

# Portable Protective Air Gaps for Live Work



PPAGs installed on a 500 kV line.

## Overview

Switching operations can take place during live work and may result in high over-voltages at the worksite. These occur when, for example, a line breaker attempts to reclose a line following a momentary single-phase fault clearing operation. The structure clearances are designed to withstand these over-voltages. However, a number of factors can lead to a breakdown as a high switching surge reaches the worksite, causing an over-voltage. Blocking the reclosure of the circuit breaker on the line reduces over-voltage magnitude. In many cases, however, this is not sufficient. Another method is the use of portable protective air gaps (PPAGs) installed near the worksite.

EPRRI is pursuing research to further develop PPAG technology. These devices are designed to allow utilities to conduct live line work in certain situations such as on compact lines or in the case of high switching transients.

## Value

The portable protective air gap is an insulating rod with two electrodes that is designed to control over-voltages by sparking at a predetermined voltage level, limiting the over-voltage and preventing the possible sparkover at the worksite. The device has traditionally been installed only as needed. Maintenance of traditional PPAGs is similar to that of other insulating tools.

PPAGs allow utilities to conduct live line work, which avoids costly outage penalties associated with de-energizing a line for

By participating in this project, utilities and their live working crews will benefit through:

- Improved safety
- Improved work ergonomics through the possibility of using shorter live working tools
- Ability to work live on structures with reduced clearances
- Ability to work on wood structures where connections to ground are not easily available

maintenance. The use of PPAGs may also help to increase transmission availability and reliability, limit congestion costs and help improve system stability.

## Research Opportunities

PPAGs still need further development in several areas:

- When the PPAG sparks over, the resulting power frequency fault current and the associated stresses on the system are significant. Means of limiting the fault current need to be developed.
- Procedures for installing PPAGs on wood structures need to be developed since wood structures do not provide a good connection to ground.
- PPAGs are now installed for live work and are removed after completion of work. Further research is needed to develop devices that could remain on critical structures and "plugged in" as needed on short notice.
- Connection of the ground cable is the most hazardous operation during installation of the PPAG. Means of reducing the hazard level of this operation requires development.
- Traditionally, PPAGs have been developed and used to control phase-to-ground over-voltages. This project will also develop phase-to-phase application of PPAGs, which is important while performing barehanded work (using helicopters, for example) on the middle phase.

## Drivers and Trends

Deregulation has led to the need for higher levels of overhead transmission network reliability and availability. Scheduled outages are increasingly difficult to obtain and they are often canceled on short notice. Live work, or work on energized circuits, is the preferred method of maintenance where system integrity, system reliability and operating revenues are at a premium and removal of a circuit from service is not an acceptable option.

## Project Summary

The goal of this project is to develop a new generation of portable protective air gaps for live work that also provide means of limiting the faults current in case of a PPAG sparkover.

Procedures for installing PPAGs on wood structures will be developed. The procedures may be demonstrated at EPRI's high-voltage laboratory or at a utility site.

Also, appropriate modifications to the PPAG design and construction will be developed so that the PPAG can be used "as needed" for live work and, when not needed, can be left on the system without degrading the system's reliability or switching and lightning performance.

## Project Details

The project will be performed in several phases. Research will be conducted to determine the parameters of a device that may be easily used and installed with the PPAG and will also effectively limit the faults current.

Next, prototypes of selected current-limiting devices will be constructed and tested at a high-current laboratory.

Later, with the help of participating utilities, procedures will be developed for installation on PPAGs on wood structures.

Finally, relying on input from participating utilities, the PPAG designs will be modified to allow permanent or at least long-term installation on a system and "plugging-in" of the PPAG when needed for live work.

## Participant Benefits

Participating utilities and their live working crews will be pro-

vided with first-hand experience in the operation, use and installation of a new-generation PPAG. They will also have access to new technology that may:

- Improve safety
- Improve work ergonomics through the possibility of using shorter live working tools
- Allow crews to work live on structures with reduced clearances
- Allow installation of PPAGs on wood structures where connections to ground are not easily available

Furthermore, participants will have the opportunity to gain both experience in the performance of the PPAG and confidence in their protective characteristics.

## Cost of Project

The estimated cost for this project is \$300,000 over two years. The minimum cost for participating in this project is \$100,000. Companies that fund any overhead transmission program can use tailored collaboration (TC) funds for up to half their contribution. Participation for two consecutive years is encouraged.

## Project Status and Schedule

This project is expected to take 24 months to complete. Research was initiated in 2008. EPRI is seeking other utilities as participants.

## Who Can Participate

Utilities that perform live work, desire to increase their work safety records or plan to perform live work in the near future are encouraged to participate in this project.

## Contact Information

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

## Technical Contact

Dr. George Gela, 413.499.5710 ([ggela@epri.com](mailto:ggela@epri.com))

## Electric Power Research Institute

3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA  
800.313.3774 • 650.855.2121 • [askepri@epri.com](mailto:askepri@epri.com) • [www.epri.com](http://www.epri.com)