NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Bringing Value to Synchrophasors: NERC Reliability Standards

CIGRE Tutorial, Chicago, IL

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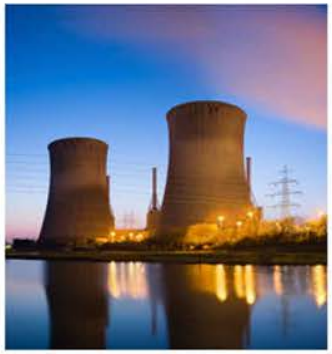
October 11, 2015

RELIABILITY | ACCOUNTABILITY

Disclaimer

- *This is **not** Compliance Guidance material.*

- *The goal is to illustrate the value in applying synchrophasor technology to NERC Reliability Standards.*

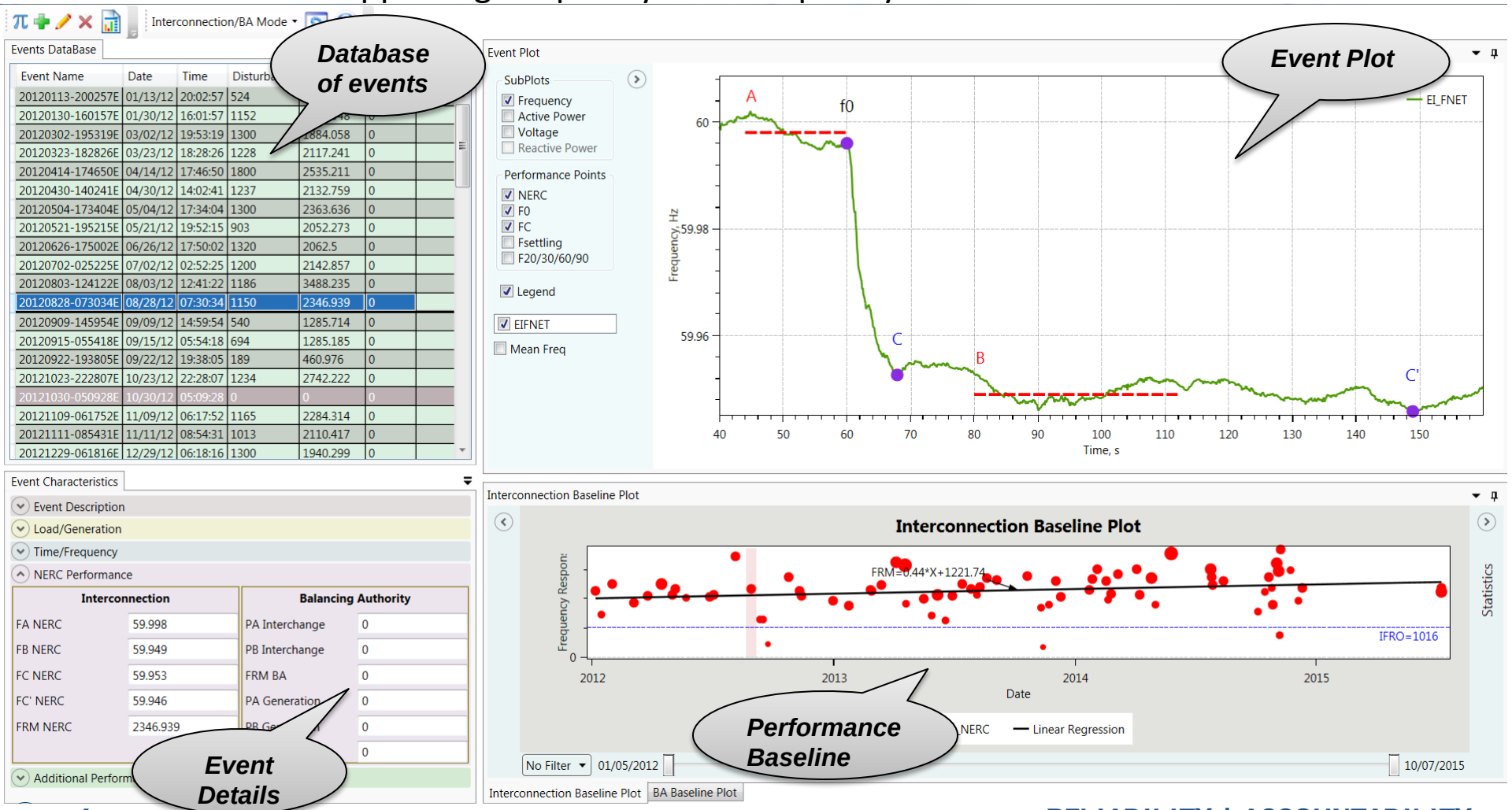
Starter Kit Highlights

- This list highlights the more **mature, high-value applications**
  - Comprehensive list will be developed by NERC SMS
- **Disclaimer:** This is not Compliance Guidance material.
- **Goal:** Illustrate value in synchrophasor technology for meeting NERC Reliability Standards.

Standard	Title	Status
BAL-003-1	Frequency Response and Frequency Bias Setting	Subject to Enforcement
