From Model Validation to Performance Analysis

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1

Level 1: Model Validation

Level 1: Model Validation
NERC MODs in 2014, WSCC in 1997

˝ Generator Owner Performs Model Validation

. Stage tests are used to develop a baseline model

. Consultants are used in majority of cases, internal capabilities exist in a few cases

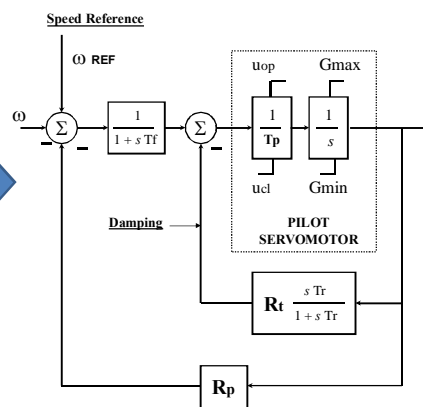˝ Transmission Planner takes the model at faith and uses in its planning and operational studies
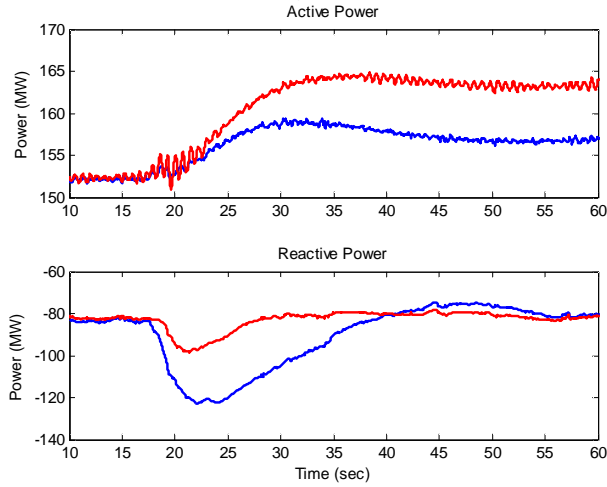
3

Baseline Model Development

Equipment

Model

4

Level 1: Model Validation
NERC MODs in 2014, WSCC in 1997

˝ … But how do you know the model is right
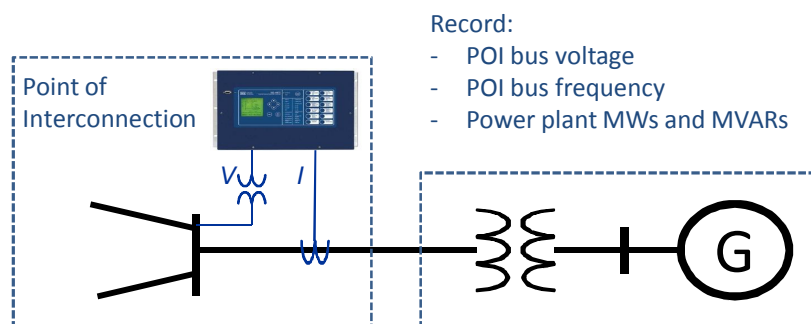
Consultant A

Consultant B

Level 2: Trust But Verify

Level 2: Trust but Verify
BPA in 1998-2013

˝ Generator Owner Performs Model Validation
˝ Transmission Planner has monitoring equipment at power plant POI, uses data for independent model validation
   - BPA worked with GE on adding disturbance play-in capabilities in PSLF software in 2001
   - BPA Transmission used play-in for independent validation of models since 2001
   - BPA developed Power Plant Model Validation (PPMV) application in 2011
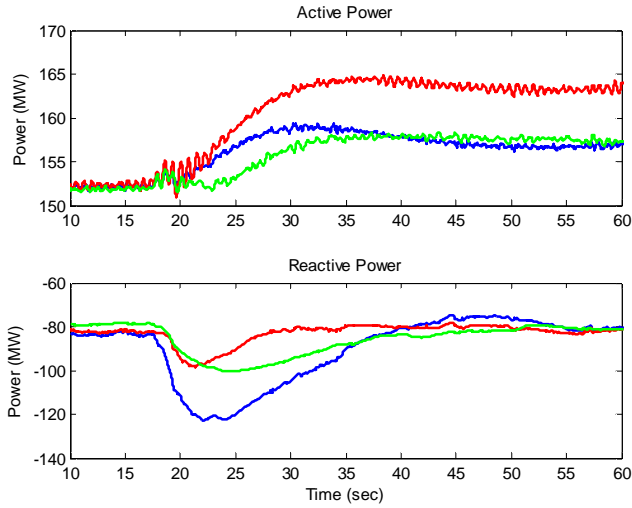   - BPA worked with PNNL on advancing data/model management capabilities 2012-2014

