#R11 South River 230kV

Generation Interconnection

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

Network Impacts

Option #1

The Queue R11 Project was studied as a 611 MW injection at the South River 230 kV substation. Project R11 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

Generator Deliverability

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

1. The South River – Red Oak A 230 kV line is overloaded from 33% to 110% of its emergency rating (793 MVA) for the outage of Atlantic - South River 230 kV line (Cont. JC17). The R11 project contributes approximately 610 MW to cause the thermal violation. (Note: The facility is also overloaded due to tower contingency).

2. The Red Oak A - Raritan River 230 kV line is overloaded from 83% to 114% of its normal rating (650 MVA). The R11 project contributes approximately 195 MW to cause the thermal violation.

3. The Red Oak B - Raritan River 230 kV line is overloaded from 82% to 110% of its normal rating (650 MVA). The R11 project contributes approximately 184 MW to cause the 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)

4. The Q11 – Parlin 230 kV line is overloaded from 90% to 123% of its emergency rating (805 MVA) for the **tower** outage of Raritan River – Red Oak A 230 kV line and Raritan River – Red Oak B 230 kV line (Cont. 31JCA_Q08OP1A). The R11 project contributes approximately 266 MW to cause the thermal violation.

5. The Parlin – Williams 230 kV line is overloaded from 94% to 122% of its emergency rating (805 MVA) for the **tower** outage of Raritan River – Red Oak A 230 kV line and Raritan River – Red Oak B 230 kV line (Cont. 31JCA_Q08OP1A). The R11 project contributes approximately 226 MW to cause the thermal violation.

6. The Williams - Freneau 230 kV line is overloaded from 93% to 121% of its emergency rating (805 MVA) for the **tower** outage of Raritan River – Red Oak A 230 kV line and

Raritan River – Red Oak B 230 kV line (Cont. 31JCA_Q08OP1A). The R11 project contributes approximately 226 MW to cause the thermal violation.

7. The Red Oak B - Q11 230 kV line is overloaded from 73% to 106% of its emergency rating (805 MVA) for the **tower** outage of Raritan River – Red Oak A 230 kV line and Raritan River – Red Oak B 230 kV line (Cont. 31JCA_Q08OP1A). The R11 project contributes approximately 266 MW to cause the thermal violation.

8. The South River – Atlantic 230 kV line is overloaded from 87% to 129% of its emergency rating (805 MVA) for the **tower** outage of Raritan River – Red Oak A 230 kV line and Raritan River – Red Oak B 230 kV line (Cont. 31JCA_Q08OP1A). The R11 project contributes approximately 342 MW to cause the thermal violation.

Short Circuit

The following breakers were found to be newly over-duty as a result of R11 option 1.

Red Oak 2881 230kV - T1034
Red Oak 2882 230kV - G1047
Raritan River 230kV - BK15
Raritan River 230kV - I1023E
Raritan River 230kV - I1023F

In addition, the analysis showed a significant fault contribution to 5 breakers which were already over-duty. This contribution is great enough to warrant a cost allocation. The breakers are listed below:

Raritan River 230kV - W1037E
Raritan River 230kV - G1047E
Raritan River 230kV - G1047F
Raritan River 230kV - T1034E
Raritan River 230kV - T1034F

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)

9. The Red Oak A - Raritan River 230 kV line is overloaded at 175% of its emergency rating (805 MVA) for the outage of Raritan River – Red Oak B 230 kV line (Cont. JC31A_Q08OP1A). The R11 project contributes approximately 366 MW to this overload.

10. The Red Oak B - Raritan River 230 kV line is overloaded at 174% of its emergency rating (805 MVA) for the outage of Raritan River – Red Oak A 230 kV line (Cont.

JC30A_Q08OP1A). The R11 project contributes approximately 365 MW to this overload.

11. The Conastone - Mt Carmel (2322 line) 230 kV line is overloaded at 140% of its emergency rating (803 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R11 project contributes approximately 33 MW to this overload.

