Technology Innovation Project

Closing Project Brief

TIP 23i: EPRI P35 Supplemental: Protective Arrester Overvoltage Control

Context

Overvoltages in power systems may be generated by lightning or by system conditions (such as switching operations, faults, load rejection, etc.), or both. Such overvoltages may cause flashovers and serious damage to equipment and endanger personnel working on energized lines. EPRI has developed traditional portable protective air gap devices (PPAGs) for utilities to use on lines ranging from 115kV through 500kV.

Their principle of operation relies on the sparkover of an air gap installed between an energized phase conductor and the ground. However, its operation introduces hazards due to step and touch potentials and arc flash. Additionally, the flashover probability of a PPAG is affected by the geometry of where it is installed, and by the ambient atmospheric conditions.

Therefore, alternative devices are needed to provide a safe working environment for live-line workers.

Description

This project sought to develop the 'next' generation of overvoltage control device for live work using current metal oxide (MO) arrester technology. Advantages of MO arresters include consistent clamping of transient voltages below switching overvoltage peak values, no line breaker operation resulting in a line outage, no exposure to power arc (Arc Flash hazard) and fault current flow (no step and touch potential concerns), and its operation is not impacted by atmospheric conditions.

This multiyear supplemental project started in August 2015 with three utility funders. BPA joined in January 2018. The project concluded in December 2018. The following tasks were completed.

Task 1: Develop Arrester Functional Requirements: Establish the functional requirements for using and selecting an arrester suitable for worksite protection from switching overvoltages during live work. Critical parameters include, maximum continuous operating voltage (MCOV), energy absorption capability, SOV protective level (i.e. clamping voltage), ground cable sizing, electric field grading, and arrester weight.

Task 2: Phase-to-Ground Application of Arrester: Develop a safe and acceptable approach (framework) for installing and removing the arrester unit from a transmission line phase conductor; and connection/removal of the grounding cable at only one voltage - that is, identify critical features, technical and safety issues; find an approach to solving them and illustrate it for at a line voltage agreed upon by funders.
Task 3: Tests Arrester Unit Performance: Perform switching impulse (SI) tests on a selected arrester unit to confirm its control and performance. Perform SI tests with positive and negative polarity and various wave-shapes to characterize the surge arrester unit. Assess the impact of the installation location on the general effectiveness of the arrester grading ring(s). Perform limited SI testing on a mockup structure with arrester unit installed using different live working methods and work practice scenarios.

Task 4: Arrester Integrity: Develop new work procedures, methods or technology for testing arrester units prior to use. The project also developed a sensing device that can monitor the arrester's condition during its application period (i.e. while performing live work).

Benefits

Although MO surge arrester technology has been applied for many years to limit voltages between phase conductors and the tower structure to prevent insulation flashover, or to protect critical substation equipment, they have not been adapted for worksite overvoltage protection of workers performing live working maintenance tasks. This project showed that the minimum approach distances could be reduced when such arresters are used. This can increase the number of situations where live-line and bare-hand work is possible.

This research project represents a new learning which considerably improves safety of workers engaged in performing live work on overhead transmission lines.

Accomplishments

The project achieved its overall goal to demonstrate a prototype portable protective arrester, and develop work procedures for installation, use, removal, and testing of the portable protective arrester.

Deliverables

- Quarterly Project Updates
- Laboratory demonstration of a technology demonstrator hardware solution with associated documentation of design, analysis, testing and monitoring technologies provided in a Final Report.
- Training webcast or Funder workshop

The non-proprietary results of this work are incorporated into EPRI R&D Program 35, and made available to the public.

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Project Start Date: October 1, 2016

Project End Date: December 31, 2018

Funding

Total BPA Cost: $50,000

Reports, References, Links

Development of a Portable Protective Arrester for Live Work – Proof of Concept
Design, Analysis, Testing, and Monitoring Technology for Live Work
EPRI Product Number 3002014324

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Participating Organizations

Electric Power Research Institute (EPRI)
CenterPoint Energy
New York Power Authority
Southern Company
Western Area Power Administration

Conclusions

"All planned high voltage laboratory tests that were outlined in EPRI's Test Plan were successfully demonstrated to Project Advisors. The testing further confirms the feasibility of adapting an MO arrester for live work and specifically, as a suitable worksite overvoltage control device.

The ability for utilities to electrically test a PPA for its internal condition (i.e. health) before installing it on an energized line addresses a potential barrier for its adoption.

Further, the EPRI arrester (Stringer) sensor provides a potential technology, should utilities wish to implement it, to monitor the condition and performance of the PPA in real time at a worksite or some other utility designed location or both. This may be helpful in situations where utilities install a PPA on a line for an extended time period to support widespread maintenance work in a particular transmission line section." - ***Development of a Portable Protective Arrester for Live Work – Proof of Concept, pg 10-1***