NIA Project Registration and PEA Document

Date of Submission

Jul 2015

Project Reference Number

NIA_NGGT0079

Project Registration

Project Title

Remaining Useful Life (RUL) determination for compressors

Project Reference Number

NIA_NGGT0079

Project Licensee(s)

National Gas Transmission PLC

Project Start

August 2015

Project Duration

1 year and 4 months

Nominated Project Contact(s)

Steve Reveley

Project Budget

£60,326.00

Summary

This project is feasibility only and will undertake a desk top study to investigate existing techniques for the determination of Remaining Useful Life (RUL). Existing asset trend data will be used for the evaluation of methods and algorithm's to establish the relevance to National Grids Compressor fleet (including gas generator, power turbine and gas compressor). Evaluation information includes;

- 'Alert'* condition monitoring system historic data for all compressors

- Existing published research papers on the subject

*'Alert' monitors all compressors and is a flexible on line monitoring system providing

- Performance monitoring

- Emissions monitoring

- Energy management

- MTBF and availability tracking

Techniques to determine RUL are used in other industries, however this approach is new for NGGT and the application to a compressor fleet would be the first in the UK. The application will explore how best to easily incorporate individual compressor unit criticality. Thus achieving optimum maintenance regime; which may lead to potential cost savings and providing a better service for our customers.

Third Party Collaborators

Cogsys

Nominated Contact Email Address(es)

Problem Being Solved

National Grid Gas operates and maintains 75 compressor units across 24 sites. Current maintenance policy for compressors ('Maint6') has limited flexibility because the current approach across the fleet does not account for individual unit criticality. The current processes are inadequate for replacement, maintenance or repair decision making on an individual unit basis.

With varying degrees of criticality these units are essential to the continued and strategic supply of gas to the UK. In order to meet the increasingly challenging economic climate and drive to increase start reliability and availability and decrease operating costs there is a greater requirement to be smarter with the management of these assets. One area with potential to reduce costs and increase reliability is that of the timing of maintenance and replacement. Optimum timing of maintenance and replacement will ensure maximum asset life and minimal undesired failures.

The key to optimizing maintenance and replacement is:-

1-   identifying the tell-tale signs of failure

2-   having the ability to detect these tell-tale signs

3-   accurately predicting the time from problem detection to total failure

We have established technology in place for 1 and 2 above, this project will focus on item 3. The results of which when combined with criticality will optimise maintenance and replacement.

The two of the key indicators for compressor performance include start reliability and mean time between failures (MTBF). Start reliability currently exceeds the target however MTBF is below the target and behind industry benchmarks. This project will target failures before they occur and will significantly improve MTBF.

Method(s)

The project is looking to expand the datasets required to identify, evaluate and apply RUL techniques for NGGT requirements. To date the information has not been sufficient to determine correlation of output results. Consequently we have been I touch with two universities (Cranfield & Warwick), both have experience in this area and both have offered to use our asset monitoring data in conjunction with a prognostics modelling tool to complete the feasibility study. The prognostic analysis will be carried out over the summer of 2016, which requires a project extension to complete.

This project is currently at the feasibility stage. Initially, the project will obtain a variety of data from available published research results and include collating information from many diverse channels.

Once the data has been obtained the following will be carried out:

- Identify analysis techniques for Remaining Useful Life (RUL) determinations
- Investigate cross industry implementations
  - Prognostic analysis to be carried by Cranfield/Warwick University student to better predict when a failure will occur in the future.
- Identify the best sources of data and define the operating envelopes which the data needs to support
- Evaluate analysis techniques in National Grid's application
- Evaluate cross industry implementations
- Apply techniques to National Grid's historic data
- Determine correlation of output results to actual maintenance history
- Identify areas where potential improvements may be made
- Determine applicability to replace or repair strategy
- Identify areas for potential operational/maintenance cost savings, ref maint6

If successful then next steps will be to carry out a trial with a view to wider implementation. Although, this is not part of the current scope of this project, it is anticipated that the second phase would be funded through NIA.

Scope

This project is feasibility only and will undertake a desk top study to investigate existing techniques for the determination of Remaining

Useful Life (RUL). Existing asset trend data will be used for the evaluation of methods and algorithm's to establish the relevance to National Grids Compressor fleet (including gas generator, power turbine   and gas compressor). Evaluation information includes;

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·   Energy management

·   MTBF and availability tracking

Techniques to determine RUL are used in other industries, however this approach is new for NGGT and the application to a compressor fleet would be the first in the UK. The application will explore how best to easily incorporate individual compressor unit criticality. Thus achieving optimum maintenance regime; which may lead to potential cost savings and providing a better service for our customers.

Objective(s)

The objective is to determine the feasibility of applying different mathematical and statistical analysis to existing available historic data in defining Remaining Useful Life to optimise maintenance and improve asset management decisions.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will deliver a report evidencing available options have been identified, investigated, evaluated and reasoned recommendations made as to their applicability to resolve the identified business problem.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

At this stage the project is small scale. This is the feasibility to determine whether RUL techniques can be applied to the compressor fleet assets. Any further work (e.g. a site trial) would be scaled appropriately based on the initial findings.

Technology Readiness at Start

> TRL3 Proof of Concept

Technology Readiness at End

> TRL4 Bench Scale Research

Geographical Area

National Grid and Cogsys offices.

Revenue Allowed for the RIIO Settlement

TBC

Indicative Total NIA Project Expenditure

£60,326

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)

Predicting asset life and optimizing maintenance will result in reliability improvements of the compressor trains; which will consequently result in financial savings which will be passed on to NGGT customers. It is difficult to quantify savings at this stage of the project. However, the annual compressor maintenance budget is in the region of £10m, estimated savings are in the region of 5%. This will need to be confirmed by this feasibility and subsequent trial.

Please provide a calculation of the expected benefits the Solution

N/A- Research project

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

The technique will be assessed for suitability across the 24 compressor sites. The Method may also be replicable on any other types of assets which have the required data or have the possibility to acquire the data. This would need to be assessed on each individual asset category basis.

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

If the feasibility study proves successful, the next stage of work will involve building and trialing the Remaining Useful Life model for one particular compressor asset type. This trial stage will give further indication of roll out costs.

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 project will demonstrate if analysis of compressor asset data can be used in optimization of the fleet maintenance planning. This could be applicable to any asset type so long as asset monitoring data is available.

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

This project is aligned to 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