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

Dec 2023

Project Reference Number

NIA2_SGN0039

Project Registration

Project Title

Materials Qualification for Hydrogen TD1 Pipelines

Project Reference Number

NIA2_SGN0039

Project Licensee(s)

SGN

Project Start

December 2023

Project Duration

1 year and 0 months

Nominated Project Contact(s)

James Heywood

Project Budget

£166,357.00

Summary

The current IGEM standards for requirements of qualification testing of onshore pipelines do not contain guidance on specific tests for hydrogen. SGN has engaged PIE to develop a material qualification procedure for inclusion in standards for assets in hydrogen service

When completed, the project will identify relevant criteria for fracture toughness, fatigue and any relevant material aspects impacted by hydrogen. Learning from this project can be applied to other operations to facilitate safe transition to 100% hydrogen.

Third Party Collaborators

Pipeline Integrity Engineers Ltd

Wood PLC

Nominated Contact Email Address(es)

sgn.innovation@sgn.co.uk

Problem Being Solved

The purpose of the project being undertaken by SGN is to provide the critical evidence required to convert to 100% hydrogen. A primary threat to steel pipelines in hydrogen pipelines is the ingress of hydrogen into the steel structure which results in its embrittlement, degrading its material properties.

Across the GB gas network there are developing projects involving the construction of new high pressure hydrogen pipelines and repurposing of existing local transmission systems (LTS) pipelines for hydrogen service. The current industry standard for pipelines (IGEM/TD/1) reverts to external guidance in the American standard: ASME B31.12.

There is currently no specified process for testing the suitability of materials used in pipelines that will carry hydrogen, and as such, the hydrogen supplement for IGEM/TD/1 needs to be developed.

Material qualification requires that the material testing is undertaken to determine the change in material properties due to exposure to hydrogen. Further projects are required to complete the practical testing for these requirements, the first of which relates to the impact of hydrogen on material properties and is the one that will be examined in this submission.

Method(s)

Discussions with industry experts have identified that a new process is needed to determine the safety of steel TD/1 pipes used with hydrogen in blends up to 100%. In order to do that, the exact requirements for measuring the change in material properties of steel used in these operations need to be researched and agreed upon. Thus, the focus of this project will be to develop a standard approach to the process of qualifying materials, which can then be used in the short term in new hydrogen pipelines.

This will be done through:

- A literature review which will assess the current research results and identify gaps
- A review of existing tests.
- A procedure for material qualification for steel hydrogen pipelines based on small scale material tests
- A draft of the material qualification clause for IGEM/TD/1 edition 6 supplement.
- Stakeholder engagement across the GB gas network

Scope

The scope of work includes reviewing the current literature, national and international projects, and current code requirements, building on existing literature reviews, and identifying the gaps. There are existing limitations and constraints of the procedure for material qualification for steel hydrogen pipelines, with current standard (ASME B31.12 and IGEM/TD/1 Edition 6 Supplement 2) requiring that:

- The stress in the pipeline is limited to 180 N/m2, which is equivalent to an X52 grade pipeline operating at a design factor of 0.5, and
- The pipeline material is qualified for hydrogen service.

From these, a testing procedure for these pipelines will be developed, which will then inform the draft of an update of clause S5.8 Material qualification for IGEM/TD/1 supplement 2, that will be shared in the industry and help the transition to 100% hydrogen. As part of the project, stakeholder engagement with all other gas network operators is key to successful delivery due to the impact of the outcome. The success of this project will initiate a second phase to confirm the materials testing, and evidence collated will be required during the production of new hydrogen pipelines in the GB gas network.

Objective(s)

The objective is to develop the scope for the testing procedure, which is required to qualify materials for steel hydrogen pipelines, and to conduct research in and around the effects of hydrogen on steel grades used for natural gas pipeline manufacture.

Given the impact of the outcome, stakeholder engagement is key to be able to disseminate the learnings from the project. Following the completion of this project, guidelines on defect acceptance levels will have been established, as well as how it impacts the pipeline failure frequency. This set out a testing program that will need to be proven and subsequently used to define the materials qualification procedure for steel pipeline manufacture.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

NA

Success Criteria

- Provide a detailed analysis of current testing requirements to manufacture pipeline materials for high pressure hydrogen pipelines.
- Considering the impact of the outcome, stakeholder engagement with all other gas networks is key for successful delivery.
- A defined testing program that will be used to evidence requirements for manufacturing materials qualification .

