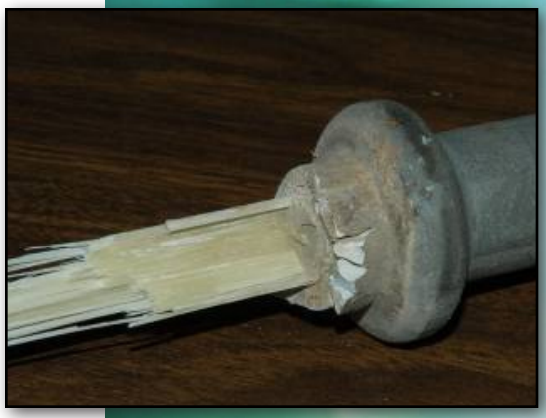
# Evaluating Corona Rings on 115/138 kV Polymer Insulators at PNM and PSE&G



## Overview

Since 2006, some utilities have experienced an increasing number of polymer insulator failures on 115 and 138 kV transmission lines. Investigations have shown that these failures can be attributed to high electric fields (E-fields) occurring close to, or on the high-voltage end fittings of these insulators. These findings suggest, contrary to common practice, that it might be necessary to consider the application of corona (also called grading) rings on polymer insulators on transmission lines with a system voltage below 161 kV. Transmission line reliability can be affected if utilities do not have measures in place to minimize the effect of corona discharges on the rubber material.

## Solution and Value

EPRI has developed a report (1015917) that provides utilities with the information necessary to develop a strategy to address premature aging of polymer insulators on 115 and 138 kV transmission lines due to high E-fields. The 72 page report provides reference information and resources to support utilities that apply polymer insulators in their network. It not only describes the problem but also provides recommendations for assessing existing insulator populations and for specifying polymer insulators for new or replacement units.

"Using a three dimensional (3-D) E-field modeling process, existing insulators are able to be retrofit," stated Emilie Dohleman of PNM in New Mexico. "This model really showed where the problem was when a 2-D model probably would not have."

"The report is conclusive in finding that there is an issue with polymer insulator degradation on 115 and 138 kV transmission lines due to the lack of corona rings in certain applications," said Andrew Phillips, director of transmission research for EPRI. "Since we have been doing related research for many years, we already had the tools in place to deal with this issue. We also have had ongoing dialog with manufacturers and standards committee representatives to make them aware of what we have learned during this process."

The polymer insulator failures also raised concerns about the health of the remaining insulators in service, and the report highlights the need to determine appropriate actions that can be taken to extend the life of remaining units in service without the loss of a highly reliable unit.

"Because of our involvement in the EPRI insulators project, we began to see increased evidence and some failures within the industry attributed to electrical discharge on 138 kV polymer insulators," said Raymond Ferraro, emergent technology and transfer specialist for PSE&G. "With this information, we felt it prudent to investigate the possibly that we might find electrical discharge activity on our recently re-conductored and re-insulated 138 kV lines. The results confirmed this fact. This lesson underscored the value derived from EPRI participation, particularly at the task

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**—Emilie Dohleman, PNM**

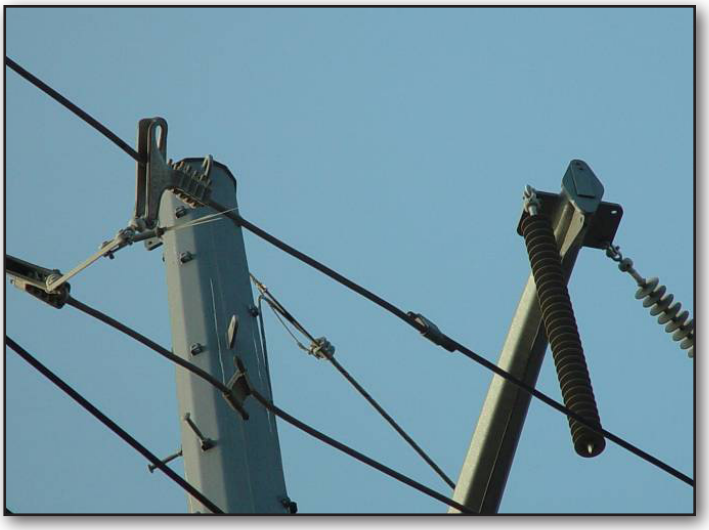
force level, because it allowed us to benefit from the knowledge gained early enough to avoid a possible polymer insulator failure and at a point where remediation options were still possible."

