Scottish and Southern Energy
Power Distribution

Date of Submission

July 2014

Network Innovation Allowance Progress 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	Project Reference
Transformer Intrascope	NIA_SHET_0005

Project Licensee(s)	Project Start Date	Project Duration
Scottish Hydro Electric Transmission	Apr 2013	2 Years

Nominated Project Contact(s)

James Tarrant

Scope

The initial objective of the project is to have a fully developed, assembled and working intrascope probe system which has been both mechanically and functionally tested within a laboratory-based environment. Once this is complete the intrascope system will be put through field-based testing on a number of spare, non-operational primary and supergrid transformers. This field based testing will provide practical experience in operating the intrascope system and allow for refinements to be made to either software or hardware if required. The system operation will be verified through destructive testing of the internal transformer winding insulation.

Providing this is successful and SHE Transmission is confident in the intrascope system, an investigation of an operational transformer will be planned. SGT3 at Tealing Substation (S/S) has been chosen based on the historical problems associated with it and the age of the asset. The final aim of the project is to investigate SGT3 using the intrascope system to analyse and assess the condition of the internal insulation.

Objective(s)

The objectives for the project are:

- Conduct research into an intrascope probe system based on the concepts of clinical endoscopy and wide-wavelength spectroscopy which can be used for the in-situ analysis of the condition of power transformers' internal insulation
- Develop a prototype of the system and perform laboratory tests for functional, mechanical and optical performance
- Test and demonstrate the prototype on out-of-service transformers and perform necessary enhancements/refinements for testing on operational transformers
- Test and demonstrate the prototype in the field on an operational transformer on the SHE Transmission network
- Evaluate the method's suitability as a condition monitoring tool for transformers and its impact on asset management

Success Criteria

The three distinct stages of this project are research, development and demonstration. Successful completion of each stage, with sufficient results to inform viability of subsequent stages, will represent success for that stage.

Successful demonstration of the system's suitability or lack of, on an operational transformer will provide enough knowledge about the system and hence indicate overall success of the project.

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

Objective: Conduct research into an intrascope probe system based on the concepts of clinical endoscopy and wide-wavelength spectroscopy which can be used for the in-situ analysis of the condition of power transformers' internal insulation.

The initial phase of the project was to conduct research into an intrascope probe system that could be used for the in-situ analysis of the condition of internal insulation within power transformers. This research phase included the investigation of the current tools, methods and techniques of assessing the condition of power transformers and looked at the feasibility of a method based on the principle of a clinical endoscope for directly accessing and assessing the kraft paper insulated internal windings of power transformers. The technology has never been extended to the application of an endoscope for in-situ testing of transformers.

This phase of the project has been completed and the objective achieved. This led to the progression and commencement of the subsequent phase of the project which was the further development and design of a prototype system.

Objective: Develop a prototype of the system and perform laboratory tests for functional, mechanical and optical performance.

Following the initial research phase of the project, the design, procurement and assembly of a prototype intrascope was undertaken. The system was then put through initial mechanical and functional testing within a laboratory environment. During this testing, several minor refinements were made to the system's hardware and software components. In addition to this, the system's optical near-infrared (NIR) image capturing functionality and interfacing with the system was developed and incorporated into the overall design.

Laboratory testing of the prototype system using sample transformer oils and kraft paper has produced successful results which have been confirmed and verified by other techniques. This testing provided confidence and experience in using the system for the subsequent field-based testing phase of the project. This concluded this laboratory testing phase of the project, which was followed by field-based trialling of the system on a number of decommissioned primary transformers.

Objective: Test and demonstrate the prototype on out-of-service transformers and perform necessary enhancements/refinements for testing on operational transformers.

Testing of the intrascope system on two decommissioned primary (33/11kV) transformers in both dry and oil-immersed situations was carried out in December 2013. This allowed for an initial evaluation of the system within a field-based environment and provided an opportunity to test the functionality and capability of the system. As a result of this testing, several further refinements were made to the hardware to improve controllability and flexibility.

A further trial of the intrascope system was then undertaken on a decommissioned supergrid (275/132kV) transformer. This was required to better assess the intrascope's functionality prior to application on a larger operational supergrid transformer, thereby reducing the risk of damage to the operational asset. An opportunity to trial the intrascope system on a decommissioned National Grid transformer at Melksham Substation in Wiltshire arose in April 2014. The intrascope system was successfully applied to inspect and analyse the transformer's winding insulation.

The trial on this decommissioned supergrid transformer better replicated the planned inspection of SHE Transmission's operational transformer SGT1 at Tealing Substation in eastern Scotland. The success of this trial provided us with the necessary confidence to

utilise the intrascope system on an operational transformer.

Objective: Test and demonstrate the prototype in the field on an operational transformer on the SHE Transmission network.

The activity to achieve this objective consists of testing the prototype intrascope system on an operational supergrid transformer under outage conditions at Tealing substation.

Objective: Evaluate the method's suitability as a condition monitoring tool for transformers and its impact on asset management

Evaluation of the earlier phases of the project, which consisted of intrascope trials on a number of decommissioned primary and supergrid transformers, have confirmed the ability of the intrascope system to assess the condition of the internal kraft paper winding insulation within power transformers. This is the main type of insulation used for the internal windings within existing and new designs of power transformers.

Evaluation of the subsequent phase of the project, which has consisted of an intrascope trial on an operational supergrid transformer, is currently ongoing. Evaluation of this key phase will indicate the method's suitability as a condition monitoring tool for assessing power transformers in business-as-usual.

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

The initial trials of the intrascope system on two decommissioned primary transformers in December 2013 indicated that an additional trial on a larger, decommissioned supergrid transformer was required prior to trialling the system on an operational supergrid transformer. This additional trial was required for further assessment of the intrascope system's operational suitability and to reduce the risk of damage to an operational network asset. This additional trial provided an opportunity to acquire further confidence and experience in operating the completed system.

Lessons Learnt for Future Projects

Evaluation of the intrascope system for inspection of two decommissioned primary transformers and an additional decommissioned supergrid transformer suggest that the system can be used for accessing and assessment of the condition of internal windings within power transformers. The ongoing evaluation of the latest phase of the project, which has consisted of an intrascope trial on an operational supergrid transformer, will indicate the method's suitability as a condition monitoring tool for assessing transformers in business-as-usual. This approach provides a better monitoring of the asset, informing decision making processes and optimising asset usage and replacement decisions.

This project has involved supervised third-party access to an operational supergrid transformer in order to undertake the intrascope trial; this access has been achieved successfully.