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

Mar 2016

Project Reference

NIA_UKPN0017

Project Registration

Project Title

Optimising overhead line conductor inspection & condition assessment

Project Reference

NIA_UKPN0017

Project Licensee(s)

UK Power Networks

Project Start

April 2016

Project Duration

1 year and 10 months

Nominated Project Contact(s)

Lynne McDonald

Project Budget

£1,520,431.00

Summary

The enhanced inspection method is planned to be trialled on a proportion of ASCR conductor spans and potentially also AAAC.

Nominated Contact Email Address(es)

innovation@ukpowernetworks.co.uk

Problem Being Solved

UK Power Networks currently has approximately 9,000 broad-based towers on its network. Of these, approximately 6,000 are strung with Aluminium Conductor Steel Reinforced (ACSR), 1,200 with All-Aluminium Alloy Conductor (AAAC), and the rest is made up of a mixture of conductors. The majority of ACSR were installed in the 1950s and 1960s and it is also currently still being installed.

Failure of ACSR conductors may occur when the supporting steel core deteriorates either through corrosion or is annealed through over-heating of the conductor. The steel core is protected from corrosion by high temperature grease and some earlier conductors had a bitumen paste layer. Corrosion can occur where there has been incorrect application of the grease during the manufacturing either by applying too little or applying too much. It can also occur where grease has migrated to a lower point of the conductor because of excess heat.

Any presence of corrosion becomes part of the determination of asset health and can lead to very expensive conductor replacement as an element of UK Power Networks’ capital programme. Inspection of the steel core in ASCR conductor to detect corrosion is difficult as it is surrounded by the conductive aluminium strands, so is impossible to see. In 1985, an electro-magnetic device (Cormon) was developed by Central Electricity Research Laboratory (CERL) which could travel along a conductor and induce eddy currents into it. These eddy currents are sensitive to strand corrosion so that the early stages of internal corrosion may be identified. UK Power Networks continues to use Cormon devices to help identify corrosion (along with infra-red patrols using helicopter to identify over-heating), but the Cormon devices are now older technology and they are reaching the end of their life and need replacement.

UK Power Networks are therefore seeking to develop new technologies or methods that can detect or predict defects in overhead line conductors. The project aims are to:

1. Identify and generate a list of potential technologies and/or methods that are able to detect and measure common failure modes.
2. Review the emerging techniques identified and select the techniques to be tested. This is proposed to take into account relevance to failure modes and technology readiness level (TRL).
3. Develop an evaluation pro forma to assess the performance of the identified techniques for consideration.
4. Test and assess each technique employed. For each technique the assessment is proposed to review: costs, time at site, ease of deployment, effectiveness and reliability of the technique and its limitations, work and safety practices and commercialisation routes.
5. Peer review undertaken of results with other DNOs.

It is possible that a multi-stage approach is adopted to inspect ASCR conductors, where we employ a preliminary coarse non-contact test to determine if a subsequent more detailed contact test using a conductor crawler type device should be carried out.

In addition to ACSR, the project may explore and identify techniques to assess the condition of AAAC conductor. The reason why this is also of interest is that AAAC is currently the second most used type of conductors in UK Power Networks’ license areas.

Method(s)

This project is planned to be carried out against the following phases:

Phase 1: Literature Review of enhanced inspection techniques & condition assessment

- Identification of inspection techniques to measure the condition of overhead line conductors to detect common failure modes. It is envisaged this may include:
- Liaison and surveying with worldwide network owners of overhead lines to develop an understanding of best in class inspections.
- Review of related company, national, and international practices to identify beneficial or obsolete practices.
- Review of existing papers and reports to best leverage existing knowledge in the relevant subject areas.

Post phase 1 we will hold a DNO forum on project insights and determine whether other DNOs wish to partner for phase 2 and onwards. Therefore, dependent on additional funding licensees coming on-board, the project may resubmit an updated registration document on to the ENA smarter network portal to take any changes into account. Such changes may also include additional trial sites and demonstrations and therefore the updated registration may include updates, such as time and/or cost changes.

Phase 2: Identity & select techniques

- Identify and generate a list of potential technologies and/or methods that are able to detect and measure conditions that lead to common failure modes in the conductor type(s) of focus.
- Review and assess the emerging techniques identified and select the techniques to be tested. This is proposed to take into account relevance to failure modes and TRL.
- Applicability of technologies to GB networks, taking into account network design, materials, health & safety practices, etc.
- Selection of candidate techniques based on expert recommendation and peer review.
- Development of an evaluation pro forma to assess the performance of each technique that will be trialled.

Phase 3: Design, build and production of prototypes

- Develop, design and build several prototype devices or obtain existing equipment that is commercially available or enhance commercially **available equipment.**

Phase 4: Trial prototypes

- Train a small number of inspectors on the use of the prototypes or equipment.
- Undertake trials at overhead line infrastructure and assess each technique employed against the developed evaluation pro forma. This assessment is proposed to include costs, time at site, ease of deployment, effectiveness and reliability of the technique and its limitations, working and safety practices and commercialisation routes.

