

#T41 Kearny 230kV
Generation Interconnection
(Final Report Issued April 2008)

(Corrected final report)

This analysis was completed to assess the reliability impact for the increase in generation interconnecting to the PJM system as a capacity resource.

Network Impacts

The Queue Project #T41 was studied as a 275MW (Capacity) injection at Kearny 138 kV substation in the PSEG area. Project #T41 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

1. The South Waterfront-Newport “R” 230kV line loads from 95.5% to 104.6% (DC power flow) of its normal rating (315MVA) for the non-contingency condition. This project contributes approximately 28.7MW to cause this thermal violation.
2. The Bergen-Leonia “T” Ckt #1 230kV line loads from 96.6% to 104.9% (DC power flow) of its emergency rating (557MVA) for the single line contingency outage of the Bergen-Leonia “K” Ckt #2. This project contributes approximately 46.3MW to the thermal violation.

Multiple Facility Contingency

(Double Circuit Tower Line, Line with Failed Breaker and Bus Fault contingencies for the full energy output)

No problems identified

Short Circuit

No problems identified

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

3. The Nottingham-Nottingham 230kV Reactor loads from 170.75% to 173.38% (DC power flow) of its emergency rating (627MVA) for the Conastone-Peach Bottom tower line outage. This project contributes approximately 16.5MW to the thermal violation. Previous project(s) T40 contribute(s) to the loading by 18.6MW(2.96%). It must be noted that the same thermal violation (DC power flow: 149.6%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
4. The Nottingham Reactor-Peach Bottom Tap 230kV line loads from 170.75% to 173.38% (DC power flow) of its emergency rating (627MVA) for the Conastone-Peach Bottom 500kV tower line outage. This project contributes approximately 16.5MW to the thermal violation. Previous project(s) T40 contribute(s) to the loading by 18.6MW(2.96%). It must be noted that the same thermal violation (DC power flow: 149.5%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
5. The Peach Bottom Tap-Graceton 230kV line loads from 170.75% to 173.38% (DC power flow) of its emergency rating (627MVA) for the Conastone-Peach Bottom 500kV tower line outage. This project contributes approximately 16.5MW to the thermal violation. Previous project(s) T40 contribute(s) to the loading by 18.6MW(2.96%). It must be noted that the same thermal violation (DC power flow: 149.5%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
6. The Northwest-Granite 2311 230kV line loads from 167.31% to 169.69% (DC power flow) of its emergency rating (641MVA) for the single line contingency outage of the Kempton-North Northwest 500kV circuit. This project contributes approximately 15.3MW to the thermal violation. Previous project(s) T40 contribute(s) to the loading by 17.1MW(2.67%). It must be noted that the same thermal violation (DC power flow: 155.6%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
7. The Manor-Graceton 230kV line loads from 163.69% to 166.26% (DC power flow) of its emergency rating (531MVA) for the Conastone-Peach Bottom 500kV tower line outage. This project contributes approximately 53.3MW to the thermal violation. Previous project(s) T40 contribute(s) to the loading by 62.0MW(2.02%). It must be noted that the same thermal violation (DC power flow: 153.0%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
8. The Conastone-North Northwest 500kV line loads from 163.71% to 166.27% (DC power flow) of its normal rating (2078MVA) for the non-contingency condition. This project contributes approximately 53.3MW to the thermal violation. Previous project(s)

T40 contribute(s) to the loading by 62MW(12.8%). It must be noted that the same thermal violation (DC power flow: 150.9%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

9. The Lackawanna-Oxbow 230kV line loads from 166.42% to 169.08% (DC power flow) of its emergency rating (504MVA) for the tower line outage of the Harwood-East Palmerton and Harwood-Siegfried 230kV circuits). This project contributes approximately 13.4MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 158.9%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
10. The Oxbow-North Meshoppen 230kV line loads from 162.67% to 165.29% (DC power flow) of its emergency rating (617MVA) for the Conastone-Peach Bottom 500kV tower line outage. This project contributes approximately 16.2MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 154.7%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
11. The Oxbow-North Meshoppen 230kV line loads from 156.82% to 159.58% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 13.8MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 150.7%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
12. The Conastone-North Northwest 500kV line loads from 147.91% to 150.04% (DC power flow) of its emergency rating (2901MVA) for the tower line outage of the Conastone – Northwest 2310 & 2322 circuits. This project contributes approximately 61.6MW to the thermal violation. Previous project(s) T40 contribute(s) to the loading by 59.8MW(2.06%). It must be noted that the same thermal violation (DC power flow: 137.0%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
13. The Conastone-Mt. Carmel 2322 230kV line loads from 141.58% to 143.55% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage of the Conastone-North Northwest 500kV circuit. This project contributes approximately 18.2MW to the thermal violation. Previous project(s) T40 contribute(s) to the loading by 17MW(9.29%). It must be noted that the same thermal violation (DC power flow: 132.3%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
14. The Conastone-Mt. Carmel 2310 230kV line loads from 141.58% to 143.55% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage of the Conastone-North Northwest 500kV circuit. This project contributes approximately 18.2MW to the thermal violation. Previous project(s) T40 contribute(s) to the loading by 17MW(1.84%). It must be noted that the same thermal violation (DC power flow:

132.3%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

15. The Mt. Carmel-North Northwest 2322 230kV line loads from 139.28% to 141.25% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage of the Conastone-North Northwest 500kV circuit. This project contributes approximately 18.2MW to the thermal violation. Previous project(s) T40 contribute(s) to the loading by 17MW(1.84%). It must be noted that the same thermal violation (DC power flow: 130.0%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
16. The Mt. Carmel-North Northwest 2310 230kV line loads from 139.28% to 141.25% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage of the Conastone-North Northwest 500kV circuit. This project contributes approximately 18.2MW to the thermal violation. Previous project(s) T40 contribute(s) to the loading by 17MW(1.84%). It must be noted that the same thermal violation (DC power flow: 130.0%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
17. The Raphael Road-Northeast 2339 230kV line loads from 135.99% to 137.57% (DC power flow) of its emergency rating (758MVA) for the single line contingency outage of the Raphael Road-Northeast 2315 230kv line. This project contributes approximately 11.9MW to the thermal violation. Previous project(s) T40 contribute(s) to the loading by 10.2MW(1.57%). It must be noted that the same thermal violation (DC power flow: 128.8%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
18. The Raphael Road-Northeast 2317 230kV line loads from 133.29% to 134.85% (DC power flow) of its emergency rating (758MVA) for the single line contingency outage of the Raphael Road-Northeast 2337 230 kV line). This project contributes approximately 11.8MW to the thermal violation. Previous project(s) T40 contribute(s) to the loading by 10MW(1.32%). It must be noted that the same thermal violation (DC power flow: 126.2%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
19. The Hudson-South Waterfront 230kV line loads from 113.60% to 119.62% (DC power flow) of its normal rating (404MVA) for non-contingency condition. This project contributes approximately 24.3MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 113.6%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
20. The Bergen-Leonia “K” Ckt #2 230kV line loads from 101.35% to 110.35% (DC power flow) of its emergency rating (557MVA) for the single line contingency outage of the Bergen-Leonia “T” Ckt #1. This project contributes approximately 50.1MW to the thermal violation. It must be noted that the same thermal violation (DC power flow:

101.4%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

21. The Northwest-Granite 2326 230kV line loads from 118.97% to 120.62% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage of the Conastone-North Northwest 500kV circuit. This project contributes approximately 15.2MW to the thermal violation. Previous project(s) T40 contribute(s) to the loading by 17.1MW(1.85%). It must be noted that the same thermal violation (DC power flow: 110.9%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
22. The Hudson-South Waterfront 230kV line loads from 100.67% to 106.35% (DC power flow) of its emergency rating (622MVA) for the Hudson-Penhorn 230kV tower line outage. This project contributes approximately 35.3MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 100.7%) already exists in the 2012 base case due to unresolved problems in the R & S queues.
23. The North Meshoppen-East Towanda 230kV line loads from 111.74% to 114.04% (DC power flow) of its emergency rating (554MVA) for the Conastone-Peach Bottom 500kV tower line outage. This project contributes approximately 12.7MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 104.8%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

1. The South Waterfront-Newport “R” 230kV line overloads can be alleviated by providing oil circulation to increase the rating by 10%. The estimated cost is **\$5 million**.
2. The Bergen-Leonia “T” ckt #1 230kV line can be alleviated by adding oil circulation to increase the emergency rating by 15%. The estimated cost is **\$2.5 million**.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

3,4 &5. The overload on the Nottingham-Graceton-Peachbottom 230kV circuit can be alleviated by relocating a portion of this line underground to facilitate the construction of additional 500 kV lines between Peach Bottom and Conastone, **\$61M** and three years to construct. Rebuilding the Peach Bottom to Nottingham portion of the line as a high capacity 230 kV line, 1243MVA_n/1411MVA_e, 13.6 miles @ \$1.5M per mile plus new Susquehanna river crossing, approx **\$40M** and four years to complete.

6. The Northwest-Granite 2311 230kV line overload can be alleviated replacing the 230kV terminal breaker at Northwest at an estimated cost of **\$383,000**.

7. The Manor-Graceton 230kV line overload can be alleviated by reconductoring the line as described .

BGE Upgrade

Reconductor from Graceton to PA line - **\$700,000** ~ 3 yrs.

