapid inclined access development equipment development monitoring and evaluation report
- Annexure 6: CFPs adverts in Mining Weekly, LinkedIn, CSIR website and Mandela Mining Precinct website respectively
- Annexure 7: Declaration of conflict of interest and confidentiality agreement form

Annexure 1: Terms and Conditions for projects related to product/prototype development challenges).

1.3.1 Development of ToR

The following activities were followed to develop ToR to appoint three manufacturers with the capability to develop rapid inclined access development equipment for narrow reef hard rock mines:

- Development of draft ToR (including project scope, expected project outcomes and evaluation criteria).
- Workshop with subject matter experts from the industry to provide inputs into the draft ToR. OEMs and Mining Equipment Manufacturers of South Africa (MEMSA) were not involved in the process due to potential conflict of interests.
- Incorporate inputs from the industry into the draft final ToR.
- Approval of the draft ToR.

1.3.2 Appointment of three manufacturers

The following process was followed in the endeavour to appoint three manufacturers with the capability to develop rapid inclined access development equipment for narrow reef hard rock mines:

- CFPs requesting manufacturers and other stakeholders with the capability to develop rapid inclined access development equipment for narrow reef hard rock mines were advertised in the Mining Weekly, on social media (specifically LinkedIn), and on the CSIR and Mandela Mining Precinct websites, on the 20th of May 2021 and the closing date was the 18th of June 2021 at 16H00. MEMSA was also assisted with sending out a notification to its member companies about the CFPs.
- Evaluation of the proposals by a five-member evaluation panel comprising three members from the research team, the MMS Programme Manager and one MMS TSC member. Unfortunately, the proposal that was received did not meet all the required technical evaluation criteria, thus it was not possible to proceed with the following planned activities:
 - Approval of the recommended nominations of the manufacturers.
 - Contracting the appointed three manufacturers.
 - Announcement of nominated three manufacturers by Mandela Mining Precinct.

1.3.3 Development of the prototype during the 2021/2022 financial year

It was anticipated that after contracting was finalised, the manufacturers would start to develop the prototypes. The development of the prototypes had been envisaged to start during the 2021/2022 financial year and was not part of the scope of the current project. Each manufacturer would have been

expected to provide a report on the progress made on the development of the prototypes as per the agreed timeframes.

1.4 Ethics

The Council for Scientific and Industrial Research (CSIR) subscribes to the highest research ethical standards and all research conducted by CSIR must follow the CSIR research ethics policy. Thus, ethical clearance approval to conduct the study was obtained from the REC prior to stakeholder engagements (Annexure 2: Ethics approval to conduct the study).

2. Milestone 2 - Development of terms of reference (ToR)

2.1 Introduction

The purpose of Milestone 2 of the project was to create a draft ToR to assist in appointing three equipment manufacturers. This was achieved through the following activities:

- Conducting a desktop study on rapid inclined access development equipment.
- Conducting a survey to solicit inputs into draft ToR from industry subject matter experts.
- Developing draft ToR containing preliminary equipment selection criteria.
- Hosting a workshop with industry subject matter experts to gain inputs into the draft ToR.
- Incorporating workshop inputs into the draft final ToR.

2.2 Desktop study

2.2.1 Background

Three main types of inclined development were identified from literature. These are conventional drill and blast (Ferreira, 2005), mechanised drill and blast and mechanical rock breaking developments (Ragoonanthun, 2003). Based on literature, the challenges encountered during inclined development have not changed significantly over the years (Wilson & Graham, 1972; Van Den Berg & Taylor, 1978; Ferreira, 2005). The development of inclines using drill and blast methods is slower but cheaper than mechanical development. The Alimak (iRing INC Knowledgebase, 2018), a mechanised drill and blast method is suited for South African steeply dipping and narrow tabular orebodies; however, the method is not used in the country as much as it is in Canada and in some European countries. The use of mechanical methods to develop raises is tipped as the most efficient of the three types of inclined development. These methods include up-reaming and blind-boring. The main drawbacks associated with these methods are high wear rates in highly abrasive rock, high capital costs and the ease of mucking broken rock. These aforementioned factors are part of a long list of other parameters that should be considered in the choice of equipment for rapid inclined access development. The other factors that should be considered in the design of alternatives to current methods and equipment for the rapid development of inclined access include the following (Wilson & Graham, 1972; Ragoonanthun, 2003; Ferreira, 2005; iRing INC Knowledgebase, 2018):

- Power source – ideally, the equipment should have its own independent power source to improve efficiency of development.
- Portability – the equipment should not be bulky; components of the equipment should be easily disassembled for transportation in confined areas and timeously assembled underground.
- Advance rate – the equipment should achieve advance rates greater than current conventional methods of development.

- Multi-functionality – the equipment should be able to conduct more than one mining cycle activity, for example, drilling, mucking and supporting.
- OHS – the use of the equipment should not compromise the OHS of workers; ideally, workers should work under protected ground or equipment compartments.
- Ventilation – use of the equipment should generate minimum heat, dust or other contaminants such as diesel or explosives fumes. These should be cleared quickly by the ventilation system to ensure a continuous cycle.
- Labour compliment – a minimum number of workers should be required to operate the equipment in order to reduce costs and the impact of OHS risks.
- Costs – the capital and operating costs of the equipment should be comparable to other affordable mechanical equipment already used in the mines.
- Maintenance – the equipment should consider predictive maintenance systems to ensure that the continuous development cycle is not interrupted randomly. In addition, spare equipment parts should be readily available.

2.2.2 Ventilation Requirements

An important factor to consider in rapid access development is ventilation. In determining the ventilation requirements for the high-speed development of ramps and tunnels, von Glehn & Bluhm (2000) note that account must be taken of factors such as:

- Heat generated by equipment (loaders, dump trucks, tunnel boring machines etc.).
- Effect of service water.
- Heat and moisture from rock being transported in the tunnel.
- Heat flow from surrounding rock.
- Effects of water pipes and condensation.
- Effects of diesel engines.
- Ground water and drain water.
- Interaction between air inside ducts and air in tunnels.
- Thermal effect of fans.
- Duct leakage.

According to von Glehn and Bluhm (2000), in multi-blast development headings, a decree from the South African Chief Inspector of Mines requires a force/exhaust overlap ventilation system. In order to achieve the general 30-minute re-entry interval, a minimum air quantity of $0.3\text{m}^3/\text{s}$ for every square metre of face must be delivered by a force duct to within 12 m of the face (von Glehn & Bluhm, 2000). Additionally, to prevent recirculation, the total quantity of air exhausted from the end must be at least twice the quantity delivered by the force fan. The intake of the exhaust duct must be maintained within 30 m of the face (von

Glehn & Bluhm, 2000). Examples of the general ventilation standards for developments ends in a South African metalliferous underground mine are listed in Table 4.

Table 4: Ventilation standards for development ends (de Villiers, 2012)

	Ventilation Parameter	Value
Force ventilation system	Minimum force quantity	0.3 m ³ /s per m ²
	Maximum force column distance	12.0 m
	Maximum water blast distance - (conventional type)	12.0 m
	Maximum water blast control distance	90.0 m
	Maximum water blast distance - (water spray type)	12.0 m
	Maximum allowable leakage	10% per 100 m
Exhaust/Force System Overlap	Minimum exhaust quantity	0.4 m ³ /s per m ²
	Minimum force quantity	0.3 m ³ /s per m ²
	Maximum exhaust column distance	20.0 m
	Maximum force column distance	12.0 m
	Maximum water blast distance	12.0 m
	Maximum water blast control distance	90.0 m
	Maximum water blast distance - (water spray type)	12.0 m
	Overlap distance	6.0 m – 20.0 m
	Maximum allowable leakage	10% per 100 m
Environmental Conditions	Temperature	< 28.5 °C
	Specific Cooling Power (SCP)	300 w/m ²
	Kata	13.6 m cal/ cm ²

2.2.3 Comparison of the various types of development and gap analysis

The selection of a method or type of equipment for rapid access inclined development is based on a number of factors that include OHS, scheduling, costing, flexibility, the ease of mucking, portability, drilling accuracy, source of power and advance rates. It is clear from the literature that a comprehensive analysis of various equipment types, that considers all of the aforementioned factors, is not feasible due to unavailability of data or the reluctance to investigate some of the parameters. In some instances, analysis of the different methods and equipment types is more qualitative than quantitative. Regardless, useful insights are still gained from the literature. It should be noted that due to varying mining conditions, success of the methods and equipment may vary between operations.

Drill and blast methods of development have been used extensively. These methods are flexible and enable the successful navigation of challenging underground geological environments. The costs associated with these methods are generally lower than those incurred when using mechanical means of inclined development. Lower advance rates are cited in literature as the drawback of drill and blast inclined development due to challenges such as a low air pressure supply to the rock drills and malpractices such as inaccurate marking and drilling and incorrect charging.

The development of inclined access using mechanical techniques and equipment offers higher advance rates and an opportunity for continuous cycles. Furthermore, these techniques result in greater quality excavation in comparison to drill and blast methods. One of the causes for this is minimal human interface and thus fewer mistakes or substandard practices. Various literature sources identified high capital costs as a hindrance to the adoption of mechanical means of developing inclined access.

Ferreira (2005) summarised the applicability of various machines used for inclined excavations as shown in Table 5. The comparison suggests that the longest excavations can be developed using raise-boring equipment. Raise boring equipment such as the Wirth HG 330 and HG380 are capable of drilling raises of more than 700 m in length. In contrast, inclined access development using handheld equipment is efficient for raises of less than 30 m whereas the Alimak raising method can be used to develop raises of up to 200 m in length. Similarly, to the Alimak, blind-boring machines are effective in developing inclined raises of up to 200 m in length.

