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

May 2020

Project Reference Number

NIA_NGGT0159

Project Registration

Project Title

Corrosion Modelling

Project Reference Number

NIA_NGGT0159

Project Licensee(s)

National Gas Transmission PLC

Project Start

May 2020

Project Duration

0 years and 11 months

Nominated Project Contact(s)

Robbie Williamson

Project Budget

£534,239.00

Summary

The objective of the proposed innovation project is to demonstrate interactive models of current and future corrosion risk using predictive analytics on a site of strategic importance on the NTS (National Transmission System).

Nominated Contact Email Address(es)

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Problem Being Solved

The National Transmission System (NTS) is largely beyond its original design life. As a result, regular inspection is required and remediation action taken where required. National Grid has duties as an operator under Pipeline Safety Regulations, COMAH and Pressure Systems Safety Regulations to maintain these assets.

Unlike buried pipelines above ground pipe work does not readily lend itself to internal inspection tools, such as “Intelligent Pigs”. As a result of this, it is difficult to effectively model corrosion, and therefore predict the time of failure of what is a complex time / event dependent failure mechanism. This is particularly challenging at complex sites such as terminals and compressors, leading to inefficient and sometimes reactive interventions. Recent interventions on site are showing the significant rate of metal loss which are difficult to assess from an external assessment only. To intrusively assess each of these features would be extremely expensive (often requiring outages) and resource intense.

Method(s)

The technology proposed will integrate inspection data into a 3D “Asset model” in order to support and allow for effective visualisation of the above ground pipework and corrosion defect locations. A mathematical model, supported and underpinned with the actual inspection data results from the existing P20/P11 reports, Inline Inspection (ILI) and cathodic protection (CP) will be developed to assist with the prediction of the corrosion growth rate in relation to the defects inspected and mapped onto the 3D Asset Model. This incorporates and enhances the condition modelling completed as part of the GRAID NIC.

A “time slider” function will be incorporated to the model to help visualise and demonstrate the effect on the pipe work itself as the corrosion defects are effectively “Grown”. This simulation will allow for detailed Asset Integrity Management (AIM) best practice to come into effect for the National Grid above ground pipe work assets and support the synergy of brining the condition of the above ground pipe work condition, from a technical integrity stand point, together with the absolute risk exposure profile presented by the above ground pipe work in its current condition. The risk profile will be presented by the quantitative probabilistic condition assessment and the quantitative consequence of failure analysis that will complement each above ground pipe work location. The 3D model, and supporting analysis, will be presented to National Grid allowing the decision on how and where it is further rolled out across the NTS to be made.

The above will solve the issues of data accuracy, data coverage (current lack of it), data location capacity / storage / validity, and ultimately support Asset Integrity Management (AIM) best practice.

The project will be structured as below:

- Project procedures and workflows + overall project management – Premtech
- Data Requirements – NGGT
- Normalisation, quality control and exploratory analysis – WRc/NGGT
- Predictive Modelling of Corrosion Risk – AFAA
- Defect initiation probability analysis, multi-model calibration – WRc
- Monetised Risk and Intervention Scenario Modelling – WRc
- BI Dashboard (cut down version) – WRc
- Update project procedures and workflows – Premtech
- Project completion and BAU – Premtech

(The numbering of work packages and tasks has been maintained for backward compatibility with earlier proposal versions and hence work package numbering now appears non-sequential.)

Scope

National Grid above ground pipe work assets typically are subject to the damage mechanisms directly as a result of the impact from that of external corrosion. The resulting damage is typically that of loss of wall thickness resulting in a reduced internal pressure containing capacity of the physical pipe itself. The ultimate failure modes for pressurised pipe work can be that of a small surface area or “Pin hole” leak to that of a full longitudinal rupture of the pipe wall itself (should a number of these smaller defects interact (link up) and reach a critical length in relation to the pipe wall thickness, steel grade and operational pressure).

The current inspection programme T/PM/CM/4 allows for a rating of corrosion defects based upon the visual condition of the defect. In this instance the defect is visually inspected, on what is an operational pressurised section of above ground pipework, and as such cannot be cleaned or prepared for detailed inspection / assessment without a pressure reduction or depressurisation of the pipework itself. This can lead to excessive time delay before the defect is inspected in detail and accurately assessed.

The current inspection programme T/PM/CM/4 is well structured and when applied with the correct rigor is effective, however, it is still a qualitative process. The follow up inspection and assessment work usually requires a good deal of planning, in relation to the development of isolations, repair work scopes, Non-Routine Operation (NRO) documents, weld procedures, Management of change (MOCs) and data capture for mechanical components to name but a few. A 3D model, with quantitative supporting analysis and scenario sensitivity development capability would greatly improve the current corrosion management and remediation programs for National Grid above ground pipe work assets.

