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# NIA Project Registration and PEA Document

### Date of Submission

May 2019

### Project Reference Number

NIA_SPEN_0039

## Project Registration

### Project Title

THOR Hammer

### Project Reference Number

NIA_SPEN_0039

### Project Licensee(s)

SP Energy Networks Distribution

### Project Start

June 2019

### Project Duration

3 years and 7 months

### Nominated Project Contact(s)

Ralph Eyre-Walker

### Project Budget

£1,317,502.00

### Summary

This project will develop the THOR Hammer device to allow the consistent and accurate measurement and assessment of wood pole asset condition.

### Nominated Contact Email Address(es)

innovate@spenergynetworks.co.uk

### Problem Being Solved

Wooden utility poles are used extensively across the GB electricity distribution network to support overhead line conductors and other associated plant. Traditionally the wooden poles are treated with creosote as a preservative, providing each pole with an approximate lifespan of 55 years. However, creosote is now considered hazardous to the environment and research is currently underway to identify an environmentally friendly alternative. While this work is ongoing, early estimations are that any alternative found will not be as long lasting as the existing creosote solution and therefore issues with decayed poles are likely to increase. If the project is successful, a practical technique will become widely available that will allow an RSV to be calculated across a wood pole network at a large scale, meaning that it can be used to make better decisions, and finally, provide better input for the Common Methodology framework – and therefore these values need aligning to this methodology in a consistent approach.

### Method(s)

Over the last ten years in partnership with Industry and Academia, Groundline Engineering has developed a seismic pole tester, “THOR” capable of non-destructively evaluating the in situ health of timber poles.

The real value of this device is its simplicity of use – being as close as possible to the traditional hammer test that the linesmen are used to performing, while still providing the following potential outputs:

- Presence and extent of any internal decay, including below ground level without excavation;
- GPS-tagged measurement results provide confirmation of measurement location for auditing purposes;

- Predicted end of life for refurbishment investment planning;
- Accurate pole condition assessment, making pole climbing activities safer; and
- Pole embedment depth and foundation stiffness.

At present, all results obtained are assessed using both qualitative and quantitative assessments. Qualitative assessment includes a review of the pole hammer input trace and its velocity (output) response in the time domain. The Quantitative Assessment of the pole is undertaken using parameters directly obtained from the THOR unit, and once real engineering units are applied, then mechanical impedance parameters such as hammer force input, duration, mobility and dynamic stiffness can be compared against similar pole populations to identify poles requiring further attention or identifying that poles are indeed healthy and sit within a normal admittance range. Poles tested to date have allowed for the building of a large database of poles and the establishment of health indices for the various parameters in determining if the pole is an “outlier” or outside of the norm.

Barriers to business as usual application for the device, to be overcome during the project, include:

- Output given as a reduction of diameter; needs modifying to output reduction of strength to allow asset management decisions to be made;
- Detailed analysis is manual, time-consuming and reliant on a small number of people. The feature that enables embedment depth to be measured can only be obtained with detailed waveform analysis at a later date following the test. In addition, the on-site indication currently provided cannot be 100% relied upon so post-test analysis is recommended;
- The instrument was developed in Australia where a different type of wood is used for the pole (hardwood vs softwood) and different issues are encountered (e.g. termites). The technique and analysis parameters need measuring and confirming for GB standard wood poles, and the effectiveness of the technique needs to be proven; and
- The measured output then needs to be turned into something meaningful, i.e. integrated with existing asset management methodologies such as CNAIM.

Currently, the device and service outputs the condition of the pole in terms of a reduction in diameter. In order for this to be integrated into the GB electricity industries’ current policy, this needs to be taken a step further and used to calculate a remaining RSV for the pole. This will be the first deliverable for the project.

Further works are currently undertaken for the automation of pole analysis – preferably at the time of test. This could be achieved with machine learning approach. The machine learning technology will convert the conventional way of analysing or processing pole data in, to a faster and potentially accurate output in a timely manner for the industry. The deliverable will be a self-contained unit that provides all of the above analysis, automatically and at the time of test.
Alongside the above, some consultancy work is required to review existing processes and the definition for an end of life pole, i.e. 80% remaining residual strength. The deliverable will be an agreed policy to use going forwards.

Training and dissemination will then be undertaken followed by a period of monitoring to ensure a smooth transition into business as usual and that the expected benefits to the business have been realised.

## Scope

**WP1: Data collection, initial data analysis and improvement of outputs** *12 months*

The existing THOR hammer units will be used to collect condition data on an initial 1,000 poles. The aim is to achieve a split of 300 waveforms from poles in good condition, 300 in a moderately degraded condition and 300 deemed to be end of life. The total volume tested may need to be increased in order to meet these minimum numbers.

Groundline will be utilised to provide training and supervision to ensure that the data collected is of a high standard. The data collected will then be analysed.

The analysed data will then be used to begin preparations for the pole autopsies which will be used to validate the accuracy of the device. Participating DNOs must ensure that poles required for autopsy are retained should they be taken out of service. Initial preparations for the machine learning process will also be undertaken.

Alongside the above work will be undertaken to improve the analysis processes and algorithms. A key deliverable at the end of this work package will be the calculation of a RSV as an output: this can then be used immediately by the business when the existing THOR hammer unit is utilised.

**WP2: Data validation, development of automated waveform analysis, integration with unit and alignment with DNO systems of work** *12 months*

For the GB electricity industry to adopt the THOR hammer tester as a test method, an extremely high degree of confidence must be applicable to the results provided. While the work undertaken by Groundline to date has proved this in principle, the key output of the data validation tasks within this project will be to demonstrate this with real data. This will be achieved by undertaking pole autopsies

on a selection of poles previously tested using the THOR hammer, to ensure that the output of the waveform analysis is consistent with what is found physically within the pole when it is dissected. Additional data validation will be undertaken by undertaking further in-situ tests using a previously proven technique: it is proposed that an experienced contractor will be utilised for this using a previously proven technology.

