#S100 Clinch River 138kV

Generation Interconnection

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

Network Impacts

The Queue Project #S100 was studied as an 80MW incease in Capactiy at Clinch River 138kV substation in the AEP service territory. Project #S100 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

The impact of the proposed generation facility on the AEP System was assessed for adherence with applicable reliability criteria. AEP planning criteria requires that the Clinch River area meet Single Contingency performance criteria, which is consistent with the AEP FERC Form 715. Therefore, this criterion was used to assess the impact of this proposed facility on the AEP transmission System. The St. Paul, Virginia S100 project was studied as 80 MW increase in capacity consistent with the interconnection application. The results are summarized below.

Generator Deliverability

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

1. The Spring Creek –Wolf Hills 2 138 kV line loading will increase from 95% of its normal rating to 101% of its normal rating (167 MVA) for the base case condition. This project contributes approximately 10 MW to cause the thermal violation.

Multiple Facility Contingency

(Double Circuit Tower Line, Stuck breaker and Bus Fault contingencies for the full energy output)

None

Short Circuit Analysis

Sixteen Circuit breakers, all at the Clinch River Station will exceed their fault interrupting capabilities as a result of Dom Va Power new generation connection, as identified for the Q43 request. (See table 1).

Table 1
Clinch River 138 kV Station Breaker Duties at 1.009 p.u.

138 kV Circuit Breaker	Type	Name Plate Ratings		Base % Asym Rating		With Proposed St Paul Generating Plant % Asym Rating	
		sym kA	asym kA	3 phase kA	l to g kA	3 phase kA	l to g kA
A	FGK-138-10000-3	59.9	35	97%	99%	121%	130%
A1	FGK-138-10000-3	59.9	35	97%	99%	121%	130%
A2	FGK-138-10000-3	59.9	35	95%	97%	119%	127%
B	FGK-138-10000-3	59.9	35	97%	99%	122%	130%
B1	FGK-138-10000-3	59.9	35	97%	99%	122%	130%
B2	FGK-138-10000-3	59.9	35	94%	97%	118%	127%
C	FGK-138-10000-3	59.9	35	96%	98%	120%	129%
C1	FGK-138-10000-3	59.9	35	91%	92%	114%	121%
C2	FGK-138-10000-3	59.9	35	96%	98%	120%	129%
D	FGK-138-10000-3	59.9	35	97%	99%	121%	130%
D1	FGK-138-10000-3	59.9	35	91%	92%	114%	121%
D2	FGK-138-10000-3	59.9	35	97%	99%	121%	130%
E	145-PA-40-20B	40.0	48.0	77%	84%	97%	111%
E1	145-PA-40-20B	40.0	48.0	75%	77%	95%	101%
E2	FX-145-11	41.3	49.5	79%	87%	99%	113%
F2	145-PA-40-30B	40.0	48.0	82%	88%	103%	116%

Stability Analysis (AEP Criteria) (From the Q43 Impact Study report)

Stability analysis was performed by PJM using the 2011 summer light load condition. The maximum generation output is considered (attachment #2). The range of contingencies (attachment #1) evaluated was limited to that necessary to assess expected compliance with AEP criteria.

The stability was maintained for all cases studied except as listed below:

- Q43-5B for all cases (Unstable)
- Q43-1B for case t1 (Unstable), for cases q1, r1, u1 and p7 (Unstable after safety margin test)
- Q43-2B for case t1 (Unstable), for cases p1, p2(Unstable after safety margin test)
- Q43-3B for cases p1, t1 (Unstable), for cases q1, u1, p2 and p7 (Unstable after safety margin test)
- Q43-4B for case t1 (Unstable)
- Q43-6B for case t1 (Unstable), for cases p1 and p2 (Unstable after safety margin test)
- Q43-7B for case t1 (Unstable), for cases p1, p2 and p5 (Unstable after safety margin test)
- Q43-8B for case t1 (Unstable)
- Q43-9B for case t1 (Unstable), for case p1 (Unstable after safety margin test)

For three phase faults, all pairs of line outages involving the Saltville #1 line are unstable given standard fault clearing times and high speed reclosing (HSR). Other line outage pairs have less than a one cycle margin to instability. Outage of Saltville #1 line by itself also has less than a one cycle margin to instability.

For phase to ground faults, the fault and trip of Saltville #1 with CB E2 failure and associated tripping of the Garden Creek and St. Paul lines has very little margin to instability. Based upon these results the following changes are recommended:

Clinch River Station

21. High speed reclosing (HSR) will be deactivated from the Clinch River end of all lines permanently. The Garden Creek and St. Paul lines will be removed from the bus and placed in a string that will require installation of two additional 138 kV circuit breakers at the Clinch River Station (as shown in Figure 1).

Note: While the stability analysis has been performed at expected extreme system conditions, there is a potential that evaluation at a different level of generator MW and/or MVAR output at different system load levels and operating conditions would disclose unforeseen stability problems. The regional reliability analysis routinely performed to test all system changes will include one such evaluation. Any problems uncovered in that or other operating or planning studies will need to be resolved.

