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

Jan 2014

Project Reference Number

NIA_NGET0010

Project Registration

Project Title

Optimised Location for Surge Arresters on the Transmission Network

Project Reference Number

NIA_NGET0010

Project Licensee(s)

National Grid Electricity Transmission

Project Start

September 2012

Project Duration

3 years and 11 months

Nominated Project Contact(s)

Dongsheng Guo

Project Budget

£163,000.00

Summary

Research and development work is required to limit the uncertainty and contribute to the review and update of National Grid documents that affect insulation coordination aspects of transmission substations. This work covers the overvoltage levels within a substation with regard to lightning and switching impulses.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

It is important to investigate the overvoltage levels within a substation under both lightning and switching surge conditions. This would allow adequate choice of surge arresters and, more importantly, determine an optimised location for more effective and reliable overvoltage protection of high voltage plant, e.g. transformers, cables and gas insulated switchgear (GIS).

Method(s)

Research

The method that has been proposed for this project includes;

Computer modelling using EMTP computations will be undertaken to determine the threat-levels related to surges in substations and examine protection against overvoltages. Further analysis will be required to derive basic rules for overvoltage protection optimisation which can then be implemented on the system.

The following tasks are proposed:

i. *Review:* Conduct a literature review to include applicable standards for insulation coordination and overvoltage protection

recommendations for various items of high voltage plant. Contact manufacturers to survey best advice on surge arrester selection and location in practice. Conduct a literature review on the possible application of co-ordinating gap as an alternative to gapless surge arresters.

ii. *Models:* Develop EMTP model for selected configurations of substation layouts including connected overhead lines and cable circuits. Use various scenarios of lightning and switching overvoltages (circuit details to be agreed based on demand), to include studies for overvoltage protection of: Transformers, GIS, substation entry, and Underground cable lengths, and

iii. *Protection distance:* Perform extensive simulations of the above, and determine level of overvoltage protection offered by surge arresters with distance. Obtain minimum and maximum practical distances for which adequate protection is provided. Identify key factors controlling surge arrester protection distance and evaluate their effects on overvoltage protection with the aim to derive simple rules and equations for estimating adequate surge arrester location.

iv. *GIS protection:* Conduct a comprehensive investigation of transients in GIS, including scenarios for very fast switching transients in order to determine the necessary requirements and rules for overvoltage protection, surge arrester ratings and location.

v. *Transformers under fault:* investigate the overvoltage protection requirements for the special case of transformers subjected to worst-case fault condition(details of circuit scenarios to be confirmed by DG/FG)

vi. *Cable-GIS protection:* Review and examine, through simulations, the transient overvoltages on cable networks and assess the effectiveness of surge arresters protection on networks with extensive cable lengths. Consider the interaction between cables and GIS and develop optimised methods of protecting such circuits.

- Insulation coordination-progress report 1: this will include the literature review and modelling results for determining surge arrester protection distances
- Insulation coordination-progress report 2: this will include the results of the GIS studies
- Insulation coordination-progress report 2: this will include the special fault studies on transformers

and GIS with extensive cable networks

- Insulation coordination – final report: this will group the above reports and include recommendations for implementation at National Grid

Scope

Research and development work is required to limit the uncertainty and contribute to the review and update of National Grid documents that affect insulation coordination aspects of transmission substations. This work covers the overvoltage levels within a substation with regard to lightning and switching impulses.

Objective(s)

To minimise costs associated with surge arrestors on the Transmission Network by optimised their location.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

1. Review of existing practice of surge arresters and related insulation coordination
2. Develop models for key scenarios of transients(Lightning and switching) in transmission substations
3. Develop simple rules and techniques for optimising the use and location of surge arresters in substations
4. Develop necessary background knowledge for overvoltage protection of transformer, GIS, and cable

5. Investigate overvoltage protection special cases of transformer fault scenarios and GIS-Cable networks
6. Obtain the EMTP simulation models of all above tasks and activities

Project Partners and External Funding

Cardiff University

No external funding.

Potential for New Learning

This project will generate new learning regarding the most appropriate choice of surge arresters and, more importantly, determine an optimised location for more effective and reliable overvoltage protection of high voltage plant.

Scale of Project

This project is being delivered on a laboratory scale.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

This work is being delivered in Cardiff.

Revenue Allowed for the RIIO Settlement

Zero.

Indicative Total NIA Project Expenditure

IFI=£42k NIA=£121k

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)

If a failure of an asset was to occur due to Overvoltage, then the cost would be (at minimum) the cost of the asset. For a transformer, this could be in the region of £5m, Cable system > £10m, GIS c£200k

Please provide a calculation of the expected benefits the Solution

Research Project - Not required.

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

This is applicable to the whole of the GB transmission system.

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

This is looking at a National System, so roll out should be captured in this project (roll out of knowledge – not hardware).

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 theme of reliability in terms of optimizing asset management.

☑ 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.

Following a review of the ENA smart portal, and our main innovation partners (including Universities and EPRI), National Grid confirm that this project doesn't unecessarily duplicate other projects.

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