#S18 Talbert 1250 MW

Generator Interconnection

This analysis was completed to assess the reliability impact for a new generator interconnecting to the PJM System as a Capacity Resource.

Network Impacts

The S18 project was studied as a 1250 MW capacity injection into the Talbert Tap - Burches Hill 230 kV circuits. Project S18 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

NETWORK IMPACTS

Generator Deliverability

(Normal System with all facilities in-service and Single, or N-1, contingencies for the Capacity portion only of the interconnection)

1. The Guilford – Grand Point 138 kV line is overloaded from **99% to 103%** of its **emergency rating** (202 MVA) for the outage of East Waynesboro – RingGold 138 kV line (Cont. Id. APS-SB-213). This project contributes approximately **9 MW** to cause the thermal violation.
2. The Talbert – Burches Hill 230 kV line #23082 is overloaded from **82% to 167%** of its **emergency rating** (730 MVA) for the outage of Talbert – Burches Hill 230 kV line #23081 (Cont Id. PP50_R17_S17B). This project contributes approximately **656 MW** to cause the thermal violation.
3. The Talbert – Burches Hill 230 kV line #23081 is overloaded from **82% to 167%** of its **emergency rating** (730 MVA) for the outage of the Tallbert – Burches Hill 230 kV line #23082 (Cont Id. PP47_R17_S17B). This project contributes approximately **656 MW** to cause the thermal violation.
4. The Talbert – Burches Hill 230 kV line #23082 is overloaded from **53% to 110%** of its **normal rating** (608 MVA). This project contributes approximately **352 MW** to cause the thermal violation.
5. The Talbert – Burches Hill 230 kV #23081 is overloaded from **53% to 110%** of its **normal rating** (608 MVA). This project contributes approximately **352 MW** to cause the thermal violation.
6. The Sandy Spring Tap – High Ridge 230 kV line #2334 from **93% to 103%** of its emergency rating (923 MVA) for the outage of Kemptown – N. Northwest 500 kV line (Cont Id. PJM13B). This project contributes approximately **89 MW** to cause the thermal violation.
7. The Sandy Spring Tap – High Ridge 230 kV line #2314 from **93% to 103%** of its emergency rating (923 MVA) for the outage of Kemptown – N. Northwest 500 kV line (Cont Id. PJM13B). This project contributes approximately 89 MW to cause the thermal violation.
8. The High Ridge - Howard (line #2332-A) 230 kV line is loaded from **98% to 101%** of its emergency rating (1131 MVA) for the outage of Kemptown – N.

Northwest 500 kV line (Cont Id. PJM13B). This project contributes approximately **101 MW** to cause the thermal violation.

9. The Possum Point 500/230 kV transformer is overloaded from **87% to 100%** of its emergency rating (969.9 MVA) for the outage of Ox - Possum Point 230 kV line (Cont Id. LN 571). This project contributes approximately **133 MW** to cause the thermal violation.
10. Normal System contribution of **205 MW further** overloads the N. Northwest - Conastone 500 kV line from **98% to 108%** of its **normal rating** (2078 MVA). [note: Previously found to be contingency overloaded for earlier PJM queues].

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)

No problems were 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)

11. Contribution of **68 MW** further overloads the Sollers Point – Riverside 230 kV line #2344 from **102% to 109%** of its emergency rating (1131 MVA) for the outage of Riverside 230/115 kV transformer (Cont Id. BG31).
12. Contribution of **70 MW** further overloads the Brandon Shores – Hawkins Points Terminal 230 kV line #2344 from **104% to 110%** of its emergency rating (1153 MVA) for the outage of Hawkins Point – Sollers Point 230 kV line #2345 (Cont Id. BG26).
13. Contribution of **99 MW** further overloads the Burtonsville – Sandy Spring 230 kV line #2334 from **102% to 113%** of its emergency rating (923 MVA) for the outage of High Ridge – Sandy Springs – Burtonsville 230 kV line (Cont Id. BG_CKT2314).
14. Contribution of **99 MW** further overloads the Burtonsville – Sandy Spring 230 kV line #2314 from **102% to 113%** of its emergency rating (923 MVA) for the outage of High Ridge – Sandy Springs – Burtonsville 230 kV line (Cont Id. BG_CKT2334).
15. Normal System contribution of **136 MW** further overloads the Oak Grove - Bowie Sub 230 kV circuit #23045 from **105% to 128%** of its **normal rating** (608 MVA).
16. Normal System contribution of **136 MW** further overloads the Bowie Sub – Burtonsville 230 kV circuit #23045 from **105% to 128%** of its **normal rating** (608 MVA).
17. Normal System contribution of **138 MW** further overloads the Oak Grove - Bowie Sub 230 kV circuit #23042 from **104% to 126%** of its **normal rating** (608 MVA).
18. Normal System contribution of **138 MW** further overloads the Bowie Sub – Burtonsville 230 kV circuit #23042 from **103% to 126%** of its **normal rating** (608 MVA).

