TIP 25g: EPRI P37: Development of Substation Equipment Spares Strategy Methodology

Context

All utilities maintain inventories of spare substation equipment to mitigate the effects of equipment failures. Without available spares, replacement times may be extended by procurement and delivery delays. In particular, substation transformers may take months to replace, potentially prolonging outages and creating significant challenges for utilities striving to maintain reliability and control capital and operating costs.

There are significant costs associated with spares inventories including capital, storage, and, for some equipment, maintenance and testing. These costs and the potential benefits from spares are a function of the number of spares kept at hand. Keeping too few spares may prolong outages while too many spares would increase costs. However, there are no industry standards or guidelines to help utilities optimize the number or mix of spares.

Description

Initially, the project focuses on power transformers. In subsequent phases the focus will expand to other substation equipment.

The first steps will define the desired spares strategy methodology characteristics and features. The spares strategy methodology will address number and types of transformers (including mobiles) in inventory, spares store locations, spares allocation policies, spares reordering criteria and strategy planning horizon. Other variables will include transportation times from stores to station and procurement times. The ability to describe both as probability distributions will be included. Additional variables may be identified.

A metric or metrics for evaluating or comparing the results of implementing various spares strategies will be determined. Costs of strategy implementation will not be included in this initial development. Rather, it is expected that the metric will be based on a measure of operational risk associated with an unfilled transformer position.

An analytical methodology will be developed that will relate the strategy metric(s) to various user define inputs (e.g. reordering criteria, spares inventory) and system specifications (e.g. number and type of installed transformers by station) to allow for scenario and what-if studies. The metric or metrics and analytics will be developed to provide views of a strategy's and its constituent decisions' impact by various categories, for example metrics by fleet, station, transformer type, circuit or criticality group. The analytic will allow the user to take into account the stochastic nature of age dependent transformer failure rates in addition to other possible natural or man-made hazards.

It is anticipated that the spares strategy analytics will be incorporated into a software tool. A spreadsheet GUI will be the objective but additional software modules (i.e., VBA or C++) may be required. Initially a beta version will be developed. In a subsequent phase, a release version may be produced.

Why It Matters

Project results may help utilities reduce capital costs and maintenance associated with spares inventories through the application of more analytical processes for determining spares strategies. Results may also help improve service availability and help keep electricity affordable by reducing unplanned outage duration and improving customer satisfaction.

Risk-based spares strategies would more appropriately align with the industry desire to incorporate asset management principles.

Goals and Objectives

The objectives for this project are to investigate and assess available methods for determining spares strategies, identify strengths and weaknesses and unmet needs and develop an enhanced analytical methodology for determining or evaluating spares strategies. The methodology will take advantage of other EPRI development in the areas of fleet management and industry-wide data bases and hazard rate analyses.

Deliverables

The non-proprietary results of this work will be incorporated into EPRI R&D program 37 (Substations) and made available to the public, for purchase or otherwise.

1. The functional requirements for an enhanced analytical methodology for determining or evaluating substation equipment spares strategies.
2. A prototype software version of new analytics for designing and evaluating spares strategies.
3. An evaluation of the prototype analytics based on the experience with a subset of utility transformer fleet and identification of any required enhancements.
4. A beta version of the analytics. A research report will be produced documenting the approach and work completed in this phase.
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**Project Start Date:** January 1, 2018  
**Project End Date:** December 31, 2018

**Reports, References, Links**

**Participating Organizations**  
Electric Power Research Institute (EPRI)

**Funding**  
BPA FY2018 Budget: $25,000

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