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

Mar 2021

Project Reference Number

NIA_SGN0167

Project Registration

Project Title

Slow Strain Rate Test and Hydrogen Permeation Correlation

Project Reference Number

NIA_SGN0167

Project Licensee(s)

SGN

Project Start

March 2021

Project Duration

0 years and 7 months

Nominated Project Contact(s)

Nancy Thomson

Project Budget

£35,507.00

Summary

The UK government has committed to reducing greenhouse gas emissions to Net Zero by 2050. All future energy modelling identifies a key role for hydrogen in providing decarbonised energy for heat, transport, industry and power generation. A key element of transition to hydrogen is to deliver compelling evidence for the enduring use of existing gas network assets in the form of a pathway to decarbonisation.

The Future of LTS project is one of the most advanced projects relating to above 7bar pipelines. The project is designed to develop the safety, technical and practical evidence to support the use of hydrogen in the LTS. A key aspect of the project involves the assessment of the known negative effect that hydrogen can have on the ductility and toughness of line pipe steel, (termed “H2 embrittlement”), which can lead to cracking of the steel.

Nominated Contact Email Address(es)

sgn.innovation@sgn.co.uk

Problem Being Solved

The hydrogen economy can be expected to play a significant role in delivering Net Zero emissions in the UK by 2050. This will require the production of large volumes of hydrogen and the rapid development of a safe and cost-effective H2 pipeline transmission network. In this context, SGN have been investigating the repurposing of the Local Transmission System (LTS) for hydrogen, hydrogen blends and carbon dioxide (CO2). The first phase of this project, “The Future of the LTS”, was a desktop study to understand the feasibility of repurposing the LTS. The study included a case study for repurposing the decommissioned SGN Granton to Grangemouth pipeline.

In February 2020, SGN held a workshop in Edinburgh to present the findings, identify gaps and develop a roadmap from the first phase. One of the topics of discussion during the workshop was the known negative effect that hydrogen can have on the ductility and toughness of line pipe steel, (termed “H2 embrittlement”), which can lead to cracking of the steel. Therefore, in order to make a safety justification for the design of new pipelines and/or the reuse of existing pipelines, guidelines are required to close the gaps in

knowledge regarding the effects of hydrogen on pipeline materials.

Method(s)

In order to assess the risk of hydrogen embrittlement of gas transmission network carbon steel, a slow strain rate test (SRRT) and a hydrogen permeation correlation study will be undertaken by National Physical Laboratory (NPL). The work will be carried out through two separate activities that include:

Work Package 1-Slow Strain Rate Testing

The work package will involve testing on a pipe section with characteristics similar to the material of the Granton to Grangemouth pipeline. Slow strain rate tests will be carried out on material specimens in both ambient air and hydrogen environments to identify susceptibility to hydrogen embrittlement. This will allow SGN to make a preliminary assessment of pipe material in the LTS for hydrogen service.

Work Package 2-Hydrogen Uptake Correlation

Desktop studies as part of work package two will provide information regarding the relationship between level of cathodic charging and the partial pressure of hydrogen in the pipeline and will enable the levels of cathodic charging to be established for the rest of the test programme. The work will link GD-OES tests being undertaken at Technical Services Provider (University of Strathclyde) as part of the material characterisation.

Scope

Work Package 1-Slow Strain Rate Testing
Slow strain rate tests will be carried out on tensile specimens manufactured from a pipe section supplied by SGN.

Tests will be carried out in duplicate on parent material specimens under the following conditions:

- Air (at ambient temperature)
- Hydrogen (at 40barg)

Susceptibility to hydrogen embrittlement will be assessed by comparing the plastic strain to failure in the two environments.

The selection of 40barg for the tests in hydrogen is based on (i) a typical operating pressure in the high-pressure gas distribution network and (ii) the highest pressure at which it is considered that tests can be safely conducted using the NPL SSRT equipment.

Work Package 2-Hydrogen Uptake Correlation

A desk-based review of the scientific literature will be conducted to establish the correlation between hydrogen uptake in steel via cathodic charging in aqueous environments and that in the presence of gaseous hydrogen under pressure.

The aim of the work is to facilitate comparison of the results of the NPL tests in pressurized hydrogen with any subsequent work at the University of Strathclyde that may employ cathodic charging to introduce the hydrogen into the steel for safety reasons.