Table 5. Comparison of various inclined development equipment (Ferreira, 2005)

	Length of hole (m)							
	<30	30-45 <45	45-60 <60	60-90 <	90-200	200-400	400-700	700 >
TYPE INCLINED								
Hand held	√							
Drop raising	√	√						
Alimak		√	√	√	√			
Blind boring								
52R		√	√					
53R	√	√	√	√	√			
33/34R	√		√					
Other	√	√						
65R	√	√	√	√	√			
Raise boring								
43R	√	√						
53R	√	√	√	√	√			
6 Series/RBM 6			√	√	√			
7 Series/RBM 7			√	√	√			
8 Series			√	√	√	√		
9 Series					√	√	√	
10 Series					√	√	√	
12 Series					√	√	√	√
HG330					√	√	√	√
HG380					√	√	√	√

The desktop study revealed that there is a shortage of up-to-date studies on rapid inclined access development. The latest information on the subject comes from equipment manufacturers, thus the studies are not entirely independent, and the results / outcomes could be biased. Studies conducted before the year 2000 seem to carry more detailed information on the subject. There is an opportunity to conduct a comprehensive assessment of rapid inclined access development equipment currently in use in different South African mining operations.

2.3 Stakeholder engagements

Mining industry stakeholders were consulted through a survey (questionnaire) and a virtual workshop. The survey was initially not planned into the project scope of work; it was later included to complement information obtained from the desktop study and workshop.

2.3.1 Survey

The survey received a low response rate of 2%. It consisted of five questions covering inclined development aspects such as current infrastructure dimensions, the types of equipment trialled or currently used and the associated costs, productivity rates and OHS aspects. The stakeholders were also asked to rank rapid inclined access development equipment design parameters in order of importance. This information was required for the drafting of the equipment selection criteria of the ToR. A summary of the feedback received from the stakeholders for the different questions is given in the following subsection.

1. *What are the dimensions of inclined infrastructure (including declines) development at your mine?*

The responses confirmed the literature findings, suggesting that the size of the infrastructure varies between mining operations based on factors such as the mining method and reef specifications.

2. *What type of equipment do you currently use for inclined infrastructure (including declines) development?*

The following equipment is used:

- Trackless drill rigs.
- Utility vehicles for charging up with emulsion.
- Trackless bolter rig for support.
- Load Haul Dump (LHD) trucks.
- Scalers and graders.

3. Please list the type of equipment that your mine has trialled or used for the development of inclined infrastructure (including declines). Kindly provide a summary of the lessons learnt, advance rates achieved, costs incurred and observed health and safety performance for each type of equipment.

The responses to this question revealed that the conventional drill and blast method remains a popular method for development of inclined access infrastructure particularly raises. However, equipment applicable for inclined access infrastructure will be included in this section as some might be applicable for some other inclined (including declines) infrastructure development. One mining operation has used a tunnel-boring machine, which is considered an equipment type for rapid access development, achieving advance rates of 160 m/month. The same mining operation trialled the Rapid Mining Development System (RMDS) and achieved advance rates of 10 m per 8-hour shift. The RMDS was integrated with a flexible and mobile conveyor belt system to remove rock at a rate of 200 t/hour. The lessons learnt from implementing both equipment types included the need for an efficient ventilation and ore removal system substantiating the desktop study findings. Drill rigs and handheld rock drills are used for drilling and load-haul-dump (LHD) trucks are used for cleaning up to 90 t/hours, which is almost half the rate achieved by the mobile conveyor belt in combination with the RMDS. A conventional operation highlighted that they were using mechanical compressed air loaders and winches for cleaning. This information is consistent with desktop study findings. Costs associated with cleaning, which are difficult to find in literature, were listed as R292.35/m and R66.08/m for mechanical compressed air loaders and winches respectively. Table 6 is a summary of the responses received.

Table 6: Summary of inclined (including declines) and inclined access infrastructure development

Mining Activity	Cycle	Equipment Name	Type /	Summary of Lessons Learnt	Productivity (Advance) Rates Achieved	Costs (rand/metre) (rand/m³) or	Indicate Whether Health and Safety Performance Improved or Regressed Following the introduction of equipment
Drilling or Rock breaking		Epiroc RMDS (Trialled)		- Layout must be correct for the application - Ventilation management critical - Ore removal strategy critical - Interface with current infrastructure critical - Production cycles critical	10 m / 8 hr Shift 14 m ³ / hour instantaneous	±R120 000 / m	Improved significantly when cutting technologies are introduced. No injuries to date.
		LP Drill Rig (4 x OEMs)			200 m on 4 ends	±R100 000 / m	
		Master Drilling TBM			160 m / month	±R100 000 / m	

	Mine Master Drill Rig from GHH	Needs proper set-up and if not drilled as per correct designed round then poor advances	Max 45 m per end	Information was classified as confidential	Improved
	HPE Twin Boom Drill Rigs	No information was given	179.3 m/month	R4393.56 / Meter	No information was given
Support	HPE Handheld Autorock Drill Machines	Needs systematic installation of Temporary Support – camlock jacks and steel safety nets	Support an end in 1.2 hours as compared to Bolter Rig which takes 2 hours	Information was classified as confidential	Improved – need proper training for Entry Examination and Temporary support installation
	HPE twin boom Drill Rigs	No information was given	No information was given	R3210.24 / Meter	No information was given
	Epiroc RMDS integrated support	- Remote installation. - Remove people from hazardous area.	8min / bolt installation during operation	No information was given	Improved significantly. Removed people from hazardous area.
	Epiroc Cabletec		6m cable anchor installed and grouted under 30 minutes		
	LP Bolter (4 x OEMs)		2 hour cycle to bolt a development end (±6 minutes / installation)	R 2800 / m (Mining Stores cost) R 2 200 / Hour (machine cost)	
Cleaning	LHD (4 x OEMs)	- Keep tramming short as possible (<200m). - Ensure good fragmentation. - Good roadway maintenance.	18,000T / month / LHD	R 1 300 / Hour	DPM Filters fitted to all equipment – major environmental & health improvement
	Conveyor (Sandvik Flexible Belt / Steel / Pantzer)	Ensure good fragmentation.	200T / hour	Information was not provided	
	New generation of 115s LHDs	Battled to clean up-dip connecting ends in-between the flat ends. The from wheel motors have since been upgraded	10 loads per hour, clean 160 – 180 tons in two hours.	Information was not provided	No effect was recognised
	Mechanical Compressed Air loaders	No information was given	179.3 m/month	R292.35 / Meter	

4. *Please rank the following design considerations on a scale of 1 to 13 (where 1 = Most important and 13 = Least important), for the design of equipment for rapid development of inclined access infrastructure (including declines), in order of importance. May you please also state and rank any other important criteria not provided on the list.*

To provide a more accurate context to this ranking, it had been envisaged that the questionnaire response rate would be higher than 15%. Therefore, feedback on this question may be considered inconclusive. The list of criteria is as follows:

- Worker health and safety
- Ergonomics.
- Advance rate.
- Environment (Track bound or trackless).
- Rock Breaking mechanism (Mechanical rock breaking or drill and blast).
- Operational functioning (Manual, remote, automated, etc.).
- Energy source (Pneumatic, Hydropower, battery, electric, diesel, etc.).
- Capital costs.
- Operating costs.
- Ventilation requirements.
- Maintenance costs.
- Equipment portability.
- Multi-functionality (drill, support, clean etc..) of the equipment.

In general, “worker health and safety” was ranked first by all the respondents, consistent with literature findings that highlighted the importance of remove workers from dangerous working environments. The next batch of important criteria for designing rapid access development equipment (in no particular order) included ventilation requirements, advance rate, rock breaking mechanism and operational functioning. Contrary to literature findings that highlighted the importance of multi-functionality as a means to increase productivity, the criteria were ranked last by two of the three respondents.

2.3.2 Workshop with industry subject matter experts

A virtual workshop with various mining industry stakeholders and academia was held on 29 January 2021. The workshop was used to solicit inputs into the evaluation criteria of the ToR for identifying participant OEMs. The key issues raised during the workshop are summarised as follows.

a. Co-funding

Stakeholders wanted to know whether an OEM would get equivalent market share of the product if they co-fund the design and development of the equipment. Some participants also suggested that the budget allocated to equipment design and manufacture may be inadequate judging from their experiences on similar projects in the past. The Mandela Mining Precinct programme manager stated that there will be potential benefits that would be agreed on during contracting.

b. Compliance with legislation and standards

The stakeholders noted the need to promote local manufacturing and to ensure that equipment intellectual property is held locally. The programme manager clarified that this is one the goals of the project and that contestants of the challenge will be informed that local manufacturing is preferred to stimulate job creation and growth of the South African economy. The programme manager added that if an international manufacturer is selected to be part of the challenge, that manufacturer will be required to be part of Mining Equipment Manufacturers of South Africa (MEMSA) and manufacture the equipment locally.

c. Advance rate

In the initial draft, the advance rate ranging between 120 and 200 m/month with a varying scoring range was suggested. There were concerns about the initially suggested advance rates, these include:

- Advance rate per month is adequate, however there are other better alternative indices such as m/hr coupled with the working indices of the material being mined, this has the advantage of not having to be concerned about efficiencies such as availability and utilisation amongst others, this will make it a clearer measure. The team however explained that the advance per month was selected to incorporate all the aforementioned parameters in order to be able to compare to current industry standards.

