#T43 Essex 230kV

Generation Interconnection

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

Network Impacts

The Queue Project #T43 was studied as a 186MW capacity injection at Essex 230 kV substation in PSEG area. Project #T43 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)

None

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

1. The Essex-Hudson 6 230kV line loads from 94.0% to 114.6% (DC power flow) of its emergency rating (826MVA) for the single line contingency outage of the Athenia-NJT Meadows 230kV circuit. This project contributes approximately 170.1MW to cause this thermal violation.

2. The Marion – Hudson 230/138 kV transformer 220-1 loads from 91.60% to 112.28% (DC power flow) of its emergency rating (296 MVA) for the tower line outage of the Hudson-Essex and Athenia-NJT Meadows 230 kV circuits. This project contributes approximately 30.6 MW to cause this thermal violation.

3. The ECRRF-Foundry Street 138kV line loads from 93.55% to 106.08% (DC power flow) of its emergency rating (350MVA) for the tower line outage of the Hudson-Essex and Athenia-NJT Meadows 230kV circuits. This project contributes approximately 43.8MW to cause this thermal violation.

4. The Passaic Valley SC-Bayonne 138kV line loads from 95.20% to 113.16% (DC power flow) of its emergency rating (299MVA) for the tower line outage of the Hudson-Essex and Athenia-NJT Meadows 230kV circuits. This project contributes approximately 53.7MW to cause this thermal violation.

5. The Newport-Hoboken “R” 230kV line loads from 98.07% to 105.27% (DC power flow) of its emergency rating (521MVA) for the tower line outage of the Hudson-Belleville 230kV circuit and the Roseland-Kearny 138kV circuit. This project contributes approximately 37.5MW to cause this thermal violation.

Short Circuit

37. Analysis found no new circuit breakers to be over-dutied, but the analysis did show a significant contribution to the Essex, 230 kV – 20H1 breaker, which was already identified as over-dutied.

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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)

6. The Hudson-South Waterfront 230kV line loads from 125.17% to 129.00% (DC power flow) of its normal rating (404MVA) for non-contingency condition. This project contributes approximately 15.5 MW to the thermal violation. Previous project(s) T41 and T42 contribute(s) to the loading by 25.9MW(6.42%) and 13MW(3.22%) respectively. It must be noted that the same thermal violation (DC power flow: 115.5%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

7. The South Waterfront-Newport "R" 230kV line loads from 113.83% to 1119.52% (DC power flow) of its normal rating (315MVA) for the non-contingency condition. This project contributes approximately 17.9MW to this thermal violation. Previous project(s) T41 and T42 contribute(s) to the loading by 31.5MW(9.99%) and 15.8MW(5.02%) respectively.

8. The Bergen-Leonia "T" Ckt #2 230kV line loads from 118.92% to 124.54% (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 31.3MW to the thermal violation. Previous project(s) T41 and T42 contribute(s) to the loading by 55MW(9.87%) and 27.6MW(4.95%) respectively. It must be noted that the same thermal violation (DC power flow: 104.1%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

9. The Bergen-Leonia "T" Ckt #1 230kV line loads from 114.20% to 119.39% (DC power flow) of its emergency rating (557MVA) for the single line contingency outage of the Bergen-Leonia "T" Ckt #2. This project contributes approximately 28.9MW to the thermal violation. Previous project(s) T41 and T42 contribute(s) to the loading by 50.8MW(9.13%) and 25.5MW(4.58%) respectively. It must be noted that the same thermal violation (DC power flow: 100.5%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

10. The Bergen-Leonia "T" Ckt #1 230kV line loads from 113.76% to 118.47% (DC power flow) of its normal rating (375MVA) for non-contingency condition. This project contributes approximately 17.7MW to the thermal violation. Previous project(s) T41 and T42 contribute(s) to the loading by 31.1MW(8.29%) and 15.6MW(4.16%) respectively.It

must be noted that the same thermal violation (DC power flow: 101.3%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

11. The Parlin-Williams 230kV line loads from 100.84% to 102.1% (DC power flow) of its emergency rating (805MVA) for the single line contingency outage of the Atlantic-South River 230kV circuit. This project contributes approximately 10.1MW to this thermal violation. Previous project(s) T41 contribute(s) to the loading by 13.5MW(1.68%).

12. The Williams-Freneau 230kV line loads from 100.21% to 101.46% (DC power flow) of its emergency rating (805MVA) for the single line contingency outage of the Atlantic-South River 230kV circuit. This project contributes approximately 10.1MW to this thermal violation.

