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

Sep 2015

Project Reference Number

NIA_NGET0173

Project Registration

Project Title

EPRI Research Collaboration on Overhead Transmission Lines Project

Project Reference Number

NIA_NGET0173

Project Licensee(s)

National Grid Electricity Transmission

Project Start

September 2015

Project Duration

1 year and 1 month

Nominated Project Contact(s)

Iliana Portugues

Project Budget

£1,486,200.00

Summary

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 aging infrastructure performance at levels that meet the reliability expectations of the public.

Structure and Sub-Grade Corrosion Management

Transmission lines are affected by sub-grade corrosion damage resulting in costly outages, increased maintenance costs, and potential health risks. Visual inspection by excavation, which is the predominant method of condition assessment for sub-grade inspections, is costly and labor intensive. This project intends to identify corrosion issues, characterize corrosion types, and develop appropriate corrosion management solutions for funders. The project will develop the technical basis for decision support in dealing with subgrade corrosion of transmission line structures as well as the tools to make cost-effective corrosion management decisions. This may include the development of inspection techniques, improved assessment practices, and mitigation methods for specific corrosion types.

Live Working: Research, Techniques and Procedures

Higher transmission loads are forcing utilities to keep transmission lines in service every day. Outages for maintenance are more difficult to obtain.

Performance and Maintenance of High-Temperature Conductors

Recently developed high-temperature conductors offer the advantages of higher current capacity, lower conductor sag, and lower line losses than conventional ACSR (aluminum conductor steel-reinforced) conductors. This project addresses issues related to the long-term performance of these conductors.

New and Emerging Inspection and Sensing Technologies

The project will deliver the following tasks:

- Identify and document the technical capability and limitations of new and emerging inspection/sensing technologies,
- Document use cases where new and emerging technologies have been utilized in the field,
- Identify gaps in currently available inspection technologies and possible applicable technologies to meet ?members' requirements,
- Conduct laboratory and field evaluation of new and emerging technologies.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

The electricity industry faces challenges that National Grid recognises are more cost-effectively and efficiently dealt with through international collaboration initiatives. In particular, challenges whose 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 and stakeholder value maximised. This approach of managing collaborative projects is beneficial to National Grid and our customers, providing valuable information, learning and knowledge, which would be more expensive to formulate on an individual basis.

In 2015, a benchmarking exercise by National Grid has determined the largest leverage within Overheads Transmission for the UK consumer is achieved through involvement in the following five projects:

- Inspection, assessment and asset management of overhead transmission lines
- Structure and sub-grade corrosion management
- Live working: research, techniques and procedures
- Performance and maintenance of high-temperature conductors
- New and emerging inspection and sensing technologies

Method(s)

Inspection, assessment and asset management of overhead transmission lines

This project 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.

Structure and Sub-Grade Corrosion Management

This project provides information and tools to better understand how the environment influences subgrade corrosion types, identifies methods to locate possible damages, and methods to remediate and mitigate the corrosion damage.

Live Working: Research, Techniques and Procedures

This project develops tools, procedures and training materials for live and de-energised work at HVAC lines to enhance worker and public safety, work efficiency, and reduction in cost and duration of maintenance outages.

Performance and Maintenance of High-Temperature Conductors

This project conducts research to address some of the outstanding issues related to high-temperature conductors such as how to quantify a carbon-fiber core conductor. The project develops a guide to assist utilities in the proper selection and application of advanced conductors. Maintenance tools and procedures for this new type of conductor will also be identified and established, including the development of a cleaning solution for various advanced conductor systems.

New and Emerging Inspection and Sensing Technologies

This project will document the latest inspection and sensing technologies for overhead transmission lines, as well as early adopters' experiences with these technologies. Some technologies are tested and evaluated and results made available. Test results and demonstrations help members make more informed decisions when deciding whether to apply or deploy such technologies.

