

Technology Innovation

BPA Approach for Voltage Stability Applications

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Voltage Stability Approach – Defense in Depth

1. Reliability starts with good planning

... But actual system conditions are often different from what is planned ...

2. Operational real-time studies - State estimator based real time contingency analysis

... But, your model may be wrong (model errors, control failures, etc) ...

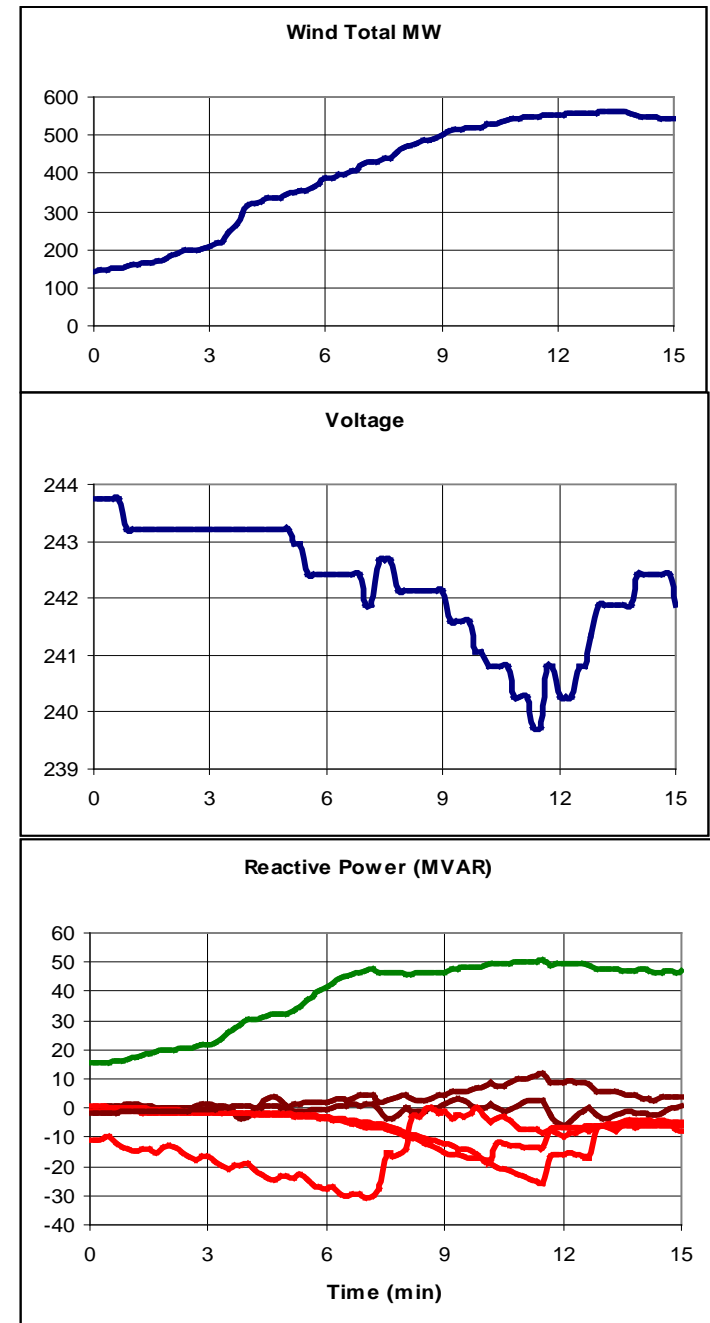
3. Intrinsic indicators of voltage stability