13. The Lackawanna-Oxbow 230kV line loads from 161.83% to 163.89% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 10.3MW to the thermal violation. Previous project(s) T41 and T42 contribute(s) to the loading by 13.8MW(2.77%) and 6.9MW(1.39%) respectively. It must be noted that the same thermal violation (DC power flow: 151.5%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

14. The Oxbow-North Meshoppen 230kV line loads from 161.66% to 163.73% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 10.3MW to the thermal violation. Previous project(s) T41 and T42 contribute(s) to the loading by 13.8MW(2.77%) and 6.9MW(1.38%) respectively. It must be noted that the same thermal violation (DC power flow: 151.4%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

15. The Raphael Road-Northeast 2339 230kV line loads from 138.38% to 139.56% (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 8.9MW to the thermal violation. Previous project(s) T40 and T41 contribute(s) to the loading by 10.2MW(1.35%) and 11.9MW (1.57%) respectively. 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.

16. The Raphael Road-Northeast 2317 230kV line loads from 135.65% to 136.81% (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 8.8MW to the thermal violation. Previous project(s) T40 & T41 contribute(s) to the loading by 10MW(1.32%) and 11.8MW (1.55%) respectively. 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.

17. The Conastone-North Northwest 500kV line loads from 167.56% to 169.47% (DC power flow) of its normal rating (2078MVA) for the non-contingency condition. This

project contributes approximately 39.7MW to the thermal violation. Previous project(s) T40, T41 and T42 contribute(s) to the loading by 62MW(2.98%), 53.3MW (2.56%) and 26.7MW (1.29%) respectively. 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.

18. The Northwest-Granite 2311 230kV line loads from 170.91% to 172.69% (DC power flow) of its emergency rating (641MVA) for the single line contingency outage of the Kemptown-North Northwest 500kV circuit. This project contributes approximately 11.4MW to the thermal violation. Previous project(s) T40, T41 & T42 contribute(s) to the loading by 17.1MW(2.67%), 15.3MW (2.39%) and 7.7MW (1.19%) respectively. 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.

19. The Conastone-Mt. Carmel 2310 230kV line loads from 141.60% to 143.57% (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 and T41 contribute(s) to the loading by 17MW(1.84%) and 18.2MW (1.97%) respectively. 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.

20. The Conastone-Mt. Carmel 2322 230kV line loads from 144.56% to 146.03% (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 13.6MW to the thermal violation. Previous project(s) T40 and T41 contribute(s) to the loading by 17MW(1.84%) and 18.2MW (1.97%) respectively. 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.

21. The Mt. Carmel-North Northwest 2322 230kV line loads from 142.26% to 143.73% (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 13.6MW to the thermal violation. Previous project(s) T40 and T41 contribute(s) to the loading by 17MW(1.84%) and 18.2MW (1.97%) respectively. 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.

22. The Mt. Carmel-North Northwest 2310 230kV line loads from 142.26% to 143.73% (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 13.6MW to the thermal violation. Previous project(s) T40 and T41 contribute(s) to the loading by 17MW(1.84%) and 18.2MW (1.97%) respectively. 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.

23. The Northwest-Granite 2326 230kV line loads from 121.46% to 122.69% (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 11.3MW to the thermal violation. Previous project(s) T40 and T41 contribute(s) to the loading by 17.1MW(1.85%) and 15.2MW (1.65%) respectively. 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.

24. The Linden-North Ave. 138kV line loads from 118.01% to 135.44% (DC power flow) of its emergency rating (308MVA) for the tower line outage of the Hudson-Essex and Athenia-NJT Meadows 230kV circuits. This project contributes approximately 53.7MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 118.0%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

25. The Bayonne-B-M Reactor 138kV line loads from 101.15% to 118.37% (DC power flow) of its emergency rating (311MVA) for the tower line outage of the Hudson-Essex and Athenia-NJT Meadows 230kV circuits. This project contributes approximately 53.5MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 101.2%) already exists in the 2012 base case.

26. The B-M Reactor-Marion 138kV line loads from 101.13% to 118.34% (DC power flow) of its emergency rating (311MVA) for the tower line outage of the Hudson-Essex and Athenia-NJT Meadows 230kV circuits(27PS). This project contributes approximately 53.5MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 101.1%) already exists in the 2012 base case.

