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

Jan 2014

Project Reference Number

NIA_NGET0035

Project Registration

Project Title

Long Term Performance of Silicon Based Composite Insulators

Project Reference Number

NIA_NGET0035

Project Licensee(s)

National Grid Electricity Transmission

Project Start

October 2008

Project Duration

5 years and 6 months

Nominated Project Contact(s)

David Clutterbuck

Project Budget

£500,000.00

Summary

National Grid has identified polymeric insulation as a potentially beneficial alterantive to existing insulator materials. The Engineering Strategy Meeting endorsed the introduction of polymeric insulation and further research and development into the aging mechanisms of silicon rubber insulator variants. National Grid policy statements support the use of polymeric insulation and provides a functional specification for units deployed on the electricity transmission network.

Nominated Contact Email Address(es)

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Problem Being Solved

Traditionally ceramic insulation has been used for all substation devices required to provide HV conductor to ground insulation clearance. Examples are CTs, VTs, Bushings and Post Insulators which use a special shed profile to optimise on size, strength, creepage and provide weather and pollution resilience. This technology is well proven, reliable, with a predictable life and has been used for over 50 years. However, although rare, these devices can fail catastrophically and unexpectedly. In addition they are heavy and susceptible to damage during manufacture, transport and installation phases and require larger civil foundations and structures to support them than those made from lighter materials.

Polymeric insulation is now a viable alternative to ceramic insulation and there is growing adoption and experience in other utilities. However there are a number of choices on the market, particularly relating to material, shed profile and manufacturing processes. There is also uncertainty over the mechanical strength, proven life, maintenance needs and performance over time.

This project seeks to address the relative paucity of information about the reliability and performance of silicone based inslulators as they age. The current research has identified an additional phenomenon that may have an impact upon life-time performance of polymeric insulators asymmetric aging patterns. Evaluations of this along with the development of an asset management tool to predict performance of polymeric insulators throughout their life forms the basis of this proposal.

Method(s)

Research

Existing service aged insulators and artifically aged insulators will be subject to number of laboratory based electrical performance tests.

Finite element anaylsis and complementary analytical techniques will be used to model aging processes and electrical performance. This will be used to forecast how aged insulators respond in extreme environments.

A stochastic model of long term performance will be developed assess the impact of different assessment stategies on likely life to point of failure.

Scope

National Grid has identified polymeric insulation as a potentially beneficial alterantive to existing insulator materials. The Engineering Strategy Meeting endorsed the introduction of polymeric insulation and further research and development into the aging mechanisms of silicon rubber insulator variants. National Grid policy statements support the use of polymeric insulation and provides a functional specification for units deployed on the electricity transmission network.

Objective(s)

The key objective is to advance understanding the aging mechansims for polymeric / composite insulators.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

- Completion of a report of the impact of asymmetrical ageing on insulator performance.
- Development of a model capable of calculating electrical stress on nsulator structures including asymmerty
- Development of a stochastic tool suitable for asset management and investment decisions.
- Recommendation of a process for composite insulator management for GB TOs

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

This project is being undertaken at a laboratory scale.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

The project is being carried out in Manchester.

Revenue Allowed for the RIIO Settlement

Zero

Indicative Total NIA Project Expenditure

IFI - £416,000

NIA - £84,000

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 further development of the ageing model will provide National Grid with an asset management tool that enables cost-effective management of polymeric insulators used on the transmission network.

This could lead to significant mid-life refurbishment savings, improved health and safety performance and improved grantor relations due to:

- Significant weight and size reduction of insulation
- Reduction in machinery required to install
- Reduced outage times
- Insulation material will not shatter on failure
- Polymeric insulators are also more resilient to attack by vandals

Furthermore, polymeric insulators are proving to provide better pollution performance, which would result in increased network availability. But should research, being performed at Cardiff University, looking at the possibility of using shorter polymeric insulator strings, circuit compaction, and hence a possible increase in circuit rating have a positive outcome a detailed knowledge of polymer aging and life expectancy could result in significant economic and societal benefits:

If polymeric insulators are considered to have a life expectancy of thirty years, for example, then mid-life refurbishment would not result in having to replace with traditional insulators thereby reintroducing all the detriments ameliorates above.

Increased ratings enable National Grid to drive the system harder benefiting consumers and the environment by lowering transport costs and obviating new overhead line routes.

Linkage with EPRI task force on accelerated aging of polymeric insulation TF 35.01.

The potential benefits outlined above are based no the assumption that gaining a better understanding of the life expectancy of polymeric insulation will result in and extension to the current anticipated 20 year life. As the final outcome of the research is uncertain it is difficult to put a figure on the financial benefits to National Grid. However, even if the research results in a reduction in life expectancy it will provide a valuable input into National grids management of overhead line and electricity substation assets.

Please provide a calculation of the expected benefits the Solution

Research project - Not required.

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

This learning can be applied to every silicon based composite insulator on the GB system.

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

The adoption of the findings of this research project do not in their own right have an associated roll out cost.

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):

- [x] 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)
- [x] 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 learning that will be generated could be used by relevant Network Licenses as it will investigate ageing mechanisms of polymeric insulation to enable a better understanding of life and reliability issues and recommend asset management strategies.

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

- [x] Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

Is the default IPR position being applied?

- [x] 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