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

Jun 2015

Project Reference Number

NIA_SGN0077

Project Registration

Project Title

Solutions to Pipeline Graphitisation and Corrosion – Stage 1 - Concept Development

Project Reference Number

NIA_SGN0077

Project Licensee(s)

SGN

Project Start

June 2015

Project Duration

1 year and 1 month

Nominated Project Contact(s)

Stephen Tomlinson, Innovation Project Manager

Project Budget

£146,367.00

Summary

This project has been divided into 6 key work packages, see below:

WP1: Solution Specification

This work package will further study the causes of pipeline corrosion generally, with particular emphasis on the unique challenges of graphitisation. This will setup the framework for generating solutions to the problem.

WP2: Concept Generation

This work will result in a 'matrix' approach to generating the concepts and will look cross-industry, and across technical disciplines, as well as at existing technology / ideas currently in the public domain.

WP3: Initial Feasibility Assessment

This work package aims to carry out assessments on each of the concepts generated in WP2, conventional and novel. Once the selection of concepts is completed, they will be grouped into target areas of: prevention, arresting, remediation, monitoring. In the first instance expert partners will be sought to help in the feasibility assessment. This will result in a desktop assessment being made on all of these concepts. Where possible the desktop assessment will be backed up with a range of workshop assessments of each concept.

WP4: Shortlisting of Concepts

Results from the feasibility assessment will be used to rate each of the concepts. This rating will then be used to short list up to 6 concepts to be taken forward to initial testing with the aim to discover any specific technical blockers to obtaining a 'Proof of Concept'.

WP5: Initial Testing

This work package will take the shortlisted concepts and develop a set of tests to assess the validity of these concepts (in effect the

work is driven to try to obtain a 'Proof of Concept' result). The testing will build upon that carried out in the feasibility assessment through the use of small scale experimental and demonstration rigs for use of these concepts in the gas mains. The outcome of these tests will be a selection of proven concepts to take forward to formal engineering development in the next stage of the project.

WP6: Project Management, Reporting

A Steering Committee (made up of representatives from Steer Energy and SGN) will meet on a bi-monthly basis. Updates will be initially produced fortnightly outlining the work carried out to allow for fast-tracked feedback especially in the early concept development stages of this work; it is envisaged that this will then move to monthly once the initial concepts have been developed

Nominated Contact Email Address(es)

sgn.innovation@sgn.co.uk

Problem Being Solved

SGN operates two of the largest gas networks in the UK, providing a safe and secure supply of natural gas to 5.8 million customers through 74,000 km of gas mains and services. A significant proportion of these networks comprise cast iron pipelines, some of which have been in service since the late 19th century. Although these pipelines have served the industry well they can suffer from a form of selective corrosion known as Graphitisation. The 11,500 fracture and corrosion failure events and 940 'gas in building' events reported in 2004 show that a large number of these pipelines are reaching the end of their lifetime. Current Health and Safety Executive (HSE) legalisation has determined that Gas Distribution Networks (GDN's) must replace all cast-iron gas mains within 30m of properties – this means that over 101,000km of iron gas pipelines will have to be replaced by 2032.

Graphitisation, or graphitic corrosion, is the process by which in certain conditions, the iron component of cast iron pipes is selectively leached out, leaving the much weaker graphite component of the pipeline. This results in an increase of pipeline failures and their associated remediated costs.

During SGN's current Large CISBOT pilots being carried out in London and Edinburgh, pipeline coupons have been routinely analysed by a technical services provider, DNV.GL. Graphitic Corrosion has been detected on all samples to date with pipelines suffering from between 20% to 60% graphitisation. It can therefore be assumed that this is an issue that affects all cast iron pipelines within SGN's (and the rest of GB's) gas distribution networks.

The forecasted decommissioning lengths of at risk tier 2 and 3 mains under RIIO-GD1 is weighted towards the end of the price control period to allow time for investigations into pipeline issues to take place and to develop solutions. Ofgem's definition of 'Decommissioning' includes other risk intervention measures and is not limited to physical decommissioning, therefore any development that can address pipeline issues such as Graphitisation has the potential to assist in creating both cost and time efficiencies in meeting RIIO GD1 Tier 2 and 3 targets.

This project aims to approach the issue of pipeline graphitisation by developing concepts that can address the problem in one or all of the following ways; preventing, arresting, or remediating. These concepts will then be refined and undergo assessments to determine which should be moved on to the next project phase – Development Engineering.

