EPRI

SUCCESS STORY

Recloser Sensor Testing Leads to Cost-Effective Solution for Increased Electric Grid Reliability

Reclosers are a critical component of modern electric distribution systems. Electric service providers install reclosers to prevent extended outages caused by momentary interruptions. Reclosers also provide added system awareness when integrated with distribution SCADA systems. Electric distribution reclosers improve customer reliability and are a significant investment, including initial equipment purchase price, installation costs, inspection, and maintenance.

One of the primary characteristics of all distribution equipment is its basic insulation level (BIL) rating. This rating was needed to allow the equipment to withstand surges, lightning, and switching spikes. Historically, recloser equipment has been rated based on the needs of distribution lines with transmission equipment requiring higher ratings.

Sensors are also a key component in reclosers that help provide monitoring of the distribution system. Electric companies with ungrounded delta systems face unique challenges in detecting line-to-ground faults. When a single-phase line to ground fault occurs on these systems, no current is generated to trip upstream overcurrent protection relays. One method to detect this type of fault is to monitor the phase-to-ground voltage on each phase. This type of monitoring does not typically exist on these systems.

The addition of voltage sensing on reclosers is a helpful tool to detect and locate ground faults and downed conductors on ungrounded systems. The voltage sensors may be embedded within the recloser itself or externally mounted to the recloser frame. Electric companies have questions about how these types of sensors will perform on reclosers when applied under these operating conditions.

> *Through EPRI's innovation, we found a cost-effective solution that wasn't hard to deploy. The return on investment was clear for us and, most importantly, our customers will benefit from the improved reliability.*
>
> ~ **MICHAEL ZAFFINA**
> *Manager of Avangrid T&D Standards*
> United Illuminating, An Avangrid Company

THINKING 'OUTSIDE THE BOX'

Avangrid questioned whether a recloser could be leveraged in locations that historically had a higher BIL requirement and if a voltage sensor integrated into their recloser installations could be applied on their 34.5 kV non-solidly grounded subtransmission system to accurately monitor the line to ground voltages. The use of a recloser in this application would lead to saving significant time and effort in deployment compared to a unit substation solution. So, Avangrid commissioned EPRI

for a supplemental research project to better understand through laboratory testing how these voltage sensors would perform on an ungrounded system. The key parameters considered during this testing were directionality, second harmonic measurements, and phase to ground voltage measurements.

"We've had a long-standing relationship with EPRI and know they have the tools, technical capabilities, and expertise to get answers in a timely manner," says Michael Zaffina, manager of Avangrid T&D standards. "EPRI is really good with testing 'outside the box.'"

PROBLEM SOLVING, PART ONE

Avangrid addressed reliability issues on their sub transmission system by adding additional reclosers on this system. The system, which serves large numbers of customers in its service territory, has historically utilized 200-kV BIL protective devices. However, 38-kV class reclosers are only rated for between 150 to 170-kV BIL. Another option Avangrid considered was the deployment of substations, but that approach would be cost prohibitive by "an order of magnitude" versus a recloser solution, says Andrew Kasznay, Avangrid's principal engineer of distribution network standards.

In conjunction with the EPRI Distribution Automation Assets project (P180.003), a scout arrester scheme was developed to reduce effective BIL exposure for the system reclosers. The scout arrester concept uses additional lightning arresters that are installed on adjacent poles to the recloser pole to help protect the recloser by reducing the lightning current that is seen by the recloser. This approach has shown in laboratory testing to reduce the lightning current that should be experienced by the recloser which should decrease the risk of failure due to lightning.

LABORATORY VERIFICATION INFORMS NEW RECLOSER PACKAGE DESIGN

This EPRI research informed how Avangrid specified a recloser package from its vendor that would work with its system. The new design is "fit-for-purpose" for sub transmission and includes high accuracy voltage sensors, line-to-line connected control power transformers, pre-installed lightning arresters, and additional protection through the inclusion of scout arresters. "We worked with our suppliers to come up with a deployment-ready design in which reclosers and surge arresters would be packaged and 'site ready'," says Zaffina. "We were able to take an existing piece of equipment and apply it differently. We saved a lot of money and effort. EPRI's validation testing gave us the assurance we needed to move forward with a great solution to a complicated situation."

Figure 1. *In the EPRI laboratory using reclosers provided by Avangrid, EPRI tested the ground reference of voltage sensors in steady state, during voltage steps and through temperature cycles to verify the measurement accuracy of magnitude and phase angle of the voltage readings.*

The new learnings from this work have helped verify that both the external and embedded LEA sensors used on reclosers can be used to reliably measure voltage in the same way as a potential transformer (PT, a.k.a. voltage transformer) connected line to ground on a 34.5kV non-solidly grounded system. These results can be applied by other electric service providers who operate ungrounded 34.5kV delta systems to detect line to ground faults and downed conductors.

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