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## NIA Project Registration and PEA Document

### Date of Submission

Jun 2014

### Project Reference

NIA\_SGN0056

## Project Registration

### Project Title

Mains and Service Replacement through Keyhole

### Project Reference

NIA\_SGN0056

### Project Licensee(s)

SGN

### Project Start

July 2014

### Project Duration

6 years and 6 months

### Nominated Project Contact(s)

Alex Stewart, Innovation Support Manager

### Project Budget

£2,538,611.00

## Summary

The scope of this project is to carry out detailed technical assessments, designs, development and field trials of keyhole tooling method and equipment for mains and service replacement activities that have the potential to be distributed and utilised safely and efficiently in Great Britain (GB) with minimal disruption to customers.

### Nominated Contact Email Address(es)

sgn.innovation@sgn.co.uk

## Problem Being Solved

From the 1850's up until the 1950's metallic mains were used extensively across Great Britain (GB) gas distribution network. Since then the gas industry has moved away from this source of material and is replacing those mains with polyethylene pipe, in order to reduce and eliminate risk of fracture, corrosion, and/or leakages. At present across Scotia Gas Network (SGN) there are approximately 5,000 kilometres of small diameter (Tier 1) metallic mains (<8") requiring replacement.

Throughout RIIO-GD1 Network Licensees are focussing attentions towards Tier 1 replacement activities as part of their total operating expenditure (TOTEX) targets. From 2013 and beyond, SGN have planned to undertake a large number of replacement projects per

annum. Such activities are strategically planned with live/dead insertion accounting for a large proportion of these works. Due to the high density of Tier 1 distribution mains in areas of domestic dwellings, inevitably any works carried out will result in a considerable impact on our customers.

SGN are now looking to develop a more advanced innovative solution to improve replacement activities of Tier 1 mains through the use of keyhole technology. The new method has the potential to allow mains and service replacement activities (up to 8") to be carried out in an effective way to minimise excavation footprints on replacement projects and reduce the disruption to our customers.

## Method(s)

The Project is split into two key Elements. Element 1 will provide a keyhole located and operated pipe installation system designated Grundopit KHD 1000/50. It will install PE pipes in the size range of 25mm through to 90mm but specifically will be provided with tooling for pipe sizes 63mm, 75mm and 90mm diameter. Combined with this a range of Long Handle Tooling (LHT) will be designed and manufactured to install and remove a service connection as required, all within the SGN designated keyhole and operated by hand from the carriage way or ground surface.

Element 2 is to design, develop and manufacture a mains replacement insertion system. The system will be designed for the live or dead insertion of pipes 63mm through to 180mm diameter in size inside existing metallic pipes from a 600mm diameter cored keyhole excavation.

This Project is designated to greatly reduce inconvenience to customers, makes the work less visible and decreases the amount of excavation required by other mains and service replacement methods. This trenchless technology provides potential for significant cost savings by decreasing the expenditure necessary for taking the main out of service, multiple excavations, restoration and required permitting for these activities.

## Scope

The scope of this project is to carry out detailed technical assessments, designs, development and field trials of keyhole tooling method and equipment for mains and service replacement activities that have the potential to be distributed and utilised safely and efficiently in Great Britain (GB) with minimal disruption to customers.

The Project has been broken down into a number of stages under each Element, as listed below:

### **Element 1 – Grundopit K**

#### **Item 1 – Grundopit KHD 1000/50**

- Design, develop and manufacture a steerable keyhole pipe installation system designed to fit into a 600mm diameter keyhole and produce the designated bore hole, for PE pipe sizes of 25mm through to 90mm in diameter, over a maximum distance of 30m subject to ground types.
- Live field trial of KHD 1000/50.

#### **Item 2 - Long Handle Tooling (LHT)**

- Design, develop and manufacture LHT to install and remove a service connection as required, all within the SGN designated keyhole and operated by hand from the carriage way or ground surface.
- Off site trials and live field trials of LHT.

#### **Item 3 – Corer Grundocore KH/SG**

- Design and manufacture one integrated, hydraulically powered, core cutting unit specifically to cut and remove a carriageway core (600mm in diameter) to a maximum depth of 630mm.
- Off site trials and live field trials of corer.

#### **Item 4 – Transportation**

- Undertake a joint feasibility of suitable vehicle required as per SGN specification.
- Produce a design layout with final vehicle specifications.
- Manufacture a suitable body frame for the lorry with conversion to house all items G-Pit KHD 1000/50, corer, LHT, PPE, fire extinguisher, space for six off safety barriers, three road signs and a hand wash system.
- Carry out off site field trials.
- Final field Vehicle delivery and final field trial carried out.

