Advanced On-line Voltage Stability Assessment

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Federal Energy Regulatory Commission
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Presentation Overview

- Introduction
- NYCA Congestion Pattern
- Central East Voltage Collapse (VC) Transfer Limits – Offline Analysis
- Voltage Stability Assessment (VSA)
- Benefits of Real-time Calculated Margin
NYCA Congestion($M) 2010-2014

Total NYCA Congestion

2010: 1156
2011: 1177
2012: 777
2013: 1803
2014: 1491

Percent Congested by Central East VC

2010: 42%
2011: 31%
2012: 33%
2013: 60%
2014: 76%
Congested Hours

Total Congested Hours

Percent Congested Hours by Central East VC
## Central-East Interface

### Definition

<table>
<thead>
<tr>
<th>Mohawk Valley (Zone E) – Capital (Zone F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>Edic-New Scotland</td>
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<tr>
<td>Marcy-New Scotland</td>
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<td>Porter-Rotterdam</td>
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<td>Porter-Rotterdam</td>
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<td>East Springfield-Inghams</td>
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<td>Inghams PAR</td>
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<tr>
<td>Inghams Bus Tie</td>
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<table>
<thead>
<tr>
<th>North (Zone D) – ISONE</th>
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<tr>
<td>Plattsburgh-South Hero</td>
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Central East VC Limit Development

Current Method

- Use PSS/E to conduct the off-line analysis
- Adjust base case dispatch to stressed conditions
- Simulate with various facilities in or out of service
  - Major generating units
  - Major 345 KV circuits
  - All the 345 KV shunt devices
- Record the incremental change limits for different outage conditions
Incremental Limit Change Table

- All the Incremental Limit data for different scenarios is stored in a “look-up” table for Energy Market software Network Security Analysis applications (RTC & RTD)
  - All line I/S limits
  - De-rate limits for 345KV shunt devices
  - De-rate limits for SVCs and STATCOM
  - De-rate limits for major generator units O/S
  - De-rate limits for particular transmission elements
# Samples of Central East VC Limits

<table>
<thead>
<tr>
<th>SCENARIOS</th>
<th>LIMITS (MW)</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cent-East_VC_14_O/S_[2 Osw]</td>
<td>2175</td>
<td>Absolute</td>
</tr>
<tr>
<td>Cent-East_VC_18_O/S_[3 Osw]</td>
<td>2090</td>
<td>Absolute</td>
</tr>
<tr>
<td>Cent-East_VC_2_Osw_2_Sithe_I/S</td>
<td>150</td>
<td>Generator Incremental</td>
</tr>
<tr>
<td>Cent-East_VC_Fraser_Cap#1_O/S</td>
<td>20</td>
<td>Incremental</td>
</tr>
<tr>
<td>Cent-East_VC_LEEDS_SVC_O/S_[3 Osw]</td>
<td>2950</td>
<td>Absolute</td>
</tr>
<tr>
<td>Cent-East_VC_Marcy_Statcom_O/S</td>
<td>50</td>
<td>Incremental</td>
</tr>
</tbody>
</table>
Central East VC – Proposed Method – Voltage Stability Assessment (VSA)

- Executes every 5 minutes in real-time
- It takes less than 20 seconds to complete the process
- Uses State Estimator solution as a base case
- Applies Continuation Power Flow (CPF) algorithm to evaluates Normal and Contingency Operations
- Evaluates Operational Margin to Voltage Instability
- Evaluates CA definitions
Voltage Stability Assessment – Output

- Central East-VC interface limits
- Critical Operating Point for Base Case and Worst Contingency Cases
  - Active reserve MW margin
  - Reactive reserve MVAR margin
- Critical station voltages
- P-V curve for current operation and Worst Contingency
- Stores limits in PI for bench mark and comparison
- Limit for BMS applications (RTC & RTD) - future
Figure 1  A continuum of power flow solution
Continuation Power Flow Overview

- Well conditioned around and at the critical point. Results used to identify the weak bus most prone to voltage collapse.
- The general principle behind the CPF is a prediction-correction scheme on a reformulated power flow equation that includes the load parameter.
Figure 2  Illustration of the Prediction/Correction Scheme
Sample of the PV Curve
Benefit of Proposed Method

- VSA Limits are determined based on the current network topology rather than off-line analysis
- Explore potential improvement on Network Security Analysis to utilize Central East VC limit directly from the VSA’s output
- Explore potential improvement on the efficiency of the Real Time Commitment (RTC) and Real Time Dispatch (RTD) functions
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