Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

NIA Project Registration and PEA Document

Date of Submission

Jan 2020

Project Reference Number

NIA_SGN0159

Project Registration

Project Title

Vacuum Excavation for Local Transmission System (VELTS) - Stage 2

Project Reference Number

NIA_SGN0159

Project Licensee(s)

SGN

Project Start

November 2019

Project Duration

0 years and 10 months

Nominated Project Contact(s)

Oliver Machan – Innovation Project Manager

Project Budget

£185,067.00

Summary

Vacuum excavation (VacEx) has become a routine working practice for utilities during their maintenance, repair and replacement of buried assets. Benefits in urban environments include more rapid exposure of the assets, particularly where multiple and congested services are present, smaller excavation footprint, reduced damage to assets, improver operative safety, and reduced disruption and delay to highway users.

In contrast to its successful (if limited) deployment in urban environments, the gas industry has made only limited use of the technology (on average three times per year over the last five years) for Local Transmission System (LTS) asset excavations in rural environments - despite its acceptance as an approved practice under current safe working guidelines. LTS challenges are different - gone is the requirement for a rapid, low intervention dig with minimal impact on road users, however the ability to safely displace hand digging operations in close proximity to higher risk assets does offer scope for VacEx to deliver substantial value to the business and its stakeholders.

A feasibility study (Stage 1) has been conducted under SGN's supervision to understand the use and perceived attitudes within SGN towards vacuum excavation near LTS assets in rural areas and questions the technical, logistical and risk barriers restricting its use. This study identified what technology developments and modified working practices might facilitate its extended use, for example as a safe excavation practice around valves, standpipes and protective sleeves. The vision is to remove all hand dig operations around LTS assets.

The scope of work for the second and the third stages of the project following the feasibility study conducted in Stage 1 is outlined below. In Stage 2 of the project, an excavator head will be developed and go through laboratory testing and validation. The validated excavation head will then be integrated in the VacEx unit in Stage 3 of the project and the system will be tested and validated on site in the UK.

Nominated Contact Email Address(es)

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Problem Being Solved

At present, excavations over and around the LTS is both time consuming and costly. Although commercially available suction systems

exist, their use in reality is restricted due to the challenging legislative and physical environment of the LTS.

The typical footprint requiring excavation for most situations is around 16m2 to a depth of 2-4m giving an extraction volume of 32-64m3. Ground types vary considerable in and between the network areas, ranging from freely draining sandy and loamy soils though raised bog peat soils to thick impermeable clayey soils and lime-rich soils over chalk or limestone. Currently this is hand dug, which is hazardous to workers, time consuming and costly.

After completion of stage 1 feasibility, we aim to develop an excavator head and go through laboratory testing and validation. The validated excavation head will then be integrated in the VacEx unit in Stage 3 for testing and validation on a live gas site.

Method(s)

Following the successful completion of the Stage 1 - feasibility study (NIA_SGN0129), Stage 2 aims to construct a prototype and test the VELTS system, culminating in stage 3 - a full-scale field trial.

The tasks and deliverables are highlighted below:

Tasks

Air nozzle design through computer simulation and laboratory testing

Design of the excavator head according to the specifications of MTS vac truck

Testing and validation on a vac truck in the US

Deliverables

Excavator head with integrated nozzles (for attachment to the stock MTS vac truck hose and boom)

Successful shop testing of the system in the US using vac truck

Scope

The objective of this project is to develop an excavation head that can be integrated on a vacuum excavator to effectively agitate the soil for fast and efficient soil removal around LTS assets. The proposed solution will be a standalone unit that can be integrated into a VacEx uni. This system will be known as VELTS (Vacuum Excavation for the Local Transmission System).

1- Air nozzle design

Air excavation is the process of using compressed air to disturb the earth's soil which is then vacuumed up into a debris tank. Air excavation is used to safely expose underground utilities and allows backfill with the dry material. A properly designed air nozzle for air excavation can increase the amount of soil agitation and improve system efficiency. Based on the research that ULC Robotics has conducted around the design of the air nozzles, specific nozzle designs can be more effective in certain areas depending on the type of soil and moisture level.

During this phase of the project, ULC Robotics focus on modifying the nozzles developed under the RRES project to optimize their use for the VELTS system. The learnings from the RRES project provides a great starting point for further development of air nozzles to be incorporated into the excavator head for this project.

2- Design of the excavator head

Based on the specifications of the air nozzles developed for the application and the specifications of the VacEx unit procured for the project, ULC will design and develop an end effector to be mounted on the stock vacuum hose of the excavator that would allow the operators to efficiently agitate the soil for removal through the vacuum hose. A prototype excavator head will be designed, fabricated and tested on the VacEx unit during shop and field testing.

