#T45 Hudson 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 T45 was studied as a 205MW (capacity) injection onto PSEG's system at the Hudson 230kV facility. The project was studied twice, due to project T42 having two options. T45 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. It should be noted that the Q75 MTX project was not modeled in our study because its associate network reinforcements were not available. Potential network impacts were as follows:

T45 with T42 Option 1:

Generator Deliverability

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

1. **(PSEG)** The Newport R-Hoboken R 230kV line loads from 99.3% to 109.0% (DC power flow) of its normal rating (366MVA) for non-contingency condition. This project contributes approximately 35.6MW to cause this thermal violation.

2. **(PSEG)** The New Milford-Maywood 230kV line loads from 97.3% to 107.7% (DC power flow) of its emergency rating (585MVA) for the single line contingency outage (PS9). This project contributes approximately 61.1MW to cause this thermal violation.

3. **(PSEG)** The Leonia T-Bergenfield 230kV line loads from 90.5% to 100.4% (DC power flow) of its emergency rating (585MVA) for the single line contingency outage (PS45B). This project contributes approximately 58.0MW to cause this thermal violation.

3a. **(PSEG)** The Kearny 1-3 Turnpike G 138kV line loads from 98.2% to 103.6% (DC power flow) of its normal rating (249MVA) for non-contingency condition. This project contributes approximately 13.5MW to cause this thermal violation.

3b. **(PSEG)** The Bergen - Athenia 230kV line loads from 93.2% to 104.2% (DC power flow) of its normal rating (500MVA) for non-contingency condition. This project contributes approximately 54.6MW to cause this thermal violation.

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)

3c. **(PSEG)** The Kearny 1-3 Turnpike G 138kV line loads from 94.8% to 102.8% (DC power flow) of its normal rating (308MVA) for the tower line outage (22PS). This project contributes approximately 24.7MW to cause this thermal violation.

Contribution to Previously Identified Overload

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

4. **(PSEG)** The Hudson 1-6-S. Waterfront 230kV line loads from 132.64% to 140.30% (DC power flow) of its normal rating (404MVA) for non-contingency condition. This project contributes approximately 30.9MW to the thermal violation.

5. **(PSEG)** The S. Waterfront-Newport R 230kV line loads from 124.90% to 136.19% (DC power flow) of its normal rating (315MVA) for non-contingency condition. This project contributes approximately 35.6MW to the thermal violation.

6. **(PSEG)** The Bergen-Leonia T 230kV line loads from 130.73% to 141.98% (DC power flow) of its emergency rating (557MVA) for the single line contingency outage (PS45). This project contributes approximately 62.7MW to the thermal violation.

7. **(PSEG)** The Bergen-Leonia T 230kV line loads from 125.14% to 135.54% (DC power flow) of its emergency rating (557MVA) for the single line contingency outage (PS45B). This project contributes approximately 58.0MW to the thermal violation.

8. **(JCPL)** The Parlin-Williams 230kV line loads from 103.38% to 104.63% (DC power flow) of its emergency rating (805MVA) for the single line contingency outage (JC17). This project contributes approximately 10.1MW to the thermal violation.

9. **(JCPL)** The Williams-Freneau 230kV line loads from 102.75% to 104.00% (DC power flow) of its emergency rating (805MVA) for the single line contingency outage (JC17). This project contributes approximately 10.1MW to the thermal violation.

10. **(PSEG)** The Bergen-Leonia T 230kV line loads from 123.86% to 133.31% (DC power flow) of its normal rating (375MVA) for non-contingency condition. This project contributes approximately 35.4MW to the thermal violation.

11. **(PPL/PENELEC)** The Lackawanna-Oxbow 230kV line loads from 172.35% to 174.33% (DC power flow) of its emergency rating (504MVA) for the single line contingency outage (PN18). This project contributes approximately 10.0MW to the thermal violation.

12. **(PPL/PENELEC)** The Lackawanna-Oxbow 230kV line loads from 166.86% to 168.92% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 10.3MW to the thermal violation.

13. **(PENELEC)** The Oxbow-N..Meshoppen 230kV line loads from 166.68% to 168.74% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 10.3MW to the thermal violation.

14. **(BGE)** The Raphael Rd.-Northeast 339 230kV line loads from 142.43% to 143.60% (DC power flow) of its emergency rating (758MVA) for the single line contingency outage (BG8). This project contributes approximately 8.9MW to the thermal violation.

15. **(BGE)** The Raphael Rd.-Northeast 317 230kV line loads from 139.64% to 140.80% (DC power flow) of its emergency rating (758MVA) for the single line contingency outage (BG18). This project contributes approximately 8.8MW to the thermal violation.

16. **(BGE)** The Conastone-N. Northwest 500kV line loads from 173.34% to 175.25% (DC power flow) of its normal rating (2078MVA) for non-contingency condition. This project contributes approximately 39.7MW to the thermal violation.

17. **(BGE)** The Northwest 311-Granite 230kV line loads from 175.82% to 177.60% (DC power flow) of its emergency rating (641MVA) for the single line contingency outage (PJM13B_NNWEST_B). This project contributes approximately 11.4MW to the thermal violation.

18. **(PECO/BGE)** The Peach Bottom-Conastone 500kV line loads from 168.82% to 170.81% (DC power flow) of its emergency rating (2598MVA) for the single line contingency outage (PJM17_2). This project contributes approximately 51.7MW to the thermal violation.

