

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

May 2015

Project Reference Number

NIA_UKPN0005

Project Registration

Project Title

Better Spur Protection

Project Reference Number

NIA_UKPN0005

Project Licensee(s)

UK Power Networks

Project Start

April 2014

Project Duration

3 years and 7 months

Nominated Project Contact(s)

Jordi Ros & Matthew Corbridge

Project Budget

£492,000.00

Summary

EPN Analysis

In EPN there far fewer ASLs installed than in SPN. Therefore there is an opportunity to install the Fuse Savers on a “clean” feeder that does not have reclosers and ASLs on it already. Through the process described above a particular feeder was identified.

Feeder Shepherd and Dog T off Langham Primary suffered 26 faults last year and 12 short interruptions. 74% of CIs and 90% of CMLs on the feeder were caused by wind & gale, lightning, and trees. The feeder also has 14 spurs with 404 customers on these spurs. The feeder has 1161 customers in total. Last year the feeder had 0.16 CIs and 0.56 CMLs. The feeder has a total of 35km of overhead line. 18km (52%) of the feeder’s overhead line is on spurs.

The feeder also has 147 worst served customers and currently there are no ASLs on the entire feeder.

SPN Analysis

SPN already has a high penetration of ASLs on the network which have been installed over many years. The trial objective here is to install Fuse Savers in a “busy” environment to see how the devices perform alongside a number of different types of reclosers and several ASLs. It is also important to see if the devices can operate in an identical fashion to the existing ASL as well how the devices grade with the existing protection schemes on the feeders.

In SPN, Cranleigh Primary has been selected to implement a number of Fuse Savers in a variety of conditions. Placing Fuse Savers on more than one feeder on one primary, to see how the Fuse Savers work with ASLs and reclosers and the device performs on two phase spurs.

Cranleigh Primary currently has 4 feeders in the worst 20 performing feeders. The primary also has 177 worst served customers. The primary also had 134 short interruptions in the last 5 years (3rd worst in SPN) and 216 faults (2nd worst in SPN) in the last 5 years.

The trial on Cranleigh Primary will be to replace 18 ASLs due for replacement on several feeders off Cranleigh Primary. The benefit of

the process is to test whether the devices can fit where ASLs have been installed and therefore be a like-for-like replacement. The customer benefit of installing the Fuse Saver is that the customers on the feeder will retain the current level of protection but without the irritation of short interruptions that occur due to reclosers operating to activate the ASL.

Cranleigh Primary currently has 4 feeders in the worst 20 performing feeders. The primary also has 177 worst served customers. The primary also had 134 short interruptions in the last 5 years (3rd worst in SPN) and 216 faults (2nd worst in SPN) in the last 5 years.

The trial on Cranleigh Primary will be to replace 18 ASLs due for replacement on several feeders off Cranleigh Primary. The benefit of the process is to test whether the devices can fit where ASLs have been installed and therefore be a like-for-like replacement. The customer benefit of installing the Fuse Saver is that the customers on the feeder will retain the current level of protection but without the irritation of short interruptions that occur due to reclosers operating to activate the ASL.

Nominated Contact Email Address(es)

innovation@ukpowernetworks.co.uk

Problem Being Solved

The Better Spur Protection project was previously an IFl funded project that is now transitioning into a NIA project.

Historically many rural customers are supplied via overhead line spurs from the overhead main line. This is a cost effective connection solution but increases the outage risk to rest of the overhead main line. In order to mitigate this risk many auto-sectionalising links (ASLs) have been installed on spurs in conjunctions with an auto-recloser on the main line. The ASLs allow the auto-recloser to protect against transient faults, but should there be a permanent fault on the spur then the ASL will drop out in the second deadtime of the auto-recloser.

Every time an ASL drops out then the actuator needs to be replaced and re-inserted after the fault has been identified and repaired. This requires a linesman to go to the ASL location which could be some distance from the fault, in order to restore power to those customers downstream. For safety reasons the actuator cannot just be re-inserted in case the fault still exists. ASLs are not rated to fault-make. Therefore an aerial break switch disconnecter (ABSD) or a vacuum circuit breaker will need to be opened upstream. The impact of this is additional switching and if the switch is not adjacent to the ASL then more customers may have to experience a temporary outage in order to restore the spur.

