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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

Jan 2014

Project Reference

NIA_NGGT0044

Project Registration

Project Title

SCT Pipeline Inspection System

Project Reference

NIA_NGGT0044

Project Licensee(s)

National Grid Gas Transmission

Project Start

January 2014

Project Duration

2 years and 4 months

Nominated Project Contact(s)

Peter Martin

Project Budget

£1,235,000.00

Summary

National Grid Gas Transmission completed a project under the IFI scheme to evaluate the MTM (Magnetic Tomography Method) for pipeline inspection. During 2011 and 2012, the MTM system was trialled on13 sections of pipe on the National Transmission System. Analysis of the results proved that the MTM system has the ability to locate anomalies in a buried pipeline. Comparison of the MTM data with ILI results has shown that there is a good correlation between anomalies detected by both systems. The trials also included 2 pipelines where existing strain gauges monitoring was fitted to evaluate ground movement in relation to mining activities. A comparison between the strain gauge measurements and the MTM/SCT data showed that there was a correlation between the SCT estimated stress in the Stress Concentration Zones and the stress recorded by strain gauges. MTM could identify the location of a defect but could not report the quantity of stress in the pipe wall caused by the defect. Given further work, it should be possible for SCT to determine pipe strain and this would remove the need to install strain gauge wires.

The MTM trials in 2011 took place in conjunction with the Russian supplier Transkor. Subsequent to the success of this initial trial, Speir Hunter (a UK based company) with the University of Leeds, have developed a more advanced version of the technology, the “SCT inspection system” (The SCT system, was used during the 2012 site trials). The change of supplier from Transkor to Speir Hunter/University of Leeds, significantly reduced the number of the challenges associated with communication when looking to progress with the required technology development. The project benefited from additional flexibility and accessibility to the expertise (i.e. not through an interpreter) of using a technique is available from a UK based source.

The IFI project identified a number of new potential opportunities that the SCT system can deliver as well as recommendations required to enhance the SCT technique such that it is suitable for field deployment. New opportunities include identification of pipeline

girth welds and pipeline depth measurement.

The current ILI system relies on the identification of girth welds for positioning ILI recorded features. This can lead to variability in accuracies. This may also be influenced by inaccuracies in as-laid records. The financial impact of this can be significant. Each dig typically costs in the range of £40-£70k. When a section of pipeline requires repair, the costs of excavation can increase dramatically if trenches are excavated in the wrong location and need to be extended in one or both directions until the desired feature is found. The precise identification of the location of a repair site using the SCT technique will eliminate these additional costs.

Nominated Contact Email Address(es)

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Problem Being Solved

The fundamental problem relates to pipelines which cannot be internally inspected and the secondary problem is the risk of corrosion, caused by disbondment of coating systems, primarily coal-tar enamel, on buried pipelines. Most of the gas transmission pipeline network is now beyond its original 40-year design life and the standard approach to identifying and controlling metal loss on buried pipelines is to conduct in-line inspection (ILI) surveys. Where sub-critical defects are detected by ILI, the level of cathodic protection (CP) is managed in conjunction with 'Close Intervals Potential Surveys' (CIPS), which are undertaken much more frequently.

CIPS can detect the location of lowest potentials but cannot diagnose the nature of the corrosion and CP will do nothing to halt or delay the corrosion in a "shielded" corrosion cell. A shielded corrosion cell can occur where coal tar or other coating has disbonded, water is drawn by capillary action between the pipeline and its coating, allowing corrosion to take place but preventing CP current reaching the area. Within this "shielded" environment, corrosion will continue even where CP potentials appear to be compliant. National Grid is therefore required to either increase the frequency of ILI surveys or carry out invasive works to monitor and assess what could be a population of many thousands of sub-critical defects on the typical pipeline.

