Generation Interconnection
Feasibility Study Report
Queue Position X3-040

The Interconnection Customer (IC) has proposed a 50 MWE (6.5 MWC; 50 MW MFO) solar powered generating facility to be located in Northampton County, Virginia. PJM studied X3-040 a 50 MW injection into the Delmarva Power and Light (DPL) system and evaluated the project for compliance with reliability criteria for summer peak conditions in 2015. The planned in-service date, as stated in the Attachment N, is December 31, 2012.

Point(s) of Interconnection

The Interconnection Customer requested a Primary and Secondary Point of Interconnection (POI) be evaluated for the X3-040 project. The Primary POI selected was a cut in of the Kellam-Bayview 69kV circuit. The Secondary POI selected was a direct connection into the Weirwood 69kV substation. The study results are provided in the Transmission Network Impacts section below.

Primary POI Option

X3-040 will interconnect with the Delmarva Power and Light system at the new Kendall Grove 69kV substation to be constructed adjacent to the Kellam-Bayview 69kV circuit.

Direct Connection Requirements

Direct Connection Issues (applicable to both POI options)

X3-040 Units and GSU modeling

The X3-040 Interconnection Customer must provide ODEC and PJM with the transformer test reports and models of the turbine generators once they are available in order to perform more detailed analyses.

X3-040 Generator Harmonic Requirements

Harmonic Voltage Requirements:
On 69 kV systems, the total harmonic distortion to the fundamental voltage wave from a single customer is limited to 1.5% of nominal. In addition, no individual harmonic component can exceed 1.0% of the fundamental system voltage.

Maximum Allowable Harmonic Voltage Distortion Table (Tariff Rule 32)		
Voltage Level	**Distortion Factor (% System Voltage)**	**Individual Harmonic (% System Voltage)**
69 kV through 138 kV	1.5	1

Harmonic current limits must comply with IEEE standard 519 (see table 10.2 and 10.3 limits for power generation). Harmonic filtering sufficient to limit harmonic current to the limits proscribed by these tables may need to be installed. X3-040 will be responsible for installing such filtering and may be disconnected until remedies are taken if these standards are violated.

Current Distortion Limits in % of 60~ Current (from IEEE 519 tables 10.2 and 10.3)						
Voltage Level	<11	11<h<17	17<h<23	23<h<35	35<h	TDD
69 kV	2.0	1.0	0.75	0.3	0.15	2.5
25 kV	4.0	2.0	1.5	0.6	0.3	5.0

X3-040 Generator Flicker Requirements
X3-040 must limit the severity of voltage variation to within 0.5%, so as not to cause observable flicker to consumers. The interconnection customer's facilities are required to be able to receive or deliver the necessary VARS during normal operation to assure that voltage does not vary more than 0.5% during periods of variable wind.

X3-040 Turbine Generator Regulation or Reactive Support Requirements
As specified in Interconnection Service Agreement, Appendix 2, Section 4.7.1.1 of the PJM OATT (Open Access Transmission Tariff), the X3-040 generator shall design its Facility to meet the following power factor requirement:
"For all new wind-powered and other non-synchronous generation facilities, if determined in the system impact study to be required for the safety or reliability of the Transmission System, the Generation Interconnection Customer shall design its Customer Facility with the ability to maintain a composite power delivery at continuous rated power output at a power factor of at least 0.95 leading to 0.95 lagging."

Impact study results show that with X3-040 operating at unity power factor only, voltage will fluctuate at Weirwood more than 4% as the unit cycles from 100% to 50.0% of output. X3-040 will therefore need to regulate its output voltage in order to insure that consumers do not experience voltage flicker.

The unit will need to absorb reactive power at full output, and supply reactive power to the system at low output. This will require the turbine generator to have the ability to change the firing angle as voltage changes.

Preliminary Schedule and Notes / Assumptions
ODEC will begin the project only after the PJM 3-party Interconnection Service Agreement (ISA) and Interconnection Construction Service Agreements (ICSA) are fully executed and ODEC receives a written authorization by PJM to commence activities. The estimated time to complete the direct connection work is approximately **48 months** after the execution of an ICSA. **The 2012 requested in-service date will not be attainable.** The schedule for the 69 kV transmission and substation work to accommodate X3-040 would depend on the project start date. The work to accommodate X3-040 will require transmission line outages. ODEC's outage windows for construction are typically available in the spring and fall of the year. Missing an outage window could result in project delays.

Notes / Assumptions
During construction, if extreme weather conditions or other system safety concerns arise, field construction may need to be rescheduled, which could possibly impact the schedule plan.

