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NIA Project Registration and PEA Document

Date of Submission

Jun 2018

Project Reference Number

NIA_NGTO009

Project Registration

Project Title

Electrical Characterisation of Silicone Oil (ECOSO)

Project Reference Number

NIA_NGTO009

Project Licensee(s)

National Grid Electricity Transmission

Project Start

June 2018

Project Duration

3 years and 2 months

Nominated Project Contact(s)

Oliver Cwikowski -
box.eto.innovationteam@nationalgrid.com

Project Budget

£632,000.00

Summary

National Grid Electricity Transmission (NGET) currently has a population of several thousand Sealing Ends (SEs) of all types (including fluid filled and XLPE) across Great Britain. With the expected increase in undergrounding technologies and the difficulties with new OHL routes, NG's SE population is expected to increase.

Experience has shown that since rapid uptake of XLPE cables in the early 2000s, that the Cable Sealing Ends (CSEs) used to terminate the cables have suffered several bulk replacements due to performance issues; for different reasons. Which has required NG to manage the increased risk presented by these assets during their early replacement, and has ultimately led to a rapid replacement timeline. With the advent of Condition Monitoring Surveys (CMS), there is opportunity to identify the poor condition assets and manage their risk effectively, without the need for immediate replacement.

However, there is a lack of understanding on the degradation mechanisms for silicone oil filled CSEs, in particular the interaction between oil contamination/degradation and discharge/breakdown process for silicone oils used in these CSEs. This poses challenges to conducting effective assessment of the condition of the CSEs in order to inform the management of CSEs, their replacement strategy and manage their end-of-life.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

National Grid Electricity Transmission (NGET) currently has a population of several thousand Sealing Ends (SEs) of all types (including fluid filled and XLPE) across Great Britain. With the expected increase in undergrounding technologies and the difficulties with new OHL routes, NG's SE population is expected to increase.

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terminate the cables have suffered several bulk replacements due to performance issues; for different reasons. Which has required NG to manage the increased risk presented by these assets during their early replacement, and has ultimately led to a rapid replacement timeline. With the advent of Condition Monitoring Surveys (CMS), there is opportunity to identify the poor condition assets and manage their risk effectively, without the need for immediate replacement.

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Method(s)

The proposed method to solve the problem is experiment based. Extensive high voltage tests will be conducted to simulate the discharge causing degradation in silicone oils and along silicone oil/solid interface by considering a range of factors including contamination, degradation and oil type. Multiple diagnostic means including PD detection, high speed imaging and chemical analysis will be used to characterize the degradation process.

Based on the results, a better understanding on the effect of contamination and degradation on discharge/breakdown degradation mechanism can be gained. Information of degradation modes and useful diagnostic parameters can be extracted to inform the insulation condition assessment of the CSEs.

Scope

This project will investigate:

- 1, Partial discharge characteristics in silicone oils under a wide range of insulation conditions.
- 2, Creepage discharge characteristics along silicone oil/solid insulation interface under a wide range of insulation conditions.
- 3, Effect of thermal ageing/degradation on the discharge performance of silicone oil/solid insulation system.

Objective(s)

The objectives of the project include:

- 1, To understand the effect of contamination and degradation on discharge/breakdown degradation process in silicone oil/solid insulation system of the CSEs.
- 2, To propose the useful diagnostic parameters which can contribute to the insulation condition assessment of the CSEs.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Success criteria of the project include:

- 1, successfully design and build the high voltage discharge and creepage testing rig.
- 2, successfully find the discharge/breakdown degradation modes in silicone oil/solid insulation system due to oil contamination/degradation.
- 3, successfully identify the diagnostic parameters to inform the insulation condition assessment of the CSEs

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

For the CSEs under investigation, there very little insulation condition data collected as no routine sampling/maintenance practice is usually implemented – due to the asset being sealed for life. In addition, there is limited information available in the literature to describe the discharge/breakdown degradation mechanisms considering a wide range of insulation conditions. Therefore extensive

high voltage tests are proposed in this project to simulate the degradation process in laboratory and to extract useful diagnostic parameters for condition assessment.

Since not only silicone oil but also solid insulation present in the CSEs, the scope of the work includes discharge testing in silicone oil and along silicone oil/solid insulation interface. The insulation conditions consider these practical scenarios like moisture ingress and ageing/degradation of insulation. These are necessary factors to include in order providing the desired business outputs.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

Testing will be carried out in laboratories.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£632,000

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 153 sets of cable sealing ends is presently being considered at an estimated cost of over £10m. This project will help inform the development of a new specification for silicone oils and improve our ability to manage ones that have shown signs of damage. This could prevent the replacement of CSEs in the future and reduce the risk associated with these assets.

Please provide a calculation of the expected benefits the Solution

Not required for research projects.

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

There are over 1,200 CSEs spread across several transmission and distribution utilities in Great Britain.

Once the knowledge has been developed, each asset manager will be able to access the information and use it to inform the decision to replace or repair the assets.

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

The outcomes of this project will be used to inform a silicone oil specification and documentation on how to manage silicone oil filled assets more effectively. We anticipate the adoption of the standard or new maintenance regime would typically cost around £20k of internal time per licensee.

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

National Grid and other utilities (network licenses) in the UK are facing issues with 132 kV CSEs belonging to a specific family. These CSEs are filled with silicone oils. The new learning on understanding the discharge/breakdown degradation mechanisms in silicone oil insulation system due to contamination/degradation will help inform the management of these CSEs, and hence benefit both NG and other network licences.

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 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