2007 RTEP Reliability Analysis Update

TEAC Meeting
April 18, 2007
• Base case development complete
• N-2 analysis, generator and load deliverability analysis complete
• Results forwarded to transmission owners
• Development of solutions to identified problems is in progress
• Initial 15 year analysis to identify longer lead time reinforcements complete
• Review of backbone transmission alternatives is in progress
5 Year Analysis Update
First Energy - JCPL Transmission Zone

- **N-2 Issues**
  - Atlantic – Larrabee 230 kV line overload for the loss of Prospect Road – Smithburg – Atlantic 230 kV line + loss of Atlantic – South River 230 kV line
  - Cookstown – Lumberton 230 kV line for the loss of Deans – Smithburg 500 kV line and the 500 / 230 kV transformers at Deans and Smithburg + loss of the East Windsor – Smithburg 230 kV line
  - New Prospect Road – Smithburg 230 kV line overload for the loss of Atlantic – South River 230 kV line + Atlantic – Larrabee 230 kV line

- **Solution**
  - Working with FE to validate the violation and develop solutions
• N-2 Violations
  – 230 / 69 kV transformers at Hummelstown and Dauphin substations and several 69 kV lines in the Hummelstown, Harrisburg and Dauphin area are overloaded as well for the contingencies noted above

• Solution
  – Build a new substation with two 150 MVA transformers between Dauphin and Hummelstown 230 / 69 kV substations by sectionalizing the Middletown Junction – North Lebanon 230 kV line in the MetEd transmission zone.
  – Expected in-service date: 6/1/12
  – Estimated cost: $24.2 million
PSEG Transmission Zone

• **N-2 Violation**

• **Solution**
  – Close the Roseland 138 kV buses

• **N-2 Violation**
  – Lawrence – Pleasant Valley 230 kV line overloads for the loss of Branchburg – Deans 500 kV line and Deans 500 / 230 kV transformer + Windsor – Orchard (aka Alloway) 500 kV line

• **Solution**
  – Replace the wave traps on the line.
  – Bring the rate B up to 782 MVA
• N-2 Issue
  – Cox’s Corner – Lumberton 230 kV line overload for the loss of Deans – Smithburg 500 kV line and 500 / 230 kV transformers in Deans and Smithburg + loss of East Windsor – Smithburg 230 kV line

• Solution
  – Build a new parallel circuit

• N-2 Issue
  – Cookstown – Lumberton 230 kV line overloaded for the loss of Deans – Smithburg 500 kV line and 500 / 230 kV transformers at Deans and Smithburg + loss of East Windsor – Smithburg 230 kV line

• Solution
  – Reconductor the line with 1033.5 ACSS
  – Increase Rate A to 800 MVA and Rate B to 1000 MVA
• N-2 Violation
  – Saddle Brook – Athenia 230 kV line overload for the loss of the 550 MW generator at Bergen 230 kV station + loss of Waldwick – Hillsdale 230 kV line
• Solution
  – Add forced oil cooling to increase Rate B by 25%
BG&E Transmission Zone

• N-2 Violation
  – Waugh Chapel 230 / 115 kV transformer overloads for the loss of the other two Waugh Chapel 230 / 115 kV transformers

• Solution
  – Add a fourth 230 / 115 kV transformer, two 230 kV circuit breakers and a 115 kV breaker at Waugh Chapel
  – Estimated cost: $17 million

• N-2 Violation
  – Harrisonville – Granite 115 kV line and Harrisonville – Dolfield 115 kV line overloads for the loss of the two Northwest 230 / 115 kV transformers

• Solution
  – Create two 230 kV ring buses at North West
  – Add two 230 / 115 kV transformers at North West
  – Create a new 115 kV station at North West
  – Estimated cost: $20 million
• **N-2 Violation**
  – Burches Hill – Palmers Corners 230 kV line overload for the loss of the other two Burchess Hill – Palmers Corners 230 kV lines

