ANNEXURE A - PROJECT PLAN

Note: This Project Plan is covered under the AEL/CPUT Umbrella Agreement (No. 4400021818) on Research and Development Projects
Research Project No CPUT/AEL MS 006

Mining Services

1. **Project Title and Overview**
Self-assembling molecules as the oxidiser component in an explosive – Novel Dimension for Explosive Materials

The Project is expected to be divided in two phases.
Phase 1 [February 2015 – January 2017]: one Post Doc; Phase 2 would be considered on success of Phase 1 and business needs

PROJECT NUMBER:	CPUT/AEL MS 006
PROJECT DESCRIPTION: *(Background, objectives, methodology)*	Project Scope: The project focuses on a novel explosive matrix whereby a self-assembling oxidiser phase (at molecular level) will be mixed in the fuel phase. The molecule must be designed to have self-assembling properties when mixed in the fuel phase. Therefore, the molecule must be amphiphilic (similar to surfactant structure), with the core being the oxidiser. Project Objectives: • Phase 1: explicit literature review as well as initial research on the design and development of the novel amphiphilic molecule, which includes initial synthesis and modelling of the molecule. • The design and development of the novel amphiphilic molecule, synthesis and modelling of the molecule. • The use of this novel molecule in the explosive matrix. Project Description: For more than a decade CPUT has gained expertise in the emulsion explosive field, especially on a molecular level. Due to this vast understanding, CPUT has the capability of expanding their expertise into a complete new family of explosives. The self-assembling oxidiser is to be mixed in the fuel phase to form a novel explosive matrix. The self-assembly (SA) refers to the process by which discrete components spontaneously re-organize themselves (stacking) when in contact with the fuel phase. This stacking is due to specific interactions with their environment (fuel phase/diluent). It is essential that the building blocks (SA oxidiser) organize themselves into ordered, macroscopic structures. This new family of explosives can be compared with the nano-emulsion explosive principle. Not that the molecule is nano-sized, but rather the "aggregation/stacking" property

	of the molecule. Therefore, This new explosive matrix will not require a surfactant The interaction of the oxidiser molecule with the fuel occurs at a molecular level, not at the interface. This could improve the sensitivity and the energy of the explosive. Chemistry is the main element in this research. Through the use of concepts developed in supra-molecular chemistry, molecular interactions can be tailored and used to create ordered assemblies (oxidiser). The project plan CPUT/AEL MS 005 also being developed for the gassing in the fuel phase (one-component and two-component gassing systems) could be applied to this new explosive matrix development. Project commercial benefits: • The development of a new type of explosive systems with enhanced sensitivity and possibly better blasting performance (when compared to current emulsion explosives) • The elimination of the use of surfactants in the fuel phase. • No stability issues in terms of crystallisation as this new explosive is not an emulsion with super-cooled oxidiser • A simplified phase manufacturing process (mixing and cooling) • The potential of developing "waxless" packaged explosives

2. Contacts:

2.1. AEL's Project Manager:
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E-mail address: Larry.Wilson@aelms.com

2.2. AEL's Project Coordinatior:
Name: Ellina Kharatyan
Telephone number: 011 605 2253
E-mail address: Ellina Kharatyan@aelms.com

2.3. The Institution's Project Manager:
Name: Prof Irina Masalova
Telephone number: 021 460 3565
E-mail address: masalovai@cput.ac.za

3. **Term**

3.1. Phase 1:

Starting Date: 01 February 2015
Completion Date Of Project: 31 January 2017

This project (Phase 1) will be funded for two years starting February 2015. The Project may be terminated due to lack of progress and/or deliverables.

4. **SCOPE OF SERVICES – TO BE PROVIDED BY INSTITUTION (DETAILS REQUIRED)**

- A comprehensive literature review
- The design and development of the novel amphiphilic molecule, which includes synthesis and modelling of the molecule .
- The evaluation of the above novel amphiphilic molecule in explosives matrix. Including:
    - proof of possible enhanced sensitivity and blasting performance (when compared to current emulsion explosives) – Modderfontein site;
    - proof of possible no stability issues in terms of product crystallisation or enhanced shelf-life;
    - proof of a possible simplified manufacturing process.

Possible exclusions from the current Project

- None

5. **DELIVERABLES**
(Documentation and other items to be provided by the Institution (details required).

No.	Deliverable
1	Quarterly feedback update – in the form of a presentation and a report
2	Copies of all publications
3	Copy of the final Post Doc Report
4	Copy of the Dissertation/Thesis (PhD)

6. **CONTRIBUTIONS**

AEL Mining Services will supply all the raw materials required to manufacture the emulsion explosives to be tested (i.e. ammonium nitrate, all surfactants and diluted mining solvent).

