Reliability Analysis Update

TEAC Meeting
September 17, 2008
Reactive Analysis Update
MAAC CETO Voltage Violation

- Low Voltage Violations
  - Cochranville 230 kV bus / Loss of Keeney - Rock Spring 500 kV line
  - Cochranville 230 kV bus / Loss of Peach Bottom - Rock Spring 500 kV line
• Voltage Collapse
  • Loss of Cedar Creek – Red Lion 230 kV line
• Loss of Keeney – Rock Spring 500 kV line
• Loss of Peach Bottom – Rock Spring 500 kV line
• Low Voltage Violations
  • Cochranville 230 kV bus / Loss of Keeney - Rock Spring 500 kV line
  • Cochranville 230 kV bus / Loss of Peach Bottom - Rock Spring 500 kV line
  • Newlinville 230 kV bus / Loss of Rock Spring – Keeney 500 kV line
MAAC CETO Voltage Violation

- Voltage Collapse
  - Loss of Conastone – Peach Bottom 500 kV line
  - Loss of Peach Bottom – Rock Spring 500 kV line
  - Loss of Keeney – Rock Spring 500 kV line
- **PV study scenario:**
  - Study Case: MAAC CETO Voltage case
  - Contingency: Loss of Conastone – Peach Bottom
  - Transfer: Generation in PJM West and South \(\Rightarrow\) Generation in MAAC
  - **Last MW transfer: -338 MW**

- **Reactive loss:**
  - 230 kV and 500 kV SW shunts fully are utilized at -338 MW transfer.

<table>
<thead>
<tr>
<th>Facility</th>
<th>Post Cont MVAR Loss</th>
<th>Pre Cont MVAR Loss</th>
<th>dMVAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keystone - Airydale Ckt 1</td>
<td>1141.7</td>
<td>746.4</td>
<td>395.3</td>
</tr>
<tr>
<td>Conemaugh - Airydale Ckt 1</td>
<td>727</td>
<td>396.3</td>
<td>330.7</td>
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<td>Airydale - Juniata Ckt 1</td>
<td>610.2</td>
<td>370.6</td>
<td>239.6</td>
</tr>
<tr>
<td>Airydale - Juniata Ckt 2</td>
<td>591.1</td>
<td>356.8</td>
<td>234.4</td>
</tr>
<tr>
<td>Juniata - Alburtis</td>
<td>475.9</td>
<td>300.1</td>
<td>175.8</td>
</tr>
<tr>
<td>Juniata - TMI</td>
<td>172.5</td>
<td>10.8</td>
<td>161.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3718.4</strong></td>
<td><strong>2181</strong></td>
<td><strong>1537.5</strong></td>
</tr>
</tbody>
</table>
MAAC PV Study

- PV study scenario:
  - Study Case: MAAC CETO Voltage case
  - Contingency: Loss of Keeney – Rock Springs
  - Transfer: Generation in PJM West and South \(\Rightarrow\) Generation in MAAC
  - Last MW transfer: -850 MW

- Reactive loss:
  - Most effective 230 kV and 500 kV SW shunts are fully utilized at -850 MW transfer.

<table>
<thead>
<tr>
<th>Facility</th>
<th>Post Cont MVAR Loss</th>
<th>Pre Cont MVAR Loss</th>
<th>dMVAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peachbottom - Limerick Ckt 1</td>
<td>953.3</td>
<td>322.2</td>
<td>631.2</td>
</tr>
<tr>
<td>Alburtis - Branchburg Ckt 1</td>
<td>521.4</td>
<td>295.9</td>
<td>225.5</td>
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<tr>
<td>TMI - Hosensak Ckt 1</td>
<td>312.4</td>
<td>93.8</td>
<td>218.7</td>
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<tr>
<td>Peachbottom - Cochrnvl Ckt 1</td>
<td>384.0</td>
<td>183.1</td>
<td>200.9</td>
</tr>
<tr>
<td>Juniata – Alburtis Ckt 1</td>
<td>449.4</td>
<td>269.2</td>
<td>180.1</td>
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<tr>
<td>Elroy – Brancburg Ckt 1</td>
<td>334.4</td>
<td>176.3</td>
<td>158.1</td>
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<td>Branburg- Deans Ckt 1</td>
<td>200.2</td>
<td>60.0</td>
<td>140.1</td>
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<tr>
<td>Lackaw- Jefferson Ckt 1</td>
<td>153.7</td>
<td>47.2</td>
<td>106.6</td>
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<td><strong>Total</strong></td>
<td><strong>3308.8</strong></td>
<td><strong>1447.7</strong></td>
<td><strong>1861.2</strong></td>
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• Develop solutions to resolve the reactive problems noted on the previous pages
  – Backbone transmission lines are being considered to address the identified problems
    • MAPP
    • Conastone to Peach Bottom
    • Peach Bottom to Keeney

• Reactive analysis for common mode failure contingencies such as bus faults and stuck breaker faults
- N-2 study summary:
  - # of 2013 single contingencies: 5379
  - Analysis: voltage magnitude and drop
  - All potential violations are tabulated by each area, and sent to TOs for verification.

- # of buses with voltage magnitude/drop violations (PJM West and South)

<table>
<thead>
<tr>
<th>Voltage Level</th>
<th>Dominion</th>
<th>APS</th>
<th>AEP</th>
<th>Dayton</th>
<th>Duquesne</th>
<th>ComED</th>
</tr>
</thead>
<tbody>
<tr>
<td>69 kV</td>
<td>0 / 0</td>
<td>0 / 1</td>
<td>0 / 29</td>
<td>25 / 33</td>
<td>2 / 2</td>
<td>18 / 0</td>
</tr>
<tr>
<td>115 kV</td>
<td>49 / 63</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
</tr>
<tr>
<td>138 kV</td>
<td>1 / 4</td>
<td>127 / 123</td>
<td>5 / 5</td>
<td>16 / 18</td>
<td>4 / 4</td>
<td>293 / 0</td>
</tr>
<tr>
<td>161 kV</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>3 / 3</td>
<td>0 / 0</td>
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<td>0 / 0</td>
</tr>
<tr>
<td>230 kV</td>
<td>24 / 11</td>
<td>15 / 19</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
</tr>
<tr>
<td>235 kV</td>
<td>0 / 0</td>
<td>0 / 1</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
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<tr>
<td>345 kV</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>71 / 0</td>
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<tr>
<td>500 kV</td>
<td>0 / 0</td>
<td>1 / 2</td>
<td>1 / 1</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
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<tr>
<td>765 kV</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 5</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>3 / 0</td>
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<tr>
<td>Blown Up</td>
<td>11 / 11</td>
<td>26 / 26</td>
<td>4 / 23</td>
<td>3 / 3</td>
<td>0 / 0</td>
<td>31 / 0</td>
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</table>
- **# of buses with voltage magnitude/drop violations (MAAC)**

(# of buses with low voltage / # of buses with voltage drop)

<table>
<thead>
<tr>
<th></th>
<th>PJM 500</th>
<th>PN</th>
<th>ME</th>
<th>JCPL</th>
<th>PPL</th>
<th>PECO</th>
<th>PSEG</th>
<th>BGE</th>
<th>PEPCO</th>
<th>AE</th>
<th>DPL</th>
<th>UGI</th>
<th>RE</th>
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<tbody>
<tr>
<td>69 kV</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>31 / 29</td>
<td>0 / 9</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>74 / 83</td>
<td>71 / 104</td>
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<tr>
<td>115 kV</td>
<td>0 / 0</td>
<td>70 / 90</td>
<td>19 / 57</td>
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<td>0 / 0</td>
<td>0 / 20</td>
<td>1 / 1</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
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<tr>
<td>138 kV</td>
<td>0 / 0</td>
<td>1 / 2</td>
<td>2 / 2</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>30 / 25</td>
<td>10 / 48</td>
<td>0 / 0</td>
<td>0 / 7</td>
<td>9 / 9</td>
<td>12 / 23</td>
<td>0 / 0</td>
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<tr>
<td>161 kV</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
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<td>0 / 0</td>
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<tr>
<td>230 kV</td>
<td>0 / 0</td>
<td>11 / 13</td>
<td>7 / 10</td>
<td>11 / 14</td>
<td>18 / 26</td>
<td>23 / 21</td>
<td>9 / 22</td>
<td>0 / 0</td>
<td>1 / 2</td>
<td>2 / 1</td>
<td>0 / 2</td>
<td>0 / 0</td>
<td>0 / 0</td>
</tr>
<tr>
<td>235 kV</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
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</tr>
<tr>
<td>345 kV</td>
<td>0 / 0</td>
<td>3 / 0</td>
<td>0 / 0</td>
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<tr>
<td>500 kV</td>
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<td>0 / 0</td>
</tr>
<tr>
<td>765 kV</td>
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<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
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<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
</tr>
<tr>
<td>Blown Up</td>
<td>1 / 1</td>
<td>59 / 56</td>
<td>4 / 3</td>
<td>8 / 10</td>
<td>5 / 4</td>
<td>19 / 13</td>
<td>8 / 10</td>
<td>3 / 3</td>
<td>21 / 20</td>
<td>2 / 3</td>
<td>16 / 12</td>
<td>0 / 0</td>
<td>0 / 0</td>
</tr>
</tbody>
</table>
Baseline Upgrades
APS Baseline Upgrades

- Thermal Overload of Cabot #1 500/138 kV transformer
- Bus fault contingency of the #2 Main 500 kV bus resulting in loss of the #2 and #4 banks
- APS Criteria
  - Solution: Install a third Cabot 500/138kV autotransformer
- Estimated Cost: $8.07M
- IS Date: 6/1/2011
• In 2013, the Ringgold #3 230/138 kV transformer is overloaded for the tower outage of Reid - Nipetown 138 kV and Marlowe - Halfway 138 kV
• Solution: Replace the Ringgold #3 230/138 kV transformer with a larger transformer
• Generator deliverability
• Estimated Project Cost: $5.8
• IS Date: June 2013
ComEd Baseline Upgrades

- Thermal Overload of East Frankfort – Goodings Grove 345 kV “Red”
- No contingency – all facilities in Service
- Solution: Reconductor East Frankfort - Goodings Grove 345 kV "Red" line 11602
- Generator and Load Deliverability
- IS Date: 6/1/2013
- Cost Estimate: $15M
ComEd Baseline Upgrades