27. The Hudson-South Waterfront 230kV line loads from 113.34% to 117.51% (DC power flow) of its emergency rating (622MVA) for the Hudson-Penhorn 230kV tower line outage. This project contributes approximately 25.9MW to the thermal violation. Previous project(s) T41 and T42 contribute(s) to the loading by 45.4MW(7.3%) and 22.8MW(3.67%) respectively. It must be noted that the same thermal violation (DC power flow: 102.4%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

28. The South Waterfront-Newport “R” 230kV line loads from 110.42% to 118.07% (DC power flow) of its emergency rating (490MVA) for the tower line outage of the Hudson-Belleville 230kV and Roseland-Kearny “D” 138kV circuits. This project contributes approximately 37.5MW to cause this thermal violation. Previous project(s) T41 and T42 contribute(s) to the loading by 63.8MW(13.02%) and 32MW(6.53%) respectively.

29. The Lackawanna-Oxbow 230kV line loads from 171.09% to 173.08% (DC power flow) of its emergency rating (504MVA) for the tower line outage of the Harwaood-East Palmerton and Harwood-Siegfried 230kV circuits). This project contributes

approximately 10.0MW to the thermal violation. Previous project(s) T41 and T42 contribute(s) to the loading by 13.4MW(2.67%) and 6.7MW(1.33%) respectively. It must be noted that the same thermal violation (DC power flow: 159.5%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

30. The Oxbow-North Meshoppen 230kV line loads from 167.18% to 169.13% (DC power flow) of its emergency rating (617MVA) for the Conastone-Peach Bottom 500kV tower line outage. This project contributes approximately 12.1MW to the thermal violation. Previous project(s) T41 and T42 contribute(s) to the loading by 16.2MW(2.62%) and 8.1MW(1.32%) respectively. It must be noted that the same thermal violation (DC power flow: 155.3%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

31. The Nottingham-Nottingham 230kV Reactor loads from 174.71% to 176.67% (DC power flow) of its emergency rating (627MVA) for the Conastone-Peach Bottom tower line outage. This project contributes approximately 12.3MW to the thermal violation. Previous project(s) T40, T41 and T42 contribute(s) to the loading by 18.6MW(2.96%), 16.5MW (2.64%) and 8.3MW (1.31%) respectively. 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.

32. The Nottingham Reactor-Peach Bottom Tap 230kV line loads from 174.68% to 176.64% (DC power flow) of its emergency rating (627MVA) for the Conastone-Peach Bottom 500kV tower line outage. This project contributes approximately 12.3MW to the thermal violation. Previous project(s) T40, T41 and T42 contribute(s) to the loading by 18.6MW(2.96%), 16.5MW (2.64%) and 8.3MW (1.31%) respectively. 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.

33. The Peach Bottom Tap-Graceton 230kV line loads from 174.68% to 176.64% (DC power flow) of its emergency rating (627MVA) for the Conastone-Peach Bottom 500kV tower line outage. This project contributes approximately 12.3MW to the thermal violation. Previous project(s) T40, T41 and T42 contribute(s) to the loading by 18.6MW(2.96%) 16.5MW (2.64%) and 8.3MW (1.31%) respectively. 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.

34. The Conastone-North Northwest 500kV line loads from 151.12% to 152.70% (DC power flow) of its emergency rating (2901MVA) for the tower line outage of the Conastone – Northwest 2310 & 2322 circuits. This project contributes approximately 45.9MW to the thermal violation. Previous project(s) T40, T41 and T42 contribute(s) to the loading by 59.8MW (2.06%), 61.6 MW (2.12%) and 30.9MW (1.07%) respectively. 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.

35. The Manor-Graceton 230kV line loads from 168.15% to 170.23% (DC power flow) of its emergency rating (531MVA) for the Conastone-Peach Bottom 500kV tower line outage. This project contributes approximately 9.5MW to the thermal violation. Previous project(s) T40, T41 and T42 contribute(s) to the loading by 10.7MW(2.02%), 14.8MW (2.79%) and 7.4MW (1.39%). 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.

36. The North Meshoppen-East Towanda 230kV line loads from 115.66% to 117.38% (DC power flow) of its emergency rating (554MVA) for the Conastone-Peach Bottom 500kV tower line outage. This project contributes approximately 9.5MW to the thermal violation. Previous project(s) T41 and T42 contribute(s) to the loading by 12.8MW(2.31%) and 6.4MW(1.15%) respectively. It must be noted that the same thermal violation (DC power flow: 105.3%) already exists in the 2012 base case due to unresolved problems in the R & S queues.

