#R37 Rehoboth / Bethany 601 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 (Option #1 – Rehoboth)

Queue R37 was studied as a 600 MW (120 MW capacity) injection to the Rehoboth to Robinsonville 138 kV Line. Project R37 was evaluated for compliance with reliability criteria for summer peak conditions in 2011. Potential network impacts were as follows:

NETWORK IMPACTS

Generator Deliverability

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

1. The N.Seaford – Taylor 69 kV line is overloaded to 101% of its emergency rating (64 MVA) for the outage of S.Harrington 138/69kV. R37 contributes **3 MVA** to the overload.

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)

2. The Oil_City – Steele 138 kV line is overloaded from 81% to 118% of its emergency rating (159 MVA) for the **tower** outage of #1 & #2 Keeney - Steele 230 kV ckt (Cont Id. DBL_1NCB). R37 contributes approximately **61 MW** to cause the thermal violation.

3. The Indian River – Nelson 138 kV line is overloaded from 90% to 134% of its emergency rating (193 MVA) for the **tower** outage Red Lion - Cedar Creek 230 kV line and Red Lion - Cartanza 230 kV line (Cont Id. DBL_4NC). R37 contributes approximately **85 MW** to cause the thermal violation.

4. The Oil_City – Church 138 kV line is overloaded from 77% to 115% of its emergency rating (159 MVA) for the **tower** outage #1 & #2 Keeney - Steele 230 kV ckt (Cont Id. DBL_1NCB). R37 contributes approximately **61 MW** to cause the thermal violation.

Short Circuit

Will be performed for the Queue R37 Impact Study.

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Contribution to Previously Identified Overloads

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

5. The Linwood - Chichester ckt2 230 kV line is overloaded at 107% of its emergency rating (904 MVA) for the outage of Chichester – Linwood ckt.1 230 kV line (Cont. PE39). The R37 project contributes approximately **21 MW** to this overload.

6. The Linwood - Chichester ckt1 230 kV line is overloaded at 107% of its emergency rating (904 MVA) for the outage of Chichester – Linwood ckt.2 230 kV line (Cont. PE43). The R37 project contributes approximately **21 MW** to this overload.

7. The Ridley – Printz 230 kV line is overloaded at 105% of its emergency rating (1432 MVA) for the outage of Eddystone – Island Road 230 kV line (Cont. PE23). The R37 project contributes approximately **8 MW** to this overload.

8. The Island Road - Eddystone 230 kV line is overloaded at 102% of its emergency rating (1411 MVA) for the outage of Ridley - Morton - Macdade 230 kV line (Cont. PE46). The R37 project contributes approximately **8 MW** to this overload.

9. The Conastone – Mt Carmel (2322 line) 230 kV line is overloaded at 165% of its emergency rating (803 MVA) for the **tower** outage of the Brighton to Doubs 500 kV line and the Brighton to Conastone 500 kV line (Cont. AP5). The R37 project contributes approximately **36 MW** to this overload.

10. The Conastone - Mt Carmel (2310 line) 230 kV line is overloaded at 146% of its emergency rating (923 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV lines (Cont Id. AP5). The R37 project contributes approximately **37 MW** to this overload.

11. The Northwest - Mt Carmel (2322 line) 230 kV line is overloaded at 162% of its emergency rating (803 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV lines (Cont Id. AP5). The R37 project contributes approximately **36 MW** to this overload.

12. The Northwest - Mt Carmel (2310 line) 230 kV line is overloaded at 144% of its emergency rating (923 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV lines (Cont Id. AP5). The R37 project contributes approximately **37 MW** to this overload.

13. The Graceton – Bagley - Rapheal 230 kV line is overloaded at 190% of its emergency rating (659 MVA) for the **tower** outage of Brighton to Doubs 500 kV

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line and Brighton to Conastone 500 kV lines (Cont. AP5). The R37 project contributes approximately **42 MW** to this overload.

14. The Milford - Steele 230 kV line is overloaded from to 183% of its emergency rating (551 MVA) for the **tower** outage of Red Lion - Cedar Creek and Red Lion - Cartanza 230 kV lines (Cont Id. DBL_4NC). The R37 contributes approximately **377 MW** to this overload.