- Using m/month as the measure of the advance rate without clearly defining the length of the month was raised as one of the concerns. A month could have 30 days in a 24/7 continuous operation, and it could have approximately 22 days in a 3x8 hours shifts, five days per week conventional operation. It was suggested that a clear definition of the month must be provided, or varying scoring should be considered.

d. Manoeuvrability

The draft evaluation criteria stated that the equipment should be compatible with existing hard rock underground mine infrastructure (including the shaft system and existing excavations). Stakeholders suggested that the type of mining infrastructure the criteria refers to be specified. This is due to the various types of mining methods in use, each with varying infrastructural requirements and design.

e. Total operating cost

In the draft evaluation criteria, the project team had suggested using an operating cost per m³ as the evaluation criteria. It was however suggested that the project team should use a different approach to determine the value of the new technology, rather than to follow a simplistic method that only assesses individual parameters or mining activities. The use of net present value (NPV) was suggested instead. It was further noted that the issue with operating cost is that it is not definitive; the equipment can have low operating cost but unreasonably high capital or maintenance costs. Operating cost is also a function of the rock being mined. Additionally, in some cases, high operating cost could be acceptable if there is an overall financial gain. It was also stated that it is important that the value of the project is clearly defined by using simulations and identifying where in the mining industry such a technology would be of much value. The systems approach should be adopted, and the work done under the Deepmine collaborative research should be referred to.

f. Availability and utilisation

It was noted that since this is the conceptual design stage of the project it would be difficult to predict utilisation (an operational factor). Therefore, it was recommended that utilisation be removed from the evaluation criteria, leaving only availability that can be estimated during the design phase.

g. Additional criteria suggestions

The following additional suggestions were made during the workshop:

- Other important criteria that affect the full development of a tunnel should be considered and these include the ability of the technology to adjust to the development of breakaways and cubbies.
- To complement the “multi-functionality” criterion, the team should define a criterion that addresses the level of automation of the technology; for example, whether the equipment would be able replace dangerous manual work.
- The initial budget of R150 000 might not be enough for the design and development of desired equipment. A project which cost R1 000 000 for design and R1 000 000 for the development of the equipment was cited as an example. The stakeholders were also concerned about whether the suggested time frames would be enough to do planned work.

Suggestions made by stakeholders in the workshop were incorporated into the evaluation criteria and the evaluation criteria forms part of the draft ToR (Annexure 4: Terms of reference / CFPs to identify organisations to participate in the design and development of rapid inclined access development equipment for hard rock underground mines).

2.4 Conclusion

A desktop study on the different types of inclined access development and associated equipment was conducted by gathering local and international literature sources on the subject. Three main types of inclined development methods were identified, namely conventional drill and blast, mechanised drill and blast and mechanical rock breaking development. Based on literature, the challenges encountered during inclined development have not changed significantly over the years. The development of inclines using conventional drill and blast methods is slower but cheaper than mechanical development. The Alimak method, a mechanised drill and blast method is suited for South African steeply dipping and narrow tabular orebodies; however, the method is not widely used in the country as much as it is in Canada and some European countries. The use of mechanical methods to develop raises is tipped as the most efficient of the three types of inclined development approaches. These methods include up-reaming and blind-boring. The main drawbacks associated with these methods are high wear rates in highly abrasive rock, high capital costs and the ease of mucking broken rock. These aforementioned factors are part of a long list of other parameters that should be considered in the choice of equipment for rapid inclined access development. The other factors include OHS, scheduling, flexibility, equipment portability, drilling accuracy, source of power and advance rates

Although the industry survey was not part of the approved scope of work, the survey was included to complement information obtained from the desktop study and workshop. The following outcomes from the survey are noteworthy:

- There is a variance in the size of inclined infrastructure at different mining operations; this should be considered by the potential equipment designers.
- OHS was ranked first. Other identified important criteria for designing rapid access development equipment included ventilation requirements, advance rate, rock breaking mechanism and operational functionality.
- Lessons learnt from previous rapid access development equipment trials include importance of customised mining layout, ventilation management, efficient cleaning systems and compatibility of the equipment to current mine infrastructure.

The key inputs from the virtual workshop with mining industry stakeholders included inadequate funding from Mandela Mining Precinct, promoting localisation of equipment manufacturing, specifying the scenario or application for the equipment and the ability of the equipment to adjust to the development of breakaways and cubbies

3. Milestone 3 - Development of progress reporting templates for OEMS

The aim of Milestone 3 was to develop a progress reporting template that will be utilised by the OEMs to report the progress made on the development of the rapid inclined access development equipment. The monthly progress report (Annexure 5: Rapid inclined access development equipment development monitoring and evaluation report) provides a number of project related details such as project name, project aim, project financials, project progress (planned versus the actual progress) and project risks. The progress report was envisaged to serve the following purposes:

- A tool for monitoring and evaluation of project progress, ensuring that the project is completed within the planned budget, brief (scope) and time.
- Keeping the project stakeholders informed about the progress made on the development of the equipment prototypes on a monthly basis.
- Keeping the project stakeholders informed about the preliminary findings or in-progress work on the project.
- Giving the project stakeholders an opportunity to evaluate the work done on the project, including suggesting changes as and when necessary.
- Notifying the project stakeholders about potential project challenges, delays and risks that hinder the execution or progress of the project, allowing timeous development and implementation of appropriate mitigation measures.

4. Milestone 4 - Call for concept designs

Milestone 4 aimed to request for proposals from manufacturers and other stakeholders with capability to design and manufacture rapid inclined access development equipment for use in narrow reef hard rock underground mines. The CFPs was advertised in the Mining Weekly, on LinkedIn, on the CSIR website and on the Mandela Mining Precinct website (Annexure 6: CFPs adverts in Mining Weekly, LinkedIn, CSIR website and Mandela Mining Precinct website respectively), on the 20th of May 2021 and the closing date was the 18th of June 2021 at 16H00.

Following the advertisement of the CFPs, MEMSA arranged a 30-minute online questions and answer session on the 1st of June 2021. The purpose of the session was to brief MEMSA member companies about the rationale of the CFPs, the process to be followed (including timelines) and to provide MEMSA member companies an opportunity to ask any clarity seeking questions to enable them to respond to the CFPs.

When the CFPs closed on the 18th of June 2021 at 16H00, only one proposal was received from a local manufacturer. The low response rate could be due to a number of reasons including the following:

- Lack of funding by the manufacturers to co-fund the design and manufacture of rapid inclined access development equipment.
- Lack of capability and time to design and manufacture rapid inclined access development equipment as per the requirements of the CFPs.
- Lack of risk appetite to pursue the innovation challenge.

Participation of more equipment manufacturers could be improved by availing sufficient funding (budget) to cover the full cost required to design and manufacture the equipment.

5. Milestone 5 - Evaluation of concept designs

The purpose of Milestone 5 was to evaluate the proposals that were received from manufacturers and other stakeholders with capability to design and manufacture rapid inclined access development equipment. The following two-phase evaluation process was followed in the evaluation of the proposal:

1. The first evaluation phase, which was based on administrative criteria (by the research team).
2. The second evaluation phase, which was based on technical equipment design criteria (by the evaluation panel).

The research team evaluated the proposal against the predetermined administrative criteria in Table 7. The proposal met all the administrative criteria and thus qualified for technical evaluation.

Table 7: Administrative Criteria

Administrative Factors	Yes	No
South African registered manufacturer	√	
Valid tax clearance certificate	√	
Completed proposal template	√	
Is the application complete?	√	
Submission of CFP Terms of Reference (this document)	√	

An evaluation panel comprising three members from the research team, the MMS Programme Manager and one MMS TSC member was established. The panel was requested to sign declaration of conflict of interest and confidentiality agreements (Annexure 7: Declaration of conflict of interest and confidentiality agreement form) before the proposals and related CFPs documentation were shared with the panel for perusal in preparation of the evaluation meeting. The evaluation meeting was held on the 16th of July 2021 and the panel members were briefed on the process and requirements. Panel members were requested to individually score the proposals

and submit their inputs for consolidation to the research team by the 19th of July 2021. Table 8 provides details of the consolidated scores.

Table 8: Consolidated scores

No.	Technical evaluation criteria	Score by evaluators 1, 2, 3, 4 and 5				
		1	2	3	4	5
1	The applicant commits co-funding a certain percentage of the total project funds	10	10	10	10	8
2	Quality and overall direction of proposal	4	4	4	2.5	4
3	Are the objectives and methodology appropriate for the proposed work?	4	4	2.5	2.5	4
4	Does the applicant have the relevant technical expertise and mining industry experience to undertake the project (attach company profile)?	5	5	5	4	5
5	Time required to develop the prototype once contracting is finalised (attach project schedule detailing timeframes for different milestones)	0	0	0	0	0
6	Compliance of the envisaged rapid inclined access development equipment prototypes with legislation and standards	10	10	10	10	10
7	Envisaged monthly advance rate of the rapid inclined access development equipment prototype (assume a 22-day month with 2 X 8 hours shifts)	10	10	10	8	8
8	The ideal equipment should be: 1. Compatible with existing hard rock underground mine infrastructure (including the shaft system and existing excavations) 2. Self-propelled 3. Trackless Conformance of the equipment to requirements 1, 2 and 3	4	4	2.5	2.5	2.5
9	Rock breaking mechanism	2.5	2.5	2.5	2.5	2.5
10	Equipment operational functionality	4	4	4	4	4
11	Equipment energy source in operation (power system)	8	8	8	8	6
12	Multi-functionality of the equipment	8	8	8	5	5
13	Envisaged availability of the equipment	10	10	10	10	8
Total scores		79.5	79.5	76.5	69	67

As per the approved CFPs, proposals with functionality/technical points of less than the pre-determined minimum overall percentage of 65% and less than 50% on any of the individual

criteria will be eliminated from further evaluation. The proposed time to develop the prototype was seven months (more than 6 months), thus the proposal was eliminated for further evaluation.

6. Milestone 6 - Appointment of three manufacturers

This milestone deliverable could not be executed as the evaluation panel concluded that the proposal that was received did not meet all the technical evaluation criteria.