19. **(PECO/BGE)** The Peach Bottom-Conastone 500kV line loads from 168.82% to 170.81% (DC power flow) of its emergency rating (2598MVA) for the single line contingency outage (PJM17). This project contributes approximately 51.7MW to the thermal violation.

20. **(BGE)** The Conastone-Mt. Carmel 22 230kV line loads from 148.71% to 150.18% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 13.6MW to the thermal violation.

21. **(BGE)** The Conastone-Mt. Carmel 10 230kV line loads from 148.71% to 150.18% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 13.6MW to the thermal violation.

22. **(BGE)** The Mt. Carmel 10-N. Northwest 230kV line loads from 146.42% to 147.89% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 13.6MW to the thermal violation.

23. **(BGE)** The Mt. Carmel 22-N. Northwest 230kV line loads from 146.42% to 147.89% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 13.6MW to the thermal violation.

24. **(BGE)** The Northwest 326-Granite 230kV line loads from 124.83% to 126.06% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_B). This project contributes approximately 11.3MW to the thermal violation.

25. **(PSEG)** The Hudson 1-6-S. Waterfront 230kV line loads from 121.55% to 129.85% (DC power flow) of its emergency rating (622MVA) for the tower line outage (24PS). This project contributes approximately 51.6MW to the thermal violation.

26. **(PSEG)** The S. Waterfront-Newport R 230kV line loads from 125.69% to 139.44% (DC power flow) of its emergency rating (490MVA) for the tower line outage (30PS). This project contributes approximately 67.4MW to the thermal violation.

27. **(PSEG)** The Newport R-Hoboken R 230kV line loads from 112.43% to 125.37% (DC power flow) of its emergency rating (521MVA) for the tower line outage (30PS). This project contributes approximately 67.4MW to the thermal violation.

28. **(PSEG)** The Hoboken R-Bergen 230kV line loads from 106.28% to 119.14% (DC power flow) of its emergency rating (524MVA) for the tower line outage (30PS). This project contributes approximately 67.4MW to the thermal violation.

29. **(PENELEC)** The Oxbow-N. Meshoppen 230kV line loads from 172.19% to 174.14% (DC power flow) of its emergency rating (617MVA) for the tower line outage (CONAS_PB). This project contributes approximately 12.1MW to the thermal violation.

30. **(PECO)** The Nottingham-Nottingham Reactor 230kV line loads from 180.24% to 182.20% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 12.3MW to the thermal violation.

31. **(PECO/BGE)** The Peach Bottom-Graceton 230kV line loads from 180.21% to 182.17% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 12.3MW to the thermal violation.
32. **(PECO)** The Nottingham Reactor-Peach Bottom 230kV line loads from 180.21% to 182.17% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 12.3MW to the thermal violation.

33. **(BGE)** The Conastone-N. Northwest 500kV line loads from 155.92% to 157.50% (DC power flow) of its emergency rating (2901MVA) for the tower line outage (CNSTN_NWEST_NNWEST_A). This project contributes approximately 45.9MW to the thermal violation.

34. **(PPL/BGE)** The Manor-Graceton 230kV line loads from 173.80% to 175.88% (DC power flow) of its emergency rating (531MVA) for the tower line outage (CONAS_PB). This project contributes approximately 11.0MW to the thermal violation.

35. **(PENELEC)** The N. Meshoppen-E. Towanda 230kV line loads from 119.92% to 121.63% (DC power flow) of its emergency rating (554MVA) for the tower line outage (CONAS_PB). This project contributes approximately 9.5MW to the thermal violation.

36. **(PPL/METED)** The Hosensack-N. Boyertown 230kV line loads from 105.26% to 107.10% (DC power flow) of its emergency rating (525MVA) for the tower line outage (CONAS_PB). This project contributes approximately 9.7MW to the thermal violation.

37. **(PPL/BGE)** The Otter Creek-Conastone 230kV line loads from 150.01% to 151.91% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 11.9MW to the thermal violation.

Short Circuit

Our analysis found 1 new breaker, to be over-duty in the PSEG transmission area. The new over-duty breakers are listed below:

Essex, 230 kV – 22H

In addition, the analysis also showed a significant fault contribution to 12 breakers, which were already identified as over-duty. The breakers are listed below:

HUDSN1-6 230.kV -1HC
HUDSN1-6 230.kV - 2HC
HUDSN1-6 230.kV - 2HA
HDSN7-12 230.kV - 3HA
HUDSN1-6 230.kV - 1HB
HUDSN1-6 230.kV – 2HB
HDSN7-12 230.kV - 3HB
HDSN7-12 230.kV - 4HA
HDSN7-12 230.kV - 3HC
HDSN7-12 230.kV - 4HC
HDSN7-12 230.kV - 4HB
HUDSN1-6 230.kV- 1HA

The T45 queue had a significant enough fault contribution at all of these breakers to receive a cost allocation for their upgrade or replacement. This study was performed on the 230 kV and above breakers in the PSEG territory.