- Thermal overload of Wolfs 345/138 kV “Blue” transformer for the loss of the Wolfs 345/138 kV “Red” transformer
- Thermal overload of Wolfs – Oswego 138 KV “Blue” for the outage of Wolfs – Oswego 138 kV “Red”
- Solution for both violations: Replace the existing baseline to install a 2nd Wolfs 345/138 kV transformer. The replacement project is a 345/138 kV transformer at Plano “Red”
- Generator Deliverability
- Cost Estimate: $20M
- IS Date: 6/1/2013
ComEd Baseline Upgrades

• Thermal overload of Electric Jct 345/138 kV TR84 for the loss of the parallel TR83 and vice versa

• Solution: Install a second 345/138 kV transformer at Plano “Red”

• Generator Deliverability and Load Deliverability

• Estimated Cost: $10M

• IS Date: June 2013
ComEd Baseline Upgrades

- Thermal overload of Goodings Grove 345/138 kV “Red” transformer for the loss of Blue Island – Alsip 138 kV
  - Solution: Install a third 345/138 kV transformer at Goodings Grove “Red”
  - Generator Deliverability & Load Deliverability
  - IS Date: 6/1/2013
  - Cost Estimate: $15M
ComEd Baseline Upgrades

- Thermal overload of East Frankfort – Goodings Grove 345 kV “Blue”
- No contingency – all Facilities in Service
- Solution: Install a 2nd East Frankfort 345/138 kV Autotransformer and reconductor Country Club Hills – Matteson 138 kV
- Generator Deliverability & Load Deliverability
- IS Date: 6/1/2013
- Cost Estimate: $11.25M
DPL Baseline Upgrades

- Basin Road – Kiamensi 138 kV line / loss of Carrcroft – Edgemoor 138 kV line + loss of Harmony 230/138 kV transformer
- Brandywine – West Wilm 138 kV line / loss of Harmony 230/138 kV transformer + loss of Basin Road – Kiamensi 138 kV line
- Carrcroft - Brandywine 138 kV line / loss of Harmony 230/138 kV transformer + loss of Basin Road – Kiamensi 138 kV line
- Basin Road - Newcastle 138 kV line / loss of Harmony 230/138 kV transformer + loss of Keeney 230/138 kV transformer
- Recommended Solution: Add 2\textsuperscript{nd} 230/138 kV transformer at Harmony
- Estimated Project Cost: $7.5M
  - Expected IS Date: 6/01/2013
Dominion Baseline Upgrade

- High load area currently fed by two 230 kV underground lines originating from same substation
- N-2 contingency loss of UG transmission lines #277 and 278 from Glen Carlyn to Clarendon causes the loss of all load at Clarendon and Ballston Substations. Restoring this load via 69 kV lines #122 and #143 will cause loading on UG transmission lines #179 and #180 Pentagon to Rosslyn 69 kV to exceed their STE ratings.
- Solution: Build new UG 230 kV circuit from Arlington to Ballston
- Expected in-service date: June 2013
- Estimated cost: $80 M
Dominion Baseline Upgrade

- Radial lines #49 Loudoun to Middleburg 115 kV and #2098 Pleasant View to Hamilton 230 kV line loading exceed Dominion Criteria Radial line load greater than 100 MVA.
- Solution: Build a 15-mile long 230 kV line from Hamilton to Middleburg and convert Line #49 to 230 kV (10 miles).
- Expected service date: May 2013
- Est. Cost: $125M
• Lines #11 Gordonsville to Oak Green and #198 Oak Green to Chancellor overloads for the loss of line #552 Ladysmith-Chancellor-Bristers 500 kV or the Chancellor 500-115 kV Tx.

• Recommended Solution: Install two 500 kV breakers and a 2nd 500-115 kV AutoTx. at Chancellor Substation

• Expected service date: May 2013

• Est. Cost: $16.0 M
The outage of line #73 Four Rivers to Elmont with Four Rivers 115 kV generation off causes low voltages at line #45 Four Rivers to Fredricksburg 115 kV.

Also Line #47 Four Rivers to Fredricksburg overloads for the outage line #29 Fredricksburg to Possum Pt and Fredricksburg 230-115 kV.

Recommended Solution: Install 2nd Fredricksburg 230-115 kV AutoTx.

Expected service date: May 2013

Est. Cost: $5.5 M
Dominion Baseline Upgrade

- North Anna to Ladysmith 500 kV overloads for the outage of North Anna to Morrisville 500 kV
- Solution: Replace wave traps on North Anna to Ladysmith 500 kV
- Generator Deliverability
- Expected service date: May 2013
- Est. Cost: $0.3 M
• North Temple 230/69 kV transformer #4 / loss of North Temple 230/69 kV transformer #6
• Berkeley Tap-Bern Church 69 kV line / loss of North Temple-Royal Green 69 kV line
• Bernville-South Hamburg 69 kV line / loss of North Temple-Berkeley Tap 69 kV line
• Construct a 230 kV Bernville station by tapping the North Temple-North Lebanon 230 kV line
• Install a 230/69 kV transformer at existing Bernville 69 kV station
• Estimated Project Cost: $5.73 M
• Expected IS Date: 5/01/2010
• Morristown 230/34.5 kV transformer #6 / loss of Morristown 230/34.5 kV transformer #5
• Morristown 230/34.5 kV transformer #5 / loss of Morristown 230/34.5 kV transformer #6
• Morristown 230/34.5 kV transformer #5 / loss of Morristown-Stoney Brook-Whippany 230 kV line
• Shift load off of 34.5 kV bus and add Morristown 230/13.2 kV transformer
• Estimated Project Cost: $1.47 M
• Expected IS Date: 6/01/2009
• Buxmont-Quakertown #2 69 kV line / loss of Buxmont-Quakertown #1 69 kV Line
• New Springfield 230/69 kV Substation and Transmission Line Connections
• Estimated Project Cost: $16.40 M
• IS Date: 5/1/2011
PPL Baseline Upgrades

- All 3 Stanton 230/69 kV transformers / loss of DCTL Stanton-Lackawanna and Mountain-Lackawanna 230 kV lines
- Add a 4th 230/69 kV transformer at Stanton
- Estimated Project Cost: $5.90 M
- Expected IS Date: 11/01/2011
PEPCO Baseline Upgrades

- Benning Station “A” 230/69 kV transformer / loss of parallel transformer
- Expand Benning 230 kV station; add a new 230/69 kV, 250 MVA transformer at Benning Sta. "A"; new 115 kV Benning switching station
- Estimated Project Cost: $54.0 M
  • Expected IS Date: 6/01/2012
- Operational issues related to the installation of two additional 230 kV underground feeders at Benning
- Add a second 50 MVAR 230 kV shunt reactor at the Benning 230 kV substation
- Estimated Project Cost: $6.4 M
  • Expected IS Date: 6/01/2012
PEPCO N-2 Baseline Upgrades

- Multiple N-2 Violations in the Bells Mill, Bethezda, Southwest, and Buzzard point 138 kV areas
- Recommended Solutions:
  - Add Slow Oil Circulation to the 4, Bells Mill Road – Bethesda 138 kV lines
  - Add Slow Oil Circulation to the 2, Buzzard Point – Southwest 138 kV lines
- Estimated Project Cost: $6.0 M
  - Expected IS Date: 6/01/2013
PEPCO N-2 Baseline Upgrades

- Bells Mill Road 031 230/138 kV transformer / loss of Bells Mill Road 028 230 kV bus + loss of Bells Mill Road 029 230 kV bus
- Bells Mill Road 030 230/138 kV transformer / loss of Bells Mill Road 028 230 kV bus + loss of Bells Mill Road 029 230 kV bus
  - In addition to the Slow Oil Circulation upgrades and Phase Shifter adjustments, the following upgrade is needed to relieve these transformer overloads:
  - Implement an SPS to automatically shed load on the 34 kV Bells Mill Road bus for this N-2 condition.
PEPCO N-2 Baseline Upgrades

- The SPS will be in effect for years 2013 & 2014 until a 3rd Bells Mill 230/34 kV transformer is placed in-service in 2015.
- Cost Estimate: $10.7M
- Expected IS Date: 6/01/2015
- Middle River – Chesaco Park 115 kV line / loss of Middle River - Northeast 115 kV line + Basecase

- Still working through upgrade plan to resolve this violation.

• Expected IS Date: 6/01/2013
- Gwynnbrook - Sudbrook 110579-E 115 kV line / loss of Northwest – Sudbrook 110578 115 kV line + Basecase
- Still working through upgrade plan to resolve this violation.
  - Expected IS Date: 6/01/2013
- Werner – Raritan River 115 kV line / loss of Smithburg-Englishtown 230 kV line + loss of Raritan River 230/115 kV transformer
- Werner 230/115 kV transformer / loss of Smithburg-Englishtown 230 kV line + loss of Raritan River 230/115 kV transformer
- Add a 2\textsuperscript{nd} Raritan River 230/115 kV transformer
- Estimated Project Cost: TBD

- Expected IS Date: 6/01/2013
Previously Reviewed Upgrades for PJM Board Approval
American Electric Power Baseline Upgrades
• 69 kV system in the Wooster-Moreland area of AEP (Northern Ohio) is no longer single contingency reliable

• Recommended Solution (major components):
  – Establish a new 69 kV circuit between the Canal Road and East Wooster stations
  – Establish a new 69 kV circuit between the West Millersburg and Moreland Switch stations (via Shreve)
  – Add reactive support VIA cap banks

• AEP Criteria
• Estimated cost: $27M
• Expected in-service date: 12/1/2010
AEP Baseline Upgrades

- Generator Deliverability
  Problem: The tower outage of West Millersport – Kirk 345 kV and West Millersport – Hyatt 345 kV overloads West Millersport – Millersport 138 kV

- Generator Deliverability

- Solution: Reconductor West Millersport - Millersport 138 kV

- Estimated Project Cost: $6.5M

- IS Date: 6/1/2012
Problem: The tower outage of Allen – Sorensen 345 kV and Convoy – Robinson Park 345 kV overloads East Side Lima – Sterling 138 kV