... but disturbance may develop too fast for operators to respond

4. Wide-area stability control and safety nets

1. Better Planning Tools for Reliable Wind Integration

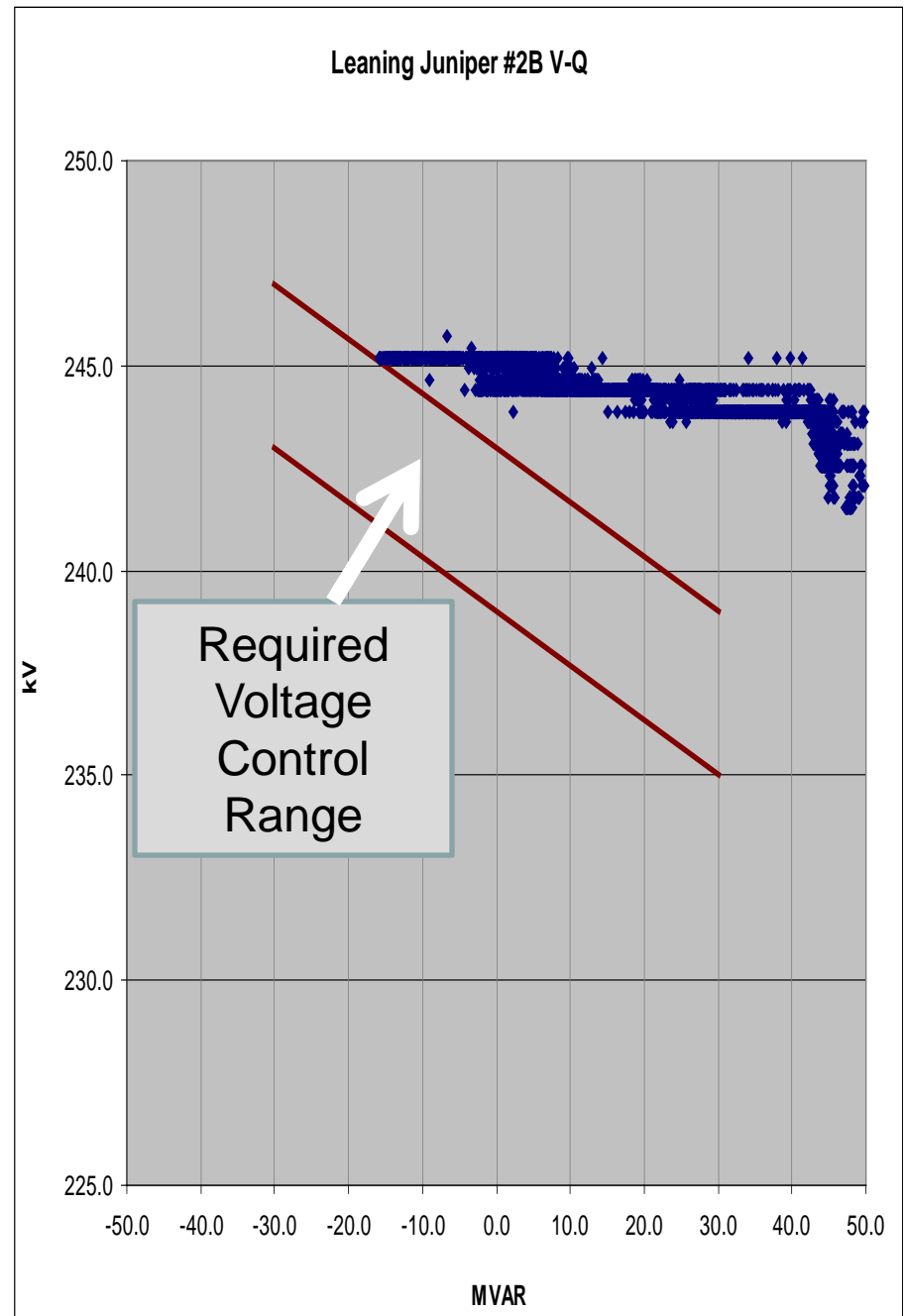
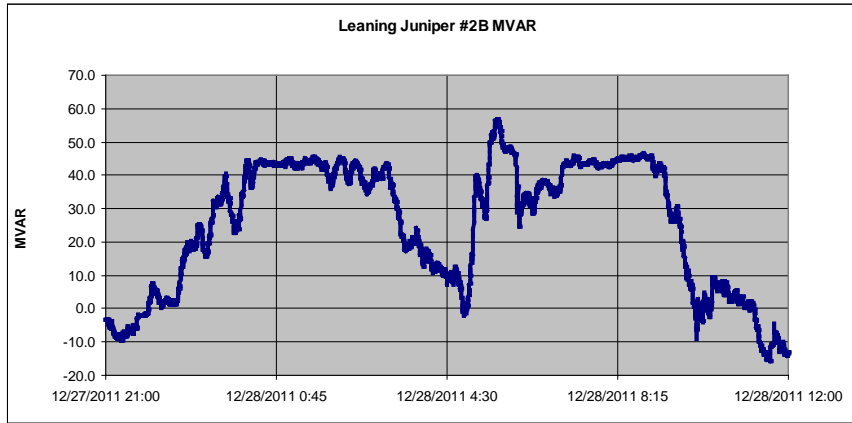
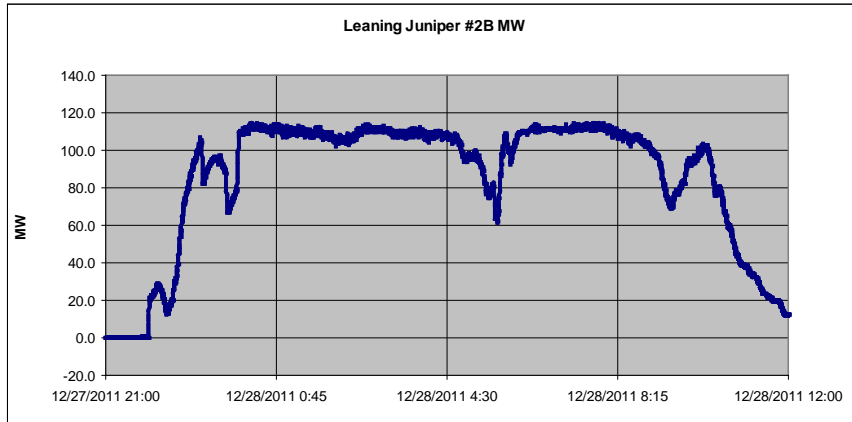
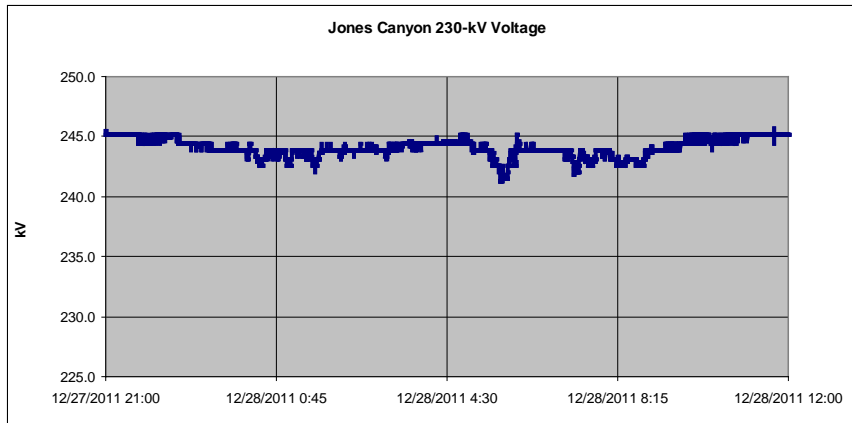
- **Conventional system**
 - Generation schedules are predictable, flows change slowly
 - Static snapshots are adequate for voltage stability assessment
- **System with variable generation**
 - Flows can change fast due to wind ramps, dispatchers may not be able to optimize voltage profile and reactive reserves
 - Need to have tools to study the impact of wind ramps on voltage stability
- Solution: BPA is developing **Time Sequence Power Flow (TSPF)** to study wind generation ramps and dynamic transfers