7. Conclusions and recommendations

Five out of six project milestones were completed. These milestones include developing a project plan during project initiation; developing the ToR to appoint three equipment manufacturers to participate in a challenge; developing progress reporting templates to monitor progress made on the development of the rapid inclined access development equipment; requesting proposals from manufacturers and other stakeholders with the capability to design and manufacture rapid inclined access development equipment for use in narrow reef hard rock underground mines and evaluating the proposals. Milestone 6 (Appointment of three manufacturers) could not be executed as only one proposal was received and it did not meet all the required technical evaluation criteria. The low response rate to the call for proposals could have been due to:

- Lack of funding by the manufacturers to co-fund the design and manufacture of rapid inclined access development equipment.
- Lack of capability and time to design and manufacture rapid inclined access development equipment as per the requirements of the CFPs.
- Lack of risk appetite to pursue the innovation challenge.

The following is recommended for similar future projects:

- Defining, clearly and concisely, the scope of the project, challenge or competition and the equipment or technology design parameters to avoid any delays that may arise from additional clarity-seeking engagements.
- Availing sufficient funding to cover the costs required to design and manufacture the relevant equipment or technologies.
- Aligning the duration of the challenge or competition to manufacturing processes, thus giving the manufacturers a realistic chance to participate.
- Facilitating collaboration between various local manufacturers.
- Promoting continuous innovation; this will ensure that when design challenges or competitions are initiated, manufacturers would readily participate.

8. References

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9. Annexures

- Annexure 1: Terms and Conditions for projects related to product/prototype development challenges
- Annexure 2: Ethics approval to conduct the study
- Annexure 3: Questionnaire on requirements for the design of rapid inclined and inclined access development equipment
- Annexure 4: Terms of reference / CFPs to identify organisations to participate in the design and development of rapid inclined access development equipment for hard rock underground mines
- Annexure 5: Rapid inclined access development equipment development monitoring and evaluation report
- Annexure 6: CFPs adverts in Mining Weekly, Linkedin, CSIR website and Mandela Mining Precinct website respectively
- Annexure 7: Declaration of conflict of interest and confidentiality agreement form

Annexure 1: Terms and Conditions for projects related to product/prototype development challenges



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12 March 2021

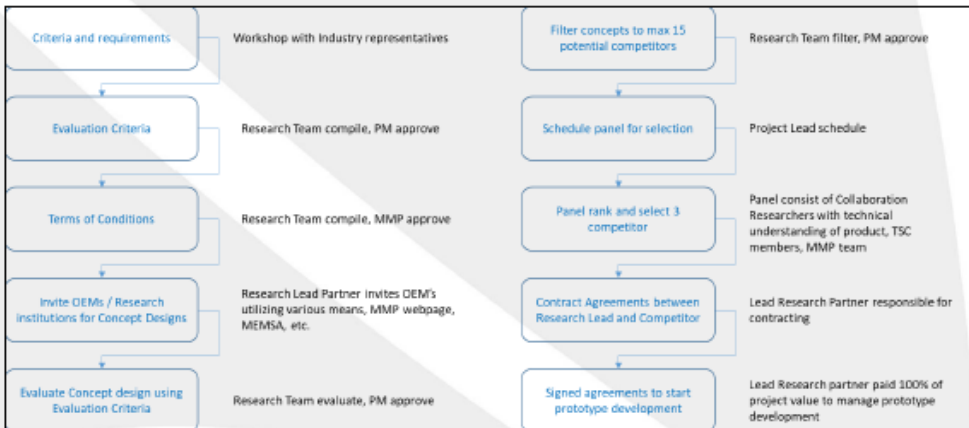
Research Partner

Re: Terms and Conditions for projects related to product/prototype development challenges within the Longevity of Current Mines Programme

The Longevity of Current Mines programme introduced a number of projects in the 2021 Business Plan, which relates to manufacturers to enter their concept designs into the project challenge. The concept designs would be evaluated according to technical alignment to the criteria and requirements established from industry representatives partaking in workshops. A selection panel would evaluate each concept design using the evaluation criteria rating matrix. The three concept designs which scores the highest would be nominated to enter into the challenge. A Collaboration agreement are to be compiled by the research lead partner and the manufacturer of the nominated concept designs in which the contract agreement are signed by both parties. These concept design will then be manufactured by the respective manufacturers according to the mutual agreed timeline and will be remunerated according the progress of development.

The following is to guide of the process and the responsibility of the research lead partner to the projects related to challenges, from the start of the project establishing the criteria up to the signing of contract agreements between the lead research partner and the three nominated manufacturers.

To provide more clarity, a process flow diagram is provided in Figure 1, which is the full spectrum from defining the prototype criteria and requirements up to the contracting of the three competitors to start the development of the prototypes.



```

graph TD
    A[Criteria and requirements] --> B[Evaluation Criteria]
    B --> C[Terms of Conditions]
    C --> D[Invite OEMs / Research Institutions for Concept Designs]
    D --> E[Evaluate Concept design using Evaluation Criteria]
    E --> F[Filter concepts to max 15 potential competitors]
    F --> G[Schedule panel for selection]
    G --> H[Panel rank and select 3 competitor]
    H --> I[Contract Agreements between Research Lead and Competitor]
    I --> J[Signed agreements to start prototype development]

    A --- A1[Workshop with Industry representatives]
    B --- B1[Research Team compile, PM approve]
    C --- C1[Research Team compile, MMP approve]
    D --- D1[Research Lead Partner invites OEM's utilizing various means, MMP webpage, MEMSA, etc.]
    E --- E1[Research Team evaluate, PM approve]
    F --- F1[Research Team filter, PM approve]
    G --- G1[Project Lead schedule]
    H --- H1[Panel consist of Collaboration Researchers with technical understanding of product, TSC members, MMP team]
    I --- I1[Lead Research Partner responsible for contracting]
    J --- J1[Lead Research partner paid 100% of project value to manage prototype development]
    
```

Figure 1: Process flow of project deliverables

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In order to ensure the successful execution of Phase 1, the following terms and conditions need to be adhered to:

1. **Criteria and Requirements:** A workshop is to be hosted by the Lead Research Partner, in which industry representatives, specialists and researchers are invited to attend in defining the criteria and requirements of the end product/prototype.
 2. **Evaluation Criteria:** An evaluation criteria as structured by the research team, approved by the Programme Manager, which consist of 60% technical evaluation and 40% based on prototype development scheduled timelines and cost/funding requirements.
 3. **Terms of Conditions:** Each project will have a unique set of terms of conditions, which would include the criteria and requirements and the evaluation information required to enable evaluation. Further Ts and Cs would include the base of these Ts and Cs within this note.
 4. **Invite OEMs/Research Institutions:** The lead research partner is responsible to place invitations in the public domain through various means and as per required procurement processes to reach local and international OEMs / research institutions to enter their concept designs into the challenge.
 5. **Evaluate Concept Designs:** All the concept designs received are to be evaluated by the research team, in which the concept design is evaluated against the evaluation criteria. All the concept design which meets and are aligned to the criteria are listed with the weighted outcome result of the evaluation. The top maximum 15 concepts are put forward to the selection panel as potential candidates, for the panel evaluation process.
 6. **Schedule Selection Panel:** The selection panel consist of agreed collaboration researchers with technical understanding of the product, TSC members and Programme Manager or his representative.
 7. **Panel selecting three competitors:** The panel re-evaluate each concept design and rate the concept designs according to the evaluation criteria. The highest three ranked concept designs are used as the three winning designs to put forward into developing prototypes. A mutual timeframe needs to be concluded in developing the product/prototype by the panel.
 8. **Contract Agreements:** The contract agreements are established by the lead research partner as per the required procurement and contracting policies and procedures.
- 8.1 Terms and Conditions** are to be includes in the agreement with these minimum Ts and Cs set out in this note. These Ts and Cs should be included in the agreement in the section "Annexure A", which defines the technical criteria and requirements, the concluded timeframe and the deliverables associated to the prototype development.

8.2 Confidentiality - The Recipient of Confidential Information shall:

- treat as strictly confidential any and all Confidential Information given or made known to it arising from this agreement;
- keep all such Confidential Information confidential towards third parties and only use it in co-operation with the other Party to this Agreement for the purpose expressly agreed upon by the Parties and to disclose same to their employees, directors, officers and consultants only on the basis of the need to know;
- accept responsibility for the observance of the confidentiality undertakings as



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contained in this Agreement by its employees, directors, officers and consultants;

- if required, cause all of its employees who are directly or indirectly given access to the Confidential Information to execute confidentiality undertakings in a form acceptable to the Disclosing Party in order to protect the Disclosing Party against the unauthorized disclosure of such Confidential Information to any third party and to fully cooperate in the enforcement of such undertakings.

The provisions of this clause shall continue to apply after any termination/ cancellation of this Agreement, for whatever reason, for a period of 5 (five) years following such termination/ cancellation.

For the avoidance of doubt, no provision of this Agreement should be construed in such a way that the Disclosing Party is deemed to have granted its consent to the Recipient to disclose the whole or any part of the Confidential Information in the event that the Recipient receives a request for the whole or any part of such Confidential Information in terms of the provisions of the Promotion of Access to Information Act, No 2 of 2000 of the Republic of South Africa as amended (the "Act"). The Recipient shall be obliged to notify the Disclosing Party immediately and in writing when it receives such a request to enable the Disclosing Party to object and approach a court of competent jurisdiction if necessary, to protect its interests.

8.3 Intellectual Property - The ownership of and all rights in and to any Background Intellectual Property shall be and remain vested in the Party who initially owned and/or developed the same and such Party shall have the exclusive right to the commercial use of such Background Intellectual Property, unless otherwise agreed in writing.

The ownership of and rights in and to Intellectual Property generated under this Agreement will be governed by the Intellectual Property Rights from Publicly Financed Research and Development Act, 2008 (Act No. 51 of 2008)

8.4 Term of Payment - The terms of payment is included in the agreement in the section "Annexure A" and should be as per example provided in table 1. Payment of the full amount will be paid to the lead research partner upon all parties signing the contract agreements, who would be responsible to manage the deliverables and payments according to these deliverables.

