NASPI & NERC SMS
MODEL VERIFICATION TOOLS TECHNICAL WORKSHOP
PLAYBACK SESSION GUIDEBOOK

October 18, 2016
1:00 to 5:30pm
Seattle Marriott Waterfront Hotel

SESSION OVERVIEW

Power Plant Model Verification (PPMV) involves verifying the model structure and model parameters associated with the building blocks of a generating facility. Disturbance-based model verification uses Phasor Measurement Unit (PMU) data or other high-resolution disturbance monitoring data to ensure that the modeled response to a system event matches the actual response of the power plant or generating unit. This verification is a binary ("yes/no") check that the model is performing as expected. Online performance monitoring provides a cost effective and efficient means of ensuring that the model is accurate.

Most commercial software vendors have included playback models that enable disturbance-based PPMV. This session will demonstrate these tools' functionality and features for performing PPMV.

The goal of the videos for this session is to show users what the playback tools do and how they work (at a high level) by showing the major features, steps, and processes or sequences involved in using the software for playback. Please use the playback event datasets provided below to demonstrate software functionality in the video (for instance, showing how the data are loaded into the software and converted to playback-capable data, and how the event is shown in playback mode).

We anticipate five participant videos demonstrating playback tools in this segment of the model verification workshop. The organizers will show these in a randomly selected order. Comments sheets will be distributed for audience members to take notes. We will entertain a few minutes of comments and questions after each video, and hold an audience discussion session after all of the videos have been shown.

PLAYBACK DEMOS

The playback demonstrations will be given in the workshop in the form of a video demo with audio narration included in the videos. Where the instructions below call for "describe", the description can be done by a combination of on-screen text, a series of in-software screen or page captures, and/or voice-over narration.

Please follow this content sequence for your video. You may insert transition or subtitle slides (e.g., a slide at 1:05 in the video with the subtitle, "Input PMU Data") between segments of the video if desired.

- **Title screen (5 seconds):** The title screen should appear when the video is brought up and paused. The title screen should include:
  - The name of the tools or software platform (e.g., GE PSLF PPMV)
  - Company name and logo(s)
- **Overview of Tool (1 minute):** A short overview of the software tool, its functionality and features, how it integrates or is included in the standard software package, any software requirements or of the tool
- **Input PMU Data (1 minute):** Describe and show the input data format and file(s), how that data gets loaded into the simulation, etc.
- **Powerflow Model (1.5 minutes):** Describe how the (reduced) powerflow model is created and the modeling requirements for this model (playback generator, added jumper lines, etc.)
- **Dynamics Data (1.5 minutes):** Describe what dynamics data records are included, explain the playback generator model, any monitors or channels that need to be added, etc.
- **Performing PPMV Playback (1 minute):** Describe and show how to execute the playback simulation run and show the playback.
- **Simulation Results (45 seconds):** Describe what format the simulation results are provided in and how to access those results.
- **Comparing Model vs. Actual Performance (1.5 minutes):** Describe and show any steps required to compare the simulation results with the actual PMU data, illustrate how these plots are compared against each other (e.g., P and Q quantities) for either one or multiple simulations, etc.

NOTE:

Videos shall be no longer than 8 minutes and 30 seconds; you are welcome to make it shorter as long as it covers the material above. If your draft video runs longer than the limit, we will ask you to modify it. The video segment times (e.g., Input PMU Data is a segment) above are guidelines to encourage you to address those aspects of the tools that are most important to the user's understanding and experience; but please be sure to address all of the points specified in the list above.

PLAYBACK DATASETS

One gas turbine generator model and two datasets are provided for illustrating your software performance and demonstrating the playback functionality. The following notes offer detail on the datasets.

- The data is provided in GE PSLF format; however, it is provided in text-readable format and can be converted to applicable software.
- The PMU data includes header data that can be ignored when converted to necessary format.
- The PMU data includes the following data: Time, Voltage Magnitude, Frequency, Active Power, Reactive Power, Voltage Phase Angle.
- The simulation output data (P and Q) are provided as a reference only.

DEVELOPMENT TIMELINE

Here are the timeline and deadlines for workshop participants:

July 5	Instructions and datasets released to workshop participants *Approx. 9 weeks to develop your playback demonstration video*
September 2	Send video to workshop organizers – please use ftp site or upload to YouTube and send a link
September 30	Organizers will review the videos and give feedback on whether it meets time limits and content requirements, and suggest improvements for clarity
October 18	PPMV Workshop

EVENT DATA FILES

Event data for the two (2) events for the gas generator are provided in the format shown in Figure 1. The headers are used in the playback model; the data records include the quantities identified in Table 1.