Excepting any operational, governmental and/or environmental regulatory delays, the use of additional resources, such as overtime, premiums for expedited material, and/or contractor labor, may enable ODEC to decrease this construction period. It is also assumed that all right-of-way and easements are secured without impact on anticipated construction start dates.

X3-040 Turbine Generator and Existing Distribution line Carrier Communications
An AMI/LM power line carrier system operates on A&N Electric Cooperative (ANEC) distribution system at a frequency of 9.615 kHz. Harmonic or other spurious emissions which emanate from X3-040 and interfere with the operation of this power line carrier system shall be mitigated by X3-040 to ANEC's satisfaction.

Transmission Owner Scope of Work

The scope of work and estimated costs for the direct connection facilities is as follows:

Construct the new Kendall Grove 69kV substation in a four (4) breaker ring bus configuration adjacent to the ODEC Kellam-Bayview 69kV circuit.

The estimated cost to perform this work is **$4,000,000** and will take **48 months** to construct after receipt of a fully executed Interconnection services Agreement and Interconnection Construction Services Agreement.

Interconnection Customer Scope of Work

The Interconnection Customer (IC) is responsible for all design and construction related to activities on their side of the Point of Interconnection (POI). Site preparation, including grading and an access road, as necessary, is assumed to be by the IC. Route selection, line design, and right-of-way acquisition of the direct connect facilities is not included in this report, and is the responsibility of the IC.

The Interconnection Customer is required to design, construct, and own the 69 kV line from the POI to the Customer Facility. This line must be built in accordance RUS standards or an accepted national standard, be effectively grounded, and appropriately shielded from lightning. (Refer to RUS bulletins 1728f-810 and 1724E-200.) The customer's transformer shall be connected wye-ground on the 69 kV side and delta on the low-voltage side.

The IC will be required to install metering and telemetry equipment at the Point of Interconnection to provide revenue metering and real-time telemetry data to PJM. The requirements for this equipment are listed in Appendix 2, Section 8 of Attachment O to the PJM Tariff, as well as PJM Manuals 01 and 14D.

At the Interconnection Customer’s discretion, ODEC will design and supply the required metering equipment but all the installation cost would be borne by the customer. ODEC requires that power quality metering be installed to monitor compliance with industry standards for harmonics.

Transmission Network Impacts

Potential transmission network impacts are as follows:

Generator Deliverability

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

None

Multiple Facility Contingency

*(Double Circuit Tower Line, Line with Failed Breaker and, Bus Fault contingencies for the **Full** energy output.*

1. The (DP&L) Steele-Oil City 138 kV line (from bus 232103 to bus 232801 ckt 1) loads from 98.35% to 102.07% (DC power flow) of its emergency rating (159 MVA) for the tower contingency 'DBL_1NCB'. This project contributes approximately 5.92 MW to the thermal violation.

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. The (DP&L) Milford-Steele 230 kV line (from bus 232004 to bus 232000 ckt 1) loads from 182.17% to 182.66% (DC power flow) of its emergency rating (551 MVA) for the tower contingency 'DBL_4NC'. This project contributes approximately 16.44 MW to the thermal violation.

Short Circuit

No issues identified.

Stability and Low Voltage Ride Through Analysis

Will be performed during the System Impact study phase of the project.

System Protection

The Interconnection Customer is responsible for the design and implementation of all protection equipment on the X3-040 side of the POI (Point of Interconnection) as shown on the one line diagram of the previous page and will do so in accordance with good utility practice.

X3-040 shall provide and maintain three suitable telephone circuits for use in transfer trip relaying from Tasley and Kellam substations, respectively, to the Kendall Grove substation. ODEC will provide sensing and a transfer trip relaying for all 69 kV faults on the lines from Bayview to Tasley.

X3-040 is required to provide ODEC with any information necessary to set ODEC line relaying and coordinate with their protective device.

Other Charges

Phone charges associated with transfer trip are estimated to be $300/month on an ongoing basis.

Distribution Service Requirements

The Interconnection Customer must submit a request for electric service through A&N Electric Cooperative (ANEC) if back up electric service at less than 69 kV is desired.

New System Reinforcements

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

1. To mitigate the (DP&L) Steele-Oil City 138 kV line (from bus 232103 to bus 232801 ckt 1) overload will require the rebuild of 0.56 miles of 477 ACSR and replacement of associated equipment. The estimated cost to perform this work is **$900,000** and will take **12 to 18 months** to complete (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. Cost allocation for these overloads will be provided in the System Impact Study Report.