Method(s)

From a high level perspective, solutions can be grouped by function:

- Prevention of the onset of degradation occurring
- Arresting further degradation preventing the situation worsening
- Remediation where degradation has already occurred
- Furthermore, the possibility of providing an option of ongoing condition monitoring for repairs will be investigated to deliver ongoing assurance of any pipeline repairs to complement the 3rd party inspection equipment being developed by SGN in alternative projects.

The project will examine solutions for all of these four categories, though it will focus on technologies to prevent, arrest, and remediate the pipelines, with the aim to develop up to six technology concepts.

An ideal solution would be a process of reversal of the corrosion whereby the iron or steel component is replaced in the corroded areas. If this is not possible then a remediation method which replaces the strength attributed to the missing iron would be desirable.

It is appreciated that this is a highly complex challenge requiring significant innovation and multi-disciplinary expertise. In order to minimise the risk to SGN, the work is planned to be carried out using a stage-gate approach. This NIA project scope describes the work packages for Stage 1 (concept development) of the overall proposed project which has been designed over 4 stages:

- Stage 1 – concept development
- Stage 2 – Development Engineering
- Stage 3 – Testing and Procedures
- Stage 4 – Field Trials

Scope

This project has been divided into 6 key work packages, see below:

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Objective(s)

This project aims to prove the concept of dealing with the issue of pipeline corrosion and more specifically to:

1. develop systems to prevent the onset of pipeline corrosion
2. develop systems to arrest existing corrosion processes in pipes
3. develop systems to remediate pipelines suffering from corrosion.

Furthermore, the possibility of providing an option of embedded condition monitoring for repairs will be investigated to deliver ongoing assurance of any pipeline repairs.

Recommendations for and progression to the next stage of development.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The following success criteria apply to this project:

- Creation of solution specification.
- Generation of concepts for investigation against solution spec.
- Completed initial feasibility assessment of concepts.
- Selection of up to six concepts for initial testing
- Initial testing of selected concepts.
- Completed full project report documenting findings and recommending next steps.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

This is a small scale initial development project that will be carried out off the gas distribution network. Due to the low Technology Readiness Level (TRL) it is not possible to accurately comment on the potential future scale until the completion of the project.

However, should the initial development provide positive outcomes, any future methods/products arising from the successful completion of this phase and all required future phases will be applicable throughout GB.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

This project will be undertaken by Steer Energy and their associates at their respective sites.

Revenue Allowed for the RIIO Settlement

During RIIO-GD1 it is estimated that SGN will spend approximately £255.7m and £209.6m on emergency and planned repairs respectively on all mains. As this project is a feasibility study for a technology at a low TRL, it is not yet possible to determine whether revenue savings are likely during RIIO-GD1.

Indicative Total NIA Project Expenditure

The total project expenditure is £146,367, 90% of which is allowable NIA expenditure (£131,730)

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)

This project is at a low TRL and it is therefore not possible to provide an accurate estimate of the potential saving to customers at this stage.

However, SGN are currently forecasting the decommissioning of over 420km of tier 2 and 3 mains during RIIO-GD1 and the successful development of technology that can assist in the remediation of pipes suffering from graphitic corrosion could enable efficiency improvement while achieving this target.

The cost benefit analysis carried out under SGN's current NIC Robotics project estimates that after successful development of the modular robotic platform and its survey of tier 2 and 3 mains, 55% of them will be eligible for remediation and 35% will require full replacement. Graphitic Corrosion is the predominate reason that replacement of these assets is required, therefore it is believed that this project has the potential to reduce the amount of assets requiring replacement and increase those that can be remediated.

Please provide a calculation of the expected benefits the Solution

N/A – low TRL.

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

The potential outcomes of this project are replicable across GB.

SGN have approximately 20,000km of metallic mains across all diameter ranges. Based on a 4:2:1:1 split with respect to the size of the Network Licensee's networks, the total length of mains across GB that this project could ultimately apply to in future years is approximately 80,000km.

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

There are no costs associated with sharing the conclusion and recommendations of this study with the other Network Licensees, which will be the first step towards roll out across GB. As stated above, the very early TRL means that it is not possible to estimate the costs of deployment at this stage.

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

All Network Licensees will be able to use the learning from this project as the outcomes will be presented in a clearly defined report that will be available to them on the Smarter Networks Portal.

The successful completion of this project will provide all UK Network Licensees with an understanding of the issues surrounding pipeline graphitisation and corrosion and the potential methods that are available to tackle these.

Although the TRL is too low at this stage to provide an accurate cost benefit analysis, future phases, if carried out, will determine potential benefits. This will then allow the Network Licensees to make informed choices as to whether to invest in any available or developed technology.

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.

n/a

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