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## NIA Project Registration and PEA Document

### Date of Submission

May 2018

### Project Reference Number

NIA\_NGTO003

## Project Registration

### Project Title

EPRI Research Collaboration on Overhead Lines (P35) 2018-2021

### Project Reference Number

NIA\_NGTO003

### Project Licensee(s)

National Grid Electricity Transmission

### Project Start

April 2018

### Project Duration

3 years and 1 month

### Nominated Project Contact(s)

Ben Muncey

### Project Budget

£22,350,000.00

## Summary

National Grid recognises that the challenges faced by the electricity industry can be more efficiently and cost-effectively addressed when approached through international collaboration initiatives. It is particularly useful when addressing challenges where the solutions require statistically diverse data sets and/or significant trialling and testing in different environments, under various conditions and/or diverse ways.

The Electric Power Research Institute (EPRI), with its wide international membership, is one of the routes through which these initiatives can be delivered, thereby maximising stakeholder value. The approach of managing collaborative projects within an internationally driven research and development initiative is beneficial to National Grid and consumers alike, because it provides valuable information, learning and knowledge that would be considerably more expensive if approached on an individual basis.

As an owner of overhead lines, National Grid faces challenges around optimisation, asset life, development of innovative and fit for purpose monitoring, maintenance practices and understanding what novel technologies could be applied to improve efficiencies. The EPRI Overhead Transmission Lines Programme 35 (P35) aims to develop this work via five supported project work-streams.

Following an assessment of our internal Overhead Line strategy and an internal review, National Grid determined that within EPRI's Overhead Transmission programme, the largest leverage for the UK consumer can be achieved through involvement in the following five projects during the period 2018-2021:

P35.001 - Inspection, assessment and asset management of overhead transmission lines

P35.002 - Conductor, earth wire and hardware corrosion management

P35.003 - Structure and Sub-Grade Corrosion Management

P35.011 - Polymer and composite overhead transmission insulators

P35.013 - Overhead line ratings and increased power flow

P35.015 - Qualification, selection and maintenance of advanced conductors

The work areas have outputs that span across multiple years, consequently, this project will benefit National Grid and our stakeholders

by committing to deliver the research activities of P35 over three years.

## Nominated Contact Email Address(es)

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## Problem Being Solved

National Grid recognises that the challenges faced by the electricity industry can be more efficiently and cost-effectively addressed when approached through international collaboration initiatives. It is particularly useful when addressing challenges where the solutions require statistically diverse data sets and/or significant trialling and testing in different environments, under various conditions and/or diverse ways.

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P35.011 - Polymer and composite overhead transmission insulators

P35.013 - Overhead line ratings and increased power flow

P35.015 - Qualification, selection and maintenance of advanced conductors

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## Method(s)

P35.001 - Inspection, assessment, and asset management of overhead transmission lines

This work package is developing a mix of tools, technology transfer methods and events, and information that will help improve line inspection and assessment as well as asset management approach and asset life understanding.

P35.002 - Conductor, earthwire and hardware corrosion management

This work package is developing effective inspection techniques, and forecasting the need for maintenance or repair operations. This will help address issues related to conductor and earth wire corrosion. It will assist in accurate prediction of asset lives.

P35.003 - Structure and Sub-Grade Corrosion Management

This work package is developing new tools and learning which will increase maintenance programme efficiencies and design considerations in eliminating corrosion on foundations, anchors and poles.

P35.011 - Polymer and composite overhead transmission insulators

This work package is developing a mix of software tools and information that will help address issues related to the selection, application and inspection of polymer insulators which are increasing in use on the National Grid network.

P35.013 - Overhead line ratings and increased power flow

This work package is developing tools and information that will help address issues to optimise and increase the ratings of transmission circuits. It will address the increasing requirements of circuits required to operate beyond their original design specifications

P35.015 - Qualification, selection and maintenance of advanced conductors

This work package is developing tools and information that will help address issues related to the qualification, selection and maintenance of new and advanced conductors.

## Scope

The full scope of research within each project work-stream for the duration of this project is listed below.

