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NIA ENWL015
Tap Changer Monitoring

Progress Report

31 July 2021

VERSION HISTORY

Version	Date	Author	Status	Comments
V1.0	14/06/2021	Kieran Bailey	Final	

REVIEW

Name	Role	Date
Lucy Eyquem	Innovation PMO Manager	21.07.21
Dan Randles	Head of Innovation	21.07.21

APPROVAL

Name	Role	Date
Steve Cox	Engineering & Technical Director	22.07.21

CONTENTS

1 PROJECT FUNDAMENTALS

Title	Tap Changer Monitoring
Project reference	NIA_ENWL0015
Funding licensee(s)	Electricity North West Limited
Project start date	February 2016
Project duration	6 years
Nominated project contact(s)	Kieran Bailey (Kieran.bailey@enwl.co.uk)

2 PROJECT SCOPE

Following previous research into tap changer monitoring carried out under an Innovation Funding Incentive project, it has been determined that the technique utilised was not sufficiently robust and that further monitoring is required. Therefore, we will work closely with Camlin Power to develop and produce a retrofittable tap changer monitoring system to accurately monitor the tap changer performance and consequently determine the intervention/trigger points.

For this project it was proposed to install the system on 10 x 132kV tap changers and 30 x 33kV tap changers and monitor and analyse the tap changer performance over a 24-month period to allow seasonal changes to be considered.

The project will allow Electricity North West to develop its understanding of the effects of tap changer failure modes and maintenance requirements and to identify the optimum window for monitoring in the life cycle of tap changers.

3 OBJECTIVES

This project is split into four distinct phases:

- **Phase 1** is to develop a retrofittable tap changer monitoring system. This phase was completed in December 2016.
- **Phase 2** is the onsite installation of 40 monitoring systems. This phase was completed by August 2018.
- **Phase 3** is the continuous data analysis and visualisation of the tap changer condition. This phase to be completed by August 2021.
- **Phase 4** is the implementation of identified trigger points into company policy and procedures. This phase to be completed by February 2022

4 SUCCESS CRITERIA

- Production and trial of a condition monitor for tap changers.

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

The project was extended in 2021 for a two year period to allow for continued monitoring of trial sites to extend the learning and develop the Anomaly Detection system (ADS).

For the ADS to be developed further it is necessary to have sufficient data to show the change in data from what is regarded as normal operation and when events occur i.e. effectively a change in data from the normal expected monitored data. A plant failure does not necessarily have to occur, simply an event that may cause the plant to operate differently. The monitoring system continually analyses data such as tap changer tank temperature, noise in both the selector and diverter tanks (if separate) during tap changeovers as well as tap changer motor currents. An anomaly would be detected if say the noise levels (caused by arcing) changes from what is the observed normal level. Unfortunately, there have been very few anomalies detected during the trial to date and it may be necessary to extend the trial to allow further data to be gathered, with the hope that additional events occur on the monitored sites. As part of the project extension commitment an expert group has been set up to review fault reports as well as bi-monthly progress reports.

Since July 21 Camlin have detected several anomalies. For each of these events a full report has been provided. Following each anomaly, the agreed process has been followed allowing the project group to review the data to determine whether further action was required and if an outage was necessary.

As the learning develops, the response may need to be more reactive, especially if more events or anomalies (that are escalating in severity) are occurring on the same unit. In these instances, it will be necessary to take immediate action with a non-planned outage for further investigations.

Additional information, that would not normally be recorded during routine maintenance outages, is being captured and used to provide additional feedback of tap changer condition.