15. The Three Mile Island 500/230 kV transformer is overloaded at 122% of its emergency rating (1077 MVA) for the outage of Conastone to Peach Bottom 500 kV line (Cont Id. PJM17). The R37 project contributes approximately **15 MW** to this overload.

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. N.Seaford – Taylor 69 kV Overload - This overload requires conductor re-tensioning to increase the temperature rating of the existing conductor at an estimated cost of **$0.4M**. It would take **12 to 18 months**.

2. Oil City – Steel 138 kV Overload – This overload requires to rebuild the existing conductor at an estimated cost of **$0.5M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

3. Indian River – Nelson 138 kV Overload – This overload requires the reconductor and rebuild of the existing line at an estimated cost of **$8M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

4. Oil_City – Church 138 kV Overload - This overload requires reconductor and rebuild of the existing line at an estimated cost of **$7.5M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

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)

5. Chichester - Linwood 230kV ckts Overload – This overload requires line reconductor and upgrade of substation terminal equipment at an estimated cost of $8M each ckt. total = **$16M (Note: This upgrade will suffice for overload 6 also)**.

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6. See Upgrade number 5 above.

7. Ridley - Printz 230kV Overload – This overload requires replacement of terminal equipment to increase emergency rating at an estimated cost of **$4M**.

8. Island Road - Eddystone 230kV Overload – This overload requires replacement of terminal equipment to increase emergency rating at an estimated cost of **$4M**

9. Northwest - Mt Carmel - Conastone 230 kV Overload – This overload requires the construction of a new substation (North Northwest station) consisting of 2-500/230kV transformers, 4-500 kV breakers, 7-230 kV breakers, related substation equipment and land at a cost of **$70M**. It also requires the reconductor ing of the Conastone to Northwest #2322 with 1,272 kcmil ACSR 1,590kcmil ACSR at an estimated cost of **$8,210,000**. This work would take 3-4 years to build substation and **18-24 months** for the line work**. (Note: This upgrade will suffice the overloads 10, 11 and 12 too)**.

10. See Upgrade number 9 above.

11. See Upgrade number 9 above.

12. See Upgrade number 9 above.

13. Graceton - Bagley – Raphael 230 kV Overload – This overload requires the addition of six 230 kV breakers at Graceton substation at an estimated cost of **$10,000,000** and the addition of six 230 kV breakers at Raphael Road substation also at an estimated cost of **$10,000,000**. It also requires rebuilding the Graceton to Raphael Rd double circuit with bundled 2-conductor construction at an estimated cost of **$30,000,000**. This work would take an estimate of **24-36 months** for the substation work and **60-72 months** for the line work.

14. Milford – Steele 230 kV Overload - This overload requires to rebuild the existing conductor at an estimated cost of **$12M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

ADDITIONAL ISSUES

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below may result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

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As a result of the aggregate energy resources in the area, the following violations were identified:

1. The Milford – Cool Springs 230 kV line is overloaded to 155% of its emergency rating (679 MVA) for the outage of Indian River – Milford 230 kV line (Cont Id. CKT23069). The R37 contributes approximately **359 MW** to this overload. This overload requires reconductor and rebuild of the existing circuit at an estimated cost of **$9M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

2. The Milford – Indian River 230 kV line is to 155% of its emergency rating (679 MVA) for the outage of Cool Springs – Milford 230 kV line (Cont Id. CKT23034A). The R37 contributes approximately **336 MW** to cause the thermal violation. This overload requires reconductor and rebuild of the existing circuit at an estimated cost of **$15M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

3. The Chichester ckt. 2 – Linwood 230 kV line is overloaded at 128% of its emergency rating (904 MVA) for the outage of Chichester – Linwood ckt. 1 230 kV line (Cont. PE39). The R37 project contributes approximately **103 MW** to this overload.

4. The Graceton – Bagley 230 kV line is overloaded at 141% of its emergency rating (659 MVA) for the outage of Five Forks to Graceton 115 kV line (Cont. 110510). The R37 project contributes approximately **29 MW** to this overload.

