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

Dec 2016

Project Reference Number

NIA_SHET_0021

Project Registration

Project Title

Composite Core (ACCC) Inspection

Project Reference Number

NIA_SHET_0021

Project Licensee(s)

Scottish and Southern Electricity Networks Transmission

Project Start

December 2016

Project Duration

2 years and 1 month

Nominated Project Contact(s)

SSEN Future Networks Team

Project Budget

£222,000.00

Summary

The project seeks to develop a prototype to evaluate the condition of the core of ACCC conductor. The following work activities make up the scope of this project:

1. Review the current technology available.
2. Analyse the jointing process of the conductor to determine stress points.
3. Develop a testing protocol and build a prototype.
4. Validate the testing against ultimate load tests.
5. Investigate the relationship between temperature, elongation and strain that would affect the stress in the carbon-fibre material
6. Develop a method to measure the strain of the carbon-fibre of the conductor, before and after the installation process of the conductor.
7. Specify the requirements for integration of prototype sensor with a travelling device.

Nominated Contact Email Address(es)

transmissioninnovation@sse.com

Problem Being Solved

Aluminium Conductor Composite Core (ACCC) consists of a carbon-fibre core wrapped by aluminium strands. This type of arrangement offers a lower weight than in typical conductors typically used on Transmission overhead lines, which tend to have a steel core. In addition, ACCC sags less thereby having the capability to be operated at much higher temperatures without contravening statutory safety clearances. There is growing usage of ACCC around the world and within GB where an increasing number of projects are seeking to increase power flows on Transmission lines without the need to upgrade weight bearing components. When ACCC is used to upgrade lines, less invasive activities are performed and there are less associated costs than would be the case when civil engineering works are needed to reinforce weight bearing components.

Currently there is no method to determine the integrity or condition of the core of ACCC overhead lines after or during the installation process which is when it is most vulnerable. This is due to potential issues introduced in transportation, handling or imperfect

workmanship. The main concern about carbon-fibre is that defects on it, such as cracks, are almost undetectable. Without confidence about the strength of ACCC cores in service network owners will not be able to leverage its benefits.

The project aims to develop a carbon-fibre inspection prototype. This is expected to give the network operators reliable information about the condition of ACCC overhead lines. The tool could potentially be used by manufacturers to detect defects at source or by utilities during and after construction.

Method(s)

The project is a technical method to develop a carbon-fibre inspection prototype. This prototype will be a portable device, which has its own power supply and recording processor. The device will be used as an inspection tool during construction or planned maintenance of ACCC strung overhead lines. It is expected to give information about the defects of the carbon-fibre core, which could subsequently propagate into potential failures. Such a tool does not exist at the moment and this may discourage networks from adopting and leveraging the potential benefits of using ACCC on their network infrastructure.

The approach will be to use the already existing optical laser technology, which is used with great success in the detection of defects on the carbon-fibre in carbon products such as yachting hulls and masts. The devices currently in the market for doing so are difficult to transport given the size and weight hence the need to develop a prototype of a portable device that can easily be deployed into the field. Where the carbon is not exposed the tool will measure the strain of the core by introducing current and monitoring the changes of the carbon-fibre core.

The prototype would be used to assess the condition of the first 20 meters from each dead-end or splice assembly. Later stages of the project will look at developing a specification for integration of the prototype sensing technology with a motorised robot which will be able to inspect the full length of the conductor.

Scope

The project seeks to develop a prototype to evaluate the condition of the core of ACCC conductor. The following work activities make up the scope of this project:
Stage 1 (Technical research and feasibility): Laser Shearography(LSI) will be used for the first time to detect defects in the carbon core of an ACCC conductor when the core is exposed, such as in dead ends. The Stage will ascertain the effectiveness of the inspection tool evaluating the carbon core. Stage 2(Technical development): Technical design and development of a working prototype capable of inspecting and detecting defects inthe carbon core.
Stage 3 (Bench Test of Composite Conductor): LSIwill be used for the first time to detect defects in the carbon core of a complete ACCC conductor (carbon core covered with aluminium strands). It will attempt to indicate successful identification of carbon core defects using LSI techniques with minimal complexity.
Stage 4 (Tensioned Composite Conductor Test Rig): A more complex bench test will be set up to simulate a short span of ACCC conductor under tensioned conditions representing a conductor suspended post installation.

