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NIA Project Registration and PEA Document

Date of Submission

Jun 2018

Project Reference Number

NIA_NGTO010

Project Registration

Project Title

Liquids for cable sealing ends (LiCaSE)

Project Reference Number

NIA_NGTO010

Project Licensee(s)

National Grid Electricity Transmission

Project Start

June 2018

Project Duration

3 years and 2 months

Nominated Project Contact(s)

Oliver Cwikowski

Project Budget

£1,061,000.00

Summary

Existing polymeric cable sealing ends (CSE) typically contain silicone oil as an insulating liquid between the cable core and the outside of the CSE. In the past year, a number of performance issues have been identified with silicone oil filled CSE. Although these devices are intended to be maintenance free, there is evidence that the insulating liquid is degrading. In some cases, this has led to the electrical degradation of CSEs. A deeper understanding of the chemical degradation of the silicone oil is needed in order to understand the possible reasons for this behaviour. It is also desirable to determine if different insulating liquids (for example, synthetic or natural esters, which have been used in transformers) could be deployed in CSE. The possibility of retrofitting existing CSE would need to be explored, along with any design changes which might be necessitated by the new insulation. Understanding of the long-term ageing of these liquids will be of paramount importance.

Nominated Contact Email Address(es)

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Problem Being Solved

Existing polymeric cable sealing ends (CSE) typically contain silicone oil as an insulating liquid between the cable core and the outside of the CSE. In the past year, a number of performance issues have been identified with silicone oil filled CSE. Although these devices are intended to be maintenance free, there is evidence that the insulating liquid is degrading. In some cases, this has led to the electrical degradation of CSEs. A deeper understanding of the chemical degradation of the silicone oil is needed in order to understand the possible reasons for this behaviour. It is also desirable to determine if different insulating liquids (for example, synthetic or natural esters, which have been used in transformers) could be deployed in CSE. The possibility of retrofitting existing CSE would need to be explored, along with any design changes which might be necessitated by the new insulation. Understanding of the long-term ageing of these liquids will be of paramount importance.

Method(s)

Three parallel streams of work will be undertaken. The first is focused on developing understanding of the chemical degradation processes of silicone oils in present use. This will be informed by the second, which will involve the development of numerical models of the CSE to investigate the electrical, thermal and mechanical environment that the insulating liquid is subjected to. The third stream will review possible alternative liquids, with a focus on ensuring that their electrical performance and degradation behavior is sufficient for the application. These three streams will run together through the project.

Scope

The scope of works for the project is as follows:

To understand the reasons for the observed behavior of silicone oil, with a focus on the influence of chemical degradation, potential chemical contaminants and compatibility with CSE materials.

Determine if other insulating liquids could be used as a replacement for silicone oil in CSE operating at 132kV and above.

Confirm whether existing silicone oil CSE can be retrofitted with different liquids, and if so what control measures might be needed to ensure long term performance.

Through the use of modelling techniques, determine worst case electrical and thermal conditions that would be experienced by the insulating liquid used in existing CSE designs.

Identify tests that can be specified such that the lifetime performance of new liquids could be determined in a laboratory environment.

Determine an appropriate field sampling strategy for the testing of CSE oils, including tests to verify that liquids are of sufficient standard prior to use.

Inform the development of new specifications for CSE with novel insulating liquids.

Working with the ENA, combine present knowledge regarding silicone oil performance into a new silicone oil standard for cable sealing ends.

Objective(s)

The overall aim of the project is to identify, characterize and verify the long term performance of new insulating liquids which could be used in Cable Sealing Ends.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Improved knowledge on the degradation behavior of insulating liquids within existing CSE, leading to the development of clear asset management recommendations and proposed revisions to technical specifications to enable the use of the new liquids on the GB network.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

A laboratory scale analysis is a suitable starting point as a number of fundamental questions exist concerning the chemical degradation of insulating liquids when exposed to a combination of high electric fields, temperature changes and pressure changes. This will be benefited by the availability of field aged silicone oils from decommissioned 132kV CSE, which should come available as part of an ongoing replacement programme.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

The work will be laboratory based and will also include desk based analysis.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

Total: £1,061k

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 replacement of a new cable sealing end is estimated to cost tens of thousands of pounds. National Grid is currently planning on replacing over 100 cable sealing end sets due to concerns around the performance of silicone oil. The cost of managing these assets while they are considered to be at a higher risk has been conservatively estimated to be £1 million per year.

The ability to identify poor quality oil during installation of the CSE would prevent this type of degradation occurring again and will allow this type of degradation to be managed more effectively in the future.

Understanding how the oil degrades with time and how this changes for different types of oil may allow a clear definition of 'good quality' silicone oil to be made, which may offer the ability to reduce replacements by allowing the oil to be changed. Developing a list of alternative oils would provide an alternative opportunity to reduce replacement cost; as the oil could be changed, rather than the entire termination.

Please provide a calculation of the expected benefits the Solution

Not required for research project.

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

All network licensees have silicon oil cable sealing ends. National Grid has around 1,400 XLPE cable terminations which will contain silicon oil. Other licensees will also have a larger number of silicon oil filled terminations. This project will also produce a silicon standard which can be adopted by all licensees.

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

As the learning from this project will be translated into a standard for handling silicon oil and a measurement method, a significant proportion of the learning can be implemented by changing policy documents. Typically costs for updating documentation will be in the order of £20,000.

Any additional tests that are performed on the silicon oil will also have a cost. These will highly depend on the method developed to test the oil prior to its installation and when a sample has been taken during the CSE's lifetime. These tests are envisaged to cost less than £100 per CSE. As CSEs are often 'seal-for-life' units, these costs would only be incurred at the start of its life, or when a problem

has been identified during its lifetime.

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 outputs of the fundamental scientific work will be published in venues which are accessible to all relevant licensees, although the immediate relevance would be to those with silicone oil filled CSE for XLPE cables. The learning from the analysis of new materials may provide a wider benefit in the future, as these liquids could be considered for use in non-cable applications.

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 fits within the value area of the Electricity Innovation Strategy:

Managing Assets - Managing assets throughout their lifecycle

- 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 part 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