### P35.001 - Inspection, assessment, and asset management of overhead transmission lines

National Grid need to understand the condition of their overhead transmission lines to effectively manage and maintain them at their designed level of performance and safety. Inspection and assessment research is needed to improve understanding about the current condition of transmission assets, extend the life of those assets while keeping the ageing infrastructure performance at levels that meet the reliability expectations of all stakeholders. This research project addresses these issues through the following activities:

A comprehensive Reference Guide Book (Yellow Book) that provides a state-of-the-art resource on inspection and assessment methods and technology that is sufficient for the day-to-day needs of both experienced and novice asset managers, inspection personnel, and other maintenance stakeholders.

Development of field deployable reference guides for field inspectors and those engaged in developing inspection and assessment programs.

Development of mobile field inspection tools, such as the Yellow Book PC Browser Application and Field Guide Apps that improve the support to field inspection personnel by making inspection and reference information available in a timelier manner, across new technology platforms (e.g. mobile devices) and in ways that improve understanding (e.g. 3D animations).

Use of multi-format training resources for training inspection and maintenance personnel through E-learning software, presentations, video streaming, conferences, and workshops encompassing both classroom and field training.

Software tool that includes new and emerging inspection and sensing technologies, information, field case studies and results from EPRI testing and evaluation.

Laboratory and field evaluations of new and emerging inspection and sensing technologies

### P35.002 - Conductor, earth wire and hardware corrosion management

There is a need to understand the present condition of conductors, earth wires and hardware, where these severely aged components are located, what caused the degradation, how future designs may avoid premature ageing and how to forecast the replacement schedule. This research work package addresses these issues through the following activities:

Identifying best in class condition assessment methods

Developing atmospheric corrosively models for engineers, planners and maintenance crews to identify areas of high risk

Evaluate and provide an assessment of new and emerging inspection technologies

Determine degradation rates of the components in different environments

Identification of the root cause and failure mode

Remaining service life forecasting

### P35.003 - Structure and Sub-Grade Corrosion Management

There is a need to make effective asset management decisions when dealing with sub-grade corrosion of transmission line structures. This includes the development of inspection techniques, improved assessment practices, and mitigation methods for specific corrosion types. This work area addresses these issues through the following activities:

Evaluation of corrosion inspection and assessment methods or tools

Developing selection and application criteria for new or existing coating systems

Developing a corrosion probe to identify severe corrosion on foundations, anchors and poles

Develop guidelines for corrosion control through material selection and environmental compatibility

Develop methods to minimise or eliminate weathering steel packout formation

Changes in galvanising performance due to new construction materials

Effects of alternating stray currents on foundations

Identifying and mitigation of microbiological induced corrosion

Mitigation methods for both direct bury and concrete encased foundations

### P35.011 - Polymer and composite overhead transmission insulators

Use of Polymer insulators is forecast to increase on the National Grid network particularly for new T-Pylon low visual impact structures. Polymer insulators offer advantages such as improved contamination performance, very low aeolian noise, light weight, and vandal resistance. In order to achieve the expected design life, utilities need to understand their design and material characteristics to properly select, procure and apply polymer insulator components. This work area addresses these issues through the following activities:

Multi-stress aging tests to understand various modes of degradation and performance of polymer components

230kV aging tests of polymer insulators and guy strain insulators

138kV aging tests of polymer insulators and guy strain insulators

development of small scale tests to determine resistance of polymer insulators to stresses

E-Field modelling tool development for polymer insulators

Insulator Reference Book updating

### P35.013 - Overhead line ratings and increased power flow

The demand for electric power over transmission circuits is increasing at a faster rate than some transmission assets were originally built for. This trend is pushing the capacity of some existing transmission circuits to their original design limits. This research work package addresses these issues through the following activities:

- improve transmission circuit reliability and safety
- increase and optimize power flow through overhead lines and entire transmission circuits
- optimize energy transactions through rating forecasts
- manage emergency situations safely and reliably
- avoid unnecessary system outages.

P35.015 - Qualification, selection and maintenance of advanced conductors

Recently developed high-temperature conductors (also known as advanced conductors, high-temperature low-sag conductors, or simply HTLS conductors) offer the advantages of higher current capacity, lower conductor sag, and lower line losses than conventional ACSR (aluminium conductor steel-reinforced) conductors. Knowledge on the long-term performance of HTLS conductors is limited, particularly for newly developed products. This research work package addresses these issues through the following activities:

- Determining the applicability of conventional conductor maintenance tools and procedures for HTLS application
- Documenting utility design and installation experience
- Developing test protocols that may be applied to predict the long term performance advanced conductors.