Table 1: Collaborative OEM/Sub-contractor Prototype Development payment guideline

Payment trigger	Rand	% Payment to total amount
Signing of memorandum of agreement (OEMs)	R	50% as start-up
Develop the product to 50% completion (OEMs)	R	20% of payment
Develop the product to 100% completion (OEMs)	R	15% of payment
Complete surface testing of product	R	15% of payment
Total (Excl VAT)	R	



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- The parties will need to establish who will be liable for loss or damage of equipment other than due to normal wear and tear, which is not included in the terms of reference.
- Payment will be based on actual project progress completed to the planned milestones, indicated in Table 1
- Project progress will be verified by the Project Lead prior to authorising invoices for payment.

These are the minimum requirements for the Terms of Conditions to the Lead Research Partner to manage the projects associated with the Challenge for OEMs/Sub-contractor to enter and compete within the challenge.

Yours sincerely

J le Roux
Co-Director- Mandela Mining
Precinct.

D Kruger
Co-Director- Mandela Mining
Precinct.

Annexure 2: Ethics approval to conduct the study

 CSIR Touching lives through innovation	CSIR Research Ethics Committee PO Box 395 Pretoria 0001 South Africa Tel: +27 12 841 4060 Fax: +27 12 841 2476 Email: R&DEthics@csir.co.za
Dear: Fleckson Magweregwe	
Approval of Protocol: The ethics application is for two workpackages (WP), WP 5 and WP 6, under the Mandela Mining Precinct (MMP)'s Mechanised Mining Systems (MMS) research programme. The project titles are as follows: 1. WP 5 - Rapid Horizontal Access Development 2. WP 6 - Rapid Inclined Access Development.	
This is to confirm that your protocol reviewed by the CSIR REC has been approved. The reference number of this research project is Ref: 344/2020.	
This approval is granted under the condition that:	
1. The researcher remains within the procedures and protocols indicated in the proposal, as well as the additions made to the procedures and protocols as indicated in the responses submitted to the questions of the REC, particularly in terms of any undertakings made and guarantees given. 2. The researcher notes that <u>any deviations to the approved project/protocol must be submitted to the REC for approval before implementation.</u> 3. The researcher remains within the parameters of any applicable national legislation, institutional guidelines and scientific standards relevant to the specific field of research. 4. This approval is <u>valid for one calendar year from the date of this letter.</u> 5. The researcher submit bi-annual progress reports to the REC 6. The researcher immediately alert the REC of any adverse events that have occurred during the course of the study, as well as the actions that were taken to immediately respond to these events. 7. The researcher alert the REC of any new or unexpected ethical issues that emerged during the course of the study, and how these ethical issues were addressed. If unsure how to respond to these unexpected or new ethical issues as they emerge, the researcher should immediately consult with the REC for advice. 8. The researcher submit a short report to the REC on completion of the research in which it is indicated (i) that the research has been completed; (ii) if any new or unexpected ethical issues emerged during the course of the study; and if so, (iii) how these ethical issues were addressed.	
We wish you all of the best with your research project.	
Kind regards,	
	
Prof David Jacobs CSIR REC Chairperson)	Ms Brenda Mapunya (CSIR REC Secretariat)

Annexure 3: Questionnaire on requirements for the design of rapid inclined and inclined access development equipment

The Mandela Mining Precinct (MMP) appointed the Council for Scientific and Industrial Research (CSIR) to execute the research projects titled “Facilitate the development of rapid inclined access development equipment” and “Facilitate the development of rapid inclined access development equipment”. The two projects aim to facilitate the development of rapid inclined and inclined access development equipment that can be used in narrow reef hard rock mines. The project is expected to produce prototypes of rapid inclined and inclined access development equipment that can be used to accelerate inclined and inclined development activities in narrow reef hard rock mines.

You are kindly requested to answer the following questions based on your knowledge and experience in the South African mining industry.

1. What are the dimensions of development infrastructure at your mine?

Dimensions	Horizontal development infrastructure type			Inclined development infrastructure type		
	Type 1 (specify name)	Type 2 (specify name)	Type 3 (specify name)	Type 1 (specify name)	Type 2 (specify name)	Type 3 (specify name)
Width						
Height						
Inclination Angle						
Other						

2. What type of equipment do you currently use for horizontal and inclined development infrastructure?

Mining Cycle Activity	Horizontal infrastructure development	Inclined infrastructure development
Drilling		
Rock Breaking		

Support		
Cleaning		
Other (please specify)		

3. Please list the type of equipment that your mine has trialled or used for the development of inclined infrastructure. Kindly provide a summary of the lessons learnt, advance rates achieved, costs incurred and observed health and safety performance for each type of equipment.

Inclined Infrastructure Development						
Mining Activity	Cycle	Equipment Type / Name	Summary of Lessons Learnt	Productivity (Advance) Rates Achieved	Costs (rand/metre) or (rand/m³)	Indicate Whether Health and Safety Performance Improved or Regressed Following the introduction of equipment
Drilling or Rock breaking						
Support						
Cleaning						
Other (Please Specify)						

4. Please list the type of equipment that your mine has trialled or used for the development of inclined infrastructure. Kindly provide a summary of the lessons learnt, advance rates achieved, costs incurred and observed health and safety performance for each type of equipment.

Inclined Infrastructure Development						
Mining Activity	Cycle	Equipment Type / Name	Summary of Lessons Learnt	Productivity (Advance) Rates Achieved	Costs (rand/metre) or (rand/m³)	Indicate Whether Health and Safety Performance Improved or Regressed Following the introduction of equipment
Drilling or Rock breaking						
Support						
Cleaning						
Other (Please Specify)						

5. Please rank the following design considerations on a scale of 1 to 9 (where 1 = Most important and 9 = Least important), for the design of equipment for rapid development of horizontal and inclined access infrastructure, in order of importance, where (1 = Most important and 9 = Least important). May you please also state and rank any other important criteria not provided on the list.

Design consideration	Horizontal Development Infrastructure Ranking	Inclined Development Infrastructure Ranking
Worker health and safety		
Ergonomics		
Advance rate (m/blast) & (m/month)		
Capital costs		
Operating costs		
Ventilation requirements		
Maintenance costs		
Equipment portability		
Multi-functionality (drill, support, clean etc..) of the equipment		
Other		

Annexure 4: Terms of reference / CFPs to identify organisations to participate in the design and development of rapid inclined access development equipment for hard rock underground mines

Call for Proposals

**Mechanised Mining Systems Programme:
Identifying organisations to participate in the concept design
and prototype development of for rapid inclined access
development equipment in narrow reef hard rock
underground mine applications**

TERMS OF REFERENCE

CFP No: 001/07/052021

Date of Issue:	20 May 2021	
Closing date and time:	18 June 2021 at 16h00	
Submission Type:	Submissions by e-mail only	
Enquiries and Submission:	CSIR Mining Cluster	Vuyo Tsotsotso – vtsotsotso@csir.co.za

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1 INTRODUCTION

This Call for Proposals (CPS) is published for the Mandela Mining Precinct (MMP) under the South African Mining Extraction Research Development and Innovation (SAMERDI) strategy. The strategy consists of programmes that include the Mechanised Mining Systems (MMS), a programme aimed at improving extraction efficiencies, improving occupational health and safety (OHS) performance and reducing operational costs of hard rock underground mining operations. This will be achieved through the development and implementation of sustainable mechanised mining solutions to execute the different production and development activities.

Work package (WP) 6 of the MMS programme aims to facilitate the prototype development of rapid inclined access development equipment. The equipment will be used to accelerate the development of inclined access infrastructure specifically, inclines, in narrow reef hard rock underground mines. This CFP is specifically directed to organisations that have the capability to develop rapid inclined access development equipment prototypes, as specified in this document.

The purpose of this document is to outline the terms of reference (TOR) that will serve as a guide to potential organisations interested in submitting rapid inclined access development equipment prototypes concept designs for consideration by the Technical Review Panel. The TOR include the evaluation criteria, project scope and expected project outcomes.

2 BACKGROUND

The South African narrow reef underground gold and platinum group metals (PGM) mines have been struggling to remain profitable against the backdrop of several challenges such as increasing mining depth, low commodity prices, increasing operational costs and declining productivity. During the 2017/2018 financial year (first year), the Longevity of Current Mines (LoCM) programme commissioned work to understand the bottlenecks in conventional narrow reef underground gold and PGM mines. Unavailability of “adequate faces” and “buffer faces” to mine was identified as one of the major constraints that is preventing some mines from attaining daily conformant blasts. Woodhall (2002) defined flexibility as “the provision of sufficient equipped mining faces to make alternative, profitable workplaces available to sustain a planned production level”. Flexibility and availability of equipped faces to mine (ore reserve availability) are critical enablers of attainment of planned conformant blasts. Musingwini et al. (2006) suggested that 18 months’ worth of faces should be the minimum for the ore availability period. In the absence of alternative equipped faces to mine, some bottlenecks within the mining cycle could easily result in lost blasts. Examples of bottlenecks within the mine production system include limited

available face time, strata control challenges, reduction in planned grades and geological features such as potholes, dykes, faults, etc. and slow inclined development.

The rapid development of inclined infrastructure is necessary to provide access to the ore body. Accelerated development of inclines can assist in ensuring the availability of equipped “adequate faces” and “buffer faces” to mine all the time. This will significantly increase the chances of attaining planned conformant blasts. Rapid access development equipment such as tunnel boring machines have been developed for use in underground operations with larger excavations, however it is more challenging for application in South African underground narrow reef hard rock mines, which are characterised by smaller tunnels.

There is, therefore, an opportunity to develop equipment that will enable the rapid development of inclined access infrastructure for South African hard rock narrow reef underground mines. The Mandela Mining Precinct has appointed the Council for Scientific and Industrial Research (CSIR) to facilitate the design and development of the rapid inclined access development equipment. The equipment will be used to accelerate the development inclined access infrastructure specifically, inclines, in hard rock narrow reef underground mines, particularly gold and platinum group metal mines.

