



MANDELA MINING PRECINCT
MINDS FOR MINES

TECHNICAL CLOSE-OUT REPORT FOR THE PERIOD – 2018/2019

Programme: LoCM

Project: Support

Work package: 4

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1 EXECUTIVE SUMMARY

During year one of the Longevity of Current Mines (LoCM) programme, a need was identified for a lightweight, easily installed underground support unit. The scope was envisaged as a continuation of work done by Impala Platinum (Implats). Implats identified composite sticks as an alternative to timber support, which is heavy, difficult to handle, and which may face supply constraints in the near future.

Work Package 4 (Support) was initiated and scoped to continue development of the composite pipe stick developed by MechCal (subsequently MOC) in collaboration with Implats. The initial budgets proposed by MOC could not be accommodated, so the project changed direction to consider other non-timber-based support options. Rescoping was done, but not executed as MOC subsequently agreed to a scope which would focus on prototype development. A new scope was prepared for the proposed work. A Memorandum of Agreement (MoA) was drafted between MOC and Minerals Council South Africa (MCSA). Further execution of the project was delayed until the approval of the MoA in October 2019.

Work done so far indicates that the MOC composite pipe stick has the potential to replace timber sticks and may compete with grout-based yielding support when assembled as clusters. Initial testing of the MOC prototype shows impressive load-bearing capacity and yielding characteristics. The response, however, also shows sudden load drops and a lack of consistency in certain batches. The work planned will focus on addressing these shortcomings through numerical simulation and prototype design and testing. The scope should be revised to reflect changing timelines and interim progress.

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2 INTRODUCTION

2.1 Background

During the Mining Phakisa it was clearly articulated that mining operations are struggling to remain profitable, primarily due to depleting ore resources, rising costs and inefficient production. The Longevity of Current Mines (LoCM) programme is an initiative within the SAMERDI programme to identify and develop processes - to be implemented in the short term - to extend the life of current operations which are based around the drill-and-blast cycle. The support activity was identified as a critical path of the production cycle, requiring further investigation into optimisation for safer operations and improved production output which could result in reserves being mined for longer. Work package 4 (WP4) – Support - was proposed in the 2018/2019 budget.

The project is aimed at delivering a lightweight support unit for use in underground mines. This will enable quicker support installation, resulting in improved shift cycle efficiency, and it is likely to reduce worker fatigue. The support unit will also be manufactured using composite material instead of timber, which can be constrained by shortages. The potential exists for local communities to manufacture the units using purpose-built equipment.

The primary objective for this project was to provide a successfully tested prototype of the composite pipe stick.

3 PROJECT PROGRESS

3.1 Evolution of the work package scope and activities

Year 1 of the Longevity of Current Mines (LoCM) program identified challenges within the current mining cycle. One of the needs identified was for a lightweight, easily installed underground support unit. The original scope for the work package is presented in Table 1.

The scope was conceptualised as a continuation of work done by Impala Platinum. In the year 2000, Impala Platinum (Implats) conducted research into alternative support systems for stope support. Implats, which predominantly uses timber-based support, identified composite sticks as a potential alternative. Three manufactures were approached to develop the composite stick, namely MechCal, Saltus Poles and Xuba Polymer Industries. MechCal was selected as the best option. After Phase 1 (development of the composite stick) was completed, the project was stopped by Impala Platinum due to budgetary constraints.

It was envisaged that the MMP would resume the project at Phase 2, which comprised the testing of the already-developed composite stick prototypes. The “Support” work package was initiated and planned as indicted in Table 1. The allocated budget was mainly for independent laboratory and in situ testing of the composite stick, assuming the final prototypes were completed during Phase 1 of the project.

Table 1. Original project scope for the development of a composite pipe stick

No	Milestone	Activities	Milestone Timelines		Milestone Cost (R)
			Start Date	End Date	
1	Start-up meeting with OEM	Set up meeting and meet the OEM	08/18	08/18	48 000
2	Obtain and review Implats trial documentation	• Contact OEM • Establish motivations and analyse trial results • Identify applicable environment based on strength, yield ability and other properties • Establish which timber based support is similar to the composite stick for comparative studies	09/18	09/18	70 000
3	Obtain yielding timber elongates with similar characteristics for comparative study	Source the timber based support with similar characteristics to the Composite stick for comparative testing	09/18	09/18	50 000
4	Secure lab testing facility and test both the timber and composite elongates	Conduct load-deformation testing of the composite stick and the timber support	09/18	09/18	154 000
5	Analyse the results and write a report	• Analyse the test results and plot load-deformation graphs • Conduct statistical analysis of the data to obtain mean values for each support unit	09/18	10/18	100 000
6	Modify the composite stick with the OEM (if necessary)	Based on the comparison and applicable environment check whether the composite stick is comparable to the timber support, if not change the composite stick mixture	10/18	10/18	26 900
7	Identify trial site at a yielding underground environment	Identify suitable test site based on support demand and design support spacing and layout of the composite for the trial area	10/18	11/18	50 000
8	Define monitoring objectives and methodology with various stakeholders. This will include risk assessments, roles and responsibility allocation with stakeholders (including MOSH implementation plan adoption) for the successful trial	Meetings with various stakeholders to conduct risk assessment and define monitoring objectives for the overall project	11/18	11/18	100 00
9	Obtain monitoring instrumentation such as closure loggers, closure robots, fog lights and other risk mitigating instrumentation	• Obtain a quotation from the supplier for monitoring equipment • Purchase the monitoring equipment to be used during the trial	12/18	02/19	120 000
10	Conduct trial at a yielding environment	Monitor the performance of the composite stick underground based on the defined monitoring objectives	03/19	05/19	200 000
11	Draft report	• Compile all information into a close out report with recommendations or value proposition for the composite stick • Research into localisation of the composite stick, define the requirements for localisation	05/19	05/19	19 200
12	QA-QC of the report	Circulate report for review	05/19	05/19	26 800

Meetings were held with Implats and with the OEM, which was subsequently became MOC Technologies (MOC). Implats indicated that they had selected the MechCal/MOC pipe stick based on the following potential benefits:

- Lighter than timber.
- Flameproof.

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- Potentially cheaper than timber.
- Easy to install.
- Could be produced locally, using local SMMEs in a local industrialisation program.
- The design could be altered to suit different environments (yieldability at depth, etc.).

Implats appreciated that the composite sticks were more expensive than timber poles. The business case for Implats was based on reducing production cost through economies of scale, managing anticipated pressures on the reliability of timber supply and the need for affordable yielding support at depth.