## **Element 2 – Pipe Pushing/Pulling Through Keyhole**

- Design, development, and manufacture pipe pusher, one of for pipe sizes 63mm to 90mm and one off for pipe sizes 110mm to 180mm.
- Carry out off site trials.
- Live field trial of pipe pusher.

For all of the stages identified, appropriate equipment operator manuals for the safe, correct operation and set up of the equipment produced will be provided, along with a standard designated SGN training course. The Project partner will appoint a Project management team with the technical expertise to support the necessary reporting and commercial appraisal aspects of the technology.

A change in project duration has been required to allow the continued development of this complex engineering project and allow the potential benefits to be fully realised.

The nature of this project is such that a large suite of cutting edge solutions have been design, development and manufacture; a new remote, double spindle coring unit, a keyhole located and operated pipe installation system designated Grundopit KHD 1250/50 as well as a range of long handled tooling, which are all housed in a bespoke vehicle in order to undertake service replacement activities through keyhole.

This suite of tooling was more complex and took longer than originally scoped due to the complexity and nature of the operations being carried out. All the tools and equipment have gone through a rigorous testing regime, SGN operatives have undertaken an extensive training programme and everything has been fully trialled and evaluated in offsite and live field trial conditions. All of this was difficult to foresee several years ago when scoping out the project and has ultimately taken longer than originally planned.

As a result of the above, Element 2 of this project has been delayed and is yet to commence. This element of the project is critical and thus by increasing the duration of the project (to March 2019) this will allow Element 2 to be completed in accordance with the project plan and the overall objectives, success criteria and benefits, as defined on registration to be fully achieved.

Element 1 of this project involved a detailed technical assessments and development of keyhole tooling equipment for mains and service replacement activities, as well as carrying out several field trials. A major focus point of this element involved installing PE pipes in the size range of 25mm through to 90mm from a 600mm diameter cored keyhole excavation. Other parts of this element included the development of a range of equipment including the Grundopit K, Grundocore, Long Handle Tooling (LHT) and suitable transportation method. The system is designed for live or dead insertion of pipes into existing metallic pipes from a 600mm diameter cored keyhole excavation.

From the closure of Element 1 of this project it was identified that inserting the PE pipes through a 600mm keyhole involves stressing the pipe beyond the manufacturer's recommendations.

It is therefore necessary to determine if the PE stress levels experienced by various diameters and pipe types are acceptable. It was identified that additional work is required to be carried out to further develop and assess the stresses experienced in several scenarios and their effect on the PE pipe.

It will be necessary to carry out bend trials with different radii, SDR ratios and bend radius to subject the pipe material to different values of stress. Additional testing will then be carried out to assess the effect of the higher stress levels applied during bending on the full lifetime of the pipe. These additional tests were not included in the original project. The necessary information is not currently available from other industry sources, therefore, the results will provide greater understanding and validation of the bending effects of PE pipe material and the pipe life expectancy.

This additional expenditure will allow testing to be completed on samples of pipe to confirm the maximum acceptable stress levels thereby allowing the continued development of the mains and service replacement technology through keyhole. In order to further develop this, an increase in expenditure of £464,341, which results in a revised increase total project cost of £2,538,611.

## **Objective(s)**

The objective of this project is to develop an innovative solution to be utilised in conjunction with SGNs keyhole excavation techniques, to allow the trenchless replacement of PE mains and services by both live and dead insertion methods. In order to address the scope, the work has been divided into two specific Elements, which represents sub-projects under the Project scope. The objectives of each Element are as follows:

**Element 1:** Design, develop and manufacture a keyhole located and operated pipe installation system that will install PE pipes in the

size range of 25mm through to 90mm, but specifically will be provided with a range of Long Handle Tooling (LHT) designed and manufactured to install and remove a service connection as

**Element 2:** Design, develop and manufacture a mains replacement insertion system for live or dead insertion of pipes (63mm through to 180mm diameter) inside existing metallic pipes from a 600mm diameter cored keyhole excavation.

The Project will evaluate the effectiveness of both Elements against current replacement methods to determine the potential cost benefit.

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

## Success Criteria

The project will be deemed to be successful if the following outcomes are:

- Carry out design, development and manufacture of mains and service technology and keyhole tooling to meet industry and SGN standards and
- Produce operator guidelines detailing the correct operating procedure of the equipment for the
- Development of an associated training packages for field
- Assess the potential benefits of this technology solution against current mains and service replacement activities.
- Produce and disseminate learning based on final project report.

## Project Partners and External Funding

N/A

## Potential for New Learning

This project is expected to provide all Network Licensees with a fundamental understanding of whether it is feasible to introduce further advancements to keyhole equipment and tooling into GB gas distribution network for the purpose of mains and service replacement.

This Project will facilitate the first gas distribution trials of mains and service replacement through a 600mm keyhole excavation in GB.

