nationalgrid

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

NIA_NGET0040

Project Registration

Project Title

Magnetic Models for Transformers

Project Reference

NIA_NGET0040

Project Licensee(s)

National Grid Electricity Transmission

Project Start

September 2009

Project Duration

6 years and 11 months

Nominated Project Contact(s)

Paul Jarman

Project Budget

£421,000.00

Summary

The project will deliver tools to analyse what happens to plant with a magnetic circuit when that circuit starts to become saturated because of extreme operating conditions. Examples of this are transformers under ferroresonant conditions, transformers subject to DC currents such as during geomagnetic (sun storm) events, series reactors under fault conditions, quadrature boosters under high load conditions and saturable shunt reactors under normal conditions. Failure to analyse these conditions leads properly either to excessive capital cost in increasing core dimensions, or potential failure in service due to the heating of the magnetic circuit and other steel parts in the transformer or reactor.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

Currently there is no model for the magnetic circuit of a transformer/Quadrature Booster (QB) under high induction conditions, limiting the conclusions about the relationship between ferroresonance and transformer damage. This inability appears to be general throughout the transformer industry and represents a significant gap in knowledge. This gap is normally not important to transformer manufacturers because during tests the core of a transformer is operated well within flux limits, however during operation these limits can be exceeded and increasing the capability of transformers to avoid this would have a direct impact on initial cost. Conservative assumptions about core saturation have therefore had to be adopted, particularly in QB design because of a lack of knowledge.

Method(s)

This project proposes the following methods;

1. Develop finite element mathematical core model of simple core and core joint
2. Validate the model against physical model core with and without joint.
3. Develop bulk property constants for laminated core steel and joint areas
4. Develop finite element model of complete large transformer core
5. Use model in QB/transformer/reactor design to develop knowledge of operating envelope with respect to the magnetic circuit

Scope

The project will deliver tools to analyse what happens to plant with a magnetic circuit when that circuit starts to become saturated because of extreme operating conditions. Examples of this are transformers under ferroresonant conditions, transformers subject to DC currents such as during geomagnetic (sun storm) events, series reactors under fault conditions, quadrature boosters under high load conditions and saturable shunt reactors under normal conditions. Failure to analyse these conditions leads properly either to excessive capital cost in increasing core dimensions, or potential failure in service due to the heating of the magnetic circuit and other steel parts in the transformer or reactor.

Objective(s)

The results from this project will be directly used within Electricity Transmission's Asset Policy and Asset Engineering in analysing future and existing designs of transformer for operational aspects of ferroresonance, geomagnetically induced currents (GIC) and over-fluxing. The knowledge may also be useful in post event analysis.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will have deemed to have been a success if the industry's knowledge in this area has been progressed. National Grid will be able to measure this by an improved analysis of the operational aspects for the magnetic circuit of a transformer/QB under high induction conditions.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

This project is a research project taking place in a university and not a focused trial.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

This project is applicable to all transformers and quadrature boosters, so is UK wide, however the work is being completed in Manchester.

Revenue Allowed for the RIIO Settlement

Zero

Indicative Total NIA Project Expenditure

IFI £111,000.

NIA expenditure is £310,000

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)

Typically, a transformer would cost in the region of £5m to replace, and National Grid believe that understanding the issues surrounding transformer magnetic saturation will help to avoid asset replacement.

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 project has the potential to apply to all sites where there are transformers installed.

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

These costs will be incurred by the technical experts within the business as part of their management of the transformer and reactor fleet.

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 through optimizing asset management as well as being partly strategic in nature as world leading research.

☑ 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