Moreover, when the proposed generating station is designed and plant specific dynamics data for the plant and its controls are available, and if it is different than the data provided for this study, a transient stability analysis at a variety of expected operating conditions using the more accurate data shall be performed to verify impact on the dynamic performance of the system. As more accurate or unit specific dynamics data for the proposed facility, as well as Plant layout become available, it must be forwarded to PJM.

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)

1. Contribution of 10 MW further overloads to the Wolf Hills 2 – North Bristol 138 kV line from 122% to 128% of its normal rating (153 MVA) for the base case condition. The first project to cause the overload is Q43. Other projects which contribute to this overload are S56 and S100.

2. Contribution of 22 MW further overloads to the Clinch River – Lebanon 138 kV line from 107% to 116% of its normal rating (266 MVA) for the base case condition. The first project to cause the overload is S56. Other projects which contribute to this overload are S100.

3. Contribution of 22 MW further overloads to the Lebanon – Elk Garden 138 kV line from 102% to 110% of its normal rating (266 MVA) for the base case condition. The first project to cause the overload is S56. Other projects which contribute to this overload are S100.

New System Reinforcements

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

1. Spring Creek to Wolf Hills 138 kV Line:

On the existing right-of-way construct a double circuit 138 kV steel lattice tower line– a distance of about 3.7 miles to alleviate the overload on the existing single circuit.

Estimated Cost [1,] $ 5,130,000

[1] The estimates are preliminary in nature, as they were determined without detailed engineering and design studies.

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)

1. The overload on the North Bristol-Wolf Hills 138kV circuit can be alleviated by constructing a double circuit 138kV steel lattice tower line on the existing right-of-way, approximately 5.4 miles, to provide second North Bristol-Wolf Hills circuit (Upgrade #n0871). The estimated cost is **$7,290,000.**

2. The overload on the Clinch River-Lebanon 138kV circuit can be alleviated by replacing replacing the bus and risers at Lebanon substation. The estimated cost **$200,000**.

3. The overload on the Lebanon-Elk Garden 138kV circuit can be alleviated by replacing replacing the bus and risers at Elk Garden substation. The estimated cost **$200,000**.

The S100 project is also responsible for the remote end relay replacements, circuit breaker replacements and additions, listed below, as identified in the Q43 report.

1. Beaver Creek Station
Replace the remote end relays to be compatible with the relays at the Clinch River Station (Upgrade #n0868).

Estimated Cost* **$ 740,000**

2. Nagel Station
Replace the remote end relays to be compatible with the relays at the Clinch River Station (Upgrade #n0869).

Estimated Cost* **$ 485,000**

3. Saltville Station
Replace the remote end relays to be compatible with the relays at the Clinch River Station (Upgrade #n0868).

Estimated Cost* **$ 625,000**

5. Clinch River Station

Replace the overdutied “A” circuit breaker and associated disconnect switches, risers, and other associated devices. (Upgrade #n0851)

Estimated Cost* **$ 1,113,300**

6. Clinch River Station

Replace the overdutied “A1” circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0853)

Estimated Cost* **$ 1,113,300**

7. Clinch River Station

Replace the overdutied "A2" circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0854)

Estimated Cost* **$ 1,113,300**

8. Clinch River Station

Replace the overdutied "B" circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0855)

Estimated Cost* **$ 1,111,300**

9. Clinch River Station

Replace the overdutied "B1" circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0856)

Estimated Cost* **$ 1,113,300**

10. Clinch River Station

Replace the overdutied "B2" circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0857)

Estimated Cost* **$ 1,113,300**

11. Clinch River Station

Replace the overdutied “C” circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0858)

Estimated Cost* **$ 1,113,300**

12. Clinch River Station

Replace the overdutied “C1” circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0859)

Estimated Cost* **$ 1,113,300**

13. Clinch River Station

Replace the overdutied “C2” circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0860)

Estimated Cost* **$ 1,113,300**

14. Clinch River Station

Replace the overdutied “D” circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0861)

Estimated Cost* **$ 1,113,300**

15. Clinch River Station

Replace the overdutied “D1” circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0862)

Estimated Cost* **$ 1,113,300**

16. Clinch River Station

Replace the overdutied “D2” circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0863)

Estimated Cost* **$ 1,113,300**

17. Clinch River Station

Replace the overdutied “E” circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0864)

Estimated Cost* **$ 1,113,300**

18. Clinch River Station

Replace the overdutied "E1" circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0865)

Estimated Cost* **$ 1,113,300**

19. Clinch River Station

Replace the overdutied "E2" circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0866)

Estimated Cost* **$ 1,113,300**

20. Clinch River Station

Replace the overdutied "F2" circuit breaker and associated disconnect switches, risers, and other associated devices (Upgrade #n0867)

Estimated Cost* **$ 1,113,300**

21. Clinch River Station

Add two 138 kV circuit breakers, disconnect switches, risers, relays and other associated devices one for the Garden Creek line and one for the St. Paul line to alleviate stability concerns (Upgrade #n0850).

Estimated Cost* **$ 2,226,600**

* The estimates are preliminary in nature, as they were determined without detailed engineering and design studies. Final estimates will require on-site review and coordination with the Interconnection Customer to determine final construction requirements. It will take approximately 22 months after obtaining the authorization to construct the facilities as outlined above.