Visualising this resulting data greatly assists with the development of Asset Integrity Management programs and the capability to demonstrate and defend Monetary Risk, however it was decided that this element was not considered ‘innovative’ and was removed from the scope. WP9 covers a very small Business Intelligence (BI) dashboard for representative purposes. NGGT will therefore be responsible for the full visualisation and roll out strategy of this methodology providing the outcome is satisfactory.

Objective(s)

- Business objective to proactively intervene in a cost-effective manner for corrosion related issues through robust time based modelling.
- Optimise the planning of remediation works on a site leading to a proactive rather than reactive response.
- To reduce corrosion related intervention costs by at least 10% in RIIO T2

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

- Business acceptance for the condition modelling, aligned to existing business processes such as NOM’s (NARM’s), unit cost modelling and CM/4.

- Demonstration of the model recreating known, advance defects (validation)
- Deliver efficiency savings of 10-30% for corrosion related investments in RIIO T2 and beyond

Project Partners and External Funding

Premtech, WRC

Potential for New Learning

The potential for new learning will come from being able to optimise planning for defect resolution on site, the output should allow an improvement in the decision-making processes moving from a reactive to proactive state of addressing corrosion on site.

Scale of Project

Site data will be collected in addition to pre-existing inspection data. The bulk of the effort shall be office based with some site visits to understand the geographical characteristics.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

The project will focus on the St Fergus Gas Terminal in order to prove the concept.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£534,239.00

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)

Corrosion and the associated costs for inspection and repair of found defects can incur significant costs especially at sites of strategic importance. Locating and addressing known issues as early as possible can prevent these costs increasing.

Clearly, performing a broader range of surveys more frequently is likely to increase the probability of detecting corrosion sooner rather than later, and performing repairs at an early stage is likely to improve the integrity of the system. However, doing things more frequently clearly increases costs. The benefit of this project is to generate a methodology to ensure that inspections and repairs are prioritised such that both safety and financial risks are maintained at an acceptable level whilst managing the cost.

Carrying out proactive rather than reactive maintenance on our key sites could lead to significant savings, as an example corrosion related investment in RIIO T2 is estimated between £150m and £200m across the compressors and terminals alone. An efficiency of at least 10% (breakeven) is readily achievable. 20-30% is the target (as per the success criteria), leading to up to £60m savings.

Please provide a calculation of the expected benefits the Solution

Potential saving of £60m across the NTS over RIIO-2 including up to £15m at St Fergus.

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

This NIA covers the trial of the concept using data from the St Fergus Gas Terminal only, following the success of this project a full roll out strategy will be proposed and a decision will be made on whether this is delivered in house or out sourced. It is likely that key sites will be focused on leading to rolling it out across the NTS.

This methodology can be fully applied to the whole NTS although in reality greater benefit will be derived from our large scale compressor and terminal sites. It is also replicable across all of the GDN above ground installations.

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

The full roll out (post NIA) is estimated at £5m-10m to model the network and allows for efficiencies once the process is developed.

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

All networks with pipeline infrastructure could benefit from this application.

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, this project also relates to the 'Fit for the Future' category of the T2 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.

Whilst this project builds on existing NIA's (GRAID, BIM etc), nowhere else does this solution exist.

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

Ultimately the key innovation is the converging of 3D modelling and corrosion analysis to give a holistic view of the current state and help to focus efforts on those areas requiring the most immediate attention and prevent wasted work. Each project partner has submitted the innovation under their work packages as below: Premtech - Modelling acceptable failure frequency on monetised and safety risks. - Combine results from different inspection methods using Bayesian techniques to give more rigors indications of failure frequency. - Consistently update the distributions using data from new inspections to obtain posterior distributions. WRc - Spatio-temporal defect initiation probability analysis - Monetisation of risk and intervention scenario modelling.

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

Subject to the outcome of this inventive step the business are looking to fund the roll out. This is unproven technology at this stage and therefore would have too much uncertainty for BAU investment.

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

Corrosion impacts all pipeline operators. With the age of the NTS we are seeing substantial corrosion hotspots leading to very inefficient interventions. These hotspots also pose H&S concerns in relation to high pressure gas and potential for projectile releases. This model could be tailored for any operator. Sharing the results and methodology of this NIA can assist the other Network Licensees carry out similar exercises on their aging assets.

This project has been approved by a senior member of staff

☑ Yes