Generator Deliverability

Solution: Reconductor East Side Lima - Sterling 138 kV

Estimated Project Cost: $5M

IS Date: 6/1/2012
APS Baseline Upgrades
- Replace Eastalco 230 kV breaker D-26, D-28, and D-31
- Estimated Project Cost: $0.300 M per breaker
  • Expected IS Date: 6/01/2012
APS Short Circuit Baseline Upgrades

- Upgrade (per ABB inspection) Hatfield 500 kV breakers due to Short Circuit
  - HFL-1
  - HFL-3
  - HFL-4
  - HFL-6
  - HFL-7
  - HFL-9
- Estimated Project Cost: $60K per breaker
- IS Date: 6/1/2011
• Replace Harrison 500 kV breaker HL-3
  • Estimated Cost: $0.7M
• Upgrade (per ABB inspection) Harrison 500 kV breakers due to Short Circuit
  – HL-6
  – HL-7
  – HL-8
  – HL-10
• Estimated Cost: $60K per breaker
• IS Date: 6/1/2011
• Replace Fort Martin 500 kV breaker 'FL-1' due to Short Circuit
• Estimated Project Cost: $0.7 M
• IS Date: 6/1/2011
Generator Deliverability Problem: The Albright – Loughs Lane 138 kV path is overloaded for various Category C contingencies on the 138 kV system in West Virginia

Recommended Solution: Reconductor Albright - Mettiki - William - Parsons - Loughs Lane 138 kV with 954 ACSR

Estimated Project Cost: $14.7M

IS Date: 6/1/2011
• Generator Deliverability Problem: Overload of Butler – Cabot 138 kV ckt “E” for the loss of the parallel circuit and Cabrey Junction 138 kV
• Recommended Solution: Reconfigure circuits in the Butler - Cabot 138 kV area
• Estimated Project Cost: $ 1.18 M
• IS Date: 6/1/2012
APS Baseline Upgrades

- Install 33 MVAR 138 kV Capacitor at Necessity due to Low Voltage Magnitude for the loss of Bethelboro – North Union Tap 138 kV

- Estimated Project Cost: $ 0.77 M

- IS Date: 6/1/2009
APS Baseline Upgrades

- Increase Cecil 138 kV Capacitor size to 44 MVAR due to low voltage magnitude for the loss of Wylie Ridge – Smith 138 kV
  - Estimated Project Cost: $0.1 M
  - IS Date: 6/1/2010
- Replace five 138 kV breakers at Cecil due to increased Short Circuit fault duty as a result of the addition of the Prexy substation
  - Estimated Project Cost: $0.45 M
  - IS Date: 6/1/2010
• Increase Whiteley 138 kV Capacitor size to 44 MVAR due to Low Voltage Magnitude for the loss of Fairview – Miracle Run 138 kV

• Estimated Project Cost: $0.64 M

• IS Date: 6/1/2010
• Problem: Thermal overload of Tidd – Carnegie – Weirton 138 kV for the loss of Tidd – Mahans Lane 138 kV

• Solution: Reconductor AP portion of Tidd - Carnegie 138 kV and Carnegie - Weirton 138 kV with 954 ACSR due to Thermal Overload

• Estimated Project Cost: $ 3.16 M

• IS Date: 6/1/2011
• Install 40.8 MVAR 138 kV capacitor at Grassy Falls due to Voltage Magnitude for a stuck breaker at Powell Mountain 138 kV

• Estimated Project Cost: $0.5 M

• IS Date: 6/1/2010
• Replace #1 and #2 138 kV breakers at Charleroi due to increased Short Circuit fault duty as a result of the addition of the Prexy substation

• Estimated Project Cost: $0.45 M

• IS Date: 6/1/2009
• Install 25.2 MVAR 138 kV Capacitor at Seneca Caverns due to low voltage magnitude for the loss of Hardy - Junction 138 kV

• Estimated Project Cost: $0.63 M

• IS Date: 6/1/2010
• Double Toll Gate - Riverton 138 kV is overloaded for the loss of the North Shenandoah 138 - 115 kV transformer & Meadowbrook - Klines Mill 138 kV line

• Solution: Reconductor Double Toll Gate – Riverton with 954 ACSR

• Estimated Cost: $2.7M

• IS Date: 6/1/2013
• Thermal overload of:
  – Blacks - Miracle Run 138 kV
  – Bracken - Luxor 138 kV
  – Eastgate – Luxor 138 kV
  – Eastgate – Sony 138 kV
  – Edgewater - Loyalhanna 138 kV
  – Edgewater - Vanceville Jct 138 kV
  – Fairview - Grant Town 138 kV
  – Fairview – Miracle Run 138 kV
  – King Farm – Sony 138 kV
  – Luxor - Loyalhanna 138 kV
  – Luxor – Stony Springs Jct 138 kV
  – Social Hall – Vanceville Jct 138 kV
  – Whiteley - Blacksville 138 kV
  – Youngwood - Yukon 138 kV
  – Yukon – Waltz Mills Tap 138 kV
  – Vanceville Jct - Washington 138 kV

• Solution: Construct new 138 kV line from Osage - Whiteley
  • Estimated Cost: $13.3M
  • IS Date: 6/1/2013

• Solution: Tap Yukon - Bethel Boro 138 kV line and construct new 138 kV Line to Sony
  • Estimated Cost: $10.3M
  • IS Date: 6/1/2013
• Thermal Overload of Franklin – Pursley 138 kV l/o Vanceville Jct – Washington 138 kV line & Dutch Fork – Windsor 138 kV line
  • Solution: Replace 600/5 CT's at Franklin
  • Estimated Cost: $0.01M
  • IS Date: 6/1/2013

• Thermal Overload of Whiteley – Pursley 138 kV l/o Vanceville Jct – Washington 138 kV line & Dutch Fork – Windsor 138 kV line
  • Solution: Replace 600/5 CT's at Whiteley
  • Estimated Cost: $0.01M
  • IS Date: 6/1/2013
• Thermal overload of Grand Point – Letterkenny 138 kV l/o East Waynesboro – Ringgold 138 kV line & Grand Point – Guilford 138 kV line
• Reconstructor Grand Point - Letterkenny with 954 ACSR
• Estimated Cost: $2.1M
• IS Date: 6/1/2013

• Thermal overload of Greene – Letterkenny 138 kV l/o East Waynesboro – Ringgold 138 kV line & Grand Point – Guilford 138 kV line
• Reconstructor Greene - Letterkenny with 954 ACSR
• Estimated Cost: $0.56M
• IS Date: 6/1/2013
• Thermal overload of Guilford – South Chambersburg 138 kV for the loss of Ringgold – East Waynesboro 138 kV
• Generator Deliverability
• Reconductor Guilford - South Chambersburg with 954 ACSR
• Estimated Cost: $3.2M
• IS Date: 6/1/2013
Atlantic Electric Baseline Upgrades
• Scull #2 – Mill #2 138 kV line / Loss of the other circuit (Single)
• Recommended Solution: Upgrade a strand bus at MILL
• Estimated cost: $0.2M
• Expected in-service date: June 1, 2013
Load Deliverability Violation - Atlantic Electric

- Mickleton 230/69 kV transformer #4 / loss of the Mickleton 230/69kV transformer #1
- Recommended Solution: Move the Monroe 230/69 kV transformer to Mickleton
- Estimated cost: $1.24 M
- Expected in-service date: June 1, 2013
BG&E Baseline Upgrades
• Brandon Shores – Hawkins Point Terminal 230 kV line / Loss of Brandon Shores – Hawkins Point Terminal – Sollers Point Terminal (#2344) 230 kV line and Brandon Shores 5T Breaker failed (Line_FB)

• Sollers Point Terminal – Riverside 230 kV line CKT 2345 / Loss of Brandon Shores – Hawkins Point Terminal – Sollers Point Terminal (#2344) 230 kV line and Brandon Shores 5T Breaker failed (Line_FB)

• Recommended Solution: Replace 230 kV breaker and associated CTs at Riverside on 2345 line. Replace all dead-end structures at Brandon Shores, Hawkins Point, Sollers Point and Riverside. Install a second conductor per phase on the spans entering each station. Brandon Shores – Hawkins Point N/E = 1243/1386 MVA. Sollers Pt. – Brandon Shores N/E = 1174/1386 MVA

• Expected service date: June 1, 2013

• Estimated Cost $1.5 M
Generation Deliverability Violation – BG&E

- Conastone 500/230 kV transformer CKT 1 / Loss of Conastone – Peach Bottom 500 kV line + Conastone 500/230 kV transformer CKT 2 (Line_FB)
  - The limitation on the transformer is associated bus
  - The bus will be replaced as part of the transformer replacement (B0298)
• Burtonsville – Sandy Spring 230 kV line CKT #2314 / Loss of High Ridge – Sandy Springs – Burtonsville CKT # 2334 (Single)
• Burtonsville – Sandy Spring 230 kV line CKT #2334 / Loss of High Ridge – Sandy Springs – Burtonsville CKT # 2314 (Single)
• Recommended Solution: Rebuild each line (0.2 miles each) to increase the normal rating to 968 MVA and the emergency rating to 1227 MVA
• Expected in-service: June 1, 2013
• Estimated cost: $0.27 M per line
- Harford - Perryman 110615-A 115 kV line / loss of Harford - Perryman 110616-A 115 kV line
- Harford - Perryman 110616-A 115 kV line / loss of Harford - Perryman 110615-A 115 kV line
- Rebuild both Harford - Perryman 115 kV lines 110615-A & 110616-A
- Estimated Project Cost: $8.0 M

• Expected IS Date: 6/01/2013
ComEd Baseline Upgrades
ComEd Baseline Upgrades

- Thermal overload of Waukegan – Gurnee 138 kV “Red”
  - Bus fault at Silver Lake 138 kV “Red”
- Thermal overload of Waukegan – Gurnee 138 kV “Blue”
  - Tower Outage of Round Lake – Wilson 138 kV “Blue” and “Red” circuits
- Generator Deliverability
- Reconductor 138 kV lines 1603 and 1607 from Waukegan to Gurnee
- Estimated Cost: $11.6M
- IS Date: 6/1/2013
Dynamic Voltage Criteria & Voltage Stability Criteria

• Solution: Add a 300 MVAR SVC at Elmhurst 138 kV “Red”
  • IS Date: 6/1/2013
  • Cost: $32.5M

