Supplemental Project Notice

ASSESSING RISK OF SUB-SYNCHRONOUS OSCILLATIONS

Screening and Risk Confirmation

PROJECT HIGHLIGHTS

- Screen systems to assess potential risk of adverse interactions between different system elements that might cause sub-synchronous oscillations.
- Study system interactions including sub-synchronous controls interaction, sub-synchronous resonance, sub-synchronous torsional interaction, and sub-synchronous oscillations resulting from interactions with weak grid.
- Demonstrate application of impedance scanning tools in positive sequence and EMT domain.
- Model system conditions in time domain simulations to ascertain risks.

Background, Objectives, and New Learnings

With growing penetration of inverter-based-resources, concerns about adverse interactions between different elements of the power system have been increasing. This has prompted the power industry to revisit traditional definitions and classifications of power system stability. Two new forms of stability, namely, resonance stability and converter-driven stability, now need to be considered. As both can result in oscillations of frequencies in the sub-synchronous range - sub-synchronous oscillations (SSO).

Resonance instability includes interactions between doubly-fed induction generator wind plants and series compensated transmission lines, also known as sub-synchronous controls interaction (SSCI). It also includes torsional interactions such as sub-synchronous resonance (SSR) caused by excitation of natural modes of turbine-generator shaft by electrical resonant frequency from series compensation, and sub-synchronous torsional interactions (SSTI) between shafts of generators and power-electronic controls of network elements such as STATCOMs, HVDC converters etc. Converter-driven instability can be fast or slow. The fast interactions result in oscillations of frequency > 10Hz between power-electronic controls of different system elements. The slower interactions are usually oscillations of frequencies < 10Hz and include interactions between power-electronic devices and low grid strength regions of the grid.

Based on the study area layout and mix of inverter-based resources (IBRs), STATCOMs, PE loads, HVDC, series compensation etc., this project will conduct screening to assess risk of different forms of adverse interactions. This will be followed by confirmation using time-domain simulations. Key questions addressed include what kind of sub-synchronous oscillation risk the system is vulnerable to, the corresponding risk level, whether the risk can be confirmed using dynamic simulations, and possible mitigation options.

This project aims to answer these questions by applying different analytics and tools. Choice of the correct screening method and modeling techniques is key to proper diagnosis of system vulnerabilities.

Benefits

Overall, this research has the potential to significantly improve understanding, mitigation, and management of power system SSOs leading to a more reliable power grid. Additional benefits of this research include:

- Guidance in applying impedance scanning tools to estimate system impedances for various operating conditions as well as short circuit tools to analyze grid strength
- Understanding of system capability to dampen oscillations resulting from unstable condition
- Guidance for deploying mitigation when significant risk of instability is confirmed by the study
- Sharing experiences, requirements, challenges, and leading practices

Project Approach and Summary

EPRI plans to work with project participants to demonstrate screening and assessment methods for sub-synchronous oscillations. The methods will assess risks of different forms of adverse interactions leading to oscillations in the sub-synchronous frequency range. Once screening is completed, a subset of system conditions with high risk will be modeled and risks will be confirmed using time-domain simulations. There are two participation levels.

Level 1: Screening analysis for Sub-Synchronous Oscillations– EPRI will work with project participants to identify scenarios that might result in adverse interactions. Based on the type of risk, impedance-based scanning tools and/or short-circuit analysis tools will be used for studying different system conditions. The project participant's subject matter experts can provide guidance on different network elements in the area under study and, based on discussions between the EPRI team and project participant, the type of risks to be screened for can be determined.

Level 2: Validation using time-domain studies– EPRI plans to work with participants to validate the risks identified in Level 1 through time-domain simulations. A reduced system will be modelled in an Electromagnetic transient (EMT) tool which would also need models of different IBRs etc., which will be obtained through the project participant.

Deliverables

Level 1 participants:

- Periodic project update webcasts or workshops.
- Utility-specific report providing guidance on risk analysis for specific system under analysis, including risk type and risk level.

Level 2 participants:

- Includes Level 1 deliverables.
- Participant-specific report with EMT results analysis, and suggested mitigation and/or next steps if required.

The non-proprietary results of this work will be incorporated into EPRI's Transmission and Distribution Operations and Planning R&D programs.

Price of Project

Level 1 and Level 2 pricing is scope dependent. Contact EPRI for additional information. The project qualifies for Self-Directed funds (SDF).

Project Status and Schedule

This project is expected to take approximately 12 months.

Who Should Join

Utilities currently developing plans for new IBRs (including HVDC connected offshore wind plants), have installed or are planning to install series compensation, or those operating in weak grid strength areas.

Contact Information

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com).

Technical Contacts

Sudipta Dutta at 845.514.4778 (sdutta@epri.com)
Deepak Ramasubramanian at 865.218.8178 (dramasubramanian@epri.com)
Mobolaji Bello at 865.218.8005 (mbello@epri.com)

Additional Contacts

Brian Long at 704.408.8139 (blong@epri.com)
Dan Tavani at 704.773.2025 (dtavani@epri.com)
David Welch at 702.208.8276 (dwelch@epri.com)
Jeff Hlavac at 402.314.1049 (jhlavac@epri.com)

Product ID: 1-118857 **Project ID: 3002028605** **December 2023**

EPRI
3420 Hillview Avenue, Palo Alto, California 94304-1338 USA • 800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com