Modeling and Validation Working Group

August 2012

Motion to TSS:

- Continue evaluation of the WECC composite load model with the revised data sets for 2012 heavy and light summer cases with a new target date of January 2013 for TSS approval for implementation of phase 1
  - Utilities to provide study reports by November 16, 2012
  - Summary report to be available by December 31, 2012

Motion approved by TSS August 30, 2012.

Request to TSS:

- Need TSS support to expedite the process of model evaluation:
  - MVWG conducting regional workshops for system planners on the composite load model
  - MVWG to be directly engaged in the study set-up and the review of the study results
  - MVWG to provide support with the load model data
  - MVWG to disseminate the lesson's learned and success stories

TSS agreed to support these efforts.

The Landscape

Realistic power system models are essential for reliable grid planning and operations. NERC Reliability Standards require Transmission Planners use the best available models for power system stability assessment. The composite load model is needed for realistic assessment of the impacts of electrical loads on the power system reliability.

There is strong evidence that the "interim" load does not represent the load impact on the power system reliability. The interim load model failed to reproduce the events of delayed voltage recovery observed in Southern California and Desert Southwest, the load loss during Mid-Valley event in Utah, or the inter-area power oscillations in the West. WECC MVWG is concerned that continuing using the interim load model leads to inadequate assessment of the grid reliability and system under-investment.

WECC MVWG has developed the composite load model from 2003 to 2011. The composite load model was implemented and extensively tested in General Electric's PSLF grid simulator. Siemens PTI followed with a similar development in PSS®E simulator. WECC utilities (mainly SCE and BPA) tested a number of electrical end-uses and developed representative load models. WECC MVWG and PNNL developed load composition data sets for various regions in WECC, as well as PSLF-based tools for the data management. WECC TSS approved the implementation plan for composite load model evaluation in August 2011. According to the initial plan, the TSS members would complete the composite load model evaluation by April 2012.

The evaluation had mixed results thus far.

There were clear success stories, including:

- Studies done by Southern California Edison that reproduced the events of delayed voltage recovery in California desert regions
- Studies done by MVWG that reproduced the critically dampened inter-area power oscillations recorded in August 2000
- FERC and NERC study of September 8, 2011 Pacific Southwest outage, where the composite load model was used for simulating the entire 11 minutes of the event
- WECC Joint Synchronized Information Subcommittee (JSIS) has run a few thousands of dynamic simulations with the composite load model to develop operating procedures for mitigating low damping conditions, a wide set of contingencies covered Canada, Pacific Northwest, California, and Arizona
- Companies involved in the composite load model development – SCE, BPA, PSE, WECC Staff – have performed a wide range of successful simulations and sensitivity studies

The TSS evaluation of the composite load model has also revealed several issues. A few of the issues are appropriate and need to be addressed before the model can be used for compliance with NERC studies. Other issues are the result of mis-understanding or data errors. A list of the composite load model issues is described in Appendix A.

WECC MVWG already addressed several data issues in their latest data release, including several major errors in generator models. However, the new data has not been made available in time to study engineers, and the model evaluation is continued with the erroneous data sets.

WECC MVWG greatly values the feedback from the TSS study engineers. A comprehensive peer review of the model is critical to ensure that the model can be used with confidence in setting system limits and making investment decisions. Therefore we outlined the steps that in our opinion will expedite the process of model review and adoption in WECC.

Moving Forward

Action 1. MVWG conducting regional hands-on workshops for system planners on the composite load model

MVWG already conducted a load modeling workshop in Portland, OR and in Bellevue, WA. Two more workshops are planned in Southern California (LA and San Diego) in September, and three more are discussed for Salt Lake City, Phoenix and Denver. The workshops include step by step process of creating load composition model, as well as background information on load model data.

In addition to the workshops, WECC MVWG is planning to conduct webinars on the lesson's learned with the composite load model evaluation.

Action 2. MVWG needs to be directly engaged in the model evaluation

WECC MVWG welcomes feedback from study engineers on their experiences with composite load model. Such feedback is essential for model improvement and successful deployment. MVWG to have direct contact with the study engineers, including the exchange of the base cases, dynamic data and switching files, so that MVWG is in a better position to address timely potential issues. WECC has established a "Composite Load Studies" folder on TSS web-site for the data exchange and posting of lesson's learned sessions. MVWG needs to create an active list of log items with observed issues and their resolutions.

Appendix A: Composite load model issues observed during the evaluation:

1. Composite load model does not initialize in a flat line

There were several reports that the cases with composite load model did not initialize in a flat line, or generator states and their derivatives are different between composite load model and interim load models. Our assessment concludes that the underlying issue is not with the composite load model but with the WECC dynamic database as a whole. Even without the composite load model, the PSLF initialization process usually reports a number of generator models with unsteady initial conditions. The composite load model interacts with the unsteady generator models during the initialization iterations. And because the composite load model has more dynamics, it will have a larger reaction to unsteady initial conditions of generator models.

Composite load model structure has been extensively tested by MVWG. The model has built-in checks for data and voltage profile. Given steady boundary conditions, the composite load model will initialize with a flat line.

2. Loss of load is observed during a 3-phase fault

Most of actual faults are 1-phase momentary faults caused by lightning strikes, or high impedance arching faults. Such faults are less likely to cause voltage depression large enough to disconnect a noticeable amount of load.

Loss of load during a 3-phase fault is consistent with the actual experiences. 3-phase faults are very rare in power system, yet a few events involved the loss of load. For example, a 3-phase fault at Keeler 230-kV substation in Portland in October 1997 resulted in loss of 500 MW of load in Pacific Northwest. A multi-phase fault at Mid-Valley 138-kV substation in Salt Lake City on July 28 2009 resulted in loss of about 800 MW of load.

WECC MVWG recognized the importance of protection modeling. WECC hired through a competitive process John Kueck, one of the leading experts in North America on motor protection. WECC MVWG also involved services of John Undrill, a well-known expert in power system dynamics. The protection data reflects the best information available up to date.

As WECC is about to review its voltage dip criteria, we recommend to have different performance levels for 1-phase and 3-phase faults to recognize the vast difference in their respective probabilities.

3. Post-transient voltage recovers to a higher voltage

Lower voltage during fault (due to larger power draw), higher initial recovery voltage (due to motor tripping) and higher post-transient voltage (due to motor tripping) is expected and valid when using the composite load model. MVWG is looking into reports of high voltages following load loss. MVWG is discussing whether the transformer saturation needs to be represented.

4. Generators go out of step

Several studies reported generators going out of step. MVWG analysis indicated that out-of-step generation is likely due to bad generator models. In one specific example, Klamath Falls gas turbine was going out of step for the faults on California – Oregon Intertie. Further examination revealed that the generator had erroneous "xcomp" of 15%. Resetting "xcomp" to zero fixed the problem.

In addition, MVWG is working on Under-Excited Limiter (UEL) models that will prevent the generator excitation from becoming too low. Loss of generator excitation is the most common cause of generators going out-of-step.

5. UVLS and UFLS operation

SCE observed that UVLS operated based on substation voltage rather than high-side voltage. MVWG will contact GE with the clarification of the load bus being monitored by the UVLS and UFLS model.

6. Voltage chatter

Voltage chatter was observed in earlier simulations. Enoch Davies subsequently found an error in the air-conditioner motor protection data, where the settings for ON and OFF contactor levels were in the wrong order.