• **Solutions**
  – Reconductor the four circuits from Burchess Hill to Palmers Corner
  – New Rate A: 1118 MVA, Rate B: 1200 MVA
  – Expected in service date: 6/1/12
  – Estimated cost: $10 million ($2.5 million per circuit)
• N-1 Load Deliverability Violation
  – Voltage collapse for the loss of the Cumberland – Orchard (a.k.a. Alloway) 230 kV line

• Solution
  – Install a 60 MVAR 230 kV capacitor at Cumberland

• N-1 Load Deliverability Violation
  – Cumberland – Union 138 kV line overload for the loss of the Dennis 230 / 138 kV transformer

• Solution
  – Complete B0433 to eliminate stranded bus limitation
  – Revise limiting relay setting to bring the line rating up to 483 MVA
  – Estimated cost: $0.0
• **N-1 Load Deliverability Violation**
  – Monroe – Landis Tap – Shieldalloy – North Central 69 kV line overload for the loss of the Cumberland – Orchard (a.k.a Alloway) 230 kV line

• **Solution**
  – Reinforce the 138 / 69 kV facilities in the AE/Vineland area.
  – Specific plans under review

• **Note:** The Atlantic Electric area analysis was done with BL England out of service. Some plans may be able to be deferred if units are available.
• **N-2 Thermal Violation**
  - Carson – Oakland 138 kV line overload for the loss of Cheswick Unit 1 + loss of Arsenal 345 / 138 kV transformer
  - Arsenal – Brunot Island 345 kV line overloaded for the loss of the other Arsenal – Brunot Island circuit

• **Solution**
  - Reviewing alternatives with DLCO

• **Generator Deliverability Violation**
  - Cheswick – Logan’s Ferry 138 kV overloads for category C contingencies involving the loss of the parallel circuit

• **Solution**
  - Reconductor the circuits
Exelon – ComEd Transmission Zone

• Generator Deliverability Violation
  – Byron – Wempletown 345 kV line overloaded for a tower contingency

• Solution
  – Advance existing baseline upgrade for second Byron – Wempletown 345 kV circuit to 2012

• N-2 and Load Deliverability Voltage Violations
  – East Frankfort, Joliet, and Will County 138 kV areas

• Solution
  – Install capacitors
  – Size and location of capacitors TBD
- Generator Deliverability Violation
  - Cherry Valley 345 / 138 kV transformer overloaded for stuck breaker contingencies involving the loss of Cherry Valley – Silver Lake 138 kV
  - Oswego – Montgomery 138 kV line overloaded for the loss of Wolfs – Oswego 138 kV
- Working with ComEd to validate the violation and develop solutions
• **Generator Deliverability Violation**
  – Tidd – Mahans Lane – Weirton 138 kV line overloaded for the loss of Wylie Ridge – Tidd 345 kV and Tidd – Collier 345 kV towerline

• **Solution**
  – Upgrade substation equipment and reconductor the line with 954 ACSR

• **N-2 Violation**
  – Mitchell – Shepler Hill Junction 138 kV line overloaded for the loss of Hatfield – Ronco 500 kV line + Hatfield Unit 1

• **Solution**
  – Reconductor the Mitchell – Shepler Hill Junction 138 kV circuit with 954 ACSR
  – Expected in service date: 6/1/10
  – Estimated cost: $3 million
• Generator Deliverability Violation
  – Conesville – Prep Tap 138 kV line overloaded for the loss of
    Muskingum – Ohio Central 138 kV, Ohio Central – Galion 138
    kV and Ohio Central 345 / 138 kV transformer
• Solution
  – Upgrade terminal equipment at Conesville Substation to 2000
    Amps
  – Estimated cost: $0.9 million
• N-2 Violation
  – Voltage violation at Fredricksburg area 230 kV buses for the loss of Four Rivers – Fredricksburg 230 kV + Possum Point – Garrisonville 230 kV
• Solution
  – Install a 150 MVAR 230 kV capacitor at Fredricksburg
  – Expected in-service date: 6/1/12
  – Estimated cost: $1.2 million

