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_NGGT0150

Project Registration

Project Title

Non Destructive testing of welds using ultrasonic Time of Flight Diffraction Techniques (TOFD)

Project Reference Number

NIA_NGGT0150

Project Licensee(s)

National Gas Transmission PLC

Project Start

June 2019

Project Duration

0 years and 5 months

Nominated Project Contact(s)

Alan Kirkham

Project Budget

£49,886.00

Summary

The objective of the project will be to determine the selection of a suitable non-destructive testing technique that makes it possible to accurately size and reference defect within pipeline girth welds.

Preceding Projects

NIA_NGGT0093 - Ultrasonic testing of thin wall pipeline girth welds using high frequency probes

NIA_NGGT0136 - Destructive Testing of Set-In and Set-on Nozzle connection welds

Third Party Collaborators

GB Inspection Systems Ltd

Lavender International

Phoenix Inspection Systems Limited

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

With the currently used ultrasonic inspection techniques the defect images are produced by displaying the reflected sound energy, this reflected energy is then analysed to try and predict the through wall size of the indications, this information is important in order to determine if the defect is detrimental to the weld. This method can be unreliable as it will be affected by both the defect shade and

orientation.

Defect height is important as from the National Grid Standard T/SP/NDT/2 E12.4 a defect will be rejected if the through wall extent exceeds 2.0mm in welds where the materials nominal wall thickness is 12.7mm or below, on material above 12.7mm then the maximum allowable defect height will be 3.0mm

Defect Type is also important as within the current welding specification any weld which contains a crack will be cut out and rewelded.

This project will investigate an alternative method for defect sizing and characterizing which will produce results which have a higher accuracy.

Method(s)

Using Standard proprietary available range of Time of flight equipment, probe manipulator and software to carry out inspection, the project will determine whether it is possible to carry out inspections of pipeline girth welds and produce more accurate information on defect sizing and nature of indications.

To enable the project to demonstrate that the defects can be located within the welds using the previously mentioned non-destructive testing technique, the following steps will be carried out:

Pipeline Maintenance Centre (PMC) will produce several suitable test welds which adequately represent the welds used
The welds will then have artificial defects applied to them, for example a drill hole. Controlled inspections will be carried out of the test welds to determine if the artificial defects introduced can be detected, and their size and position determined accurately using a manual TOFD ultrasonic technique and the more advanced manual phased array system. The welds will then be cut open to obtain actual data on defect type and size
Produce a detailed report with the information captured from the trial.

The project will be managed internally by National Grid Gas Transmission and will utilise the expertise of the Pipeline Maintenance Centre (PMC). Additionally, the required suppliers of equipment and training are:

- Phoenix Inspection Systems Limited
- Lavender international
- GB Inspection Limited

Project Plan

1. PMC start production of test welds (4 weeks work)
2. Providing all equipment has been delivered the scanning will start (4 to 5 days spread over 4 weeks)
3. Cutting up test welds reviewing data (4 weeks)
4. Reporting and cross checking (4 weeks)

Scope

Time of flight defection (TOFD) is an advanced ultrasonic technique which displays the sound energy that is diffracted from defect extremities, this can then be analysed to provide very accurate measurement of the defect position and height.

In a TOFD system, a pair of ultrasonic probes sits on opposite sides of a weld. One of the probes, the transmitter, emits an ultrasonic pulse that is picked up by the probe on the other side, the receiver. In undamaged pipes, the signals picked up by the receiver probe are from two waves: one that travels along the surface and one that reflects off the far wall. When a crack is present, there is a diffraction of the ultrasonic wave from the tip(s) of the crack. Using the measured time of flight of the pulse, the depth of a crack tips can be calculated automatically by simple trigonometry.

The project will produce a number of test welds with actual defects these will then be analysed with both conventional and TOFD techniques once all the data has been collected the welds will be sliced open to enable actual measurements to be made of the defect height.

Objective(s)

The objective of the project will be to determine the selection of a suitable non-destructive testing technique that makes it possible to accurately size and reference defect within pipeline girth welds.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will inform the debate concerning the suitability of the latest ultrasonic techniques for weld integrity assessments. The success criteria will be that if following the programme suitable equipment is identified, National Grid will be able to integrate this technology for inspection of welds and accurately assess defect sizes and type of defect for assessment against welding standards for

defect acceptance

This would require a change within the requirements of the current National Grid specification for welding of steel land pipelines designed to operate at pressures greater than 7 bar (supplementary to BS 4515-1: 2009), T/SP/P/8 (Welding of steel onshore natural gas installations designed to operate at pressures greater than 7 bar) and T/SP/NDT/2 (Specification for non-destructive testing of welded joints in steel pipelines and pipework).