5. The Raphael Road – Bagley 230 kV line is overloaded at 130% of its emergency rating (659 MVA) for the outage of Five Forks to Graceton 115 kV line (Cont. 110510). The R37 project contributes approximately **29 MW** to this overload.

6. The Conastone – Peach Bottom 500 kV line is overloaded at 153% of its normal rating (2338 MVA) for which the R37 project contributes approximately **239 MW** to this overload.

7. The Indian River – Nelson 138 kV line is overloaded to 144% of its emergency rating (193 MVA) for the outage of Milford – Steele 230 kV line (Cont Id. CKT23076). Queue R37 contributes approximately **72 MW** to this overload. This overload requires line reconductor and rebuild at an estimated cost of **$8M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

8. The Indian River – Cool Springs 230 kV line is overloaded to 148% of its emergency rating (679 MVA) for the outage of Indian River – Milford 230 kV line (Cont Id. CKT23069). The R37 contributes approximately **238 MW** to this overload. This overload requires reconductor and rebuild of the existing circuit at

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an estimated cost of **$6M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

9. The Milford - Steele 230 kV line is overloaded from 86% to 126% of its emergency rating (551 MVA) for the outage of Cedar Creek - Red Lion 230 kV line (Cont Id. CKT23030). Queue R37 contributes approximately **222 MW** to cause the thermal violation. This overload requires re-tensioning of the line conductor to increase the temperature rating of the existing conductor at an estimated cost of **$6M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

10. The Rehoboth – Robinsonville 138 kV line is overloaded from 24% to 126% of its normal rating (275 MVA) for which the project R37 contributes approximately **412 MW** to cause the thermal violation. This overload requires reconductoring and rebuild of the line at an estimated cost of **$2.8M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

11. The Glasgow – Cecil1 138 kV line is overloaded at 118% of its emergency rating (79 MVA) for the outage of Conowingo to Colora 230 kV line (Cont. PE78). The R37 project contributes approximately **7 MW** to this overload. This overload is based on a directional relay setting that limits the flow from Glasgow to 180 MVA. The relay will need to be replaced with an impedance type relaying scheme.

12. The Lorretto – Piney 138 kV line is overloaded from 80% to 104% of its emergency rating (159 MVA) for the outage of Milford – Steele 230 kV line (Cont Id. CKT23076). Queue R37 contributes approximately **38 MW** to cause the thermal violation. This overload requires re-tensioning the conductor to increase the temperature rating of the existing conductor at an estimated cost of **$3M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

13. The North Seaford – Indian River 138 kV line is overloaded from 85% to 123% of its emergency rating (242 MVA) for the outage of Cool Springs – Milford 230 kV line (Cont Id. CKT23034A). Queue R37 contributes approximately **91 MW** to cause the thermal violation. This overload requires re-tensioning of the conductor to increase the temperature rating of the existing conductor at an estimated cost of **$5M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

14. The Indian River – Robinsonville 138 kV line is overloaded from -30% to 120% of its emergency rating (275 MVA) for which the project R37 contributes approximately **412 MW** to cause the thermal violation. This overload requires reconductoring and rebuild of the line at an estimated cost of **$3.9M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

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15. The Ridley – Printz 230 kV line is overloaded at 110% of its emergency rating (1432 MVA) for the outage of Eddystone – Island Road 230 kV line (Cont. PE23). The R37 project contributes approximately **40 MW** to this overload.

16. The Clay – Edgemoor 230 kV line is overloaded from 89% to 100% of its emergency rating (805 MVA) for the outage of Linwood to Edgemoor 230 kV line (Cont Id. PE77). Queue R37 contributes approximately **88 MW** to cause the thermal violation. This overload requires reconductor and rebuild of the existing circuitat an estimated cost of **$2.8M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

17. The Island Road - Eddystone 230 kV line is overloaded at 107% of its emergency rating (1411 MVA) for the outage of Ridley to Morton to Macdade 230 kV line (Cont. PE46). The R37 project contributes approximately **41 MW** to this overload.

18. The Macdade - Ridley 230 kV line is overloaded 99% to 102% of its emergency rating (1432 MVA) for the outage of Eddystone – Island Road 230 kV line (Cont. PE23).The R37 contributes approximately **41 MW** to cause the thermal violation.