Examples of captured data are shown below

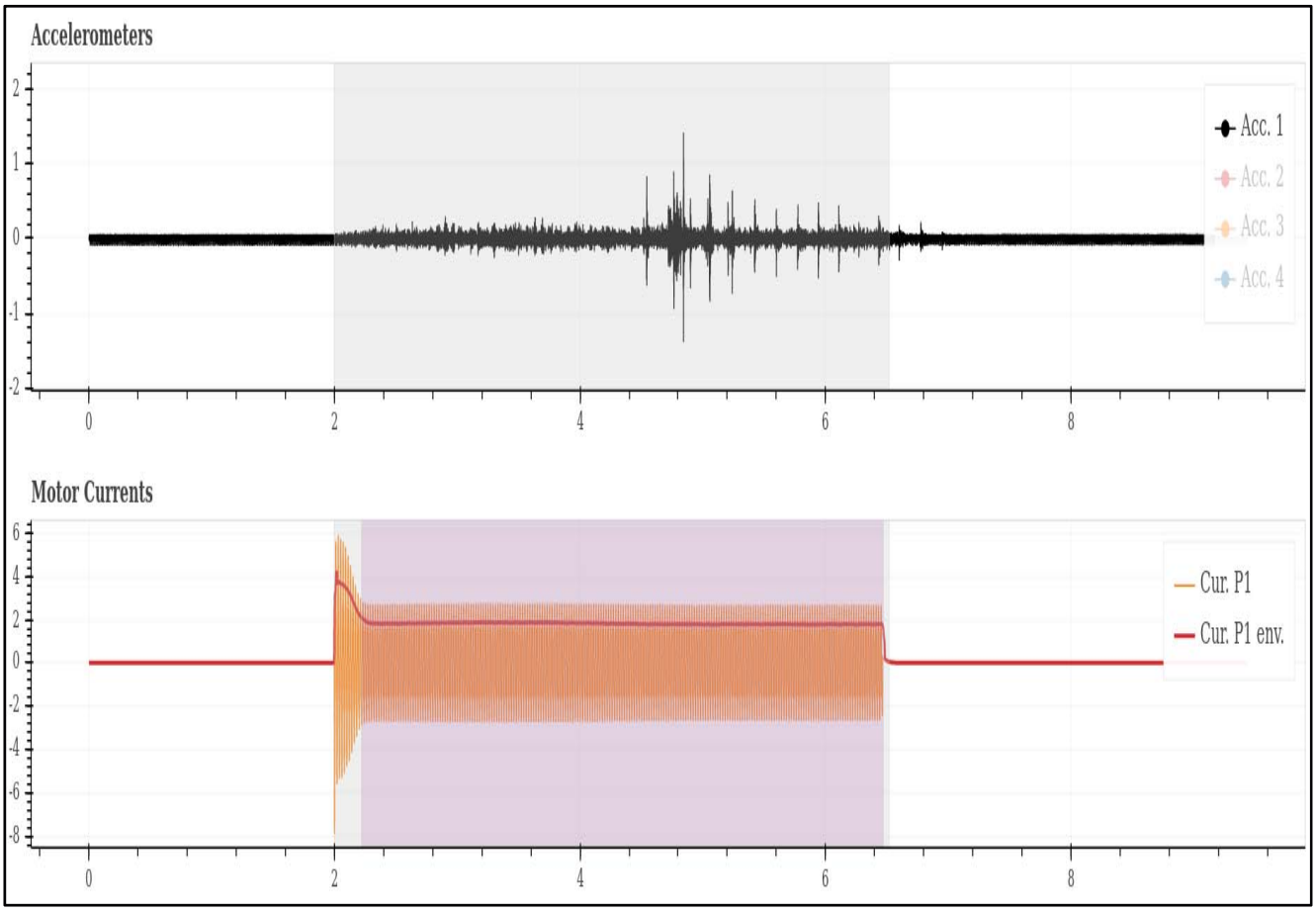

Figure 1:Tap change over data - accelerometer and motor current.