• N-2 Violation
  – Voltage violation at Pratts 115 kV for the loss of Gordonsville – Louisa Ct 230 kV + Gordonsville – Charlottesville 230 kV
• Solution
  – Install a 25 MVAR 115 kV capacitor at Somerset
  – Expected in-service date: 6/1/12
  – Estimated cost: $0.5 million
Dominion Transmission Zone

• N-2 Violation
  – Voltage violation at Northwest 230 kV for the loss of Chesterfield
    – Southwest 230 kV + Northwest – Elmont 230 kV

• Solution
  – Install a 150 MVAR 230 kV capacitor at Northwest
  – Expected in-service date: 6/1/12
  – Estimated cost: $1.2 million

• Mid-Atlantic Load Deliverability
  – Dooms – Lexington 500 kV line overloads for the loss of Bath County – Valley 500 kV

• Solution
  – Replace the wave traps at both Lexington and Dooms
  – Expected in-service date: 6/1/12
  – Estimated cost: $0.3 million
Dominion Transmission Zone

• Dominion Criteria Violation
  – Endless Caverns 230 / 115 kV transformer overloads for the loss of Dooms – Grottoes 230 kV

• Solution
  – Add a second Endless Caverns 230 / 115 kV transformer
  – Expected in-service date: 6/1/10
  – Estimated cost: $6 million

• Dominion Criteria Violation
  – Edinburg – Mt. Jackson 115 kV overloads for the loss of Cunningham – Elmont 500 kV

• Solution
  – Reconduct 9.4 miles of the Edinburg – Mt. Jackson 115 kV line
  – Expected in-service date: 6/1/10
  – Estimated cost: $5 million
Dominion Transmission Zone

• Dominion Criteria Violation
  – Newport News – Chuckatuck 230 kV overloads for the loss of Surry – Winchester 230 kV

• Solution
  – Reconductor 2.4 miles of the Newport News – Chuckatuck 230 kV line
  – Expected in-service date: 6/1/12
  – Estimated cost: $3 million

• Tower line outage & Dominion Criteria Violation
  – Tower line outage – Morrisville to Marsh Run overloads 115 kV network in the area.
  – Loudoun 500 / 230 kV transformer overloads for loss of one on the other.

• Solution
  – Convert the Remington – Sowego 115 kV line to 230 kV
  – Add a new 230 kV line from Sowego – Gainsville
  – Add a Sowego 230 / 115 kV transformer
  – Estimated cost $30 million
15 Year Analysis Update
NNJ Overloads – north west state
• Five Transmission Alternatives studied
  – Alternative 1: Amos – Kemptown 765 kV
  – Alternative 2: Amos - Bedington 765 kV and Bedington - Kemptown 500 kV
  – Alternative 3: Bossards – Jefferson – Roseland 500 kV
  – Alternative 4: Stanton – Roseland 230 kV
  – Alternative 5: Susquehanna – Jefferson – Roseland 500 kV
• No other 2012 proposed upgrades included in study
• Alternatives 1 & 2 compared for 500 kV backbone overload relief
• Alternatives 3, 4 & 5 compared for NNJ overload relief
### 500 kV Backbone Overload Comparison

