Operational Modeling and Model Inputs

Robert W. Cummings
Director, Reliability Initiatives and System Analysis
NASPI Model Validation Workshop
July 11, 2013
• If something is not modeled, how can you predict system behavior or the interaction of components?
• Bad modeling can give a false sense of security
• Bad Modeling ➔ Bad Decisions
  – Planning – wasted money
  – Operations – unknowingly operating in insecure states
August 10, 1996 WSCC Outage

Real event

Dynamic simulations

No confidence in dynamic database
WSCC Actions Since 1996

- Aggressive testing of generating units
  - 80% of units directly tested
- Validation by Observation adopted
- System probing testing
  - Pacific DC Tie (PDCI) signal injection (ongoing process)
  - Chief Joseph Braking Resistor (1,400 MW) insertion
- Validation by system disturbance PMU recordings
  - Ongoing for significant system events
- Identified 12 discreet inter-area oscillatory modes
  - Identified mode shapes and participating generators
  - Tuned generator controls and Power System Stabilizers
WECC Confidence today

- grid frequency

Malin Frequency, June 14 2004 West Wing event

System simulations of June 14, 2004

- COI power

COI Power, June 14 2004 West Wing Disturbance

Real event

Simulations
Unable to Simulate EI Frequency Response

Highlighted in December 2011 FERC report
“…simulation predicted significantly greater frequency response than was, in fact, recorded by monitoring equipment.”
Actual Aug. 4, 2007 Frequency
Un-modeled Generation Behavior

Shakespearean generation

• How can I trip thee, let me count the ways

In 133 system disturbances examined:

• Unexpected Gen. Turbine Control Action (35 times)

• Voltage sensitivity of gen. aux. power systems (13 generators tripped)
Power-Load Unbalance Control Function

Newton Unit Response

freq(min) = 59.642, Max Unit MW, and Min Unit MVAR @ 16:44:16.3667 at the same time as Rockport-Sullivan trip

Unit 2 MVA decreases at a rate of 3.37pu/sec
• Improved and validated powerflow and dynamics models
  ▪ Benchmarking against actual system performance
• Library of standardized component models for generators and other electrical equipment
• Composite load modeling
• Move toward node-breaker modeling
• Tie to protection setting databases
• Interaction of System Protection and Turbine Controls
• Modeling Guideline – industry technical reference
Modeling Gap Analysis

1. Generator Dynamics – Eastern Interconnection governor and exciter models are suspect

2. Load Behavior – load composition changing
   Use of composite load models necessary
   - More air conditioning load
   - CFL and LED lighting – not like incandescent
   - Variable speed drives

3. Frequency Response – EI dynamics models not capable of simulating primary frequency response
4. Inter-Area Oscillations – EI models not capable of predicting
5. Equipment Modeling – lack of standardized system component models
   - Creating standardized component model library
6. Modeling Errors – data errors, wrong component models
7. Modeling Consistency – varying understanding of models and parameters
Modeling Gap Analysis

8. Model Compatibility – data exchange problems between platforms and programs
9. Approaches to Modeling – operational node-breaker models / Planning bus-line models
10. Special Protection Systems/Remedial Action Schemes – must model to predict interaction
11. Protection Systems – better modeling of protection systems needed
12. Turbine and Boiler Controls – research starting on what should be modeled
Questions?