## Objective(s)

The objectives for the 2018-2021 period include the continuation of National Grid's membership with EPRI P35 and the delivery of a selection of reports and guidance documents associated with the five work-streams by undertaking the following tasks:

P35.001 - Inspection, assessment and asset management of overhead transmission lines

- Overhead Transmission Line Inspection, Assessment and Asset Management Reference Guide (Yellow Book):
- Yellow Book Browser Application (Software)
- Overhead Transmission Line Inspection – Online Training (OTLOT) Version 2018
- Overhead Transmission Inspection and Sensing Information Tool (OTIS) Version 2018
- Practical Inspection and Assessment Workshop
- Overhead Transmission Line Field Guides

P35.002 - Conductor, earthwire and hardware corrosion management

- Assess and evaluate new and emerging inspection technologies including non-contact and ground based inspection
- understanding the potential of using near infra-red (NIR) spectroscopy to determine degradation rates and remaining conductor life
- Develop corrosivity models using algorithms for aging and atmospheric exposure of conductors and hardware and correlate results through lab and field testing
- continued development of NIR spectroscopy technology application for condition assessment of degraded hardware or component surfaces

P35.003 - Structure and Sub-Grade Corrosion Management

- Corrosion probe inspection tool for sub-grade corrosion evaluations
- Coating system selection and application guidelines
- Corrosion education
- Fleet management
- Failure database
- Concrete foundation mitigation and remediation methods

P35.011 - Polymer and composite overhead transmission insulators

- multi-stress ageing tests to understand various modes of degradation and performance of polymer components National Grid has commissioned EPRI to carry out accelerated aging tests on a range of polymer insulators at various stages over the last 15 years. These tests are planned to continue for several years more to provide reliable information on long term performance alongside some ongoing field trials on the NG network. In addition to this National Grid are also able to receive benchmark data across a broader field of suppliers

- continued development of the failure database to help identify trends and attributes to failures
- developing short duration, small scale tests that are representative of in-service stresses. The tests may be included in utility specifications
- inspecting service-aged insulators to aid in understanding how insulators age and the factors of aging which in turn helps improve applications and improve reliability and performance
- development of E-field modelling software to help model the electric field on new or existing insulator designs.

P35.013 - Overhead line ratings and increased power flow

- Development of software tools
- Development of rating methodologies
- Development of guidebooks, reports, and training materials for implementing increased power flow strategies, and for training engineers on increased power flow technologies.
- Comparison of economic benefits of increased power flow technologies, enabling utilities to make informed decisions when choosing options for their specific applications.

P35.015 - Qualification, selection and maintenance of advanced conductors

Developing an HTLS conductor application guide.  
Developing a test protocol to compare different carbon fiber composite core conductors  
Provide information on comparing and selecting suitable HTLS conductors for specific applications.  
Developing maintenance procedures and recommend that can be incorporated into utility's maintenance manuals.  
Testing the thermal and mechanical performance of these HTLS conductors.

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

n/a

### Success Criteria

Continuing to expand National Grid's knowledge and to deliver value to our stakeholders, participation in P35 during the period means the provision of a range of specific outputs across the five work-streams.

P35.001 - Inspection, assessment, and asset management of overhead transmission lines

Continued development of a mix of tools, technology transfer methods and events, and information that will help members improve their line inspection and assessment as well as asset management approaches, with the production and issue of update reports when they become available.

Specific Deliverables:-

New Version of OHTL Inspection, Assessment and Asset Management Reference Guide Book (Yellow Book)  
New Version of the Yellow Book Browser Application (Software)  
Updated Overhead Transmission Line Inspection – Online Training (OTLOT) (Software)  
Updated Overhead Transmission Inspection and Sensing Information Tool (OTIS)  
Evaluation of Overhead Transmission Line Inspection Technology  
Practical Inspection and Assessment Workshop  
Development of Field Guides for Mobile Devices (Software)  
P35.002 - Conductor, earth wire and hardware corrosion management

Continued development of effective inspection techniques, and forecasting the need for maintenance or repair operations. These will help address issues related to conductor, earth wire and hardware corrosion, with the production and issue of update reports when they become available.