Meetings were held with MOC to discuss further development of the prototype. They supplied a proposal and cost estimate for MR 3.4 to complete laboratory and underground tests, and to conduct pilot plant testing. The available budget at this stage was only MR 0.95. In light of the shortfall and the possibility that the collaboration would not continue, the project was re-scoped to consider alternative support lightweight systems through the execution of industry surveys and workshops. The proposed scope is presented in Table 2. The changes were communicated to MMP management in October 2018.

Table 2. Revised scope for developing alternative support systems

No.	Milestone	Milestone timelines (mm/yy)		HR costs (R)	Total (Excluding VAT*) (R)
		Start	End		
1	Draft a close out report on the work completed (testing programme, Impala trials and independent value proposition based on the work from Impala platinum)	26/10	07/11	94 000.00	94 000
2	Develop survey methodology to be applied for industry participation in the survey to identify research focus for year 3 (interaction with the Steering Committee and SATCAP)	26/10	23/11	94 000.00	94 000.00
3	Conduct a survey with Rock Engineers, Department of Minerals Resources, Mine Managers and other stakeholders to identify industry needs to address the FOG risk by ensuring support is installed correctly, timeously at all times	26/11	30/11	100 000.00	100 000.00
4	Analyse feedback from the survey and prepare for a workshop	30/11	14/12	54 000.00	54 000.00
5	Conduct a workshop to identify the project focus for year 3	18/12	18/12	54 000.00	54 000.00
6	Draft a proposal for year 3 project and submit to the Steering Committee	19/12	22/12	54 000.00	54 000.00
Total					451 200.00

Before the proposed events could take place, further meetings were held with MOC and they suggested a scope which would focus on prototype development in February 2019 (Appendix A). A Memorandum of Agreement (MoA) was prepared and the scope was amended again (Table 3) in April 2019. The MoA was ultimately signed in September 2019.

Table 3. Revised scope for continuing development of the MOC composite pipe stick

No.	Milestone	Milestone timelines (mm/yy)		HR costs (R)	Running cost (R)	Total (Excluding VAT*) (R)
		Start	End			
1	Project initiation	Aug-18	Oct-18	72,750		72,750
2	Close out report for composite stick submission	Aug-18	Nov-18	251,500	20,840	279,690
3	Laboratory testing of the composite stick	Nov-18	Jan-19	101,060		101,060
4	Comparative study of the performance of the composite stick with conventional timber support such as Strocams, pencil stick and timber packs	Dec-18	Feb-19	100,900		100,900
5	Price comparison of the composite stick with conventional timber support such as Strocams, pencil stick and timber packs	Feb-19	Mar-19	65,250		65,250
6	Drafting of the value proposition for the composite stick and schedule for further testing	Feb-19	May-19	70,000		70,000
7	Submission of the close out report to the Steering Committee	Feb-19	May-19	64,900		64,900
Total				726,360	20,840	747,200

As discussed above, three scopes were ultimately prepared for this project to accommodate changes in research direction. The following sections deal with delivery against the last approved scope (Table 2).

3.2 Milestone 1: Project Initiation

The research team started with the first milestone, which was to contact OEMs through start-up meetings to discuss the work package requirements and determine the OEM's ability to participate in the design and manufacture of the set criteria prototype.

The OEM met twice with the team from the MMP to discuss the composite sticks. An introductory meeting was held at MOC where basic information was shared and a way forward was agreed upon. A second meeting was held where the specifications of the sticks, manufacturing process and test results were shared. Further to that, laboratory consultants were approached and testing procedures were developed. Quotations were received from the OEM (to manufacture the sticks) as well as from the laboratory consultants (to test the sticks). Subsequent to this, engagements took place between Timrite, MOC and MMP researchers. It was agreed that further testing would take place at Timrite's facilities. A non-disclosure agreement was drawn up for Timrite, but this was never signed. The failure to obtain an NDA, together with concerns regarding possible conflicts of interest, resulted in preliminary testing being done at the CSIR's Rope Testing facility.

The milestone deliverables were met and completed to the cost of R55,250.

Milestone 2: Close-out report for composite stick submission

The second milestone deliverable was to submit a close out report for composite stick. This close-out report presents the details of the work which transpired up to the point of the second

milestone been completed. The work completed amounts to R244,690.00, which concludes the deliverables for milestone 2.

3.2.1 Technical details of the composite pipe stick

A compression test result on a prototype composite pipe stick is shown in Figure 1. The yielding capacity of the unit is aptly demonstrated by the maintenance of 380-500 kN loads up to deformations of 160 mm. The response also shows sudden decreases in load bearing capacity (at 30 and 58 mm deformation). These were associated with failure of the circumferential fibres and resulting splitting down the axis of the unit, as highlighted in Figure 2. Moreover, Figure 2 shows that the damage is localised at the end of the unit, and that the yielding mechanism is associated with progressive “unpeeling” of longitudinal strips. This mode of failure causes preferential failure at the ends of the unit, and effectively inhibits the undesirable buckling failure mode. It was noted during meetings with MOC that it would be necessary to test units of lengths representative of typical mining heights, to confirm that buckling does not occur.

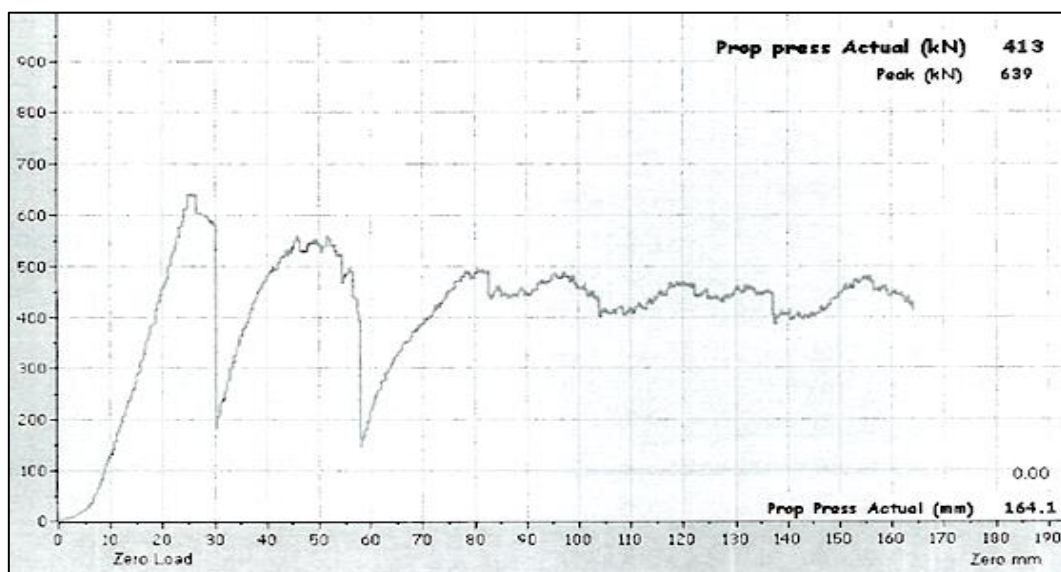


Figure 1. Load-deformation response of a short (400 mm long) MOC composite pipe stick



