Reliability Analysis Update

Transmission Expansion Advisory Committee
August 11, 2016
2016 RTEP Window #3 Anticipated Scope and Timeline
Anticipated 2016 RTEP Window #3

- Anticipated 2016 RTEP Window #3
  - Scope
    - 2021 Winter
    - 2021 Light Load Reliability Analysis
    - Short Circuit
  - Timing
    - Post preliminary results
    - Open Window
    - Close Window
    - Window Duration
2016 RTEP Proposal Window #2
• **Scope:**
  – Baseline N-1 (thermal and voltage)
  – Generation Deliverability and Common Mode Outage
  – N-1-1 (thermal and voltage)
  – Load Deliverability (thermal and voltage)
• **Window Opened:** 6/29/2016
• **Window Closed:** 7/29/2016
  – Proposal definitions, simulation data and planning cost estimate due
• **Detailed Cost due:** 8/15/2016
  – Additional 15 days to develop and provide detailed cost data
  – See the window documentation for additional information
• 140 total flowgates

<table>
<thead>
<tr>
<th>Test/kV Level*</th>
<th>100kV - 200kV</th>
<th>230kV</th>
<th>345kV</th>
<th>500kV</th>
<th>765kV</th>
<th>Total</th>
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<tr>
<td>N-1 Thermal</td>
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<td>N-1 High Voltage</td>
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<tr>
<td>N-1 Low Voltage</td>
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<td>N-1 Voltage Drop</td>
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<tr>
<td>Gen Deliv &amp; CMO</td>
<td>76</td>
<td>9</td>
<td>13</td>
<td>3</td>
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<td>102</td>
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<tr>
<td>Load Deliv Thermal</td>
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<tr>
<td>Load Deliv Voltage</td>
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<td>N-1-1 Voltage Collapse</td>
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<td>Total</td>
<td>91</td>
<td>27</td>
<td>15</td>
<td>3</td>
<td>1</td>
<td>137</td>
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</tbody>
</table>

*xfmr are categorized based on low side kV
2016 RTEP Proposal Window 2 Violation Locations
2016 RTEP Proposal Window 2

- Window Closed: 7/29/2016
- Additional 15 day window close: 8/15/2016
- 137 Flowgates Identified, 71 Flowgates Recommended for proposals (Remaining flowgates related to Retired Generators)
- 87 Proposals Received from 13 Entities addressing 12 TO Zones
  - 46 Greenfield
    - Cost Range $5M - $224M
  - 41 Transmission Owner Upgrades
    - Cost Range $0.03M - $125M
PSE&G End Of Life Assessment
Metuchen – Edison – Trenton – Burlington Corridor
- PSE&G’s FERC 715 Transmission Owner criterion addresses equipment condition assessments
  - PSE&G assessed the condition of the Metuchen to Trenton (MT-T) and Trenton to Burlington (T-BU) 138 kV circuits.
• Refer to PSE&G criteria:

VII. EQUIPMENT ASSESSMENT AND STORM HARDENING

http://www.pjm.com/~/media/planning/planning-criteria/PSE&G-planning-criteria.ashx

– Metuchen to Trenton is approximately 30 miles of 138 kV circuit and the average structure age is 86 years.
– Trenton to Burlington is approximately 22 miles of 138 kV circuit and the average structure age is 75 years.
PSE&G Transmission Zone

• Assessment Result:
  – Consultant - Foundation assessment
    • 23% and 30% of structures for MT-T and T-BU respectively will require extensive foundation rehabilitation or total foundation replacement.
  – Consultant – Tower line assessment
    • 25 % of the tower structures exceed the tower load carrying design capability
    • 35% of the towers are at 99-100% of the tower’s load bearing capability, and 81% of the towers at 95-100% of the tower’s capability.
Problem:

PSE&G FERC 715 Transmission Owner Criteria

- Equipment condition assessment for the entire corridor
- Equipment has reached its end of life

NERC Reliability Criteria

- N-1-1 voltage violations in the Metuchen vicinity in the 2016 RTEP Window #2
Potential Solution for Metuchen - Brunswick:

- Convert the R-1318 and Q1317 (Edison – Metuchen) 138 kV circuits to one 230 kV circuit
  - Metuchen 138 kV will be eliminated
  - The Brunswick 230/138 kV autotransformer will be eliminated
  - The new converted 230 kV circuit will be terminated at the existing Metuchen and Brunswick 230 kV stations.

Project Benefits:

- Resolves voltage violation in the Metuchen vicinity identified in the 2016 RTEP 2nd Window
- Eliminates the need for baseline upgrade (B2590 – Install two 75 MVAR 230 kV capacitors at Sewaren station) identified in the 2014 RTEP window.
- Strengthens the system by replacing 138 kV circuits with 230 kV circuits, improving capacity and voltage.
- Creates a strong tie between Southern and Central PSE&G
- Increases transfers capability to Central PSE&G
- Addresses future reliability and economic needs

Estimated Project Cost: $ 125 M

Alternatives Considered:

- Rebuild the existing transmission corridor in-kind at 138 kV
Metuchen – Brunswick Existing and Future Diagram

