Technology Innovation Project

Closing Project Brief

TIP 350: Power Plant Dynamic Performance Monitoring Center

Context

BPA has been the industry leader in using disturbance recordings for validation of dynamic models of power plants. In early 2000s, BPA engineers worked with General Electric Company on implementing a disturbance play-in function in its Positive Sequence Load Flow (GE PSLF) grid simulator. The function was used to inject Phasor Measurement Unit-recorded voltage and frequency data at plant point of interconnection in grid simulations. TIP 52* advanced model validation capabilities. Scripts were developed in GE PSLF to batch multiple validation runs for multiple plants.

TIP 274** further advanced the model validation capabilities by introducing state-of-the art data and model management capabilities. BPA collaborated with Pacific Northwest National Laboratory (PNNL) in this effort.

BPA also expanded model validation capabilities to wind power plants, and tested model calibration methods. BPA is working with EPRI on wind power plant model validation and model calibration.

Description

With this project, we combined available tools and techniques into an integrated system for monitoring power plant dynamic performance and model validation. The system detects and logs system events, as well as streamlines data extracts to enable the model validation process.

The system also monitors power plant dynamic performance and notifies BPA technical staff when a controller-forced oscillation develops. It includes tools for assessing the oscillation cause. The monitoring system also benchmarks the generator responses.

The following tasks were completed:

Task 1: Data and Information Flow Design
Develop an integrated data flow from (a) event detection to (b) event classification and initial assessment to (c) automated data retrieval to (d) analysis and reporting to (e) performance baselining.

Task 2: Advances to event detection algorithms
Research, develop and demonstrate analytical capabilities to identify event metrics and include them into the email notification system.

We develop an event log with direct links to the PMU data, so that the data can be easily downloaded from the archive or historian.

Task 3: Model Validation and Stressed Tests
BPA manually performs “stressed” tests of power plant models by subjecting them to extreme events to ensure model fidelity, robustness and numeric stability. We automate “stressed” tests, and integrate them with the BPA-PNNL Power Plant Model Validation (PPMV) application.

Task 4: Performance Monitoring
BPA-PNNL PPMV application can be used to benchmark and monitor generator performance.

BPA has been working with PNNL on demonstrating a spectrum coherency method for detecting small signal oscillations that can be a pre-cursor to an impending controller failure.

Task 5: Technology Transfer and Outreach
The tools developed and demonstrated in this project will be deployed at BPA’s Transmission Grid Modeling and Measurement Systems workstations, training will be conducted, and business processes will be updated.

BPA will conduct industry outreach with its customers in Pacific Northwest, as well as other parts of the Western Interconnection. Currently, PPMV is actively used at Pacific Gas Electric.

Benefits

The benefits of the BPA model validation projects are indisputable. As a result of previous Technology Innovation and Transmission projects a number of modeling errors have been detected, and subsequently corrected. Model calibration studies were completed for Columbia Generating Station in lieu of re-testing. Models also helped to identify several control abnormalities, including Grand Coulee PSS failure, abnormal reactive power runback at Chief Joseph, and frequency response withdrawal at Grand Coulee.

Further development of BPA’s model validation and calibration capabilities will improve the quality of Federal Columbia River Power System (FCRPS) dynamic database significantly.

Accomplishments

This project developed and demonstrated an integrated system for monitoring power plant dynamic performance and model validation.

Deliverables

A Power Plant Dynamic Performance Monitoring Center that has been demonstrated in the relevant environment and has the following capabilities:

- Events are detected and classified, notifications are sent through the BPA e-mail, e-mail includes event report. Data is extracted automatically
- Updates PPMV with State Estimator Models, upgraded to new API with GE PSLF that does not require use of external EPCLs
- Automates model acceptance process similarly to PPMV process
- Performs routine benchmarking of power plant performance against performance metrics such as Frequency Response Obligation and voltage control
- Deploys small signal oscillation detection application, log events of sustained oscillations, and provides data extraction capabilities

User training and customer outreach programs

TIP 350: Power Plant Dynamic Performance Monitoring Center

Project Start Date: October, 2015

Project End Date: September, 2018

Funding

Total Project Cost: $430,000

Reports & References

Related Technology Innovation Projects

*TIP 52: Generating Facility Performance Measures and Model Validation

**TIP 274: Development and Demonstration of Applications for BPA and FCRPS Compliance with Modeling Standards and Performance Monitoring

For More Information Contact:

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Participating Organizations

Pacific Northwest National Laboratory (PNNL)
US Army Corps of Engineers (USACE)
US Bureau of Reclamation (USBOR)

Conclusions:

Organizational users of this project are TPMG and TECM groups. The tools will be deployed at their workstations, training will be conducted, business processes will be updated.

BPA will also conduct industry outreach with its customers in Pacific Northwest primarily, as well as other parts of the Western Interconnection. Currently, PPMV is actively used at Pacific Gas Electric.

This TIP 350 is a very successful project in a series of successful TI Project developing tools in Power Plant Performance Modeling and Validation. We recommend continuous use of the tools developed and continued communication with USACE and USBOR