Scottish and Southern Energy
Power Distribution

Date of Submission

November 2013

NIA Project Registration and PEA Document

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.

Project Registration

Project Title		**Project Reference**
Lightning Protection		NIA_SHET_0011
Project Licensee(s)	**Project Start Date**	**Project Duration**
Scottish Hydro Electric Transmission	Dec 2013	3 Years
Nominated Project Contact(s)		**Project Budget**
David MacLeman		£220,000

Problem(s)

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.

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.

Technology Readiness Level at Start	Technology Readiness Level at Completion
3	5

Project Partners and External Funding

None

Potential for New Learning

The project has potential learning in the following areas:

- Improved understanding on the mechanics' of lightning propagation through transmission lines and towers, and the effects of non-ideal grounding of towers; and
- Improved understanding of the effects of lightning protection solutions.

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.

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 in 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

Specific Requirements 1

1a. A 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 systems and 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	☐

Specific Requirements 2

2a. Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees ☒

Please answer one of the following:

i) Please explain how the learning that will be generated could be used by relevant Network Licenses.

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

ii) Please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the Project.

2b. Is the default IPR position being applied?

Yes	☒
No	☐

If no, please answer i, ii, iii before continuing:

i) Demonstrate how the learning from the Project can be successfully disseminated to Network Licensees and other interested parties

ii) Describe any potential constraints or costs caused or resulting from, the imposed IPR arrangements

iii) Justify why the proposed IPR arrangements provide value for money for customers

2c. Has the Potential to Deliver Net Financial Benefits to Customers ☒

i) Please provide an estimate of the saving if the Problem is solved.

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.

ii) Please provide a calculation of the expected financial benefits of a Development or Demonstration Project (not required for Research Projects). (Base Cost – Method Cost, Against Agreed Baseline).

Not required for Research Projects

iii) Please provide an estimate of how replicable the Method is across GB in terms of the number of sites, the sort of site the Method could be applied to, or the percentage of the Network Licensees system where it could be rolled-out.

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.

iv) 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.

2d. Does Not Lead to Unnecessary Duplication ☒

i) Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

This project has been discussed with the other Transmission Owners, to confirm that it is not duplicative.

ii) If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

Not Applicable.