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## NIA Project Registration and PEA Document

### Date of Submission

Sep 2015

### Project Reference Number

NIA\_UKPN0012

## Project Registration

### Project Title

Pressurised Cable Active Control and Monitoring

### Project Reference Number

NIA\_UKPN0012

### Project Licensee(s)

UK Power Networks

### Project Start

September 2015

### Project Duration

3 years and 7 months

### Nominated Project Contact(s)

Maxi Faridi

### Project Budget

£1,075,600.00

## Summary

This project will be applicable to all pressurised cables running at 33kV, 66kV and 132kV. For the purpose of the trial cables selected will be oil-filled and those that have a history of regular leaks.

### Nominated Contact Email Address(es)

innovation@ukpowernetworks.co.uk

## Problem Being Solved

Within UK Power Networks operating licence areas there are 2,409 km of pressurised EHV cables.

Within all GB DNOs there are approximately 6,607 km pressurised cables in operation at 132kV, 66kV and 33kV.

These cables were installed since the 1920s, with the majority being installed in the 1960s. As these cables age the likelihood of leaks increases. This can be in joints, ancillary equipment or along the cable itself, due to degradation of materials.

The current accepted best practise for stopping leaks on poor condition cable is to either carry out a repair on localised area (if practicable) or replace the full length of cable in that section as the whole section becomes unusable and needs to be changed). Often a localised repair is not possible due to the obsolescence of parts, or that the full cable length has degraded and cannot maintain a safe operating pressure.

To replace the cable it requires an operator to lay a new cable by open trench method, and then decommission the existing cable. This is a very costly process and makes up a significant part of the network maintenance programme.

By reducing the pressure of pressurised circuits leakage will be reduced, however all current methods of pressure reduction rely on making an assessment of the minimum required pressure based on historic design guidelines which used empirical data from the 1960s. This is because at the time of developing these recalculation methods technology limitations meant only alarm systems were

installed. No active control mechanism was installed to manage the cable pressure. The alarms are on/off signals sent via the pilot cable laid with the cable. These are triggered by an analogue dial based in the pit where oil is pumped. As the dial moves, it hits a contact and sends the alarm back through the pilot cable.

As fluid lost is a key indicator of asset health of pressurised cables, by actively reducing leakage from pressurised cables the asset life of these assets can be extended and as a consequence a reduction in network maintenance costs to the customer can be realised along with the associated environmental benefits. Therefore an active control mechanism for pressurised cables if proven could offer significant benefits.

## Method(s)

The project will develop a control strategy and system using technology to enable monitoring and active control of pressurised cable systems. The goal of this will be to enable the pressurised cable to run at a lower pressure, thus reducing leakage along its route.

It is anticipated the system will include:

- Pressure transducers
- GSM/Mobile communication systems
- Pressure reduction valves, actuated with remote control
- Locally based control modules
- Locally based meter to measure the oil or gas
- Additional fluid (oil or gas) storage to enable pressure increase or reduction.

Using the above technology the system will control the pressure to the minimum operating pressure to ensure leakage is reduced, and that there is less need for site visits to carry out oil or gas pumping. The projects primary focus and trial are on oil-filled cables, however it should be noted that the projects findings are applicable on gas filled cables.

## Scope

This project will be applicable to all pressurised cables running at 33kV, 66kV and 132kV.

For the purpose of the trial cables selected will be oil-filled and those that have a history of regular leaks.

## Objective(s)

The objective of this project will be to reduce leakage from pressurised cables, by operating oil-filled cables at lower pressure, to such an extent that their operational life can be extended. This will result in fewer pressurised cables requiring replacement and so a lower cost to the customer for the maintenance of the electricity network.

This will be done by developing and installing a system using equipment to actively reduce cable pressures to the minimum operating pressure at all times. Specifically there are five objectives within this project:

- Identify minimum operating conditions for pressurised cables (pressure, load, oil temperature, external temperature)
- Develop control strategy to identify required control and monitoring points
- Develop control system to be deployed on selected cable sections
- Implement control system
- Active control of cable pressures , leading to a reduction in leakage

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

## Success Criteria

The success of the project will be judged against the six objectives described above:

- Identify minimum operating conditions for pressurised cables
- Develop control strategy to identify required control and monitoring points
- Develop control system to be deployed on selected cable sections
- Implement control system
- Active control of cable pressures , leading to a reduction in leakage

- Improved Health Index through better management of fluid leakage and thus Health Index improvement on FFCs.

## Project Partners and External Funding

The project partner for the supply, installation and commissioning of monitoring systems will be selected through a competitive tender process.

