national gas transmission

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NIA Project Registration and PEA Document

Date of Submission

Jan 2014

Project Reference Number

NIA_NGGT0045

Project Registration

Project Title

Acoustic Emission Measurements in Valve Leakage Detection and Quantification

Project Reference Number

NIA_NGGT0045

Project Licensee(s)

National Gas Transmission PLC

Project Start

February 2014

Project Duration

1 year and 7 months

Nominated Project Contact(s)

Steve Johnstone, box.GT.innovation@nationalgrid.com

Project Budget

£318,000.00

Summary

On the National Transmission System (NTS) there are two types of ball valves used for pipework isolation purposes, Cameron and Cort. The primary interest on this project is the large ball valves used to isolate pigtraps across the NTS, necessary for inline inspection of the pipelines. There are over 200 of these valves of various sizes of which 127 are Cameron type 31. Due to the age and condition of the asset, some of these valves are experiencing seal leakage. It has been identified that there is a mechanism on the Cameron type 31 valves by which if gas is leaking into the body cavity and the cavity becomes pressurized, the valve will selfrelieve into the downstream pipework. This is a serious safety consideration for National Grid as the valve would relieve at full line pressure (35-94 bar) into open pipework where an employee working on the pigtrap would be situated. Additionally, seal leakage and the subsequent release of natural gas to atmosphere is a contributing factor to National Grid's overall carbon footprint. There is an opportunity to investigate both the self relieving mechanism on the Cameron type 31 valve and methods for reducing fugitive emissions as one such valve, 42" diameter and weighing over 13 tonnes, was removed from a National Grid site, due to it's age and condition (see figure 1). This proposal looks to make full use of the opportunity; the removal of this asset facilitates a research project designed to fully simulate the performance of the valve in service in a way that would otherwise not be possible.

The project scope is to develop an additional safety control measure when work is being carried out downstream of a closed-off valve. The Cameron type 31 has a self-relief (single piston) system which is designed to avoid dangerous pressure build up in the body cavity. However, there is the potential for a hazardous situation to arise, whereby if a valve is closed, gas leakage past the upstream seal will start to pressurise the body cavity. This pressure should be relieved through the vent line(s), if the leakage rate is high enough then the pressure will rise and if this cavity pressure exceeds downstream line pressure by 200 psi, this will cause the downstream seat to lift off the ball, and allow the pressure to relieve into the pipeline. It would therefore be advantageous to understand this self-relief behavior and to consider how its occurrence might be foreseen. The project looks to investigate options for innovative alarm system solutions, by using the 42" Cameron self-relieving ball valve which has recently been taken out of service.

The second aspect of the work concerns methods to detect and quantify leaks on self-relieving (single piston) ball valves in operation on the gas transmission system. One method used by National Grid for the detection and quantification of leaks is the use of a

portable acoustic emission device where a sensor is directly coupled to the surface of the valve. This device can be used on above ground assets but a significant number of National Grid Gas' assets are below ground where access to the surface of the valve is not possible. Listening to the valve and/or vent pipe can also provide an indication of leakage. A 42" Cameron self-relieving ball valve has recently been taken out of service as it was leaking (see figure 1 in Appendix 1).

Third Party Collaborators

Health & Safety Laboratory

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

National Grid are looking to conduct a research project aimed at improving the quantification of leakage from valves and understanding safety related self relieving (single piston) operations on Cameron type 31 ball valves.

Method(s)

Investigate the behaviour of the Cameron type 31 ball valve in its self relieving operation and assess solutions for potential early warning alarm systems for this. Conduct an acoustic trial with National Grid's leakage detection equipment.

Key tasks include:

1. Determine leak rate across the ball valve upstream and downstream seats.

2. Measure vent tip velocity and pressure in cavity.

3. Assess how long it takes to reach the self relieve (single piston) pressure for the seats.

4. Determine the pressure in the cavity at the trigger point.

5. Confirm how the self relieving seat behaves on operation.

6. Take additional leakage measurements simulating the valve buried, to enable the correlation between above and below ground assets.

Scope

On the National Transmission System (NTS) there are two types of ball valves used for pipework isolation purposes, Cameron and Cort. The primary interest on this project is the large ball valves used to isolate pigtraps across the NTS, necessary for inline inspection of the pipelines. There are over 200 of these valves of various sizes of which 127 are Cameron type 31. Due to the age and condition of the asset, some of these valves are experiencing seal leakage. It has been identified that there is a mechanism on the Cameron type 31 valves by which if gas is leaking into the body cavity and the cavity becomes pressurized, the valve will self- relieve into the downstream pipework. This is a serious safety consideration for National Grid as the valve would relieve at full line pressure (35-94 bar) into open pipework where an employee working on the pigtrap would be situated. Additionally, seal leakage and the subsequent release of natural gas to atmosphere is a contributing factor to National Grid's overall carbon footprint. There is an opportunity to investigate both the self relieving mechanism on the Cameron type 31 valve and methods for reducing fugitive emissions as one such valve, 42" diameter and weighing over 13 tonnes, was removed from a National Grid site, due to it's age and condition (see figure 1). This proposal looks to make full use of the opportunity; the removal of this asset facilitates a research project designed to fully simulate the performance of the valve in service in a way that would otherwise not be possible.