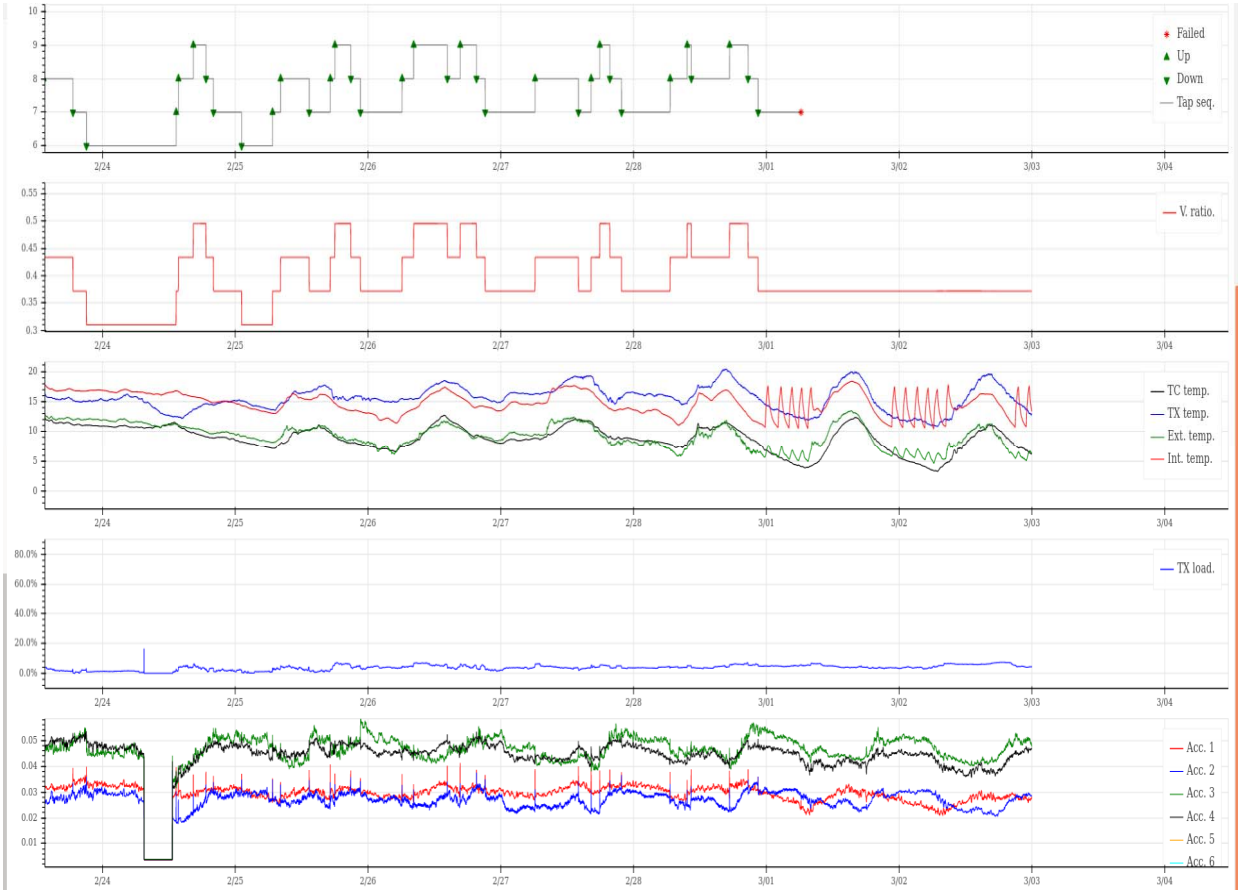

Figure 2: Tap position, v-ratio, temperature, load and accelerometer data

The main objective of this project is to develop an Anomaly Detection System (ADS). Development of the ADS is based on having sufficient data available to set trigger levels.

The developed and deployed system monitors and collects operational data, including vibration, motor currents, tap position and temperature readings. The triggered high speed data like vibrational information is concentrated on the individual tap operations. This is then fed into a trained Anomaly Detection System. This is designed and trained to detect when something different from the standard operation pattern is happening. For example, a change in the vibration traces, in motor current patterns, a sudden change in load patterns or loss of load, a change in tap pattern or range use, and other types of anomalous behaviour.

When attention is focused onto a particular installation due to an anomaly, it means that something unusual is happening at that individual installation, and we are able to give that installation expedient attention to understand better why there are changes happening.

As mentioned earlier, a number of anomalies have been detected and reported, and this is increasing the understanding of the TC operation, maintenance needs, and with time, more will be learnt about the failure modes as well.

Work will also be undertaken in the next stages of the project to use the learning developed so far in the project to create a detailed specification for a new generation of monitors that are more compact and that can be easily and cost effectively installed as part of a business-as-usual deployment. This will help with assessment of the fleet of tap changers across the network, and if necessary will help to understand the impact of LCT's and mitigation strategies.

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

Not applicable – there are no modifications to the planned approach, but an extension to the data collection period, and more rigor applied to the feedback process in the analysis stage will significantly increase the useful learning.

7 LESSONS LEARNED FOR FUTURE PROJECTS

Not applicable.

8 THE OUTCOME OF THE PROJECT

Not applicable.

9 DATA ACCESS

Electricity North West's innovation data sharing policy can be found on our website.

10 FOREGROUND IPR

The project will develop and bring to pre-production and trial a tap changer condition monitoring system. Camlin Power have developed and productionised the retrofittable tap changer monitoring system and own the IPR for the development of that system. The system will be made available for purchase from Camlin Power and the method used for the trials will be made available via Electricity North West for others to replicate the project.

11 PLANNED IMPLEMENTATION

Not applicable.

12 OTHER COMMENTS