FAC-001-2	Facility Interconnection Requirements	Subject to Enforcement
IRO-003-2	Reliability Coordination – Wide-Area View	Subject to Enforcement
MOD-026-1	Verification of Models and Data for Generator Excitation Control System or Plant Volt/Var Control Functions	Subject to Enforcement
MOD-027-1	Verification of Models and Data for Turbine/Governor and Load Control or Active Power/Frequency Control Functions	Subject to Enforcement
MOD-033-1	Steady-State and Dynamic System Model Validation	Subject to Enforcement
PRC-002-2	Disturbance Monitoring and Reporting Requirements	Subject to Future Enforcement

BAL-003-1: Frequency Response and Frequency Bias Setting

- Maintain Interconnection Frequency within predefined bounds by arresting frequency deviations and supporting frequency until frequency is restored to scheduled value.



Frequency Response Analysis Tool (FRAT)

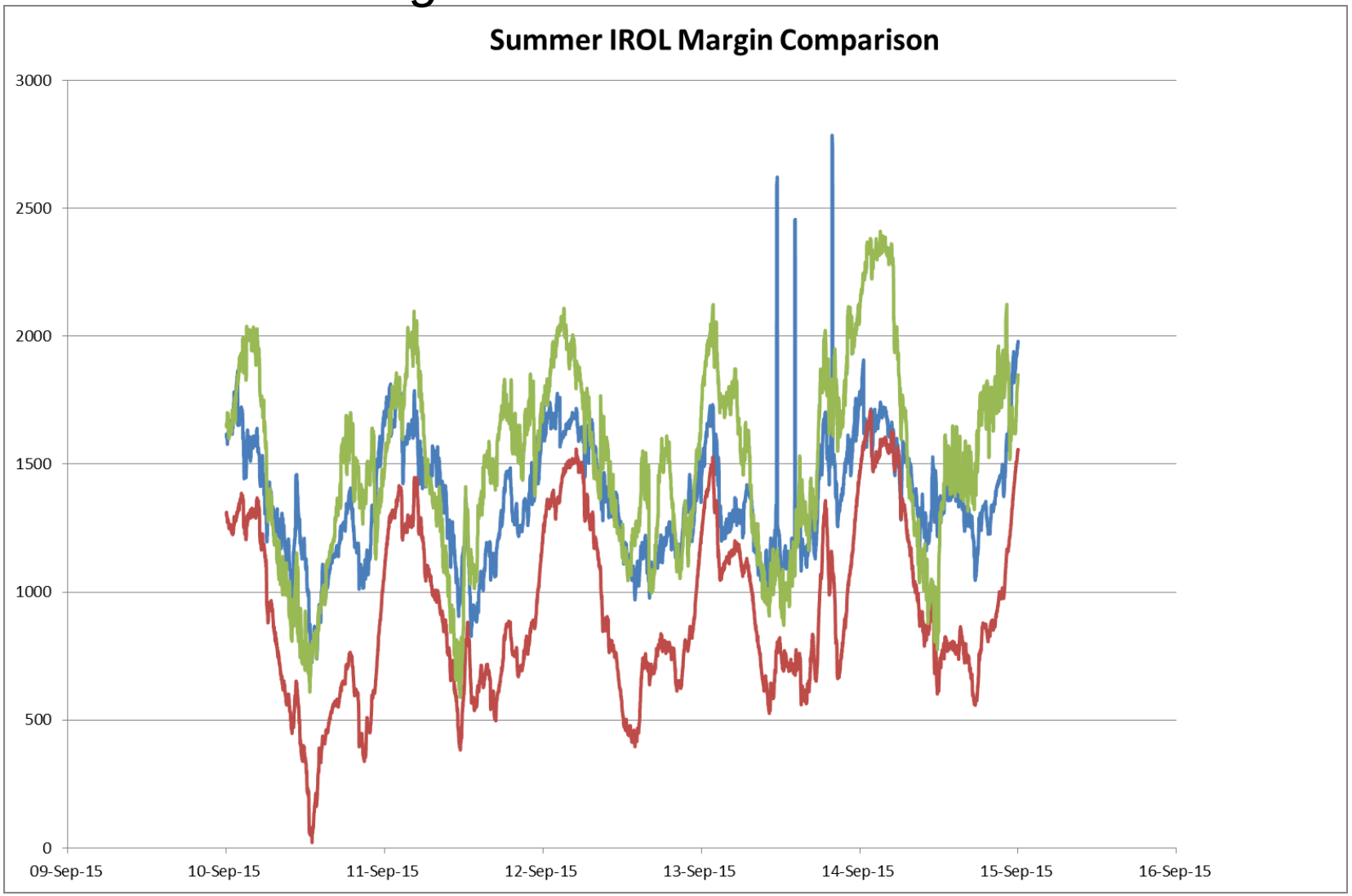
FAC-001-2: Facility Interconnection Requirements