Objective(s)

Objective(s)
The project objectives are:
• To gain an understanding of the effectiveness of the ACCC composite core inspection tool in evaluating the carbon core.
• To develop a fully working prototype with a design fully tested and evaluated for performance.
• To produce a report with details of defects and inspections done with the prototype on defective samples.
• To produce a report with details of training, data capture requirements, certification and requirements for integrating with a travelling inspection device.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be considered a success if a prototype is built and fully assessed for deployment readiness, or if learning is gained through the project showing unresolvable issues in the process.

Project Partners and External Funding

N/A

Potential for New Learning

The project has potential to provide valuable new learning relating to:

1. Development and validation of a working prototype to assess the ACCC composite core condition.

2. Establishment of the failure modes and mechanisms of ACCC composite core.

3. Requirements for the development of a motorised robot, which is fundamental to the full deployment of the ACCC conductor in the network infrastructure in Great Britain

The learning from the project will be disseminated to the other Network Licensees through the online learning portal, dissemination workshops and the LCNI annual conference

Scale of Project

The project is planned to allow maximum learning for minimal cost. It is expected to take the technology from TRL 5 to TRL 6. The output from the project is expected to eventually result in the development of a motorised robot, which is fundamental to the full deployment of the ACCC conductor in the network infrastructure in Great Britain. The scale of this project is deemed appropriate for the magnitude of learning from this project.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL6 Large Scale

Geographical Area

The project will be performed within the SHE Transmission licence geographical area in Scotland.

Revenue Allowed for the RIIO Settlement

There is no revenue allocated in the RIIO settlement.

Indicative Total NIA Project Expenditure

The total spending for the revised project is projected to be £222,000, 90% of the sum (£199,800) is allowable NIA spending.

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)

Potential savings are calculated considering the avoidance of outages as well as repair costs through assuring that any new ACCC installations are commissioned in good condition. It is assumed that a compromised ACCC core is most likely to fail in extreme weather conditions such as those already witnessed at least once in Scotland since the start of RIIO-T1 period. It is anticipated that this method will enable actions to minimise chances of ACCC failures even under the aforesaid weather conditions. Assuming like for like costs of returning the circuit to service and compensation payments for the typical number of affected customers, the conservative estimate of savings if the method is successfully deployed within the remaining RIIO-T1 years nears £100k. However, more savings could be quantified if other costs such as direct Distribution costs arising from Transmission outage are taken into account.

Please provide a calculation of the expected benefits the Solution

Base cost for an unplanned outage = £272,000
Method cost of deploying the technology = £194,000

Estimated cost savings = Base cost – Method cost = £78,000

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

There is an ever increasing need for extra capacity on Transmission and Distribution networks to accommodate dispersed renewable energy sources. Various methods of reinforcing existing networks exist but all have different cost and environmental impacts which need careful assessment. The limited impact on the environment from use of ACCC makes it an attractive option for network reinforcement. For the foregoing reasons as well as the confidence currently being gained from existing installations in GB, use of ACCC is expected to increase in the coming years. The method to be developed in this project will be replicable to all parties who have or are planning to use ACCC conductors. Conversely, this method, if successful, is expected to enable wider adoption of ACCC and hence its potential benefits by Network Licensees who may currently be hesitant due to the absence of such a method.

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

The costs detailed above indicate the cost savings of using this method over not having one. The costs of GB roll out of the method proposed depend on the number of ACCC conductor a network owner wishes to inspect. The true costs of each device will only be fully known at the end of the project and the total costs for each Network Licensee will be in proportion with the number of devices necessary for the number of lines strung with ACCC.

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

At the end of this project, details about the development of a tool for inspecting ACCC conductor will be known by relevant Network Licensees through dissemination activities that will have been undertaken. These details will include the viability of the prototype developed, its strengths and limitations as well as any further work that may be necessary to refine the technology. Based on this learning, relevant Network Licensees will be in a position to make informed decisions about whether to use the tool on their own networks or not.

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

n/a

☑ 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.

The project is focused on the development of a tool to assess the condition of an ACCC conductor composite core, after or during the installation process. According to the published NIA information, there are no known projects being performed by other network licensees to evaluate this technology. Additionally, the conductor suppliers have also indicated that no such method exists at the moment.

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