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 2019

Project Reference Number

NIA_NGGT0147

Project Registration

Project Title

Flow Loop Test for Hydrogen

Project Reference Number

NIA_NGGT0147

Project Licensee(s)

National Gas Transmission PLC

Project Start

June 2019

Project Duration

1 year and 1 month

Nominated Project Contact(s)

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Project Budget

£130,000.00

Summary

To evaluate the durability of pipelines materials in the context of the future proofing of gas grid service where the has mix include a significant proportion of hydrogen.

Third Party Collaborators

Sustainable Pipeline Systems Ltd

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

There is little understanding of what the impact that blended gas would have on the NTS. The Health Safety Laboratory (HSL) Hydrogen in the NTS desk top research project is examining the concept, along with the physical capabilities of the NTS for the transporation of hydrogen.

National Grid needs to understand the implications that a hydrogen rich gas mix may have on X52 12” pipe; x52 represents 12% across the NTS by evaluating this type of steel against the resistance to hydrogen embrittlement of high strength steel welds, may validate the safe transportation of hydrogen through the NTS.

This project will examine impact of transporting up to 30% hydrogen and 70% methane via NTS.

Method(s)

The project will research and evaluate changes in metallurgy over a six-month period caused by exposing specific grade of steel to Natural Gas containing up to 30% hydrogen. The flow loop will cycle between pressures of 60 barg and 80 barg at a rate of up to 3

cycles per hour.

The flow loop will be connected to a pump and two 50 litre, 400 barg bladder filled accumulators which will be used to cycle between the two pressures. The pump will be controlled remotely using a SCADA system to operate the actuated valves between the two set pressures. The number of cycles achieved will be dependent on the rate set and the down time required to change samples.

There are several stages to the project:

- Initial materials testing of all selected materials including coupons cut from pipe.
- Detailed mechanical testing requirements for the laboratory outlining the standards to be used for the tests.
- Initial set-up report with details of the steel used before exposure to high pressure hydrogen/methane mix.
- Commission test loop with pressure cycling and monitoring.
- Assess the metallurgy of the coupons after three month exposure. Provide progress report of findings.
- Examine the metallurgy of the coupons and sections of the pipe body after six months exposure.
- Provide written report of interpretation of results and recommendations for further work.

Scope

There has been a lot of investment to explore the role that hydrogen might play, particularly by the gas distribution networks. However, little is known about the impact of hydrogen on the assets within the high-pressure transmission network (NTS).

SPS have designed and manufactured a test loop comprising of both MASIP pipe utilising Innovate UK funding; along side this National Grid approached SPS to incorporate pipework representative of the NTS into the loop. The MASIP pipe has already been tested in 100% methane and is being tested to understand the longer term effects on hydrogen enriched methane compositions. The loop has been hydrotested and is ready to be commissioned, this can be delayed to allow for National Grid technical input, should it be requested.

The purpose of this test loop is to assess the metallurgical properties of the whole pipe system (including all welds) when subjected to natural gas combined with a varying percentage of hydrogen.

This test loop will then cycle gas (leading to cyclical flow within the loop) the gas under varying different pressure regimes to assess the impact on the pipe. Stress and strain gauges will be fitted at strategic locations on the set up to capture all required information.

The loop fabrication proposed in this project aims to resemble potential real-life scenarios that the National Transmission System (NTS) would face in the future. It was decided that a 30% hydrogen and 70% methane mix would represent the highest likely percentage of hydrogen that the NTS would see. There are no other planned compositions. The selection of 5m of X52 12" represents the most commonly used steel currently in place on the NTS. It was also decided to carry out the pressure cycling between 60 and 80 bar as this would provide some degree of acceleration, applying a realistic stress to both the parent pipe and welded joints in the system; this in turn tests the mechanical resilience of the pipe sections under test.

Once the intial 6 month test phase has beencompleted, there is scope to replace sections with other assets (e.g. valves, regulators, insulation joints) but this will need to be designed into the project before approval.

The project team will issue periodic test reports from DNVGL and also commission metallurgy reports from an independent test house (eg Intertek- approved by DNV) for more specialist testing and interpretation. The results will report if X52 pipe is or is not adversely affected by the hydrogen content down to a certain threshold - which it may be possible to interpret in terms of residual lifetime.

Objective(s)

To evaluate changes in metallurgy of NTS representative pipe when exposed to a hydrogen rich gas mix under pressure.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Understand the impact of a 30% hydrogen mixture, and by extrapolation lower concentrations, on the metallurgy of X52 steel. Develop recommendations on further testing of NTS components to demonstrate the suitability of the current NTS to transport methane/hydrogen mixtures.

Project Partners and External Funding

Project Partner – SPS and DNVGL
External Funding – Innovate UK

Potential for New Learning

A modified test rig has been designed to incorporate the impact of hydrogen on x52 pipes and MASIP loop. The results from the

project could determine what steps must be taken to ensure that mixed gases can be transported through the NTS. This project will enhance the learning and feed into the National Grid Hynts programme.

Scale of Project

Testing facility

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

Spadeadam

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£130000

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 study assesses the potential to deliver a hydrogen and methane mix with the existing natural gas transmission network with the potential to mitigate the cost of building dedicated hydrogen pipelines.

Please provide a calculation of the expected benefits the Solution

The evolution of the gas network, mainly through hydrogen, could represent a saving of up to £200bn across the entire gas industry, per a report from KPMG.

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

A higher permissible hydrogen content would allow for greater flexibility on the GB energy system and an increased variety of gas sources on the NTS.

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

The project will be testing the metallurgy of the pipes when natural gas is mixed with hydrogen, therefore it is not possible to provide an implementation cost.

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 impact of natural gas and hydrogen mix on materials used within gas transmission infrastructure would also be valuable, for example many of the steels that are common to gas transmission and distribution assets.

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.

Within the UK there are no programmes that are testing the metallurgy of steel pipes exposed to hydrogen in a high pressured environment.

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

There are no known studies witin the UK Gas industry that have experimented with transporting hydrogen/methane compositons and the impact hydrogen would have on the grades of steel used in the NTS. This approach is unique as the metallurgy of the gas pipes will be tested to ascertain what changes a hydrogen rich gas mix will have on the exposed metal for a six month time period.

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

This would not be funded by BAU activities as it is not part of our core business model. The project aims to evaluate the changes in

metallurgy caused by the exposing X52 steel to hydrogen rich gas mix under pressure. Gas Safety Management regulation (GSMR) does not allow any level of hydrogen within the NTS so a separate offline test loop will be required to test the impact of hydrogen on X52 steel pipe.

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

Introducing a hydrogen rich compositon to the NTS cannot be shown to be low risk as it is unknown what effect the gases will have on the short and long term propeties of the varied assets present. The data provided by this project may be applicable to other networks licensees and can be included in wider research to support the viability of using the current network to transport hydrogen. The NIA programme offers a robust, open framework to support this work and ensure the results are fully articulated to all stakeholders.

This project has been approved by a senior member of staff

☑ Yes