• Solution: Add a 300 MVAR SVC at Elmhurst 138 kV “Blue”
  • IS Date: 6/1/2013
  • Cost: $32.5M
Voltage Stability

• Solution: Install 115.2 MVAR switched capacitors at the following locations by 6/1/2013:
  – East Frankfort 138 kV ($2.9M)
  – Plano 138 kV Red ($2.3M)
  – Plano 138 kV Blue ($2.3M)
  – McCook 138 kV Red ($2.3M)
  – McCook 138 kV Blue ($2.3M)
  – Wayne 138 kV Blue ($2.9M)
  – Wayne 138 kV Red ($2.9M)
  – Crawford 138 kV Blue ($2.3M)
  – Crawford 138 kV Red ($2.3M)
  – Bedford Park 138 kV Blue ($2.9M)
  – Bedford Park 138 kV Red ($2.9M)
  – Wolfs 138 kV (57.6 MVAR) ($1.5M)
ComEd Baseline Upgrades

- Thermal overload of Prospect Heights 345/138 kV “Red” transformer for the loss of Prospect Heights – Leithton 138 kV line 11708
- Solution: Add a breaker at Aptakisic 138 kV to split the line in two for the 11708 contingency
- ComEd criteria & PJM Load Deliverability
- Expected IS Date: 6/1/2013
- Cost estimate: $4M
• Thermal overload of 0902 Frankfort – New Lenox 138 kV for the loss of Dresden – Shorewood 138 kV
• Solution: Reconductor line 0902 Frankfort - New Lenox 138 kV
• Generator Deliverability
• Expected IS Date: 6/1/2013
• Cost Estimate: $2M
• Thermal overload of 138 kV line 0902 between E. Frankfort TSS 66 and Davis Creek TSS 86 tap for the loss of East Frankfort – Matteson 138 kV
• Solution: Increase capacity of 138 kV line 0902 between E. Frankfort TSS 66 and Davis Creek TSS 86 tap ~ 1.5 miles
• Generator Deliverability
• Expected IS Date: 6/1/2013
• Cost Estimate: $1.5M
Delmarva Baseline Upgrades
- Voltage collapse / loss of Indian River unit 3
- Voltage collapse / loss of Cedar Creek - Red Lion 230 kV line
- Voltage collapse / loss of Keeney - Steele 230 kV line
- Recommended Solution (for all three issues): Convert the 138 kV network path from Vienna to Loretto to Piney Grove to 230 kV and add 230/138 kV transformer at Loretto 230 kV station
- Estimated cost: $40M
- Expected in-service date: June 1, 2013
Generation Deliverability Violation – Delmarva

- Keeney 500/230 kV transformer CKT 1 / Loss of Keeney – Red Lion + Keeney 500/230 kV transformer CKT 2 (Line_FB)
- Keeney 500/230 kV transformer CKT 2 / Loss of Keeney – Red Lion + Keeney 500/230 kV transformer CKT1 (Line_FB)
- Recommended Solution: Add two additional breakers at Keeney 500 kV
- Estimated cost: $4.5M
- Expected in-service date: June 1, 2013
- Vaugh – Wells 69 kV line / loss of Harrington – South Harrington 69 kV line
- Rebuild Vaugh – Wells 69 kV line
- Estimated Project Cost: $1.6 M
• Expected IS Date: 6/01/2013
- Oil City – Steele 138 kV line / loss of Glasgow – Mount Pleasant 138 kV line + loss of Lums - Reybold 138 kV line
- Oil City – Church 138 kV line / loss of Glasgow – Mount Pleasant 138 kV line + loss of Lums - Reybold 138 kV line
- Recommended Solution: Rebuild Church – Steele 138 kV line
- Estimated Project Cost: $20 M
- Expected IS Date: 6/01/2013
- Indian River - Omar 138 kV line / loss of Frankford- Bishop 138 kV line + loss of Indian River – Robinson 138 kV line
- Bethany - Omar 138 kV line / loss of Frankford- Bishop 138 kV line + loss of Indian River – Robinson 138 kV line
- Recommended Solution: Rebuild Indian River – Omar - Bethany 138 kV line
- Estimated Project Cost: $9.6 M
- Expected IS Date: 6/01/2013
DPL Baseline Upgrades

- Dumpont Edgemoor - Edgemoor 69 kV line / loss of Kiamensi - Silverbrook 138 kV line + loss of Carrcroft - Edgemoor 138 kV line

- Dumpont Edgemoor - Silverside 69 kV line / loss of Kiamensi - Silverbrook 138 kV line + loss of Carrcroft - Edgemoor 138 kV line

- Recommended Solution: Rebuild Dupont Edgemoor – Edgemoor – Silverside 69 kV line

- Estimated Project Cost: $5.0 M

• Expected IS Date: 6/01/2013
- Numerous 69 kV overloads involving 2 sets of contingencies related by the loss of Bethany – 138th Street 138 kV line + loss of either one of the two 138 kV lines out of Bishop
- Recommended Solution: Build a new Indian River – Bishop 138 kV line
- Estimated Project Cost: $18 M
- Expected IS Date: 6/01/2013
- Steele 230/138 kV transformer AT21 / loss of Steele 230/138 kV transformer AT20 + loss of Mount Pleasant – Townsend 138 kV line

- Steele 230/138 kV transformer AT20 / loss of Steele 230/138 kV transformer AT21 + loss of Mount Pleasant – Townsend 138 kV line

- Townsend – Church 138 kV line / loss of Steele 230/138 kV transformer AT20 + loss of Steele 230/138 kV transformer AT21

- Recommended Solution: Add a 3rd Steele 230/138 kV transformer

- Estimated Project Cost: $8 M

- Expected IS Date: 6/1/2013
Load Deliverability Violation - Delmarva

- Reybold – Lums Pond 138 kV line for the loss of Glasgow – Keeney 138 kV line
  - Recommended Solution: Replace two circuit breakers to bring the emergency rating up to 348 MVA
  - Estimated cost: $1.0M
  - Expected in-service: June 1, 2013

- Glasgow – Mt. Pleasant 138 kV line for the loss of Lums Pond – Reybold 138 kV line
  - Recommended Solution: Rebuild 10 miles of Glasgow to Mt. Pleasant 138 kV line to bring the normal rating to 298 MVA and the emergency rating to 333 MVA
  - Estimated cost: $5.7 M
  - Expected in-service: June 1, 2013
Dominion Baseline Upgrades
Dominion Baseline Upgrade.

- With Possum Pt #3 off the outage of Possum Pt 230-115 Tx overloads for the outage of the parallel Tx.
- Loading on line#183 Bristers-Independent Hill 115 kV line and # 145 exceeds their 100 MVA line loading limits for Dominion Criteria for radial line loading.
- Recommended Solution: Close switch 145T183 to network the lines. Rebuild the section of Line #145 between Possum Point – Minnieville DP 115kV (15 miles).
- Expected service date: May 2013
- Est. Cost: $9.0 M
Dominion Baseline Upgrade.

- Chesapeake to Reeves Avenue 115 kV is overloaded for the loss of Chesapeake to Craddock 115 kV
- Recommended Solution: Reconductor one mile of Chesapeake to Reeves Avenue 115 kV line
- Expected service date: May 2013
- Est. Cost: $1.0 M
An outage of Line #160 Dooms-Dupont-Waynesboro 115 kV causes area voltage violations.

Solution: Build 2\textsuperscript{nd} Dooms - Dupont-Waynesboro 115 kV line.

Expected service date: May 2013.

Est. Cost: $6.0 M
The loading on Kitty Hawk to Nag’s Head exceed 100 MW.

Solution: Build 115 kV line from Kitty Hawk to Colington 115 kV.

- Colington on the existing line and Nag’s Head and Light House DP on new line.

Service Date: May 2009

Est. Cost: $9.0 M
Dominion Baseline Upgrade.

- The Chase City - Crewe 115 kV line overloads when the Crewe to Farmville line is fed from Chase City
- Rebuild the Chase City - Crewe 115 kV line
- In-service: Spring 2011
- Est. Cost: $11.0 M
- The Farmville - Crewe line is overloaded for various line segment conditions
- Reconduct the Moran DP - Crewe 115 kV segment
- In-service: June 2011
- Est. Cost: $5.0 M
Dominion Baseline Upgrade.

- The Chase City - Pamplin 115 kV line is overloaded when the Pamplin to Farmville line is fed from Pamplin
- Uprate the Chase City - Twitty’s Creek 115 kV segment
- In-service: June 2011
- Est. Cost: $7.0 M
• The Chase City - Pamplin - Farmville 115 kV line overloads when the entire line is fed from the Farmville end
• Reconduct the line from Farmville – Pamplin 115 kV
• Expected service date: June 2011
• Est. Cost: $9.0 M
• When the Possum Point #3 Unit is out and the outage of the Fredricksburg 230-115 kV Tx or the outage of the Fredricksburg to Possum Pt 115 kV line occurs the Possum Point 230-115 kV Tx overloads.