- TOs and applicable GOs must document and make Facility Interconnection requirements available so that entities seeking to interconnection will have the necessary information.
  - **Does not** explicitly specify requirements for synchrophasor technology
  - **However**, utilities requiring PMU capability at new generation interconnections
    - Facility Connections Requirements (FCR)
    - Open Access Transmission Tariff (OATT)

Entity	Reference
PJM	http://www.pjm.com/documents/agreements.aspx http://www.pjm.com/documents/manuals.aspx
BPA	http://www.bpa.gov/transmission/Doing%20Business/Interconnection/Pages/default.aspx
AESO	http://www.aeso.ca/rulesprocedures/18592.html
ERCOT	http://www.ercot.com/mktrules/guides/noperating
Duke Midwest	http://www.ferc.duke-energy.com/DEW/MidwestConnection.pdf
IPC	https://www.idahopower.com/pdfs/BusinessToBusiness/facilityRequirements.pdf

IRO-003-2: Reliability Coordination – Wide-Area View

Peak RC Baselining of IROL Calculations



Source: Peak RC

MOD-026-1 & MOD-027-1: Verification of Models and Data

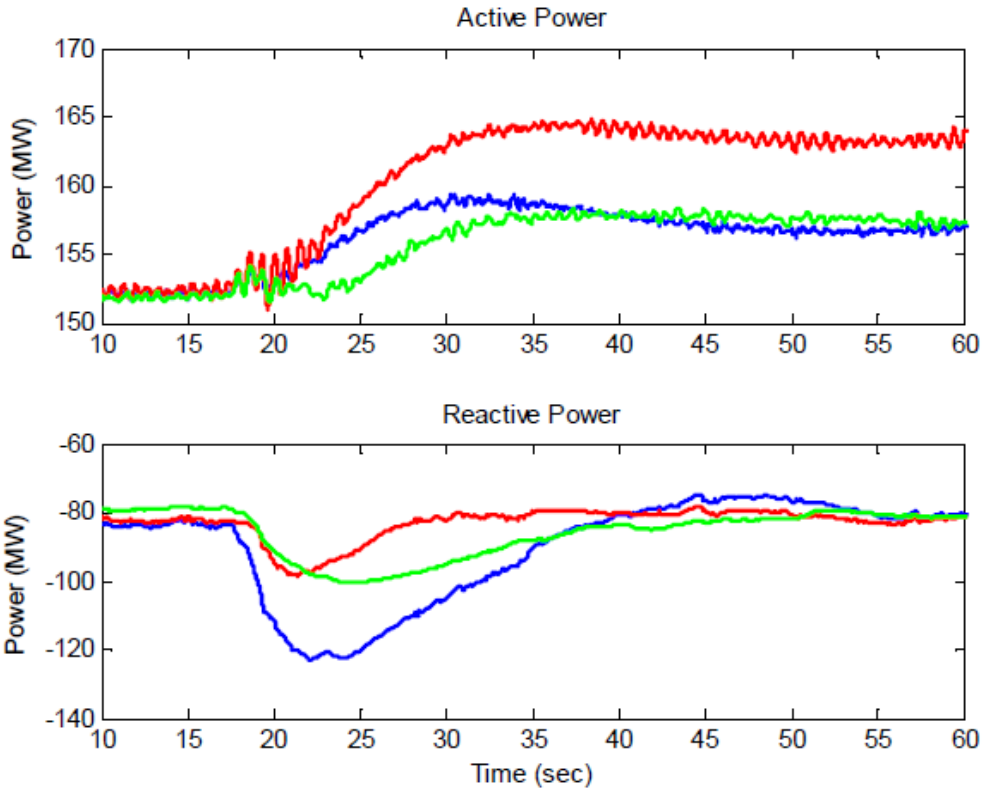
- MOD-026: Generator excitation control system or plant volt/var control functions
- MOD-027: Turbine/governor and load control or active power/frequency control functions
- Applicability:
  - Individual generating unit greater than 100 MVA gross nameplate rating
  - Individual generating plant consisting of multiple generating units that are directly connected at a common BES bus with total generation greater than 100 MVA gross aggregate nameplate rating
- Process:
  - R1. TP provides instructions and model data to GO
  - R2. GO provides verified model back to TP
  - R3. TP can provide oversight of model and performance
  - R4. GO provides revised model/plans upon any changes made