3 INVITATION TO SUBMIT PROPOSALS

This CFP is aimed at identifying qualifying organisations that have the capability to concept design and develop rapid inclined access development equipment prototypes. The equipment will be used to accelerate the development of inclined access infrastructure specifically inclines in hard rock narrow reef underground mines, particularly gold and platinum group metals mines.

a. QUALIFYING ORGANISATION

Any manufacturer or organisation that has the capability to develop the required equipment within the scope and timeframes set out in this document is eligible to submit a CFP. Both large and small companies are eligible, but local South African manufacturers meeting the criteria will take preference.

Note: All South African applicants are required to include their Broad-Based Black Economic Empowerment (B-BBEE) certificate in their response to the CFP. The B-BBEE level is required to be maintained or improved throughout the duration of the project.

b. THE CALL FOR PROPOSALS PROCESS

The CFP process (depicted in Figure) is as follows:

- Qualifying organisations are invited to complete the response template and submit to the CSIR as described in Section 0.
- All proposals will initially be reviewed to ensure that they fulfil the qualification and critical evaluation factors. If not, the project proposal will be disqualified, and the organisation will be informed thereof.
- All design concepts that fulfil the qualification and critical evaluation factors will then be categorised accordingly and the project proposals will be distributed to the members of a pre-determined Technical Review Panel.
- Each member of the Technical Review Panel will review and score the projects using the pre-approved design criteria.
- A technical review will take place to obtain a final score and approval of three concept designs.
- Organisations will be formally informed if their concept design was selected for further development into a prototype.
- Approved projects will be contracted through the CSIR processes and procedures.
- Contracts and the monitoring of approved deliverables will be handled by the CSIR and Mandela Mining Precinct.

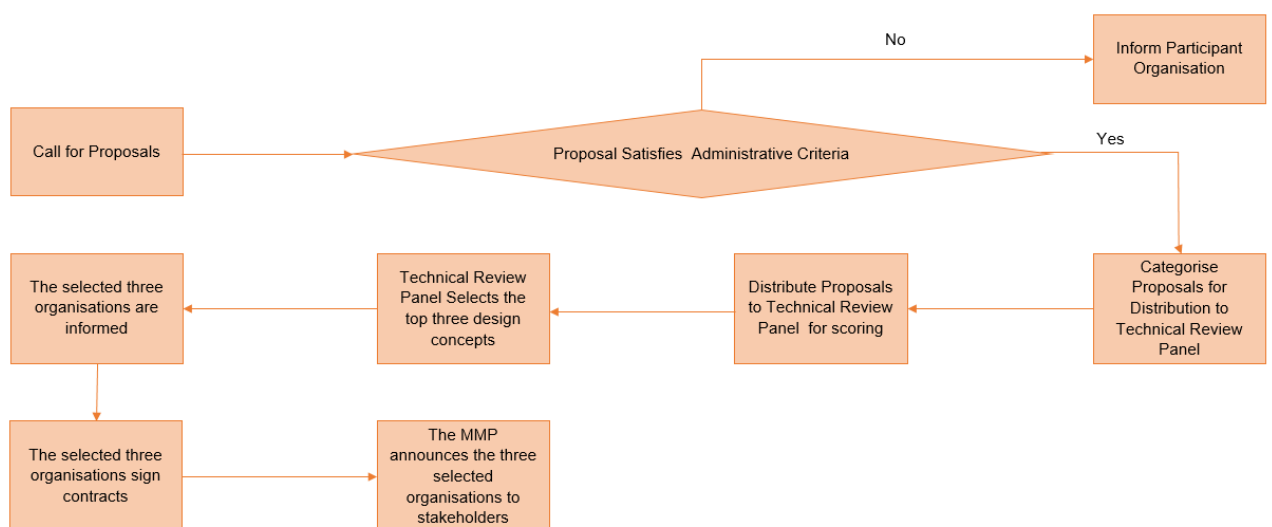


Figure 1: Call for Proposal Assessment Process.

c. PROJECT BUDGET

The project budget will be finalised during the contract signing stage as shown in Figure 2.

4 EVALUATION PROCESS AND CRITERIA

EVALUATION OF PROPOSAL

All proposals will be evaluated by a Technical Review Panel based on the predetermined administrative and technical equipment design criteria. Based on the results of the evaluation process, the Mandela Mining Precinct and the CSIR will approve the awarding of the contract to successful organisations. The proposal template which is also published with this CFP is required to be completed and submitted. The evaluations of the CFP will be based on the information provided in the response template and any additional documentation requested. The qualification, critical and differentiation evaluation will be performed for all applications.

A two-phase evaluation process will be followed:

- The first phase which is based on administrative criteria; and
- The second phase which is based on technical equipment design criteria.

Price and B-BBEE will only be considered after the first phase has been evaluated and accepted. Only proposals that achieved the minimum qualification score for functionality will be evaluated further using the 80/20 preference point system, where 80 points will be dedicated to price and 20 points to B-BBEE status.

i. Administrative Criteria

The assessment criteria for the evaluation of all project proposals are firstly divided into administrative factors based on the service provider and the quality of proposal and technical equipment design factors based on the design concept. These are shown in Table. This evaluation will be done by the Technical Review Panel.

Table 1: Administrative factors for assessing project proposals

Administrative Factors	Yes	No
South African registered manufacturer		

Valid tax clearance certificate		
Completed proposal template		
Is the application complete?		
Submission of CFP Terms of Reference (this document)		

The proposal template, which is published with this CFP, must be completed and submitted. The evaluation of the CFP will be based on the information provided in the proposal template and any additional documentation requested.

ii. Technical Evaluation Factors

The technical factors for the evaluation of all project proposals are shown in Table. Each technical factor is assigned a score (maximum 10), which is then weighted according to the importance of the factor. Please note the following:

- Proposals with functionality/technical points of less than the pre-determined minimum overall percentage of 65% and less than 50% on any of the individual criteria will be eliminated from further evaluation.
- The proposal will be evaluated according to the technical evaluation criteria detailed in Table.
- Please provide information as per Table 3, noting that this information is required for information purposes only and is not part of the evaluation criteria.

Table 2: Technical evaluation factors

Technical evaluation factor	Scoring	Score	Weight	Weighted Score
		(/10)	(%)	
Co-Funding	The applicant commits the following co-funding as a percentage of the total project funds: • More than 80% of the total project funding (assigned score 10) • Between 50% and 79% of total project funding (assigned score 8) • Between 25% and 49% of total project funding (assigned score 5) • Less than 25% of total project funding (assigned score 0)		10	
	Quality and overall direction of proposal: • The proposal successfully addresses all applicable aspects, no limitations (assigned score: 10) • The proposal addresses the criterion thoroughly, but with a small number of limitations (assigned score: 8) • The proposal broadly addresses the criterion, but there are significant weaknesses / limitations (assigned score: 5) • The proposal fails to address the criterion and/or cannot be assessed due to missing or incomplete information (assigned score: 0)		5	
Quality and Feasibility				
	Are the objectives and methodology appropriate for the proposed work?		5	

	• The proposal successfully addresses all applicable aspects, no limitations (assigned score: 10) • The proposal addresses the criterion thoroughly, but with a small number of limitations (assigned score: 8) • The proposal broadly addresses the criterion, but there are significant weaknesses /limitations (assigned score: 5) • The proposal fails to address the criterion and/or cannot be assessed due to missing or incomplete information (assigned score: 0)			
	Does the applicant have the relevant technical expertise and mining industry experience to undertake the project (attach company profile): • More than 10 years (assigned score: 10) • Five to 10 years (assigned score: 8) • Less than five years (assigned score: 5)		5	
	Time required to develop the prototype once contracting is finalized (attach project schedule detailing timeframes for different milestones): • Prototype already developed and is ready for testing (assigned score: 10) • Prototype development is in progress and will be completed within 3 months (assigned score 8) • Concept design is available, and the prototype can be developed within six months (assigned score: 5) • Concept design is available, and the prototype can be developed in more than six months (assigned score: 0)		10	

Compliance with legislation and standards	Compliance of the envisaged rapid inclined access development equipment prototypes with legislation and standards: • Compliance with the Mine Health and Safety Act No. 29 of 1996 and applicable regulations; Occupational Health and Safety Act of 1993 and regulations (specifically ergonomics regulations of 2019); Relevant South African Bureau of Standards (SABS) and International OHS standards that are relevant to mining equipment (assigned score: 10) • Compliance with the Mine Health and Safety Act No. 29 of 1996 and applicable regulations and any two of the following: Occupational Health and Safety Act of 1993 and regulations (specifically ergonomics regulations of 2019); Relevant South African Bureau of Standards (SABS) and International OHS standards that are relevant to mining equipment (assigned score: 8) • Compliance with the Mine Health and Safety Act No. 29 of 1996 and applicable regulations and any one of the following: Occupational Health and Safety Act of 1993 and regulations (specifically ergonomics regulations of 2019); Relevant South African Bureau of Standards (SABS) and International OHS standards that are relevant to mining equipment (assigned score: 5) • Not complying (assigned score: 0)		10	
Advance rate	Envisaged monthly advance rate of the rapid inclined access development equipment prototype (assume a 22-day month with 2 X 8 hours shifts):		10	

	• Advance rate of at least 200 m per month (assigned score: 10) • Advance rate of between 150 m and 199 m per month (assigned score: 8) • Advance rate of between 120 m and 149 m per month (assigned score: 5) • Advance rate of less than 120 m per month (assigned score: 0)			
Manoeuvrability	The ideal equipment should be: 1. Compatible with existing hard rock underground mine infrastructure (including the shaft system and existing excavations). 2. Self-propelled (i.e., should be able to move from point A to B on its own without the need to be transported by another equipment). 3. Trackless Conformance of the equipment to requirements 1, 2 and 3: • Conforms to all requirements (assigned score: 10) • Conforms to requirement one and either of two or three (assigned score: 8) • Conforms to requirement one only (assigned score: 5)		5	
Rock breaking mechanism	Rock breaking mechanism: • Non-explosive (rock cutting, thermal spalling, diamond wire cutting, etc.) (assigned score: 10) • Drilling and blasting (assigned score: 5)		5	