19. The Elmwood – MacDade3 230 kV line is overloaded from 97% to 100% of its emergency rating (1339 MVA) for the outage of Eddystone – Island Road 230 kV line (Cont. PE23). The R37 contributes approximately **41 MW** to cause the thermal violation.

20. The Bethany - 138th St 138 kV line is overloaded 96% to 102% of its emergency rating (272 MVA) for which the project R37 contributes approximately **17 MW** to cause the thermal violation. This overload requires reconductor and rebuild of the existing circuit at an estimated cost of **$1.5M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

21. The Indian River - Robinsonville 138 kV line is overloaded at 103% of its emergency rating (341 MVA) for which the project R37 contributes approximately **10 MW** to cause the thermal violation. This overload requires reconductor and rebuild of the existing circuit at an estimated cost of **$2.8M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

22. The Rehoboth - Robinsonville 138 kV line is overloaded at 113% of its emergency rating (341 MVA) for which the project R37 contributes approximately **45 MW** to cause the thermal violation. This overload requires reconductor and rebuild of the existing circuit at an estimated cost of **$4.4M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

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23. The North Seaford - Taylor 69 kV line is overloaded at 116% of its emergency rating (64 MVA) for the outage of S.Harrington 138/69kV transformer. Queue R37 contributes approximately 10 MW to cause the thermal violation. This overload requires retensioning of the conductor to increase the temperature rating of the existing conductor at an estimated cost of **$0.4M**. It would take **12 to 18 months**.

24. The Maridel – Ocean City 69 kV line is overloaded at 110% of its emergency rating (116 MVA) for the outage of Bishop to Worcester 138kV. The R37 contributes approximately 11 MW to cause the thermal violation.

25. The Culver – Ocean City 69 kV line is overloaded at 110% of its emergency rating (93 MVA) for the outage of Bishop to Worcester 138kV. The R37 contributes approximately 9 MW to cause the thermal violation.

26. The Todd – Vienna 69 kV line is overloaded at 103% of its emergency rating (111 MVA) for the outage of Vienna to West Cambridge 69kV. The R37 contributes approximately 3 MW to cause the thermal violation.

27. The Taylor – Bridgeville 69 kV line is overloaded at 103% of its emergency rating (64 MVA) for the outage of S. Harrington 138/69kV. The R37 contributes approximately 2 MW to cause the thermal violation.

28. The Harrington – S.Harrington 69 kV line is overloaded at 111% of its emergency rating (91 MVA) for the outage of Kent to Cheswold 69kV. The R37 contributes approximately 10 MW to cause the thermal violation.

29. The Harrington – Wells 69 kV line is overloaded at 112% of its emergency rating (59 MVA) for the outage of Kent to Cheswold 69kV. The R37 contributes approximately 7 MW to cause the thermal violation.

30. The Rehoboth 138/69 kV transformer is overloaded at 186% of its emergency rating (239 MVA) for the outage of Robinsonville to R37 138kV. The R37 contributes approximately 7 MW to cause the thermal violation.

31. The Bethany – Omar 138 kV line is overloaded from 72% to 203% of its emergency rating (275 MVA) for which the project R37 contributes approximately 359 MW to cause the thermal violation.

32. The OceanBay – 138th St 138 kV line is overloaded from 77% to 142% of its emergency rating (275 MVA) for which the project R37 contributes approximately 359 MW to cause the thermal violation.

33. The Indian River 2&3 – Omar 138 kV line is overloaded from 69% to 200% of its emergency rating (275 MVA) for which the project R37 contributes approximately 359 MW to cause the thermal violation.

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Network Impacts (Option #2 – Bethany 138 kV)

Queue R37 was studied as a 600 MW (120 MW capacity) injection to the Bethany 138kV substation. Project #R37 was evaluated for compliance with reliability criteria for summer peak conditions in 2011. Potential network impacts were as follows:

NETWORK IMPACTS

Generator Deliverability

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

1. The N.Seaford – Taylor 69 kV line is overloaded to 101% of its emergency rating (64 MVA) for the outage of S.Harrington 138/69kV. The R37 project contributes **3 MVA** to the overload.

