Date of Submission

April 2020

Annual Project Progress Report Document

Notes on Completion: Please refer to the **NIA Governance Document** to assist in the completion of this form. Please use the default font (Calibri font size 10) in your submission. Please ensure all content is contained within the boundaries of the text areas.

Project Title

Informed Lightning Protection

Project Reference

NIA_SSEN_0035

Funding Licensee(s)

Scottish Hydro Electric Power Distribution
Southern Electric Power Distribution

Project Start Date

March 2019

Project Duration

48 months

Nominated Project Contact(s)

SSEN NIA Programme Delivery Manager – Colin Mathieson

Year

2020

Scope

Lightning strikes are known to cause a significant number of supply interruptions to our customers. In our Scottish Network, lightning strikes are the second highest cause of customer interruptions and minutes lost and in our Southern Network it is the fifth highest cause. Therefore, there is a need to reduce the impact that lightning related faults have on our customers.

One method of reducing lightning related faults is to install surge arresters. Present practice of installing surge arresters involves identifying circuits that historically experienced large numbers of lightning related faults and applying blanket coverage of surge arresters on these circuits i.e. installing surge arresters on every third pole. However, many of our circuits extend long distances i.e. over 30km in length, which means thousands of surge arresters would be necessary for blanket protection. Not only is this expensive but it may be ineffective as lightning may only strike in small hot spots around the network. There is a need to identify where lightning hot spot locations occur and to understand the impacts of supply interruptions to our customers in these areas. This will help inform us on where to install surge arresters for maximum prevention of supply interruptions at minimum cost. To do this, we plan on combining multiple data sets e.g. lightning strike location data, ground resistance data, etc. and perform advanced data analytics to identify key locations for surge arresters to be installed.

Our surge arresters are designed to withstand multiple lightning strikes and operate for about 12 years. However, from past experience we are aware that many of these surge arresters can fail prematurely without protecting against a lightning strike. When a surge arrester fails it causes a fault, which then leads to a supply interruption until the fault is fixed. So, rather than preventing supply interruptions, they can cause them. Furthermore, it is difficult to diagnose when one of these types of surge arresters has failed as often there are no visible signs of failure. This increases the time taken to identify and fix/replace the failed arrester, which means customers are potentially off supply for long periods of time or expensive and carbon intensive diesel generators are used. There is a need for an in-depth trial of surge arresters with the ability to disconnect, which are designed to sacrifice themselves in the event of a lightning strike or premature failure. This will prevent supply interruptions occurring and make it easier for field staff to identify which surge arresters have failed (as the earth lead will have disconnected), so they can be more easily replaced.

Lightning Development Phases

Phase 1a – Data Analytics Pre-Execution Phase. This phase involves preparation work to ensure the execution phase runs smoothly. Specifically, it involves the following tasks;

- Define model success criteria
- Create model requirements specification
- Provide Data Analytics Team (DAT) with necessary data sources required to implement functional requirements
- Perform data compatibility testing
- Perform GDPR & Security Assessment

Phase 1b– Data Analytics Execution Phase. This is the actual 'analytical' phase of the project, where a geospatial model is created to analyse various data inputs including;

- Lightning strike location data
- Customer number data
- Lightning IIS fault data
- Lightning Opex data
- Ground resistivity data
- GIS asset data

The objective of this phase is to identify high risk areas or 'hot spots' where lightning protection should be installed. Both probability of strike and impact of strike will be utilised in the identification process i.e. high-risk sites will not only be susceptible to lightning strikes, but also contain a significant number of customers that are at risk of experiencing a lightning related outage.

Phase 2 – Internal review of high-risk sites: Once the high-risk sites have been identified, the specific sections of these circuits, identified for lightning protection, will be reviewed internally. This is to confirm they are suitable for protection e.g. confirm no investment is planned to take place that may address the lightning issue and to sense check that they are suitable.

Phase 3 – Lightning protection procurement: Surge arresters will be installed on the network i.e. surge arresters with earth lead disconnects. Surge arresters with earth leads that disconnect can prevent outages from occurring if the surge arrester unit faults. This is a common occurrence that can lead to an unplanned outage. We will also consider the installation of novel surge arresters, such as those with drop out mounts, that are able to prevent the need for unplanned outages after the arrester is spent or reaches end of life.

Phase 4 – Installation: Lightning protection equipment will be installed in locations defined by the data analytics model.

Phase 5 – Monitoring & Analysing: Weekly monitoring of IIS and strike data will take place, possibly moving to fortnightly or monthly depending on the value of frequent monitoring. Annual reporting will take place detailing lightning strike frequency and IIS costs on selected locations. Any learning will also be detailed here e.g. faulty equipment, issues, etc.

