Disclaimer

- My opinions are my own
What is CIP-014?

- NERC has a collection of Reliability Standards divided into ~ a dozen reliability categories that apply to ~ a dozen registered functional entities.
- One classification family: CIP addresses Critical Infrastructure Protection
  - Mostly cyber assets and security
  - CIP-014 is an exception as it addresses physically energized high voltage assets.
  - Driven by recent substation incidents.
<table>
<thead>
<tr>
<th>CIP-014 Organization</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>First Half</td>
<td>Second Half</td>
</tr>
<tr>
<td><strong>Electric Focus</strong></td>
<td><strong>Physical Focus</strong></td>
</tr>
<tr>
<td>Determine the Substation’s electric system criticality</td>
<td>Secure the critical substation</td>
</tr>
</tbody>
</table>
Electric Studies:
What does the Standard Primarily Require?

- Stations which require study:
  - All 500 kV and higher
  - Three or more 345 kV
  - Two 345 and one or more 230 kV
  - One 345 kV and three or more 230 kV
  - Five or more 230 kV

- Have a methodology

- Follow Your Methodology

- Have an Independent Third Party Verify your work.
What are the Elements of a Comprehensive Evaluation?

• An analysis of each Stage
  
  • Evaluate how the fault condition will progress through clearing
  • Evaluate how the recovery will occur through the point when normal operation is reestablished.
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  • Remote or Delayed Clearing
    • 20 Cycles or more
    • Entire Substation
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• Recovery Stage
  • How long is the recovery stage?
  • There are actually two recovery stages
## Replacement/Repair Times
### Major Substation Equipment

<table>
<thead>
<tr>
<th>Damaged Station Equipment</th>
<th>Weeks to Replace</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Bus</td>
<td>O</td>
</tr>
<tr>
<td>Circuit Breakers</td>
<td>O</td>
</tr>
<tr>
<td>Switches</td>
<td>O</td>
</tr>
<tr>
<td>Current Transformers</td>
<td>O</td>
</tr>
<tr>
<td>Other Switchgear</td>
<td>O</td>
</tr>
<tr>
<td>Power Transformers</td>
<td>O</td>
</tr>
<tr>
<td>Cooling Radiators</td>
<td>O</td>
</tr>
<tr>
<td>Surge Arresters</td>
<td>O</td>
</tr>
</tbody>
</table>

O: Optimistic  P: Pessimistic

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Key Dynamic Factors

• Initial fault accelerates nearby generation units

• Loss of transmission reduces the system’s ability to absorb pent-up energy

• Changes the unit’s critical clearing time
Recovery $P = \frac{V_1V_2}{x} \sin \delta$

\[
P = \left( \frac{V_1 V_2}{x} \right) \sin \delta
\]
Conclusions

• Real-time is not when you want to discover a unit stability limit exists
  • Define helpful operating procedures

• N-1 in recovery stage is needed
  • Power Flow Evaluation
    • Full station out and next N-1
    • Transformers out and next N-1
  • Dynamics
    • Full station out and critical N-1 at generation
    • If necessary, transformer out and next N-1

• Evaluate the fault condition
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Article:
McElvain, F. Siemens PTI, (Electricity Today Online April / May 2015), Transmission Planning: Protecting the Physical Security of the Power Grid,

http://online.electricity-today.com/doc/electricity-today/et_april_may_2015_digital/2015051401/#50

siemens.com/answers