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)

2. The Bethany – Omar 138 kV line is overloaded from 60% to 166% of its emergency rating (336 MVA) for the **tower** outage of #1 & #2 Keeney - Steele 230 kV ckt (Cont Id. DBL_1NCB). The R37 contributes approximately **360 MW** to cause the thermal violation.

3. The Indian River – Omar 138 kV line is overloaded from 57% to 163% of its emergency rating (193 MVA) for the **tower** outage of #1 & #2 Keeney - Steele 230 kV ckt (Cont Id. DBL_1NCB). The R37 contributes approximately **360 MW** to cause the thermal violation.

4. The Oil City – Steel138 138 kV line is overloaded from 81% to 125% of its emergency rating (159 MVA) for the **tower** outage of #1 & #2 Keeney - Steele 230 kV ckt (Cont Id. DBL_1NCB). The R37 contributes approximately **71 MW** to cause the thermal violation.

5. The Oil City – Church 138 kV line is overloaded from 77% to 122% of its emergency rating (159 MVA) for the **tower** outage #1 & #2 Keeney - Steele 230 kV ckt (Cont Id. DBL_1NCB). The R37 contributes approximately **61 MW** to cause the thermal violation.

6. The Indian River – Nelson 138 kV line is overloaded from 90% to 134% of its emergency rating (193 MVA) for the **tower** outage Red Lion - Cedar Creek 230 kV line and Red Lion - Cartanza 230 kV line (Cont Id. DBL_4NC). The R37 contributes approximately **87 MW** to cause the thermal violation.

7. The Bethany - 138th St 138 kV line is overloaded 75% to 126% of its emergency rating (272 MVA) for the **tower** outage Red Lion - Cedar Creek 230 kV line and Red Lion - Cartanza 230 kV line (Cont Id. DBL_4NC). The project R37 of which

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the project R37 contributes approximately **178 MW** to cause the thermal violation.

8. The OceanBay - 138th St 138 kV line is overloaded 77% to 142% of its emergency rating (272 MVA) for which the project R37 contributes approximately **177 MW** to cause the thermal violation.

Short Circuit

Will be performed for the Queue R37 Impact Study.

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 Linwood - Chichester ckt2 230 kV line is overloaded at 108% of its emergency rating (904 MVA) for the outage of Chichester – Linwood ckt. 1 230 kV line (Cont. PE39). The R37 project contributes approximately **21 MW** to this overload.

10. The Linwood - Chichester ckt1 230 kV line is overloaded at 108% of its emergency rating (904 MVA) for the outage of Chichester – Linwood ckt. 2 230 kV line (Cont. PE43). The R37 project contributes approximately **21 MW** to this overload.

11. The Ridley – Printz 230 kV line is overloaded at 105% of its emergency rating (1432 MVA) for the outage of Eddyston - IslandR6 – Island Road 230 kV line (Cont. PE23). The R37 project contributes approximately **8 MW** to this overload.

12. The Island Road - Eddystone 230 kV line is overloaded at 102% of its emergency rating (1411 MVA) for the outage of Ridley to Morton to Macdade 230 kV line (Cont. PE46). The R37 project contributes approximately **8 MW** to this overload.

13. The Conastone – Mt Carmel (2322) 230 kV line is overloaded at 165% of its emergency rating (803 MVA) for the **tower** outage of Brighton to Doubs 500 kV line and Brighton to Conastone 500 kV line (Cont. AP5). The R37 project contributes approximately **36 MW** to this overload.

14. The Conastone - Mt Carmel (2310) 230 kV line is overloaded at 146% 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 R37 project contributes approximately **37 MW** to this overload.

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15. The Northwest - Mt Carmel (2322) 230 kV line is overloaded at 162% 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 R37 project contributes approximately **36 MW** to this overload.

16. The Northwest - Mt Carmel (2310) 230 kV line is overloaded at 144% 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 R37 project contributes approximately **37 MW** to this overload.