• Solution: Install 2\textsuperscript{nd} 230-115 kV TX at Possum Point

• Expected service date: May 2009

• Est. Cost: $3.5 M
Dominion Baseline Upgrade

- Lanexa to Chesterfield is overloaded for the loss of Chickahominy to Lanexa
- Chickahominy to Lanexa is overloaded for the loss of Birchwood to Northern Neck
- Solution: Build new Elko station and transfer load from Turner and Providence Forge stations
- Expected service date: May 2009
- Est. Cost: $2.2 M
The Yorktown to Whealton 115 kV line overloads for an outage of the remote end of the line

Solution: Rebuild 17.5 miles of the line for a new summer rating of 262 MVA

Expected service date: May 2009

Est. Cost: $18.0 M
Dominion Baseline Upgrade

- For an outage of the Chesapeake Energy Center end of the Greenwich – Chesapeake Energy Center 115 kV line, the Greenwich end of the line overloads.
- Solution: Increase the rating on 2.56 miles of the line between Greenwich and Thompson Corner 115 kV.
- Expected service Date: May 2009
- Est. Cost: $4.0 M
• The loading on Kitty Hawk to Nag’s Head exceed 100 MW
• Solution: Build 115 kV line from Kitty Hawk to Colington 115 kV.
  – Colington on the existing line and Nag’s Head and Light House DP on new line.
• Service Date: May 2009
Dominion Baseline Upgrade

- For N-2 events involving the loss of any combination of Bull Run #3 230-115 kV, Loudoun #3 230-115 kV or Loudoun #4 230-115 kV, the remaining autotransformer exceeds its emergency rating.
- Solution: Add a second Bull Run 230-115 kV autotransformer.
- Expected service date: May 2009.
- Est. Cost: $3.0 M.
• A section of the radial Loudoun to Middleburg 115 kV line is expected to be overloaded due to increased load at various delivery points on the line
• Solution: Increase the rating of the line between Loudoun and Cedar Grove 115 kV to a minimum of 150 MVA
• Expected service date: May 2009
• Est. Cost: $0.2 M
Dominion Baseline Upgrade

- Line loading at Pearsons and Old Church Subs. exceeds 100 MVA
- Solution: Extend the line from Old Church to Chickahominy 230 kV
- Expected Service Date: November 2009
- Est. Cost $17.0 M
Dominion Baseline Upgrade

- For the loss of line #266 and line #273 into Glen Carlyn, Tx. #1 and #3 along with line #277 and line #278 will be out of service.
- Solution: Loop line #251 Idylwood to Arlington into the GIS sub.
- Service Date: May 2010
- Est. Cost: $25.0 M
Dominion Baseline Upgrade

- The Garner to Lancaster portion of Northern Neck to Harmony Village 115 kV line overloads for the loss of Lanexa to Harmony Village 230 kV
- Solution: Re-tension 15 miles of the line for a new summer rating of 216 MVA
- Expected service date: May 2010
- Est. Cost: $5.5 M
Loss of the Lanexa to Correctional segment of Lanexa to Harmony Village overloads the Lanexa 230-115 kV autotransformer.

Solution: Add a second 230-115 kV autotransformer at Lanexa

Expected service date: May 2010

Est. Cost: $3.2 M
Dominion Baseline Upgrade

- In 2010 James River crossing is overloaded for the loss of Chickahominy to Yortown or the loss of Lanexa to Chickahominy
- In 2012 a portion of the Chesterfield to Lanexa line between Chesterfield and Turner overloads for the loss of Chickahominy to Lanexa
- Chickahominy to Lanexa overloads for the loss of Birchwood to Northern Neck
- Chickahominy to Lanexa overloads for the loss of Chickahominy to Harmony Village
- Solution: Build a parallel Chickahominy to Lanexa 230 kV line
- In-service date: May 2010
- Est. Cost: $3.5 M
Dominion Baseline Upgrade

- The Northwest 230-115 kV autotransformer overloads for the loss of Elmont to Northwest 230 kV line
- Solution: Install a second Elmont 230-115 kV autotransformer
- In-service date: May 2010
- Est. Cost: $4.5 M
Dominion Baseline Upgrade

- Stability concerns exist at Gosport 115 kV for double line to ground faults.
- Solution: Install dual primary protection schemes on lines #62 and #51 at remote terminals.
- Expected service date: May 2010
- Est. Cost: $0.46 M
Dominion Baseline Upgrade

- Loss of the Bremo 230-115 kV autotransformer is causing low voltage on the 115 kV system at Bremo
- Solution: Install a 33 MVAR capacitor on the Bremo 115 kV
- In-service: May 2011
- Est. Cost: $0.5 M
The Bayside to Greenwich portion of Greenwich - Virginia Beach 115 kV overloads for the loss of Greenwich - Amphibious Base 115 kV

The Greenwich to Davis Corner portion of Greenwich - Amphibious Base 115 kV overloads for the loss of Greenwich to Virginia Beach 115 kV

Solution: Reconductor Greenwich to Virginia Beach 115 kV to bring it up to a summer rating of 261 MVA. Reconductor the Greenwich to Amphibious Base 115 kV line to bring it up to 291 MVA

In-service: May 2011

Est. Cost: $2.1 M
The Trowbridge to Winfall 115 kV overloads for the outage of the Elizabeth City to Shawboro 230 kV and the Suffolk to Winfall 230 kV.

Solution: Re-build Trowbridge to Winfall 115 kV

Expected in-service date: June 2011

Est. Cost: $16.4 M
Dominion Baseline Upgrade

- Solution: Terminate the Thelma to Carolina 230 kV circuit into Lakeview 230 kV.
- Expected service date: June 2011
- Est. Cost: $4.0 M
• Loss of the Yorktown to Lanexa 115 kV line results in low voltage at Grafton and Lebanon
• Solution: Install 29.7 MVAR capacitor at Lebanon
• Expected service date: May 2012
• Est. Cost: $0.5 M
Dominion Baseline Upgrade

- Loss of Lanexa to Harmony results in low voltage on underlying 115 kV
- Solution: Build a new 230 kV line from Yorktown to Hayes but operate at 115 kV initially
- Expected service date: May 2012
- Est. Cost: $25.0 M
Dominion Baseline Upgrade

- Chesapeake to Yadkin 115 kV is overloaded for the loss of Chesapeake to Yadkin 230 kV with reduced generation at Chesapeake #4 off (221MW)
- Solution: Reconductor Chesapeake to Yadkin 115 kV line
- Expected service date: May 2012
- Est. Cost: $2.0 M
Dominion Baseline Upgrade

- Chesterfield to Shockoe 115 kV is overloaded for the loss of ACCA to Carver and visa-versa
- Solution: Reconductor and replace terminal equipment on line 17 and replace the wave trap on line 88
- Expected service date: May 2012
- Est. Cost: $0.3 M
• Loss of the Dooms source of Dooms to Dupont Waynesboro line results in low voltage at Waynesboro
• Install a new 115 kV capacitor at Dupont-Waynesboro substation
• Expected in-service date: May 2013
• Est. Cost: $0.5 M
First Energy Baseline Upgrades
ME Baseline Upgrades

- Jackson-JE Baker Tap-Taxville 115 kV line / loss of the Yorkana 115 kV bus
- Reconductor Jackson-JE Baker Tap-Taxville 115 kV line
- Estimated Project Cost: $1.19 M
- Expected IS Date: 5/29/09
ME Baseline Upgrades

- Low voltage in Bern Church 69 kV area / loss of the North Temple-Berkley 69 kV line
- Install 20 MVAR capacitor at Bern Church 69 kV bus
- Estimated Project Cost: $0.403 M
- Expected IS Date: 5/29/09
ME Baseline Upgrades

- Harley Davidson-Pleasureville 115 kV line / loss of the Yorkana 115 kV bus
- York Incinerator-Harley Davidson 115 kV line / loss of the Yorkana 115 kV bus
- Undervoltage at Violet Hill 115/69 kV station/ loss of the Yorkana 115 kV bus
- Install Bus Tie circuit breaker on Yorkana 115 kV bus
- Estimated Project Cost: $0.953 M
- Expected IS Date: 5/01/09
• Cambria Slope 115/46 kV transformer / fault on the Wilmore Junction 115 kV 3-terminal line + failure of Cambria Slope SPS
• Various other 46 kV overloads
• Reconfigure the Cambria Slope and Wilmore Junction 115 kV stations to eliminate the Wilmore Junction 115 kV 3-terminal line
• Estimated Project Cost: $1.28 M
• Expected IS Date: 5/30/09
• Lakehurst-Glidden-Van Hiseville 34.5 kV line / loss of Cookstown end of V22 34.5 kV circuit
• Cookstown-Great Adventure Tap 34.5 kV line / loss of Lakehurst end of V22 34.5 kV circuit
• Voltage collapse / loss of Larrabee end of U73 34.5 kV circuit
• Construct Boston Road 34.5 kV station
• Construct Hyson 34.5 kV station
• Add 7.2 MVAR capacitor at Boston Road 34.5 kV
• Estimated Project Cost: $5.81 M
• Expected IS Date: 6/01/2009
JC Baseline Upgrades

- Low voltage at Taylortown 34.5 kV bus / loss of Montville-Taylortown 34.5 kV line
- Add 6.6 MVAR capacitor at Taylortown 34.5 kV
- Estimated Project Cost: $0.400 M
- Expected IS Date: 5/20/2009
JC Baseline Upgrades

- Low voltage at Clinton 34.5 kV bus / loss of Glen Gardner-Clinton 34.5 kV line
- Add 7.2 MVAR capacitor at Clinton 34.5 kV
- Estimated Project Cost: $0.400 M
- Expected IS Date: 5/28/2009
• Voltage collapse / Forest 230 kV circuit breaker fault causing the loss of the Forest-Glade Tap 230 kV line
• Reconfigure and expand the Glade 230 kV ring bus to eliminate the Glade Tap 230 kV 3-terminal line
• Estimated Project Cost: $5.64 M
• Expected IS Date: 6/01/2010
- Altoona 230/46 kV transformer #1 / loss of Altoona-Raystown 230 kV line and Altoona 230/46 kV transformer #2
- Add 3 breakers to form a ring bus at Altoona 230 kV
- Estimated Project Cost: $2.73 M
- Expected IS Date: 6/01/2010
ME Baseline Upgrades

- **Driver:** Violation of FE Thermal Criteria / Hunterstown - Texas Eastern Tap - Gardners 115 kV
- **Solution:** Rebuild Hunterstown - Texas Eastern Tap 115
- **Estimated Project Cost:** $2.1 M
- **IS Date:** 6/1/2008
- **Solution:** Rebuild Texas Eastern Tap - Gardners 115 kV and associated upgrades at Gardners including disconnect switches
- **Estimated Project Cost:** $1.9 M
- **IS Date:** 5/1/2009
PECO Baseline Upgrades
• Bradford – Planebrook 230 kV line CKT 220-02 / Loss of the other 230 kV line (Single)
• Recommended Solution: Reconductor the line to provide a normal rating of 677 MVA and an emergency rating of 827 MVA
• Expected in-service: June 1, 2013
• Estimated cost: $7.0 M
• Bradford – Planebrook 230 kV line CKT 220-31 / Loss of Bradford – Planebrook 230 kV line + Bradford CB 220 failed (Line_FB)

• Recommended Solution: Reconductor the line to provide a normal rating of 677 MVA and an emergency rating of 827 MVA

• Expected in-service: June 1, 2013

• Estimated cost: $7.5 M
- Bryn Mawr – Plymouth Meeting 138 kV line / loss of Llanerch – Eddystone CKT 130-42
  138 kV line + basecase
- Bryn Mawr – Plymouth Meeting 138 kV line / loss of Llanerch – Eddystone CKT 130-42
  138 kV line + loss of Llanerch – Eddystone CKT 130-45
  138 kV line
- Rebuild Bryn Mawr – Plymouth Meeting 138 kV line
- Estimated Project Cost: $12.5 M
  • Expected IS Date: 6/01/2013
- Bluegrass – Byberry 138 kV line / loss of Woodbourne – Byberry 230 kV line + loss of Neshaminy – Emilie 138 kV line

- Switching Procedure: If the Woodbourne - Byberry 230 kV line were to occur first, then open the low side of Neshaminy #17 transformer so that all of the load (94 MVA) at Neshaminy will be dropped when the Neshaminy - Emilie 138 kV line contingency occurs.

