



Transmission Planning Stability Study Overview

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- One element of transmission system reliability analysis in regional transmission expansion planning (RTEP) process
 - Power flow, **Stability** and short-circuit analyses
- Ensure bulk electric system (BES) stability in planning horizon.
- Comply with applicable NERC standards (e.g., TPL-001-4).
- Transmission Planning mainly focuses on existing generators and BES stability.

- Establish Transmission system planning performance requirements to BES.
- Stability performance planning events (TPL-001-4, Table 1)
 - Single contingencies (P1, P2)
 - Multiple contingencies: stuck breaker (P4), failure of non-redundant relay (P5) and common structure (P7)
 - N-1-1 contingencies (P3, P6): with the loss of single element due to an N-1 contingency followed by system adjustments and second N-1 contingency is applied.

- PJM also incorporates Transmission Owners specific stability criteria into stability analyses.
- Some Transmission Owners have more conservative criteria than NERC and PJM criteria in terms of:
 - Fault types for multiple contingencies
 - Generation reactive power dispatch
 - Transient voltage recovery performance
 - Damping performance

- PJM annual system-wide stability study
 - Conduct stability analysis for 1/3 of network each year.
 - Evaluate summer light load and summer peak load conditions.
 - Monitor transient (angle) stability, damping and transient voltage recovery performances.
- Stability study for system changes on an as-needed basis
 - Generating system changes (generator, excitation system, power system stabilizer, etc.)
 - Generator step-up transformer replacements

- Stability study for operational performance issues
 - Conduct stability study for specific system outage conditions upon PJM Operations request.
 - Support PJM Operations to update/develop operating guides for stability limited areas.
 - Provide PJM Operations with potential stability issues identified from Planning stability studies and conduct further necessary studies upon Operations request.

Interconnection Analysis Stability Study Overview

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- Enter PJM New Services Queue
- Two queue windows per calendar year
 - April 1st – September 30th
 - October 1st – March 31st
- Feasibility Study and System Impact Study identify required transmission enhancements
- ISA or WMPA execution

- One element of Interconnection Analysis (IA) study process
 - Power flow, **Stability** and short-circuit analyses
- IA stability study ensures stability for new Interconnection projects and system-wide stability and identify the need for upgrades, operating guides or Remedial Action schemes (RAS)
- Stability studies are performed for all the queue projects greater than or equal to 20 MW or for generators connecting to areas with known stability concerns
- Comply with applicable NERC standards (e.g., TPL-001-4) and TO stability criteria (FERC 715 Filing)

- Studies performed on Summer Peak and Summer Light load cases
- Fault scenarios included depend on queue project location
- Monitor angle stability, damping and transient voltage recovery performances
- Low Voltage Ride Through tests performed for Inverter based projects
- Reactive Power Requirement Assessment is performed for all new generators

- N-1-1 and SPS scenarios listed in Manual 3 operating guides and N-1-1 scenarios as per TO criteria are considered
- Least cost remedy to N-1-1 outage violations for new generators under study is to allow them to curtail during the event
- Interconnection customers are required to reinforce the system if curtailment is not an option
- PJM operations staff are notified of any changes required to operating guides or any generator curtailments prior to commercial operation of a generator

- IA performs tests on “As built” data submitted by the generator and sends the model along with any required mitigations to PJM Operations
- PJM planning ensures the necessary system upgrades identified in the ISA or WMPA are constructed prior to the commercial operation of the generator, or a mitigation plan is in place
- PJM planning notifies PJM Operations of a generator’s plan to initially synchronize to system and begin initial operations (testing) typically a week prior to the generator synchronizing