Project Partners and External Funding

N/A

Potential for New Learning

This work will provide important infield experience to show that it is possible to inspect the welds using the latest ultrasonic non-destructive techniques. The results generated can then determine the size and nature of any defects within the welds that potentially cause the weld to fail the current acceptance criteria.

The outcomes of the project will be published on the Energy Network Associations' (ENA) Smarter Networks Portal and the results presented at the Welding Institute and The British Institute of NDT forums.

If the investigation ultimately proves successful, knowledge dissemination presentations will be conducted using the likes of the Institute of Gas Engineers and Managers and paper evenings.

Scale of Project

If this investigation is successful, the use of Time of Flight Detection can be utilised for determining when a defect needs to be removed or if it is acceptable to remain in the weld. It could be used by all UK Gas Transmission and Distribution companies on future in service inspection and construction projects.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

If fully successful, this technique could be employed across all the UK for gas transmission and distribution girth welding operations.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£49886

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 difficulty of obtaining accurate information on defect sizes and type will mean that some welds which are actually acceptable have been repaired unnecessarily.

Please provide a calculation of the expected benefits the Solution

The projected use of this NDT methodology is 30 sites per annum.

The use of conventional NDT ultrasonic phased array equipment is projected to be £250/day.
The cost of an uninspected weld failing could be significant. The cost of repairing a weld unnecessarily is approximately £3000

Current Method Welding Personnel and consumables + reinspection of acceptable weld = £3000, assume 30 sites per annum. **Base Cost: £90,000/year**

Proposed Method Ultrasonic Equipment Cost: £250/site/day (inclusive of labour), assume 30 sites per annum. **Method Cost: £7,500**

Financial Benefit Projected Savings/year (Base – Method) = **£82,500/year**

It should be noted that if the trials are successful the technology could be used to accurately assess defects already in the system when carrying out assessments of previously uninspected welds.

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

The use of conventional ultrasonic NDT test equipment would be easily deployed across the network. Incorporating the necessity of the ultrasonic testing into the National Grid Standards and Specifications suite would ensure a consistent approach to the on-going assessment of the connection welds. These updated standards will be shared with gas distribution networks which could facilitate a country-wide roll-out.

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

The cost of deployment will be dependent on the choice of suitable NDT equipment, in line with the National Grid specifications and the method of use (direct hire or purchase).

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

Similar challenges are experienced across the Gas distribution industry with respects to inspection of welds on gas pipework. UK gas distribution companies would therefore be able to utilise the output of this project on their own inspections.

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

Reliability and Maintenance, ensuring the most accurate defect measurements are collected.
☑ 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.

No other innovation programmes have been registered in employing the techniques and equipment to be evaluated in this programme.

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 is innovative as this ultrasonic non-destructive testing technique has not been investigated for its effective use in providing

detailed information about weld defect size and type. It has not been tried before due to the technology involved not being as accurate and developed as it is now.

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 method of NDT has not been proven for testing of girth welds mainly due to the complex nature of the data interpretation involved with this type of inspection. This programme will facilitate an investigation to identify if recent advances in Time of Flight Non-Destructive testing, along with a dedicated probe manipulator, can be utilised to locate and provide accurate information as to the exact nature of the defects. National Grid will not fund this project as business as usual due to the unproven application of this technology for weld inspection and no current evidence to support its effectiveness.

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

NGGT operates under a comprehensive standards framework. The latest advances of innovative non-destructive techniques (NDT) analysis equipment offer considerable benefit to the NGGT and other network operators if their capabilities are proven. However due to the lag in standards development, new NDT equipment may not be compatible with the standards as written and hence their use is restricted. A full capability assessment requires a dedicated programme of evaluation by the relevant technical experts. Innovation funding provides a robust framework that enables these assessments to be undertaken. Innovation funding ensures that the generic findings are communicated to all networks which improves efficiency and ensures that relevant proven equipment is readily deployed.

This project has been approved by a senior member of staff

☑ Yes