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

Mar 2016

Project Reference Number

NIA_NPG_009

Project Registration

Project Title

Development of Oil-filled Cable Additive

Project Reference Number

NIA_NPG_009

Project Licensee(s)

Northern Powergrid

Project Start

March 2016

Project Duration

1 year and 4 months

Nominated Project Contact(s)

NPg – Kevin Willerton (kevin.willerton@northernpowergrid.com) UK Power Networks – Ismini Dimitriadou (Ismini.Dimitriadou@ukpowernetworks.co.uk)

Project Budget

£180,000.00

Summary

The project will research and identify candidate repair technologies, experimentally evaluate the preferred options, build and trial a working prototype of the preferred technology. Along with this the project will produce recommendations on the best route to commercialization for the preferred technology.

Nominated Contact Email Address(es)

yourpowergrid@northernpowergrid.com

Problem Being Solved

All major GB electricity utilities have fluid filled cable circuits on their distribution networks. These are mostly of the low pressure fluid filled type, typically designed to operate at 3 - 5 bar pressure with short term peaking pressures up to 8 bar. Over time these cables may begin to leak cable fluid and subsequently the cable pressure may drop and the cable insulation system (fluid impregnated paper or paper-polypropylene laminate) may eventually fail. In some cases the leaks may also cause environmental contamination that is of concern to the network operator, to the public and importantly the Environment Agency who could enforce the closure of cable circuits or impose limits on their operation. The causes of leaks can be categorised as follows:

{C}· Third party damage leading to rupture of the metallic sheath (the most common cause)

{C}· Ageing/corrosion of metallic sheaths due to thermal and mechanical stress or possibly vibrations

{C}· Changes in the thermal resistance of the soil surrounding the cable

{C}· Corrosion of contacts in pressure gauges leading to faulty alarm function

{C}· Degradation of terminations

{C}· Influence of cable construction on ageing

Further reduced reliability has been associated with:

{C}· Exceeding the normal design life of the order of 30 to 40 years – many of the oil/fluid filled cable circuits in operation are in this position

{C}· A significant reduction in the skills of repairers and poor quality repairs

{C}· A significant decrease in maintenance on fluid filled systems due to pressure on operating budgets

{C}· The increasing difficulty of sourcing spares

These aspects have resulted in an uncertain outlook for the future reliability of fluid filled cables. However there are still many of these circuits in operation, and the challenge remains to improve the condition and reliability of existing cable circuits, to reduce failures and outages, and to significantly reduce the associated liability costs of outage and environmental pollution.

There is an urgent and on-going need in the GB electricity distribution network to prevent and treat cable fluid leaks to improve the reliability of fluid filled cables and to reduce environmental damage that often accompanies oil leakage. However, it is important that the methods used to achieve this fit into a low-maintenance strategy and where possible are self-managing without the need for detection, location-finding and manual repair.

For land based cables deployed underground in backfill, in cable trough installations or deployed in cable ways in tunnels and other civil constructions, damage may occur at the time of installation and also during operation when third parties carry out civil repairs. Damage may also occur through cable ageing and stressing.

Once cable leakages have been detected, locating the source of the leak is a difficult process.

In-situ cable self-repair is seen as invaluable as damage may be localised and non-obvious from inspection of the cable during operation and may appear many years after installation. In many cases it may not be possible to inspect the cable in inaccessible environments.

Method(s)

The project seeks to address this challenge by utilising new developments in self-repairing polymers, resins and reactive chemical technologies for fluid systems that are potentially capable of providing a repair function for a variety of cable sheath defects and damage types that may occur. The uniqueness relates to the use of the fluid medium to affect the repair when key reactions are triggered by the presence of a leak and exposure of the fluid to the ambient conditions around the cable.

This project is being undertaken in a series of self-contained stages. The first three of these have already been completed under IFI. The method as a whole has to be taken in the context of this previous work which is described below to provide that context.

Stage 1 – Completed under the IFI

* Critical review and selection of potential repair technologies with account of the damages/ leaks to be repaired, and the sourcing of the component compounds and design of test rigs – to include consultations with EDF R&D.

Stage 2 – Completed under the IFI

* First level scoping assessment of synthesised and formulated self-repair technologies to assess their ability to function in cable-like environments when subjected to damage and use these findings to select candidates for more detailed evaluation.

Stage 3 – Completed under the IFI

* Second level evaluation of the best candidate repair technologies from Stage 2 with recommendations on which technologies to move to cable testing in stage 4.

Stage 4 – This project

* Component sourcing and construction of the fluid containment rig for lab assessment of containment. Operation of the containment rig to assess different fluid blends.

* Operation of the rig to investigate fluid containment in relation to backfill and soil type and self-repair fluid type.

* Evaluate the properties of modified self-repair fluids to support containment.

* Carry out cable test rig design and costing to accelerate phase two.

* Consult with the DNOs on the type and details of FF cables to be tested in Phase 2. Select the location to host the cable test rig and establish a costing for its operation.

* Define the development activities to refine the self-repair fluids to enhance leak repair and the containment of fluids to the vicinity of the cable circuit.