- Switching Procedure : If the Neshaminy - Emilie 138 kV line contingency were to occur first, then open the Byberry 17-18, 18-19 and 20-21 bus ties so that 85 MVA of Byberry load will be dropped when the Woodbourne – Byberry 230 kV line contingency occurs.

- Estimated Project Cost: $0 M

- Expected IS Date: 6/01/2013
PEPCO Baseline Upgrades
• Station H – Quince Orchard 230 kV line / Loss of Dickerson – Quince Orchard DCTL
• Recommended Solution: Upgrade circuit to 3,000 amps using the ACCR
• Expected in-service date: June 1, 2013
• Estimated cost: $6.252M
- Quince Orchard – Bells Mill (030) 230 kV line / loss of Bells Mill (028) 230 kV bus + loss of Bells Mill (029) 230 kV bus

- Quince Orchard – Bells Mill (028) 230 kV line / loss of Bells Mill (029) 230 kV bus + loss of Bells Mill (031) 230 kV bus

- Recommended Solution: Upgrade terminal equipment on both lines

- Estimated Project Cost: $1.415 M

• Expected IS Date: 6/01/2012
- Oak Grove – Ritchie 23061 230 kV line / loss of Oak Grove – Ritchie 23058 230 kV line + loss of Oak Grove – Ritchie 23060 230 kV line
- Recommended Solution: Upgrade Oak Grove – Ritchie 23061 230 kV line
- Estimated Project Cost: $3.25 M
  • Expected IS Date: 6/01/2013
- Oak Grove – Ritchie 23058 230 kV line / loss of Oak Grove – Ritchie 23059 230 kV line + loss of Oak Grove – Ritchie 23060 230 kV line
- Recommended Solution: Upgrade Oak Grove – Ritchie 23058 230 kV line
- Estimated Project Cost: $3.25 M
  - Expected IS Date: 6/01/2013
- Oak Grove – Ritchie 23059 230 kV line / loss of Oak Grove – Ritchie 23058 230 kV line + loss of Oak Grove – Ritchie 23060 230 kV line

- Recommended Solution: Upgrade Oak Grove – Ritchie 23059 230 kV line

- Estimated Project Cost: $3.25 M

- Expected IS Date: 6/01/2013
PEPCO N-2 Baseline Upgrades

- Oak Grove – Ritchie 23060 230 kV line / loss of Oak Grove – Ritchie 23058 230 kV line + loss of Oak Grove – Ritchie 23059 230 kV line
  - Recommended Solution: Upgrade Oak Grove – Ritchie 23060 230 kV line
  - Estimated Project Cost: $3.25 M
  - Expected IS Date: 6/01/2013
PP&L Upgrades
- Various overloads for N-2 Events:
  - Steel Tap - Steelton 230 kV line
  - Steelton-Steel H1 230 kV line
  - Steelton-Steel H3 230 kV line
  - Brunner Island - West Shore 230 kV line
  - West Shore - Steelton 230 kV line
  - Juniata - Cumberland 230 kV line
- Recommended Solution: Rebuild existing Brunner Island – West Shore 230 kV line and add 2nd Brunner Island – West Shore 230 kV line
- Estimated Project Cost: $34 M
  • Expected IS Date: 6/01/2013
The following upgrade addresses the previous 6 violations prior to the Brunner Island – West Shore 230 kV line rebuild in 2013.

Recommended Interim Solution: SPS Scheme to drop 190 MVA of 69 kV radial load at West Shore and 56 MVA of 69 kV radial load at Cumberland.

Estimated Project Cost: $0 M

Expected IS Date: 6/01/2010
- Susquehanna – Jenkins 230 kV line / loss of Susquehanna – Lackawanna 500 kV line + loss of Mountain Tap 230 kV bus
- Susquehanna – Jenkins 230 kV line / loss of Susquehanna – Lackawanna 500 kV line + loss of Susquehanna-Mountain Tap 230 kV line
- Susquehanna – Jenkins 230 kV line / loss of Susquehanna – Lackawanna 500 kV line + loss of Stanton-H1 230 kV bus
- Recommended Solution: SPS Scheme at Jenkins substation to open the Stanton #1 and Stanton #2 230 kV circuit breakers after the second contingency
- Estimated Project Cost: $0 M
- Expected IS Date: 6/01/2013
PPL Baseline Upgrades

- 210 MVA load loss / loss of double circuit South Akron-South Reading 230 kV lines and Berks transformers #1 and #2
- Exceeds PPL guidelines for maximum allowable load loss
- Berks Substation modification on Berks-South Akron 230 kV Line. Modification will isolate the line fault on the South Akron line and will allow Berks transformer #2 to be energized by the South Lebanon 230kV circuit
- Estimated Project Cost: $0.523 M
- Expected IS Date: 5/01/2010
• Eldred-Pine Grove 69 kV Line / basecase
• Eldred-Pine Grove 69 kV Line Rebuild Part 2: 8 Miles
• Estimated Project Cost: $10.22 M
• IS Date: 5/1/2012
• Several overloads in Lackawanna/Providence 69 kV area / loss of DCTL Lackawanna-Mountain 230 kV line and Lackawanna-Stanton 230 kV line
• Stanton-Providence #1 & #2 69 kV Line: Reconductor/Rebuild w/ 69 kV Design: Approximately 8 Miles Total
• Estimated Project Cost: $4.89 M
• IS Date: 5/1/2011
PPL Baseline Upgrades

- Harwood 230/69 kV transformer / loss of DCTL Susquehanna-Harwood #1 & #2 230 kV lines
- Harwood Substation: Add 150MVA, 230/138/69 Transformer #6
- Estimated Project Cost: $13.97 M
- IS Date: 11/1/2011
• Siegfried-Jackson 138 kV line / loss of Monroe-Jackson 138 kV line and low voltage in Jackson 69 kV area
• Bartonsville Substation - New 138kV tap off Monroe-Jackson #1
• Stroudsburg Substation: New 138kv Taps from Monroe-Jackson Lines
• Gilbert Substation: New 138kV tap off Siegfried-Jackson #2 to Transformer #2
• Estimated Project Cost: $1.95 M
• IS Date: 11/1/2010
PPL Baseline Upgrades

- Siegfried-Jackson 138 kV line / loss of Monroe-Jackson 138 kV line and low voltage in Jackson 69 kV area
- Siegfried 230/138 kV Substation: New 138 kV Line and Terminal, Add Second Circuit to Siegfried-Jackson for 8.0 Miles
- Jackson 138/69 kV Substation: 138 kV Yard Upgrades and Transmission Line Rearrangements
- Estimated Project Cost: $10.03 M
- IS Date: 11/1/2010
• South Farmersville 69 kV overloads / basecase
• South Farmersville Substation: New 69kV Tap off Nazareth-Quarry #2 to Transformer #2
• Estimated Project Cost: $0.40 M
• IS Date: 5/1/2011
PPL Baseline Upgrades

- Siegfried-Quarry 69 kV Line / basecase
- Siegfried-Quarry 69 kV Line Rebuild from Siegfried to North Bethlehem: 6.7 Miles
- Estimated Project Cost: $5.0 M
- IS Date: 5/1/2011
PPL Baseline Upgrades

- Buxmont-Hatfield #3 69 kV line / loss of Buxmont-Hatfield #4 69 kV line
- Elroy Substation Expansion and New Elroy-Hatfield 138/69 kV Double Circuit Lines: 1.9 Miles
- Estimated Project Cost: $38.42 M
- IS Date: 5/1/2013
PPL Baseline Upgrades

- Quarry-Elliott Heights #1 69 kV Line / loss of Quarry-Elliott Heights #3 69 kV Line
- Seidersville-Quakertown 138/69 kV Recductor/Rebuild 12 Miles and Hosensack New 75 MVA, 230/69 kV Transformer #4
- Estimated Project Cost: $23.14 M
- IS Date: 5/1/2009
PPL Baseline Upgrades

- West Shore-Cumberland #1 69 kV line / loss of West Shore 69 kV bus section 2
- New Double Circuit 138/69 kV Line from West Shore to Whitehill Taps: 1.3 Miles
- Estimated Project Cost: $4.91 M
- IS Date: 5/1/2013
• West Shore-Cumberland #2 69 kV line / basecase
• Cumberland-West Shore 69 kV Double Circuit Line: Reconductor 3.7 Miles from Cumberland to Wertzville
• Estimated Project Cost: $2.87 M
• IS Date: 12/1/2009
• West Shore-Cumberland #3 & #4 69 kV lines / Cumberland #1 & #2 230/69 kV transformers
• Reconductor West Shore-Cumberland #3 & #4 69 kV Lines from Mt. Allen to Rossmoyne: 1.6 Miles
• Estimated Project Cost: $1.03 M
• IS Date: 5/1/2013
PPL Baseline Upgrades

• Harrisburg-Capital Park #1 69 kV line / loss of Dauphin 69 kV bus section 1

• Replace UG Cable from Walnut Substation to Center City Harrisburg Substation for Higher Ampacity: 0.25 Miles

• Estimated Project Cost: $1.73 M

• IS Date: 5/1/2013
PPL Baseline Upgrades

- Lincoln 69 kV transformer / basecase
- Lincoln Substation - 69 kV Tap to Convert to Modified Twin A
- Estimated Project Cost: $0.12 M
- IS Date: 11/1/2012
PPL Baseline Upgrades