Notes:

· ULC will evaluate the practicality and technical feasibility of controlling the angle of the air nozzle to enable agitation from various angles under the excavator. The nozzle may be pneumatic or hydraulically actuated using existing connections on the vac truck or via an auxiliary system (compressor). The price/scope associated with designing and prototyping an angularly adjustable nozzle have not been included in this phase of work.

· In order to minimize design time and modifications to enable integration with the vac ex boom/hose, information and drawings which detail the available connection points and other pertinent information related to the vac ex system should be provided to ULC prior to the start of the excavator head design tasks for the project.

Objective(s)

The objective of this project is to develop an excavation head to be integrated on a vacuum excavator to effectively agitate the soil for fast and efficient soil removal around LTS assets. The proposed solution will be a standalone unit that can be integrated into an existing VacEx unit.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be deemed successful if the following has been achieved:

- Excavator head constructed with integrated nozzles
- Successful shop testing of the system

The key milestone outputs are shown below:
1) System Specification Document
2) Simulation results of the nozzle design
3) Doc on Nozzle Design and Lab Testing
4) Excavating Head Specification Doc
5) Doc on Design of the Excavator Head
5) Shop Testing

Project Partners and External Funding

ULC Pipeline Robotics

Potential for New Learning

The project is expected to provide all Network Licenses with a fundamental understanding of whether it is possible to introduce a cost effective and safe vacuum excavator's system in the challenging legislative and geographical rural areas of the LTS.

Scale of Project

The project aims to design, fabricate and test the excavator head that then can be integrated on a vac excavator to be trailed on the LTS.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

The development, laboratory testing and validation of the excavator head will be carried out at our partners office.

Revenue Allowed for the RIIO Settlement

There are no direct saving benefits anticipated.

Indicative Total NIA Project Expenditure

The total expenditure for Stage 2 is £185,067, 90% of which (£166,561) will be recovered via the NIA funding mechanism in line with the funding conditions.

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

n/a

How the Project has potential to benefit consumer in vulnerable situations:

n/a

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

The financial benefit will be dependent on the assumed performance of the vehicle and the ability to realize savings from current labor arrangement.

From our stage 1 feasibility report, an outline business case forecasts net benefits of around £4m over 5 years if VELTS vehicles were deployed across the business.

A fleet of between 2 and 4 vehicles would be sufficient to carry out all 'danger zone' excavations that are currently carried out by hand digging, with substantial expense in time and, importantly, detriment to operator welfare.

Please provide a calculation of the expected benefits the Solution

Benefits - costs

1st year which includes development costs = £-600,000

2nd year = £518,000

3rd to 6th year (2024) = £770,000 per annum

Please provide an estimate of how replicable the Method is across GB

The potential outcome of this project is applicable across all GDNs than manage transmission pipeline.

Please provide an outline of the costs of rolling out the Method across GB.

There are no costs associated with sharing the outputs and recommendations of this study with the other Network Licensees, which will be the first step to roll across GB.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

☐ A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).

☑ A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)

☐ A specific novel operational practice directly related to the operation of the Network Licensees system

☐ A specific novel commercial arrangement

RIIO-2 Projects

☐ A specific piece of new equipment (including monitoring, control and communications systems and software)

☐ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven

☐ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)

☐ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology

☐ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution

☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

The learning from this project will benefit all network licensees. If the project leads to the successful development of a safer and more cost-effective solution to the issues around excavating transmission assets then other network licensees will be able to use the learning generated to embed this new solution in their businesses. This will enable cost reductions and improvements in safety.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

The project aligns to the target area of repair and aims to improve the efficiency of excavation around the LTS as well as increasing the safety of the workforce.

☑ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

Is the default IPR position being applied?

☑ Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

A review has been made of all Network Licensees and no other similar projects have been identified.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

n/a

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

The delivered system will challenge current policies, guidance and procedures to reduce costs when excavating near LTS assets. The innovation of a smart excavator head fused with a deployable vac ex vehicle will eliminate the need to carry out the labour-intensive task of excavating in proximity of LTS, making the procedure cheaper, easier and safer.

Relevant Foreground IPR

n/a

Data Access Details

n/a

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

At the moment, Velts is at a low technological level and requires development before business as usual funding can support a proven system into an implemented practice.

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

The project can only be undertaken with the support of the NIA funding as the system still needs designed, tested and trailed before a commercially available product is produced. Some key risks of the Velts project are shown below: 1) Design of air-chunking system to avoid sudden stop/start of high pressure air and any consequential lurching. This is a development issue for both the hydraulic and air compression system. 2) Proximity or soft-touch smart sensor in head limits any force applied. This is most beneficial to excavation around standpipes and fittings. 3) Smart vehicle positioning and arc of boom/mechanical stops avert any possible contact. Although the rubber head will absorb any accidental impact of the head with pipeline assets, it is possible that the main articulating arm could make unintentional contact with the assets. Further consideration needed on boom position and mechanical stops.

This project has been approved by a senior member of staff

☑ Yes