



ELECTRIC GRID RESEARCH PROGRAM

Project Summary

Concentric Neutral Degradation and Failure Analysis

Context

Electricity travels from the point of its production to its ultimate consumption through a complex network of conducting cables. Cables that are directly buried in the ground or installed in buried conduit comprise a significant (and growing) percentage of this network, especially in suburban and urban environments. These cables are comprised of individual conductors, a series of insulating and protective coverings and a spiral wrapping of copper wire that is known as the 'Concentric Neutral.'

The concentric neutral provides an essential role in the electrical protection of the conducting elements of an underground cable. Deterioration of the concentric neutral leads to premature cable failures as well as localized (and sometimes cascading) blackouts. Buried cables can offer a useful life of 40 years. Deterioration in the concentric neutral, however, can truncate the useful life of a buried cable in half, can reduce network reliability and can increase both operational costs and (electric transmission and distribution) network congestion. New online approaches are needed to detect change, predict failure, and establish the remaining useful life of underground cables if such cables are to fulfill a role in facilitating the growth of the electric grid to accommodate distributed, renewable resources – while simultaneously mitigating public resistance to the visible growth in the electric infrastructure.

Goals and Objectives

To investigate means for detecting, in advance of failure, the degradation of the Concentric Neutrals of underground power distribution cables and to do so while the cable is in service (energized).

Specific objectives are to analyze, evaluate, and conduct proof-of-concept demonstrations for 3 alternative methods of concentric neutral degradation.

Description

The project will examine and model (through finite element analysis) the variety of mechanisms in which concentric neutral deterioration lead to performance degradation and cable failure. This includes, for

example, the examination of the corrosion of the neutral and its subsequent separation from the semi-conducting shield and how this influences cable performance. Corrosion (and breakage) of individual strands of concentric neutrals will also be examined to quantify its impact upon performance loss.

Three methods will be investigated to determine their potential for determining concentric neutral deterioration:

- Measuring the currents in individual concentric neutrals at the end of a cable section
- Using pairs of concentric neutrals as signal paths for probing the cable.
- Using radio frequency surface waves guided by an insulator-covered conductor as signal paths for probing the cable

Each method will be analyzed, sensor requirements defined, data processing strategies developed and, where necessary, prototype sensors developed.

Investigators will then collaborate with one or more California utilities to conduct a proof of concept demonstration in the field with the prototype systems and sensors developed.

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. Improved methods of determining concentric neutral deterioration 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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Participating Organizations

Principal Investigator:

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

Research Advisors:

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

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Reports

Final Report: Concentric Neutral Degradation and Failure Analysis (Not yet available)

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For More Information, Contact

Dr. Merwin Brown,
CIEE Electric Grid Research Program Director
(916) 551-1871
merwin.brown@uc-ciee.org