Performance Monitoring and Model Validation of Power Plants

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Outline

- Motivation
- Model validation technique
- Results
- Findings
- BPA’s vision
- Question
Motivation

August 10, 1996

Observed COI Power (Dittmer Control Center)

Simulated COI Power (initialWSCC base case)

Time in Seconds
Motivation (continued)

- Planning and operational decisions are made based on system studies using models, without the accurate models, these study results give false outcome.

- Accurate and realistic assessments dynamic response capability of all plants are essential for system stability especially with high capacity wind integration.

- WECC generator testing program has improved generator models but we believe there are still lot of room to improve.

- No certification program on generator test performers.
BPA Generator Monitor Locations

**PMU**
- The Dalles 230 - 1,776 MW
- John Day - 2,576 MW
- John Day 230 (wind) - 800 MW and growing
- Chief Joseph - 2,670 MW
- McNary - 840 MW
- Grand Coulee 3rd - 4,600 MW
- Colstrip 3&4 - 1,526 MW
- Columbia Generating Station - 1,100 MW
- Boardman (at Slatt) - 620 MW
- Hermiston Power Partners - 580 MW
- Hermiston Generating Project - 480 MW

**Portable Power System Monitor (PPSM)**
- Bonneville PH#2 - 576 MW
- Centralia - 1,530 MW
- Boundary - 1,050 MW
- Chehalis Generating Project - 600 MW
- Kemano (Canada) - 920 MW
- Tucannon River (wind) - 150 MW
- Spring Creek (wind) - 200 MW
- **Total: (18 projects)** > 22,000 MW

**Future Locations:** Lower Monumental, Lower Granite, Little Goose, Libby, Grand Coulee 230, Grays Harbo (Combine cycle), Slatt 230 (wind), Rock Creek (wind), Jones Canyon (wind), Condon (wind)
Validation Overview

GE PSLF Simulations

Inject Recorded Voltage and Frequency

Compare Recorded and Simulated Power: MW and MVAR

Disturbance “playback” is a standard feature in PSLF
Validation Set-Up

- Build a sub system by extracting data from the latest base case
- Create a dyd file by extracting data from the latest dynamic file
- Solve load flow and confirm
Example of a sub-system
Validation Procedure

1. Archive disturbance data from PMU(.dst)/PPSM(.mat) from the point of interconnection

2. Using ExportDST/Matlab, convert the .dst/.mat files to .csv to create event files

3. Create Generator.ini file with .con file if two or more units are combined (SCADA data)

4. Run EPCL "GENS_set_base_cases.p" and "GENS_Simulate.p"

5. Plot the results
Results

- Blue trace is recorded data
- Red trace is simulated data
Chief Joseph Braking Resister (1400 MW)

A device used to help maintain stability in a power system by absorbing electrical energy for a brief period following a system disturbance. The BPA resistance brake, installed at Chief Joseph Substation and switched on for about one-half second when certain abnormal system conditions are detected, consists of five kilometers (three miles) of one-half inch stainless steel wire for each of the three phases of the power system, each wire strung in a vertical configuration on a modified transmission tower.
Calpine combine cycle plant – Chief Jo Brake event (August 2008) – Real Power
Calpine combine cycle plant – Chief Jo Brake event (August 2008) – Reactive power
Grand Coulee Unit 19 – Chief Jo Brake event (August 2008) – Real Power
Grand Coulee Unit 21 – Chief Jo Brake event (August 2008) – Real Power
Grand Coulee Unit 21 – Chief Jo Brake event (August 2008) – Real Power-PSS-Off
Grand Coulee Unit 21 – Chief Jo Brake event (August 2008) – Reactive Power
Grand Coulee Unit 21 – Chief Jo Brake event (August 2008) – Reactive Power-PSS-Off
Calpine – 3-24-2009 (Alberta Separation) – Governor off - Real Power
McNary PH1 – Chief Jo Brake event (August 2008) – Real Power
Gentpj test
McNary PH1 – Chief Jo Brake event (August 2008) – Reactive Power
McNary PH1 – Chief Jo Brake event (August 2008) – Reactive Power-gentpj
Chief Joseph Power Plant issue
Inadequate baseline test
Chief Joseph PH4 Round Mountain RAS event
06-11-2008 – Real Power
Chief Joseph PH4 Round Mountain RAS event 06-11-2008 – Reactive Power
Findings

- Model data errors, missing or misrepresentation of equipments
- Detection of the equipment problems (PSS off, off governor control)
- Good baseline test is required
- Sensitivity tests
- Data management and reporting
- There are limitations to the method (AGC, plant control)
BPA’s Vision

- R&D project “Generator Facility Performance and Model Validation”
  - Build a tool so that after an event all the generator performance within BPA region can be verified within hours
- Deployment of Phasor Measurement Unit on POI for every major power plant, including wind generation
- Pilot project with US Army Corp of Engineer, relay PMU in the plant
- Load model validation
- Implement PMU dynamic response requirement
- Continually work with the generator owners within the BPA Control Area on resolving any modeling issues
Thank You

Questions?