Table 1: Data File Quantities

Column	Quantity	Units
A	Time (relative)	Sec
B	Bus Voltage Magnitude	kV
C	Bus Frequency	Hz
D	Active Power Output	MW
E	Reactive Power Output	MVAR
F	Bus Voltage Angle	Deg

5					
Time Vact Fact Pact Qact //Head					
1 500 60 1 1 // Scale					
0 0 0 0 0 // Offset					
0 0 0 0 0 // Tf					
0 0.8 0.99 0 -200 // min					
0 1.2 0.99 1000 200 // max					
75 1 1 1 1 // Plot					
0	547.4673	60.00002	79.98307	-1.99037	-143.67
0.033333	547.456	60.00002	79.97124	-1.98633	-142.766
0.066667	547.4365	60.00003	79.96841	-1.9858	-141.842
0.1	547.4334	60.00004	79.96796	-1.98537	-141.828
0.133333	547.4307	60.00001	79.98277	-1.94515	-141.442
0.166667	547.4285	59.99997	79.98241	-1.94654	-140.981
0.2	547.4281	59.99995	79.99251	-1.9517	-140.636
0.233333	547.4366	59.99995	79.99373	-1.95304	-140.151
0.266667	547.4298	59.99993	79.97747	-1.9955	-139.327
0.3	547.4276	59.9999	80.0025	-1.96091	-138.379
Time	*V_{mag}*	*Freq*	*P*	*Q*	*Ang*

Figure 1: PMU Data Format

POWERFLOW BASE CASE AND PMU MEASUREMENTS

The powerflow base cases provided for each unit include a single generating unit connected to a generator step-up (GSU) transformer and a system equivalent network. This is shown in Figure 2. The generator under test and GSU connect to a jumper line with impedance less than the powerflow jumper threshold. This is for ease of monitoring powerflow quantities in some of the software platforms. The jumper line is connected to a system equivalent generator in the powerflow which corresponds to the playback generator in the dynamics dataset. Note the one powerflow base case is provided as reference. This case may need to be modified for playback to match the initial conditions of each test case; however the powerflow parameters remain unchanged across all events.

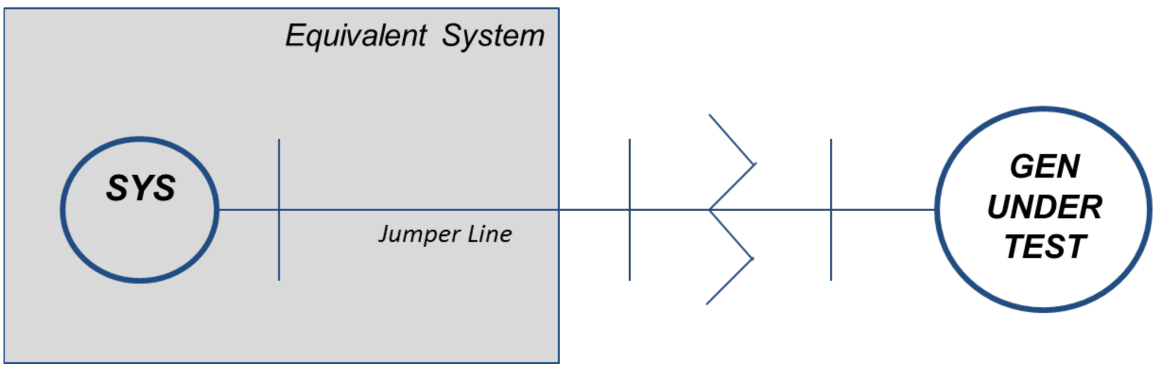

Figure 2: Powerflow Base Case Setup

The PMU measurements provided in the event data files are measured at the high-side of the GSU, as shown in Figure 3. Positive quantities of active and reactive power relate to flows out of the generator while negative quantities relate the flows into the generator.