19. Contribution of **14 MW** further overloads the Roxbury 138/115 kV transformer from **113% to 123%** of its emergency rating (923 MVA) for the outage of Kemptown – N. Northwest 500 kV line.
20. Contribution of **14 MW** further overloads the Greene - Roxbury 138 kV line is loaded from **112% to 122%** of its emergency rating (923 MVA) for the outage of Kemptown – N. Northwest 500 kV line.
21. Contribution of **179 MW** further overloads the Oak Grove - Bowie Sub 230 kV circuit #23045 from **115% to 140%** of its emergency rating (730 MVA) for the **tower** outage of Chalk Point to Bowie 230 V line and Oak Grove to Burtonsville 230 kV line (Cont Id. 5PEPCO).
22. Contribution of **179 MW** further overloads the Bowie Sub – Burtonsville 230 kV circuit #23045 from **115% to 140%** of its emergency rating (730 MVA) for the **tower** outage of Chalk Point to Bowie 230kV line and Oak Grove to Burtonsville 230 kV line (Cont Id. 5PEPCO).
23. Contribution of **180 MW** further overloads the Oak Grove - Bowie Sub 230 kV circuit #23042 from **116% to 140%** of its emergency rating (730 MVA) for the **tower** outage of Bowie to Oak Grove 230 kV line and Oak Grove to Chalk Point 230 kV line (Cont Id. 7PEPCO).
24. Contribution of **180 MW** further overloads the Bowie Sub – Burtonsville 230 kV circuit #23042 from **116% to 141%** of its emergency rating (730 MVA) for the **tower** outage of Bowie to Oak Grove 230 kV line and Oak Grove to Chalk Point 230 kV line (Cont Id. 7PEPCO).
25. Contribution of **199 MW** further overloads the Conastone – Peach Bottom ckt#2 500 kV line from **122% to 130%** of its emergency rating (2598 MVA) for the outage of Conastone – Peach Bottom ckt#1 500 kV line (Cont Id. PJM17).
26. Contribution of **199 MW** further overloads the Conastone – Peach Bottom ckt#1 500 kV line from **122% to 130%** of its emergency rating (2598 MVA) for the outage of Conastone – Peach Bottom ckt#2 500 kV line (Cont Id. PJM17_2).
27. Contribution of **157 MW** further overloads the N. Northwest - Conastone 500 kV line from **101% to 107%** of its emergency rating (2901 MVA) for the outage of North Northwest 500/230 kV transformer.
28. Normal System contribution of **140 MW** further overloads the Kemptown – N. Northwest 500 kV line from **168% to 175%** of its **normal rating** (2078 MVA).
29. Contribution of **193 MW** further overloads the Kemptown – N. Northwest 500 kV line from **180% to 186%** of its emergency rating (2901 MVA) for the **tower** outage of Granite – High Ridge ckt #2312 and ckt #2332.

Short Circuit Analysis

30. Queue S18 contributes to the overduty of four Westinghouse 230 kV OCB's on bus No. 3 at Burtonsville Substation previously identified for Queue S17.

31. The 230kV circuit breakers at Burches Hill substation are over-duty as a result of Queue S18. All 12 circuit breakers have an interrupting capability of 50 kA, and need to be replaced with 63 kA rated breakers.

Stability Analysis
Will be performed for the Impact Study.

NETWORK UPGRADE REQUIREMENTS

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

1. Guilford – Grand Point Upgrade - The required reinforcement is to reconductor the circuit (7.22 miles) with 954 ACSR and upgrade terminal equipment at Guilford and Grand Point. The estimated cost to perform this work is **$1,900,000**

2. Talbert (S17/S18) – Burches Hill 230 kV Upgrade - Bundle approximately 4.43 miles of circuit 23082. The cost is approximately **$2,000,000**. **This also satisfies Network Impact number 4.**

3. Talbert (S17/S18) – Burches Hill 230 kV Upgrade - Bundle approximately 4.43 miles of circuit 23081. The cost is approximately **$2,000,000**. **This also satisfies Network Impact number 5.**