AEL Mining Services will accommodate the researcher when the explosives properties of the emulsions are being investigated and tested at Modderfontein or else where.

CPUT will supply any specialized chemicals/equipment necessary for the project.

Funds and their sources:

Amount	Required for
Phase 1	
R500 000 first year (AEL MS) to be paid in two instalments of 6 months	1 x Post Doc bursary, materials, outsourcing equipment/expertise, travel
R500 000 second year (AEL MS) to be paid in two instalments of 6 months	1 x Post Doc bursary, materials, outsourcing equipment/expertise, travel

7. OWNERSHIP OF EQUIPMENT

Equipment to be procured using funding contributed by AEL	AEL%	Institution%
All capital items (specifies equipment) will be on loan to the University	100	0

8. INSTITUTION RESEARCH TEAM MEMBERS

Names	Role	Contact Details
Prof. Irina Masalova	Supervisor	masalovai@cput.ac.za (021) 460 3565
Naziem George	Lab Manager	georgen@cput.ac.za (021) 460 3689
Research Fellow	PostDoc	Details to be available on appointment

9. MILESTONES

9.1. The following table sets out the stages of the Project, and reporting dates. (At any time the Parties can revise the Project to ensure that the requirements of AEL are being met)

No.	Milestone	Completion Date
	Phase 1	
1	Initial Literature Review	30th April 2015
2	Progress report/Feedback: • A comprehensive literature review • The design and development of the novel amphiphilic molecule, which includes synthesis and modelling of the molecule • The evaluation of the above novel amphiphilic molecule in explosives matrix	30th April 2015 31th July 2015 31th October 2015 31th January 2016 30th April 2016 31th July 2016 31th October 2016
3	Purchasing required materials, experimental design, continue literature study	30th June 2015

4	Experimental part of work, continue literature study	31th October 2016
5	Write up final report	31st January 2017

NOTE: Phase 2 of the project is subject to suitable performance of research by the Cape Peninsula University of Technology (CPUT) and an understanding of the possible final commercial success demonstrated in Phase 1 of the project. The detailed mile stones will be determined at a later stage as an Appendix to this Project Plan.

The Institution shall immediately, at any stage of a Project, notify AEL's Project Manager in writing if it considers that any material deviation in the Project is imminent. The Institution shall include in such notification the reason for such deviation and to what extent the Project may be affected by the deviation. The Institution shall not proceed with the deviation unless AEL's Project Manager has given, in writing, his/her consent to proceed therewith.

10. IPR ACT

10.1. THE PARTIES ACKNOWLEDGE THE PROVISIONS OF THE IPR ACT

10.2. Is the Project to be funded by AEL on a full cost basis as referred to in Section 15(4) of the IPR Act?

Yes [ ] No [X] (tick as applicable)

For and on behalf of AEL MINING SERVICES LIMITED

For and on behalf of the Institution

Funding and related contributions – (details of Fees and details of Reimbursable Expenses).

The total fees associated with the Project Phase 1, which will commence on 01 February, 2015 and terminate 31 January 2017 is R1 000 000 (one million Rands), which is to be divided into 4 payments over a 2 year period with all costs including VAT.

Detailed milestones have been set for the Project Phase 1.

The Project Phase 1 should entail Progress Reports (written and also a presentation) where the progress can be clearly demonstrated.

Phase 2 of the project is subject to suitable performance by the Cape Peninsula University of Technology (CPUT) and an understanding of the possible final commercial success demonstrated in Phase 1 of the project.

10.3. If the Project is not to be funded on a full cost basis as referred to in Section 15(4) of the IPR Act then the Project IP arising from the Project, which does not constitute AEL IP, constitutes the Institution's IP and, in respect of the Institution's IP, the Parties shall prior to the Starting Date of the Project conclude a Licence Agreement on the basis of the pro forma agreement contained in Annexure B.

10.4. AEL Mining Services will have the first refusal of any possible IP licensing initiative.

FOR: AEL MINING SERVICES LIMITED

Sign: _____ Sign: _____

Name: L. S. Wilson. Name: SAMIR MUKHOPADHYAY

Project Manager Senior Manager for Academic Research

Date: 28 OCTOBER. Date: 31 October 2014

Place: MODDERFONTEIN Place: Pinelands

Sign: _____ Sign: _____

Name: C.L. Kelly Name: M. Nera

R&D Manager AEL MS Contract Managert

Date: 31.10.14 Date: 12.11.2014

Place: Pinelands Place: Modderfontein

FOR: THE INSTITUTION

Sign: _____

Name: T. Maseko

Project Manager

Date: 19.11.2014

Place: Cape Town