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

Aug 2024

Project Reference Number

NIA_NGT0245

Project Registration

Project Title

Fatigue of pipework at compressor sites

Project Reference Number

NIA_NGT0245

Project Licensee(s)

National Gas Transmission PLC

Project Start

August 2024

Project Duration

0 years and 9 months

Nominated Project Contact(s)

Katie Jones, Robert Best,
box.GT.innovation@nationalgas.com

Project Budget

£118,827.00

Summary

National Gas is looking at repurposing many of its pipelines and assets to hydrogen usage (100% and blends). For this to happen, extensive work needs to be done to make sure that assets will be able to cope.

This project will be focusing on fatigue of pipework in compressor sites to see whether National Gas has the appropriate methodology to manage fatigue with hydrogen. This project will be looking at both 100% hydrogen and also blends of 2%, and 20%.

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

Due to the nature of compressor sites, the pipework around it needs to be assessed and managed to guard against fatigue failure. As it's currently unknown what the implications of this in a hydrogen system are (with the difference in compression cycles and gas), it's critical that we explore this so that National Gas can continue to operate compressors in a safe way. Hydrogen has different properties to that of natural gas and policies and procedures may have to be adapted in order for hydrogen to be transported in a safe way.

National Gas has an ambitious programme of work called 'Project Union' which will repurpose up to 2000 km of high-pressure transmission network in the UK to carry hydrogen.

Previous work has been done with TD/12, on the current system using natural gas. This project will be looking at the feasibility of adapting this process and demonstrating its use on compressor site pipework in hydrogen. If successful, this could be expanded out to many other compressor sites for analysis.

Updating our methodology and procedure for this is a key enabler for Project Union as the updated documents will be used for maintaining the 100% hydrogen backbone.

Method(s)

Workpacks 1-3 have an output summary presentation milestone to act as the completion trigger for each workpack for NIA reporting purposes. All work undertaken will be documented in detail in the final WP4 technical report. Sufficient time has been incorporated for a 1-hour weekly progress meeting with between FRONTLINE and NGT throughout the duration of the project.

Workpack 1

- Review current assumptions in TD/12 to see if they are justified or as accurate as they can be
- Review how TD/12 would be affected with 2% hydrogen
- Review how TD/12 would be affected with 20% hydrogen
- Review how TD/12 would be affected with 100% hydrogen
- Adapt TD/12 so that it is suitable for hydrogen in different blends and 100% - through this recommend an update to this document

Workpack 2

- Apply the adapted TD/12 that is appropriate for hydrogen - that was created in WP1 to known sites and report results
- Analyse and compare the differences between natural gas and hydrogen. Clear analytical report that provides impacts (or the 'so what') on the variations and key recommendations.

Workpack 3

- Assessment of asset readiness on sites covered in WP2 and recommendations for where further work may be needed
- Extrapolate findings nationwide and get a view of asset readiness for pipelines at compressor sites across the NTS.

- This assessment will be more of a high-level directional assessment to understand whether hydrogen increases the exceptions or decreases them. This assessment will also be able to show us if there are any particular problem areas in the system (e.g. types of fittings, certain pipework designs etc.) We are not expecting the assessment to show us anything definitive or specific, just rather where further work should be prioritised.

Workpack 4

- The supplier will provide a technical report of all work carried out.

- The supplier will provide the summary within the above-mentioned technical report.

- NG to review output of project and identify if any standards need to be updated considering the results.

- The supplier will look at the feasibility to apply adapted TD/12 and any other associated documents to other fatigue assessments on different assets and scope project out if appropriate

- Depending on funding mechanism, the supplier may need to populate an ENA closure report document using the information provided in the technical report.

- Clear analytical report that provides impacts (or the 'so what') on the variations and key recommendations.

Measurement Quality Statement

The measurement approach used to meet Data Quality objectives will be through the identification of high calibre project partners who are experts in their given field. The methodology used in this project will be subject to our supplier's own ISO 9001 certified quality assurance regime and the source of data, measurement process and equipment as well as data processing will be clearly documented and verifiable. The measurements, designs and economic assessments will also be clearly documented in the relevant deliverables and final project report and made available for review.

Data Quality Statement (DQS)

The project will be delivered under the NIA framework in line with the agreed Energy Networks Innovation Process document and NGT internal policies. Data produced as part of this project will be subject to quality assurance to ensure that the information produced with each deliverable is accurate to the best of our knowledge and sources of information are appropriately documented. All deliverables and project outputs will be stored on our internal SharePoint platform ensuring backup and version management. Relevant project documentation and reports will also be made available on the ENA Smarter Networks Portal and dissemination material will be shared with the relevant stakeholders.

Scope

Workpack 1 - Review of Pipework Fatigue Methodologies (TD/12 and other relevant documents)

The primary impact of H2 on steel pipework materials will be two-fold – a reduction in fracture toughness and an increase in fatigue crack growth rates. These combine to escalate the fatigue cracking threat in pipelines and pipework significantly above that experienced in Natural Gas Service. This is compounded by the fact that the lower energy carrying capacity and density of Hydrogen have been shown to likely impact the gas compression requirements which in turn subject the station pipework to a more aggressive fatigue loading. In summary, the more aggressive threat drivers, and lower material resistance to fatigue damage escalate the threat of fatigue failures.

Workpack 2 - Compressor Site Analysis and Comparison

Testing the fatigue methodology developed in WP1 on a range of existing compressor station pipework designs and comparing fatigue hotspot locations to those identified in natural gas service is critical to understanding the impact on management of the fatigue threat, as well as validating and optimising the methodology itself.

Workpack 3 - Asset Capability Estimates

Appraising the overall readiness of compressor asset population nationally is essential to being able to shape and cost the required

asset integrity management plans for Hydrogen service.