Figure 2. Localised failure at the end of the pipe stick, showing breakage of circumferential fibres

MOC has tested a number of “engineered” units at Timrite. The results from one of these sets of tests are shown in Figure 3. These results show reduced load drops following the initial failure of the unit. It must be noted, however, that these tests were not observed by the research team and the results cannot be confirmed until such tests have been observed or conducted by MMP researchers.

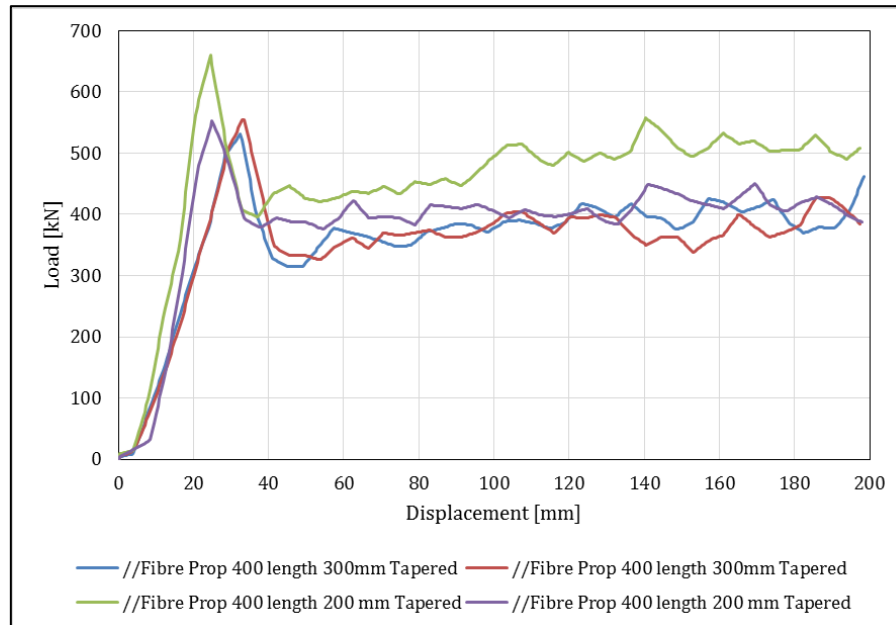


Figure 3. Test results for “engineered” composite pipe sticks

3.3 Milestone 3 to 5: Develop questionnaire and survey methodology to be applied; Conduct Survey; Conduct a Workshop

The last-approved scope included the development of a survey questionnaire, to conduct a survey and to conduct workshops that would inform strategies for the development and uptake of novel support systems. This work was initiated, but was placed on hold as a result of an agreement being reached with the composite stick manufacturer regarding the further development of their product. The project was then re-scoped (Table 3) to focus on funding development of the MOC product.

Only the costs associated to the researcher’s time and rates were declared for payments from CSIR, which these payments were made prior to March 2019. The milestone 4.3 amount declared was R66,060.00 and milestone 4.4 amount declared was R90,400.00. Milestone 4.5 was cancelled and no amount was declared or payment being made.

In anticipation of the tests to be conducted in Milestone 3, the current state of the composite pipe stick (CPS) development was evaluated, and is described in the next section. This information provides some background and details on the current status of the technology.

3.4 Milestone 3.6: Submission of Final Close-out Report

The project was scoped to include the development of a survey questionnaire, and to conduct workshops that would inform strategies for the development and uptake of novel support systems. In the interim, agreement was reached with the composite stick manufacturer (MOC

Technologies) regarding the further development of their product. The milestone 5 was cancelled as it was found not applicable as the project progressed and due to the delay which resulted from finalising the Memorandum of Agreement. The project was then re-scoped to focus on funding development of the MOC product.

The first two deliverables for the project are project initiation and completion of the close-out report. These have been achieved, but further progress has been stalled by delays in finalising the memorandum of agreement (MoA) between MOC and Minerals Council South Africa (MCSA). The MoA was signed in August 2019 which concluded the deliverables of the work package deliverables for the budget 2018/2019. The close out report was completed and are herewith being submitted as the final close-out report, which this final milestone deliverable amounts to R44 400.00

4 RECOMMENDATIONS

The composite pipe stick has the potential to provide support and yielding capacity comparable with yielding timber units. The units weigh approximately one quarter of equivalent timber support, and can be manufactured locally. It is possible that local mining communities can manufacture the units. Projected unit costs are not yet comparable with individual timber support units, but, when the units are combined into clusters, the cost of these is competitive with equivalent grout-based options.

The phase 3 deliverables are set out in the signed MoA. This work package deliverable resides under the Budget 2019/2020. The manufacturing of 1.6m pipesticks are to be tested and the deformation results are to be documented. This follows further cluster testing of pipesticks, which would result in a final report been submitted to TSC for approval, which is scheduled for completion in March 2020. The scope for work to be done through MMP should be revised to reflect changes within the project and interim progress.

5 APPENDICES / SUPPORTING DOCUMENTS

5.1 Appendix A – Proposal from MOC



Composite design Poles

Reference Number: MEC_Q2019-IMP-14

Date: February 2019

Version: 3

Nelson Mandela Mining Precinct/CSIR

Our Ref: MEC_Q2019-IMP-14

Your Ref: Attention: Nondumiso Nkosi Email: NNkosi2@csir.co.za Tel: 12 March 2019

Research and investigation of substitute Mine Props

Dear Nondumiso, We thank you for the opportunity to submit this quotation and trust that it meets your requirements. Please do not hesitate to contact us should you have any queries or need additional information.

1 SCOPE OF WORK

The underlying technology has been completed by MOCTech and is the platform for the continued work for the development of alternate supports for the mining sector. High success was achieved during a few tests in the last part of 2018 and is the basis for continued work. After a meeting held on the 9th January 2019 the following was decided as the next phase of development/Testing.