17. The Graceton – Bagley 230 kV line is overloaded at 190% of its emergency rating (659 MVA) for the **tower** outage of Brighton to Doubs 500 kV line and Brighton to Conastone 500 kV line (Cont. AP5). The R37 project contributes approximately **39 MW** to this overload.

18. The Milford - Steele 230 kV line is overloaded to 183% of its emergency rating (551 MVA) for the **tower** outage of Red Lion - Cedar Creek 230 kV line and Red Lion - Cartanza 230 kV line (Cont Id. DBL_4NC). The R37 contributes approximately **371 MW** to this overload. This overload requires to rebuild the existing conductor at an estimated cost of **$12M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

19. The Three Mile Island 500/230 kV transformer is overloaded at 122% of its emergency rating (1077 MVA) for the outage of Conastone to Peachbottom 500 kV line (Cont Id. PJM17). The R37 project contributes approximately **15 MW** to this overload.

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. N. Seaford – Taylor 69 kV Overload - This overload requires re-tensioning the conductor to increase the temperature rating of the existing conductor at an estimated cost of **$0.4M**. It would take **12 to 18 months** assuming no major regulatory or environmental impacts.

2. Bethany – Omar 138 kV Overload - This overload requires to rebuild the line at an estimated cost of **$4.4M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

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3. Indian River – Omar 138 kV Overload - This overload requires to rebuild the line at an estimated cost of **$4.7M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

4. Oil_City – Steel1 138 kV Overload - This overload requires line reconductor and rebuild at an estimated cost of **$0.5M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

5. Oil_City – Church 138 kV Overload - This overload requires line reconductor and rebuild at an estimated cost of **$7.5M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

6. Indian River – Nelson 138 kV Overload - This overload requires line reconductor and rebuild at an estimated cost of **$8M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

7. Bethany – 138th Street Overload - This overload requires line reconductor and rebuild at an estimated cost of **$4.3M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

8. Ocean Bay – 138th St 138 kV Overload - This overload requires line reconductor and rebuild at an estimated cost of **$1.2M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

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. Linwood - Chichester ckt2 230 kV Overload. ***See Upgrade number 10 below***.

10. Chichester - Linwood 230kV ckts Overload – This overload requires reconductor of the lines and upgrade of substation equipment to increase the emergency rating for an estimated cost of **$8M each ckt**. ***(Note: This upgrade will suffice overload 9 too)***.

11. Ridley - Printz 230kV Overload – This overload requires replacement of terminal equipment to increase emergency rating for an estimated cost of **$4M**.

12. Island Road - Eddystone 230kV Overload – This overload requires replacement of terminal equipment to increase emergency rating for an estimated cost of **$4M**.

13. Northwest - Mt Carmel - Conastone Overload – This overload requires the construction of a new substation "North Northwest" with 2-500/230kV

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transformers, 4-500 kV breakers, 7-230 kV breakers, related substation equipment and land at a cost of **$70M**. It also requires reconductor of the Conastone to Northwest #2322 line from 1,272 kcmil ACSR to 1,590 kcmil ACSR with an estimated cost of **$8.21M**. This work would take **36-48 months** to build substation and **18-24 months** for the line work. **(Note: This upgrade will suffice for overloads 14, 15 and 16 also)**.

14. Conastone- Mt Carmel (2310) 230 kV Overload – *See Upgrade number 13 above.*

15. Northwest- Mt Carmel (2322) 230 kV Overload – *See Upgrade number 13 above.*

16. Northwest - Mt Carmel (2310) 230 kV Overload - *See Upgrade number 13 above.*

17. Graceton - Bagley - Raphael 230 kV Overload – This overload requires the addition of 6-230kV breakers at Graceton with an estimated cost of **$10M**, and the addition of 6-230kV breakers at Raphael Road at an additional cost of **$10 M**. It also requires rebuilding Graceton to Raphael Rd to double circuit 2-conductor bundled construction at an estimated cost of **$30M**. This work would take an estimate of **24-36 months** for the substation work and **5-6 years** for the line work.

18. Milford – Steele 230 kV Overload - This overload requires line re-conductor and rebuild at an estimated cost of **$12M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

19. TMI 500-230 kV transformer Overload – The estimated cost to add a second 500-230 kV transformer is **$11,800,000** and the time required is approximately **20 months**.

