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 2014

Project Reference Number

NIA_NGGD0022

Project Registration

Project Title

Study of crater formation threshold during gas leakage on high pressure pipes

Project Reference Number

NIA_NGGD0022

Project Licensee(s)

Cadent

Project Start

January 2014

Project Duration

2 years and 2 months

Nominated Project Contact(s)

Neil Jackson – National Grid Gas Distribution Project Manager

Project Budget

£92,400.00

Summary

The main objective is to develop and to validate a method and model to determine the limit between crater formation (that leads to a gas release into air with well known consequences) and gas migration in soils for gas transmission pipelines. The JIP partners are looking to develop learning in order to have a realistic model for the scenario of small leak on a high pressure pipe.

Experimental tests will be performed in order to collect data to develop and validate adequate models to determine this criterion. A two phase programme is planned. Phase 1 will involve a review of existing knowledge, followed by a series of large scale experiments to address the gaps in knowledge. Phase 2 will involve the development and validation of a mathematical model to determine the relationship between crater formation and gas migration for different soil types and pipeline parameters.

Tests will be performed with high pressure natural gas and hydrogen.

Experimental parameters for the characteristics are:

- Release diameter: 5 and 12 mm (to be representative of corrosion leaks)
- Release direction: upwards, downwards, horizontally
- Release pressure: 16, 40, 70 and 100 bar gauge.

If during the experiments it appears useful for the project partners to test another release diameter, it will be possible to test one less than 12 mm after checking that this release diameter have a compatible burst disk.

Experimental parameters for the ground characteristics are:

- Ground nature: clay, sand
- Ground compactness: q4 density

- Gas: methane, hydrogen

A video from above and sideways at ground level will be taken and based on the experimental results, analytical models will be developed in order to:

- Respect the main geomechanical models,
- Determine the main criteria for crater formation according to the various parameters (soil characteristics, pressure, size and orientation of leak).
- Quantify dispersion of gas in the soil (1D spherical or linear geometries).

Nominated Contact Email Address(es)

Innovation@cadentgas.com

Problem Being Solved

In order to meet to meet its obligations under current safety legislation including the Pipelines Safety Regulations, National Grid have developed risk models so that it can predict the likelihood and consequences of pipeline failure. These models currently assume that high pressure pipeline leaks always result in a release to atmosphere directly around the location of the failure. However it is known that very small leaks could potentially lead to gas migration through the soil into nearby properties. If this occurs it could significantly affect the predicted level of risk to individuals living near the pipeline. Therefore National Grid are proposing to co-operate in a joint industry project to undertake some large scale experiments to determine when gas migration rather than crater behaviour will occur.

Method(s)

The project will perform full scale tests on an experimental site in order to collect data and develop a model that can be used to determine the circumstances under which the gas released from a small leak in a high pressure pipeline will migrate through the soil rather than coming to the surface and forming a crater.

The project comprises of four key elements:

- Literature study
- Experimental Study
- Ground movement 3D video
- Model development

Scope

The main objective is to develop and to validate a method and model to determine the limit between crater formation (that leads to a gas release into air with well known consequences) and gas migration in soils for gas transmission pipelines. The JIP partners are looking to develop learning in order to have a realistic model for the scenario of small leak on a high pressure pipe

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Objective(s)

To develop and validate a methodology and a model in order to determine the limit between crater formation and dispersion of gas in soil for high pressure pipes.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The experimental work will be able to identify the conditions (pressure and leak sizes) under which gas soil migration rather than crater behaviour would occur. This would result in the development of a model that could be used to predict future behaviour.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The project includes full scale experimental tests on a buried section of high pressure pipe. Full scale tests are necessary to validate the modeling aspects of the work prior to business implementation.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL6 Large Scale

Geographical Area

The results of the project will be relevant to all of National Grid's buried above 7 bar assets across the whole of the UK.

Revenue Allowed for the RIIO Settlement

No Revenue Allowed for in the RIIO Settlement

Indicative Total NIA Project Expenditure

NGGD

£46,200 Total NIA Project Expenditure

NGGT

£46,200 Total NIA Project Expenditure

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)

Implications of high pressure gas pipeline incidents are extremely serious - The BP incident in the Gulf of Mexico has cost in excess of £40billion, and an incident on the Belgian transmission system, Fluxys, resulted in the death of twenty four people when a pipeline ruptured. The primary driver for this project is to reduce risks to individuals located in the vicinity of high pressure gas pipelines.

Projects Benefits Rating = 4/25

Please provide a calculation of the expected benefits the Solution

This project could lead to the reduction of a single potential fatality >£1.5m or more.

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

The results of the project will be relevant to all above 7 bar gas pipelines in the UK.

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

The project is about improving knowledge in this area across the UK, this will done by publishing a technical paper to share this knowledge. This is one of the defined outputs of the project following on from which updates will be made to all relevant internal standards and specifications.

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

On conclusion of the project a technical paper will be produced that can be made available to all Network Licensees.

This technical paper will give:

· A high level description of the experimental equipment and set up that was used;

· A high level summary of the conclusions of the project including whether gas dispersion in the soil was detected as well as crater behaviour;

· The circumstances under which the behaviour changed from crater behaviour to dispersion, e.g. at pressures below X bar g and hole diameters below Y mm. This would be in general terms and would not need to give detailed results of individual experiments i.e. depth of cover soil type etc.

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

This project will enable National Grid to ensure that it is taking appropriate steps to manage the risks associated with its high pressure gas pipeline network.

☑ 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