Scope

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 aging infrastructure performance at levels that meet the reliability expectations of the public. This research project will perform the following tasks:

- Research and document modes of component degradation, identify indicators and symptoms of impending failures, as well as assesses effective inspection practices and technologies
- Develop a self-paced computer-based technology transfer program for inspection and assessment technologies and components ?
- Develop and maintain field guides for field personnel that help identify and provide information on the condition of components and remedial action
- Develop fleet management approaches to assess the overall health and condition of overhead transmission line assets and components ?
- Develops techniques for systematically inspecting and assessing an in-service population of various line components to identify the at-risk component classes ?
- Develops and hosts hands-on tech transfer workshops and conferences ?
- Provides a synopsis of findings resulting from analysis of different EPRI line component performance and ?failure data repositories ?

Structure and Sub-Grade Corrosion Management

Transmission lines are affected by sub-grade corrosion damage resulting in costly outages, increased maintenance costs, and potential health risks. Visual inspection by excavation, which is the predominant method of condition assessment for sub-grade inspections, is costly and labor intensive. This project intends to identify corrosion issues, characterize corrosion types, and develop appropriate corrosion management solutions for funders. The project will develop the technical basis for decision support in dealing with subgrade corrosion of transmission line structures as well as the tools to make cost-effective corrosion management decisions. This may include the development of inspection techniques, improved assessment practices, and mitigation methods for specific corrosion types.

The following core tasks will be performed:

- Evaluation of new and emerging coating systems to support development of selection and application guidelines ?
- Evaluation of inspection and assessment methods for tubular structures, grillage and anchor rods. ?
- Development of new tools and techniques for inspection and assessment of structure foundations ?
- Development of mitigation methods for concrete foundations and tubular structures ?
- Development of sub-grade corrosion models to support fleet management practices and population assessment methods ?
- Development of sub-grade mitigation methods for pack-out and coating system failure on weathering steel structures ?
- Transfer of new learning through workshops and conferences by providing education and training for new ?corrosion inspection, mitigation, and remediation techniques ?
- Expansion of the failure database to trend make and model failures on transmission line structures ?

Live Working: Research, Techniques and Procedures

Higher transmission loads are forcing utilities to keep transmission lines in service every day. Outages for maintenance are more difficult to obtain. ?This project will perform the following tasks:

- Development of Basic Information for Calculation of Switching Minimum Approach Distance (MAD) and Gap Factors
- Evaluation of New Materials for Rigid LW Tools
- Evaluation of New Materials for Non-Rigid LW Tools?
- Robotics for LW
- Next Generation Temporary Grounding Equipment?
- Equipotential Zones for Worksites Aloft and on the Ground?
- Designing for Maintenance and Live Working
- Investigation of Causes of Insulating Tool Flashover and Approached for Flashover Mitigation?
- Identify and Document Relevant Regulations Impacting Live Working

Performance and Maintenance of High-Temperature Conductors

Recently developed high-temperature conductors offer the advantages of higher current capacity, lower conductor sag, and lower line losses than conventional ACSR (aluminum conductor steel-reinforced) conductors. This project addresses issues related to the long-term performance of these conductors. Tasks undertaken in this project may include the following:

- Short-term accelerated aging evaluation on carbon core advanced conductors,
- Development of guidelines for selection and application of advanced conductors,
- Development of a cleaning solution for various advanced conductor systems,
- Evaluation of the effects of high-temperature on live-working tools.

New and Emerging Inspection and Sensing Technologies

The project will deliver the following tasks:

- Identify and document the technical capability and limitations of new and emerging inspection/sensing technologies,
- Document use cases where new and emerging technologies have been utilized in the field,
- Identify gaps in currently available inspection technologies and possible applicable technologies to meet ?members' requirements,
- Conduct laboratory and field evaluation of new and emerging technologies. ?

