



Integration of Asset and Outage Management Tasks for Distribution Application

Final Project Report

Power Systems Engineering Research Center

*Empowering Minds to Engineer
the Future Electric Energy System
Since 1996*



Integration of Asset and Outage Management Tasks for Distribution Application

Final Project Report

Project Team

Mladen Kezunovic, Project Leader

Yimai Dong

Texas A&M University

Ward Jewell

Visvakumar Aravinthan

Prasad Dongale

Wichita State University

PSERC Document 09-11

October 2009

Information about this project

For information about this project contact:

Mladen Kezunovic, Ph.D., P.E.
Texas A&M University
Department of Electrical and Computer Engineering
College Station, TX 77843-3128
Tel: 979-845-7509
Fax: 979-845-9887
Email: kezunov@ece.tamu.edu

Power Systems Engineering Research Center

The Power Systems Engineering Research Center (PSERC) is a multi-university Center conducting research on challenges facing the electric power industry and educating the next generation of power engineers. More information about PSERC can be found at the Center's website: <http://www.pserc.org>.

For additional information, contact:

Power Systems Engineering Research Center
Arizona State University
577 Engineering Research Center
Tempe, Arizona 85287-5706
Phone: 480-965-1643
Fax: 480-965-0745

Notice Concerning Copyright Material

PSERC members are given permission to copy without fee all or part of this publication for internal use if appropriate attribution is given to this document as the source material. This report is available for downloading from the PSERC website.

© 2009 Texas A&M University. All rights reserved.

Acknowledgements

This is the final report for the Power Systems Engineering Research Center (PSERC) research project titled “Integration of Asset and Outage Management Tasks for distribution Application” (T-36) . We express our appreciation for the support provided by PSERC’s industry members.

The project industry advisors with affiliations at the time of the project approval were: ABB (James Stoupis), AEP (Doug Fitchett), California ISO (Ali Choudhury), GE (Devin Van Zandt), NRECA (Robert Saint), PG&E (Ben Tatera) and TVA (Bruce Rogers).

Executive Summary

Faults in distribution system may cause interruption of power supply to customers. Since distribution systems in general encounter high frequency of faults caused by weather, component wear and other reasons, the need to reduce outage time caused by faults is required for an important reason: better service to customers. Customer requirements on the quality of service are constantly growing. As an example, sensitive loads in modern industry, such as chip manufactures or ore smelters, are very sensitive to interruptions in power supply. The consequence of failure is more severe nowadays than decades before when such sensitive loads were not so prominent. The most direct impact of faults on the utility profit is the loss in customer sales as well as the increase in maintenance expenses.

Reliability indices, defined in an IEEE standard, are used to evaluate the impact of faults on distribution system performance. The System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) are the two most widely used indices. Lower values of SAIDI and SAIFI are associated with higher levels of distribution reliability. However, each reliability index reflects only one or two aspects of system reliability. When analyzing distribution reliability, several reliability indices should be used.

On the other hand, different types of customers have different reliability requirements. The trade-off between the reliability experienced by individual customers and the overall reliability for the whole system should also be considered when estimating outage costs.

This study looked at two ways to improve the reliability of a distribution system. One is to improve the performance of outage management tasks so that the impact of faults can be minimized. The second way is to improve the performance of asset management tasks so that failures occur less frequently and the fault is “prevented”.

This study explores the technologies available for both asset management and outage management tasks by addressing the following issues:

- *Lack of data.* Beside voltage and current measurement at substations, few monitoring devices for measurements are installed in a distribution system; this study develops a methodology on how to correlate improvement in the measurement infrastructure with improvement in performance, a crucial decision-making tool for making investment allocations.
- *Ineffective processing of faults and maintenance scheduling caused by inefficient use of operational data.* The fault location practice is currently based on trouble calls and manual switching while maintenance is performed either with a run-to-failure strategy or with a fixed ahead-of-the-time planned schedule which does not require operational data but yields less efficient performance. The study points out how operational data (i.e., measurements from intelligent electronic devices or IEDs) can be utilized for implementing more efficient outage and asset management solutions.
- *Independent planning and operation of asset and outage management tasks.* Those two functions are planned independently, including planning of budgets even though the equipment that may record and collect relevant data from the

field maybe common to both applications. The study ties the two planning function together through risk-based cost analysis, a unique solution for optimized planning of budgets and tasks associated with both outage and asset management simultaneously.

The approaches mentioned above have been implemented on the distribution system model connected to a bus in an IEEE reliability test system. The result shows that the frequency and duration of faults decrease and system reliability improves as a result of the proposed technology deployment and tool improvements.

Additional research issues need to be studied so that the investment in asset management and outage management can provide maximum return. Further research may include:

- *Integrated view of capital investment strategy.* This effort should answer the question of how the investment in monitoring equipment should be allocated among asset management and outage management tasks in a most efficient way, i.e., how to gain the largest return for utilities and the greatest improvement in reliability of the system for the customers. The risk-based assessment of outage cost can be used as the objective of the optimization problem;
- *Post-fault reconfiguration.* The impact of reconfiguration cost after the fault has been located using the outage task needs to be addressed. The following two costs should be compared:
 - The implementation cost of the best scheme for reconfiguration made possible with improvements in the technology and tools proposed in this study
 - Cost of conventional practice: isolate the faulted area and after the replacement or repair is done restore service to the customers that lost power due to the fault.
- *Placement of IEDs in a distribution system.* This topic requires a more comprehensive study of the optimal placement of IEDs. Given a certain amount of capital funds, the research needs to focus on where the measurements should be taken in the system so that the overall accuracy of fault location program is maximized.