## Scale of Project

The aim is to run both Project elements in parallel and involve the research, design and manufacturing of keyhole equipment and tooling, along with all off site and on site trials and evaluation. A number of trials shall take place throughout the duration of the Project, both in Germany and GB (Bedford and Scotland). The field trials will allow SGN to assess the benefits of this innovative solution and deliver learning as outlined above.

The Project duration allows both SGN and the project partner to carry out all acceptance and evaluation work prior to approving the use of this technology within the GB gas distribution network. There would be less potential for learning if the scale of the project was any smaller than this.

## Technology Readiness at Start

TRL2 Invention and Research

## Technology Readiness at End

TRL8 Active Commissioning

## Geographical Area

All laboratory based research, design work, development, and manufacturing and off site trials will be carried out in a Tracto Technik facility in either Germany or Bedford, England. All equipment will be transported from Germany and/or Bedford, England to suitable live field trial sites located in Scotland. The live field trial sites have yet to be identified.

## Revenue Allowed for the RIIO Settlement

During RII-GD1 it is estimated that OFGEMs proposed allowance for 2013-21 Replacement Tier 1-3 activities for all Network Licensees is approximately £5,195.2m. While no direct saving on this is expected during the Project, it is anticipated that successful completion of this Project could in future potentially provide Network

Licensees with a significant cost reduction saving solution with regards to Tier 1 (25mm through to 180mm) replacement works

### **Indicative Total NIA Project Expenditure**

The total predicted project expenditure is £2,765,417, 90% of which is allowable NIA expenditure (£2,488,875).

## 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)

In addition to the operational, safety and customer impact benefits of this Project, the development of this technology and tooling has the potential to deliver substantial financial benefits. The benefits of deploying this in terms of cost savings will vary depending on the type and scale of replacement activity being undertaken. Based on early assumptions, the average cost savings over and above traditional Tier 1 replacement activities is estimated to be 10%. It is anticipated that these savings can be replicable throughout GB.

It is difficult to accurately quantify the actual financial benefit at this stage; as indicated by the low start TRL shows the Method is at an early stage of development and cost estimates will be refined as it is further developed. However, It is envisaged that deployment of this technology may lead to financial benefits in the following

- Reduction in excavations in the public
- Less excavated material send to
- More efficient and costs effective reinstatement
- Reduction in the import of virgin or recycled backfill
- Less disruption to customers and members of the general public.

#### Please provide a calculation of the expected benefits the Solution

This Project is designed to extend keyhole technology across wider gas distribution activities in GB. Key aspects of the Project will begin at a low TRL, however the Project has been structured around Go/No Go Stage Gates, where in the potential cost benefits of the Project will become progressively clearer.

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

There are approximately 5,000 km of small diameter (Tier 1) metallic mains (<8") requiring replacement across SGNs Scotland and Southern license areas per annum. Although it is recognised that this figure will inevitably reduce as SGN progress through RIIO-GD1, it can be assumed that SGN will still have a sufficient proportion requiring replacement, following the completion of this Project. It is also envisaged that the other Network Licensees may have identified a similar proportion of replacement projects (based on network size). Therefore, this Project has the potential to be rolled out across GB and provide future savings in the capital and operational

costs associated with mains and service replacement, while improving asset integrity.

It must be noted that these figures and assumptions are based on estimates and the nature of replacement activities across all Network Licensees and sites will vary, which could affect the potential to apply the method and the benefits of applying it. The main focus of this project is to research, design, develop and manufacture new keyhole technology solutions and understand the potential benefits.

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

As the number of replacement projects beyond the end date is unknown across GB, it is difficult to determine the exact roll out costs. There will be costs associated with sharing the results and learning of this project. SGN will continue to share Project progress throughout the duration of the project with the other Network Licensees.

Upon successful completion, Network Licensees will make a decision on whether to implement this solution throughout their organisations. Excluding the cost of purchasing the equipment, it is anticipated that the only foreseeable costs will revolve around the training costs for operatives. At present it is unclear as to how many operatives will be trained and how Network Licensees would choose to deliver training. More accurate quantification of roll out costs will be possible when the TRL of the Method is advanced.

### **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**

n/a

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

N/A

- 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 of all other Network Licensees' Innovation Funding Incentive Annual Reports has been performed, along with a review of the Smarter Networks Portal and no similar projects have been identified. A similar review of current academic literature and journals has also been performed to avoid any potential overlap with the current Project. Nothing of this nature has been done in GB. SGN are at the forefront of keyhole technology in GB gas distribution. As the first Network to develop this technology for GB, we have and will continue to share our learning with the other Network Licensees.

### 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

n/a

### 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

n/a

### 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

n/a

### This project has been approved by a senior member of staff

Yes