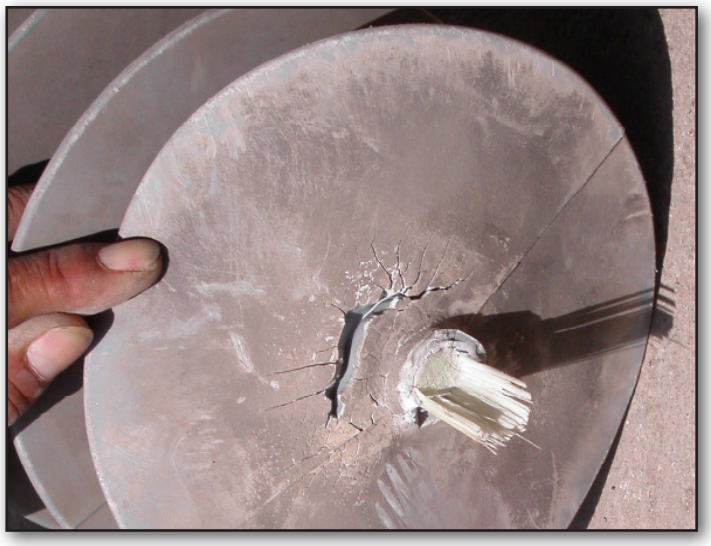
## Previous Experience

EPRI is credited for being one of the first in identifying high E-fields and the resulting discharge activity as an important cause of premature aging of polymer insulators. Based on the results from the multistress aging chambers and testing at the EPRI lab in Lenox, Massachusetts, this phenomenon was identified as a primary aging mechanism on 230 kV and 500 kV insulators, and appropriate E-field limits for polymer were established. The insulator failures, which are documented in the new report, show that these limits are also valid and applicable to lower system voltages such as 115 and 138 kV. In developing the new report, EPRI relied heavily on previously developed EPRI products, such as the practical field guides for the assessment of polymer insulators as well as daytime discharge inspection technology. It also used software developed in collaboration with polymer insulator manufacturers, called EPIC (1015916), for the calculation of E-fields on polymer insulators.

During the past three years, several insulator failures were investigated by EPRI, including daytime discharge line inspections, detailed condition assessments on polymer insulators, and E-field calculations. In this report, the results of these activities are summarized and analyzed in order to establish recommendations for assessing existing insulator populations and specifying polymer insulators for new or replacement units on 115 kV and 138 kV transmission networks.

"EPRI's long-term research in the area of corona effects and non-ceramic (polymer) insulator degradation was invaluable in assisting us in developing a cost-effective solution to this problem," said Dohleman. "EPRI developed a utility-specific guide for evaluating existing insulators for continued use on the system. This not only saved the cost of new insulators, but also the added expense of staff time, equipment, and line outages.





