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

Nov 2013

Project Reference Number

NIA_SHET_0011

Project Registration

Project Title

Lightning Protection

Project Reference Number

NIA_SHET_0011

Project Licensee(s)

Scottish and Southern Electricity Networks Transmission

Project Start

December 2013

Project Duration

3 years and 11 months

Nominated Project Contact(s)

SSEN Future Networks Team

Project Budget

£220,000.00

Summary

The scope of this project is to build and verify simulation models of lightning strikes on lineswhere the towers have high footing resistances (applicable to steel-lattice towers at voltages of 132kV and above), and investigate the protection options to inform decisions on lightning protection approaches.

Nominated Contact Email Address(es)

transmissioninnovation@sse.com

Problem Being Solved

Transmission towers require to have a low footing resistance (i.e. the legs of the tower provide earthing), so that if the tower is stuck by lightning, the lightning can travel directly through the tower to the ground without damaging the lines or insulators.

Furthermore, transmission towers carry an overhead earth wire as the uppermost wire. The primary purpose of this wire is to protect the conductors and insulators from lightning strikes (being uppermost and grounded it is more 'attractive' to the lightning that the conductors, providing the least resistance path to earth). It is directly connected to the top of each tower to provide a route for lighting to ground through the tower.

However, where a tower is not sufficiently earthed (e.g. where a tower is built into rock which typically has a high resistance), it will have a high footing resistance; therefore lightning will not find a route to the ground through the tower and so will tend to travel along the transmission conductors instead. This can overload the conductor causing damage to the conductor and insulators, with the risk of conductor failure and outages.

There are a number of potential solutions to this problem, the first would be to provide additional earthing for the tower in the form of copper earthing rods in the ground to lower the footing resistance (to approximately 10 ohms).

Where additional earthing has been tried, but the resistance is still too high (i.e still above 10 ohms), there is a risk of flashovers, where a lightning strike to the shield wire 'jumps' across the conductor causing undesirable effects. To reduce the risk of flashovers damaging conductors or insulators, lightning surge arrestors can be fitted between the phase conductors and the tower, This provides a 'safe' route from the shield wire through the tower and on to the phase wire, without a flashover.

However, there is currently not a consistent understanding on how to deploy surge arrestors (e.g. on which phases and which towers), or the extent to which a tower's resistance should be decreased if a surge arrester is used (i.e. how much costs should be invested in additional copper earthing), or what other methods may be preferred, to enable the identification and optimisation of least-cost mitigation options.

Method(s)

Improving the understanding of lightning strikes where towers have high footing resistances, in a variety of scenarios, will help to further inform the decisions on the most cost effective lightning protection methods.

To achieve this the project will:

1) Investigate state-of–the-art of technologies and published work.

2) Develop a comprehensive model for the simulation of issues involved.

3) Verify models with lab and/or field studies.

Scope

The scope of this project is to build and verify simulation models of lightning strikes on lines where the towers have high footing resistances (applicable to steel-lattice towers at voltages of 132kV and above), and investigate the protection options to inform decisions on lightning protection approaches.

Objective(s)

1) Understand the behaviour of transmission lines under lightning strike conditions.

2) Determine the alternative techniques to provide lightning protection on transmission lines.

3) Create recommendations for a lightning protection policy for transmission lines.

This is intended to inform the further development of SHE Transmission's lightning protection policy.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be successful if it can deliver recommendations to further improve our approach to lightning protection , and more informed decisions on lightning protection options can be made.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The scale of this project is sufficient to investigate and develop recommendations for lightning protection solutions for towers with high footing resistances.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

This project is intended to be mainly undertaken at Herriot Watt University near Edinburgh, utilising specialist academic expertise.

The results are intended to be applicable to all steel-lattice towers with high footing resistances across GB.

Revenue Allowed for the RIIO Settlement

This should enable more informed and cost-effective decisions on lighting protection for over-head transmission lines for some of our Strategic Wider Works projects. These projects are subject to Ofgem review and assessment on a case by case basis and therefore no funding is allowed as part of the RIIO-T1 settlement. We will provide further information as part of our project submissions.

Indicative Total NIA Project Expenditure

The project plans to be funded through SHE Transmission's NIA allowance.

£220k has been budgeted for the project (of which 90% is allowable NIA spend).

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)

Currently there is significant spend on reducing the footing resistances of towers (£10k-£30k per tower), and if the resistances are still too high then other lightning protection methods are deployed (e.g. lightning surge arrestors) at an additional cost of approximately £25K (for purchase and installation) .

If successful, this project will more fully inform understanding of the alternative approach available for high footing resistance towers, enabling the most appropriate approach to be adopted for a given set of circumstance. This is anticipated to deliver savings of up to £30k per high footing resistance tower.

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

This learning will be applicable to providing low footing resistance in the design and construction of all lattice steel-lattice towers to mitigate against lightning strikes. It therefore has the potential to be relevant to all TOs in GB, along with DNO's in England and Wales.

Based on our experience on the Beauly-Denny Line, if we are able to reduce the need for additional tower earthing, this would save up to £30k per high footing resistance tower.

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

Based on the outcomes of this project, it is expected that there will be minimal costs associated with relevant licensees developing/refining their lightning protection policy based on the learning generated.

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 resulting reports, model and recommendations will be shared with relevant network licensees.

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.

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