Date of Submission

July 2014

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 Closedown

Project Title	Project Reference
Alternative Differential Unit Protection for Cable only and Cable & OHL hybrid installations	NIA_NGET0072

Project Licensee(s)	Project Start Date	Project Duration
National Grid Electricity Transmission	Jan 2012	2 Years

Nominated Project Contact(s)

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Scope

This R&D Project aims :

- To evaluate the practicability, reliability and benefits of implementing alternative non conventional current sensors (i.e. Rogowski coil) based differential unit protection for Cable systems (i.e. Cable only and Cable & OHL hybrid installations) over conventional Current Transformer (CT) based protection. To carry out the preliminary evaluation a pilot installation is recommended on Pitsmoor-Wincobank cable circuit on April 2012 as monitoring unit.
- To determine the systems suitability to be utilised as Emergency Return to Service (ERTS) system.

  This will help to formulate a technical and operational knowledge base for Non Conventional Instrument Transformer (NCIT) protection systems which could lead to evaluation of future technical and procurement strategy to deploy as replacement and/or new Cable system protection.

Objective(s)

To report on the practicalities reliability and potential benefits of implementing alternative non conventional current sensors.

Success Criteria

To identify potential of implementing non conventional current sensors across the transmission network.

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

The novel protection solution using Rogowski coils and one multi-function relay at each end of the protected cable to perform cable differential protection was installed in May 2012. The relays communicate over the existing Synchronous Digital Hierarchy (SDH) network. The SDH network enables relays to exchange current phasor information to determine if a fault is on the cable (In-Zone) or is somewhere else in the power system (Out-of-Zone). This also enables remote access to the relays for performing setting changes, event file upload, and other relay observations. The differential protection system uses the GOOSE messaging system over Ethernet.

Since the project implementation several Out-of-Zone events occurred and the protection system performed reliably, providing high security of the scheme. As of now, no In-Zone events occurred. However, manually triggered event records have been collected periodically to analyze the scheme performance and the level of differential currents during normal operating conditions, confirming that the system operates well balanced. The relays are also programmed to acquire statistics about the system availability during operation. Satisfactory high availability of communication performance was confirmed.

The main conclusions about the protection system performance:

1. The protection system operates well balanced. No mal-operation occurred since the system installation.

2. The scheme preserved security for all through-fault (Out-of-Zone) events and switching operations

3. Communication availability was high, in the order of 99.99%

4. Because of these balanced conditions, the scheme settings of operate currents may be reduced from the existing 1000 A to 500 A to provide more sensitive operation.

In respect to ERST support, the RC based protection scheme identified a potential for Cable systems and deployment of the protection will reduce commissioning timescale. However, further investigation is required for ERTS support where high impedance based Bus bar protection is utilised.

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

There were no modifications to the planned approach.

Lessons Learnt for Future Projects

Benefits of using Rogowski coil-based protection systems:

1. Rogowski coils are high-precision, compact, light-weight, and robust sensors.
2. The same Rogowski coil can measure currents from several amps to over 100 kilo-amps.
3. Traditional cable differential protection was not feasible since the limited space restricted the installation of CTs.
4. Installation of the system required no changes in the existing high-voltage system design. Only minimal outage time of the circuits was required for the commissioning of the system.
5. The Rogowski coil split-core design allowed for installation without disconnecting the power cables.
6. The Rogowski coil low output signal is safer for people and secondary equipment, even when the high currents and voltages exist on the primary side. A broken circuit or short-circuit in the signal cable will cause no hazards or damage.
7. An important safety aspect of Rogowski coils is that they cannot catastrophically fail under any operating conditions — including heavy-current faults that would cause conventional CTs to fail.

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 outcome of this project are detailed in the following papers:

Relay Protection Solutions based on Non-Conventional Current Sensors in Actual Industrial/Utility Applications (CIGRE Study Committee B5 Colloquium, Brazil 2013)

Planned Implementation

None planned at this moment. Optioneering for potential projects is ongoing.

Other Comments

None.