OTHER ISSUES

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below may result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

As a result of the aggregate energy resources in the area, the following violations were identified:

1. The Bethany – Omar 138 kV line is overloaded from 72% to 203% of its emergency rating (275 MVA) for which the project R37 contributes approximately 359 MW to cause the thermal violation. This overload requires line reconductor and rebuild at an estimated cost of **$4.7M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

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2. The Ocean Bay – 138th St 138 kV line is overloaded from 77% to 142% of its emergency rating (275 MVA) for which the project R37 contributes approximately **359 MW** to cause the thermal violation. This overload requires rebuilding the existing circuit at an estimated cost of **$1.2M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

3. The Indian River – Omar 138 kV line is overloaded from 69% to 200% of its emergency rating (275 MVA) for which the project R37 contributes approximately **359 MW** to cause the thermal violation. This overload requires rebuilding the line at an estimated cost of **$4.4M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

4. The Milford - Steele 230 kV line is overloaded from 85% to 125% of its emergency rating (551 MVA) for the outage of Cedar Creek - Red Lion – 230 kV line (Cont Id. CKT23030). Queue R37 contributes approximately **217 MW** to cause the thermal violation. This overload requires rebuild of the existing circuit at an estimated cost of **$6M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

5. The Milford – Cool Springs 230 kV line is overloaded to 156% of its emergency rating (679 MVA) for the outage of Indian River – Milford 230 kV line (Cont Id. CKT23069). Queue R37 contributes approximately **347 MW** to this overload. This overload requires rebuild of the existing circuit at an estimated cost of **$9M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

6. The Indian River 4 – Cool Springs 230 kV line is overloaded to 154% of its emergency rating (679 MVA) for the outage of Indian River – Milford 230 kV line (Cont Id. CKT23069). Queue R37 contributes approximately **280 MW** to this overload. This overload requires rebuild of the existing circuit at an estimated cost of **$6M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

7. The Milford – Indian River 230 kV line is overloaded to 153% of its emergency rating (679 MVA) for the outage of Cool Springs – Milford 230 kV line (Cont Id. CKT23034A). Queue R37 contributes approximately **332 MW** to this overload. This overload requires rebuild of the existing circuit at an estimated cost of **$15M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

8. The Chichester ckt. 2 – Linwood 230 kV line is overloaded at 128% of its emergency rating (904 MVA) for the outage of Chichester – Linwood ckt. 1 230 kV line (Cont. PE39). The R37 project contributes approximately **121 MW** to this overload.

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9. The Rapheal – Bagley 230 kV line is overloaded at 130% of its emergency rating (659 MVA) for the outage of Five Forks to Graceton 115 kV line (Cont. 110510). Queue R37 project contributes approximately **29 MW** to this overload.

10. The Lorretto – Piney 138 kV line is overloaded from 80% to 103% of its emergency rating (159 MVA) for the outage of Milford – Steele 230 kV line (Cont Id. CKT23076). Queue R37 contributes approximately **37 MW** to cause the thermal violation. This overload requires conductor re-tensioning to increase the temperature rating of the existing conductor at an estimated cost of **$3M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

11. The North Seaford – Indian River 138 kV line is overloaded from 85% to 123% of its emergency rating (242 MVA) for the outage of Cool Springs – Milford 230 kV line (Cont Id. CKT23034A). Queue R37 contributes approximately **94 MW** to cause the thermal violation. This overload requires re-tensioning to increase the temperature rating of the existing conductor at an estimated cost of **$5M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

12. The Ridley – Printz 230 kV line is overloaded at 110% of its emergency rating (1432 MVA) for the outage of Eddystone – Island Road 230 kV line (Cont. PE23). The R37 project contributes approximately **47 MW** to this overload.

13. The Clay 230 – Edgemoor 230 kV line is overloaded from 89% to 100% of its emergency rating (805 MVA) for the outage of Linwood to Edgemoor 230 kV line (Cont Id. PE77). Queue R37 contributes approximately **88 MW** to cause the thermal violation. This overload requires rebuild of the existing circuit at an estimated cost of **$2.8M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

14. The Island Road - Eddystone 230 kV line is overloaded at 104% of its emergency rating (1411 MVA) for the outage of Ridley to Morton to Macdade 230 kV line (Cont. PE46). The R37 project contributes approximately **41 MW** to this overload.