- W. Hempfield - Donegal 69 kV Line / loss of DCTL West Hempfield-Grin & West Hempfield-Hummelston 69 kV lines
- W. Hempfield - Donegal 69 kV Line - Reconduct / Rebuild from Landisville Tap to Mt. Joy Substation to Double Circuit 69 kV: 2 Miles
- W. Hempfield - Donegal 69 kV line - Reconduct / Rebuild to Double Circuit from Mt. Joy Substation to Donegal Substation: 2 Miles
- Terminate new S.Manheim-Donegal 69 kV Circuit into South Manheim #3 69 kV Bay
- Estimated Project Cost: $4.50 M
- IS Date: 10/1/2013
• W. Hempfield - Donegal 69 kV Line / loss of DCTL West Hempfield-Grin & West Hempfield-Hummelston 69 kV lines
• South Manheim-West Hempfield #3 69 kV Line - Rebuild from South Manheim to near Fuller Tap for Double Circuit 69 kV: 1.0 Mile
• West Hempfield - South Manheim #3 69 kV Line - Reconductor from Fuller tap to Landisville: Double Circuit 4.1 Miles
• Estimated Project Cost: $5.66 M
• IS Date: 9/1/2011
PPL Baseline Upgrades

- More than 30 MW load loss / loss of the Rohrsburg Tap 69 kV bus
- Exceeds PPL guidelines for maximum allowable load loss
- New Derry-Millville 69 kV line
- Estimated Project Cost: $9.35 M
- Expected IS Date: 11/01/2010
• Greenfield, Tinker, Elk Mountain 69 kV buses undervoltage / loss of Lackawanna-East Carbondale 69 kV line
• Rebuild Lackawanna-Edella 69 kV line to double circuit
• Estimated Project Cost: $5.09 M
• Expected IS Date: 11/01/2009
PPL Baseline Upgrades

- Lackawanna-Scranton #1 69 kV line / basecase
- Reconductor Suburban-Providence #1 69 kV line & Re-sectionalize the Suburban 69 kV lines
- Estimated Project Cost: $1.05 M
- Reconductor Suburban Taps #1 and #2 69 kV line portions
- Estimated Project Cost: $3.84 M
- Expected IS Date: 11/01/2012
PPL Baseline Upgrades

- More than 30 MW load loss / loss of the Blooming Grove-Hemlock 69 kV line
- Exceeds PPL guidelines for maximum allowable load loss
- Construct Bohemia-Twin Lakes 69 kV line
- Install 10.8 MVAR capacitor bank near Bohemia 69 kV station
- Estimated Project Cost: $18.35 M
- Expected IS Date: 11/01/2013
• Jenkins-Scranton 69 kV lines #1 and #2 / basecase
• Reconductor Stanton-Old Forge 69 kV line & Re-sectionalize the Jenkins-Scranton #1 and #2 69 kV lines
• Estimated Project Cost: $5.29 M
• Expected IS Date: 5/01/2012
PPL Baseline Upgrades

• More than 30 MW load loss / loss of the Lake Naomi 69 kV Tap
• Exceeds PPL guidelines for maximum allowable load loss
• New Double Circuit 69 kV Line from Jackson to Lake Naomi Tap
• Estimated Project Cost: $7.33 M
• Expected IS Date: 11/01/2013
• More than 45 MW load loss / loss of double circuit Cumberland-West Carlisle #1 and #2 69 kV lines
• Exceeds PPL guidelines for maximum allowable load loss
• Install New Double Circuit 69 kV Line between Carlisle and West Carlisle Substations
• Estimated Project Cost: $8.11 M
• Expected IS Date: 11/01/2012
• More than 45 MW load loss / loss of double circuit Hummelstown-Hershey and South Hershey-Hershey 69 kV lines
• Exceeds PPL guidelines for maximum allowable load loss
• Install 3rd 69 kV Line from Reese’s Tap to Hershey Substation
• Estimated Project Cost: $9.75 M
• Expected IS Date: 5/01/2012
PPL Baseline Upgrades

- More than 45 MW load loss / loss of double circuit outage of the Whitehill 69 kV Taps
- Exceeds PPL guidelines for maximum allowable load loss
- New 69 kV Line: from a tap of the West Shore-Cumberland #1 69 kV Line to Whitehill Substation
- Estimated Project Cost: $3.49 M
- Expected IS Date: 11/01/2013
PPL Baseline Upgrades

- More than 50 MW load loss / double-circuit outage on the 69kV Greenland Tap
- Exceeds PPL guidelines for maximum allowable load loss
- Construct a 69 kV Line Between Strassburg Tap and the Millwood-Engleside #1 69kV Line
- Estimated Project Cost: $1.32 M
- Expected IS Date: 11/01/2009
PPL Baseline Upgrades

- More than 70 MW load loss / double-circuit outage on the 69kV Dillersville Tap
- Exceeds PPL guidelines for maximum allowable load loss
- Construct a new 138kV Double Circuit Line between Dillersville Tap and the West Hempfield - Prince 138kV Line
- Estimated Project Cost: $0.545 M
- Expected IS Date: 5/01/2010
- Prepare Roseville Tap for 138 kV Conversion
- Estimated Project Cost: $0.107 M
- Expected IS Date: 11/01/2010
PPL Baseline Upgrades

- More than 70 MW load loss / double-circuit outage on the 69kV Dillersville Tap
- Exceeds PPL guidelines for maximum allowable load loss
- Transfer South Akron-South Manheim #1 & #2 lines from the South Akron 69kV Yard to the South Akron 138 kV Yard
- Estimated Project Cost: $3.01 M
- Expected IS Date: 11/01/2012
- Install Switches on South Akron-South Manheim #1 & #2 138 kV Lines
- Estimated Project Cost: $2.04 M
- Expected IS Date: 11/01/2013
PPL Baseline Upgrades

- 33 MVA load loss / loss of the Morgantown-Twin Valley 69 kV line
- Exceeds PPL guidelines for maximum allowable load loss
- Add 2nd 69 kV Circuit from Morgantown to Twin Valley
- Estimated Project Cost: $0.731 M
- Expected IS Date: 11/01/2009
PSE&G Baseline Upgrades
- Driver: Short Circuit Violation
- Replace Athenia 230 kV breaker 31H due to Short Circuit
- Estimated Project Cost: $ 0.4 M
- IS Date: 6/1/2012
- Replace Bergen 230 kV breaker 10H due to Short Circuit
- Estimated Project Cost: $ 0.4 M
- IS Date: 6/1/2012
- Replace Saddlebrook 230 kV breaker 21P due to Short Circuit
- Estimated Project Cost: $ 0.4 M
- IS Date: 6/1/2012
• Driver: 2009 Base Conditions
• Replace Essex 138 kV breakers due to Short Circuit
  – 4LM (C1355 line to ECRRF)
  – 1LM (220-1 TX)
  – 1BM (BS1-3 tie)
  – 2BM (BS3-4 tie)
• Estimated Project Cost each: $ 0.4 M
• IS Date: 6/1/2009
PSEB Baseline Upgrades

