Supplemental Project Notice

SENSING TO DETECT FAULTS AND DOWNED CONDUCTORS ON UNGROUNDED DELTA SYSTEMS

Voltage and current line sensors being used to monitor an ungrounded 4kV delta distribution circuit

PROJECT HIGHLIGHTS

- Detect and trip energized, downed conductors on ungrounded systems
- Better apply distribution automation to ungrounded distribution systems
- Understand solutions to detect line to ground faults on ungrounded delta systems

Background, Objectives, and New Learnings

Electric companies with ungrounded delta systems on their distribution system face unique challenges in detecting line to ground faults and broken conductors. When a single-phase line to ground fault occurs on these circuits, there is no current 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. However, this type of monitoring does not typically exist on these circuits. The addition of voltage and current sensing on reclosers and at other points along these circuits may help to detect and locate ground faults on distribution.

There is some uncertainty that voltage and current sensors, especially those embedded in other devices such as reclosers, may be unable to detect ground faults on ungrounded distribution systems. Another uncertainty is detection sensitivity. For instance, can a sensing system detect high-impedance faults from downed conductors, especially on lower-voltage (5-kV) systems?

The objective of this project is to evaluate the efficacy of different sensing solutions to detect faults on ungrounded delta circuits through testing of different field scenarios and conditions in a laboratory environment. Research questions to be addressed in the project include:

- Are voltage and current measurements from typical reclosers capable of detecting directionality to ground faults on 4-kV ungrounded systems?
- Are other voltage and current sensors from primary line sensors capable of detecting directionality to ground faults on 4-kV ungrounded systems? This can include insulator-post styles and bird-on-a-wire line sensor styles.
- What is the best way to detect ground faults on automated systems where reclosers can be bi-directional?
- How does ground-fault detection perform for faults on different surfaces (asphalt, concrete, grass, gravel, and sand)?
- For detection by multiple devices, what are the options to trip the most appropriate device?
- Is it possible to incorporate broken-conductor detection to help identify and locate issues?

Benefits

The public benefits from this project include the ability to detect energized downed conductors more easily on an ungrounded delta system which may pose a public safety hazard.

Funder benefits include increased reliability of their 5-kV ungrounded delta systems by being able to detect downed conductors and line to ground faults.

Project Approach and Summary

EPRI plans to perform the following laboratory testing and analysis to help inform utility sensing applications to detect faults and downed conductors on ungrounded delta systems.

1. **Industry review of ground-fault detection on ungrounded systems:** Detection and location of ground faults on ungrounded distribution systems is a challenging problem. This task will review industry approaches, particularly for high-impedance faults, involved in downed conductors.
2. **Test planning and setup**: This task aims to develop and build out a 4-kV ungrounded delta circuit to the downed conductor testing area at the EPRI Lenox laboratory. A series of tests will be developed to run on different sensing solutions to determine their ability to reliably detect and locate a line to ground fault on an ungrounded delta system.
3. **Laboratory evaluation and testing**: This task plans to test the scenarios developed in Task 2 with different sensing solutions. The sensing solutions planned include a recloser with internal and external voltage sensing, a "bird on the wire" line sensor, and an insulator-post combination voltage and current sensor. The performance of each solution will be documented, especially the ability to measure the line-to-ground voltage and the directionality of the current. Ability to detect loss of voltage from a broken conductor is also planned.
4. **Guidance on sensing and protection options:** Results from testing and evaluations will be developed with member input to identify effective ground-fault detection.

Optional task – Evaluation of utility-specific sensing and protection solutions: This task will conduct laboratory evaluation and testing with sensors and protection selected by and provided by the utility.

Deliverables

Participating companies will receive regular update webcasts, the results of each task in a final report, and an end of project workshop.

The non-proprietary results of this work will be incorporated into EPRI's Distribution Systems R&D program, and available to the public for purchase, or otherwise.

Price of Project

The price to participate is $70,000. Six participants are needed to complete the full scope of the project. The optional task will be $20,000 for each sensing solution evaluated. This project qualifies for Self-Directed Funding (SDF). The project can be funded over two years.

Project Status and Schedule

The project is planned to occur over a 12-month period and will commence when three participants have joined.

Who Should Join

Utilities who have ungrounded distribution systems (especially 5-kV systems) and are considering distribution automation.

Contact Information

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