15. The Macdade to Ridley 230 kV line is overloaded 99% to 102% of its emergency rating (1432 MVA) for the outage of Eddystone – Island Road 230 kV line (Cont. PE23). Queue R37 contributes approximately **41 MW** to cause the thermal violation.

16. The Elmwood – MacDade3 230 kV line is overloaded from 97% to 100% of its emergency rating (1339 MVA) for the outage of Eddyston – Island Road 230 kV line (Cont. PE23). Queue R37 contributes approximately **41 MW** to cause the thermal violation.

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17. The Graceton – Bagley 230 kV line is overloaded at 145% of its emergency rating (659 MVA) for the outage of Five Forks to Graceton 115 kV line (Cont. 110510). The R37 project contributes approximately **29 MW** to this overload.

18. The Conastone – Peach Bottom 500 kV line is overloaded at 153% of its normal rating (2338 MVA) for whch the R37 project contributes approximately **239 MW** to this overload.

19. The Indian River - Robinsonville 138 kV line is overloaded at 103% of its emergency rating (341 MVA) for which the R37 project contributes approximately **10 MW** to cause the thermal violation. This overload requires rebuild of the existing circuit at an estimated cost of **$2.8M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

20. The Rehoboth - Robinsonville 138 kV line is overloaded at 113% of its emergency rating (341 MVA) for which the R37 project contributes approximately **45 MW** to cause the thermal violation. This overload requires rebuild of the existing circuit at an estimated cost of **$4.4M**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

21. The North Seaford - Taylor 69 kV line is overloaded at 116% of its emergency rating (64 MVA) for the outage of S.Harrington 138/69kV transformer. Queue R37 contributes approximately **10 MW** to cause the thermal violation. This overload requires re-tensioning of the conductor to increase the temperature rating at an estimated cost of **$0.4M**. It would take **12 to 18 months** assuming no major regulatory or environmental impacts.

22. The Maridel – Ocean Bay 69 kV line is overloaded at 110% of its emergency rating (137 MVA) for the outage of Bishop to Worcester 138kV. The R37 project contributes approximately **14 MW** to cause the thermal violation. This overload requires rebuyild of the existing line at an estimated cost of **$2M**. It would take **12 to 18 months** assuming no major regulatory or environmental impacts.

23. The Worcester – Ocean Pines 69 kV line is overloaded at 111% of its normal rating (64 MVA). The R37 project contributes approximately **7 MW** to cause the thermal violation. This overload requires rebuild of the line at an estimated cost of **$0.7M**. It would take **12 to 18 months** assuming no major regulatory or environmental impacts.

24. The Maridel – Ocean City 69 kV line is overloaded at 110% of its emergency rating (116 MVA) for the outage of Bishop to Worcester 138kV. The R37 contributes approximately 11 MW to cause the thermal violation.

25. The Culver – Ocean City 69 kV line is overloaded at 110% of its emergency rating (93 MVA) for the outage of Bishop to Worcester 138kV. The R37 contributes approximately 9 MW to cause the thermal violation.

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26. The Todd – Vienna 69 kV line is overloaded at 103% of its emergency rating (111 MVA) for the outage of Vienna to West Cambridge 69kV. The R37 contributes approximately 3 MW to cause the thermal violation.

27. The Taylor – Bridgeville 69 kV line is overloaded at 103% of its emergency rating (64 MVA) for the outage of S. Harrington 138/69kV. The R37 contributes approximately 2 MW to cause the thermal violation.

28. The Harrington – S.Harrington 69 kV line is overloaded at 111% of its emergency rating (91 MVA) for the outage of Kent to Cheswold 69kV. The R37 contributes approximately 10 MW to cause the thermal violation.

29. The Harrington – Wells 69 kV line is overloaded at 112% of its emergency rating (59 MVA) for the outage of Kent to Cheswold 69kV. The R37 contributes approximately 7 MW to cause the thermal violation.

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