ELECTRIC GRID RESEARCH

Project Summary

Fault Analysis in Underground Cables

Context

The aging of installed underground distribution cables is a looming issue facing electric utilities in California and throughout the U.S. While a variety of technologies and tests are currently available to evaluate underground cables, the costs of these methods can be quite high and their accuracy needs considerable improvement if they are to be effective diagnostic tools.

One of the primary causes of cable failure is the development of microchannel voids, known as "water trees," in the polyethylene insulation, which develop at defect sites and propagate in the presence of water and voltage stress. Improved understanding of this phenomenon can lead to opportunities to minimize deterioration and extend the useful life of cables.

New diagnostic approaches are needed to detect defects, estimate time to failure, and establish the remaining useful life of installed underground distribution cables. There is a need for an order of magnitude improvement in accuracy along with an order of magnitude reduction in testing costs, compared to present methods.

Goals and Objectives

The goals of this project are to evaluate existing diagnostic approaches used to detect or predict incipient failure in solid-dielectric cables, and to determine the feasibility and cost-effectiveness of new innovative technologies to improve the accuracy of cable fault diagnosis.

Specific objectives are to:

- Establish a viable and robust technique for detecting defects in cables by the *in situ* measurement of cables.
- Explain incipient water tree development and develop methods or products to inhibit the formation of water trees.

Description

This 3-year, multi-campus project will utilize a combination of analysis, experiment, design, and testing. Work will proceed on several fronts:

- Analysis, testing, and simulation aimed at understanding water trees and the opportunities for sensing incipient failure.
- Investigation of system-level inspection strategies, possibly including devices that can be inserted into conduits that carry cable for localized examination of cable deterioration.
- Investigation of ultrasonic probing as a method of *in situ* fault detection.
- Use of the concentric neutral conductors as data transmission media and the possible use of electric current non-linearities for diagnostic purposes.
- Evaluation and prototype development, where warranted, of microsensors for *in situ* inspection and possible inclusion in new cable designs.

Why It Matters

Over the last several decades, electric utilities have installed many miles of underground distribution lines using solid-dielectric polyethylene insulated cables, a preferred alternative to overhead lines for many reasons. As these cables age, they deteriorate and fail, leading to costly replacement and repair, and adversely affecting customer reliability. A better understanding of the causes of cable failure, particularly concerning the development of water trees, can lead to installation and maintenance practices that will promote longer underground cable life expectancy, and better diagnosis of incipient cable failures. Repair and maintenance costs will be minimized, and customer service reliability will be improved.

{More details}

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Fault Analysis in Underground Cables (Pg 2)

Participating Organizations

Principal Investigator:

Center for Information Technology in the Interest of Society (CITRIS), University of California

Research Advisors:

Pacific Gas & Electric Co.
Southern California Edison Co.
San Diego Gas & Electric Co.
California Independent System Operator
Georgia Institute of Technology
Institute of Electrical and Electronics Engineers

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Reports

Final Report: *Fault Analysis in Underground Cables*
(Not yet available)

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For More Information, Contact

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