Project Partners and External Funding

Pipeline Integrity Engineers Ltd

Wood Group UK Ltd

Potential for New Learning

The project will provide unique and referenceable information for industry on the effect of hydrogen on material properties of steel pipelines. It will also help the development of existing testing procedure to include hydrogen-specific guidelines and requirements.

Scale of Project

The project has potential to impact every operation related to testing materials for TD/1 pipelines for use in high-pressure hydrogen networks. The current standard approach to material qualification doesn't exist for TD/1 pipeline manufacturing, hence the need for developing methods based on current literature. It is the first step to involve hydrogen in TD/1 and may have wider global impact.

Technology Readiness at Start

TRL1 Basic Principles

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

Not applicable- desktop exercise

Revenue Allowed for the RIIO Settlement

£166357

Indicative Total NIA Project Expenditure

External: £124768

Internal: £41589

Total: £166357

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:

The project will provide the GB networks with the ability to specify material for safe operation of the new hydrogen transmission pipelines.

There are also potential projected long-term savings made as a result of appropriate materials specification. These may reduce the overall material manufacturing costs for the quantity of new pipelines that will be required to increase safe operation capacity of the gas network.

How the Project has potential to benefit consumer in vulnerable situations:

Hydrogen is going to be used in future, in blends up to 100%, in order to achieve the UK governments zero emissions target. The new materials requirements will facilitate the safe pipeline operation and deployment of hydrogen heating for consumers, fulfilling their needs while also providing a significant environmental benefit, by reducing or even eliminating the resulting emissions.

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)

NA

Please provide a calculation of the expected benefits the Solution

NA

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

This should impact all networks across GB. The new materials specification will apply to any TD/1 new pipeline being laid as part of the zero emissions strategy of the GB gas network.

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

Costing for this type of activity is defined on a project-by-project basis. This is because the variables including types of steel and blends using hydrogen, as well as the extent of new pipelines being implemented will determine the overall cost of each project.

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 project will provide unique and referenceable information for Network licensees and Industry on transmission pipelines with 100% hydrogen. It is a modification toTD/1 supplement for materials qualifications in gas distribution networks across the country, thus extremely useful and widely applicable. The learning gained from the project can be applied to Network Licensees and their network operations to facilitate safe transition to hydrogen from natural gas.

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

NA

Is the default IPR position being applied?

☐ Yes

Please demonstrate how the learning from the project can be successfully disseminated to Network Licensees and other interested parties.

The findings from the literature review, report and draft modification to the standards will be made widely available to all the gas distribution networks, through ENA materials working group and the stakeholder engagement plan

Please describe how many potential constraints or costs caused, or resulting from the imposed IPR arrangements.<

NA

Please justify why the proposed IPR arrangements provide value for money for customers.

No IPR is being developed aspart of this project, only the testing requirements to define GB IGEM Industry standards

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.

There is currently no framework for the materials qualification for TD/1 pipelines that will transport hydrogen or mixes with hydrogen. The findings from the project will be shared with all key stakeholders.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

NA

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

The project will provide critical insight into the identified issues and identify failure frequency recommendations for new pipelines. It will set out procedure for materials qualifications for new TD/1 pipelines. The current standard approach to material qualification doesn't exist for TD/1 pipeline manufacturing, hence the need for developing methods based on current literature. It is the first step to involve hydrogen in TD/1 and may have wider global impact.

Relevant Foreground IPR

NA

Data Access Details

NA

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

This project is deemed an essential part of the 100% hydrogen trials process and is a key step towards the conversion of the network to 100% hydrogen. It will have a GB-wide impact across all gas distribution networks.

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 conversion of the GB gas network to 100% hydrogen is key on the road towards net zero. A reliable supply and the assurance of safe operations for workers and the public are crucial to support the viability of the hydrogen transition. The NIA framework can support works that ensure results that play an essential part in the roll-out of hydrogen.

This project has been approved by a senior member of staff

☑ Yes