Date of Submission

May 2021

Network Innovation Allowance Closedown Report

Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form.

Network Licensees must publish the required Project Progress information on the Smarter Networks Portal by 31st July 2014 and each year thereafter. The Network Licensee(s) must publish Project Progress information for each NIA Project that has developed new learning in the preceding relevant year.

Project Progress

Project Title

Fault Passage Indicators for Sensitive Earth Faults

Project Reference

NIA_SSEPD_0023

Funding Licensee(s)

Scottish Hydro Electric Power Distribution

Project Start Date

December 2015

Project Duration

2 years and 3 months

Nominated Project Contact(s)

SSEN Future Networks Team

Scope

To establish the magnitude of reduction in Customer Minutes Lost (CMLs) achievable by locating SEF faults with a revised FPI supplied by Bowden Brothers and modified to be sensitive to currents as low as 4A through tests at PNDC, field trials and a post-trial evaluation.

Objectives(s)

1. Determine, from testing, that the revised FPIs successfully meet the required standard
2. Train operational staff in the correct use of the revised FPIs
3. Perform a field trial with trained operational staff
4. Monitor and evaluate the reduction in customer hours lost per Customer affected by an SEF fault in the trial area when compared to previous years.

Success Criteria

This project will be successful if we are able to determine the ability of the revised FPI to reduce CMLs due to SEF faults.

Performance Compared to the Original Project Aims, Objectives and Success Criteria

Project Aims
The project aimed to address a limitation with conventional portable fault passage indicators (FPIs). A portable FPI is a useful tool for improving the speed by which the exact location of a permanent fault can be identified on an overhead line at 11,000 or 33,000 volts.It does this by giving an indication of the faulty section of the line with reference to an overhead line structure on which the FPI is attached during fault sectionalisation. By using several such FPIs at different points on the line simultaneously, the faulty section of the line can be quickly narrowed down thereby leaving the shortest possible section on which to physically patrol, if need be.
A high number of faults on the overhead network are line to ground, or earth faults. Such faults involve a short circuit or unintended contact between a live conductor and a part of the system that is bonded to earth. This creates a low impedance path which results in the flow of a large current from the supply thereby operating the protection of the line and taking the circuit out of service. However, not all earth faults result in this draw of a large current from the system.For instance, if a conductor breaks and falls on the ground, the high ground resistance may result in a very small magnitude of current drawing from the source. As this presents a hazardous situation if the conductor remains energized longer than absolutely necessary, a form of protection called Sensitive Earth Fault (SEF) protection which is designed to operate for very low magnitudes of earth fault current is implemented.The generation of FPIs that existed prior to this project could not detect such faults. If an SEF existed in that case, successful sectionalisation would involve multiple operations of downstream switches and reclosing of the circuit from the point at which the SEF is monitored. This would cause an unnecessarily high number of interruptions on customers on the healthy parts of the network situated between the SEF monitoring location and the downstream switches.To reduce the number and the duration of supply interruptions,a modified version of the FPIs with the ability to detect the passage of sensitive earth faults as low as 4A was trialled in this project. The following section details the work which has been done to meet the objectives and the success criteria of the project.
Objective 1 –Determine, from testing, that the revised FPIs successfully meet the required standard
Testing has been carried out at the Power Networks Demonstration Centre and the device successfully flagged for 100% of SEF faults at 4A over a range of times from 3 seconds to 10 seconds. This objective has been met in full
Objective 2 –Train operational staff in the correct use of the revised FPIs
Training was carried out in April 2016 at 6 locations across the Highland Region of SHEPD.70 sets of FPIs were subsequently issued to linespersons and rapid response teams. Each operational staff member received three of the new SEF FPIs. 2 sets were retained by the project team for testing purposes. This objective has been met in full.
Objective 3 –Perform a field trial with operational staff
The units have now been in use in Highland area since April 2016. A further 72 sets of FPIs were issued out to staff when the trial FPI was modified to include both the normal fault and SEF detection capabilities. After a field trial a series of meetings with operational staff were held to obtain feedback on ease of use and assessment of the improvements observed. The feedback from these sessions formed part of the analysis used to derive conclusions from the project.This objective has been met in full.
Objective 4 -Monitor and evaluate the reduction in customer hours lost per Customer affected by an SEF fault in the trial area when compared to previous years
Analysis and review of SEF faults has shown an overall reduction in Customer Interruptions (CI) and Customer Minutes Lost (CML)for these faults.The analysis showed that one fault prior to use of the SEF FPIs and one fault post the introduction had each contributed more than 50% of the total CML and CI costs within the recording period. Comparison of the CMLs before FPI implementation and after showed that there was an average reduction of just under 37 minutes per CI. The conclusions from the analysis have informed recommendations made for business as usual conversion of the technology. This objective has been fully met.
Success Criteria -This project will be successful if we are able to determine the ability of the revised FPI to reduce CMLs due to SEF faults
As stated in the foregoing section, based on the comparison of typical CMLs of like for like faults before SEF FPIs trial and after, it has been shown that use of the FPIs has led to reductions in CMLs. Based on the trial sample, an average reduction of approximately 37 minutes per CI was observed.The project is therefore deemed to have met its success criteria fully. However, analysis will continue in business as usual to try and refine the quantification of the benefits from continued use of the devices. This is because there is still a need to better understand the extent of the impact of variables such as weather conditions and ease of fault finding in aiding FPI implementation to produce the observed or potentially further reduction in CMLs. Such understanding is likely to arise from use of the devices on the network over a longer period and varying conditions than were possible under the limited duration of the NIA project.

