

Innovation

Predicting Failures with EPRI's Transmission Asset Database

Records on Nearly 50,000 Components from 80 Utilities Inform Asset Planning and Budgeting

By Matthew Hirsch

Twenty years ago, EPRI's utility collaborators started reporting the premature failure of polymer insulators on high-voltage transmission lines where rubber had worn out from exposure to high electric fields or the seals had failed.

Polymer insulators are widely used in the utility industry because they are smaller, lighter, and less expensive than glass and ceramic insulators. Utilities needed to know how many were susceptible to failure and whether the problem could be narrowed down to a subset of units.

"It's tough to convince utility executives that they need to spend \$30 million to replace polymer insulators just because field workers at their own company are reporting that some of them are failing," said Dr. Andrew Phillips, EPRI director of transmission and substations.

Using EPRI's growing database on performance of transmission assets, utilities had information about 388 failures of polymer insulators on high-voltage transmission lines dating to the late 1970s. This helped them isolate the problem to one out-of-business vendor.

"Utilities have used this data to remove from service an entire inventory of polymer insulators of a specific family, make, and model and improve grid reliability," Phillips said.

The performance database groups 11 transmission assets, such as insulators, transformers, circuit breakers, and conductors. It contains records from 80 utilities in the United States, Canada, the United Kingdom, Malaysia, Taiwan, and Australia, including 43,213 in-service assets, 4,746 failures, and 1,832 assets that have been retired or taken out of service. EPRI is incorporating analytics into the database. For instance, utilities have also used it to develop a year-by-year prediction of substation transformer and circuit breaker failures along with strategies for spare parts inventory and online monitoring. The North American Transmission Forum (NATF), an industry association that enables utilities to share information outside the regulatory arena, is a key collaborator in expanding the database.

Strength in Numbers

Thirty years ago, when transmission equipment failed, an asset manager would record and file descriptions of the equipment and causes of failure. Although such records may now be on the manager's computer hard drive or a networked drive, analyzing such data remains time-intensive, making it difficult to plan and budget for equipment repair and replacement.

Even if a single utility has a well-structured database recording its own failure data, the data set's small number of component failures and different component applications make it statistically invalid. By combining such data from across the power industry, EPRI's database provides a data set statistically valid for making informed asset management decisions on when to replace, refurbish, monitor, and buy spares for specific assets. It also enables utilities to make inferences on performance by asset family, make, model, application, and age.

Staff at participating utilities log into EPRI's system to enter failure data, including type of component, manufacturer, photos, and laboratory reports. EPRI experts review all inputs before posting to the database.

Utility experts can view data in charts, graphs, and other formats and analyze a catalog of their component failures alongside related failure data from the rest of the industry, providing a benchmark for performance. Users can sort and chart industry-wide failures by component type, cause, manufacturer, rated voltage, location, and other attributes, helping to identify high-risk units and informing decisions on R&D priorities. For example, one company concerned about its 69-kilovolt transformers determined that it would have to acquire 18 spares to account for aging equipment with a high probability of failure.

Data security is essential to the project's success and growth. To preserve confidentiality, utilities can view their own data but only aggregated data from other utilities.

This year, EPRI is expanding the database to track performance for 14 new components in overhead power lines, substations, and underground transmission, and another 17 are expected to be added in 2017 (see table below).

A Growing Database of Transmission Assets		
Assets in Current Database	Assets to Be Added in 2016	Assets to Be Added in 2017
Overhead Line Components		
Conductors	Arrestors	Foundations
Connectors	Glass, porcelain, guy strain insulators	Marker balls
Polymer insulators	Shield wire	Dampers
Structures		All-dielectric self-supporting and optical ground wire fiber-optic cable
		Switches
		Hardware
Substation Components		
Bushings	Coupling capacitor voltage transformers	Reactors
Transformers	Arrestors	Connectors
Circuit breakers	Current transformers and voltage transformers	Post insulators
	Capacitor banks	Raceways
	Disconnect switches	Ground grid
	Electromechanical relays	Digital relays
		Control cable
Underground Components		
Extruded joints	Pipe-type cable systems (including joints, terminations, cable, accessories, and cathodic protection)	Self-contained, fluid-filled systems (including joints, terminations, cable, and accessories)
Extruded termination		
Extruded cable		

Key EPRI Technical Experts

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