37. The Hosensack-North .Boyertown 230kV line loads from 100.59% to 102.43% (DC power flow) of its emergency rating (525MVA) for the Conastone-Peach Bottom 500kV tower line outage. This project contributes approximately 9.7MW to the thermal violation. Previous project(s) T42 contribute(s) to the loading by 6.5MW(1.24%).

New System Reinforcements

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

1, 3 & 4, 24, 25, 26. The Essex-Hudson 230kV, Pasaic Valley SC-Bayonne 138kV, ECCRF-Foundry Street, Linden-North Ave., Bayonne-B-M Reactor, The B-M Reactor-Marion 138kV 138kV circuit overloads can be alleviated by constructing a new 138kV oiverhead circuit between Essex and Kearny Switching Stations. The estimated cost is **$15.7 million.**

2. The Marion-Hudson 138kV circuit overload can be alleviated by replacing transformer 220-1 (Marion-Hudson 138kV) with a minimum emergency rating of 315MVA. The estimated cost is **$10 million**.

5. The Newport-Hoboken "R" 230kV circuit overload can be alleviated by replacing approximately 200 feet of underground cable and pot heads in the Newport Switchyard. The estimated cost is **$1.5 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)

6 & 26. The Hudson-South Waterfront 230kV circuit overload 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**.

7. The South Waterfront-Newport "R" 230kV circuit overload can be alleviated by providing oil circulation to increase the rating by 10%. The estimated cost is **$5 million**.

8, 9 & 10. The Bergen-Leonia "K" Ckt #2 and The Bergen-Leonia "T" Ckt #1230kV line overloads can be alleviated by installing a third pipe-type 230kV cable between Bergen and Leonia. The estimated cost is **$60 million**.

11. The Parlin-Williams 230kV circuit overload can be alleviated by reconductoring the 2.9 mile circuit with 1590 Kcmil 54/19 ACSS/AW conductor to achieve a rating of 869/1069 MVA summer, addition of a 3000 amp, 230kV disconnect switch at Williams Substation and installation of bundled drop loop bus conductor at the Parlin substation. The estimated cost is **$1,545,000**.

12. The Williams-Freneau 230kv circuit overload can be alleviated by reconductoring the 7.7 mile circuit with 1590 Kcmil 54/19 ACSS/AW conductor to achieve a rating of 869/1069 MVA summer, addition of a 3000 amp, 230kV disconnect switch at both Freneau and Williams Substations and installation of bundled drop loop bus conductor at the Parlin and Williams substations. The estimated cost is **$4,040,000**.

13 & 28. 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.

14 & 29. The Oxbow-North Meshoppen 230kV line overload can 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**.

15. 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 braker is **$382,000**.

16. 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 braker is **$382,000**.

17 & 33. 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

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

19 & 20 & 21 & 22. 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 Nortwest 2322 230kV circuit can be alleviated by installing a new 500kVstation mamed North Northwest that includes 2-500/230kV xfmrs 4-500 kV bkrs, 7-230 kV Bkrs and related substation equipment and land at a cost of **$70 million**. It also requires tthe 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**.

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

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

27. The South Waterfront-Newport “R” 230kV circuit overload can be alleviated by Providing oil circulation on the S Waterfront - Newport circuits (L-2264 & Q-2269) to increase emergency rating on Q-2269 by 10%. The estimated cost is $5 million.

30 & 31 & 32. The overload on the Nottinghan-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. Rebuild ing the Peach Bottom to Nottingham portion of the line as a high capacity 230 kV line, 1243MVAn/1411MVAe, 13.6 miles @ $1.5M per mile plus new Susquehanna river crossing, approx **$40M** and four years to complete.

34. 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.

35. 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**).

36. The Hosensack-North Boyertown 230kV line overload can be alleviated by reconductoring of approximately 8 miles of 230kV transmission line with 1590 ACRS wire. The existing structures between Hosensak and North Boyertown are insufficient to support a large size wire, so they will also need to be upgraded. For the worst case scenario where all support structures need to be replaced, the estimated cost of the reinforcement is **$11,760,000**. The upgrade will take approximately 3 years to complete

37. The overdutied condition of the Essex 20H 230kV circuit breaker can be alleviated by replacing the existing circuit breaker with on with a higher interrupting rating. The estimated cost is **$500,000**.