Phase 5: Development of equipment, systems and policies

- Support further development of units based on feedback of use by inspectors.
- Peer review with other DNOs' inspection techniques to identify the safest and most cost effective.
- Produce instructional guide on use of technology.
- Develop a commercial approach business case for evaluation of purchase, hire, and service provider alternatives for performing the inspection work using the selected technologies. Produce report detailing how the system works and overhead line conductor inspection & maintenance policies (this may include a multiple approach where we employ a preliminary coarse non-contact test to determine if a subsequent more detailed contact test using a conductor crawler type device should be carried out).
- Develop any necessary training materials.
- Training on use of inspection techniques to inspectors.
- Production of a strategy for the enhanced inspection for the conductor type(s) of focus to be available to all GB DNOs.

Scope

The enhanced inspection method is planned to be trialled on a proportion of ASCR conductor spans and potentially also AAAC.

Objective(s)

The objectives of the project are to:

- Identify new technologies or existing off-the shelf equipment that can monitor the condition of overhead line conductors to detect their common failure modes.
- Understand through trialling the new technologies or equipment the ease of deployment, the effectiveness and reliability of the techniques, safety, cost and time considerations.
- Produce a roadmap of the transition from the current techniques used to inspect and measure ASCR conductor condition to the new technologies and equipment.
- Explore the commercial mechanisms that could be considered to implement the new technologies or equipment.
- Produce policies and procedures, along with training manuals for deployment of the techniques.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The following will be considered when assessing whether the project has been successful:

- Collection of overhead line inspection practices used worldwide and evaluation relative to the GB DNO market.
- A list of suppliers and their contact details that provide services for the inspection of overhead line conductors, along with the techniques (tested and untested) they are able to offer as an alternative to the traditional Cormon technique.
- Alternative techniques trialled for conductor condition assessment.
- A roadmap of the potential commercial routes to implement the new technologies or equipment.
- Produce/update policies and procedures along with training materials.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The enhanced inspection method is planned to be trialled on a proportion of ASCR conductor spans and potentially also AAAC.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

Work will be carried out to review and select appropriate routes for testing the conductor inspection techniques. The conductor types of interest are ASCR conductor spans and potentially also AAAC.

Revenue Allowed for the RIIO Settlement

The RIIO Settlement included revenue for both inspection and maintenance of tower line conductors.

Indicative Total NIA Project Expenditure

£1,520,431 is the total expenditure which we expect will be incurred during the duration of the project.

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 financial calculations have been based on a scenario in which our ability to conduct condition-based testing is compromised due to limited support and limited existing suppliers.

In this situation, it is possible that an age-based approach would have to be re-introduced. The benefit that is calculated demonstrates that the inherent value of being able to always follow a condition-based approach versus an aged-based approach more than pays for the development of replacement products. Separately, the products may prove to be better and provide additional benefits to customers.

Please note we have also based our calculations on the overhead line conductor type, ACSR.

UK Power Networks has currently forecast a total of £50.9m replacement schemes for tower line conductors (33kV, 66kV and 132kV) and around £354k for Cormon inspection costs over the ED1 period. It is expected that the new inspection technique's inspection costs will be similar to those currently incurred by Cormon in the SPN and LPN area.

When comparing an age-based approach (assuming replacement after 50 year conductor's lifetime) with a condition-based approach (where the replacement schemes are deferred by two years from the age-based replacement year) for all the replacement schemes currently planned in ED1, and taking into account the estimated inspection cost profile for ED1 period, it is estimated that the benefits could be approximately £1.8m for ED1 period. However this can only be confirmed after the ACSR inspection technologies and/or methods are identified and the trials are completed. Looking at annual savings from a two year deferral in replacement schemes being realised it is estimated to be on average £257k per annum over the period from 2016 to 2023.

Please provide a calculation of the expected benefits the Solution

A CBA has been used to confirm expected return from this project if successful, this can be summarised as:

Base Cost: £2.394m

Based on assuming that:

- Two replacement schemes (respectively 55 and 66 years old) are forecast at the beginning of ED1 (2015-2016) according to the age-based approach for a total value of £2.7m.

Method Cost: £2.379m

Based on assuming that:

- Both replacement schemes are deferred by two years in ED1 following the introduction of a new ACSR failure mode inspection technique and/or conductor inspection method (therefore moving to a condition-based approach for asset refurbishment planning); and
- The new inspection unit cost is around £90k and UK Power Networks purchases two units.
- The new unit inspection costs (to cover eight spans in a day) with the new technology are the same across all license areas and are similar to the upper value of inspection costs for Cormon (£1k for four spans in SPN and LPN) for a total of £2k per circuit.

Financial benefit: £15k

NPV: Base Cost - Method Cost

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

All DNOs within Great Britain that operate overhead line ASCR conductors at 33kV, 66kV and 132kV.

The Method would be replicable to all DNOs who operate this type of overhead line.

There are around 19,406 km of overhead line cables operating at 33kV, 66kV and 132kV throughout Great Britain. Assuming that the other DNOs have a similar asset type profile as UK Power Networks with approximately 70% of the broad-based towers being strung with ASCR conductors, there are roughly 13,500 km of overhead line cables throughout Great Britain where this technology can potentially be deployed.

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

Based on the following assumptions, it is estimated the cost of the roll out would be around £1.17m:

- Most of overhead line routes operating at 33kV, 66kV and 132kV across GB are ASCR conductors.

Between 10 to 13 inspection units are required across the GB network (around 20,000 km) to roll out the Method across GB considering either two inspection units every 4,000 km or one inspection unit per license area (excluding LPN).

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)

Innovation strategy capability themes addressed:

- Understand the condition of our assets; and
- Managing asset risk and improving fault performance.

☑ 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