The project scope is to develop an additional safety control measure when work is being carried out downstream of a closed-off valve. The Cameron type 31 has a self-relief (single piston) system which is designed to avoid dangerous pressure build up in the body cavity. However, there is the potential for a hazardous situation to arise, whereby if a valve is closed, gas leakage past the upstream seal will start to pressurise the body cavity. This pressure should be relieved through the vent line(s), if the leakage rate is high enough then the pressure will rise and if this cavity pressure exceeds downstream line pressure by 200 psi, this will cause the downstream seat to lift off the ball, and allow the pressure to relieve into the pipeline. It would therefore be advantageous to understand this self-relief behavior and to consider how its occurrence might be foreseen. The project looks to investigate options for innovative alarm system solutions, by using the 42" Cameron self-relieving ball valve which has recently been taken out of service.

The second aspect of the work concerns methods to detect and quantify leaks on self-relieving (single piston) ball valves in operation on the gas transmission system. One method used by National Grid for the detection and quantification of leaks is the use of a portable acoustic emission device where a sensor is directly coupled to the surface of the valve. This device can be used on above ground assets but a significant number of National Grid Gas' assets are below ground where access to the surface of the valve is not possible. Listening to the valve and/or vent pipe can also provide an indication of leakage. A 42" Cameron self-relieving ball valve has recently been taken out of service as it was leaking (see figure 1 in Appendix 1). This valve had been in operation for about 30 years and had undergone regular maintenance. National Grid will test the portable acoustic emission device on the surface of the 42" self-relieving valve and also test for potential use on the vents. Used on the vents the device may provide a measurement which could be used to estimate leakage of buried assets. The project therefore looks to determine if the device can be used reliably on above ground and below ground assets to detect and quantify leakage.

Objective(s)

1. Investigate the self relieve system on the Cameron type 31 valve and assess possible solutions

2. Model and validate the use of leak detection equipment for above ground and below ground process valves

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will identify suitable alarm options for the self relieving single piston valve, and provide an assessment of the performance of the valve leakage detection equipment in quantifying leakage for both above and below ground process valves.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The project will be a full scale evaluation conducted at the HSL test facility in Buxton, making use of a valve removed from service on the NTS. The full scale investigation is necessary to fully evaluate how the technology would perform in the field environment. The facility at the HSL means this is possible without disruption to the live network.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

The project will take place at the HSL test facility in Buxton. The acoustic emissions detector could be used on buried valve assets across the gas transmission network. The results on potential alarm systems for the self relieving (single piston) valve could be applied to Cameron type 31 valves on the gas transmission system.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£318,000

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)

The primary benefit is associated with the safety of those working downstream of a valve that may self- relieve. For example if work is being undertaken on a pig trap downstream of a leaking valve and the valve self relieves, this could result in a gas release at full line pressure through the open pigtrap, which could result in serious injury or a fatality. It has been identified through International Forums that other European Gas Transmission Operators use either one (double piston seats) or two (single piston seats) valves with a vent line upstream of a pig trap to achieve an effective and safe "double block and bleed", however this would be a costly option involving the installation of another valve. This project looks to investigate other simpler, cheaper options to installing an additional valve.

There will be additional environmental savings if the acoustic emissions tool can be used to identify assets experiencing high levels of fugitive emissions and drive targeted maintenance in these areas.

Please provide a calculation of the expected benefits the Solution

Base cost: Installing additional valves to comply with requirements for "block and bleed"- £300k per additional valve.

Method Cost: Self Relieving Alarm – estimated £30k per valve.

If the solution was successful and implemented on half the total population of pig trap isolation valves that are Cameron type 31 (60 out of a population of 127), total financial benefits would be over £16m.

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

If successful the self relieving single piston alarm system would be installed on all appropriate valves of this type. The equipment could be use to assess leakage on above and below ground valves of this type. There are circa 1,500 valves across the National Grid gas transmission network.

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

Roll out costs for the alarm system.

Assuming the solution was a permanent fixed one: £30, 000 x 60 = £1.8m.

(However if the solution was a mobile one, this roll out could be significantly reduced. National Grid could have a number available for

use across the network, for example one per network zone: £30,000 x 13 = £390,000)

Roll out costs associated with the acoustic emissions detector for below ground assets are estimated as:

Equipment: £35,000 per unit procured in each of the thirteen zones = £455,000

Procedural updates and training: £15,000

Total = £1,800,000 + £390,000 = £2,190,000

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 learning with regards to the acoustic emissions device could potentially be applied to other sources of natural gas leakage across gas transmission and distribution networks. Any learning associated with alarm systems for self relieving valves of this type can also be used by relevant asset owners.

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 reliability and environment theme within the innovation strategy.

☑ 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