TIP 314: End-Use Testing and Model Development

Context

While computer models for transmission elements and generators have been greatly advanced over the past 40 years, load models have been substantially lagging.

Western Interconnection has made significant advancement in dynamic load modeling in the past 10 years. A composite load model was developed, tested and implemented in all major production-level grid simulators used in Western Electricity Coordinating Council (WECC). Bonneville Power Administration and Southern California Edison played the leadership role in the model development, testing, validation and deployment. WECC approved the Phase 1 composite load model for planning studies starting 2014 study program.

Although air-conditioner models were developed as a part of the composite load model, a stall feature was not included for assessment studies in the phase 1 roll-out.

Studies performed for Portland metro area indicate that along with growing air-conditioning load, delayed voltage recovery and risk of system over-voltages are increasing. Underrepresentation could be very expensive as dynamic reactive devices are needed for mitigation. Additional risk-based planning studies are needed as well as further research to ensure models adequately represent air-conditioner stalling.

Description

The project will accomplish the following tasks:

Additional Testing of Air-Conditioners and their Controls: The data will be analyzed and used for model validation.

Point-on-Wave Model Validation: The test data will be used to develop appropriate data sets and to validate the models that will then be used to generate a manifold of air-conditioner stall characteristics, as a function of voltage dip, duration, point-on-wave and crank position. This will establish a diverse set of motor stall thresholds.

Deterministic Feeder Aggregation and Motor Benchmarking: A simple feeder model will be developed in the PSLF program to simulate a wide variety of faults. When results are compared with an aggregated model, the impact of aggregation on the simulations of air-conditioner stalling phenomenon can be determined.

Statistical Feeder Aggregation and Motor Benchmarking: By including statistical diversity of the air-conditioner stalling phenomenon in the LD1PAC model, we will determine whether statistical modelling can give a closer prediction of motor stalling phenomenon.

Benchmarking against actual events: All developed models will be benchmarked against actual events at two levels:

- Service entry using data collected by Southern California Edison
- Large scale FIDVR events

Recommendations on how to proceed with Phase 2 will be made based on benchmarking and sensitivity studies

Why It Matters

It is important to understand the risks associated with Fault-Induced Delayed voltage recovery (FIDVR) exacerbated by increasing air-conditioning loads. Although the exposure window for large scale FIDVR is small (40 hours mean, up to 120 hours) relative to southern states where most FIDVR occurrences are recorded, initial studies show that FIDVR transient performance could become a limiting factor if air-conditioning loads keep growing.

Investments to mitigate FIDVR are very expensive, as they require dynamic voltage support. At the same time, wide-spread outages are also very expensive particularly on extreme hot days. Therefore, we need to continue model improvements..

Goals and Objectives

The goal of this project is to make revisions to the air-conditioner component of the composite load model.

Deliverables

Project deliverables will include: Air-conditioner test report, including new elements such as sensitivities with respect to initial voltage, fault voltage, fault duration, recovery voltage, point on wave where a fault is applied; Electronically commutated motors test report; Code for single-phase AC model, sensitivity studies of motor stalling with respect to initial voltage, voltage sag magnitude, sag duration, recovery voltage, point on wave and crank shaft position where a fault is applied; Feeder model, runs with deterministic and statistical models; and a Model validation report for aggregated residential air-conditioner models.

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Project Start Date: October 1, 2014

Project End Date: September 30, 2017

Reports & References (Optional)

Links (Optional)

Participating Organizations

Western Electricity Coordinating Council (WECC)

Funding

Total Project Cost: $540,000

BPA FY2015 Budget: $125,000

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