



The future

NIA Progress Report

NIA_ENWL007

Reliable, low cost earth fault detection for radial OHL systems

22 July 2016



VERSION HISTORY

Version	Date	Author	Status	Comments
v.1.0	20/07/2016	D Harber	Final	Final version following internal review and comment

REVIEW

Name	Role	Date
A Howard	Programme Manager	21/07/2016
D Randles	Network Performance and Innovation Manager	21/07/2016
P Turner	Future Networks Delivery Manager	21/07/2016

APPROVAL

Name	Role	Date
Steve Cox	Head of Network Engineering	22/07/2016

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1 PROJECT BASICS

Project Title	Reliable, low-cost earth fault detection for radial OHL systems
Project Reference	NIA_ENWL007
Funding Licensee(s)	Electricity North West Limited
Project Start Date	October 2015
Project Duration	2 years
Nominated Project Contact(s)	Daniel Harber (daniel.harber@enwl.co.uk)

2 SCOPE

Prototype overhead line fault passage indicator (FPI) equipment will be installed at approximately ten sites. Locations will be selected based on a range of factors including performance. The circuit selection will also consider the number of customers, the overall length of overhead line associated with the feeder and considerations towards straightforward installation. Monitoring equipment will need to be installed at the selected sites to gather data to support development of the required algorithms. The FPIs will be integrated via a DNP3 interface into Electricity North West's existing network management system and will be monitored via Nortech's iHost system.

3 OBJECTIVES

- To reduce the time taken to locate faults on rural OHL networks
- To develop a method for reliable detection of earth fault and over-current on OHL networks
- Install overhead line FPIs for over-current and earth fault detection using live line techniques
- Develop a method of overhead line FPI installation with minimal commissioning and set-up and without need for shutdown (including location methodology and installation method statement)
- Understand the impact of overhead line FPIs on a DNO's ability to locate faults more quickly and restore supplies to customers more efficiently.

4 SUCCESS CRITERIA

- Development of a technical engineering specification for overhead line FPIs
- Installation and test procedures for overhead line FPIs
- Communication to central system (iHost) with NMS compatibility via SCADA
- Validation of overhead line FPI performance (reliable communications, earth fault detection, over-current detection).

5 PERFORMANCE COMPARED TO THE ORIGINAL PROJECT AIMS, OBJECTIVES AND SUCCESS CRITERIA

The project is on track to meet its original objectives, reducing the time taken to locate faults on rural OHL networks.

The method for reliably detecting earth faults and over-current faults has been specified and is being implemented within three clip-on-the-line sensors (one for each phase of the system). The detection method incorporates voltage measurements, as well as current measurements, for confirming fault conditions. This allows the OHL FPI to differentiate between network switching activities and fault conditions. As a first practical step in the project, a number of voltage measurement devices were installed within Electricity North West's network, confirming whether or not line energisation and de-energisation can be detected without the need for earthing the FPI. Early indications suggest the method is feasible but is sensitive to environmental conditions (such as rainfall and humidity) local to the overhead line. This step has significantly increased the chance of project success and overcomes the limitations of other manufacturers' OHL FPI products.

As part of the voltage measurement trial, the units were installed using Electricity North West approved live line techniques.

The method for OHL FPI installations is currently in development and is being designed to minimise on-site set-up and commissioning requirements. The OHL FPI devices will be self-powered, designing out the need for power supplies from pole-mounted transformers. In addition, the installation using live line techniques avoids the need for network shutdowns as part of the commissioning process.

Following installation of several OHL FPI devices later this year, Electricity North West will be in a position to start quantifying the benefits of locating faults more quickly and restoring supplies to customers more efficiently.

The development of a functional requirements specification for overhead line FPIs was completed during the first six months of the project. This will form the basis of the technical engineering specification, which will be finalised after the FPI devices have been trialled.

The functional requirements specification covers the following:

- Network and operational environment requirements (such as the rated installation voltage, withstand voltage, ingress protection rating and operating temperature range)
- Fault current detection requirements (including earth faults and over-current faults)
- Power supply and communications requirements
- Mounting, installation and maintenance requirements
- Design lifetime and availability.

Performance against the other success criteria will be assessed at a later stage in the project.

6 REQUIRED MODIFICATIONS TO THE PLANNED APPROACH DURING THE COURSE OF THE PROJECT

At this stage in the project there have been no required modifications to the planned approach.

7 LESSONS LEARNT FOR FUTURE PROJECTS

Overhead line clamping mechanism

During the installation of the voltage measurement devices, it was observed that an alternative vendor's OHL FPI products had travelled down the overhead line (about ten metres away from their original installation position).

It is recommended that any clip-on-the-line type sensors are secured in place on the line using DNO approved techniques (such as rubber bundling). As part of factory acceptance testing, vendors should prove that OHL FPI devices can be securely attached to the line without any damage to the conductor through over-tightening.

Line voltage detection

For a set of controlled switching conditions, this project has demonstrated a technique for voltage presence detection on 6.6kV and 11kV overhead lines without the need for monitoring device earthing. This has the potential to overcome limitations with previous OHL FPI devices.

8 THE OUTCOMES OF THE PROJECT

Not applicable.

9 PLANNED IMPLEMENTATION

Not applicable.

10 OTHER COMMENTS

Not applicable.

11 APPENDIX

This appendix detail is additional to the information provided on the Smarter Network Portal.

As part of the voltage measurement trial, the units were installed using Electricity North West approved live line techniques, as illustrated in Figure 1.1. The same techniques will be used for installing the OHL FPI devices.

Figure 1.1: Electricity North West lines team installing a voltage measurement device using live line techniques



Figure 1.2 shows the historical switching record from Electricity North West’s CRMS. Figure 1.3 shows the voltage presence detection events, which were measured independently using a line-mounted voltage detection sensor. Without affecting customers, the line was energised and de-energised for three periods of ten minutes followed by three periods of one minute. The voltage measurement device consistently reported the change in line energisation status to within two seconds accuracy ie the latency of wireless communications from the site to Nortech’s iHost system (a web-based monitoring platform).

Figure 1.2: Network switching log from Electricity North West’s CRMS

Type	Cat	Cat	Time / Date	Region	Description	KV	State
I	C	1	12:15:57.330 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Closed
I	J	1	12:09:04.955 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Opened
I	C	1	11:28:53.199 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	DBI
I	C	1	11:25:17.497 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Opened
I	C	1	11:24:10.366 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Closed
I	J	1	11:23:15.799 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Opened
I	C	1	11:22:26.128 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Closed
I	J	1	11:21:26.639 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Opened
I	C	1	11:19:54.760 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Closed
I	C	1	11:12:35.292 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Opened
I	C	1	11:02:23.831 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Closed
I	C	1	10:51:59.271 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Opened
I	C	1	10:41:02.928 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Closed
I	C	1	10:31:16.684 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Opened
I	C	1	10:19:25.550 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Closed
I	J	1	10:10:57.186 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Opened
I	C	0	09:28:03.865 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	DBI
I	C	0	09:23:25.872 04-MAY-16	West Lancashire	ST PETER & ST PAULS SALT PIT LN O.D. SF6 SWITCH 2 RMU""A""	11	Opened

Figure 1.3: Voltage measurements from an independent device mounted on the overhead line