4. See Network Upgrade number 2.

5. See Network Upgrade number 3.

6. High Ridge to Sandy Spring 230 kV double circuit 2314/2334 - Existing circuits use 1590 kcmil ACSR conductor designed for @ 160 degC operation (923 MVA rating). An overload of 108% will require an upgrade to a rating of 996 MVA or greater.
   Solution: Rebuild the existing line using double bundle 1033 ACSR @ 125 degC (1227 MVA) at a cost of **$10,000,000** and **5 years** to construct. Assumptions include; a full structure replacement required, existing structure removal, line length of 3.61 miles and 2+ year CPCN process required. **This also satisfies the upgrade requirement for Network Impact number 7.**

7. See Network Upgrade number 6.

8. High Ridge to Howard 230 kV line, circuit 2332-A - Existing circuit 2332-A uses 1590 kcmil ACSR conductor designed for @ 160 deg. C operation. An overload of 113% of the Summer Emergency rating of 1131 MVA will require an upgrade to at least 1278 MVA.

Solution: Rebuild line to accommodate double bundle 1272 kcmil ACSR at a cost of **$24,000,000** and **5 years** construction time. Assumptions include; length of line is 8.9 miles, 2+ year CPCN process required and existing tower removal required.

9. Possum Point 500-230 kV transformer – The calculated emergency loading was at a very marginal 100 % of rating. If possible, the transformer rating may be increased by adding more cooling (fans and pumps) at a relatively small cost and short construction time. Transformer replacement may be necessary if it is not possible to uprate with the addition of more cooling. This will be determined for the Impact Study.

10. See Network Upgrade number 27.

Contribution to Previously Identified System Reinforcements *(This project contributes to the Network Impact causing the need for these Network Upgrades. This project will be allocated a cost to be determined during the Impact Study)*

11. Sollers Pt - Riverside 230 kV and Brandon Shores - Hawkings Pt 230 kV line #2344 - Install 1 additional Harbor Crossing cable Hawkins Point to Sollers Point, upgrade the new OH sections to 180C at a cost of **$40,250,000** and a time of **8-10 years** to design and construct. **This also satisfies the reinforcement requirement for Network Impact number 12.**

12. See Network Upgrade number 11.

13. Sandy Spring to Burtonsville 230 kV double circuit 2314/2334 - The existing circuits use 1590 kcmil ACSR conductor designed for operation at 60 degC for a rating of 923 MVA. An overload of 118% will require an upgrade to a rating of 1089 MVA or greater. Solution: Rebuild the existing line using double bundle 1033 ACSR at 125 degC (1227 MVA) at a cost of **$540,000** and construction time of **5 years**. **This also satisfies the reinforcement requirement for Network Impact number 14.**

    Assumptions include; a full structure replacement is required, existing structure removal, line length of 0.2 miles and 2+ year CPCN process required.

14. See Network upgrade number 13.

15. The estimated cost to upgrade the Oak Grove - Bowie 230 kV circuit (23045) is **$5,000,000**. This cost represents the addition of a second 230kV conductor to circuit 23045 from Oak Grove to Bowie (approximately 12 miles).

    This upgrade also mitigates Multiple Facility Contingency Network Impact number 21.

16. The estimated cost to upgrade the Bowie - Burtonsville 230 kV circuit (23045) is **$3,400,000**. This cost represents the addition of a second 230kV conductor to circuit 23045 from Bowie to Burtonsville (approximately 8 miles).

This upgrade also mitigates Multiple Facility Contingency Network Impact number 22.

17. The estimated cost to upgrade the Oak Grove - Bowie 230 kV circuit (23042) is **$5,000,000**. This cost represents the addition of a second 230kV conductor to circuit 23042 from Oak Grove to Bowie (approximately 12 miles).
    This upgrade also mitigates Multiple Facility Contingency Network Impact number 23.

18. The estimated cost to upgrade the Bowie - Burtonsville 230 kV circuit (23042) is **$3,400,000**. This cost represents the addition of a second 230kV conductor to circuit 23042 from Bowie to Burtonsville (approximately 8 miles).
    This upgrade also mitigates Multiple Facility Contingency Network Impact number 24.

    In order to bundle the above circuits, the existing lattice tower line structures are required to be replaced with new steel poles, foundations and new conductors. Engineering design work will need to be performed as well as the regulatory work related to obtain the necessary CPCN (Certificate of Public Convenience and Need). The cost estimates include material (steel poles, conductor, shield wire, insulators/hardware/grounding), construction, engineering and CPCN filings.

