A NEW APPROACH TO INTERMITTANT FAULT MANAGEMETN IN LOW VOLTAGE NETWORKS TO REDUCE THE NUMBER OF REPEAT INTERRUPTIONS

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ABSTRACT

This paper presents the implementation of new technologies and methodologies implemented by Alliander to reduce the number of repeat faults on their network. The new tools used to find these faults in order to reduce the number of customer interruptions (CI's) and customer minutes los (CML's)t on their LV networks is also discussed. The 'REZAP Fault Master' is a multi shot auto recloser fault management system with built in fault location and communications. The use of the REZAP Fault Master on Fault Management and Fault Location will be presented in this paper and how it has been utilized to develop the policies and procedures for fault management on LV networks within Alliander.

INTRODUCTION

Improving the reliability of supply to customers is a key area of focus for electricity supply companies. Maintaining supply of the network is vital and the ability to locate faults both with speed and accuracy is critical to the network operator. Intermittent and repeat faults on Low Voltage Networks causes significant issues for Distribution Network Operators (DNO's) in maintaining continuity of supply to customers. With new regulations from regulatory bodies penalizing the time which customers are off supply means that operations departments need to adapt new approach's from their "business as usual" to fault finding and customer restoration. This can be achieved by utilizing new techniques and tools to maintain and improve the quality of supply to customers.

The intermittent fault is a problem which all DNO's face. A faulty cable causes a fuse to blow which takes customers offline. In many cases the fault will clear itself and replacing a fuse will restore customer supplies. However, the intermittent nature of these faults can and does cause repeated fuse ruptures on low voltage networks. This in turn causes repeated customer interruptions and customer minutes lost for the DNO, but also can incur penalties from the regulatory authorities. A new approach and policy has been executed to "attack the fault" using a broad range of techniques to reduce customer minutes lost and customer interruptions. As part of this new approach a new analysis tool, the 'REZAP Fault Master', which is a multi shot automatic reclosing device designed specifically for low voltage networks is installed when a fuse blows. This device maintains the customer's supply during an intermittent fault by auto reclosing after an intermittent fault keeping the customers on supply without the need for an operator to travel to the fault. Furthermore the auto re-closer measures voltage and current enabling fault data to be measured and recorded. This data can then be used by operations to find the fault using bespoke fault finding analysis tools, which are simple to use, that come with the REZAP Fault Master. Data from the device is sent remotely to operators via built in remote communications. They can then make informed decisions on the steps which need to be taken to resolve the fault on the LV cable.

Figure 1- REZAP Fault Master Installer

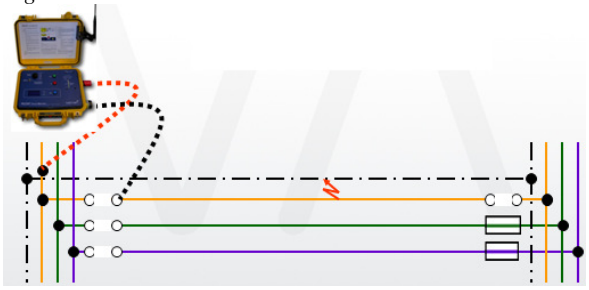

Figure 2 – REZAP Fault Master connection circuit diagram

Multi Shot auto recloser

The REZAP Fault Master is used to replace the NH fuses at the substation when there is an intermittent fault on the network. It has adjustable current ratings to emulate all the NH fuse current characteristics up to 400A. One or more REZAP Fault Master are installed in a substation or in a link box in the faulted fuse position as shown in Figure 1 and 2.

The REZAP can be placed inside the substation and left onsite measuring voltage and current to monitor the faulted circuit. Records and events are stored in the REZAP and sent via GPRS to a remote REZAP server where the user can monitor the DNO's fleet of REZAP Fault Masters. Users can receive email or text notifications of any fault activity on the circuit for one or more REZAP's for which they are responsible. All the information and events reported by the REZAP Fault Master can be monitored by the user through a webpage controlled by the REZAP server. The voltage and current waveforms captured from fault activity are recorded as records on the server and can be used for analysis as shown in figure 2. A key development of the REZAP Fault Master is the fault location Algorithm called Single Ended Location of Fault (SELF). Using a number of voltage and current waveforms from a fault the SELF algorithm estimates the impedance to the faulted location on the cable. Inputting the cable parameters this information outputs a distance to fault to the user which is used to excavate and repaire the fault.[1]. The cable parameters can be entered on the REZAP on site, remotely via REZAP web or using a mobile phone application which enables both onsite and remote analysis.