Planned activities for single mine poles:

1. Model the possible failure modes for the composite stick to understand the current behavior and identify methods of inducing failure. (160 hours FEA)
2. Manufacture 25, 40mm long composite sticks to test the failure modes (5 of each failure method) (120 hours, 25 poles)
3. Test the 25 composite sticks (8 hours)
4. Select the best design (2 hours)
5. Manufacture 30, 1.6mm long composite sticks (130 hours, 30 poles)
6. Test the 30 composite sticks, possibly test at Groundwork or UP and Timrite (see Groundwork

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for the quotation) (8 hours)

7 Test the composite stick (40mm) for FST and moisture (we can reuse the sticks here) (8 hours)

8. Close out report for underground testing (24 hours)

Planned activities for cluster stick:

9. Manufacture 3 types of composite clusters one with 5 poles, the next with 7 poles and the last one with 9 poles (8 hours) (285 hours, 63 poles)

10. Test the clusters (8 hours) 11. Define the engineering of the pack (8 hours)

2 DELIVERY

A memo shall be generated and be subject to approval by all stakeholders before proceeding. In conclusion, the options shall be listed and the next phase of the project shall be planned taking into account the knowledge gained during the above test phase/investigation.

3 EXCLUSIONS

Anything not specifically mentioned in the scope of work or the deliverables is not incorporated in this quotation.

4 PRICE

DESCRIPTION	COST
Single mine poles	R438 080.00
Cluster Pack	R277 268.00
TOTAL (Excl VAT)	R715 348.00

Engineering Costs per hour: R820/hour

Technician Cost per Hour/fabrication: R450/hour

Cost of material and consumables R40kg poles average is 15kg

5 SCHEDULE

The work defined in the scope, preceding, can commence as soon as a purchase order is received. It will be completed according to an agreed project plan, but is a 4 to 6 month delivery.

6 VALIDITY

This quotation is valid for a period of 21 days.

7 TERMS AND CONDITIONS

This quotation is subject to our standard terms and conditions, which are available on request.

By awarding a contract to, or placing a purchase order on, MocTech, the terms and conditions are agreed to and accepted by Nelson Mandela mining precinct

8 Indemnity for consequential losses of damages

MocTech shall have no liability in contract or legally for any loss of profit, loss of business, increased costs of operation or any consequential losses or damages no matter howsoever arising.

9 GUARANTEES/ warrantee

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MocTech's liability from all sources shall be limited to the provision of corrective services only for the services, as supplied, in terms of the contract, to correct errors and omissions of MocTech's own making only.

10 TERMS OF PAYMENT

The following payment terms apply to the complete contracts:

Milestone progress payments will be agreed to by project team and will be accompanied by a completion certificate per task

11 COMMUNICATION

All correspondence regarding any contractual matters shall be addressed to:

MocTech (Pty) Ltd

Attention: Gavin Ratner Tel: +27 83 3520306

5.2 Appendix B – Terms of Conditions with MOC



Corner Carlow & Rustenburg Road
PO Box 91230, Auckland Park, 2006



+27 11 358 0003



enquiries@MandelaMiningPrecinct.org.za

Mr Gavin Ratner
6 Director Road
1619 Kempton Park – Spartan Ext 21
Gauteng South Africa

4 March 2019

Dear Gavin

The terms and conditions (T&Cs) for the composite pipestick test work are detailed as follows:

Terms and Conditions

1. Agree and sign the Memorandum of Agreement.
2. Agree and sign the Terms and Conditions.
3. Test work can commence following the acceptance and final signatures of the Memorandum of Agreement and the Terms and Conditions.
4. Model different failure modes.
5. Manufacture 25 x 40mm long samples of the composite pipestick.
6. Design 5 different modes of inducing failure for the 25 x 400mm composite pipestick. Each failure mode will be tested on 5 identical samples.
7. MMP researchers to view all test samples and verify test results.
8. Record test results for each sample (25 off) as follows:
 - a. Finalise and confirm the test site and facilities;
 - b. Measure dimensions of each sample and confirm that each sample is identical;
 - c. Photograph and number each test sample prior to test work;
 - d. Calibrate test device to confirm the integrity of the device, prior to any test work;
 - e. Design and finalise the test criteria, with MMP researchers;
 - f. Complete the testing of the 25 x 400mm samples in the presence of MMP researchers;
 - g. Record all test results and failure details for each failure mode. MMP researchers must verify all the test results;
 - h. Record photographs of each test sample, before and after test work;
 - i. Compare results of all failure modes and record the decision for further test work. Further test work will be based on the failure mode which recorded the best strength results according to the test criteria;



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9. Manufacture 30 x 1.6m long composite pipesticks, for further test work. These 30 samples will be based on the failure mode which recorded the best strength results according to the test criteria, as follows:
 - a. Finalise and confirm the test site and facilities;
 - b. Measure dimensions of each sample and confirm that each sample is identical;
 - c. Photograph and number each test sample prior to test work;
 - d. Calibrate test device to confirm the integrity of the device, prior to any test work;
 - e. Design and finalise the test criteria, with MMP researchers;
 - f. Complete the testing of the 30 x 1.6m samples in the presence of MMP researchers;
 - g. Record all test results and failure details for each 1.6m sample. MMP researchers must verify all the test results;
 - h. Record photographs of each test sample, before and after test work;
10. Test the composite pipestick (40mm sample) in terms of reactions to:
 - a. Moisture and fire, smoke and toxicity (FST). The test samples used in previous test work can be re-used for these tests
 - b. Determine test criteria for these tests
 - c. All test work to be completed with MMP researchers present
11. Compile a close out report describing all test work, results, findings, conclusions and recommendations for further work.
12. Manufacture 63 x 1.6m length composite pipesticks for cluster test work. Three types of clusters will be tested as follows:
 - a. 5 composite pipestick cluster x 3;
 - b. 7 composite pipestick cluster x 3;
 - c. 9 composite pipestick cluster x 3;
 - d. Finalise and confirm the test site and facilities;
 - e. Measure dimensions and shape of each sample and confirm that each cluster is relevant for comparison with a pack type of support;
 - f. Photograph and number each test cluster prior to test work;
 - g. Calibrate test device to confirm the integrity of the device, prior to any test work;
 - h. Design and finalise the test criteria, with MMP researchers;
 - i. Complete the testing of the cluster samples in the presence of MMP researchers;
 - j. Record all test results and failure details for each cluster sample. MMP researchers must verify all the test results;
 - k. Record photographs of each cluster sample, before and after test work;



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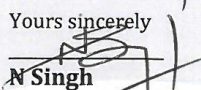
13. Define the engineering criteria and parameters for the cluster, with MMP researchers.
14. Document a final report of all findings and test work.
15. Describe how this project will be used within your company to develop human capital.
16. A risk register (what are the risks during the development of the support prototype, and how will these be managed).