Station	Voltage	Breaker	Int Rating Amps	Calculated Short Circuit Current			
				Before T45		After T45	
				3-phase	Ph-Gnd	3-phase	Ph-Gnd
Essex	230kV	22H	46147	52798	51632.3	53021.8	51799.1
Hudson 1-6	230kV	1HC	94711.3	76200.3	79064	77829.5	80920.7
Hudson 1-6	230kV	2HC	107603.4	76200.3	79064	77829.5	80920.7
Hudson 1-6	230kV	2HA	98980.8	76200.3	79064	77829.5	80920.7
Hudson 1-6	230kV	1HB	97529.5	76200.3	79064	77829.5	80920.7
Hudson 1-6	230kV	2HB	93300	76200.3	79064	77829.5	80920.7
Hudson 1-6	230kV	1HA	87252	76200.3	79064	77829.5	80920.7
Hudson 7-12	230kV	3HA	98535	75311.9	78094.7	76873.6	79870.8
Hudson 7-12	230kV	3HB	92508.3	75311.9	78094.7	76873.6	79870.8
Hudson 7-12	230kV	4HA	107313.6	75311.9	78094.7	76873.6	79870.8
Hudson 7-12	230kV	3HC	91799.3	75311.9	78094.7	76873.6	79870.8
Hudson 7-12	230kV	4HC	107190.3	75311.9	78094.7	76873.6	79870.8
Hudson 7-12	230kV	4HB	102170.5	75311.9	78094.7	76873.6	79870.8

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 Newport – Hoboken R 230kV circuit overload can be alleviated by installing a 4 breaker ring bus at 49th street which taps Hoboken – Bergen. The line from 49th street to Bergen will also need to be reconductored with 1590 ACSS wire. The upgrade will cost approximately **$21.3**. **This upgrade also mitigates Network Impact number 27**.

2. The North Milford – Maywood 230kV overload can be alleviated by constructing a new 230kV line from Athenia directly to Bergen. Although the North Milford – Maywood overload

is a new violation, this reinforcement has already been identified by a previous project. The estimated cost for the Athenia-Bergen circuit is **$95 million.**

3. The Bergen – Leonia "T" circuit overload can be alleviated by adding oil circulation to increase the emergency rating by 15%. This oil circulation, in conjunction with the new 230kV Athenia – Bergen line (see reinforcement for Network Impact 2) will mitigate the Bergen – Leonia T overload. The estimated cost of providing oil circulation to this line is approximately **$2.5M**.

3a. The Kearny – Turnpike 138kV line overload can be alleviated by constructing a new 230kV circuit, approximately 7.5 miles long, along the path Bergen – Homestead – Hudson. The estimated cost (estimate by PJM) for the circuit is **$15 million. This upgrade also mitigates Network Impact number 3b and 3c**.

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)

4. The Hudson-South Waterfront 230kV line overloads can be alleviated by reconductoring the circuit to increase its normal rating to a minimum of 475MVA and the emergency rating to a minimum of 575MVA. The estimated cost is **$6 million**. **This upgrade also mitigates Network Impact number 25**.

5. 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**. This upgrade, in conjunction with the 4-breaker ring bus at 49th street (upgrade for Network Impact 10) will alleviate the overload. **This upgrade also mitigates Network Impact number 26**.

6. The Bergen-Leonia "T" ckt #2 230kV line overload can be alleviated by adding oil circulation to increase the emergency rating by 15%. The estimated cost is **$2.5M**. The overload will also warrant a cost allocation for a new 230kV line from Athenia – Bergen. The estimated cost for the Athenia-Bergen circuit is **$95 million.**

7. The Bergen-Leonia "T" ckt #1 230kV line overload can be alleviated by adding oil circulation to increase the emergency rating by 15%. The estimated cost is **$2.5M**. The overload will also warrant a cost allocation for a new 230kV line from Athenia – Bergen. The estimated cost of this upgrade is unknown at this time. **This upgrade also mitigates Network Impact number 10**.

8. Parlin - Williams (K1025) Upgrade: This overload requires reconductoring of Parlin - Williams line from 1590 Kcmil 45/7 ACSR (2.9 mile DCT) to 1590 Kcmil 54/19 ACSS/AW - Bundled (1.7 mile DCT) for 1642/1850 MVA summer normal/emergency ratings. It also requires

replacement of disconnect switch (4000 amp) (1), bundled conductor at Williams substation and at Parlin substation. Total estimated cost is **$3,860,000**.

9. Williams - Freneau 230 kV (K1025) Upgrade: This overload requires reconductoring of Freneau to Williams line from 1590 Kcmil 45/7 ACSR (7.7 mile) to 1590 Kcmil 54/19 ACSS/AW (7.7 mile) for 869/1068 MVA summer normal/emergency ratings at an estimated cost of $3,850,000. It requires addition of a disconnect switch (3000 amp) (1) at Freneau substation at an estimated cost of $75,000 and a disconnect switch (3000 amp) (1) at Williams substation at an estimated cost of $75,000. It also requires bundled conductor at Freneau substation at an estimated cost of $20,000 and at Williams substation at an estimated cost of $20,000. The total estimated cost of the upgrade is **$4,040,000.**

11. Lackawanna-Oxbow 230kV line: Lackawanna is a PP&L owned substation and any associated terminal upgrades would have to be confirmed by PP&L. This overload would require the rebuild of approximately 16.33 miles of transmission line. (estimated to cost approximately $19,596,000). This overload also requires the following terminal upgrades at Oxbow substation: replace substation conductor (estimated cost approximately $125,000) and replace a disconnect switch (estimated cost approximately $85,000). The total estimated cost for this upgrade is **$19,806,000. This upgrade also mitigates Network Impact number 12**.

13. The Oxbow-North Meshoppen 230kV line overload can be alleviated by reconductoring approximately 10.16 miles of transmission line (estimated to cost approximately $5.08 million), 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 million**. **This upgrade also mitigates Network Impact number 29**.

14. Raphael Rd - Northeast 230 kV 339 line - replace 230kV breaker at Northeast The estimated cost is **$382,000**.

15. Raphael Rd - Northeast 230 kV 317 line - replace 230kV breaker at Northeast The estimated cost is **$382,000**.

16. The Conastone-North North West line can be upgraded by adding a single circuit 500kV line at an estimated cost of **$109 million** and estimated time of 10 yrs.