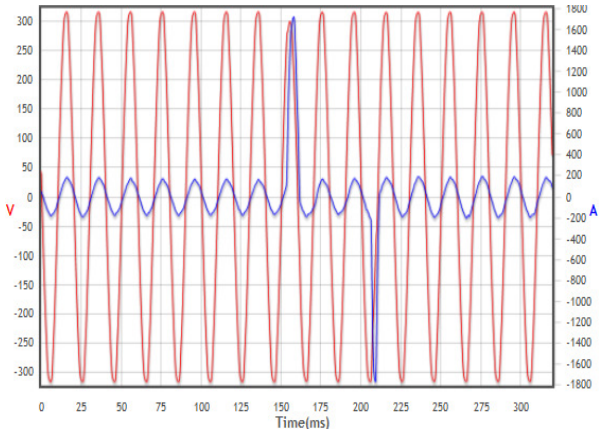

Figure – Voltage(V) and Current(A) against time (ms) REZAP FM Fault record

Fault Management

Alliander face the same issues as any network operator due to intermittent and repeat faults on their network. Not only does it affect the quality of supply to customers but financial penalties can be incurred due to new regulatory drivers in the Netherlands for CI's and CML's. If a fault occurs five times or more this is recorded as a 'repeat fault' on the network. This is extremely frustrating for customers and everything is done to try and prevent 'repeat faults' from occurring and to locate the source of this fault as soon as possible. The conventional methods for fault location is often labour intensive and time consuming disrupting customers for long periods. As re-establishing supply to customers is the highest priority it is not always feasible to utilise conventional methods. The development of a new innovative fault location tool and methods which can be used on live networks has enabled Alliander to use this in their strategy to significantly reduce the number of repeat faults on their network.

In Alliander the Netcare, ondersteuneded diensten (Netwcare support service) department has 39 specialists responsible for the management and resolution of faults on the Liander network. Each year approximately 5000 fault measurements are carried out in order to find and repair faults and ensure quality of supply to the Liander network through the Netcare department. With a continued focus on improving quality of supply to customers new policies and procedures have been developed through the Netcare department to actively prevent repeat faults on the network.

Alliander have utilised the REZAP on their network for over a decade as a multi shot auto recloser to restore supply to customers on difficult faults. With the developments in communications and fault location discussed above there has been an increased use of the REZAP Fault Master. Two years ago a new approach was introduced to fault management that stated after two fuse interruptions on a circuit instead of replacing the fuse a second time the Netcare support service department would be contacted in order to install a REZAP Fault Master. This enabled the Netcare specialists to monitor the faults remotely via the REZAP server and manage the fault more effectively. Fault data gathered by the REZAP was used to calculate the Distance to Fault using the SELF algorithms. Utilising Alliander's online mapping system this allowed repair teams to find the fault in less time, and meant that there was a large reduction in the interruption of supply to customers.

Due to the success of this policy after six months of this policy a trial was introduced in a region in Alliander which the REZAP would be installed after just one fuse rupture instead of two. REZAPs were distributed to mechanics in this region who would install the REZAPs when a fault occurred. The Netcare specialists would monitor the fault and use the information gathered to assist in locating the fault. The approach was to "attack the fault" by monitoring it as soon as it became an issue. This meant the fault could be managed in a controlled manner being able to inform customers of activity on their supply rather than customers informing them. This was highly beneficial instead of waiting for the fault to repeat and possible become permanent.

The success of this trial has now led to the roll out of this policy throughout the whole Liander network. This has led to a large increase in the number of REZAP's which are being

deployed across the Liander network. The deployment of which is currently ongoing with more benefits expected as deployment is increased.

Key Benefits

- The number of fuse replacements required was reduced by 70%. As the REZAP auto recloses after 30 seconds on an intermittent fault this meant a significantly improved quality of supply to customers instead of the time required for a mechanic to replace a fuse. Due to this significant reduction in the number of Fuse replacement's there was an equivalent reduction in time required by mechanics and specialists replacing fuses. This has had significant operational benefits in terms of resource efficiency as well as financial benefits.

- The number of 'repeat faults' since the introduction of these policy's has gone from 35 to 11 per year before the roll out across Alliander was initiated. This means that the fault is resolved after one fuse operation.

- The reduction in CI's and CML's has meant a reduction in penalties imposed by the regulator.

- Improved communications between departments through the development of the new policy and procedures.

Summary

This new approach has been very successful within the operations department in Alliander. Combined with improved cooperation and communications within the organization this new approach has significantly reduced the number of repeat LV faults to customers. It has also significantly reduced the number of customer minutes lost which has had a significant benefit to customers and to Alliander as a business. The continued roll out of this policy will see further benefits to customers throughout the Alliander network.

REFERENCES

[1] Andreas Borlinghaus, 2011, "Innovative Fehlerortung in Niederspannungs netzen sekkt Kosten und Ausfallzeiten", *Netpraxis*, , Nr.11 230, aus Jg 50, Heft 4,s.30-234