MOD-026-1 & MOD-027-1: Verification of Models and Data

- Requirement R3: "…[GO] receiving one of the following items for an applicable unit:"
  - "…indicating that the ***simulated*** excitation control system or plant volt/var control function model response did not match the ***recorded*** response to a transmission system event."
- Requirement R5: "[GO] …following receipt of a technically justified*…request from the [TP] to perform a model review of a unit or plant…"
  - ***technical justified**: …[TP] demonstrating that the ***simulated*** unit or plant response does not match the ***measured*** unit or plant response.

Value of Event Verification

- Prior to PMU-based verification, TP used model at face value
- With PMU-based verification, TP can VALIDATE the verified model



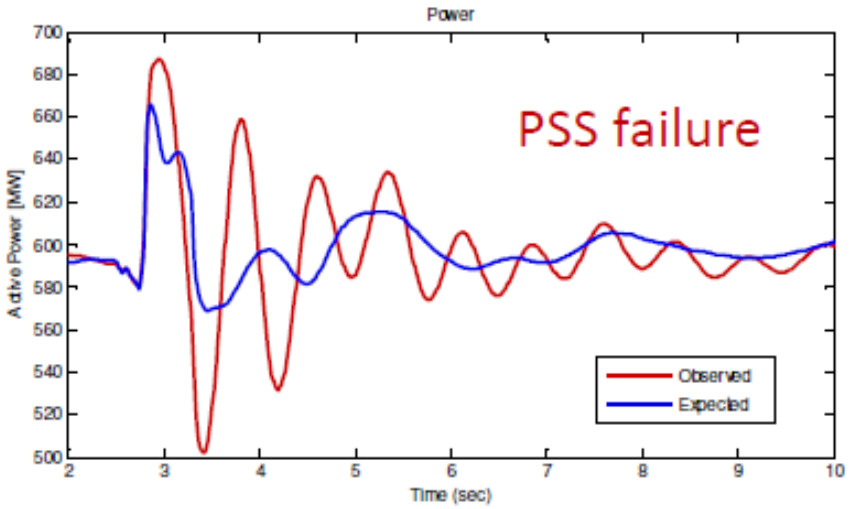
Consultant A

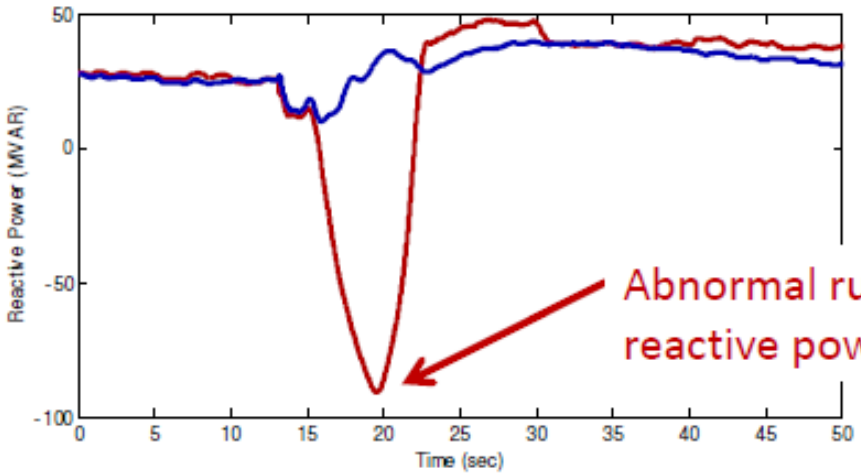
Consultant B

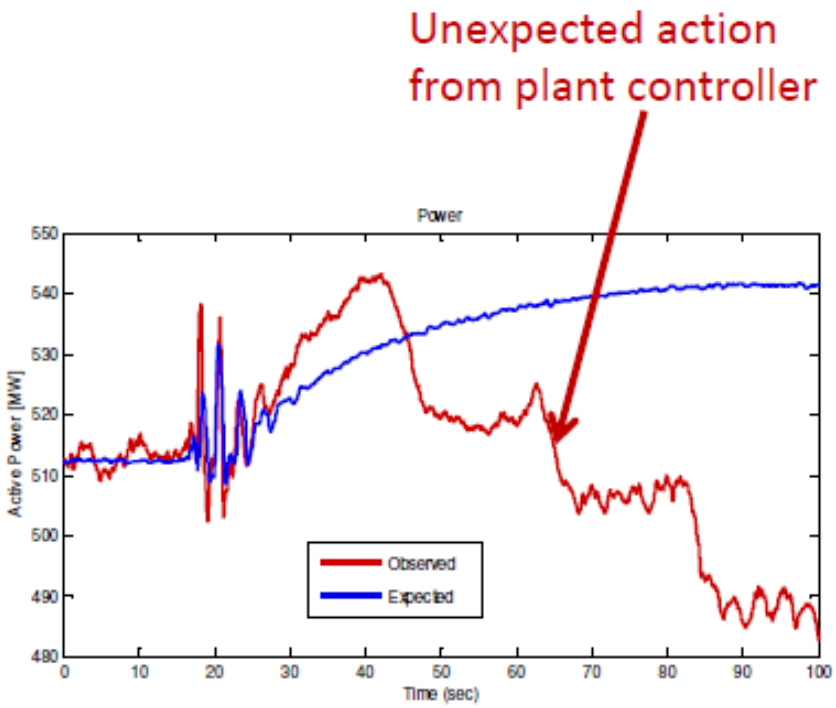
Reality

Source: BPA

Beyond Model Verification: Performance Monitoring



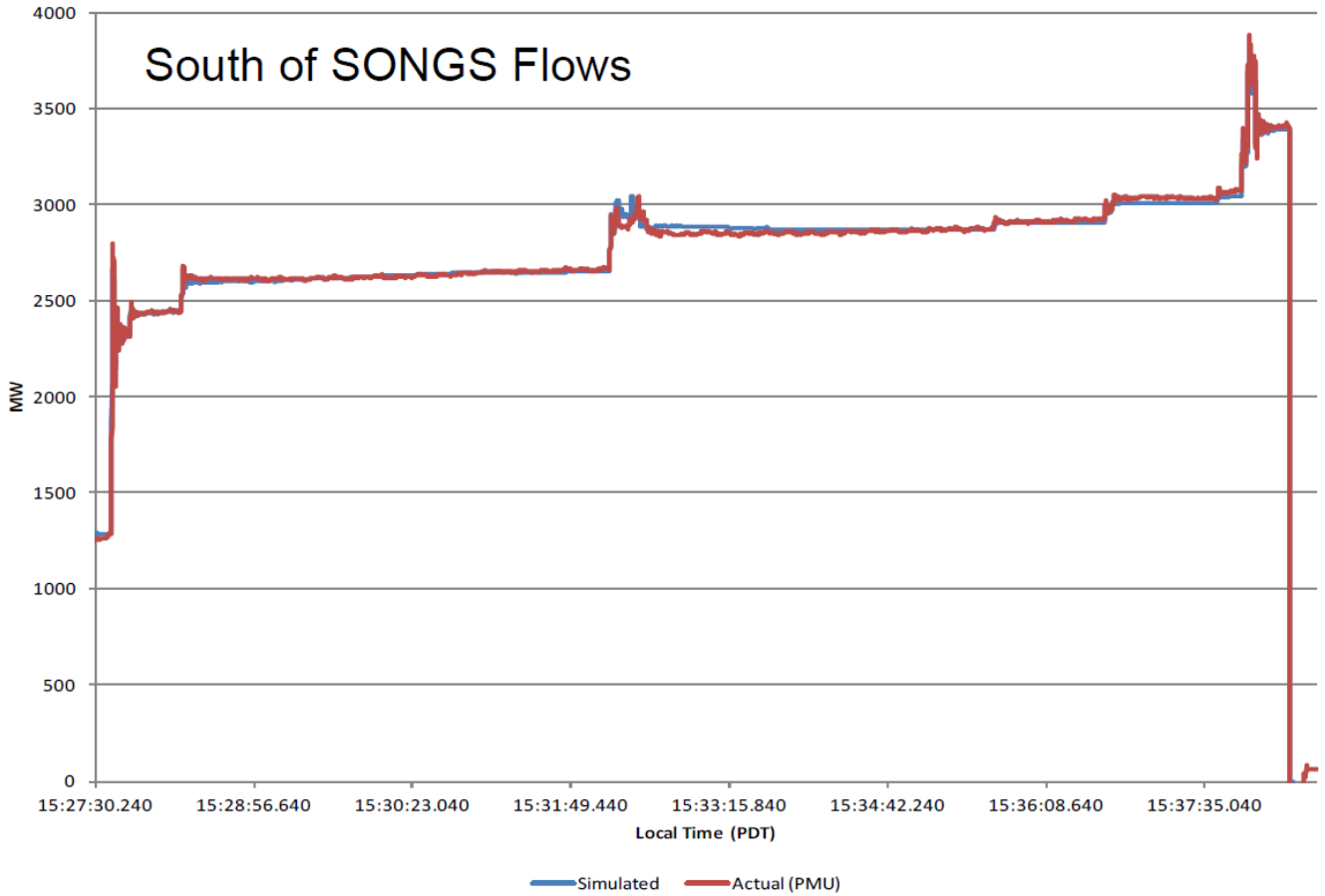




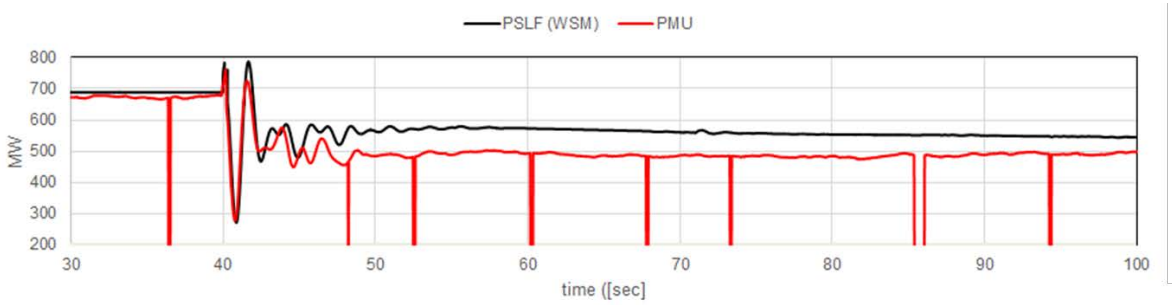
Source: BPA

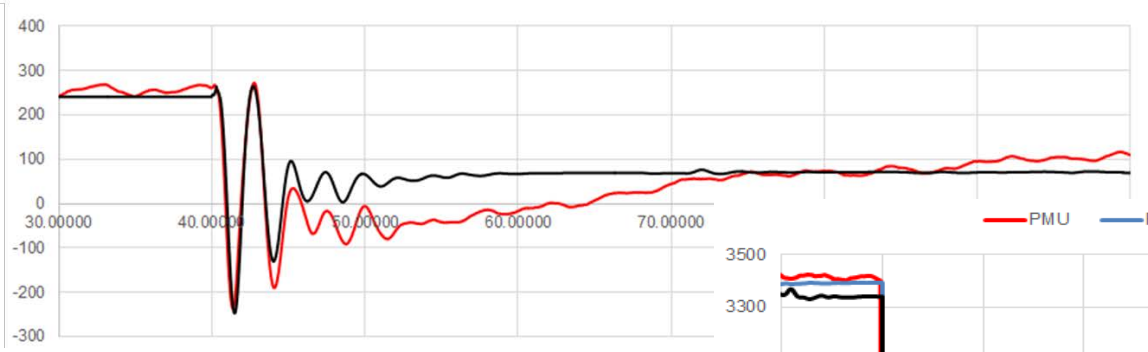
MOD-033-1: Steady-State and Dynamic System Model Validation