7

Level 2: Trust but Verify

Record:
- POI bus voltage
- POI bus frequency
- Power plant MWs and MVARs

Point of Interconnection

G

8

Level 2: Trust but Verify
Now you know the model is WRONG

Consultant A

Consultant B

Reality

Level 2+: Calibration

Level 2+: Calibrate
Q: My Model is WRONG, what can I do?
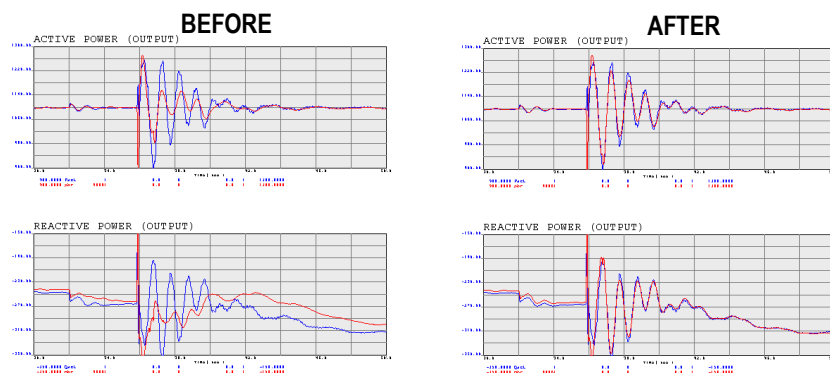## A: Calibrate using disturbance data !

˝ There are several research-grade products that can "calibrate" model using disturbance recordings – PNNL, MATLAB, Georgia Tech, University of Texas, University of Wisconsin, EPRI

˝ **Engineering judgment is essential**

˝ BPA collaborates (not endorses) with University of Wisconsin (Bernie Lesieutre) and EPRI (Pouyan Pourbeik)

11

Level 2+: Calibrate
Calibration can be done when supervised with competent engineers
BPA (Steve Yang) and University of Wisconsin (Bernie Lesieutre)

BEFORE   **AFTER**

Blue = Actual, Red = Model

We did this for 20 events and counting

12

Level 3: Performance Analysis

Level 3: Performance Analysis starting 2014

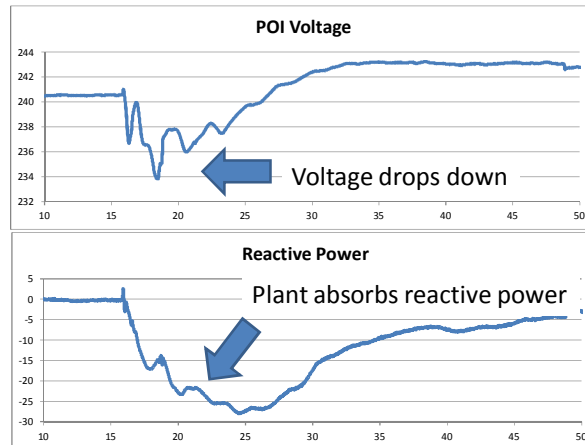˝ Would you like to have a precise model of malfunctioning or mis-tuned equipment ?

˝ NO!

˝ Fix and tune your equipment to do GOOD!

14

Level 3: Performance Analysis
Understanding system requirements

″ The project is critical for voltage support

″ However, overly aggressive PSS over-rides voltage control during power swings

POI Voltage

Voltage drops down

Reactive Power

Plant absorbs reactive power

15

Level 3: Performance Analysis

″ **Back to the Future**

″ Transmission planner understands equipment capabilities

″ Generator owner understands the power system requirements

″ Both work together on optimal tuning of generator controls to improve reliability of the Bulk Electric power System

″ Use PMUs for performance monitoring

16

Level 3: Performance Analysis starting 2014

Generator has

˝ two controllable things (a) generator excitation, (b) gate/control valve/fuel valve

˝ and many control objectives (sometimes conflicting)

. Voltage control

. Damping of oscillations

. Frequency response

. Isolated operation / black-start

. …

17

Level 3: Performance Analysis starting 2014

˝ Understand system performance needs

. Well, they may vary with operating conditions

˝ Conduct system impact and sensitivity studies to determine robust settings (respect equipment capabilities)

˝ Tune the equipment to do good (not to be a hero)

˝ Use PMU disturbance data for performance monitoring

18