Objective(s)

Inspection, assessment and asset management of overhead transmission lines

This programme of work aims to meet the following objectives:

- Develop tools and/or methods to help improve reliability;?
- Increase the effectiveness of the inspection and assessment process;
- Increase the safety for the public and transmission operator 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.

Structure and sub-grade corrosion management

The objectives of this work package are to:

- Provide new tools and inspection methods to identify and assess corrosion issues on structures and foundations;
- Demonstrate new and emerging inspection, mitigation, and remediation technologies by evaluating accuracy, risk, efficacy, and cost; ?
- Reduce maintenance costs by matching reject and ranking criteria with appropriate mitigation and remediation techniques;
- Improve designs through better material compatibility and elimination of specific corrosion types ?
- Develop fleet management practices for population assessment by screening geographic areas prone to support severe corrosion rates.

Live working: research, techniques and procedures

This programme of work aims to:

- Increase worker safety;
- Improve reliability and availability by enabling timely maintenance of transmission lines, both energized ?and de-energized;
- Improve transmission performance;
- Decrease maintenance costs;
- Implement innovative ideas and tools to live work.

Performance and maintenance of high-temperature conductors

Work in this area aims to achieve the following objectives:

- Provide information and tools that are currently not available to evaluate the performance of various high- temperature conductors;
- Provide maintenance procedures and recommend tools to ensure the safety of utility personnel and the reliability of transmission lines.

New and emerging inspection and sensing technologies

The objectives of this programme of work are to:

- Develop our knowledge and understanding of the latest technologies;
- Have easy access to other utilities' experience and performance testing; ?

Identify gaps and possible technologies as well as future research and development needs.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Inspection, assessment and asset management of overhead transmission lines

If successful, this programme of work will deliver the following:

- Report on New Version of OHTL Inspection, Assessment and Asset Management Reference Guide; ?
- Report on Overhead Transmission Line Component Performance and Failure Summaries-2015;
- Guidelines for Assessing the Condition of Overhead Transmission Line Components;
- Guide for Data Collection Requirements to Evaluate Line Component Condition.

Structure and sub-grade corrosion management

Success in this area will be measured against the delivery of the following:

- Report on Remediation Methods for Concrete Foundations;
- Report in Corrosion Probe Development for Assessing Grillage foundations, Anchors and Steel Poles;
- Report on Coating System Selection and Application Guidelines;
- Report on Design changes for concentration cell corrosion in bolt details: pack-out in weathering steel and galvanized carbon steel construction.?

Live working: research, techniques and procedures

The success criteria for this work package will be the delivery of the following:

- Report on Basic Data for Calculation of Minimum Approach Distance (MAD) and Gap Factor for Live Work
- Report on Electrical Performance of New Jacketed Rope for Live Work
- Guide to the Design of Transmission Structures to Facilitate Maintenance and Live Working
- Tool with Probable Causes of Recent Flashovers of Live Working
- Report on the Impact of Recently Released Regulatory Requirements on Live Working

Performance and maintenance of high-temperature conductors

This project will delivery the following:

- Guide for Selection and Application of High-Temperature Conductors;
- Guide for Maintenance of High-Temperature Conductors.

New and emerging inspection and sensing technologies

This project will me measured against the delivery of the following:

- Software Tool for with Inspection & Sensing Information;
- Report detailing the Evaluation of Emerging Inspection or Sensing Technology.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

These projects are predominantly laboratory or desk based projects, with a minimal amount of site trials as required and as such 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 the EPRI Substations programme is predominantly carried out in the UK and the US, although the

programme also reviews 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 2015 is £219,000.

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 will have different financial savings based on the outcomes and potential benefits gained. Each EPRI programme that National Grid joins has been through three 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 Leader 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 suite of projects in this proposal 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 are its components, including tower structures down to 132kV inclusive, would benefit from this work. Some of the output is also relevant and transferrable to lower voltages such as the condition assessment tools 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)

Managing Assets and Corporate Responsibility

☑ 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