Required Modifications to the Planned Approach During the Course of the Project

Technically, the new FPIs with SEF were a big advantage over the previous versions. However, from an operational point of view there were some problems with knowing whether to set up units for SEF faults or for normal faults. This was provisionally resolved by fitting both an SEF and a normal FPI on the same pole. Although technically feasible, this approach was not very efficient.The FPI supplier subsequently devised a better solution which culminated in the integration of both SEF detection and normal fault detection into the same unit. The retrospective launch of the new, mark 9B version of the FPI, necessitated further evaluation to ensure that the revised device still performed as envisaged and as already observed on the preceding version. The project duration was therefore extended to two years and three months to allow the foregoing evaluation. 72 sets of the mark 9B version were therefore procured and issued to operational staff to replace the initial batch of the mark 9 version. The project conclusions were reached after successful trial in the field of the mark 9B FPI and subsequent analysis.

Lessons Learnt for Future Projects

The unforeseen need to revisit the design of the FPI confirms the importance of field trials for technologies required for operational environments. While the concept of the SEF detection was proven early in the project, the practical aspect of how to optimally make use of the FPI where a potential conflict existed between a normal fault and an SEF fault raised an issue that had not been anticipated. A dynamic approach to reviewing learning from the project helped in the identification of the problem and eventually, a solution. Projects should therefore be flexible enough to allow design improvements during project execution subject to the business case of the proposed changes. In addition, this reinforces how great care should be exercised in reaching the scale of trial activities. Based on the foregoing learning, similar projects should consider limiting the number of trial devices at the early stages to cater for potential iterative development processes.

Note: The following sections are only required for those projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

The project has successfully evaluated an FPI with SEF detection capability. Subsequently, it has led to the development of a new FPI version with the combined functions of normal fault detection and SEF detection. The aforesaid technologies were means to the ultimate end of reducing CI/CMLs on HV faults on the overhead network. At project registration, SEF faults accounted for 6% of the faults on the SHEPD network, yet they were responsible for approximately 11.8% of the CIs and 8.3 of the Customer Hours Lost (CHLs).
The preliminary tests performed at the PNDC proved the concept of SEF detection on FPIs and also that the devices performed in line with the technical specification. The project trained operational staff in SHEPD to use the device and as a result, 70 sets of FPIs (with three units per set) could be issued out for use on real faults. For SHEPD, the training already provided will expedite the conversion of the project outputs to business as usual. The results of the field trial provided data which enable devaluation of the project aims to establish if these FPIs were a viable way of reducing CI/CMLs.
Based on the data from the trial, and comparison of this data with that from previous years, this project produced a conclusion that use of the FPIs with SEF detection is a viable way of reducing CMLs. On this trial, the average reduction was approximately 37 minutes per CI. This outcome resulted in recommendations being made to roll out the devices to operational staff who respond to high voltage overhead line faults at 11kV and 33kV. A business case paper has subsequently been produced making these recommendations to the stakeholders responsible for assessing and approving business as usual investment in SSEN.

Data Access

N/A

Foreground IPR

N/A

Planned Implementation

It hasbeen recommended that the project outcomes are adopted into business as usual. A paper to demonstrate the business case and outline the required process changes has been drafted and is currently undergoing stakeholder review. If the board responsible for investment decisions approves the business as usual adoption of this project's outputs, it is expected that the rollout of the outputs will be implemented commencing within the 2018/19 financial year.

Other Comments

In addition to this report, this project has produced further learning material such as detailed reports of tests during proof of concept. If needed, such material can be availed on request via an email to futurenetworks@sse.com.

Standards Documents

The learning from this project has no implication on standards.