TIP 408: Federal Columbia River Power System (FCRPS) Generator Modeling, Monitoring and Governor, and Voltage Control Optimization

Context

This project is a continuation of a multi-year collaborative effort between BPA Transmission and US Army Corps of Engineers (USACE) in the area of generator modeling, monitoring and control optimization. The project is continuation of the work that had been started in earlier Technology Innovation RD&D projects referred to as Phase 1 (TIPs 274 and 313*) and Phase 2 (TIP 350*).

The first phase of generator model validation was successfully completed and developed tools that have been adopted by USACE and BPA staff for improving generator models while reducing NERC compliance costs. The second phase completed in Sep. 2018 covers the state of PMU-based model validation and performance monitoring tools.

With the completion of phase 2, we can now report the dynamic performance of the entire FCRPS fleet! BPA's success was greatly publicized within the industry (NERC, WECC, NASPI).

Description

The project is a continuation of a multi-year collaborative effort between BPA Transmission and US Army Corps of Engineers in the area of generator modeling, monitoring and control optimization. This project completes work started under TIP 313* and focuses on the optimization of generator primary controls (AVR, PSS, governors) to provide essential reliability services.

Phase 3 – Control Optimization for Essential Reliability Services will be accomplished in four tasks:

Task 1: Governor tuning for stable black-start operation (NERC EOP-005-3 Standard). Black-start is the essential reliability service. Tuning hydro-governors is challenging because of the water inertia effects. We experienced several cases when hydro generators failed to pick-up load in islanded conditions. We tested "proof-concept" tuning at Hills Creek and Chief Joseph plants. Under this project, we will continue development of analytical tools and performance tuning of FCRPS hydro-governors for isolated operations.

Task 2: Voltage control optimization and PSS tuning (WECC VAR Standards). Voltage control is an essential reliability service. Recent automatic voltage regulation (AVR) and power system stabilizers (PSS) performance issues at Libby and Chief Joseph, as well as oscillatory interactions between PSS and UEL at multiple power plants highlight the need for AVR optimization to meet voltage control and oscillation damping requirements. We started development of analytical tools and performed initial tests at John Day. Under this project, we will continue development of tools, test procedures to enable USACE HDC staff to perform AVR / PSS/ UEL control tuning and optimization at FCRPS plants

Task 3: Governor tuning to optimize frequency response (NERC BAL-003 Standard). There is trade-off between how fast governor responds and system stability. While we want to maximize the availability of frequency responsive reserves, we need to make sure that fast response does not result in the oscillation problems. We will study the trade-off from plant and the system perspectives to recommend the on-line governor response strategy (PID settings, use of load versus speed governor mode, etc.)

Task 4: Coordination between primary controls (governors), secondary plant controls (GDACS) and BA controls (BPA AGC). This task provides an interface between the BPA Grid Modernization project and this project. Should additional performance requirements result from BPA Grid Modernization project, we will make sure the primary controls are aligned.

Why It Matters

The benefits of the BPA generator modeling, monitoring and control optimization projects are indisputable. This work will reinforce FCRPS position to provide essential reliability services. DOE and FERC have emphasized the need essential reliability services like voltage and frequency controls, damping of power oscillations and black-start.

Results from this project will support:

- optimization of FCRPS generator controls to provide essential reliability services,
- reduced costs and risks of reliability compliance,
- optimized transmission capacity and reliability margins,
- improved equipment condition monitoring,
- promote professional development, and improve decision making.

Goals and Objectives

There are three main objectives for this project:

- improve Cost Management Discipline,
- modernize federal power and transmission system operations and supporting technology,
- and, address load service, congestion and new transmission service requests.

Deliverables

At the conclusion of this project, we will have a fully operational system with the following features:

- Governor tuning for stable black-start operation (NERC EOP-005-3 Standard). We will also provide analytical tools and performance tuning of FCRPS hydro-governors for isolated operations.
- Voltage control optimization and PSS tuning (WECC VAR Standards) We will provide tools and test procedures to enable USACE HDC staff to perform AVR / PSS/ UEL control tuning and optimization at FCRPS plants.
- Governor tuning to optimize frequency response (NERC BAL-003 Standard). This will include a study of the trade-offs between plant and the system perspectives to recommend the on-line governor response strategy (PID settings, use of load versus speed governor mode, etc.)
- Coordination between primary controls (governors), secondary plant controls (GDACS) and BA controls (BPA AGC).

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Project Start Date: October, 2018

Project End Date: September, 2022

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

TIP 313: Power Frequency Control: Phase 1- Model Development

TIP 350: Power Plant Dynamic Performance Monitoring Center

Participating Organizations

US Army Corps of Engineers (USACE)
US Bureau of Reclamation (USBR)

Funding

The scope of this project is BPA-centric and specific. This is a Technology Demonstration project focused specifically to BPA needs, and not a general interest Research project. External co-funding is not applicable.

Total Project Cost:	$960,000
BPA FY2019 Budget:	$240,000

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Acronyms:

- AGC – Automatic Generator Control
- AVR – Automatic Voltage Regulator
- DOE – Department of Energy, United States
- FCRPS – Federal Columbia River Power System
- FERC – Federal Energy Regulatory Commission
- GDACS –Generic Data Acquisition and Control System
- HDC – Hydroelectric Design Center
- NERC – North American Reliability Corporation
- NASPI – North American Synchro Phasor Initiative
- PMU – Phasor Measurement Unit
- PSS – Power System Stabilizer
- RD&D – Research, Development and Demonstration
- UEL – Under-Excitation Limiter
- VAR – Volt Amperes Reactive
- WECC – Western Electricity Coordinating Council