Phase 6 – Reporting, Dissemination & Closedown: learnings derived from the project will be used to create new policy and processes on lightning protection investment methodology. Any learning will be shared with the wider DNO community.

Objective(s)

1)Develop a 'point in time' lightning analysis tool that can be used to locate lightning protection equipment in the most optimal way i.e. integrate various data sets and update visual display as described in phase 1a and 1b above.
2)Install lightning protection equipment in 'optimal' locations provided by the lightning analysis tool.
3)Monitor and analyse fault data to confirm effectiveness of lightning protection.
4)Update internal policies and procedures if the project is successful.
5)Share learnings with a wider audience.

Success Criteria

The project will be a success if;
1)A point in time analytical tool is sufficiently developed so that it can integrate the different data sources described in phase 1b and perform advanced analytics, so that it can be used for the purpose of deciding where to place lightning protection equipment down to the nearest pole.
2)We install lightning protection equipment safely, on time and within budget.
3)We prove the effectiveness of this methodology for protecting against lightning related faults from a cost and fault reduction point of view.

Performance Compared to the Original Project Aims, Objectives and Success Criteria

Objective 1 and Success Criteria 1 have been met via the creation of an analytical tool that was able to analyse multiple data sets to identify the circuits most likely to be at risk of a fault caused by a lightning strike. We then utilised further information from an existing internal lightning tracker tool to identify the location of lightning hot spots. Information from the combination of these two tools has then been used to identify the locations to install lightning protection.

The installation of these surge arresters, which will protect the overhead circuit form a lightning strike, is planned for later this year.

Details of how the Project is investigating/solving the issue described in the NIA Project Registration Pro-forma. Details of how the Project is performing/performed relative to its aims, objectives and success criteria.

Required Modifications to the Planned Approach During the Course of the Project

No modifications to date.

The Network Licensee should state any changes to its planned methodology and describe why the planned approach proved to be inappropriate.

Lessons Learnt for Future Projects

An interesting early finding has been that the circuits deemed highest risk of experiencing lightning faults by the data analytics phase were significantly different from those circuits that historically have been recorded as experiencing lightning faults in our fault database. This could possibly mean:

1) Labelling faults as being caused by lightning is incorrect. It may be that extreme weather and water ingress is the problem rather than lightning, therefore it might be more prudent to alter maintenance/replacement cycles associated with overhead circuit assets rather than protect circuits against lightning.
2) The analytics algorithm could be incorrect and therefore not correctly identifying the highest risk circuits.

With the course of the project entering the field installation and trialling phase, more certainty will be gained as to whether point 1 or 2 is correct. The field install will see lighting protection trialled on both circuits deemed high risk by the data analytics and circuits deemed high risk by historic fault data.

Recommendations on how the learning from the Project could be exploited further. This may include recommendations on what form of trialling will be required to move the Method to the next TRL. The Network Licensee should also state if the Project discovered significant problems with the trialled Methods. The Network Licensee should comment on the likelihood that the Method will be deployed on a large scale in future. The Network Licensee should discuss the effectiveness of any Research, Development or Demonstration undertaken.

The Outcomes of the Project

Project is still in early phases with no significant updates.

When available, comprehensive details of the Project's outcomes are to be reported. Where quantitative data is available to describe these outcomes, it should be included in the report. Wherever possible, the performance improvement attributable to the Project should be described. If the TRL of the Method has changed as a result of the Project, this should be reported. The Network Licensee should highlight any opportunities for future Projects to develop learning further.

Data Access Details

The main data sources that were used and links on how to obtain them can be found below:

Lightning data: https://www.meteorage.com/
Soil resistance data: https://www.bgs.ac.uk/home.html?src=topNav
SSEN GIS data: mapping.services@sse.com

SSEN fault data: This is not publicly available. It is possible that a fault data extract can be provided, but this is subject to approval.

Contact futurenetworks@sse.com for more information.

See Network Innovation Competition (NIC) and Network Innovation Allowance (NIA) Data Sharing Procedure at https://www.ssen.co.uk/InnovationLibrary/Distribution/

A description of how any network or consumption data (anonymised where necessary) gathered in the course of the Project can be requested by interested parties. This requirement may be met by including a link to the publicly available data sharing policy.

Foreground IPR

The main IPR developed here is how the decision is made on whether a lightning strike caused a fault. The table below shows this. However, it should be noted that this methodology is still not proven. More clarity will be gained on this by the end of the project.

Probability	Time Overlap	Distance of lightning strike to fault (km)
Definite	<10 minutes	<1
Probable 1	<10 minutes	<10
Probable 2	<24 hours	<1
Possible 1	<24 hours	<10
Possible 2	<10 minutes	<100
Possible 3	<1 week	<1
Unlikely	>24 hours	>10

A description of any foreground IPR that have been developed by the project and how this will be owned.