2. Operational Engineering Tools

- BPA Operating Engineers will start using state estimator cases for voltage stability assessment in April 2013 – Day Ahead and Outage studies:
 - Breaker-node models
 - Actual RAS modeling

- BPA developed applications for voltage control monitoring
 - Implemented in OSI Soft PI DataLink
 - Currently applied at large wind hubs
 - Example at Next slide ...



3. Measurement-Based Voltage Stability Applications

- Several algorithms are considered:
 - Quanta Technology Reactive Power Margin is researched by the project
 - University of Wisconsin Singular Value Decomposition is researched by this project
 - DOE-supported voltage stability project by Rennesellaer Polytechnic Institute
- BPA approach:
 - Develop test cases to select most effective approaches
 - Prototype and test the selected algorithm in BPA synchrophasor lab

Real-Time Voltage Control Under Stressed Conditions

See It Fast to Keep Calm

AS THE ELECTRICAL UTILITY INDUSTRY ADDRESSES ENERGY AND environmental needs through greater use of renewable energy, storage, and other technologies, power systems are becoming more complex and stressed. Increased dynamic changes that require improvements in real-time monitoring, protection, and control increase the complexity of managing modern grids. In an effort to ensure the secure operation of power systems, more attention is being given to voltage management. Voltage management includes addressing voltage stability and fault-induced delayed voltage recovery (FIDVR) phenomena. Deployment of phasor measurement unit (PMU) technology, in combination with recently developed methodologies for tracking voltage behavior, has resulted in improved real-time voltage monitoring, protection, and control.

This article describes simple and accurate methodologies based on real-time measurement—and independent of the system model—designed for tracking both slow-developing and transient voltage stability conditions under various and changing system configurations. Tests with real-time supervisory control and data acquisition (SCADA) and PMU data, as well as data from comprehensive simulation studies, from the Bonneville Power Administration (BPA) and Southern California Edison (SCE) systems show very accurate detection as the system is approaching voltage instability. The calculated reactive power margin and other indices are easily visualized for operator awareness. For quickly developing disturbances, they allow the initiation of fast control and protection actions. This methodology also discriminates well between FIDVR and short-term

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IEEE Power & Energy Magazine, July/August 2012

IEEE Publication

4. Wide Area Controls under Development

- Response-based controls, take actions within 1/2 second
- Start with low risk actions:
 - shunt capacitor switching
 - Use wide-area synchronized measurements
- BPA deliverable under WISP