12. The Mt Carmel - NWest (2322 line) 230 kV line is overloaded at 137% of its emergency rating (803 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R11 project contributes approximately 33 MW to this overload.

13. The Conastone - Mt Carmel (2310 line) 230 kV line is overloaded at 122% of its emergency rating (923 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R11 project contributes approximately 33 MW to this overload.

14. The Mt Carmel - NWest (2310 line) 230 kV line is overloaded at 124% of its emergency rating (923 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R11 project contributes approximately 34 MW to this overload.

15. The Graceton – Bagley 230 kV line is overloaded at 154% of its emergency rating (659 MVA) for the **tower** outage of Brighton - Doubs 500 kV line and Brighton - Conastone 500 kV line (Cont. AP5). The R11 project contributes approximately 41 MW to this overload.

16. The Rapheal – Bagley 230 kV line is overloaded at 142% of its emergency rating (659 MVA) for the **tower** outage of Brighton - Doubs 500 kV line and Brighton - Conastone 500 kV line (Cont. AP5). The R11 project contributes approximately 41 MW to this overload.

17. The Whippany – Roseland 230 kV line is overloaded at 122% of its emergency rating (1646 MVA) for the outage of Kittatiny – Newton 230 kV line (Cont Id. JC4). The R11 project contributes approximately 47 MW to this overload.

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New System Reinforcements

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

1. South River – Red Oak (T1034) Upgrade: This overload requires reconductoring of Red Oak to South River line from 1590 Kcmil 45/7 ACSR (1.25 mile) to 1590 Kcmil 54/19

ACSS/AW (1.25 mile) for 869/1068 MVA summer normal/emergency ratings, addition of bundled conductor at Red Oak substation and at South River substation at an estimated cost of **$830,000**.

2. Raritan River – Red OakA 230 kV (T1034) and Raritan River – Red OakA 230 kV (G1047) Upgrade: This overload requires the reconductoring of Double Circuit Tower line from 1590 Kcmil 45/7 ACSR (2.58 mile) to 1590 Kcmil 54/19 ACSS/AW (2.58 mile) for 869/1068 MVA summer normal/emergency ratings, addition of bundled conductor at Raritan River substation and at Red Oak substation at an estimated cost of **$8,251,000**. also requires adding bundled drop loop conductors at Raritan River and Red Oak substations on the G1047 line at an estimated cost of **$80,000. (Note: This upgrade will suffice the overloads 3, 9, 10 too)**.

4. Q11 – Parlin 230 kV (G1047) Upgrade: This overload requires reconductoring of Q11 to Parlin line from 1590 Kcmil 45/7 ACSR (1.9 mile) to 1590 Kcmil 54/19 ACSS/AW (1.71 mile) for 869/1068 MVA summer normal/emergency ratings and it requires addition of bundled drop loop conductors at Parlin substation at an estimated cost of **$1,066,000**.

5. Parlin - Williams 230 kV (K1025) Upgrade: This overload requires the reconductoring of Williams to Parlin line from 1590 Kcmil 45/7 ACSR (2.9 mile) to 1590 Kcmil 54/19 ACSS/AW (2.9 mile) for 869/1068 MVA summer normal/emergency ratings, addition of a disconnect switch (3000 amp) (1) at Williams substation and bundled drop loop conductors at Parlin substation at an estimated cost of **$1,980,000**.

6. 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, addition of a disconnect switch (3000 amp) (1) at Freneau substation, addition of a disconnect switch (3000 amp) (1) at Williams substation and the addition of bundled drop loop conductors at Freneau substation and at Williams substation at an estimated cost of **$5,100,000**.

7. Red Oak B – Q11 230 kV (G1047) Upgrade: This overload requires the reconductoring of Red Oak to Q11 line from 1590 Kcmil 45/7 ACSR (1.9 mile) to 1590 Kcmil 54/19 ACSS/AW (0.2 mile) for 869/1068 MVA summer normal/emergency ratings and addition of bundled drop loop conductors at Red Oak and Q11 substations at an estimated cost of **$200,000**.