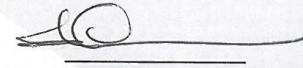
Payment Terms and Milestones

Payment will be structured according to the completion of defined milestones as follows:

Milestones Completed	Rand	Comment
Individual composite pipestick tests		
3	71,535	Mobilisation
4	58,533	Model failure modes
5	71,400	Manufacture 25 x 40mm poles
6	4,340	Test 25 x 40mm poles and select best design
7	1,640	MMP verify test results and select best design with MOC Tech.
9	83,900	Manufacture 30 x 1.6m poles
9	4,340	Test 30 x 1.6m samples
10	5,080	Test 40mm sample for moisture and FST
11	122,180	Project management and close out report
Sub Total	422,948	
Cluster Composite Pipestick tests		
12	179,000	Manufacture 63 x 1.6m poles
12	4,340	Test clusters
13	6,560	Define Engineering
14	102,500	Project management and close out report
Sub Total	292,400	
Total	715,348	

Yours sincerely


N Singh
Co-Director- Mandela Mining Precinct
Precinct


A Macfarlane
Co-Director- Mandela Mining
Precinct

5.3 Appendix C - Memorandum of Agreement with MOC

- Also accessed at:

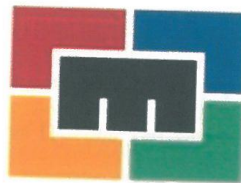
<https://drive.google.com/file/d/1NDQG9dTes5GDmfoL5BQX39kGb1lHfkqQ/view?usp=sharing>

CONFIDENTIAL

MEMORANDUM OF AGREEMENT

(hereinafter called "the Agreement")

between



**MINERALS COUNCIL
SOUTH AFRICA**

THE MINERALS COUNCIL SOUTH AFRICA

The Minerals Council South Africa means an employer's organization registered in terms of the Labour Relations Act (with Registration number: LRA/2/6/3/2) herein represented by **Mr Sietse van der Woude** in his capacity as Senior Executive: Modernisation and Safety who confirms that he is duly authorised thereto by virtue of his signature to this Agreement

(hereinafter referred to as "Minerals Council")

AND

MOC TECHNOLOGIES PROPRIETARY LIMITED

(hereinafter referred to as "MOC Tech")

A private company, with company registration number 2002/017804/07 and with its principal place of business at 6 Director Road, Kempton Park- Spartan Ext 21, Johannesburg, 1619 as herein represented by **Mr Gavin Ratner**, acting in his capacity as Director and duly authorised thereto

(jointly referred to as "Parties" and individually as "Party")

1. INTRODUCTION

- 1.1. The Mandela Mining Precinct ("MMP") means the public-private partnership that stems out of the Mining Phakisa held in 2015 to facilitate and coordinate the research activities pertaining to the South African Mining Extraction Research, Development & Innovation ("SAMERDI") Strategy.
- 1.2. The broad aim of Mining Phakisa, held in October 2015, was to foster growth, transformation, investment and employment preservation and creation along the entire mining value chain, in relevant input sectors and within communities affected by mining activities. This is to be achieved by conducting innovative research and development initiatives in collaboration with industry, the OEM's within the mining supply chain, tertiary education institutions, and Government departments, such as the DST and DTI as well as other stakeholders in the industry.
- 1.3. The SAMERDI Strategy, adopted post the Phakisa as the Mining Research and Development claims to maximise the returns of South Africa's mineral wealth through collaborative, sustainable Research, Development, Innovation and Implementation of mining technologies in a socially, environmentally and financially responsible manner that is rooted in the wellbeing of local communities and the national economy. The Mandela Mining Precinct is the physical location where the Research and Development ("R&D") activities will be coordinated from. The Mandela Mining Precinct provides a management oversight in the implementation of the SAMERDI strategy.
- 1.4. In line with the SAMERDI strategy, there is a need for the development of a lighter and easy to install support system to replace timber based support in underground mining activities.
- 1.5. MOC Technologies Pty Ltd, a private company (registration number 2002/017804/07), was identified as one of the industry manufacturers to deliver the composite stick prototype.
- 1.6. The parties, in respect of their mission and initiative, agree to jointly collaborate with respect to Phase 2 of the composite pole elongate and cluster support and wish to record the framework of such intended collaboration.

2. DEFINITIONS

In this Agreement, unless clearly inconsistent with or otherwise indicated by the context of the pursuant Agreement, the following words, terms or phrases have the following meanings:

- 2.1. **"Agreement" or "Memorandum of Agreement"**: This collaboration agreement together with all Annexures and Appendices hereto;
- 2.2. **Background Intellectual Property**: Any Intellectual Property owned or controlled by either of the Parties as at the Signature Date, and made available by a Party to the other for purposes of conducting the Project as well as all Intellectual Property rights in existence before the Signature Date as well as Intellectual

Property developed by a Party to this Agreement after the commencement of this Agreement and which does not fall within the scope of the definition of Foreground Intellectual Property;

- 2.3. **"Business Day" or "Day"**: Any day except a Saturday, Sunday or statutory public holiday in South Africa;
- 2.4. **"Commencement Date"**: the start date of project implementation, which is 15 July 2019;
- 2.5. **"Confidential Information"**: proprietary technical and commercial information, whether written, electronic, oral, or graphic, that includes without limitation a party's Background Intellectual Property, Foreground Intellectual Property, the Results, the disclosing party's past, present or future research, development, business activities, products, services and technical knowledge, and which has either been identified in writing as confidential, or is of such a nature (or has been disclosed in such a way) that it should be obvious to the receiving party that it is claimed as confidential. In the context of any obligation relating to Confidential information the party disclosing Confidential Information is referred to as the "disclosing party" and the party receiving the Confidential Information is referred to as the "receiving party";
- 2.6. **"DST"**: Department of Science and Technology
- 2.7. **"DTI"**: Department of Trade Industry
- 2.8. **"Foreground Intellectual Property"**: Intellectual Property conceived, created or developed in the execution of a Project;
- 2.9. **"Intellectual Property" or "IP"**: Intellectual capital in the form of any and all technical or commercial information, including specifications and formulae; know-how, data, systems and processes; production methods; trade secrets; undisclosed inventions, financial and marketing information; as well as registered or unregistered intellectual property in the form of patents, trademarks, designs, and copyright in any works, including literary works or computer software programs;
- 2.10. **"IPR-PFRD Act"**: Collectively, the South African Intellectual Property Rights from Publicly Financed Research and Development Act, 2008 (Act 51 of 2008) and its Regulations;
- 2.11. **"Mandela Mining Precinct"**: means the public –private cooperation that stems out of the Mining Phakisa held in 2015 to facilitate and coordinate the research activities pertaining to the South African Mining Extraction Research, Development & Innovation (SAMERDI) Strategy;
- 2.12. **"Minerals Council South Africa"**: an employer's organization registered in terms of the Labour Relations Act (with Registration number: LRA/2/6/3/2) with its principal place of business at 5 Hollard Street, Marshalltown, Johannesburg;