Objective(s)

The main objectives of the work are to determine whether there is a potential risk of hydrogen embrittlement of gas network pipeline steel by comparing SSRT results in are and in 40 bar hydrogen and to establish a correlation between hydrogen uptake in steel by cathodic charging in aqueous environments with that in gaseous hydrogen under pressure.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Key success criteria of the project include:

- NPL report covering reporting and scientific discussion of the SSRT results
- NPL report on the correlation between cathodic and gaseous phase charging
- Online presentation of the results to SGN and the University of Strathclyde

Project Partners and External Funding

- National Physical Laboratory (NPL)
- External Funding NIA
- University of Strathclyde (Technical Services provider)

Potential for New Learning

The project will provide key learning on the viability of hydrogen distribution into the existing LTS network. The pipeline material due to be tested has been identified as a material representative of the GB network and has close similarity to the Granton to Grangemouth decommissioned asset that has been earmarked to be the blueprint for repurposing an LTS pipeline for hydrogen.

Scale of Project

The project will be a combination of desktop study and laboratory testing.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

The project will be testing a section of LTS pipeline taken from diversion work undertaken at Erskine bridge in Scotland. The pipeline section is representative of GB LTS pipeline and is similar to the Granton to Grangemouth decommissioned pipeline. This allows results of the project to be broadly applied to the GB LTS network.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£26,630

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 UK government has set binding targets of Net Zero by 2050. In order to achieve this goal effectively and economically, all options for decarbonisation should be evaluated in order to identify the most cost-effective solutions for UK consumers.

Reports have evaluated the cost to Net Zero through a range of decarbonisation scenarios such as hydrogen and electrification. Findings suggest that electrification of heat would be a more expensive option as opposed to repurposing of the gas network to distribute low carbon hydrogen. The CCC highlighted in their recent 6th Carbon Budget that hydrogen will be key in facilitating the transition to Net Zero.

Please provide a calculation of the expected benefits the Solution

N/A

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

As stated previously, the pipeline selected for testing is representative of the GB LTS network and is similar to the Granton to Grangemouth decommissioned asset earmarked to be repurposed for hydrogen distribution as part of the LTS Futures programme. The testing will inform the development of a material qualification strategy for the GB LTS.

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

Key learning from the project will close knowledge gaps on the viability of the GB LTS to distribute hydrogen. The use of this pipeline infrastructure for the transport and storage of hydrogen within the UK and at the local level would be highly advantageous for the supply and delivery of low carbon energy to consumers.

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

A review as part of the LTS Futures programme has identified the material chosen for testing is a good representative of the GB network and it is similar to the Granton to Grangemouth pipeline which SGN has earmarked to be the blueprint for repurposing an LTS pipeline to hydrogen. The slow strain rate testing for hydrogen embrittlement and the hydrogen permeation correlation study will be fed into the material testing on vintage pipeline metals at Strathclyde University, the IGEM LTS Futures Group and LTS Futures programme which are investigating repurposing the GB LTS network. The findings will be disseminated to all licenses and outcomes will be valuable for the National Grid, Future Grid project.

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

SGN are investigating the use of existing LTS infrastructure for hydrogen distribution and storage. The project will investigate the susceptibility of pipeline steel to cracking and determine the plastic strain at failure for hydrogen distribution at pressure experienced in LTS pipelines. In order to make a safety justification for the design of new pipelines and/or the reuse of existing pipelines, guidelines are required to close the gaps in knowledge regarding the effects of hydrogen on pipeline materials.

☑ 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.

The project scope has been reviewed against all existing projects and no areas of duplication have been identified. All GDN's and NGGT are members of the IGEM LTS Futures Group where the scope has been shared and no duplication was mentioned.

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 project aims to close current gaps around the susceptibility of pipeline steel to cracking with the distribution of hydrogen at pressure experienced in the LTS. This project forms part of Phase 2 of the LTS Futures programme involving material testing and analysis.

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

The project aims to identify the impact of hydrogen distribution at pressure on existing pipeline steels within the LTS. Testing forms a key part of SGN's pathway to decarbonisation to Net Zero through transition to hydrogen from existing natural gas. As such, it is not part of the usual activities of the business.

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 NIA framework offers a robust, open framework to support this work and ensures the results are disseminated to all licenses. The repurposing of the GB LTS involves potentially significant technical risks. The project addresses the question of the suitability of vintage line pipe steels under hydrogen service.

This project has been approved by a senior member of staff

☑ Yes