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
This upgrade also mitigates Network Impact number 33.

17. The Northwest-Granite 2311 230kV line overload can be alleviated by reconductoring the line with 2,167 ACSR which will increase the rating to 1105MVA. There will also be substation

terminal cost upgrades associated with the reinforcement. The total cost estimate of the reinforcement is approximately **$23.6M**, and the time estimate for completion is about **6 years**.

18. Conastone – Peach Bottom 500 kV Line - To mitigate the overload of the Conastone – Peach Bottom 500 kV circuit a second circuit will need to be built.

If RIGHT OF WAY can be acquired following is the Reinforcement and Cost Estimates:

PECO portion of the Conastone – Peach Bottom line:

Substation work at Peach Bottom	$ 2,500,000
Construct 6.25 miles of 500kV line	$10,000,000
	$12,500,000

This estimate does not include the cost of new right of way.
Construction of the new line will take approximately **30 months** after the right of way is acquired.

Note: It should be noted that PJM Queue P04 project also requires widening of about two miles of this right of way for their direct connection line and would use the last remaining terminal position that exists at Peach Bottom substation. If Queue P04 proceeds with their project it may complicate right of way acquisition and double the substation costs at Peach Bottom.

BGE portion of the Conastone – Peach Bottom line:
Build new 500 kV line adjacent to existing circuit 5012 from Conastone to Pennsylvania State Line at an estimated cost of **$48,000,000** and a construction time of approximately **84 months.**

Assumptions:

- Acquire 150 ft. wide R/W adjacent to existing R/W, mostly rural land at $100,000 per acre
- 2 to 3 year CPCN process prior to land acquisition
- Length of line 9.6 miles

Install one 500kV breaker at Conastone **$1,500,000**. Breaker installation can be completed concurrently with the line construction.

If RIGHT OF WAY cannot be acquired following is the Reinforcement and Cost Estimates:

The line from Graceton to Peach Bottom is about 7.5 miles long and has a normal rating of 528MVA. Assuming that we could maintain this rating with a single 230 kV pipe type cable (and we may not be able to do this), the new underground installation would cost about $30M plus another $1M for terminal modifications. I assume that the underground

line will not have to cross any rivers or large creeks. If a cable rating of 450 MVA is insufficient, it will cost an additional $30M.

Removal of the existing 230 kV tower line is about $1.5M.

Construction of a double circuit 500kV line from Conastone to Peach Bottom would be about $3.5M per mile. The line is 16.5 miles long. Total cost $58M.

Substation additions and modifications at Peach Bottom would cost about $10M.

Note: Future work is being done by the TOs to come up with reinforcements to further mitigate the overload.

This upgrade also mitigates Network Impact numbers 19.

20. Northwest - Mt Carmel - Conastone upgrade –

This overload requires installation at NNW station 2-500/230kV xfmrs 4-500 kV bkrs, 7-230 kV Bkrs and related substation equipment and land at a cost of $70M. It also requires to reconductor Conastone to Northwest #2322 with 1,272kcmil ACSR 1,590kcmil ACSR with an estimated cost of $8.21. This work would take 3-4 years to build substation and 18-24 months for the line work. **This upgrade also mitigates Network Impact numbers 21, 22, and 23**.

24. The Northwest-Granite 2326 230kV line overload can be alleviated by reconductoring the line with 2,167 ACSR which will increase the rating to 1105MVA. There will also be substation terminal cost upgrades associated with the reinforcement. The total cost estimate of the reinforcement is approximately **$23.6M**, and the time estimate for completion is about **6 years**.

28. The Hoboken R – Bergen 230kV overload can be alleviated by installing a 4 breaker ring bus at 49th street which taps Hoboken – Bergen. The line from 49th street to Bergen will also need to be reconductored with 1590 ACSS wire. The upgrade will cost approximately **$21.3**.

30. The overload on the Nottingham-Graceton-Peach Bottom 230kV circuit can be alleviated by relocating a portion of this line underground to facilitate the construction of additional 500kV lines between Peach Bottom and Conastone, **$61** million and three years to construct. Rebuilding the Peach Bottom to Bottingham portion of the line as a high capacity 230kV line, 1243MVAn/1411MVAe, 13.6 miles @ $1.5 million per mile plus new Susquehanna river crossing, approx **$40** million and four years to complete. **This upgrade also mitigates Network Impact numbers 31 and 32**.

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.

Based on previous estimate by R.W.M. for PJM (B48) study on circuit 22008, and Conastone to Ottercreek 2302 estimate (above)

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 composing of 795 ACSR. This rebuild will require new custom embedded steel poles to accommodate the larger conductor size of the new conductor. The new line will be 1590 Kcmil ACSR conductors (1 per phase) designed and operated at 230 kV. 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.

The rebuild will be 14.4 miles long and will travel the existing right of way.