Where a pipeline cannot be internally inspected an OLI4 survey is conducted consisting of CIPS in conjunction with a coating defect survey e.g. Pearson or DCVG (Direct Current Voltage Gradient). Where low CP potential areas coincide with open coating defects invasive works are undertaken. This technique cannot identify corrosion taking place beneath disbanded coating and does not identify dents or corrosion depth/orientation. Where cathodically shielded corrosion takes place metal loss will occur at a typical rate of between 0.1-0.2mm/year which could equate to a metal loss of between 4-8mm of pipe-wall in a 40year old pipeline with early onset of disbondment (this would equate to a 31-62% wall thickness loss on a typical 12.7mm pipeline).

Method(s)

Stage 1 – Instrumentation

- Revise the current Stress Concentration Tomography (SCT) software design base (continues over 24 months and at multiple stages)
- Independent review and verification of results from existing data
- Development of new calibration, verification and testing procedures
- Construct dedicated SCT system for field trials
- Construction of test rigs' for laboratory and site trials

Stage 2 - Experimental Study

- Laboratory based analysis of magnetic fields
- Test site based analysis of magnetic fields
- Girth welds – verification of model and accuracy
- Advanced Pipe Location - Depth and central position of the pipeline

Stage 3 - Modelling development

- Girth welds – on site verification
- Advanced Pipe Location
- Laboratory and Site comparison work
- Weld and defect differentiation

Stage 4 - Evaluation

- Girth welds – field verification of new models
- Advanced Pipe Location – finalise Finite Element Analysis (FEA) model

At each of the main stages GL Noble Denton will provide an independent review and report in relation to the deliverables along with a final report outlining the results and making appropriate recommendations.

Scope

National Grid Gas Transmission completed a project under the IFI scheme to evaluate the MTM (Magnetic Tomography Method) for pipeline inspection. During 2011 and 2012, the MTM system was trialled on13 sections of pipe on the National Transmission System. Analysis of the results proved that the MTM system has the ability to locate anomalies in a buried pipeline. Comparison of the MTM data with ILI results has shown that there is a good correlation between anomalies detected by both systems. The trials also included 2 pipelines where existing strain gauges monitoring was fitted to evaluate ground movement in relation to mining activities. A comparison between the strain gauge measurements and the MTM/SCT data showed that there was a correlation between the SCT estimated stress in the Stress Concentration Zones and the stress recorded by strain gauges. MTM could identify the location of a defect but could not report the quantity of stress in the pipe wall caused by the defect. Given further work, it should be possible for SCT to determine pipe strain and this would remove the need to install strain gauge wires.

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The IFI project identified a number of new potential opportunities that the SCT system can deliver as well as recommendations required to enhance the SCT technique such that it is suitable for field deployment. New opportunities include identification of pipeline girth welds and pipeline depth measurement:

The current ILI system relies on the identification of girth welds for positioning ILI recorded features. This can lead to variability in accuracies. This may also be influenced by inaccuracies in as-laid records. The financial impact of this can be significant. Each dig typically costs in the range of £40-£70k. When a section of pipeline requires repair, the costs of excavation can increase dramatically if trenches are excavated in the wrong location and need to be extended in one or both directions until the desired feature is found. The precise identification of the location of a repair site using the SCT technique will eliminate these additional costs.

An additional issue is that the SCT system could resolve is identification of shallow pipeline cover. Topsoil has been eroded, especially in arable farmland, over the years since pipelines were installed. This is estimated at up to 50mm per year. Many lengths of pipeline were installed 40 years ago which potentially leads to the possibility that significant lengths of pipeline, originally buried between 1-2m deep, are now close to exposure or risk of damage from normal agricultural practices such as ploughing or sub soil ripping and represents a potentially dangerous situation – especially in areas of known soil erosion where farm machinery is used.

The proposed research would tap the source of technical expertise at Leeds University and it is predicted that within 24 months a tool would be developed that would accurately report the location of girth welds with a 90% probability of detection. This is within the same level of tolerance as ILI. In addition, the SCT system should be able to predict and report the depth of the buried pipeline to within a tolerance of +/-100mm, along the length of the pipeline being inspected. Finally, further work will be carried out to enhance current capabilities which will enable SCT to complement ILI inspections by accurately identifying the location of stress concentration zones (SCZs) (to a maximum resolution of +/- 100mm), reporting the value of stress within the SCZ, its clock position and characterisation of defects causing the SCZ.

