

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

Jun 2017

Project Reference Number

NIA_NGET0209

Project Registration

Project Title

EPRI Research Collaboration on Overhead Lines (P35) 2017

Project Reference Number

NIA_NGET0209

Project Licensee(s)

National Grid Electricity Transmission

Project Start

January 2017

Project Duration

1 year and 7 months

Nominated Project Contact(s)

David Clutterbuck

Project Budget

£7,450,000.00

Summary

EPRI research projects span across multiple years. Because of this approach, not all of the work in P35 will be realised at the end of 2017. Nevertheless, there is scope for the delivery of a number of reports and guidance documents in 2017. The full scope of research within each project work-stream for 2017 is listed below.

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

Utilities 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 understand 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 the public. d the present condition of their conductors, shield 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.

P35.011 - Polymer and composite overhead transmission insulators

Polymer insulators offer advantages such as contamination performance, 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.

P35.013 - Overhead line ratings and increased power flow

The demand for electric power over transmission circuits is increasing at a faster rate than transmission assets were originally built for. This trend is pushing the capacity of many existing transmission circuits to their design limits.

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.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

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.

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 support this work via five project work-streams.

Following 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 in 2017:

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

P35.002 - Conductor, shield wire and hardware 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

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 members improve their line inspection and assessment as well as asset management approaches.

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

This work package is developing effective inspection techniques, and forecasting the need for maintenance or repair operations. These will help address issues related to conductor, shield wire and hardware corrosion.

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.

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 their transmission circuits.

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 advanced conductors.

Scope

EPRI research projects span across multiple years. Because of this approach, not all of the work in P35 will be realised at the end of 2017. Nevertheless, there is scope for the delivery of a number of reports and guidance documents in 2017. The full scope of research within each project work-stream for 2017 is listed below.

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

Utilities 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 understand 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 the public. This research project addresses these issues through the following activities:

- development of a Reference Guide Book (Yellow Book) which provides state-of-the-art resource on inspection and assessment methods and technology
- development of field deployable reference guides for field inspectors
- development and training resources for training inspection personnel
- development of software tools that include new and emerging inspection and sensing technologies, information, field case studies and results from EPRI testing and evaluation

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

Utilities need to understand the present condition of their conductors, shield 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:

- exploring the possibility of using near infra-red (NIR) spectroscopy to determine degradation rates and remaining conductor life
- developing the application of NIR spectroscopy technology for condition assessment of degraded hardware or component surfaces
- deriving ageing algorithms for atmospheric hardware through assessment methods

P35.011 - Polymer and composite overhead transmission insulators

Polymer insulators offer advantages such as contamination performance, 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 research work package addresses these issues through the following activities:

- 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 for polymer insulators
- Insulator Reference Book

P35.013 - Overhead line ratings and increased power flow

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

- analysis of acceptable methodologies for determining forecasted ratings for use by power companies.
- determining the effective area that can be rated given a certain density of sensors
- testing and analysis of emerging methods for dynamic rating studies on transmission lines

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:

- short-term accelerated aging evaluation on carbon core advanced conductors
- developing guidelines for selection and application of advanced conductors
- developing specification guidelines for various advanced conductor systems
- developing a cleaning solution for various advanced conductor systems
- evaluating the effects of high-temperatures on live-working tools

Objective(s)

The objectives for 2017 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:

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

- continued development of tools and methods to help improve reliability
- increase the effectiveness of the inspection and assessment process
- increase the safety for the public and transmission owner personnel by helping to detect components with a high risk of failure before the actual event through new inspection methods and hands-on tech transfer

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

- understanding the potential of using near infra-red (NIR) spectroscopy to determine degradation rates and remaining conductor life
- continued development of NIR spectroscopy technology application for condition assessment of degraded hardware or component surfaces
- continued assessment of methods to derive new aging algorithms for atmospheric hardware

P35.011 - Polymer and composite overhead transmission insulators

- multi-stress ageing tests to understand various modes of degradation and performance of polymer components
- 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

- continued development of software tools
- continued development of rating methodologies
- continued development of EPRI guidebooks, reports, and training materials for implementing increased power flow strategies, and for training their engineers on increased power flow technologies

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

- developing a test protocol to compare different carbon fiber composite core conductors
- providing 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

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 2017 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:-

- Field Guide(Application): Daytime Discharge Inspection of Transmission and Distribution Overhead Lines and Substations (Software Dec 2017)
- New Version of OHTL Inspection, Assessment and Asset Management Reference Guide Book (Yellow Book Dec 2017)
- Overhead Transmission Line Component Failure and Performance Summary Report (report Dec 2017)
- Evaluation of OHTL Inspection Technologies (report Dec 2017)
- New Version of the Yellow Book PC Browser Application (Software Dec 2017)

P35.002 - Conductor, shield 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, shield wire and hardware corrosion, with the production and issue of update reports when they become available.

Specific Deliverables:-

- Evaluation of Conductor Failures due to Corrosion (Technical Results Dec 2017)
- Development of Fleet Management Strategies for Population Assessment of Conductors (Technical Results Dec 2017)
- NIR Spectroscopy (C-Corr) Development for ACSR Conductor (Technical Results Dec 2017)

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:-

- Insulator Reference (Violet) Book (Dec 2017)

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:-

- Methods for Calculation of Forecasted Ratings Using a Risk Based Approach (Report Dec 2017)
- Selection of Ratings Criteria for Radiative Heat Transfer (Report Dec 2017)

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

Continued development of tools and information that will help address issues related to the qualification, selection and maintenance of advanced conductors, with the production and issue of update reports when they become available.

Specific Deliverables:-

- Selection and Application of High- Temperature Conductors (Technical Results Dec 2017)
- Installation and Maintenance of High- Temperature Conductors (Technical Results Dec 2017)
- Results of Carbon Core Conductor Qualification Tests (Technical Results Dec 2017)

Project Partners and External Funding

Each project facilitated by an EPRI programme is funded through collaborators, including National Grid, that contribute to the development of the project portfolio and then express interest in to be involved with a specific project once the portfolio is decided. The total contribution from all EPRI OHL members for 2017 is anticipated at £7.45m

Potential for New Learning

These projects in their totality will help National Grid and GB utilities by providing new learning in the following areas:

- Improved analytics and management of transmission line components
- Improved approaches and techniques for conductor and hardware corrosion management
- Improved approaches to selecting, applying, inspecting, and assessing insulators
- Improved knowledge on overhead transmission line ratings and increased power flow

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 2017 is £295,000

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.

By participating in collaborative projects through EPRI National Grid can ensure that unnecessary duplication with other projects under NIA is avoided.

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