## Approach

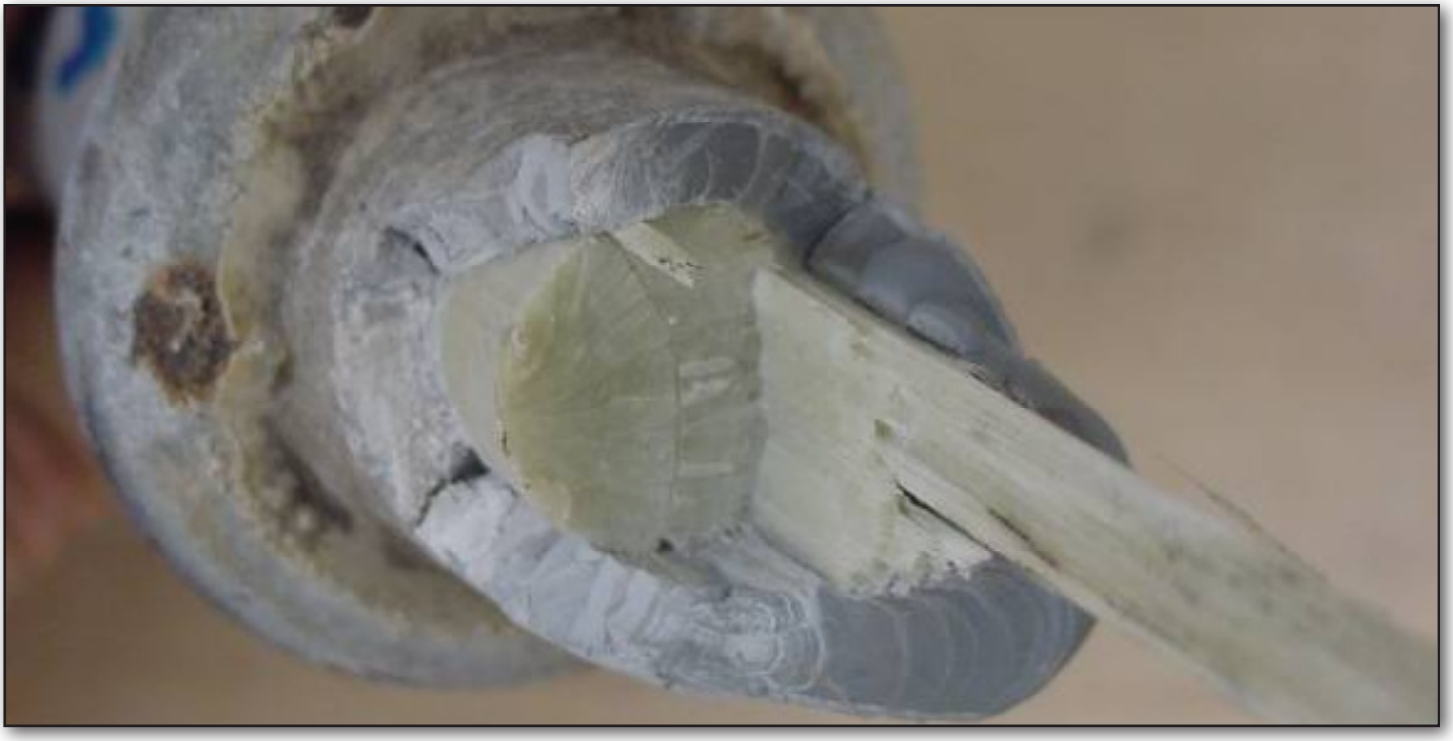
As a first step a paper exercise can be done to form an initial risk assessment of the specific insulator type involved. Such an assessment is based on past experience in combination with an evaluation of the insulator design and its installation environment to determine its susceptibility to aging as a result of high E-fields.

Insulator manufacturers have changed their design from time to time to implement new materials, streamline processes or respond to negative user experiences. Not all these designs perform equally well, and it is necessary to interpret past performance data in terms of the insulator vintages involved. EPRI helps this process by keeping track of insulator design changes for their members with the EPRI Polymer Insulator Vintage Guide (1012328). The vintage guide was a vital tool in determining the risk posed to the member utilities insulators populations being evaluated.

This assessment is followed up with daytime discharge inspections, E-field modeling and the removal of units from service. Based on one or all of the above tasks, guidelines are then developed on how to address the existing population as well as how to account for this in the specification of new units.

"Once the presence of electrical discharge was verified with the daytime corona camera, EPRI worked closely with us to develop an approach to assess our level of risk for the installed population of insulators," said Ferraro. "They also helped formulate a suitable remediation plan and instruct our workforce on condition assessment of field units which included a customized field guide.

"Through early detection and intervention, PSE&G was able to reduce the risk of possible insulator failure by identifying which insulators should be removed from service, or where corona rings could be retro-



fitted. The results from this project allowed our re-conductoring project to continue, prevented a greater population of polymer insulators from being installed without corona rings, avoided the need to replace a significant number of in-service polymer insulators and established an approach for future assessments," he said.

One of the EPRI recommendations implemented by utilities is to retrofit corona rings on selected existing units. When this is implemented field crews also do a visual inspection of the insulators using the Polymer Insulator Field Guide (1018374). "For routine line inspections, insulator field guides have been very valuable in educating the workforce, especially new members," observed Ferraro. "They provide a consistent approach to inspecting and assessing the condition of an installed population of insulators. Each of our workers has received a copy of these guides."

## Outlook

Deterioration due to corona discharge activity takes time to develop. It is therefore logical that units which have been exposed to unacceptable levels of discharge activity for an extended period of time will exhibit more deterioration than newer units. How long it takes to deteriorate depends on a number of factors, but capturing that data so it can be analyzed is a key to better understanding this process. Condition assessments made on an existing in-service population of polymer insulators are a vital element for utilities to assess the degree of deterioration and their individual levels of risk. EPRI has developed and maintains a set of tools including field guides, failure databases, E-field modeling techniques, corona inspection, accelerated aging test results for this kind Transmission Line Issue. In addition EPRI is initiating a follow-up research effort which will include an accelerated aging test specifically to address these concerns

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

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