A solution to this would be to have a reclosable spur switch that can be remotely controlled.

The Fuse Saver is an in-line per phase vacuum breaker which can make or break under fault conditions. It does this within a half-cycle to protect the phase fuse. Should the fault be permanent in nature then the expulsion fuse will drop out. Fuse Savers have the ability of opening and closing remotely, monitoring the current on the spur, recording the magnitude of the fault within the fault event history, a range of definable protection settings, device battery life and vacuum interrupter life.

Currently the Fuse Savers have been used in a number of different countries but not yet in the UK. The proposal of this device is that not only does it provide greater protection for customers per phase on the spur but it also reduces the risk of the spur to the main overhead line. Initial indication show that the Fuse Savers have lower operational costs and potentially the overall installation cost of the device is cheaper than the current solution which is ASLs that need to be installed with ABSDs.

The monitoring functionality will be a crucial development in moving towards operating a smarter and more automated network. UK Power Networks' pole-mounted transformers currently do not have a monitoring capability but by installing these devices on spurs it will be possible to have a better understanding of the load and generation demands on rural networks.

Method(s)

Demonstration Identification of Trial Sites

The business has identified "At Risk" overhead lines and spurs as part of the business as usual quality of supply process. This process has provided the best test cases for the trial.

From the review of auto-sectionalising links, the key sites were identified for Fuse Saver deployment.

Spur Risk Identification Process

A script has been developed to trace down each feeder recording every overhead line spur off the mainline. From each of these

overhead lines spur points the script then traces the rest of the spur: identifying if there are ASLs, counting the number of customers either side of the ASL and measuring the length of the overhead line and underground cable either side of the ASL. If there are no ASLs on the spurs the script returns the number of customers and the length of overhead line and underground cable.

The script finally produces a list of spur with the above characteristics for every feeder. Using historical data to find the fault rate, average CI and CML for overhead lines and underground cables in the locality of feeder, it is possible to discover the impact spurs have on the main feeder. Then by applying a ratio of spur length to feeder length it is possible to rank the spurs by order of impact.

By removing the spurs that already have ASLs fitted, it is possible to achieve a shortlist of spurs for intervention. This approach is then compared to the results of the Worst Performing Circuit in order to validate and calibrate the results. The Worst Performing Circuit process is an annual review conducted by Asset Management which ranks feeders by the number of faults and the financial impact of CIs and CMLs. The thresholds vary for each DNO depending on the target number of faults and outage duration.

Test RTU and Fuse Saver Compatibility

It will be necessary to test that the Fuse Saver in the Operation Telecommunications Labs to ensure that the RTU can communicate with the three Fuse Saver vacuum interrupters and collect all of the necessary information. It will be important that this information can then be communicated back to the control system so that the devices can demonstrate the open/close functionality and that it is possible to record the current measurements. It is intended that two Fuse Saver devices will be withheld from the initial installation programme to facilitate the training of staff in the installation, commissioning and operation of the devices.

Installation of RTU and Fuse Saver

After passing the compatibility test the devices will need to be installed and commissioned in multiple sites. Each site will require the necessary design and safety planning.

Coordination within existing feeder protection schemes

Once the devices have been installed it will be necessary for a protection engineer to commission the protection settings to coincide with the existing circuits protection settings to ensure effective and safe device operation.

Assessment of project

Once the devices have been installed it will be necessary to test the following:

- Communication capability with the control system
- Operation under fault condition (simulate if necessary)
 - Phase to Phase transient
 - Phase to Earth transient
 - Phase to Phase permanent
 - Phase to Earth permanent
- Storage of current measurements

By installing these devices over a broad area with high fault rates, this will provide real fault operations as evidence of how the Fuse Savers are working.

Scope

EPN Analysis

In EPN there far fewer ASLs installed than in SPN. Therefore there is an opportunity to install the Fuse Savers on a “clean” feeder that does not have reclosers and ASLs on it already. Through the process described above a particular feeder was identified.