Operational functionality	Equipment operational functionality: • Autonomous equipment (assigned score: 10) • Remote controlled equipment (assigned score: 8) • Manually operated equipment (assigned score: 5)		5	
Energy source	Equipment energy source in operation (power system): • Electric or battery powered (assigned score: 10) • Hydropower (assigned score: 8) • Pneumatic (assigned score: 6) • Diesel (assigned score: 5)		10	
Multi-functionality	Multi-functionality of the equipment: • Equipment capable of executing face drilling or rock cutting, support drilling, support installation, cleaning and development of secondary infrastructure such as breakaways and cubbies (assigned score: 10) • Equipment capable of executing face drilling or rock cutting and any two of the following support drilling, support installation, cleaning and development of secondary infrastructure such as breakaways and cubbies (assigned score: 8) • Equipment capable of executing face drilling or rock cutting only (assigned score: 5)		10	
Availability	Envisaged availability of the equipment:		10	

	• At least 85% (assigned score: 10) • Between 75% and 84% (assigned score: 8) • Between 60% and 74% (assigned score: 5) • Less than 60% (assigned score: 0)			
--	--	--	--	--

Table 3: Additional information required for information purposes only

No	Required parameter	Response
1	Estimated cost estimate for concept design (ZAR)	
2	Estimated duration of concept design (Weeks)	
3	Estimated cost estimate for prototype development (ZAR)	
4	Estimated duration of prototype development (Weeks)	
5	Estimated total funding requirement (ZAR)	

5 PROPOSAL SPECIFICATION

All proposals are to be submitted in a format as specified in the CFP document (a template is provided under Annexure A).

6 ELIMINATION CRITERIA

Proposals will be eliminated under the following conditions:

- Submission after the deadline date and time.
- Incomplete submissions,
- Proposal template not completed, signed and submitted (Section **Error! Reference source not found.**, Annexure A).
- CFP compliance checklist not signed and submitted (Section 0).
- Declaration of Conflict of Interest not signed and submitted (Section 0).
- Declaration of Conflict of Financial Interest not signed and submitted Interest not signed and submitted (Section 18).
- Final Declaration not signed and submitted (Section 19).
- No B-BBEE certificate (South African manufacturers).
- Companies that have a B-BBEE level of non-compliant (South African manufacturers).
- No Valid Tax Clearance Certificate.
- No signed CFP Terms of Reference (this document), each page should be initialled and submitted with the proposal.

7 PROGRAMME DURATION

The programme, as currently envisaged, incorporates the dates shown in Table.

Table 4: Envisaged dates of programme completion

Item	Due date
Call for concept designs	18 June 2021 at 16h00
Evaluation of concept designs	
Establish selection team and signing of non-disclosure agreements (NDA).	25 June 2021

Evaluate concept designs and select three concept designs which best meet the defined selection criteria.	2 July 2021
Approval of recommended three manufacturers with the capability to develop rapid inclined access development equipment for narrow reef hard rock mines.	16 July 2021
Appointment of three manufacturers	
Contracting with appointed three manufacturers.	30 July 2021
Announcement of appointed three manufacturers by MMP.	13 August 2021

8 SUBMISSION OF CFP

As a result of the COVID-19 pandemic, all CFP documents shall be submitted electronically via email.

- The CFP documents should be marked for attention of Vuyo Tsotsotso, Email: vtotsotso@csir.co.za
- The documents subject line should be **“Mechanised Mining Systems WP6 – Rapid Inclined Access Development”**.

All CFP documents must be received no later than the stipulated closing date and time. Any CFP submitted after the stipulated time and date will be automatically disqualified.

All queries pertaining to the CFP must be forwarded via email.

- The documents should be marked for attention of Vuyo Tsotsotso, Email: vtotsotso@csir.co.za

The documents subject line should be **“Mechanised Mining Systems WP6– Rapid Inclined Access Development”**.

Proposals submitted by companies must be signed by a person or persons duly authorised.

9 DEADLINE FOR SUBMISSION

Proposals must be submitted electronically (to the address mentioned above) by no later than the closing date of **Friday, 18 June 2021 before 16h00.**

Where a proposal is not received by the CSIR by the due date and at the stipulated time, it will be regarded as a late submission. Late submissions will not be considered.

10 GENERAL TERMS, GUIDELINES AND KEY POINTS

Any South African Original Equipment Manufacturers (OEMs), **Equipment Designers**, and other organisations with the capability of developing the required equipment are invited to submit proposals in support of this call. Applicants are encouraged to collaborate. Please note the following:

- a. Beneficiaries who have not completed and submitted all deliverables, as per the projects undertaken with the Mandela Mining Precinct during the previous project cycle, will not be considered for funding.

- b. An organisation may submit more than one proposal but only one project can be supported per company.
- c. The Mandela Mining Precinct reserves the right not to engage further with the participants should the CFP not meet or address the Mandela Mining Precinct's needs.
- d. The Mandela Mining Precinct reserves the right to cancel this CFP, or not to appoint any participant should the business condition warrant such a move. This will be done in line with the spirit of Preferential Procurement Policy Framework Act and its associated regulations.
- e. More than one company will be supported through this call.
- f. All project proposals, relevant documentation, data and information will be treated as confidential.
- g. The process of evaluating all proposals will be conducted in a fair and confidential manner.
- h. All technical experts in the review committee are also bound by an obligation of confidentiality.
- i. Contracts will be entered into between the CSIR (on behalf of the Mandela Mining Precinct) and the successful institution(s) for each successful project proposal.
- j. A payment schedule will be negotiated during the contracting phase.
- k. Subject to the nature and scope of a project, a Project Manager from the Mandela Mining Precinct will be the primary technical contact between the Mandela Mining Precinct and the recipient.
- l. Submit your applications and enquiries via email to fmagweregwede@csir.co.za.
 - Contact by any means whatsoever with the Mandela Mining Precinct personnel is not permitted during the CFP process other than as required through existing service arrangements and/or as requested by the Mandela Mining Precinct as part of the CFP process.
 - Any form of canvassing by an applicant to any member of staff or supplier, for purposes of influencing the process, will automatically disqualify the applicant from the evaluation process.
 - Applicants shall not offer or give any consideration of any kind to any employee or representative of the Mandela Mining Precinct as an inducement or reward for doing, or refraining from doing, any act in relation to the obtaining or execution of this or any other contract with the Mandela Mining Precinct.

- Failure to comply will render your submission non-responsive and disqualified.
- m. Companies receiving support will be based on merit.
 - The Mandela Mining Precinct will nominate the applicants' who's CFPs are determined to be the most advantageous to the Mandela Mining Precinct, taking into consideration the technical suitability of the shortlisted participant.
- n. The terms participant, organisation and applicant will be used interchangeable and must be read in context with the sentence in which they are used.
- o. The applicant accepts that the results of any analysis of their business will be shared with the MMP and that CSIR staff may be involved on-site as part of the audit teams in addition to independent audit staff.

11 COST OF CFP

Applicants are expected to fully acquaint themselves with the conditions, requirements and specifications of this CFP before submitting their CFP. Each applicant assumes all risks for resource commitment and expenses, direct or indirect, of proposal preparation and participation throughout the CFP process. The Mandela Mining Precinct or the CSIR is not responsible – directly or indirectly for any costs incurred by applicants in the preparation and submission of the CFP.

12 VALIDITY AND CORRECTNESS OF RESPONSES

The applicant confirms satisfaction regarding the correctness and validity of its proposal.

13 RESPONSIBILITY TO EXECUTE, AND FAILURE TO COMPLY

The successful applicant hereby accepts full responsibility for the proper execution and fulfilment of all obligations and conditions devolving on him/her under this CFP.

The respondent hereby offers to render all the services described in the attached document (if any) to the Mandela Mining Precinct on the terms and conditions and in accordance with the specifications stipulated in this CFP documents.

14 VERIFICATION OF DOCUMENTS

- a. Applicants should check the numbers of the pages to satisfy themselves that none are missing or duplicated. No liability will be accepted by the Mandela Mining Precinct or the CSIR regarding anything arising from the fact that pages are missing or duplicated.
- b. Telegraphic and telefax submissions will not be accepted.
- c. Only submissions via email will be accepted.

The Mandela Mining Precinct reserves the right to:

- a. Amend any CFP conditions, validity period, specifications, or extend the closing date and/or time of CFP before the closing date. All applicants, to whom the CFP documents have been issued, will be advised in writing of such amendments on time.
- b. Verify any information contained in a CFP.
- c. Request documentary proof regarding any CFP issue.
- d. Not appoint any applicant.
- e. Vary, alter, and/or amend the terms of this CFP, at any time prior to the finalisation of its adjudication hereof.
- f. Cancel or withdraw this CFP at any time, without attracting any liability.
- g. Cancel or withdraw from this CFP as a whole or in part without furnishing reasons and without attracting any liability.
- h. Request an applicant to do a presentation to the Technical Review Panel.

15 DISCLAIMERS

- The Mandela Mining Precinct has produced this CFP in good faith. However, the Mandela Mining Precinct, its agents and its servants do not warrant its accuracy or completeness. To the extent that the Mandela Mining Precinct is permitted by law, the Mandela Mining Precinct will not be liable for any claim whatsoever and howsoever arising (including,

without limitation, any claim in contract, negligence or otherwise) for any incorrect or misleading information contained in this CFP due to any misinterpretation of this CFP.