- 2.13. **"MOC Tech"**: a private company with registration number 2002/017804/07 and principal place of business at 6 Director Road, Kempton Park-Spartan Ext 21, Johannesburg, 1619;
- 2.14. **"OEM"**: Original Equipment Manufacturer
- 2.15. **"Party"**: MOC Tech or Minerals Council as determined by the context;
- 2.16. **"Personnel"**: A Party's officials, employees, consultants, contractors, students and researchers;
- 2.17. **"Project"**: A joint project or activity undertaken in terms of this Agreement, and detailed in this Agreement;
- 2.18. **"Rules and Regulations"**: Each Party's internal policies, directives, rules and regulations;
- 2.19. **"SAMERDI"**: South African Mining Extraction Research Development and Innovation;
- 2.20. **"Signature Date"**: the date on which this Agreement is signed by the last Party to do so;

3. INTERPRETATION

- 3.1. In this Agreement:
 - 3.1.1. An expression which denotes-
 - 3.1.1.1. the singular includes the plural and *vice versa*;
 - 3.1.1.2. any gender includes the other genders;
 - 3.1.1.3. a natural person includes a juristic person and *vice versa*; and
 - 3.1.1.4. a Party includes a reference to that Party's successors in title and assigns allowed at law;
 - 3.1.2. Where appropriate, meanings ascribed to defined words and expressions in clauses 2.1-2.20 shall impose substantive obligations on the Parties.
 - 3.1.3. The clause headings appearing in this Agreement are for reference purposes only and will not affect the interpretation of the subject matter of this Agreement;
 - 3.1.4. Words and expressions defined in any sub-clause shall, for the purposes of the clause of which that sub-clause forms part, bear the meanings assigned to such words and expressions in that sub-clause.

- 3.1.5. The use of the word "including" followed by a specific example or examples shall not be construed or interpreted as limiting the meaning of the general wording preceding it and the *eiusdem generis* (of the same kind) rule shall not be applied in the interpretation of such general wording and/ or such specific example or examples.
- 3.1.6. In its interpretation, the *contra preferentum* rule of construction shall not apply (this Agreement being the product of negotiations between the Parties) nor shall this Agreement be construed in favour of or against any Party by reason of the extent to which any Party or its professional advisors participated in the preparation of this Agreement.
- 3.1.7. This Agreement shall be governed by and interpreted in accordance with the laws of the Republic of South Africa.
- 3.1.8. The Annexures to this Agreement form an integral part of the Agreement and will be read as if incorporated herein, provided that if there is any conflict between the body of the Agreement and the Annexures the meaning contained in the body of the Agreement will take precedence, unless the context expressly indicates otherwise;
- 3.1.9. If reference is made in this Agreement to any other document for the purpose of defining words and/or phrases used in this Agreement, the applicable definition or description in such document shall be read and interpreted in terms of this Agreement as if specifically incorporated herein.
- 3.1.10. Save where specifically provided otherwise, references to statutory provisions are to be construed as references to those provisions as amended or re-enacted or as their application is modified by other provisions (whether before or after the Signature Date) from time to time and will include any provisions of which they are re-enactments (whether with or without modification);
- 3.1.11. When any number of days is prescribed, it will be calculated exclusively of the first and inclusively of the last day unless the last day falls on a day which is not a Business Day, in which case the last day will be the first Business Day thereafter;
- 3.1.12. If the date on which any payment is to be made or any action is to be taken pursuant to this Agreement falls on a day which is not a business day (i.e. any day except a Saturday, Sunday, public holiday in South Africa), then such payment shall be made or such action shall be taken on the immediately preceding business day.
- 3.1.13. Where figures are referred to in numerals and in words, if there is any conflict between the two, the words will prevail.
- 3.1.14. Expressions defined in this Agreement will bear the same meanings in Annexures to this Agreement which do not themselves contain their own definitions.

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- 3.2. Each Party must ensure that any decision, determination, instruction, inspection, examination, testing, consent, approval, expression of satisfaction, acceptance, agreement, exercise of discretion (whether sole or otherwise) or similar act required by it from another Party in respect of this Agreement must be applied for or requested promptly.
- 3.3. Whenever this Agreement provides for approvals, consents or expressions of satisfaction by any one of the Parties, that Party may not unreasonably withhold or delay that approval, consent or expression of satisfaction.

The expiry or termination of the Agreement will not affect such of the provisions of the Agreement as expressly provide that they will operate after any such expiry or termination or which of necessity must continue to have effect after such expiry or termination, notwithstanding that the clauses themselves do not expressly provide for this.

4. CONFIDENTIALITY

4.1. The Parties shall:

- 4.1.1. Treat as strictly confidential any and all Confidential Information given or made known to them as a result of this Agreement
- 4.1.2. Assume responsibility for the observance of the provisions of this Agreement by their employees;

4.2. The above undertakings shall not apply to:

- 4.2.1. Confidential Information which at the time of disclosure is published or otherwise generally available to the public;
- 4.2.2. Confidential Information which after disclosure by the disclosing party is published or becomes generally available to the public, other than through any act or omission on the part of the recipient;
- 4.2.3. Confidential Information which the recipient can show was in its possession at the time of disclosure, and which was not acquired directly or indirectly from the disclosing party;
- 4.2.4. Confidential Information rightfully acquired from others who did not obtain it under pledge of secrecy to any of the Parties; and
- 4.2.5. Confidential Information which the recipient is obliged to disclose in terms of an order of court subpoena or other legal process and in the event of the recipient receiving a subpoena or other validly issued administrative or legal process requesting the disclosure of Confidential Information, the recipient shall promptly notify the disclosing Party thereof.
- 4.2.6. Confidential Information which either of the parties requires for research purposes or to fulfil other purposes and obligations in line with

this agreement and other specific agreements which the parties have agreed to.