8. South River - Atlantic 230 kV (P1030) Upgrade: This overload requires the reconductoring of Atlantic to South River line from 1590 Kcmil 45/7 ACSR (18.7 mile) to 1590 Kcmil 54/19 ACSS/AW (18.7 mile) for 869/1068 MVA summer normal/emergency ratings, the addition of a disconnect switch (3000 amp) (1), a line trap (3000 amp) (1) and bundled drop loop conductors at Atlantic substation and bundled drop loop conductors and new Line Trap (3000 amp) (1) at South River substation at an estimated cost of **$11,734,000**.

Short Circuit Reinforcements
Replacement of each of the following breakers is estimated to cost **$350,000** each.

Red Oak 2881 230kV - T1034
Red Oak 2882 230kV - G1047
Raritan River 230kV - BK15
Raritan River 230kV - I1023E
Raritan River 230kV - I1023F

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)

11. Northwest - Mt Carmel - Conastone 230 kV Upgrade – This overload requires installation of a new North Northwest substation consisting of 2-500/230kV xfmrs 4-500 kV bkrs, 7-230 kV Bkrs and related substation equipment and land at a cost of **$70,000,000**. It also requires reconductoring Conastone to Northwest #2322 230kV circuit with 1,272kcmil ACSR 1,590kcmil ACSR at an estimated cost of **$8,210,000**. This will take 3-4 years to build the substation and 18-24 months for the line work**. (Note: This upgrade will suffice the overloads 12, 13 and 14 too)**.

15. Graceton - Bagley - Raphael Upgrade – This overload requires Graceton station to add 6-230kV breakers with an estimated cost of **$10,000,000** and Raphael Road station to add 6-230kV breakers **$10,000,000**. It requires rebuilding the Graceton to Raphael Rd circuit to double circuit 2-conductor bundled at an estimated cost of **$30**,**000,000**. This work would take an estimate of 2-3 years for the substation work and 5-6 years for the line work. **(Note: This upgrade will suffice the overload 16 too)**.

16. Whippany – Roseland 230 kV (A941) Upgrade: This overload requires rebuilding existing Whippany to Roseland line from 1033.5 Kcmil 54/7 ACSR (2) (2.7 mile) to 1590 Kcmil 54/19 ACSS/AW (2) (2.7 mile) for 1303/1601 MVA (JC) summer normal/emergency ratings and addition of a line trap (4000 amp) (1) and bundled drop loop conductors at Whippany substation at an estimated cost of **$5,580,400**.

Short Circuit Reinforcements
Replacement of each of the following breakers is estimated to cost **$350,000** each.

Raritan River 230kV - W1037E
Raritan River 230kV - G1047E
Raritan River 230kV - G1047F
Raritan River 230kV - T1034E
Raritan River 230kV - T1034F

Option #2

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

1. The Red Oak A - Raritan River 230 kV line is overloaded from 83% to 113% of its normal rating (650 MVA). The R11 project contributes approximately 195 MW to cause the thermal violation.

2. The Red Oak B - Raritan River 230 kV line is overloaded from 82% to 111% of its normal rating (650 MVA). The R11 project contributes approximately 188 MW to cause the 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)

3. The R11 ring – Parlin 230 kV line is overloaded from 90% to 123% of its emergency rating (805 MVA) for the **tower** outage of Raritan River – Red Oak A 230 kV line and Raritan River – Red Oak B 230 kV line (Cont. 31JCA_Q08OP1A). The R11 project contributes approximately 272 MW to cause the thermal violation.

4. The Parlin – Williams 230 kV line is overloaded from 94% to 121% of its emergency rating (805 MVA) for the **tower** outage of Raritan River – Red Oak A 230 kV line and Raritan River – Red Oak B 230 kV line (Cont. 31JCA_Q08OP1A). The R11 project contributes approximately 231 MW to cause the thermal violation.

