NASPI Novel Applications for Synchronized Power Instrumentation
A DOE-EPRI Joint Initiative

Bulk Power System Oscillations Terms and Real-World Events

Engineering Analysis Task Team (EATT)

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Outline

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Task Force Mission

- To define and standardize terminology for electromechanical, forced, and sub/super-synchronous oscillations
  - Enhance and Update the WECC Oscillation Analysis Working Group (OAWG) Document, "Bulk Power System Oscillation Terms"
  - Develop a detailed white paper that outlines definitions, classifications and real-world examples for analyzing and mitigating power system oscillations.
- Support effective communication and consistent analytical practices for oscillation monitoring, detection, classification, and mitigation
  - Contribute to evolving standards and best practices that guide real-time monitoring, modeling, and mitigation of power system oscillations.
- Integrate insights from related task forces

Updates

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Oscillatory modes are often broken into categories:

- **Common (or Governing) mode**: This is the synchronized electromechanical movement of all generators due to an underdamped governing response. Largely dictated by the generator governor control. Typically in the 0.01 to 0.15 Hz range.
- **Electromechanical mode**: This is the electromechanical exchange of energy primarily between synchronized generators during a transient. Typically in the 0.2 to 2 Hz range.
- **Control mode**: These modes are typically the interaction of the generator and/or network electrical components and their control systems. Examples include: poorly tuned excitation systems on synchronous generators; and, poorly tuned control systems on IBRs. Typically in the 1 to 10 Hz range.
- **Torsional mode**: NEED TO DEFINE.

The common and electromechanical modes are governed by the electromechanical physics of the system. We refer the reader to the book [1] for more details.

2.3 Response Types

Ambient Response: An ambient response is the response of the system to the small random changes within the system, such as small changes in load, line switching, etc. Because of the wide-spread nature of these changes, they tend to behave randomly and are best analyzed using stochastic analyses methods [1].

Transient Response: A transient response is the response of the system immediately after a sudden disturbance such as a fault, line tripping, generator trip, or load tripping. A transient response consists of the oscillatory modes along with initial nonlinear effects. Many often term the transient response a "**Ringdown**."

Forced Response: A forced response is the response of the system associated with an external input. Examples include malfunctioning equipment such as a steam valve cycling on and off improperly, hydro turbines operating in a rough zone, unintentional behavior introduced by control systems, or normal operation of an arc furnace inducing its dynamics into the grid. A Forced Response is often referred to as a Forced Oscillation (FO).

Action Items

- Complete the first draft of the report up to section 4 by April 2026.
  - Add section on different types of resonance phenomenon, such as resonance between forced oscillations and natural modes, between control/torsional modes and grid impedance.
  - Add event examples – Large load data center, sub/super synchronous oscillations

Questions and Discussion

Thank you for attending the NASPI Quarterly EATT Meeting

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