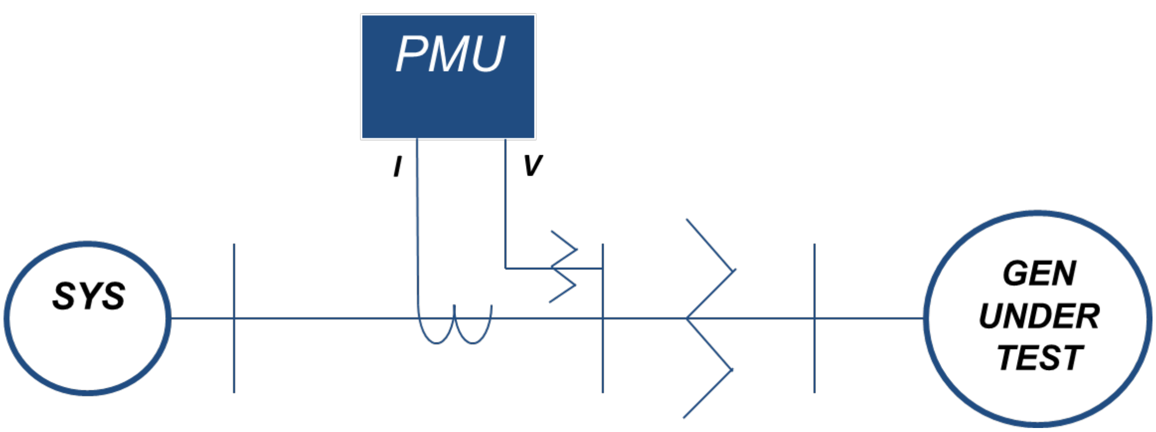

Figure 3: PMU Measurement Location

DYNAMICS DATASETS

The dynamics data are provided in .dyd format, which is text readable and easily convertible. These datasets include models related to the monitoring of signals and the playback model used for PPMV[1]. These models can be ignored for conversion purposes; only the generator models under test must be used.

DESCRIPTION OF POWER PLANT

Gas Turbine Generating Plant

A 230 MVA gas turbine generator is modeled using the following:

- genrou: Round Rotor Machine
- rexs: Rotating Excitation System
- ggov1: General Purpose Turbine-Governor
- pss2a: Analog Dual-Input Stabilizer\

The datasheet for the gas unit is provided on the following pages. This data matches the data provided in the dynamics data files part of the simulation package.

[1] These include the alwscc, vmeta, fmeta, ameta, imetr, plnow, and gthev models.

GAS TURBINE PLANT MODEL

GENROU		REXS		GGOV1		PSS2A	
Param	**Value**	**Param**	**Value**	**Param**	**Value**	**Param**	**Value**
Xd	1.85	Tr	0.02	R	0.05	J1	1
X'd	0.21	Kvp	600	Rselect	1	K1	0
X''d	0.15	Kvi	0	Tpelec	0.6	J2	3
Xq	1.3	Vimax	0.2	Maxerr	0.025	K2	0
X'q	0.7	Ta	0.02	Minerr	-0.025	Tw1	1
X''q	0.15	Tb1	1	Kpgov	6	Tw2	1
Xl	0.15	Tc1	10	Kigov	0.22	Tw3	5
Ra	0.003	Tb2	1	Kdgov	0	Tw4	0
T'd0	5	Tc2	1	Tdgov	1	T6	0
T''d0	0.25	Vrmax	10	Vmax	1	T7	5
T'q0	1	Vrmin	-10	Vmin	0.24	Ks2	0.5
T''q0	0.05	Kf	0.045	Tact	0.6	Ks3	1
S(1.0)	0.12	Tf	5	Kturb	1.5	Ks4	1
S(1.2)	0.48	Tf1	1	Wfnl	0.25	T8	0.5
H	3.1	Tf2	1	Tb	1	T9	0.1
D	0	Fbf	1	Tc	1	N	1
Rcomp	0	Kip	5	Flag	1	M	5
Xcomp	0	Kii	0	Teng	0	Ks1	15
Accel	0.5	Tp	0	Tfload	0.3	T1	0.28
Kis	0	Vfmax	99	Kpload	1	T2	0.043
Pfd	0	Vfmin	-99	Kiload	3.3	T3	0.281
Pkd	0	Kh	0	Ldref	1	T4	1.16
Pfq	0	Ke	0.4	Dm	0	Vstmax	0.1
Pkq	0	Te	1.2	Ropen	99	Vstmin	-0.1
Speed	0	Kc	0	Rclose	-99	A	1
Angle	0	Kd	0.7	Kimw	0	Ta	0
		E1	2.4	Pmwset	0	Tb	0.043
		Se1	0.05	Asest	99		
		E2	3.2	Ka	10		
		Se2	0.3	Ta	1		
		Rcomp	0	Db	0		
		Xcomp	0	Tsa	1		
		Nvphz	0	Tsb	1		
		Kvphz	0	Rup	99		
		Flimf	0	Rdown	-99		

GENROU		REXS		GGOV1		PSS2A	
Param	**Value**	**Param**	**Value**	**Param**	**Value**	**Param**	**Value**
		Xc	0				
		Vcmax	0				
		Kefd	0				
		Limflg	0				