35. North Meshoppen - East Towanda 230 kV Line - This overload would require the reconductor of 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 for this upgrade is **$17,085,000.**

36. Hosensak – North Boyertown 230kV Line – This overload would require the 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. Conastone – Otter Creek 230 kV Line -

PPL upgrade
The PPL portion of the Conastone to Otter Creek line (from Otter Creek to the point where ownership changes to BG&E) can be upgraded by reconductoring approximately

17.2 miles of 795 kcmil 30/19 ACSR conductor (Ratings 425/531 MVA Summer Normal/Emergency based on conductor temp @125^{O}C) with new 795 kcmil 30/19 ACSS (new ratings 516/632 MVA Summer Normal/Emergency, conductor operating temperature of 160^{O} C)

No terminal equipment upgrade is required at Otter Creek, it is currently built with 2000 amp rating equipment. The estimated cost of this upgrade is **$8.5 million.** Estimated construction time is **36 months.**

This upgrade will result in minimal change to the impedance of the line.
Existing Z = 0.0042 + j 0.0266 pu
New Z = 0.0048 + j 0.02676 pu

BG&E Upgrade

The BG&E portion of the Conastone to Otter Creek line can be upgraded by Reconducting from Gorsuch Mills to the Pennsylvania State Line (change of ownership to PPL). The existing circuit 2302 conductor is 1,590 kcmil 45/7 ACSR from Conastone to Gorsuch Mills and 795 kcm 30/19 ACSR from Gorsuch Mills to the PA State Line.
Assumptions:

- Reconductor with 1,590 kcm ACSR from Gorsuch Mills to PA line to match capability of remainder of line.
- Length of this line section is 1.7 miles.
- Towers can be reinforced instead of replaced.
- Based on previous estimate by R.W.M. for PJM (B48) study on circuit 22008

The estimated cost of this upgrade is **$700,000**. Estimated construction time is **36 months**.

T45 with T42 Option 2:

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

1. **(PSEG)** The Newport R-Hoboken R 230kV line loads from 97.9% to 107.6% (DC power flow) of its normal rating (366MVA) for non-contingency condition. This project contributes approximately 35.6MW to cause this thermal violation.

2. **(PSEG)** The New.Milford-Maywood 230kV line loads from 95.8% to 106.2% (DC power flow) of its emergency rating (585MVA) for the single line contingency outage (PS9). This project contributes approximately 61.1MW to cause this thermal violation.

2a. **(PSEG)** The Kearny 1-3 Turnpike G 138kV line loads from 98.2% to 103.6% (DC power flow) of its normal rating (249MVA) for non-contingency condition. This project contributes approximately 13.5MW to cause this thermal violation.

2b. **(PSEG)** The Bergen - Athenia 230kV line loads from 93.2% to 104.2% (DC power flow) of its normal rating (500MVA) for non-contingency condition. This project contributes approximately 54.6MW to cause this thermal violation.

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)

2c. **(PSEG)** The Kearny 1-3-Turnpike G 138kV line loads from 94.8% to 102.8% (DC power flow) of its normal rating (308MVA) for the tower line outage (22PS). This project contributes approximately 24.7MW to cause this thermal violation.

Short Circuit

Our analysis found 1 new breaker, to be over-duty in the PSEG transmission area. The new over-duty breakers are listed below:

Essex, 230 kV – 22H

In addition, the analysis also showed a significant fault contribution to 12 breakers, which were already identified as over-duty. The breakers are listed below:

HUDSN1-6 230.kV -1HC
HUDSN1-6 230.kV - 2HC
HUDSN1-6 230.kV - 2HA
HDSN7-12 230.kV - 3HA
HUDSN1-6 230.kV - 1HB
HUDSN1-6 230.kV – 2HB
HDSN7-12 230.kV - 3HB
HDSN7-12 230.kV - 4HA
HDSN7-12 230.kV - 3HC
HDSN7-12 230.kV - 4HC
HDSN7-12 230.kV - 4HB
HUDSN1-6 230.kV- 1HA

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. **(PSEG)** The Hudson 1-6-S. Waterfront 230kV line loads from 131.69% to 139.35% (DC power flow) of its normal rating (404MVA) for non-contingency condition. This project contributes approximately 30.9MW to the thermal violation.

4. **(PSEG)** The S. Waterfront-Newport R 230kV line loads from 123.25% to 134.54% (DC power flow) of its normal rating (315MVA) for non-contingency condition. This project contributes approximately 35.6MW to the thermal violation.

5. **(PSEG)** The Bergen-Leonia T 230kV line loads from 129.09% to 140.34% (DC power flow) of its emergency rating (557MVA) for the single line contingency outage (PS45). This project contributes approximately 62.7MW to the thermal violation.

6. **(PSEG)** The Bergen-Leonia T 230kV line loads from 123.62% to 134.03% (DC power flow) of its emergency rating (557MVA) for the single line contingency outage (PS45B). This project contributes approximately 58.0MW to the thermal violation.

7. **(JCPL)** The Parlin-Williams 230kV line loads from 103.38% to 104.63% (DC power flow) of its emergency rating (805MVA) for the single line contingency outage (JC17). This project contributes approximately 10.1MW to the thermal violation.

8. **(JCPL)** The Williams-Freneau 230kV line loads from 102.75% to 104.00% (DC power flow) of its emergency rating (805MVA) for the single line contingency outage (JC17). This project contributes approximately 10.1MW to the thermal violation.

9. **(PPL/PENELEC)** The Lackawanna-Oxbow 230kV line loads from 172.35% to 174.33% (DC power flow) of its emergency rating (504MVA) for the single line contingency outage (PN18). This project contributes approximately 10.0MW to the thermal violation.

10. **(PSEG)** The Bergen-Leonia T 230kV line loads from 122.49% to 131.94% (DC power flow) of its normal rating (375MVA) for non-contingency condition. This project contributes approximately 35.4MW to the thermal violation.

11. **(PPL/PENELEC)** The Lackawanna-Oxbow 230kV line loads from 166.86% to 168.92% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 10.3MW to the thermal violation.