Existing:

Circuit 2303 is 795 kcm 30/19 ACSR @ 125 C.

Assumptions:

- Reconductor with 1,590 kcm ACSR from Graceton to PA line.
- Length of this line section is 1.4 miles.
- Towers can be reinforced instead of replaced.

PPL Upgrade - The estimated magnitude cost for this upgrade including substation terminal equipment cost is **\$31,000,000**.

Description of Work:

In order to provide additional capacity on the Graceton – Manor 230kV line, PPL EU is proposing to rebuild the existing single circuit 230kV line composed of 795 ACSR. The new line will be 1590 Kcmil ACSR conductors (1 per phase) designed and operated at 230 kV. This rebuild will require new custom embedded steel poles to accommodate the larger conductor size. The 230 kV lines will be rated for summer normal/emergency of 653/793 MVA respectively. These ratings are based on the conductor ratings and may be lower when the line is actually built.

8 & 12. The Conastone-North Northwest 500kV line overload can be alleviated by adding a single circuit 500kV line at an estimated cost of \$ 109 million and estimated time of 10 yrs and installing a 1 breaker bay at Conastone, estimated cost \$3.2 million, and a two breaker bay at North Northwest, estimated cost \$6.4 million for a total upgrade cost of **\$118.6 million**.

Assumptions:

New 200 ft. wide R/W parallels existing Conastone to Northwest R/W

Total R/W length = 19.6 miles

3 - bundle 1,590 kcm conductor

North Northwest located 4 miles north of Northwest

9. The Lackawanna-Oxbow 230kV line overload can be alleviated by reconductoring approximately 16.33 miles of transmission line (estimated to cost approximately **\$8,165,000**). Lackawanna is a PP&L owned substation and any associated terminal upgrades would have to be confirmed by PP&L.

10 & 11. The Oxbow-North Meshoppen 230kV line overload can be alleviated by reconductoring approximately 10.16 miles of transmission line (estimated to cost approximately \$5,080,000), a CT circuit (estimated to cost approximately \$140,000), and substation conductor (estimated to cost approximately \$125,000) at North Meshoppen substation. The total estimated cost is **\$5,345,000**.

13, 14, 15 & 16. The Conastone-Mt. Carmel 2310 230kV circuit, the Conastone-Mt. Carmel 2322 230kV circuit, the Mt.Carmel-North Northwest 2310 230kV circuit and the Mt.Carmel-North Northwest 2322 230kV circuit can be alleviated by installing a new 500kV station named North Northwest that includes 2-500/230kV xfms, 4-500 kV bkr, 7-230 kV Bkr and related substation equipment and land at a cost of **\$70 million**. It also requires the reconductor of the Conastone to Northwest #2322 with 1,272kcmil ACSR, 1,590kcmil ACSR with an estimated cost of **\$8.21 million**. This work would take 3-4 years to build substation and 18-24 months for the line work and by adding a single circuit 500kV line at an estimated cost of \$109 million and estimated time of 10 yrs and installing a 1 breaker bay at Conastone, estimated cost \$3.2 million, and a two breaker bay at North Northwest, estimated cost \$6.4 million for a total upgrade cost of **\$118.6 million**.

17. The Raphael Rd.- Northeast 230kV 2339 line overload can be alleviated by replacing the 230kV line breaker at Northeast substation. The estimated cost to replace the breaker is **\$382,000**.

18. The Raphael Rd.- Northeast 230kV 2317 line overload can be alleviated by replacing the 230kV line breaker at Northeast substation. The estimated cost to replace the breaker is **\$382,000**.

18 & 22. The Hudson-South Waterfront 230kV line overloads can be alleviated by reconductoring the circuit to increase its normal rating to a minimum of 475 MVA and the emergency rating to a minimum of 575 MVA. The estimated cost is **\$6 million**.

20. The Bergen-Leonia "K" ckt #2 230kV line can be alleviated by adding oil circulation to increase the emergency rating by 15%. The estimated cost is **\$2.5 million**.

21. The Northwest-Granite 2326 230kV line overload can be alleviated replacing the 230kV terminal breaker at Northwest at an estimated cost of **\$383,000**.

22. The North-Meshoppen-East Towanda 230kV line overload can be alleviated by reconductoring approximately 21.66 miles of 230 kV transmission line between North Meshoppen and East Towanda substations, which is estimated to cost approximately \$16,245,000. This overload also requires the following terminal upgrades at East Towanda substation: replace substation conductor (estimated cost approximately \$125,000), replace line trap (estimated cost approximately \$125,000), replace/upgrade three (3) CT circuits (estimated cost approximately \$420,000), and replace/upgrade two (2) disconnect switches (estimated cost approximately \$170,000). The total estimated cost of the upgrade is **\$17,035,000**.