5. The Williams - Freneau 230 kV line is overloaded from 92% to 121% of its emergency rating (805 MVA) for the **tower** outage of Raritan River – Red Oak A 230 kV line and Raritan River – Red Oak B 230 kV line (Cont. 31JCA_Q08OP1A). The R11 project contributes approximately 231 MW to cause the thermal violation.

6. The R11 ring – Atlantic 230 kV line is overloaded from 88% to 130% of its emergency rating (805 MVA) for the **tower** outage of Raritan River – Red Oak A 230 kV line and Raritan River – Red Oak B 230 kV line (Cont. 31JCA_Q08OP1A). The R11 project contributes approximately 335 MW to this overload.

Short Circuit

The following breakers were found to be newly over-duty as a result of R11 option 1.

Red Oak 2881 230kV - T1034
Red Oak 2882 230kV - G1047
Raritan River 230kV - BK15

Raritan River 230kV - I1023E
Raritan River 230kV - I1023F
Raritan River 230kV - W1037F

In addition, the analysis showed a significant fault contribution to 5 breakers which were already over-duty. This contribution is great enough to warrant a cost allocation. The breakers are listed below:

Raritan River 230kV - W1037E
Raritan River 230kV - G1047E
Raritan River 230kV - G1047F
Raritan River 230kV - T1034E
Raritan River 230kV - T1034F

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)

7. The Red Oak A - Raritan River 230 kV line is overloaded at 178% of its emergency rating (805 MVA) for the outage of Raritan River – Red Oak B 230 kV line (Cont. JC31A_Q08OP1A). The R11 project contributes approximately 369 MW to this overload.

8. The Red Oak B - Raritan River 230 kV line is overloaded at 178% of its emergency rating (805 MVA) for the outage of Raritan River – Red Oak A 230 kV line (Cont. JC30A_Q08OP1A). The R11 project contributes approximately 369 MW to this overload.

9. The Graceton – Bagley 230 kV line is overloaded at 154% of its emergency rating (659 MVA) for the **tower** outage of Brighton - Doubs 500 kV line and Brighton - Conastone 500 kV line (Cont. AP5). The R11 project contributes approximately 41 MW to this overload.

10. The Raphael – Bagley 230 kV line is overloaded at 142% of its emergency rating (659 MVA) for the **tower** outage of Brighton - Doubs 500 kV line and Brighton - Conastone 500 kV line (Cont. AP5). The R11 project contributes approximately 41 MW to this overload.

11. The Conastone - Mt Carmel (2322 line) 230 kV line is overloaded at 141% of its emergency rating (803 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R11 project contributes approximately 33 MW to this overload.

12. The Conastone - Mt Carmel (2310 line) 230 kV line is overloaded at 125% of its emergency rating (923 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R11 project contributes approximately 34 MW to this overload.

13. The Mt Carmel - NWest (2322 line) 230 kV line is overloaded at 137% of its emergency rating (803 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R11 project contributes approximately 33 MW to this overload.

14. The Mt Carmel - NWest (2310 line) 230 kV line is overloaded at 122% of its emergency rating (923 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R11 project contributes approximately 33 MW to this overload.

15. The Whippany – Roseland 230 kV line is overloaded at 123% of its emergency rating (1646 MVA) for the outage of Kittatiny – Newton 230 kV line (Cont Id. JC4). The R11 project contributes approximately 50 MW to this overload

New System Reinforcements

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

1. Raritan River – Red OakA 230 kV (T1034) and Raritan River – Red OakA 230 kV (G1047) Upgrade: This overload requires the reconductoring of Double Circuit Tower line from 1590 Kcmil 45/7 ACSR (2.58 mile) to 1590 Kcmil 54/19 ACSS/AW (2.58 mile) for 869/1068 MVA summer normal/emergency ratings, addition of bundled conductor at Raritan River substation and at Red Oak substation at an estimated cost of **$8,251,000**. also requires adding bundled drop loop conductors at Raritan River and Red Oak substations on the G1047 line at an estimated cost of **$80,000. (Note: This upgrade will suffice the overloads 2,7,and 8 too)**.