12. **(PENELEC)** The Oxbow-N..Meshoppen 230kV line loads from 166.68% to 168.74% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 10.3MW to the thermal violation.

13. **(BGE)** The Raphael Rd.-Northeast 339 230kV line loads from 142.43% to 143.60% (DC power flow) of its emergency rating (758MVA) for the single line contingency outage (BG8). This project contributes approximately 8.9MW to the thermal violation.

14. **(BGE)** The Raphael Rd.-Northeast 317 230kV line loads from 139.64% to 140.80% (DC power flow) of its emergency rating (758MVA) for the single line contingency outage (BG18). This project contributes approximately 8.8MW to the thermal violation.

15. **(BGE)** The Conastone-N. Northwest 500kV line loads from 173.34% to 175.25% (DC power flow) of its normal rating (2078MVA) for non-contingency condition. This project contributes approximately 39.7MW to the thermal violation.

16. **(BGE)** The Northwest 311-Granite 230kV line loads from 175.82% to 177.59% (DC power flow) of its emergency rating (641MVA) for the single line contingency outage (PJM13B_NNWEST_B). This project contributes approximately 11.4MW to the thermal violation.

17. **(PECO/BGE)** The Peach Bottom-Conastone 500kV line loads from 168.82% to 170.81% (DC power flow) of its emergency rating (2598MVA) for the single line contingency outage (PJM17). This project contributes approximately 51.7MW to the thermal violation.

18. **(PECO/BGE)** The Peach Bottom-Conastone 500kV line loads from 168.82% to 170.81% (DC power flow) of its emergency rating (2598MVA) for the single line contingency outage (PJM17_2). This project contributes approximately 51.7MW to the thermal violation.

19. **(BGE)** The Conastone-Mt. Carmel 10 230kV line loads from 148.71% to 150.18% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 13.6MW to the thermal violation.

20. **(BGE)** The Conastone-Mt. Carmel 22 230kV line loads from 148.71% to 150.18% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 13.6MW to the thermal violation.

21. **(BGE)** The Mt. Carmel 10-N. Northwest 230kV line loads from 146.42% to 147.89% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 13.6MW to the thermal violation.

22. **(BGE)** The Mt. Carmel 22-N. Northwest 230kV line loads from 146.42% to 147.89% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 13.6MW to the thermal violation.

23. **(BGE)** The Northwest 326-Granite 6 230kV line loads from 124.83% to 126.06% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_B). This project contributes approximately 11.3MW to the thermal violation.

24. **(PSEG)** The Hudson 1-6-S. Waterfront 230kV line loads from 120.35% to 128.65% (DC power flow) of its emergency rating (622MVA) for the tower line outage (24PS). This project contributes approximately 51.6MW to the thermal violation.

25. **(PSEG)** The S. Waterfront-Newport R 230kV line loads from 123.83% to 137.58% (DC power flow) of its emergency rating (490MVA) for the tower line outage (30PS). This project contributes approximately 67.4MW to the thermal violation.

26. **(PSEG)** The Newport R-Hoboken R 230kV line loads from 110.68% to 123.61% (DC power flow) of its emergency rating (521MVA) for the tower line outage (30PS). This project contributes approximately 67.4MW to the thermal violation.

27. **(PSEG)** The Hoboken R-Bergen 230kV line loads from 104.54% to 117.40% (DC power flow) of its emergency rating (524MVA) for the tower line outage (30PS). This project contributes approximately 67.4MW to the thermal violation.

28. **(PENELEC)** The Oxbow-N..Meshoppen 230kV line loads from 172.19% to 174.14% (DC power flow) of its emergency rating (617MVA) for the tower line outage (CONAS_PB). This project contributes approximately 12.1MW to the thermal violation.

29. **(PECO)** The Nottingham-Nottingham Reactor 230kV line loads from 180.24% to 182.20% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 12.3MW to the thermal violation.

30. **(PECO)** The Nottingham Reactor-Peach Bottom Tap 230kV line loads from 180.21% to 182.17% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 12.3MW to the thermal violation.

31. **(PECO/BGE)** The Peach Bottom Tap-Graceton 230kV line loads from 180.21% to 182.17% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 12.3MW to the thermal violation.

32. **(BGE)** The Conastone-N. Northwest 500kV line loads from 155.92% to 157.50% (DC power flow) of its emergency rating (2901MVA) for the tower line outage (CNSTN_NWEST_NNWEST_A). This project contributes approximately 45.9MW to the thermal violation.

33. **(PPL/BGE)** The Manor-Graceton 230kV line loads from 173.80% to 175.88% (DC power flow) of its emergency rating (531MVA) for the tower line outage (CONAS_PB). This project contributes approximately 11.0MW to the thermal violation.

34. **(PENELEC)** The N..Meshoppen-E.Towanda 230kV line loads from 119.92% to 121.63% (DC power flow) of its emergency rating (554MVA) for the tower line outage (CONAS_PB). This project contributes approximately 9.5MW to the thermal violation.

35. **(PPL/METED)** The Hosensack-N.Boyertown 230kV line loads from 105.26% to 107.10% (DC power flow) of its emergency rating (525MVA) for the tower line outage (CONAS_PB). This project contributes approximately 9.7MW to the thermal violation.

36. **(PPL/BGE)** The Otter Creek-Conastone 230kV line loads from 150.01% to 151.91% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 11.9MW to the thermal violation.

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 Newport – Hoboken R 230kV circuit overload can be alleviated by installing a 4 breaker ring bus at 49th street which taps Hoboken – Bergen. The line from 49th street to Bergen will also need to be reconductored with 1590 ACSS wire. The upgrade will cost approximately **$21.3**. **This upgrade also mitigates Network Impact number 26**.