- Driver: 2009 Base Conditions
- Replace Linden 138 kV breaker 3 (132-7 TX) due to Short Circuit
- Estimated Project Cost: $0.4 M
- IS Date: 6/1/2009
- Replace Metuchen 138 kV breaker ‘2-2 Transfer’ due to Short Circuit
- Estimated Project Cost: $0.4 M
- IS Date: 6/1/2009
PJM Queued Generation Network Upgrades
• Poston Station and Elliot Tap - Rebuild approximately 3 miles of 138kV line between the Poston Station and Elliot Tap
  – Estimated Cost: $3M
• Sporn - Replace risers and switches at Sporn station and rebuild approx. 4 miles of the 34.5kV line between Sporn station and the new P54 Interconnection Station
  – Estimated Cost: $13.4M
• Muskingum River - Waterford - Rebuild approximately 4 miles of the 345kV line between Muskingum River and Waterford Station
  – Estimated Cost: $10.7M
• Sporn - Replace the "CC" 345kV circuit breaker
  – Estimated Cost: $1.9M
• Sporn - Replace the "CC1" 345kV circuit breaker
  – Estimated Cost: $1.9M
• Waterford - Replace the "52-A" 345kV circuit breaker
  – Estimated Cost: $2M
• Waterford - Replace the "52-B" 345kV circuit breaker
  – Estimated Cost: $2M
• Waterford - Replace the "52-C" 345kV circuit breaker
  – Estimated Cost: $2M
• Muskingum River - Replace the "SD" 345kV circuit breaker
  – Estimated Cost: $1.7M
• Muskingum River - Replace the "SE" 345kV circuit breaker
  – Estimated Cost: $1.7M
• Muskingum River - Replace the "SD" 345kV circuit breaker
  – Estimated Cost: $1.7M
• Tidd - Carnegie - 138kV line section 1.21 miles of 556 ACSR with 954 ACSR conductor
  – Estimated Cost: $0.32M
• French Creek - Heaters Tap - 138kV line section - reconductor 25.11 mile line section with 954 ACSR conductor
  – Estimated Cost: $9.5M
• Belmont - Install a third breaker in the Harrison - Belmont line cross bus
  – Estimated Cost: $0.385M
• Burtonsville - Sandy Springs - Rebuild existing line using double bundle 1033 ACSR. Double circuit 2314/2334. Time dependent on High Ridge to Sandy Springs
  – Estimated Cost: $0.5M
• Kemptown - Conastone - Replace 500kV Breaker Disconnects
  – Estimated Cost: $0.5M
• Conastone - Peach Bottom - Replace 500kV line two circuit breakers, est. time 30 months
  – Estimated Cost: $1.3M
• Bergen 230 kV breaker 12H  
  – Estimated Cost: $0.4M
• Athenia 230 kV breaker 21H  
  – Estimated Cost: $0.4M
• Athenia 230 kV breaker 11H  
  – Estimated Cost: $0.4M
• Athenia 230 kV breaker 51H  
  – Estimated Cost: $0.4M
• Athenia 138 kV breaker 2BH  
  – Estimated Cost: $0.4M
• TSS 112 Wilton Center - Upgrade existing 8012 line relaying to be compatible with new line 11212 terminal at TSS 976 Cayuga Ridge South
  – Estimated Cost: $0.278M
• TSS 80 Pontiac Midpoint - Upgrade existing 8012 line relaying to be compatible with new line 8012 terminal at TSS 976 Cayuga Ridge South
  – Estimated Cost: $0.12M
• TSS 976 Cayuga Ridge South - Erect new interconnection substation for Queue position O51
  – Estimated Cost: $0.47M
• TSS 80 Pontiac Midpoint - TSS 976 Cayuga Ridge South - TSS 112 Wilton Center - Install digital microwave communication for addition of new Livingston 2 ring bus
  – Estimated Cost: $1.677M
• TSS 976 Cayuga Ridge South - TSS 112 Wilton Center - Reconductor 0.187 miles of line 11212 between TSS 976 Cayuga Ridge South and TSS 112 Wilton Center
  – Estimated Cost: $0.07M
- Lackawanna - Oxbow - Rebuild approximately 16.33 miles of transmission line to support bundled conductor
  - Estimated Cost: $19.596M
- Lackawanna - Oxbow - Upgrade disconnect switch at Oxbow substation
  - Estimated Cost: $0.1M
- Oxbow - N. Meshoppen - Rebuild approximately 10.6 miles of transmission line to support bundled conductor, North Meshoppen Substation upgrade/replace two CT circuits and replace substation conductor
  - Estimated Cost: $12.597M
- North Meshoppen - Add two 230kV circuit breakers, reconfigure 230kV bus into ring bus
  - Estimated Cost: $1.5M
- Lackawanna - Upgrade terminal equipment at 230kV substation, replace substation conductor and replace disconnect switch
  - Estimated Cost: $0.125M
- Juniata - Replace 500/230kV transformer #2
  - Estimated Cost: $10M
- Lackawanna - Upgrade terminal equipment at the 230kV substation
  - Estimated Cost: $0.7M
• Raritan River - Red Oak A Mitigation Upgrade, Drop Loop/Bus Conductor (Bundled)
  – Estimated Cost: $8.331M
• Williams - Freneau Mitigation Upgrade, Drop Loop/Bus Conductor (Bundled)
  – Estimated Cost: $4.845M
• Parlin - Williams Mitigation Upgrade, Drop Loop/Bus Conductor (Bundled)
  – Estimated Cost: $1.937M
• South River - Atlantic 230kV line, Mitigation Upgrade, Drop Loop/Bus Conductor (Bundled)
  – Estimated Cost: $11.057M
• South River - Atlantic 230kV line (G1047), Mitigation Upgrade, Drop Loop/Bus Conductor (Bundled)
  – Estimated Cost: $0.878M
• Conastone - Relocate 500kV 501 line into a new two breaker bay
  – Estimated Cost: $7M
• Eddystone 3 - Island Road 6 - Replace metering equipment
  – Estimated Cost: $0.2M
• Milford - Steele - Recondor 230kV line
  – Estimated Cost: $10.225M
• Steele - Oil City - Upgrade the temperature rating on the 138kV line
  – Estimated Cost: $0.25M
• Manor - Graceton - 230kV line upgrade terminal equipment
  – Estimated Cost: $37M
• Nottreach-Peach Bottom - Reconductor 230kV line 220-08-p, estm new rating 724 MVAe
  – Estimated Cost: $29M
• Peach Bottom - Graceton - Reconductor 230kV line 22008
  – Estimated Cost: $5.085M
• Red OakA - (T1034) 230kV line - Mitigation upgrade, Drop Loop/Bus Conductor (Bundled)
  – Estimated Cost: $0.14M
• Red OakB - (G1047) 230kV line - Mitigation upgrade, Drop Loop/Bus Conductor (Bundled)
  – Estimated Cost: $0.14M
• Atlantic - 230kV Disconnect Switch replacement Estimated Cost: $0.085M
• Nottingham-Nottreac - 230kV line replace line reactor 220-01Reac
  – Estimated Cost: $0.2M
• Aaron to supply name - Install new 115kV 3 breaker ring bus substation approx. 15.46 miles east of Mansfield 115kV substation (disconnect switches, bus structures and a control house)
  – Estimated Cost: $2.763M
• South Troy - East Towanda - New 115kV structure extending from the Mansfield - South Troy 115kV line to interconnection substation
  – Estimated Cost: $0.25M
• Mansfield - Relay and control work at 115kV substation. Includes relays, carrier set, line trap and tuner
  – Estimated Cost: $0.25M
• East Towanda - Relay and control work at 115kV substation - Includes relays, carrier set, line trap and tuner
  – Estimated Cost: $0.25M
• South Troy - East Towanda - Reconductor 19.54 miles of the South Troy - East Towanda 115kV transmission line
  – Estimated Cost: $5.373M
• South Troy - Replace two disconnect switches at the 115kV substation (One on East Towanda line, second on Mansfield line)
  – Estimated Cost: $0.16M
• East Towanda - Replace two CT circuits at the 115kV substation
  – Estimated Cost: $0.25M
• Mansfield - Replace a CT circuit and disconnect switch at the 115kV substation
  – Estimated Cost: $0.33M
• Waiting for name from Aaron - 115kV 3 breaker ring bus
  – Estimated Cost: $2.763M
• Waiting for name from Aaron - Install line tap structure from existing Westover South-Madera 115kV line to new network substation
  – Estimated Cost: $0.25M
• Garman - Perform relay and control work at 115kV Substation
  – Estimated Cost: $0.25M
• Shawville - Perform relay and control work on 115kV Substation
  – Estimated Cost: $0.25M
• Altoona - Replace 230kV line trap at substation (Altoona - Raystown)
  – Estimated Cost: $0.125M
• Steele - 230/138kV replace the 220 MVA unit with a 300 MVA unit
  – Estimated Cost: $4.3M
• Loretto - Piney Grove - Upgrade 9.51 miles of 477ACSR at 80 degrees C to 125 degrees C
  – Estimated Cost: $0.5M
• Linwood - Chichester (Circuit 1) - Reconductor line and upgrade substation equipment Linwood to Chichester 220-39 line.
  – Estimated Cost: $8M
• Linwood - Chichester (Circuit 2) - Reconductor line and upgrade substation equipment Linwood to Chichester 220-43 line.
  – Estimated Cost: $8M
• Mehoopany - Install 4 new 115kV breakers at the substation, Install Disconnect Switches and Bus Structures
  – Estimated Cost: $1.5M
• Mehoopany - Install new tap structure at the 115kV Substation
  – Estimated Cost: $0.25M
• North Meshoppen - Perform relay and control work at 115kV Substation
  – Estimated Cost: $0.36M
• Mehoopany - Perform relay and control work at 115kV Substation
  – Estimated Cost: $0.36M
• Mehoopany - North Meshoppen - Install approximately 6.56 miles of fiber optic cable between Substations
  – Estimated Cost: $0.656M
- Constone - Mt. Carmel - 230kV Line 2322 with 1590 kcmil ACSR (160 C design) to match the ratings of adjacent 230kV circuit 2310
  - Estimated Cost: $4.63M
- Constone - Northwest - Reconductor 230kV line 2322 with 1,590kcmil (160 C design) to match the ratings of adjacent 230kV circuit 2310
  - Estimated Cost: $5M
- E. Towanda - E. Sayreville - upgrade/replace CT 115kV circuit at East Sayreville
  - Estimated Cost: $0.125M
- Constone - Mt Carmel - 230kV install 2 500/230kV xfmrs, 4-500kV bkrs., 7-230kV bkrs.
  - Estimated Cost: $70M
• Red Oak - Modify 230kV substation to connect a 5 breaker ring bus to Raritan River - Parlin and Raritan River - South River 230kV lines
  – Estimated Cost: $7.9M
• Raritan River - Install 230kV breaker, two 230kV switches and reroute existing control cabling at the 230kV substation
  – Estimated Cost: $1.115M
• Red Oak - Install 230kV breaker, two 230kV switches and control work at substation
  – Estimated Cost: $1M
• Richmond - Richmond - Replace line reactors est. time 18 months  
  – Estimated Cost: $0.2M

• Homesburg-Richmond - Replace terminal equip 230 kV line est time 30 months, est new rating 457/574 MVA  
  – Estimated Cost: $4M

• Emilie-Neshaminy - Replace terminal equip 230kV line  
  – Estimated Cost: $0.5M
• Albright - Install 138kV relaying at the Albright Substation for the Afton circuit
  – Estimated Cost: $0.189M

• Garrett - Install 138kV relaying at the Garrett substation for the Afton circuit
  – Estimated Cost: $0.197M

• Afton - Loop Albright-Garrett 138kV circuit into new Afton substation. Perform relay setting/adjustment at the new Afton substation
  – Estimated Cost: $0.185M
• Bear Rock - Inspect/Upgrade grounding grid at existing 230kV Substation
  – Estimated Cost: $0.02M
• Lewistown - Replace linetrap at the 230kV substation
  – Estimated Cost: $0.117M
• Lewistown - Replace CT circuit at the 230kV Substation
  – Estimated Cost: $0.14M
• Printz - Replace 2 circuit breakers 230kV line  
  – Estimated Cost: $0.6M

• N. Meshhoppen - 230/115kV addition of two 230kV breakers, reconfigure ring bus  
  – Estimated Cost: $1.5M
• Keystone - Replace #3 500/230kV Transformer
  – Estimated Cost: $5.5M

• Keystone - Replace #4 500/230kV Transformer
  – Estimated Cost: $5.5M
• Conastone-Peach Bottom - Build 500kV line, Conastone end (BGE portion of line)
  – Estimated Cost: $1.5M
• Conastone-Peach Bottom - Replace 500kV line metering equip 5012 (Peach Bottom to Conastone - PECO only)
  – Estimated Cost: $0.1M
• Monroe - Construct new Interconnection Switching Station T Bus and set remote relays
  – Estimated Cost: $1.6M
• Martins Creek - Install automatic relay and control scheme to existing disconnect switches 230kV
  – Estimated Cost: $0.1M
• Fair Lawn - Upgrade the Z-598 circuit to a summer normal rating of 73MVA
  – Estimated Cost: $0.5M
Next Steps
Next Steps

- Develop upgrades to address the common mode failure reactive issues
- Finalize upgrades for global reactive issues
- Northern New Jersey Upgrades
- 2012 Retool

Board Approval
- Expect to take the baseline upgrades reviewed today to the PJM Board of Managers for approval on October 15, 2008.
- Comments on the material presented today can be sent to: RTEP@pjm.com