



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

Context

There are relationships between power-frequency control and system stability issues such as oscillation damping, angular stability and voltage stability. Studying these relationships affords opportunities to reduce system stress and increase transmission efficiency and overall reliability.

The BPA Frequency Response Reserve (FRR) studies demonstrated that unbalanced frequency responses have caused California-Oregon Intertie (COI) overload of more than 500 MW during critical contingencies compared to those during balanced responses.

Description

The project researched technical approaches for the BPA to meet the emerging NERC frequency response standards and reliability challenges. It built on the success of hydro-governor design and tuning work done under the existing TIP 50 research to develop plant control and Automatic Generation Control (AGC) strategies to meet diverse reliability objectives.

The overall Power-Frequency Control project is staged in the following three phases: MODEL DEVELOPMENT > PROTOTYPE > IMPLEMENT

Phase 1 focused on modeling and was comprised of three main tasks.

- 1) Determine objectives for power-frequency controls and their interrelation with other control functions and regulatory requirements
- 2) Develop prototype transient stability models for hydro-turbines and turbine governors in MATLAB
- 3) play-in ambient frequency data through governor models to quantify MW-traveled and develop additional models and capabilities needed for conducting simulations of system performance.

Benefits

Power frequency control needs to become a part of the BPA strategy to improve dynamic transfer capabilities, reduce mechanical stress and degradation on hydro generators, alleviate BPA risk for instability due to large contingencies external to the BPA control area, and meet the emerging NERC Standards in the area of frequency responsive reserves.

Accomplishments

By investigating relationships between frequency controls, angular stability, and voltage stability issues this project determined the benefits and feasibility of various technical strategies to address stability issues.

The project objectives sought to:

- Develop technical solutions for the BPA to meet the emerging NERC Standards in the area of frequency responsive reserves;
- Develop software applications for tracking frequency response performance of individual generators so their response characteristics can be correctly represented as required by the approved NERC MOD-027 Standard, TPL-001-2 Standard and upcoming MOD-B standards;
- Develop technical solutions to rebalance frequency response in the Western Interconnection, reducing transient stress on the California – Oregon Intertie and North of John Day paths; and
- Construct studies to evaluate the reliability implications of Reliability Based Controls (RBC) operation, as well as other approaches to meet the objective of reducing “MWs traveled” generators by BPA generating fleet and thereby reduce mechanical stress and degradation on hydro generators.

These objectives were met over the course of the project.

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Project Start Date: October 1, 2014

Project End Date: September 30, 2017

Funding

Total Project Cost: \$505,000

Deliverables

Task 1: Report on power-frequency control objectives, regulatory requirements, and interactions between frequency regulation and other stability limitations

Task 2: Hydro turbine and governor model and prototypes in MATLAB. A set-up for simulating turbine-governors in MATLAB. Specifications for model implementation in production programs. (PSLF, PowerWorld)

Task 3: Time Sequence Powerflow Set-Up for studies of power-frequency control strategies

For More Information Contact:

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Participating Organizations

US Army Corps of Engineers
US Bureau of Reclamations

Conclusions

Information from the Power-Frequency Control summit has greatly enhanced the value of this project by incorporating new information from BPA and industry experts. Tech Transfer is also boosted by informing key BPA subject matter experts of the project's findings and results, increasing the probability that the results will be incorporated into the operating environment of the BPA.