Before

After
• **Potential Solution for Brunswick - Trenton:**
  - Convert the N-1340 and T-1372/D-1330 (Brunswick – Trenton) 138 kV circuits to 230 kV circuits
    - The converted circuits will be terminated at the existing Brunswick 230 kV
    - The Deans 230 kV station will be expanded with additional two breaker and half bay
    - The converted two 230 kV circuits will be looped in to Deans 230 kV station
    - The new converted 230 kV circuit will be terminated at the Trenton 138 kV station with two 138 kV transformers

• **Project Benefit:**
  - Strengthens the system by replacing 138 kV circuits with 230 kV circuits, improving capacity and voltage.
  - Provides better transfers across the network
  - Addresses future reliability and economic needs

**Estimated Project Cost:** $ 327 M

• **Alternatives Considered:**
  - Rebuild the existing transmission corridor in-kind at 138 kV
Brunswick – Trenton Existing and Future Diagram

**Before**

- Brunswick to Devils Brook
- Devils Brook to Plainsboro
- Plainsboro to Trenton
- Trenton to Metuchen
- Trenton to PECO
- Plainsboro to Burlington

**After**

- Brunswick to Devils Brook
- Devils Brook to Plainsboro
- Plainsboro to Trenton
- Trenton to Metuchen
- Trenton to PECO
- Plainsboro to Burlington
• Potential Solution for Trenton - Burlington:
  – Convert the F-1358/Z1326 and K1363/Y-1325 (Trenton - Burlington) 138 kV circuits to 230 kV circuits
    • Trenton 138 kV substation will be replaced with six bay breaker and half 230 kV substation
    • The A-130-27 138 kV currently from Trenton - US Steel (PECO) will be terminated at Mercer 230 kV with 230/138 kV transformer and the Trenton – Mercer portion of the circuit will be converted to 230 kV
    • Mercer station will be expanded with additional breaker and half bay.
  • Project Benefit:
    • Eliminates the need for baseline upgrade (B2589 – Install a 100 MVAR 230 kV shunt reactor at Mercer station) identified in the 2014 RTEP window.
    • Strengthens the system by replacing 138 kV circuits with 230 kV circuits, improving capacity and voltage.
    • Provides better transfers across the network
    • Addresses bottled generation issue at Mercer

Estimated Project Cost: $ 349 M
• Alternatives Considered:
  – Rebuild the existing transmission corridor in-kind at 138 kV
Trenton – Burlington Existing and Future Diagram

Before

After

To PECO
To Lawrence
To Brunswick/Metuchen
To Brunswick/Metuchen
To Lawrence
To PECO
PSE&G End Of Life Assessment
Newark Switch Review
Problem:
PSE&G FERC 715 Transmission Owner Criteria
Newark Switch Aging Infrastructure

PSE&G FERC 715 Transmission Owner Criteria

- Age
  - Substation: 1953
  - Transformer 1: 1972
  - Transformer 2&3: 1958
  - Spare: 1992
- Housed in an urban building
- Equipment condition assessment
- Equipment has reached its end of life

Alternatives Considered:
1. Build new Newark GIS station in a building located adjacent to the existing Newark Switch and demolish the existing Newark Switch
2. Build a new Newark GIS station elsewhere in Newark and relocate all transmission and distribution cables and protection equipment

Potential Solution:
Alternative #1 - Build new Newark GIS station in a building located adjacent to the existing Newark Switch and demolish the existing Newark Switch

Estimated Cost: $353 M
Immediate Need Baseline Upgrades
Problem: Stability
• Martins Creek and Lower Mount Bethel Energy units go unstable for a 3-Phase fault at 80% of Martins Creek – Morris Park 230 kV line with zone 2 clearing

Immediate Need: Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

Alternatives Considered: Due to the immediate need of the project no alternatives were considered

Proposed Solution:
• Install 12 mi of optical pilot ground wiring (OPGW) between Gilbert and Springfield substations
  – 7 mi of construction by PPL on bulk power lines (b2754.1)
  – 5 mi of construction by JCPL on bulk power lines (b2754.2)
• Install 7 mi of all-dielectric self-supporting (ADSS) fiber optic cable between Morris Park and Northwood substations (JCPL) (b2754.3)
• Use ~ 40 route mi. of existing fibers on PPL system to establish direct fiber circuits (b2754.4)
• Upgrade relaying at Martins Creek (PPL) (b2754.5); Morris Park (JCPL) (b2754.6); and Gilbert (JCPL) (b2754.7)

Estimated Cost: $ 1.001 M (PPL)
$1.456 M (JCPL)

Projected IS Date: 12/01/2019
Short Circuit Upgrades
Problem: Short Circuit
- The Martins Creek 230kV breakers are overdutied

Immediate Need:
- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

Alternatives Considered:
- Due to the immediate need of the project no alternatives were considered

Proposed Solution:
- Install 2% reactors at Martins Creek 230kV (B2756)

Estimated Cost: $10 M
Required IS Date: 06/01/2018
Artificial Island Update
PJM Board Meeting – week of August 1st, 2016

- The PJM Board decided to suspend all elements of the Artificial Island project and directed PJM staff to perform a comprehensive analysis to support a future course of action.

- Andy Ott Letter on Behalf of the PJM Board

- Steve Herling Letter to Members and Stakeholders
RTEP Next Steps
Questions?

Email: RTEP@pjm.com
Revision History

- V1 - Original version posted to PJM.com – 8/8/2016
- V3 – Updated the equipment ages of the Newark Switch (current slide #21) and added a potential solution