3. Parlin - South River Ring (G1047) Upgrade: This overload requires reconductoring of Parlin - South River ring from 1590 Kcmil 45/7 ACSR (1.3 mile) to 1590 Kcmil 54/19 ACSS/AW (1.3 mile) for 869/1068 MVA summer normal/emergency ratings and addition of bundled drop loop conductors at Parlin substation at an estimated cost of **$830,000**.

4. Parlin - Williams 230 kV (K1025) Upgrade: This overload requires the reconductoring of Williams to Parlin line from 1590 Kcmil 45/7 ACSR (2.9 mile) to 1590 Kcmil 54/19 ACSS/AW (2.9 mile) for 869/1068 MVA summer normal/emergency ratings, addition of a disconnect switch (3000 amp) (1) at Williams substation and bundled drop loop conductors at Parlin substation at an estimated cost of **$1,980,000**.

5. 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, addition of a disconnect switch (3000 amp) (1) at Freneau substation, addition of a disconnect switch (3000 amp) (1) at Williams substation and the addition of bundled drop loop conductors at Freneau substation and at Williams substation at an estimated cost of **$5,100,000**.

6. South River - Atlantic 230 kV (P1030) Upgrade: This overload requires the reconductoring of Atlantic to South River line from 1590 Kcmil 45/7 ACSR (18.7 mile) to 1590 Kcmil 54/19 ACSS/AW (18.7 mile) for 869/1068 MVA summer normal/emergency ratings, the addition of a disconnect switch (3000 amp) (1), a line trap (3000 amp) (1) and bundled drop loop conductors at Atlantic substation and bundled drop loop conductors and new Line Trap (3000 amp) (1) at South River substation at an estimated cost of **$11,734,000**.

Short Circuit Reinforcements
Replacement of each of the following breakers is estimated to cost **$350,000** each.

Red Oak 2881 230kV - T1034
Red Oak 2882 230kV - G1047
Raritan River 230kV - BK15
Raritan River 230kV - I1023E
Raritan River 230kV - I1023F
Raritan River 230kV – W1037F

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)

9. Graceton - Bagley - Raphael Upgrade – This overload requires Graceton station to add 6-230kV breakers with an estimated cost of **$10,000,000** and Raphael Road station to add 6-230kV breakers **$10,000,000**. It requires rebuilding the Graceton to Raphael Rd circuit to double circuit 2-conductor bundled at an estimated cost of **$30**,**000,000**. This work would take an estimate of 2-3 years for the substation work and 5-6 years for the line work. **(Note: This upgrade will suffice the overload 10 too)**.

11. Northwest - Mt Carmel - Conastone 230 kV Upgrade – This overload requires installation of a new North Northwest substation consisting of 2-500/230kV xfmrs 4-500 kV bkrs, 7-230 kV Bkrs and related substation equipment and land at a cost of **$70,000,000**. It also requires reconductoring Conastone to Northwest #2322 230kV circuit with 1,272kcmil ACSR 1,590kcmil ACSR at an estimated cost of **$8,210,000**. This will take 3-4 years to build the substation and 18-24 months for the line work**. (Note: This upgrade will suffice the overloads 12, 13 and 14 too)**.

12. Whippany – Roseland 230 kV (A941) Upgrade: This overload requires rebuilding existing Whippany to Roseland line from 1033.5 Kcmil 54/7 ACSR (2) (2.7 mile) to 1590 Kcmil 54/19 ACSS/AW (2) (2.7 mile) for 1303/1601 MVA (JC) summer normal/emergency ratings and addition of a line trap (4000 amp) (1) and bundled drop loop conductors at Whippany substation at an estimated cost of **$5,580,400**.

Short Circuit Reinforcements

Replacement of each of the following breakers is estimated to cost **$350,000** each.

Raritan River 230kV - W1037E
Raritan River 230kV - G1047E
Raritan River 230kV - G1047F
Raritan River 230kV - T1034E
Raritan River 230kV - T1034F