Feeder Shepherd and Dog T off Langham Primary suffered 26 faults last year and 12 short interruptions. 74% of CIs and 90% of CMLs on the feeder were caused by wind & gale, lightning, and trees. The feeder also has 14 spurs with 404 customers on these spurs. The feeder has 1161 customers in total. Last year the feeder had 0.16 CIs and 0.56 CMLs. The feeder has a total of 35km of overhead line. 18km (52%) of the feeder’s overhead line is on spurs.

The feeder also has 147 worst served customers and currently there are no ASLs on the entire feeder.

There are 7 spurs of note:

- Holly Lodge Spur: 1.642km
- Brook Fm Spur: 3.567km
- Creaks Grove Spur: 2.313km
- Garnons Reservoir: 2.158km
- Spring Cott Spur: 2.909km
- Worningford Village Spur: 1.960km
- Peartree Cotts Spur: 3.605km

SPN Analysis

SPN already has a high penetration of ASLs on the network which have been installed over many years. The trial objective here is to install Fuse Savers in a “busy” environment to see how the devices perform alongside a number of different types of reclosers and several ASLs. It is also important to see if the devices can operate in an identical fashion to the existing ASL as well how the devices grade with the existing protection schemes on the feeders.

In SPN, Cranleigh Primary has been selected to implement a number of Fuse Savers in a variety of conditions. Placing Fuse Savers on more than one feeder on one primary, to see how the Fuse Savers work with ASLs and reclosers and the device performs on two phase spurs.

Cranleigh Primary currently has 4 feeders in the worst 20 performing feeders. The primary also has 177 worst served customers. The primary also had 134 short interruptions in the last 5 years (3rd worst in SPN) and 216 faults (2nd worst in SPN) in the last 5 years.

The trial on Cranleigh Primary will be to replace 18 ASLs due for replacement on several feeders off Cranleigh Primary. The benefit of the process is to test whether the devices can fit where ASLs have been installed and therefore be a like-for-like replacement. The customer benefit of installing the Fuse Saver is that the customers on the feeder will retain the current level of protection but without the irritation of short interruptions that occur due to reclosers operating to activate the ASL.

Cranleigh Primary currently has 4 feeders in the worst 20 performing feeders. The primary also has 177 worst served customers. The primary also had 134 short interruptions in the last 5 years (3rd worst in SPN) and 216 faults (2nd worst in SPN) in the last 5 years.

The trial on Cranleigh Primary will be to replace 18 ASLs due for replacement on several feeders off Cranleigh Primary. The benefit of the process is to test whether the devices can fit where ASLs have been installed and therefore be a like-for-like replacement. The customer benefit of installing the Fuse Saver is that the customers on the feeder will retain the current level of protection but without the irritation of short interruptions that occur due to reclosers operating to activate the ASL.

October 2016 Update

During the course of investigating and testing the device on the test RIG constructed at Nelson St, London, it came to light that it would be possible to modify the device in order to increase the overall benefit of the device. The device typically operates in conjunction with a fuse. The device will see the fault current and open. After a defined time it will then close. This is done in order to clear a transient fault. Should the fault be permanent then the fuse will clear the fault from the network. The Fusesaver is configured to grade with the fuse during installation. A proposal was put to Siemens that if the defined time was extended beyond the capacitor recharge time, it would then be possible for the device to open a second time. This functionality enables the device to be a single shot recloser and removes the need to install a fuse on site. The benefit of this is a reduction in consumable cost and man-time for replacing fuses.

Siemens took the suggestion onboard and at their own cost, adding the enhancements and then re-testing the new version of the device. UK Power Networks took receipt of device in February 2016.

A number of difficulties arose in re-integrating the new device into the control system using the previous symbol. In order to accommodate the new functionality, the symbol required a composite symbol. The symbol needed to reflect the three phase elements as well as the wireless consideration which is a completely new symbol methodology for the UK Power Networks control system.