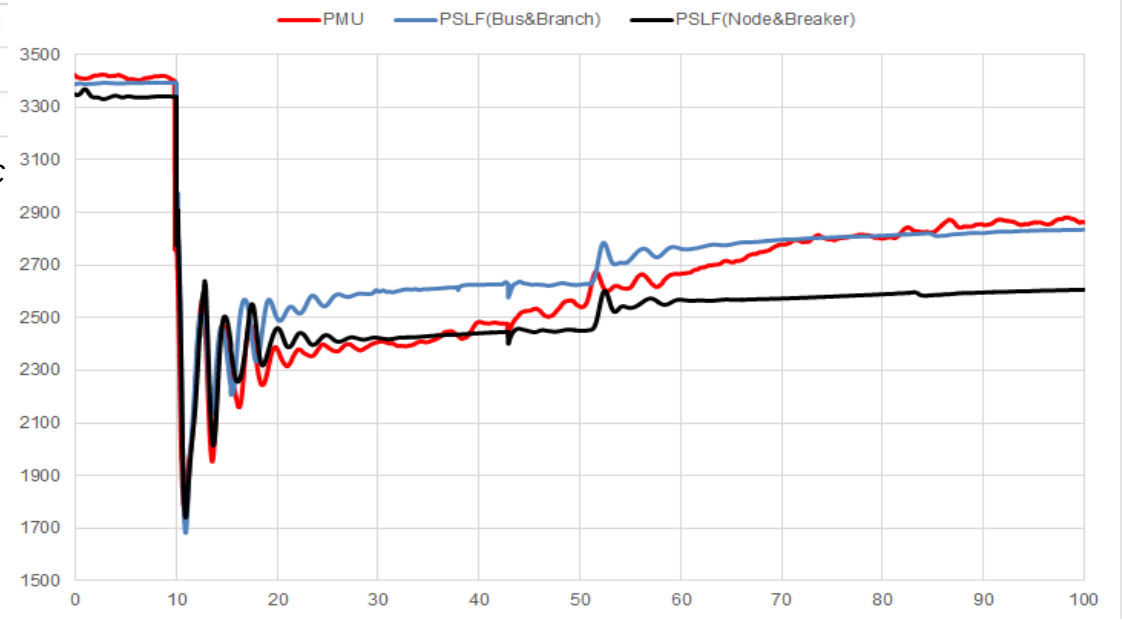
- Comparing modeled performance and actual system performance during dynamic events



Comparison of Major Transmission Interface Flows







Source: Peak RC

PRC-002-2: Disturbance Monitoring and Reporting Requirements

- Location Requirements:
  - **Generating resource(s)**:
    - **Single unit >= 500 MVA; Units >= 300 MVA at plant >= 1000 MVA**
  - Any one BES Element that is part of a **stability (angular or voltage) related System Operating Limit (SOL).**
  - Each terminal of **HVDC circuit** with rating >= 300 MVA, on AC side.
  - One or more BES Elements that are part of an **Interconnection Reliability Operating Limit (IROL)**.
  - Any one BES Element within a **major voltage sensitive ar**ea, defined as area with in-service undervoltage load shedding (UVLS) program.
- Measurement Requirements:
  - **V, I, F, P, Q**
  - **Continuous data recording and storage**, unless grandfathered.
  - Time sync'd data with or without local time offset **+/- 2 ms of UTC**

PRC-002-2: Disturbance Monitoring and Reporting Requirements

- Data Retention, Reporting, and Storage Requirements
  - **Retrievable for the period of 10-calendar days**, inclusive of the day the data was recorded.
  - P**rovided within 30-calendar days of a request** unless an extension is granted by the requestor.
  - P**rovided in electronic** files formatted in **C37.111 (COMTRADE), revision C37.111-1999 or later**.
  - Named in conformance with **C37.232 (COMNAME), revision C37.232-2011 or later**.

Questions and Answers