- This CFP is a request for CFP only and not an offer document; answers to it must not be construed as acceptance of an offer or imply the existence of a contract between the parties.
- The Mandela Mining Precinct makes no representation, warranty, assurance, guarantee or endorsements to any applicant concerning the CFP, whether regarding its accuracy, completeness or otherwise and the Mandela Mining Precinct shall have no liability towards the respondent or any other party in connection therewith.

16 CFP COMPLIANCE CHECK LIST

To be completed by the applicant:

- I/We hereby undertake to render services described in the attached CFP documents as and when requested to the Mandela Mining Precinct in accordance with the requirements stipulated in CFP Number: **001/07/052021**.
 - The following documents will be deemed to form and be read and construed as part of this CFP. The documents are:
 - CFP Terms of Reference (this document).
 - The Response Template to the CFP.
 - I/We confirm that I/we have satisfied myself/ourselves as to the correctness and validity of my/our CFP proposal and that the proposal cover all the services specified in the documents.
 - I/We declare that I/we have no participation in any collusive practices with any other applicant or third party regarding this or any other CFP.
 - I/we confirm that I/we am duly authorised to sign this document.

NAME (PRINT)

CAPACITY

SIGNATURE

NAME OF FIRM

DATE

WITNESSES

1

2

17 DECLARATION OF CONFLICT OF INTEREST FORM (APPLICANT)

This declaration of interest must be completed and submitted with the CFP. Failure to do so may result in the elimination of the Applicant's CFP.

Declaration of Interest – Mandela Mining Precinct CFP 001/07/052021

Are any staff members, from your company involved in this CFP process, connected or have any relationship with anyone employed by the MMP/CSIR?

Yes		No	
-----	--	----	--

If yes, please state particulars:

18 DECLARATION OF CONFLICT OF FINANCIAL INTEREST

Is the integrator or sub-systems supplier/Small Medium Micro Enterprises (SMME) receiving support for similar interventions from any other South African government department or international organisation?

Yes		No	
-----	--	----	--

If yes, please state particulars:

DECLARATION

I, _____ (THE UNDERSIGNED), DULY AUTHORISED, CERTIFY THAT THE INFORMATION FURNISHED IN THIS CFP IS CORRECT. I ACCEPT THAT THE CSIR MAY TAKE APPROPRIATE ACTIONS, DEEMED NECESSARY, SHOULD THIS DECLARATION PROVE TO BE FALSE.

Signature

Date

Position

Name of applicant

END OF CFP

Annexure 5: Rapid inclined access development equipment development monitoring and evaluation report

1 PROJECT DETAILS AND FINANCIALS

All payments to be invoiced upon completion of project stages and as per the payment schedule set out in contract.

Table 1: Project details and financials

Project name	Rapid inclined access development equipment
Project aim	Developing equipment that can be used to accelerate the development of inclined access infrastructure in underground gold and platinum group metals mines
Reporting month	March 2021
Amount co-funded by Mandela Mining Precinct	R---- (excluding VAT)
Amount paid to date	R---- (excluding VAT)
Outstanding amount	R---- (excluding VAT)

2 PROJECT PROGRESS

- This section provides a graphical representation of the project plan / project Gantt chart.
- A clear indication of the intended plan versus the actual progress is needed.
- The text and the schematic shown below is for demonstrative purposes and can be deleted and replace with the project specific details.

Table 2: Legend

Legend	
Planned	
Off-track and needing support	
Issues impeding progress	
On-track	
Not started	

Task	Progress	Timelines						Variations	Corrective actions / Comments
		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6		
Task 1	Planned								
	Actual								
Task 2	Planned								
	Actual								
Task 3	Planned								
	Actual								
Task 4	Planned								
	Actual								

3 PROJECT RISKS

- A risk in this context refers to an uncertain event or condition that may negatively affect the project deliverables (scope, schedule and cost.)
- The probability of a risk occurring is classified as low, medium or high.
- The impact of the risk on project deliverables if it occurs is classified as low, medium or high.
- Risk mitigation refers to feasible measures, which must be put in place to eliminate the risk or reduce the impact of the risk on project deliverables (scope, schedule and cost).

Table 3: Project Risks

No	Risk description	Affected tasks	Risk Probability (Low, Medium, High)	Risk Consequence (Low, Medium, High)	Risk Mitigation
1					
2					
3					
4					

Annexure 6: CFPs adverts in Mining Weekly, Linkedin, CSIR website and Mandela Mining Precinct website respectively

Group out of local manufacturing

CREAMER MEDIA'S ENGINEERING NEWS

Magazine round up | 28 May 2021

REAL ECONOMY NEWS IN REAL TIME

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CLOSING DATE: 18 June 2021

CFPs advert in the Mining Weekly



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The Mandela Mining Precinct and the #CSIR invite suitably qualified organisations to submit proposals in response to the two calls below. For more information and to download the required documentation please visit <https://lnkd.in/driAhyX>



MANDELA MINING PRECINCT
MINDS FOR MINES

CALL FOR PROPOSALS (CFP)

The Mandela Mining Precinct and the Council for Scientific and Industrial Research (CSIR) hereby invite suitably qualified organisations to submit proposals in response to the two calls below.

RAPID HORIZONTAL ACCESS DEVELOPMENT

CFP No. (01/17/00202)

The rapid development of horizontal tunnels is necessary to provide roadways for transportation of personnel and materials, ventilation and access to the ore body. Accelerated development of horizontal tunnels can assist in ensuring the availability of equipped "adequate faces" and "buffer faces" to mine all the time. This will significantly increase the chances of attaining planned conformant blasts.

There is therefore, an opportunity to develop equipment that will enable the rapid development of horizontal access infrastructure for South African hard rock narrow reef underground mines. The equipment will be used to accelerate the development of horizontal access infrastructure (specifically haulages and crosscuts) in hard rock narrow reef underground mines, particularly gold and platinum group metals mines.

RAPID INCLINED ACCESS DEVELOPMENT

CFP No. (02/17/00202)

The rapid construction (development) of inclined access infrastructure enables mining to commence quicker and at a lower cost thus, leading to high output. The rapid development of inclines results in the availability of additional "adequate faces" and "buffer faces" to mine all the time. This will significantly increase the chances of attaining planned conformant blasts. There is therefore, an opportunity to develop equipment that will enable rapid development of inclined access infrastructure for South African hard rock narrow reef underground mines. The equipment will be used to accelerate the development of incline access infrastructure (specifically raises) in hard rock narrow reef underground mines, particularly gold and platinum group metals mines.

For more information and to obtain the full call for proposal including guidelines and evaluation criteria, contact **Vuyo Tstotsotso**: vtstotsotso@csir.co.za.

Deadline: Friday, 18 June 2021 at 16H00. Late submissions will not be considered.



CFPs advert on LinkedIn



CALL FOR PROPOSALS (CFP)

Date: Thursday, May 20, 2021 to Friday, June 18, 2021

CALL FOR PROPOSALS (CFP)

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Deadline: Friday, 18 June 2021 at 16H00



Documents to download:

- [Inclined Rapid Access Development Template](#)
- [Terms of Reference](#)
- [Horizontal Rapid Access Development Template](#)
- [Terms of Reference](#)

CFPs advert on CSIR website

MINDS FOR MINES



CALL FOR PROPOSALS (CFP)

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Deadline: Friday, 18 June 2021 at 16H00



CFPs: DEVELOPMENT OF RAPID HORIZONTAL AND INCLINED ACCESS DEVELOPMENT EQUIPMENT

The Mandela Mining Precinct and the Council for Scientific and Industrial Research (CSIR) hereby invite suitably qualified organisations to **submit proposals** in response to the two calls below.

CFPs advert on Mandela Mining Precinct website

Annexure 7: Declaration of conflict of interest and confidentiality agreement form

 CSIR Touching lives through innovation	 MANDELA MINING PRECINCT MINDS FOR MINES	
MECHANISED MINING SYSTEMS (MMS) PROGRAMME DECLARATION OF CONFLICT OF INTEREST AND CONFIDENTIALITY EVALUATION OF PROPOSALS FOR THE CONCEPT DESIGN AND PROTOTYPE DEVELOPMENT OF RAPID HORIZONTAL ACCESS DEVELOPMENT EQUIPMENT FOR NARROW REEF HARD ROCK UNDERGROUND MINES (CFP No: 001/07/052021)		
I (please print full name) of (please print organisation details)		
(Declaration of Interest) 1. Declare that neither I nor any of my immediate family¹ have any interests, pecuniary or otherwise, other than that mentioned below or described in the attached sheet(s), which could reasonably be construed as having any influence on the proper and objective performance by me of my duties in relation to the evaluation of the proposal received from Novatek Drills (Pty) Ltd. Note: Interests to be declared include but are not limited to: affiliations; conference funding; equipment donations; financial assistance; travel assistance; rebates; hospitality; relationships; shares; company ownership; training and development; consultancy services; gifts; and/or sponsorships. Declared Interest: Additional Information attached? Yes / No (Please circle and initial as applicable) 2. Agree to truthfully declare, in writing to the Accountable Authority or delegate, any changes which may occur that relate to the matters stated in clause 1 of this Declaration, as soon as practicable after I become aware of the same.		
¹ Immediate family members are spouses, de facto partners, children, parents, brothers and sisters.		

(Declaration of Confidentiality)

3. Agree to keep all information and documents relating to the Request planning, development or evaluation process confidential, and not to disclose or communicate the same to any person or persons except in the course of my duties without the prior written approval of the CSIR and Mandela Mining Precinct;
4. Agree not to make copies of, or take any extracts of information except as may be necessary and essential for the due and proper performance of my duties;
5. Agree to return all documents, papers and other materials given to me relating to this project to the project manager immediately when requested to do so; and
6. Acknowledge that conflicts of interests, breach of confidentiality and unauthorised disclosure are subject to the provisions and penalties contained in the relevant South African legislation.

This declaration is made by me on the understanding that I will not be taken to have breached its terms if I am legally required to disclose the information referred to.

Signed:

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Dated

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