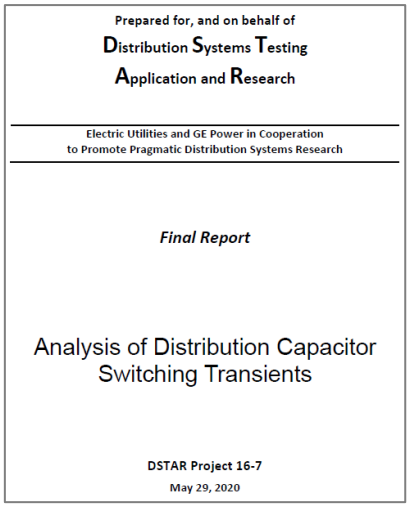
Project 16-7:
Analysis of Distribution Capacitor Switching Transients

Final Report prepared May 2020; available online @ www.dstar.org

Project Summary:


Prepared for, and on behalf of
Distribution Systems Testing
Application and Research

Electric Utilities and GE Power in Cooperation
to Promote Pragmatic Distribution Systems Research

Final Report

Analysis of Distribution Capacitor Switching Transients

DSTAR Project 16-7
May 29, 2020

Capacitor bank switching is one of the most common switching events on electrical power systems. Capacitors are quite economical and are generally a convenient means of providing reactive power compensation to correct power factor and support voltage. This makes them prevalent in mots U.S. power systems. When energized, a capacitor bank can interact with the system inductance to yield oscillatory transients which can propagate into the local power system and pass through distribution transformers into customer loads and facilities. Under specific circumstances, these transients may cause misoperations or even damage equipment at customer facilities.

The primary objective of this project is to define and quantify, through use of detailed computer simulations, the key factors which affect capacitor switching transients, with respect to their magnitude and frequency, on distribution systems.

The approach of the study involved three main tasks

1) Developing an EMTP-RV model of a real-world distribution system to be used as a test system,
2) Performing a parametric study to determine the sensitivity of switching transients on a number of different parameters, and
3) Developing general rules for distribution engineers to help them with capacitor placement to minimize switching transients.

An additional task reviewed the impact of capacitor switching transients on nearby reclosers.

Based on the analysis of the case study results, some of the key findings are summarized as follows:

- Load models can be represented using standard RLC models in EMT-type simulations which can accurately capture the effects of potential transient damping or magnification
- To perform detailed simulation analyses using EMT tools, large distribution circuit models may need to be reduced while keeping portions as detailed as possible, using equivalencing
- Averaged peak transient magnitudes, and in most cases, maximum peak transient magnitudes diminish with decreasing switched capacitor size
- Residential circuits are likely less prone to high peak transients
- Detailed model representations of power electronic devices and/or adjustable-speed drives (ASDs) should be included in capacitor switching studies.

- Loads with a leading (capacitive) power factor can, under some circumstances, lead to magnification of the capacitor switching transients
- Prolonged underground cable sections could be a concern even when the potential switched capacitor site is some distance away and contribute to potential magnification
- Capacitor switching transients can, under specific circumstances, cause misoperations or even damage loads and equipment at customer facilities
- No ratings are specified in recloser standards for capacitor bank switching, but some reclosers have been tested and in accordance with breaker standard C37.06.
- Feedback from nine of the ten utility respondents indicate that they do not specify capacitor switching duty for reclosers.

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Who Should Use:

Distribution/Transmission Planners, Standards Engineers, PQ/Reliability Engineers

For the complete report for DSTAR Project 16-7: Analysis of Distribution Capacitor Switching Transients, visit www.dstar.org.

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