UK Power Networks will test the new device at the Power Network Demonstration Centre (PNDC) in Cumbernauld in November 2016, in order to synthesize the results needed to test the devices' performance and review how the devices integrate with the

control system. Once the SCADA has been integrated with the control system, the device (with the new functionality) will be taken up to the PNDC in order to test the device's new functionality and prove integration with the SCADA system under live testing. With the SCADA proved, the sites that have been installed will have their remote terminal units commissioned.

In the event of no faults occurring on the network, the test results will be used to assess the effectiveness of the device on the overall network.

The extension of the project will allow for the completion of the remaining SCADA installations, project documentation, a new training video and new training to the teams involved who will be installing the devices in a business as usual element. A final cost is the proposal and adoption of the device by the ENA.

April 2017 Update

Due to complications in testing at the PNDC which added several months delay to the project and internal staff movements, the work above is still outstanding and requires a further 6 months to complete.

Objective(s)

- Prove device works as expected
- Prove device is compatible with the UK Power Networks SCADA system
- Prove device can be safely installed by HV Live Line teams
- Prove Wi-Fi security
- Prove device works in the same manner as an ASL

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The successful demonstration that the Fuse Saver can operate in a superior fashion to ASLs, and provide greater information regarding normal and fault conditions on the spur.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

Because the product is relatively mature UK Power Networks has decided on two small but targeted trials. The first trial is in EPN on Shepherd and Dog T feeder off Langham Primary. This feeder itself has 35km of overhead line. 16km of this length is on spurs. None of the spurs have ASLs. This is a "clean" and an excellent case study to trial the devices.

The second trial is in SPN where there is a high penetration of ASLs and auto-reclosers. This provides an example of installing the devices in a multitude of different arrangements such that UK Power Networks can learn about the various interactions. SPN's overhead line also has a number of spurs off spurs and this provides the opportunity of testing the Fuse Savers in series.

Technology Readiness at Start

TRL7 Inactive Commissioning

Technology Readiness at End

TRL9 Operations

Geographical Area

The trials will involve the installation of 7 Fuse Savers in EPN (Shepherd and Dog T feeder off Langham Primary) and 18 Fuse Savers in SPN (Cranleigh Primary).

Revenue Allowed for the RIIO Settlement

In the UK Power Networks business plan for ED1 there is already money set aside, across EPN and SPN, to spend on improving overhead line performance. One of the options to mitigate faulting overhead spurs is to use auto-sectionalizing links and the Fuse Saver could be a more cost effective means of doing so, thus saving the customer money.

Indicative Total NIA Project Expenditure

£244,371

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 savings associated with the solution depends on whether Automatic Sectionalising links (ASLs) are already installed:

- If fuse savers are installed on clean feeders, there are savings associated with reduced C/CMLs.
- If fuse savers are installed as replacements to existing ASLs, the savings are associated with reduced maintenance costs.

The benefits associated with the 7 EPN sites (without ASLs) and 18 SPN sites (with ASLs) could provide approximate benefits of £70k/year.

When considering a full scale deployment, it is estimated that the benefits could be in excess of £1m/year. However this can only be confirmed after further sites are identified and the trials are completed.

Please provide a calculation of the expected benefits the Solution

Base Cost: £46,069

Based on the assumption that a yearly base cost of approx. £7,700 is required for the maintenance of existing 18 ASL sites in SPN (including the replacement of fuses).

Method Cost: £297,694

Cost of deploying the solution and taking into consideration the ongoing running cost (e.g. communications) which is estimated to be £5k per year for all the sites included within the project.

Benefits: £368,314 NPV of the CML/CI benefits over the RIIO ED1 period to 2022/23.

Financial Benefits: £116,689 Base cost – (Method cost – Benefits)

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

Network design philosophy will have a significant impact on how other DNOs might manage faulting spurs and each area will have their own approach depending on the number of customers and current protection arrangements.

Based on the number of suitable sites per km in UK Power Networks, it is estimated that this technology could be deployed at 23,080 sites across GB.

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 £27m:

- The cost of deploying the solution at 25 sites will cost approx. £280k.
- 15% of the 23,080 sites would be equipped with fuse savers in order to target the worst performing feeders.
- A volume price reduction for the fuse saver would be achieved.

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

The project will be applicable to all overhead networks that contain spurs with no or minimum further development required.

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