2. The North Milford – Maywood 230kV overload can be alleviated by constructing a new 230kV line from Athenia directly to Bergen. Although the North Milford – Maywood overload is a new violation, this reinforcement has already been identified by a previous project. The estimated cost for the Athenia-Bergen circuit is **$95 million.**

2a. The Kearny – Turnpike 138kV line overload can be alleviated by constructing a new 230kV circuit, approximately 7.5 miles long, along the path Bergen – Homestead – Hudson. The estimated cost (estimate by PJM) for the circuit is **$15 million. This upgrade also mitigates Network Impact number 3b and 3c**.

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. The Hudson-South Waterfront 230kV line overloads can be alleviated by reconductoring the circuit to increase its normal rating to a minimum of 475MVA and the emergency rating to a minimum of 575MVA. The estimated cost is **$6 million**. **This upgrade also mitigates Network Impact number 24**.

4. 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**. This upgrade, in conjunction with the 4-breaker ring bus at 49th street (upgrade for Network Impact 10) will alleviate the overload. **This upgrade also mitigates Network Impact number 25**.

5. The Bergen-Leonia "T" ckt #2 230kV line overload can be alleviated by adding oil circulation to increase the emergency rating by 15%. The estimated cost is **$2.5M**. The overload will also warrant a cost allocation for a new 230kV line from Athenia – Bergen. The estimated cost for the Athenia-Bergen circuit is **$95 million.**

6. The Bergen-Leonia "T" ckt #1 230kV line overload can be alleviated by adding oil circulation to increase the emergency rating by 15%. The estimated cost is **$2.5M**. The overload will also warrant a cost allocation for a new 230kV line from Athenia – Bergen. The estimated cost of this upgrade is unknown at this time. **The estimated cost is $2.5 million**. **This upgrade also mitigates Network Impact number 10**.

7. Parlin - Williams (K1025) Upgrade: This overload requires reconductoring of Parlin - Williams line from 1590 Kcmil 45/7 ACSR (2.9 mile DCT) to 1590 Kcmil 54/19 ACSS/AW - Bundled (1.7 mile DCT) for 1642/1850 MVA summer normal/emergency ratings. It also requires replacement of disconnect switch (4000 amp) (1), bundled conductor at Williams substation and at Parlin substation. Total estimated cost is **$3,860,000**.

8. Williams - Freneau 230 kV (K1025) Upgrade: This overload requires reconductoring of Freneau to Williams line from 1590 Kcmil 45/7 ACSR (7.7 mile) to 1590 Kcmil 54/19 ACSS/AW (7.7 mile) for 869/1068 MVA summer normal/emergency ratings at an estimated cost of $3,850,000. It requires addition of a disconnect switch (3000 amp) (1) at Freneau substation at an estimated cost of $75,000 and a disconnect switch (3000 amp) (1) at Williams substation at an estimated cost of $75,000. It also requires bundled conductor at Freneau substation at an estimated cost of $20,000 and at Williams substation at an estimated cost of $20,000. The total estimated cost for this upgrade is **$4,040,000.**

9. Lackawanna-Oxbow 230kV line: Lackawanna is a PP&L owned substation and any associated terminal upgrades would have to be confirmed by PP&L. This overload would require the rebuild of approximately 16.33 miles of transmission line. (estimated to cost approximately $19,596,000). This overload also requires the following terminal upgrades at Oxbow substation: replace substation conductor (estimated cost approximately $125,000) and replace a disconnect switch (estimated cost approximately $85,000). The total estimated cost for this upgrade is **$19,806,000. This upgrade also mitigates Network Impact number 11**.

12. The Oxbow-North Meshoppen 230kV line overload can be alleviated by reconductoring approximately 10.16 miles of transmission line (estimated to cost approximately $5.08 million), 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 million**. **This upgrade also mitigates Network Impact number 28**.

13. Raphael Rd - Northeast 230 kV 339 line - replace 230kV breaker at Northeast The estimated cost is **$382,000**.

14. Raphael Rd - Northeast 230 kV 317 line - replace 230kV breaker at Northeast The estimated cost is **$382,000**.

15. The Conastone-North North West line can be upgraded by adding a single circuit 500kV line at an estimated cost of **$109 million** and estimated time of 10 yrs.

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
This upgrade also mitigates Network Impact number 32.

16. The Northwest-Granite 2311 230kV line overload can be alleviated by reconductoring the line with 2,167 ACSR which will increase the rating to 1105MVA. There will also be substation terminal cost upgrades associated with the reinforcement. The total cost estimate of the reinforcement is approximately **$23.6M**, and the time estimate for completion is about **6 years**.

17. Conastone – Peach Bottom 500 kV Line - To mitigate the overload of the Conastone – Peach Bottom 500 kV circuit a second circuit will need to be built.

If RIGHT OF WAY can be acquired following is the Reinforcement and Cost Estimates:

PECO portion of the Conastone – Peach Bottom line:

Substation work at Peach Bottom	$ 2,500,000
Construct 6.25 miles of 500kV line	$10,000,000
	$12,500,000

This estimate do not include the cost of new right of way.
Construction of the new line will take approximately **30 months** after the right of way is acquired.

Note: It should be noted that PJM Queue P04 project also requires widening of about two miles of this right of way for their direct connection line and would use the last remaining terminal position that exists at Peach Bottom substation. If Queue P04 proceeds with their project it may complicate right of way acquisition and double the substation costs at Peach Bottom.

