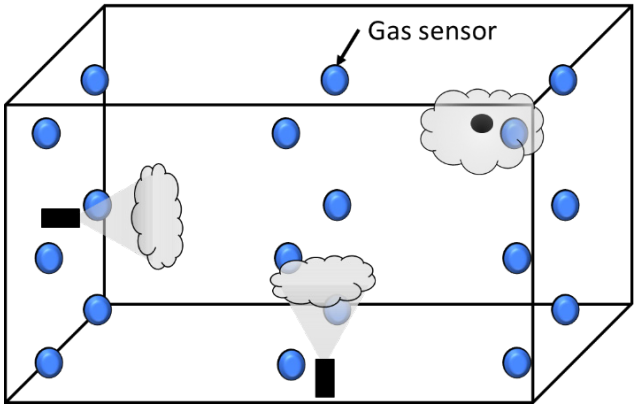
Underground Structure Monitoring Guiding Alarm Settings and Monitor Deployment



- Increase industry understanding of combustible gas behavior in underground structures
- Provide guidance for underground structure monitoring sensor placement and for setting alarms for gas monitors
- Provide guidance for stray voltage detector placement and alarm setting levels
- Leverage underground structure monitoring technologies to identify precursor conditions of underground structure events

Background, Objectives, and New Learnings

As underground cables and components degrade, they can generate a variety of gases from chemical reactions caused by heating, overheating, arcing, and general aging. These gases may be combustible and, should the presence of these gases not be identified, can build up and lead to an explosive event which can endanger the public, utility workers, and damage equipment.

Underground structure (manholes and vaults) monitoring systems are available on the market, which include gas monitoring and stray voltage detection, but their technical efficacy is not well understood. Moreover, utilities lack guidance for deploying sensors in an underground structure to effectively detect the presence of combustible gases and stray voltage.

This research seeks to understand the expected movement, migration, pocketing, and dissipation characteristics of selected gases within an underground structure to inform detection sensor placement, sensitivities, and alarm settings. In addition, the research will examine the characteristics of elevated (stray) voltages to inform elevated voltage detection sensor placement, sensitivities, and alarm settings.

The objective of the research is to provide guidance for: 1) leveraging underground structure monitoring sensors including sensor placement, 2) setting alarms for selected gases, and 3) stray voltage detector placement and alarm setting levels.

Benefits

This research is expected to increase industry understanding of combustible gas behavior in underground structures to inform detection sensor placement within the structures, required sensitivities, and alarm settings. In addition, the research will increase industry understanding of the characteristics of elevated voltages to inform elevated voltage detection sensor placement, sensitivities, and alarm settings.

Findings from this research will enable utilities to better leverage underground structure monitoring technologies to identify precursor conditions of underground structure events, enabling them to respond and minimize or prevent these events from occurring, and increase public safety.

Project Approach and Summary

Literature/Research Review

This task will seek to identify industry practices for placing gas sensors and establishing and responding to alarms, including documenting practices utilized by selected gas utilities. In addition, this task will seek results from prior research into understanding selected gas behaviors and levels associated with underground structure event precursor conditions. This task will also summarize publicly available stray voltage detection guidelines and requirements to inform stray voltage detection settings for monitoring systems.

Testing to identify gas volume levels required for ignition

This task will seek to establish the volumes of selected combustible gases which must be present to achieve ignition.

This information, coupled with information about gas behavior and the expected rates of change of gas volumes will be essential to the selection of alarm levels for action. Gases to be examined include methane, carbon monoxide, acetylene, and ethylene.

Gas Behavior Testing

This task will utilize a specialized gas texting fixture to better understand gas movement, gas pocketing, and gas level rates of change in the structure. Testing will include expected gases present in underground structure events; specifically, methane, carbon monoxide, acetylene, and ethylene. Testing will monitor gas concentrations at multiple locations over time, and under different ambient conditions. Testing may include experimentation with different gas flow rates to identify potential differences in gas behaviors. Results from this testing are intended to inform both the placement of sensors within an underground structure and alarm settings.

Infrared (IR)/Visual Camera Testing

EPRI will perform research to better understand the implications of different IR camera sensors and lens accuracy on the quality of the IR images/visual. EPRI will work with participant utilities to establish expectations for camera resolution.

Communications Testing

The ability to communicate monitored information is a key to underground structure monitor effectiveness. EPRI plans to develop and demonstrate a method for ascertaining communication strength at various locations within its test underground structure(s) at the Lenox Lab to inform monitor and/or antenna placement. This task will involve development of a "test box" designed to test signal strength, using a cellular (LTE) modem and battery pack with different antenna types, to examine communication signal strength at various locations within EPRI's test structure (s). EPRI will document the process used so that a utility could repeat this process with their own facilities.

EPRI will also research available communications media for communicating from within an underground structure to produce fact-based information on various subterranean structure communication methods' efficiency and effectiveness.

Reporting

EPRI will prepare a report that includes the learnings from the practices/literature review, present test results from the gas behavior testing, and provide guidance on both sensor placement within the hole, and alarm levels for selected gases based on the test findings. The report will also include guidance for stray voltage sensing, a summary of learnings from the camera testing, and results from the communications research.

Deliverables

Technical Report detailing project approach and documenting all findings.

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

Price of Project

$50,000 per participant.

This project qualifies for tailored collaboration (TC) or self-directed funds (SDF) funding. Four (4) funding companies are required to start work

Project Status and Schedule

This project is expected to start in January 2022 and run for approximately 15 months.

Who Should Join

Organizations with cable systems and equipment in underground structures.

Contact Information

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com).

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