    The **estimated construction time is approximately four years**. This schedule assumes that all the necessary engineering work and issuance of the CPCN can be completed within the first year. The scheduling of outages will be very critical.

19. Roxbury 138/115 kV transformer Upgrade - This overload would require the upgrade of the transmission transformer and associated equipment (circuit breaker, substation conductor, CT circuits), which is estimated to cost approximately $2,250,000 and requires a lead time of **2 years**. **This upgrade also satisfies Network Impact number 20.**

20. See Network Upgrade number 19..

21. See Network Upgrade number 15.

22. See Network Upgrade number 16.

23. See Network Upgrade number 17.

24. See Network Upgrade number 18.

25. and 26.
    Conastone – Peach Bottom 500 kV Upgrade: To mitigate the overload of the Conastone – Peach Bottom 500 kV circuit(s), an additional circuit will need to be built.

    IF RIGHT OF WAY CAN BE ACQUIRED:

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
Total	**$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: PJM Queue P04 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 a new 500 kV line adjacent to existing circuit 5012 from Conastone to the Pennsylvania State Line at an estimated cost of **$48,000,000** and a construction time of approximately **84 months.**

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

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

If RIGHT OF WAY CAN'T BE AQUIRED:

The line from Graceton to Peach Bottom is about 7.5 miles long and has a normal rating of 528MVA. Assuming that this rating could be maintained with a single 230kV pipe type cable (and that may not be possible), the new underground installation would cost about **$31,000,000** for the circuit and terminal modifications. It is assumed that the underground line will not need to cross any rivers or large creeks. **If a cable rating of 450 MVA is insufficient, it will cost an additional $30,000,000 for a second cable.**

Removal of the existing 230 kV tower line is about **$1,500,000**.

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 **$58,000,000.**

Substation additions and modifications at Peach Bottom would cost about **$10,000,000.**

Note: Future work is being done to come up with reinforcements to further mitigate the Conastone – Peach Bottom 500 kV overload. The additional reinforcements may include the following:

Conastone – Otter Creek 230 kV Upgrade:

PPL portion of Conastone – Otter Creek
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 **$8,500,000.** 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 portion of Conastone – Otter Creek.
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. The estimated cost of this upgrade is **$700,000**. Estimated construction time is **36 months**.
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.

High Ridge – Howard 230 kV Upgrade - The existing circuit 2332-A has 1590 Kcmil conductor which will need to be replaced. The estimated cost to rebuild the structures to accommodate new 2167 Kcmil ACSR conductor is **$16,000,000** and it will take approximately **60 months**.
Assumptions:

- Length of line 8.0 miles
- 2+ year CPCN process at a cost of $500,000
- Existing tower removal at a cost of $1M included.

Graceton - Bagley - Raphael Upgrade

This upgrade requires the addition of 6-230kV breakers at Graceton with an estimated cost of $**10,000,000** and 6-230kV breakers at Raphael Road for an additional **$10,000,000**. It also requires rebuilding Graceton to Raphael Rd to double circuit 2-conductor bundled with an estimated cost of **$30,000,000**. This work would take an estimate of 2-3 years for the substation work concurrently with **5-6 years** for the line work.

27. Conastone to North Northwest 500 kV line – Construct one single circuit line at an estimated cost of **$109,000,000** 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

    Substation Terminations:
    Conastone - Install a 1 breaker bay **$3,200,000**.
    NNW - Install a 2 breaker bay $**6,400,000**.

28. and 29.
    Kemptown to North Northwest 500 kV line - 2 single circuit lines at an estimated cost of **$279,000,000** and estimated time of **10 yrs**.

    Assumptions:
    New 350 ft. wide R/W parallels existing Northwest to Mt Airy Tap R/W
    Total R/W length = 28.3 miles
    3 - bundle 1,590 kcm conductor
    Kemptown located 1/4 mile west of Mt Airy Tap
    North Northwest located 4 miles north of Northwest

    Substation Terminations:
    NNW - Install a 3 breaker bay **$7,700,000**
    Kemptown - Install a 3 breaker bay **$7,700,000**

Short Circuit Reinforcements

30. The four over-duty 230 kV Westinghouse OCB's at Burtonsville, rated at 50 kA interrupting capability will require replacement with 63kA rated breakers. The cost of each breaker replacement is $1,500,000. The total estimated cost is **$6,000,000** and will take approximately **24 months.**

31. The twelve 50 kA over duty 230kV circuit breakers at Burches Hill substation need to be replaced with 63 kA rated breakers. The cost of each new breaker is $1,500,000 for a total of **$18,000,000** and will take approximately **48 months**.