<table>
<thead>
<tr>
<th>Overloaded Facility</th>
<th>Year in Violation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mt. Storm – Doubs 500 kV</td>
<td>2012</td>
</tr>
<tr>
<td>Keystone – Conemaugh 500 kV</td>
<td>2012</td>
</tr>
<tr>
<td>Keystone – Airydale 500 kV</td>
<td>2012</td>
</tr>
<tr>
<td>Juniata – Airydale 500 kV (Both)</td>
<td>2013, 2021, 2021</td>
</tr>
<tr>
<td>Pruntytown – Mt. Storm 500 kV</td>
<td>2015, &gt;2022, &gt;2022</td>
</tr>
<tr>
<td>Harrison – Pruntytown 500 kV</td>
<td>2016, &gt;2022, &gt;2022</td>
</tr>
<tr>
<td>Loudoun – Pleasant View 500 kV</td>
<td>2017, &gt;2022, &gt;2022</td>
</tr>
<tr>
<td>Lexington – Dooms 500 kV</td>
<td>2017, &gt;2022, &gt;2022</td>
</tr>
<tr>
<td>Mt. Storm – Greenland Gap 500 kV</td>
<td>2020, &gt;2022, &gt;2022</td>
</tr>
<tr>
<td>Greenland Gap – Meadowbrook 500 kV</td>
<td>2020, &gt;2022, &gt;2022</td>
</tr>
<tr>
<td>Hosensack – Elroy 500 kV</td>
<td>2021, &gt;2022, &gt;2022</td>
</tr>
<tr>
<td>Bath County – Valley</td>
<td>2022, &gt;2022, &gt;2022</td>
</tr>
</tbody>
</table>
## Northern New Jersey Overload Comparison

<table>
<thead>
<tr>
<th>Overloaded Facility</th>
<th>Base</th>
<th>Year in Violation</th>
</tr>
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<tbody>
<tr>
<td>Greystone – Whippany 230 kV</td>
<td>2013</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>Larrabee – Atlantic 230 kV</td>
<td>2013</td>
<td>2022</td>
</tr>
<tr>
<td>Branchburg – Flagtown 230 kV</td>
<td>2013</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>Flagtown – Somerville 230 kV</td>
<td>2013</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>East Windsor – Smithburg 230 kV</td>
<td>2014</td>
<td>2018</td>
</tr>
<tr>
<td>Hosensack – Elroy 500 kV</td>
<td>2014</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>Cedar Grove F – Roseland 230 kV</td>
<td>2015</td>
<td>2016</td>
</tr>
<tr>
<td>Whippany – Roseland 230 kV</td>
<td>2015</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>Kittatinny – Pohatcong 230 kV</td>
<td>2016</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>Bushkill – Kittatinny 230 kV</td>
<td>2016</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>Roseland – Cedar Grove B 230 kV</td>
<td>2016</td>
<td>2016</td>
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<tr>
<td>Gilbert – Morristown 230 kV</td>
<td>2017</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>Readington – Roseland 230 kV</td>
<td>2017</td>
<td>&gt;2022</td>
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## Northern New Jersey Overload Comparison

<table>
<thead>
<tr>
<th>Overloaded Facility</th>
<th>Base</th>
<th>Alt. 3</th>
<th>Alt. 4</th>
<th>Alt. 5</th>
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</thead>
<tbody>
<tr>
<td>Pleasant Valley – Lawrence 230 kV</td>
<td>2018</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>Cox’s Corner – Lumberton 230 kV</td>
<td>2018</td>
<td>2022</td>
<td>2019</td>
<td>2022</td>
</tr>
<tr>
<td>Kittatinny – Newton 230 kV</td>
<td>2018</td>
<td>&gt;2022</td>
<td>2021</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>Gilbert – Glenn Gardner 230 kV</td>
<td>2018</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>Branchburg – Readington 230 kV</td>
<td>2018</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>Portland – Martins Creek 230 Kv</td>
<td>2019</td>
<td>&gt;2022</td>
<td>2022</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>Somerville – Bridgewater 230kV</td>
<td>2019</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
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<tr>
<td>Glen Gardner – Chester 230 kV</td>
<td>2020</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
</tr>
<tr>
<td>Smithburg – New Prospect 230 kV</td>
<td>2020</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
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<tr>
<td>Montville - Roseland 230 kV</td>
<td>&gt;2022</td>
<td>2020</td>
<td>&gt;2022</td>
<td>2020</td>
</tr>
<tr>
<td>Alburtis - Branchburg 500 kV</td>
<td>2022</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
<td>&gt;2022</td>
</tr>
</tbody>
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Next Steps

- Identify solutions to remaining violations
- Analyze potential solutions to violations to ensure their effectiveness
- Sensitivity analysis to determine impact of potential generation retirements
- Continue to analyze various backbone alternatives