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

Dec 2013

Project Reference Number

NIA_NGET0017

Project Registration

Project Title

Oil/Paper Insulation HVDC Performance

Project Reference Number

NIA_NGET0017

Project Licensee(s)

National Grid Electricity Transmission

Project Start

October 2010

Project Duration

5 years and 10 months

Nominated Project Contact(s)

Gordon Wilson & Paul Jarman

Project Budget

£388,000.00

Summary

The project will investigate the performance of the oil-paper insulation system used in HVDC transformers under a variety of electrical stress conditions. It will attempt to determine the effects of oil resistivity and other insulation condition parameters on the capability of the insulation to withstand the electrical stresses seen within HVDC transformers particularly during polarity reversal or other changes in stress.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

Recent work in CIGRE has highlighted that oil resistivity can greatly influence the stress distribution within an oil-paper insulation system in a DC stress environment especially during voltage changes such as polarity reversals. There have been several failures of bushings at Sellindge (convertor station) during or shortly after polarity reversals and there is evidence that the factory testing of DC transformers is inadequate to cover service conditions.

A new CIGRE group is being established to look at this further and this work could usefully link to this group. The measurement of the DC conductivity of oil is not routine and a repeatable method needs to be established. This project will provide the knowledge to specify appropriate tests on new transformers and make sure that oil quality in service is maintained to suitable levels.

Method(s)

The method that has been proposed for this project includes;

The project will probably employ two PhD students, one looking at oil conductivity measurement and the other looking at space charge measurement, the two projects will allow a full understanding of the charging and dielectric strength of an oil-paper system under DC conditions.

• Literature report on oil conductivity, measurement and effect on stress in insulation

- Preliminary tests on oil conductivity and charge measurement
- Results of tests on insulation under different conditions, effect of electrode materials and

temperature on DC conductivity

- Results of investigation into oil DC conductivity measurement and the effect of oil conductivity and pressboard condition on charge retention and migration on surfaces and the potential for creep breakdown on surfaces.
- Final report in form of PhD thesis

Scope

The project will investigate the performance of the oil-paper insulation system used in HVDC transformers under a variety of electrical stress conditions. It will attempt to determine the effects of oil resistivity and other insulation condition parameters on the capability of the insulation to withstand the electrical stresses seen within HVDC transformers particularly during polarity reversal or other changes in stress.

Objective(s)

The objective of this project is to better understand the DC impacts on transformers.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

National Grid will evaluate the success of the project by seeing if the results provide useable information which supports the specification and operation of HVDC equipment.

Project Partners and External Funding

Southampton University

There is no external funding being brought to this project.

Potential for New Learning

There is a high potential for new learning as CIGRE have identified there is a lack of knowledge in this area. Dissemination will be via technical experts (both National Grid and academic) to national and international technical meetings, as well as through ENA portal, National Grid.com websites.

Scale of Project

The project is laboratory scale with two PhD studies at the University as the topic is larger than one PhD student.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

This project will be completed in Southampton.

Revenue Allowed for the RIIO Settlement

Zero

Indicative Total NIA Project Expenditure

IFI= £287k

NIA=£94k

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)

The saving would be against avoided costs due to a failure of the new HVDC assets, this project decreases the uncertainty and risk of the operation of the assets. A failure would have high associated costs depending on the asset impact but could be many million pounds, this project will contribute to reducing that risk.

Please provide a calculation of the expected benefits the Solution

Research Project - N/A

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

It is replicable across all oil filled assets on the network via the technical experts in Electricity Transmission Asset Management.

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

The learning will be embedded into the business as part of this project.

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

n/a

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 addresses the themes of reliability and system operability through a focus on improved HVDC asset management to enable network challenges from renewables.

☑ 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.

Given a review of all companies' IFI reports and industrial and technical knowledge of the international literature and best practice, the project engineer confirms that no duplication of innovation work. On top of this, we have also checked our standard supply base, including Universities and EPRI, and the ENA smart portal.

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