NIA Project Registration and PEA Document

Date of Submission

Feb 2017

Project Reference Number

NIA_NGET0204

Project Registration

Project Title

Frequency Response Analysis for Transformer Characterisation and Objective Interpretation of Results

Project Reference Number

NIA_NGET0204

Project Licensee(s)

National Grid Electricity Transmission

Project Start

January 2017

Project Duration

4 years and 7 months

Nominated Project Contact(s)

Paul Jarman

Project Budget

£340,000.00

Summary

This four year PhD iCase project seeks to:

- establish a database of FRA results in a common format to enable automatic processing

- reduce or parameterise the data so that records can be compared and similar transformers identified<

- correlate FRA characteristics with known design features

- use high frequency modelling and knowledge of the relationship between FRA responses and design to develop quantitive measures that can be used to determine whether transformer damage has occured

Nominated Contact Email Address(es)

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Problem Being Solved

Frequency Response Analysis (FRA) is a measurement carried out on transformers both in the factory and in service to determine the complex relationship between electrical impedance and frequency. The result is a bit like a fingerprint for a particular transformer design which will change if the transformer is damaged internally and is different for each design. With the knowledge gained by this project it should be possible to more accurately identify which design category a transformer belongs to and focus the asset replacement plan on the most reliable designs.

FRA results have been collected for many years on all new transformers and on many in service units. This is primarily in order to establish a benchmark for future occasions when it is needed to use FRA to determine if the transformer has been damaged by a high current event, such as, a short circuit on the terminal or a tap-changer fault.

It may be possible to use this accumulated data for asset management. Specifically, the asset management of transformers depends heavily on being able to identify which transformers are of the same design within the tank, or which ones share particular design

features that may have a bearing on the expected lifetime of the unit. An example of this would be the presence or absence of stress rings with a poor performance record within a group of externally identical units. Often the original manufacturer of the transformer is no longer in business and the availability of information on internal details is patchy at best.

Previous studies undertaken by the University of Manchester, established that it is possible to reduce the raw FRA data into a limited number of key parameters that can be easily compared between transformers in the database. At present FRA interpretation and comparison is a manual process that is hard or impossible to do if a large number of records are to be compared.

Method(s)

The method this four year PhD iCase seeks to advance, is to improve the usefulness and understanding of FRA results.

This project involves establishing a database of FRA results, in a common format, to enable automatic processing, parameterising the data to enable records to be compared and similar transformers identified and correlating FRA characteristics with known design features.

This project will run in parallel with, and to some extent be guided by, work within the A2.52 Cigre working group.

Scope

This four year PhD iCase project seeks to:

- establish a database of FRA results in a common format to enable automatic processing
- reduce or parameterise the data so that records can be compared and similar transformers identified
- correlate FRA characteristics with known design features
- use high frequency modelling and knowledge of the relationship between FRA responses and design to develop quantitive measures that can be used to determine whether transformer damage has occured

Objective(s)

The objective of this project is to improve our understanding of FRA results, with a view to establishing a method of automatically determining what specific differences in FRA mean in terms of design changes or winding damage.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

This project will be deemed successful if the database of FRA results is created; the data can be parameterised so that comparisons can be made and similar transformers identified; known design features can be correlated and quantitive measures can be developed to determine whether transformer damage has occurred.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

This project will predominately be desk top based and the project will provide a database, in a common format, to enable FRA results to be automatically processed. This will have a direct benefit in terms of the accessibility of this data, which is at present scattered amongst suppliers and old databases, in different formats and in danger of being lost.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

This project will be undertaken by two PhD students and based at the University of Manchester.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£260,000

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)

It is estimated that there could potentially be a 0.5% reduction in capital employed in replacement (or approx. £225k per year) within the transformer replacement programme. It would be reasonable to give a 50% probability of success, and a return time of 10 years, giving a return of approx. £1M.

Please provide a calculation of the expected benefits the Solution

Not applicable - Research Project

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

This Method will enable all Network Licensees to better understand FRA results and to also understand what the specific differences in FRA mean in terns of design change or winding damage.

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

This is a research project to establish a database to enable automatic processing. As such there are currently no requirements for the purchase of any additional assets or supplies.

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

This method has the potential to be utilised by all Network Licensees as they will have similar data and issues which would benefit from the results of this project.

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 fits within the Managing Assets value area of the Electricity 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.

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