Project 14-4:
Surge Protection of Electronic Capacitor Controllers

Final Report: December 2014; available online @ www.dstar.org

Project Summary:

One of the ways that utilities have improved the performance and efficiency of the distribution system is by installing equipment-based electronic controllers throughout the distribution system. Examples of these controllers include ones used with voltage regulators, reclosers, sectionalizers, tap changers, and overhead feeder capacitor banks. As the number of controller installations has increased, several DSTAR utilities have experienced more controller failures than expected. In particular, overhead feeder capacitor controllers were identified for study, particularly controller failures attributed to lightning.

Pole installation diagrams of capacitor bank controllers were provided by several DSTAR members, and the pole installations were simulated in the Alternate Transients Program (ATP). Local lightning strikes were simulated to determine the factors which affect the transient voltages at the controller.

Based on a parametric study of both actual DSTAR member pole installations and variations of these installations, observations and recommendations were identified and documented in the P14-4 report.

Observations:

1) Among DSTAR member utilities, there does not appear to be common practices regarding the installation of capacitor bank controllers. Differences exist in the following areas:
    a. number and location of ground connections,
    b. number and location of surge arresters,
    c. shielded versus unshielded control cable,
    d. kVA size of control power transformer (CPT),
    e. pole grounding practices.

2) The local ground resistance appears to have little impact on controller voltages based on selected cases with the Southern Company configuration (without CPT primary surge arresters). The surge voltage across the controller is relatively constant (from 31 kV to 28 kV) as the three pole ground resistances varied from 1 Ω to 1000 Ω.

    The impact of local ground resistance, however, is a much more important factor for any voltage measured from the controller or CPT terminals to ground. Higher pole ground resistances will increase the common mode voltages for all equipment on the pole.

3) In the absence of surge arresters on the CPT or on the controller, the initial voltage transfer is determined largely by the winding capacitances. As a spot check, using two cases, the peak primary and secondary voltages on the CPT are 60 kV / 4.7 kV and 133 kV / 10 kV respectively which are ratios of 12.8 and 13.3 respectively. These values are consistent with the ratio obtained under impulse testing whereby a 1,450 V impulse resulted in 110 V on the secondary. The ratio of these values is 13.2. Thus, the impulse response of the CPT under test and the simulations are consistent.

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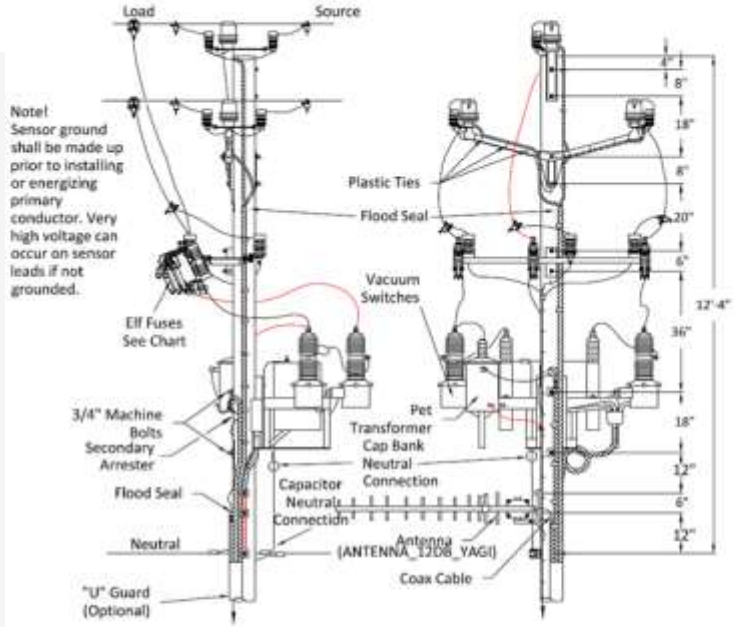
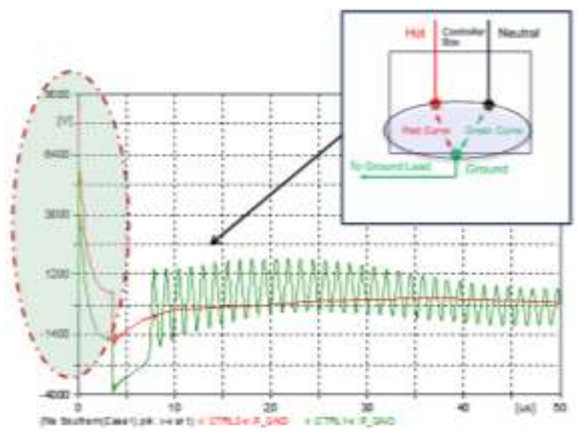


Pole diagram from DSTAR member

Who Should Use:

Distribution Planners, Standards Engineers, Power Quality/ Reliability Engineers

For the complete report on Project 14-4: Surge Protection of Electronic Capacitor Controllers, visit www.dstar.org.



Voltage between controller terminals and cabinet ground

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