## Potential for New Learning

Learning that will be shared with other DNOs is expected to include:

- An improved understanding of pressure monitoring and control techniques within pressurised cables;
- A method by which other DNOs can reduce leakage from their pressurised cables; and
- Identification of the potential of applying modern day technology to reducing leakage from pressurised cables.

Update November 2017-

Whilst preparing to start with the building and trialling of the rig, an alternative supplier with suitable expertise in fluid filled cable design was brought to the project's attention. This resulted in a further tender exercise, not originally included in the project scope, which introduced delays to the original project programme. The tender concluded in awarding the testing of the rig to Elmeridge Cable Services (ECS). This has led to financial savings, but introduced delays to the delivery of the project. To ensure that the full benefits from the project are realised, we have decided to extend the project to allow for laboratory and network tests of the developed active pressure control units.

Update July 2018

Since the update in November 2017, five single feed units have been installed on the network successfully and they have been monitoring for over three months. To date, no fault has been observed by the units installed on the network, which was unexpected and does not allow us to test all functionality of the unit. For this reason, it has been decided to extend the timescales of the project by additional eight months at no extra costs in order to:

- ensure that both load and season variations are captured through the network testing phase, and
- gather more data for analysis to establish the reliability of both single and twin feed units to be deployed into business as usual.

Monitoring both units (single and twin feed) for a longer period of time is paramount to understand if the technology works or fails under different circumstances.

## Scale of Project

Following the initial stages deployment of the new technology is planned for five cable routes.

Identification of these routes can only be made once the control system is developed, as this may impose specific site requirements on the types of cable that can be controlled. This may include low voltage power source, space requirements within oil pits and space requirements for the provision of additional fluid capacity.

## Technology Readiness at Start

TRL6 Large Scale

## Technology Readiness at End

TRL6 Large Scale

## Geographical Area

Specific routes will be selected following development of the active monitoring and control equipment. It is anticipated this equipment and control system may impose requirements on the site that may make routes chosen at this stage unfeasible. The requirements will be related to leakage of cables, criticality of the circuit, LV supply availability, available space in pits along route and GSM signal.

Routes will consist of fluid filled cables operating at 33kV 66kV and 132kV.

## Revenue Allowed for the RIIO Settlement

There is no allowance in the RIIO-ED1 settlement for pressure reduction of fluid filled cables.

## Indicative Total NIA Project Expenditure

£1,075,600 is the total expenditure which we expect will be incurred during the duration of the project.

## 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)

By reducing the leakage rate of pressurised cables, the health index of these cables would be improved without the need to replace the cables in the short term. This would mean enhanced asset lives and a lower level of intervention of asset replacement being needed, leading to a customer benefit.

In UK Power Networks business plan there is £120.1m investment programmed in RIIO-ED1 for the replacement of fluid filled cables, this project aims to realise 20% savings.

When considering a full scale deployment, it is estimated that the annual savings from realising 20% efficiency would be on average £5m over 2016 to 2023. However this can only be confirmed after trials are completed.

Update July 2018

Please note that given the new project completion date, the expected benefits will not be materialised until project closure in 2019.

#### Please provide a calculation of the expected benefits the Solution

**Base Cost: £ 9.36m**

Based on assuming that:

- the cost for replacing 1km of 132kV FFC is £1.3m
- assuming 600m for a section on each circuit where the trial is looking at 12 sections => 7.2km of 132kV cable length
- therefore, giving £9.36m.

**Method Cost: £ 0.785m**

Cost of deploying the solution of same scale but not taking into consideration the project management, procurement and internal cost of UK Power Networks.

**Financial Benefits: £8.58m**

Benefits are taken from replacing the costly replacement of 7.2km of 132kV FFC and instead deploying a more cost-efficient control

system for cable pressure management that avoids in the short term, capital expenditure of £8.85m.

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

Most DNOs within Great Britain operate pressurised cable networks at EHV or above. This process would be replicable to all DNOs who operate this type of cable.

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

Based on the following assumptions, it is estimated that the cost of rolling out to GB would be approximately £4.71m:

- target five of DNOs top 10 leaking routes and that each of those are operating at high pressure and can be targeted for active control of cable pressures leading to the reduction on fluid leakage
- as this project aims to address 5 of UK Power Networks Top 10 leaking routes at £0.785k rolling out to the 6 licensee groups, we simply multiply £0.785 by six
- therefore, the cost of rollout may be £4.71m.

### **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**

If successful, the learning could be used by relevant network licensees to reduce pressurised 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.**

No current NIA project is planning to actively control the pressure of pressurised circuits operating at 33kV, 66kV or 132kV.

### **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