Groundline will then utilise various machine learning and analysis techniques to develop an automatic analysis of the pole condition and embedment depth that can then be built into the unit, to enable the capability to provide this information at the time of test. This is a key deliverable.

**WP3: Policy and standards** *12-18 months*

The currently industry recognised standard is that a RSV of 80% is used as the criteria to "fail" a pole. This is what is written in DNO policies.

The problem with this fixed value is twofold:

1. It takes no account of the existing factor of safety, which will vary from one pole to the next depending upon factors such as the stoutness of the pole and the plant installed on it.
2. The RSV for declaring a pole unsafe to climb will be significantly higher than the RSV at which the pole is likely to have an unacceptable probability of failure in service.

The THOR hammer has the potential to facilitate the accurate measurement of the RSV of poles across the network on a large scale. There is therefore the opportunity to use the RSV more within the asset management process, as such this project presents the ideal opportunity to revisit the values used within the policy.

This would be undertaken using a combination of internal and external resource.

**WP4: Integration with DNO systems and CNAIM** *24 - 36 months*

There are two elements to the full integration with existing systems: obtaining the pole and network data prior to an inspection in order to allocate the results correctly; and uploading the results into the systems following an inspection.

Full integration may require a second stage project as it is difficult to clearly define what would be required at this stage. However the minimum requirements that must be achieved within this project are as follows:

- Be able to import network data provided by the DNOs to form inspection plans.
- Accurately record results against the correct asset following the above data.
- Export the result data in an agreed format. SPEN (and other DNOs) can then manipulate this data and import into the relevant corporate IT systems.
- Outputs must be aligned with CNAIM requirements: primarily this will be the output of an accurate RSV.

**Deliverables:**

1. Calculation of RSV as an output. *12 months*.
2. Review the criteria for declaring poles fit for purpose using the RSV and update policy as required. *18 months*, *starting month 6*.
3. Full validation of the results obtained by THOR. *18-24 months*.
4. Algorithms to enable the automated analysis of results, providing required outputs at the time of test. *24 months*.
5. Integration as business as usual and monitoring of benefits. *36 months*.

## Objective(s)

1. Convert the existing output from the instrument (reduction in residual diameter) to reduction of residual strength value (RSV, as documented in BS1990-1), by determining and agreeing method and assumptions.
2. Utilise machine learning to automate the detailed waveform analysis and provide the required outputs at the time of test.
3. Use real data and destructive examinations to prove the accuracy of the technology on pole types common to the GB electricity industry.

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

## Success Criteria

1. Achievement of the above objectives.
2. Adoption of the device as a preferred method for wooden utility pole condition assessment.

## Project Partners and External Funding

Groundline Engineering are the key partner and are self-funding £128,000 of the project cost.

## Potential for New Learning

All licensees (apart from LPN) will benefit from the introduction to the GB market of a device that can assess the internal condition of wooden poles, that is both accurate and efficient in application. This will allow for a significant improvement in the quality of the asset condition data for these assets.

## Scale of Project

Total project value is £1,317,502, of which £128,000 is Groundline's contribution.

NIA funding required is £1,070,552.

## Technology Readiness at Start

TRL7 Inactive Commissioning

## Technology Readiness at End

TRL9 Operations

## Geographical Area

Wooden electricity poles are used in all DNO license areas across GB (apart from LPN).

## Revenue Allowed for the RIIO Settlement

N/A

## Indicative Total NIA Project Expenditure

£902,308, including DNO costs and purchase of trial devices.

# 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)

SPEN expect potential savings of £600,000 per annum from reduction of wood pole asset condition and replacement costs.

This is scaleable to other network operators depending upon number of poles replaced on the networks per annum.

## Please provide a calculation of the expected benefits the Solution

For SPEN:

Current annual SPEN spend on wood pole inspection and replacement: £15.5m
Annual savings from life extension of 15%: £333k
Annual savings from increased inspection cycle/reduced headcount of inspectors: £400k
Annual training, purchase of equipment, calibration and maintenance of new devices: -£120k
**Total estimated impact: £600,000 annual saving. Savings in Year 1 will be significantly more with the effect of the initial life extension.**

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

All wooden electricity poles used by the GB electricity industry are of the same type of wood. Therefore this is highly replicable across the country.

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

Following completion of the development project this will only require commercial purchase of the device and staff training. Est. <£1m per DNO for full rollout.

## 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

All licensees (apart from LPN) will benefit from the introduction to the GB market of a device that can assess the internal condition of wooden poles, that is both accurate and efficient in application. This will allow for a significant improvement in the quality of the asset condition data for these assets.

### 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.

The THOR Hammer Device utilises a measurement technique and analysis algorithm that is currently unique in the marketplace.

### 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

No device currently exists that can be mass-deployed to efficiently and cost-effectively take an accurate measurement of wood pole health. Trial device is an innovative approach and needs further development for full rollout.

### 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

The plan is to use machine learning to automate the waveform analysis: there is no guarantee that this will work and is therefore not suitable for BaU expenditure.

## 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

Funding is required to: prove the device works on GB utility poles and is suitable for the network requirements; undertake machine learning to automate the analysis, enabling mass-deployment over large networks; assess overall suitability for new business as usual processes. As there is no guarantee of success with several clear break-points throughout the project, NIA funding is the only viable option.

## This project has been approved by a senior member of staff

☑ Yes