BGE portion of the Conastone – Peach Bottom line:

Build new 500 kV line adjacent to existing circuit 5012 from Conastone to Pennsylvania State Line at an estimated cost of **$48,000,000** and a construction time of approximately **84 months.**

Assumptions:

- Acquire 150 ft. wide R/W adjacent to existing R/W, mostly rural land at $100,000 per acre
- 2 to 3 year CPCN process prior to land acquisition
- Length of line 9.6 miles

Install one 500kV breaker at Conastone **$1,500,000**. Breaker installation can be completed concurrently with the line construction.

If RIGHT OF WAY cannot be acquired following is the Reinforcement and Cost Estimates:

The line from Graceton to Peach Bottom is about 7.5 miles long and has a normal rating of 528MVA. Assuming that we could maintain this rating with a single 230 kV pipe type cable (and we may not be able to do this), the new underground installation would cost about $30M plus another $1M for terminal modifications. I assume that the underground line will not have to cross any rivers or large creeks. If a cable rating of 450 MVA is insufficient, it will cost an additional $30M.

Removal of the existing 230 kV tower line is about $1.5M.

Construction of a double circuit 500kV line from Conastone to Peach Bottom would be about $3.5M per mile. The line is 16.5 miles long. Total cost $58M.

Substation additions and modifications at Peach Bottom would cost about $10M.

Note: Future work is being done by the TOs to come up with reinforcements to further mitigate the overload.

This upgrade also mitigates Network Impact numbers 18.

19. Northwest - Mt Carmel - Conastone upgrade –

This overload requires to install NNW station 2-500/230kV xfmrs 4-500 kV bkrs, 7-230 kV Bkrs and related substation equipment and land at a cost of $70M. It also requires to reconductor Conastone to Northwest #2322 with 1,272kcmil ACSR 1,590kcmil ACSR with an estimated cost of $8.21. This work would take 3-4 years to build substation and 18-24 months for the line work. **This upgrade also mitigates Network Impact numbers 20, 21, and 22**.

23. The Northwest-Granite 2326 230kV line overload can be alleviated by reconductoring the line with 2,167 ACSR which will increase the rating to 1105MVA. There will also be substation

terminal cost upgrades associated with the reinforcement. The total cost estimate of the reinforcement is approximately **$23.6M**, and the time estimate for completion is about **6 years**.

27. The Hoboken R – Bergen 230kV overload can be alleviated by installing a 4 breaker ring bus at 49th street which taps Hoboken – Bergen. The line from 49th street to Bergen will also need to be reconductored with 1590 ACSS wire. The upgrade will cost approximately **$21.3**.

29. The overload on the Nottingham-Graceton-Peach Bottom 230kV circuit can be alleviated by relocating a portion of this line underground to facilitate the construction of additional 500kV lines between Peach Bottom and Conastone, **$61** million and three years to construct. Rebuilding the Peach Bottom to Bottingham portion of the line as a high capacity 230kV line, 1243MVAn/1411MVAe, 13.6 miles @ $1.5 million per mile plus new Susquehanna river crossing, approx **$40** million and four years to complete. **This upgrade also mitigates Network Impact numbers 30 and 31**.

33. 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.

Based on previous estimate by R.W.M. for PJM (B48) study on circuit 22008, and Conastone to Ottercreek 2302 estimate (above)

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 composing of 795 ACSR. This rebuild will require new custom embedded steel poles to accommodate the larger conductor size of the new conductor. The new line will be 1590 Kcmil ACSR conductors (1 per phase) designed and operated at 230 kV. 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.

The rebuild will be 14.4 miles long and will travel the existing right of way.

34. North Meshoppen - East Towanda 230 kV Line - This overload would require the reconductor of 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 for this upgrade is **$17,085,000.**

35. Hosensak – North Boyertown 230kV Line – This overload would require the 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.

36. Conastone – Otter Creek 230 kV Line -

PPL upgrade

The PPL portion of the Conastone to Otter Creek line (from Otter Creek to the point where ownership changes to BG&E) can be upgraded by reconductoring approximately 17.2 miles of 795 kcmil 30/19 ACSR conductor (Ratings 425/531 MVA Summer Normal/Emergency based on conductor temp @125^{O}C) with new 795 kcmil 30/19 ACSS (new ratings 516/632 MVA Summer Normal/Emergency, conductor operating temperature of 160^{O} C)

No terminal equipment upgrade is required at Otter Creek, it is currently built with 2000 amp rating equipment. The estimated cost of this upgrade is **$8.5 million.** Estimated construction time is **36 months.**

This upgrade will result in minimal change to the impedance of the line.
Existing Z = 0.0042 + j 0.0266 pu
New Z = 0.0048 + j 0.02676 pu

BG&E Upgrade

The BG&E portion of the Conastone to Otter Creek line can be upgraded by Reconducting from Gorsuch Mills to the Pennsylvania State Line (change of ownership to PPL). The existing circuit 2302 conductor is 1,590 kcmil 45/7 ACSR from Conastone to Gorsuch Mills and 795 kcm 30/19 ACSR from Gorsuch Mills to the PA State Line.
Assumptions:

- Reconductor with 1,590 kcm ACSR from Gorsuch Mills to PA line to match capability of remainder of line.
- Length of this line section is 1.7 miles.
- Towers can be reinforced instead of replaced.
- Based on previous estimate by R.W.M. for PJM (B48) study on circuit 22008

The estimated cost of this upgrade is **$700,000**. Estimated construction time is **36 months**.