- 4.2.7. Both parties agree to publish research information on credible platforms but should beforehand inform each other about such intention
- 4.3. This Agreement shall not confer rights to any invention, discovery improvement or know-how currently existing or emerging from the execution of this Agreement or any further joint project of any of the Parties, and the ownership of such rights and the use thereof shall form the subject matter of a separate agreement or agreements between the Parties. Unless a separate agreement about the subject matter of this clause 4.3 is subsequently entered into between the Parties, in writing, the provisions of this clause 4.3 shall remain valid and binding. The provisions of this clause 4 shall survive any termination/cancellation of this Agreement, for whatever reason, for a period of two (two) years following such termination/cancellation.
- 4.4. In the event of termination of this Agreement for any reason, each Party shall forthwith return to the other Parties all electronic documents and papers relating to the operations of the other Parties which came into their possession and they shall procure that their advisors or representatives do likewise.
- 4.5. Save as expressly agreed to in any Project Specific Agreement (as defined in clause 5.1 below) no right or license is given by the Disclosing Party to the Receiving Party to use the disclosing Party's Confidential Information.

5. SCOPE OF THIS AGREEMENT

- 5.1. This Agreement sets out the basis on which the Parties shall negotiate in good faith in order to the development of the composite pipe stick, such as but not necessarily be limited to those contained in **Annexure "A"** hereto, with the aim of concluding a formal contractual agreement or agreements relating to such identified areas of possible collaboration ("Collaborative Projects"). For each Collaborative Project the Parties will conclude an agreement in terms of which various tasks can be undertaken towards the research, development and training work required for the Collaborative Projects ("Project Specific Agreement").
- 5.2. Consistent with each Party's applicable policies and procedures, areas of collaboration under this Agreement may include, but not limited to, those set out below and/or contained in **Annexure "A"**:
 - 5.2.1. Areas of collaboration under this Agreement will consist primarily of supporting MOC Tech in achieving the implementation of its strategy to continue the development of the composite pipe stick.
 - 5.2.2. Any other activities as mutually agreed upon in writing.

6. PROPOSED FORMAL AGREEMENTS

- 6.1. As envisaged in clause 5.1 above, it is the firm intention of the Parties to enter into a Project Specific Agreement on a project-by-project basis, which Agreement(s) shall incorporate the terms of this Agreement, as well as such other terms as the Parties may subsequently consider desirable or necessary for the specific Collaborative Project.
- 6.2. The Minerals Council will assist MOC Technologies in the development of the products for the benefit of the mining industry at large, however it is hereby unequivocally agreed between the Parties that all right, title and ownership in and to the product(s) developed in terms of this Agreement shall remain that of MOC Tech, unless otherwise agreed to in writing and signed by both Parties.
- 6.3. The Parties record by their signature hereto that this document is intended to promote a business relationship in good faith, for the benefit of the Parties.
- 6.4. At the Signature Date hereof, the possible areas of collaboration, as apparent in clause 5, have been identified.

7. AGENCY AND PARTNERSHIP

- 7.1. No Party shall present itself as the representative of the other Party for any business, legal or any other reason nor shall it have the power of authority to commit the other Party, unless it receives the other Party's prior written consent.
- 7.2. Nothing in this Agreement shall be interpreted as establishing a partnership between or joint venture of the Parties and the Parties shall act as independent contractors.

8. COMMENCEMENT AND DURATION

- 8.1. Notwithstanding date of signature, this Agreement shall be deemed to have been in operation from the Commencement Date and shall remain binding for the duration of the Project, unless terminated prior thereto by mutual written consent between the Parties or by three (3) months written notice by one (1) Party to the other.
- 8.2. This Agreement may, on its expiry, be renewed by the Parties, in accordance with clause 11.2 below.

9. FINANCIAL ARRANGEMENT

- 9.1. Each Party will bear its own costs relating to the negotiation, preparation and signature of this Agreement.

- 9.2. Each Project Specific Agreement shall include the financial obligations of each Party in respect of a Collaborative Project.
- 9.3. The Minerals Council shall contribute the agreed financial commitment as per Annexure "A" hereto alternatively as necessary for the furtherance of this Agreement or as agreed between the Parties in writing by the Parties and payment shall be made as per the agreed milestones.

10. GOVERNING LAW

- 10.1 This Agreement shall be governed by and interpreted in accordance with the laws of the Republic of South Africa and any dispute arising therefrom shall be adjudicated by a competent high court in South Africa (unless otherwise agreed to between the Parties at the time by means of an arbitration or other agreement), and for these purposes the Parties agree to the exclusive jurisdiction of the South African courts for the adjudication of such disputes.
- 10.2 In the event of a dispute, the Parties shall first endeavour to resolve the dispute between themselves, failing which the dispute shall be resolved between the Parties on director level and if the dispute still remains thereafter, the dispute shall be resolved by an adjudicator, being the President of the Law Society of the Northern Provinces if the dispute is a legal matter. If the dispute is an accounting matter, the adjudicator shall be the President of Chartered Accountants. No technical disputes are foreseen as the specification and timelines are clearly set out in the Annexure hereto

11. GENERAL

- 11.1. This document and **Annexure "A"** hereto contain the entire Agreement between the Parties, and neither Party shall be bound by any undertaking, representation or warranty not recorded herein or added hereto as provided herein.
- 11.2. No alteration, variation, addition or agreed cancellation of this Agreement shall be of any force or effect unless reduced to writing as an addendum to the Agreement and signed by the Parties or their duly authorised signatories.
- 11.3. No failure or delay on the part of either Party in exercising any right, power or privilege hereunder shall operate as a waiver of this Agreement, nor shall any single or partial exercising of any right, power or privilege preclude any other or further exercise thereof, or the exercising of any other right, power or privilege. The rights and remedies herein expressly provided are cumulative and not exclusive of any rights or remedies which the Parties would otherwise have.
- 11.4. This Agreement shall be for the personal benefit of each of the Parties and may not be assigned in whole or in part by either Party without prior consent of the other Party, except that a Party's interest shall be assignable without the consent of the

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other in pursuance of any merger, consolidation or reorganisation or voluntary sale or transfer of all or substantially all the assigning Party's assets where the merged, consolidated or reorganised corporation or entity resulting therefrom or the transferee of such sale or transfer shall have the authority and power effectively to perform that Party's obligations to the other under this Agreement.