Workpack 4 – Standards & Reporting

Identifying where existing standards should be modified in order to formalise the methodology developed in WP1 is an essential input to the eventual development of formal policy and procedure to support the asset management of hydrogen pipework in compression stations.

Objective(s)

- Understand if TD/12 and PW/13 Carrying out pipe stress analysis to IGE/TD/12 and any other associated documents are fit for purpose for hydrogen

- Use known analyses at compressor sites to compare between hydrogen and natural gas

Understand asset readiness levels across the NTS

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

Not Applicable

Success Criteria

The following key criteria need to be met for the project to be considered successful:

- To understand how to maintain pipework at compressor sites in a safe way
- To determine the key areas of work required to update the safety case and enable deployment on the network
- To inform the standards, policies and procedures aligned to the safety case to enable update prior to operation.
- Project delivered to time, cost and quality and meets the project objectives

Project Partners and External Funding

Lead network: National Gas Transmission plc

Lead supplier: Frontline Integrity

External funding - £0

Potential for New Learning

We will be able to gain information around the standards, policies and procedures aligned to the safety case of hydrogen transport in our pipelines to enable update prior to operation.

Scale of Project

The scale of the project is sufficient to understand how to assess fatigue of pipework around compressors and preliminarily showing where the problems areas may be. This work will enable us to see whether more work in this area is needed in the future. This project has dependencies on both Futuregrid and also the T sections and welds projects, so while we may not know the exact hydrogen numbers to go into our models, this work will act as an indicative placeholder for the safety case until these other projects are completed. In particular, from the learnings, we should be able to see where further work may be required if asset readiness look directionally much lower compared to a methane network.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

Mostly not applicable as this is a desktop study, however the sites with already-identified models will be St Fergus, Bishop Auckland and King's Lynn.

Revenue Allowed for the RIIO Settlement

Not applicable

Indicative Total NIA Project Expenditure

Internal funding - £29,706.67

External funding - £89,120

Total project funding - £118,826.67

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:

This project will be looking at how we currently assess fatigue in pipework at compressor sites and see whether this is suitable to do this for hydrogen. Through this a high level asset readiness assessment will allow us to understand what extra work needs to be completed for the energy transition.

Updating our methodology and procedure for this is a key enabler for Project Union as the updated documents will be used for maintaining the 100% hydrogen backbone.

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

N/A this is a hydrogen safety project

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)

Not applicable

Please provide a calculation of the expected benefits the Solution

Value tracking	Data Point	Data Point Definition
Maturity	TRL 3-5	In development (NIA project)
Opportunity	<25% of single asset class	Covers pipework at compressor sites and a very high level of other assets
Deployment costs	£0	Unknown research project,

potentially £0

Innovation cost	£118,826.67	
Cost of project		
Financial Saving	£0	Unknown at
project start, research project		
Safety	100%	Focus of
project and essential for hydrogen safety		
Environment	0.0	Unknown, not
project focus but will enable energy transition		
Compliance	Ensures compliance	
Skills & Competencies	Departmental	
Future proof	Must have for	
business strategy		

With forecast benefits to be delivered:

- Enable the understanding of how we can maintain pipework around our compressor sites in a safe way for hydrogen

- Understand high level asset readiness by identifying directional differences between the hydrogen and methane network and problem areas which need further focus.

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

This should impact all networks across GB. The methods used will be completely replicable, as they will be using an adapted version of a policy which already exists to make assumptions and calculations.

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

This project is more focussed on adapting current methodologies than necessarily changing a physical component- therefore it is expected that the adoption of applying new methodologies would be nearly zero. Having said this, there is some uncertainty about

whether the results of this (overall asset readiness) will lead to more costs in the future. However, this isn't the primary focus of this 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 knowledge generated will let other relevant network licensees understand more about what they need to do to manage fatigue at compressor sites and give an insight into how their potential asset readiness may change.

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

Not applicable

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.

There is currently not a sufficient level of understanding for how we will be able to measure fatigue at compressor site pipework in an appropriate way. Additionally to this we are closely aligning ourselves with Futuregrid phase 2: compression project and the T-section and welds project to avoid duplication where possible and get the most accurate data for this project. There will be no duplication of activities done as part of this program. This project will address a gap in National Gas' ongoing innovation work looking at hydrogen transportation and enabling work to support the energy transition.

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

Network Licensees.

Not applicable

Additional Governance And Document Upload

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

This project will be researching the best way to assess fatigue of pipework at compressor sites that transport hydrogen- something which hasn't been done before but is necessary to safe transportation of hydrogen. It will be also using a novel method to look at high level asset readiness and identify problem areas.

Relevant Foreground IPR

Not applicable

Data Access Details

Details on how network or consumption data arising in the course of an NIA funded project can be requested by interested parties, and the terms on which such data will be made available by National Gas can be found in our publicly available "Data sharing policy relating to NIA projects" at www.nationalgas.com/gasinnovation. National Gas data access is managed IAW provisions under 2.15-2.18 for the current NIA Governance Document.

National Gas already publishes much of the data arising from our NIA projects at www.smarternetworks.org. You may wish to check this website before making an application under this policy, in case the data which you are seeking has already been published.

Data Quality Statement (DQS):

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Measurement Quality Statement (MQS):

The methodology used in this project will be subject to our supplier's own ISO 9001 certified quality assurance regime and the source of data, measurement process and equipment as well as data processing will be clearly documented and verifiable. The measurements, designs and economic assessments will also be clearly documented in the relevant deliverables and final project report and made available for review.

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.

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

Funding this project through NIA gives and opportunity to share the findings with other network licensees to enable their own progression of hydrogen transportation related activities.

This project has been approved by a senior member of staff

☑ Yes