* Prime the UK's leading suppliers of low pressure cable fluids to supply purified fluids for the cable test rigs and cable trials in advance of network deployment.

Review the project and determine whether it still has the potential to deliver benefits to customers.

Scope

The project will research and identify candidate repair technologies, experimentally evaluate the preferred options, build and trial a working prototype of the preferred technology. Along with this the project will produce recommendations on the best route to commercialization for the preferred technology.

Objective(s)

* Construction and commissioning of the laboratory fluid leak containment rig.

* Evaluation of the properties of the modified self-repair fluids that support containment.

* Design and costing of the fluid filled cable test rig with the cable requirements of the supporting DNOs fed back into the design.

* Selection of the cable test rig host and establishing a costing for the hosting of the technology.

* Define the development activities to enhance repair and containment function for Evaluation of materials produced using the assessment methods already reported in Stage 2.

* Accelerate the design, costing and location of the FFC cable test rig in preparation for an accelerated follow-up project.

* Prime the low pressure FFC fluid producers in the UK to provide purified fluids in volumes suitable for the cable test rig and FFC circuit trials.

* Stage gate review to decide whether the project can still deliver benefit to customers and to determine the required follow-up work.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The success for this low TRL project is the delivery of the objectives detailled above and a confirmed decsion as to whther to continue the porject into a further development phase as a separate follow-up activity.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The project is relatively small scale laboratory study.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

N/A. This project is knowledge development and does not involve field trials.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

The indicative project cost is £180,000.

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)

The net finanacila benefit has been produced using Northern Powergrid costs and then scaling up for full GB network implementation.Actual benefit may vary depending on indvidual DNO costs but the magnitude of the potential benefit is clealry indicated.

Approximate average costs associated with repairing an FFC leak = £30k

Approximate average costs associated with environmental clean-up and oil replacement for an FFC leak = £23k

Approximate average costs of planned FFC replacement = £485k per kilometer

The costs associated with the current FFC cable strategy are:

* Based on NPg's planned strategy of replacing 16.75 km of FFC per annum the total cost to the business will be £8.13M per annum.

* The ongoing cost of repairing FFC cables, replacing fluid lost and environmental clean-up is £1.9M per annum for NPg alone.

Our Cost Benefit Analysis has indicated the project will deliver the following benefits with a project cost of £884,840 based on the cost of stage 4 and phase 2:

* Allow deferment of half of FFCs needing replaced by 5 years, beginning in 2019 which will provide a financial benefit = £2.61M over a period of 5 years.

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Our Cost Benefit Analysis has indicated the project will deliver the following benefits with a project cost of £884,840 based on the cost of stage 4 and phase 2:

* Allow deferment of half of FFCs needing replaced by 5 years, beginning in 2019 which will provide a financial benefit = £2.61M over a period of 5 years.

* Reduce the cost of repair to £9,600 per km and reduce the quantity of oil lost (and therefore environmental clean-up and oil replacement costs) by 50% providing a financial benefit = £4.34M over a period of 5 years.

The total length of FFCs across all GB Network Licensees is 8500km, Northern Powergrid have 1048km of these cables on the network so projecting the financial benefit of Northern Powergrid across all GB Network Licensees gives the following financial benefit:

(£6.95)x(8500km/1048km) = £56.37M

Please provide a calculation of the expected benefits the Solution

This is a laboratory demonstration. The results are scalable to the entire FFC network. A nominal 1km of such cable has been assessed to provide this calculation.

Base Cost (Replacement of 1km of FFC + average cable repair costs + environmental costs for 1km of leaking cable + average oil replacement costs) = £485,000 + £30,000 + £15,000 + £8,000 = £538,000

Method Cost (Replacement of 1km of FFC deferred by 5 years + Oil additive treatment cost + environmental costs for 1km of leaking cable + reduced average oil replacement costs) = £408,000 + £9,600 + £7,250 + £4,000 = £428,850

Financial Benefits = £109,150 per km of cable treated

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

The technology developed could be applied across all Network Licensees for use on their oil filled cable asset base. This is approximately 8500km across the entire GB network.

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

This remains a relatively low TRL development and final costs are not yet known although we have an initial target cost - subject to a great deal of further work of uncertain outcome. The cost of the service being developed is targetted to be under £9,600 per km of cable treated.

It is estimated that there are approximately 8,500 km of oil filled cable affected by cable leakage across all the GB Network Licensees, which means the GB rollout costs for additive treatment would be £81.6m assuming the technology is adopted as the sole solution to leakage problems.

There are 1,048km of oil filled cable on Northern Powergrid’s network, which means the rollout costs would be £10M assuming this technology is adopted in the same manner as Perflourocarbon Tracer (PFT) technology; where a proactive approach to treatment is being carried out on prioritized assets with a view to eventually treating all FFCs on the Network.

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 relevant Network Licensees will be able to use the learning generated as the outcomes will be relevant to each individual Network Licensee;

Specifically, all relevant Network Licensees operate fluid filled cables and as such could benefit from the development of a technology which could reduce maintenance and repair costs as well as increasing the lifespan of current cables and reducing environmental damage from cable leakage.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

n/a

☑ 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