Specific Deliverables:-

Development of Fleet Management Strategies for Population Assessment of Conductors  
NIR Spectroscopy (C-Corr) Development for ACSR Conductor Inspections refinement  
Evaluation of Conductor Failures due to Corrosion  
Conductor Inspection Tool Selection and Application Guidelines  
P35.003 - Structures and Sub-Grade Corrosion Management

Continued development of the inspection techniques, improved assessment methods, and mitigation methods for specific corrosion types.

Specific Deliverables:-

Coating system selection and application guidelines  
Fleet management for structural corrosion  
Inspection tool for sub-grade corrosion and structures, foundations, anchors and ground electrodes  
P35.011 - Polymer and composite overhead transmission insulators

Continued development of a mix of software tools and information that will help address issues related to the selection, application and inspection of polymer insulators, with the production and issue of update reports when they become available.

Specific Deliverables:-

field Modelling Software  
Insulator Reference (Violet) Book update  
Polymer Insulator Population Assessment  
230kV Indoor Aging Chamber Report  
138kV Indoor Aging Chamber Report  
Polymer Insulator Vintage Guide  
Small Scale Testing of End Fitting Corona: Condition Assessment and Development  
P35.013 - Overhead line ratings and increased power flow

Continued development of tools and information that will help address issues to optimize and increase the ratings of their transmission circuits, with the production and issue of update reports when they become available.

Specific Deliverables:-

Increased Power Flow Guide Book  
Methods for Calculation of Forecasted Ratings Using a Risk Based Approach  
Selection of Ratings Criteria for Radiative Heat Transfer

P35.015 - Qualification, selection and maintenance of advanced conductors

National Grid have limited long term experience operating advanced conductors and few installations. Continued development of tools and information in this area that will help address issues related to the qualification, selection and maintenance of advanced conductors, with the production and issue of update reports as work progresses.

Testing the Mechanical Properties of HTLS Conductors  
Short-Term Accelerated Aging Evaluation of Carbon Core Conductors:  
Development of Guidelines for the Specification, Selection and Application of Advanced Conductors  
Identification of New and Emerging HTLS Conductors

### **Project Partners and External Funding**

n/a

### **Potential for New Learning**

n/a

### **Scale of Project**

The project work-streams associated with P35 are predominantly laboratory or desk based projects, with a minimal amount of site trials, if and when required. Because of this approach, there is no scope to reduce the scale of the projects any further.

### **Technology Readiness at Start**

TRL3 Proof of Concept

### **Technology Readiness at End**

TRL7 Inactive Commissioning

### **Geographical Area**

The research undertaken in EPRI P35 is predominantly carried out in the US with some in the UK, however, the programme carries out reviews of the latest research from across the world.

### **Revenue Allowed for the RIIO Settlement**

None

### **Indicative Total NIA Project Expenditure**

The total indicative NIA expenditure for the four year programme is £780,000 based on 2018 rates

## 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)

Each project work-stream will have different financial savings based on the outcomes and potential benefits gained. Each EPRI programme that National Grid joins has been through several stages of review that consider the potential to deliver financial benefits.

In the first instance, within EPRI's governance, the Research Advisory Committee provides guidance on policies and issues that impact the power industry to inform the content of the research programmes.

Within National Grid, the Technical Lead for each aspect of the GB Transmission Network undertakes a review of the proposed EPRI programme, relevant to their technical expertise and responsibilities, and evaluates which provide potential value from a GB perspective as part of an annual review of which programmes to participate in. The work-packages within P35 are expected to generate valuable learning which can improve and maintain the reliability of the system.

#### 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

Overhead transmission lines and their components, including tower structures down to 66kV inclusive, would benefit from this work. Some of the output is also relevant and transferrable to lower voltages such as the condition assessment tools, conductor management, composite insulation and reviews of new technologies.

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

The direct cost of making a policy or procedure change could range from as little as ten thousand to hundreds of thousands of pounds depending on the complexity of the change implications. The wider cost implications arising from such changes will be dependent on the specific outcomes generated from the project and typically will be subject to further stages of demonstration prior to roll out. Further information regarding roll out costs can be provided prior to demonstration stage.

### 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 GB electricity licensees own and manage overhead lines. They all face similar challenges around estimating remaining asset life, development of new monitoring and maintenance practices and understanding what novel technologies could be applied to improve efficiencies.

#### Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

This project sits within the Managing Assets and Corporate Responsibility value areas of the electricity transmission owner (ETO) innovation strategy.

- 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