Item 6: Addressing Subsynchronous Resonance – NPRR562 Overview and Series Capacitors Go-Live Update

Shun-Hsien (Fred) Huang
Manager, Dynamic Studies

Woody Rickerson
Vice President, Grid Planning & Operation

Board of Directors Meeting

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Series Capacitor and Subsynchronous Resonance (SSR)

- Series capacitors can increase transfer capability and improve dynamic stability.

- But also can cause SSR that has the potential to damage generator shafts, protection, and series capacitors.

- SSR: Coincident oscillation between Generation Resources and a series capacitor compensated transmission system at a frequency lower than ERCOT nominal frequency (60Hz)
NPRR 562 History

- **08/12/2013**
  - ERCOT Submitted NPRR 562
  - Had one PUCT workshop and three ERCOT workshops
  - PRS tabled NPRR 562
  - Key Comments to be addressed:
    - Cost Allocation
    - Technical Assessment

- **12/2014**
  - Had three ERCOT workshops
  - Revised scope and criteria for technical assessment, including SSR assessment for all existing generators
  - Discussed process and responsibility for SSR vulnerability management

- **12/2016**
  - Had two ERCOT workshops

- **02/2017**
  - Presented SSR assessment results and findings
  - Submitted revised NPRR 562 for PRS review

- **06/2017**
  - PRS recommended approval in April, 2017
  - TAC recommended approval in May 2017
NPRR 562 Revision

• To address SSR for all generators and the related series capacitors

<table>
<thead>
<tr>
<th>Technical Assessment</th>
<th>Process and Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Scope</td>
<td>• Existing Gen</td>
</tr>
<tr>
<td>• Methodology</td>
<td>• New Gen</td>
</tr>
<tr>
<td>• Criteria</td>
<td>• New Transmission</td>
</tr>
<tr>
<td></td>
<td>• Annual Review</td>
</tr>
<tr>
<td></td>
<td>• Operation</td>
</tr>
<tr>
<td></td>
<td>• Outage Coordination</td>
</tr>
</tbody>
</table>
# Subsynchronous Resonance Taxonomy

<table>
<thead>
<tr>
<th>Subsynchronous Resonance (SSR)</th>
<th>Synchronous Generator</th>
<th>Inverter-Based Generator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Induction Generation Effect (IGE)</td>
<td>IGE / Subsynchronous Control Interaction (SSCI)</td>
</tr>
<tr>
<td></td>
<td>Torsional Interaction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Torque Amplification</td>
<td></td>
</tr>
</tbody>
</table>

**Mohave incident (1970): Torsional Interaction**

Steam Turbine-Generator Torsional Vibration Interaction with the Electrical Network, EPRI, 2005

**South Texas Incident (2009): SSCI**

ERCOT SSR Assessment Results

• Torsional Interaction was identified for synchronous generators.

• SSCI was identified for inverter-based generator.

• Generators identified with SSR vulnerability are electrically very close to the series capacitors.
  – Most identified ones are connected to 345 kV grid.
Operational Controls

• Generators are vulnerable within N-4 outages
  – Bypass series capacitors until implementation of transmission options to mitigate the concern.

• Generators are vulnerable for N-5 or N-6 outages
  – Operate series capacitors with SSR monitoring.

• Generators are vulnerability for more than N-6 outages
  – Operate series capacitors as normal operation.
Initial Series Capacitors Operations

Cross (x2)  
SSR monitoring

Gauss (x2)  
Bypass 1; SSR monitoring

Kirchhoff (x2)  
SSR Monitoring

Romney (x2) & Kopperl (x2)  
Normal Operation

Oersted (x2) & Edison (x2)  
Bypass Oersted (x2) or Edison (x2), SSR monitoring

Cenizo (x1) / Del Sol (x1) / Rio Hondo / (x1)  
North Edinburg (x1)  
Normal Operation
Next Steps

• ERCOT has communicated SSR results with all affected Resource Entities and TSPs.

• ERCOT will complete operator training and procedures in July.

• ERCOT will coordinate with TSPs to identify transmission options for generators with SSR vulnerability within N-4 outages.
Acknowledgement

Thank you!