Objective(s)

To develop the SCT inspection system such that it can be used as complementary tool to other pipeline inspection systems such as ILI, DCVG and CIPS.

1. The identification of pipeline girth welds to an accuracy of 90% where the PD/2t >60MPa (a measure of hoop stress where P is pressure, D is diameter and t is the wall thickness). This applies for seamed and seamless pipe but not spiral welded pipe.

2. Obtaining the depth of a pipeline to an accuracy of +/- 100mm with reference to a control point.

3. Obtaining the lateral (central) position of a pipeline using survey grade GNSS (GPS) hardware and software incorporated into the

SCT system to an accuracy of +/- 100mm with reference to a control point.

4. Development of the SCT software, to enable a stress profile of the pipeline to be obtained in terms of quantified stress in each stress concentration zone related to hoop stress and SMYS.

5. Identifying the position of Stress Concentration Zones (SCZs) on the pipe circumference.

Progress the characterisation of SCZ features.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

1. To undertake research and development and field trials on the SCT solution to enhance functionality in the key areas as listed in the objectives section.

2. To provide an inspection tool, to compliment ILI or OLi4, that is capable of lateral pipe location, definition of its pipeline depth and the identification of the location of girth welds for use by National Grid.

3. To identify and potentially develop any additional functionality or features as agreed as part of this project.

To identify and recommend future development opportunities.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The majority of the work will take place within the laboratory at the University of Leeds. Site work will take place on National Grid gas transmission assets.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL6 Large Scale

Geographical Area

The tool will be used on pipelines across the gas transmission network.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£1,232,000

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)

Benefits associated with the SCT system are predominantly associated with two aspects of pipeline inspection, excavations and "unpiggable" pipelines. Financial benefits are estimated to be in the region of £200 k/year.

The SCT system also provides additional functionality that is currently not available using any non invasive survey technique allowing repeat surveys to be carried out without impacting the network e.g. accurate depth and position recording, stress analysis of pipework similar to strain gauge monitoring; this will also allow accurate identification of areas of most stress for siting of permanent monitoring solutions such as strain gauges.

Please provide a calculation of the expected benefits the Solution

Excavation

Dig accuracy - verification of location accuracy reducing size of excavation and incorrect digs provides additional assurance that the dig is in the correct location. Identification of accurate weld position allows targeted excavation on pipelines subject to suspect girth welds (P/18) reducing radiographic costs and additional work. Cost of excavation works are currently around £70k per excavation although for difficult locations this can exceed £250k if access/working requirements are difficult. Currently UKT are carrying out around 60 digs a year. Assuming that dig accuracy could reduce this by 5% this would equate to savings in the region of £200k per year savings.

"Unpiggable pipelines"

Currently it is not possible to internally inspect all of the UKT pipelines. Alternative maintenance (OLi/4) has to take place on these pipelines (referred to as "unpiggable"). The OLi4 inspection technique can only identify open coating defects and relative CP performance; it is not possible to identify dents, shielded metal loss or stress zones. A technique that could identify these types of issues on pipelines that are currently deemed "unpiggable" would have significant safety benefits, reducing the risk of a high pressure pipeline incident, the costs of which would be considerable, many millions of pounds, including human and societal factors, environmental consequences, compensation payments, resource constraints and reputational damage.

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

The SCT inspection system could be used on steel pipeline networks worldwide.

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

Estimated cost of running SCT - £20k per inspection (depending on length of survey – this includes survey team, processing and production of report)

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

n/a

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

The project is aligned to the optimizing asset management within the reliability theme.

☑ 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.

n/a

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

n/a

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

n/a

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

n/a

This project has been approved by a senior member of staff

☑ Yes