- 11.5. If any clause or term of this Agreement should be invalid, unenforceable or illegal, then the remaining terms and provisions of this Agreement shall be deemed to be severable therefrom and shall continue in full force and effect unless such invalidity, unenforceability or illegality goes to the root of this Agreement.
- 11.6. Where it is specified in this Agreement that certain matters are to be agreed between the Parties, failure to reach agreement in respect of such matter will not affect the validity and enforceability of the whole or any other part of this Agreement.
- 11.7. Neither Party is, by virtue of this Agreement, authorized to use the name, logo(s) or trademarks of the other in connection with any advertising, publicity, marketing or promotional materials or activities, or for any other purpose whatsoever, without the prior written consent of the other Party.
- 11.8. Both Parties shall remain free to use, in the normal course of its business, its general knowledge, skills and experience incurred before, during or after the discussions envisaged hereunder. To this end, it is also recorded that nothing in this Agreement shall be construed as constituting an exclusive arrangement between the Parties and both Parties shall remain free to explore market opportunities in any field, unless otherwise agreed to in writing in a subsequent agreement.

12. DOMICILIA CITANDI ET EXECUTANDI

- 12.1. The Parties choose the following addresses for the purpose of any notices, summons or execution to be served in terms of this Agreement, as follows:

12.1.1 For Minerals Council South Africa

Physical Address:	5 Hollard Street Marshalltown Johannesburg 2017
E-mail:	svdwoude@mineralscouncil.org.za
Tel number:	+27 11 498-7100

12.1.2 For MOC Technologies Pty Ltd:

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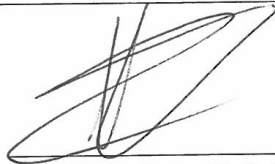
Physical Address: 6 Director Road
Kempton Park-Spartan Ext 21
Johannesburg
1619
Email: gavin@moctech.co.za
Tel number: +27 83 352 0306

- 12.2. Any notice or communication required or permitted to be given in terms of this Agreement shall be valid and effective only if in writing, but it shall be competent to give notice by e-mail.
- 12.3. Any notice to a Party -
- 12.3.1. sent by prepaid registered post (by airmail if appropriate) in a correctly addressed envelope to it at an address chosen as its *domicilium citandi et executandi* to which post is delivered shall be deemed to have been received on the 10th Business Day after posting (unless the contrary is proved);
- 12.3.2. delivered by hand to a responsible person during ordinary business hours at the physical address chosen as its *domicilium citandi et executandi* shall be deemed to have been received on the day of delivery; or
- 12.4. Notwithstanding anything to the contrary herein contained a written notice or communication actually received by a party shall be an adequate written notice or communication to it notwithstanding that it was not sent to or delivered at its chosen *domicilium citandi et executandi*.
- 12.5. Any notices addressed to a Party at its physical address may be delivered by hand or sent by e-mail and shall be deemed to be given on the date of such delivery or sending.

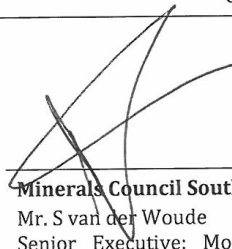
13. SIGNATURE AND COUNTERPARTS

This Agreement may be signed in two or more counterparts all of which together will constitute the entire agreement between the Parties.

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MOC Technologies Pty Ltd
Mr. G Ratner
Director



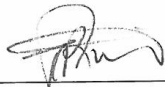
Minerals Council South Africa
Mr. S van der Woude
Senior Executive: Modernisation and
Safety

DATE: 3/09/2019

DATE: 15/08/2019

PLACE: Johannesburg

PLACE: JOHANNESBURG



WITNESS 1



WITNESS 1



WITNESS 2



WITNESS 2

ANNEXURE "A"

AGREED POSSIBLE AREAS OF COLLABORATION AS PER CLAUSE 5.2

The terms and conditions (T&Cs) for the composite pipe stick test work are detailed as follows:

Terms and Conditions

1. Agree and sign the Memorandum of Agreement.
2. Agree and sign the Terms and Conditions.
3. Project work can commence following the acceptance and final signatures of the Memorandum of Agreement and the Terms and Conditions.
4. Model the possible failure modes for the composite stick to understand the current behaviour and identify methods of inducing failure.
5. Manufacture 25 x 40mm long samples of the composite pipe stick.
6. Test the 25 x 40mm composite sticks.

MMP researchers to view all test samples and verify test results.

Record test results for each sample (25 off) as follows:

- a. Finalise and confirm the test site and facilities;
 - b. Calibrate test device to confirm the integrity of the device, prior to any test work;
 - c. Design and finalise the test criteria which are based on 5 different modes of inducing failure to the 5 identical sample tests, with MMP researchers;
 - d. Measure dimensions of each sample and confirm that each sample is identical;
 - e. Photograph and number each test sample prior to test work;
 - f. Complete the testing of the 25 samples, 5 identical tests per failure mode as per test criteria in the presence of MMP researchers;
 - g. Record all test results and failure details for each failure mode. MMP researchers must verify all the test results;
 - h. Record photographs of each test sample, before and after test work;
7. MOC Tech representatives with MMP researchers compare results of all failure modes, select and record the design specifications for further test work. Further test work will be based on the failure mode which recorded the best strength results according to the test criteria;

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16. Compile a risk register (what are the risks during the development of the support prototype, and how will these be managed).

Payment terms and Milestones

Payment will be structured according to the completion of defined milestones, which these deliverables are due as from the "Commencement Date" as follows:

Milestones Completed	Price in SA Rand (Excl VAT)	Duration	Comment
Individual composite pipe stick tests			
3	71,535	1 Week	Mobilisation
4	58,533	1 Week	Model failure modes
5	71,400	5 Weeks	Manufacture 25 x 40mm poles
6	4,340	1 Week	Test 25 x 40mm poles and select best design
7	1,640	1 Week	MMP verify test results and select best design with MOC Tech.
8	5,080	1 Week	Test 40mm sample for moisture and FST
9	83,900	4 Weeks	Manufacture 30 x 1.6m poles
10	4,340	1 Week	Test 30 x 1.6m samples
11	122,180	1 Week	Project management and close out report
Sub Total	422,948	16 Weeks	

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Cluster Composite Pipe stick tests			
12	179,000	9 Weeks	Manufacture 63 x 1.6m poles
13	4,340	1 Week	Test clusters
13	6,560	1 Week	Define Engineering process for bulk manufacturing
14	102,500	1 Week	Project management and close out report
Sub Total	292,400	12 Weeks	
Total	715,348		