1. To mitigate the (DP&L) Milford-Steele 230 kV line (from bus 232004 to bus 232000 ckt 1) overload will require the rebuild of 23.42 miles of existing 1590 ACSR and replacement of associated equipment. The estimated cost to perform this work is **$24,000,000** and will take **12 to 18 months** to complete (assuming no major regulatory or environmental impacts).

Transmission Owner Identifed Overloads

The following overloads were identified by the Old Dominion Electric Cooperative (ODEC) during their evaluation of the X3-040 project.

New Overloads

X3-040 causes the following overloads:

1. The (ODEC) Tasley-W1-008 tap 69kV line loads from 85% to 149% of its normal rating (59 MVA) for non contingency condition.

2. The (ODEC) V4-064 tap-W1-008 tap 69kV line loads from 46% to 117% of its normal rating (59 MVA) for non-contingency condition.

To mitigate the overloads in items **#1 and #2** above will require rebuilding the V4-064-Tasley 69kV circuit (6721). The estimated cost to perform this work is **$7,000,000** and will take **48 months** to complete.

3. The (ODEC) Kellam-Weirwood 69kV line loads from 32% to 101% of its normal rating (64 MVA) for the loss of the Bayview–Kendall Grove 69kV line.

   To mitigate the overloads in item **#3** above will require rebuilding the Kellam-Weirwood 69kV circuit (6750). The estimated cost to perform this work is **$7,000,000** and will take **48 months** to complete.

Contribution to Existing Overloads

X3-040 further contributes to the overloading of the following circuits:

4. The (ODEC) Oak Hall-W3-054A tap 69kV line loads from 118% to 141% of its normal rating (86 MVA) for non-contingency condition.

5. The (ODEC) Oak Hall-Perdue 69kV line loads from 103% to 136% of its normal rating (121 MVA) for the loss of the Oak Hall-W3-054 tap 69kV line.

6. The (ODEC) Tasley-Perdue 69kV line loads from 138% to 183% of its normal rating (93 MVA) for the loss of the Oak Hall-W3-054 tap 69kV line.

7. The (ODEC) Oak Hall-W3-054A tap 69kV line loads from 110% to 149% of its normal rating (113 MVA) for the loss of the Oak Hall-Perdue 69kV line.

   Note: The reinforcements, along with costs and schedule, for the above items 5,6,7, and 8 are currently under development and will be provided in the System Impact Study Report for X3-040. It is anticipated that queue project X3-040 will have cost allocation to these reinforcements.

Potential Congestion due to Local Energy Deliverability

(PJM also studied the delivery of the energy portion of the surrounding generation. Any potential problems identified below are likely to 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 Transmission Interconnection Request. Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full deliverability for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the identified overloaded element(s). As a result of the aggregate energy resources in the area, the following violations were identified:

These are ***not*** required reliability upgrades.

1. The (DP&L) Milford-Steele 230 kV line (from bus 232004 to bus 232000 ckt 1) loads from 116.35% to 116.55% (DC power flow) of its emergency rating (551 MVA) for the operational

contingency 'CKT 23032'. This project contributes approximately 6.64 MW to the thermal violation.

2. The (PECO/BG&E) Cooper-Graceton 230 kV line (from bus 214089 to bus 220964 ckt 1) loads from 198.70% to 198.88% (DC power flow) of its emergency rating (485 MVA) for the operational contingency 'PJM17'. This project contributes approximately 5.48 MW to the thermal violation.

3. The (DP&L) Piney Grove-Mount Hermon 69 kV line (from bus 232274 to bus 232272 ckt 1) loads from 148.35% to 159.48% (DC power flow) of its emergency rating (143 MVA) for the operational contingency 'CKT 23002'. This project contributes approximately 15.92 MW to the thermal violation.

4. The (DP&L) W1-008 TAP-Tasley 69 kV line (from bus 901040 to bus 232284 ckt 1) loads from 40.03% to 124.77% (DC power flow) of its normal rating (59 MVA) for non contingency condition. This project contributes approximately 50.00 MW to the thermal violation.

5. The (DP&L) Oak Hall-Pocomoke 138 kV line (from bus 232132 to bus 232130 ckt 1) loads from 89.67% to 101.43% (DC power flow) of its emergency rating (289 MVA) for the operational contingency 'CKT 23002'. This project contributes approximately 33.99 MW to the thermal violation.

6. The (DP&L) Oak Hall-Wattsville 69 kV line (from bus 232280 to bus 232281 ckt 1) loads from 138.16% to 155.92% (DC power flow) of its emergency rating (89 MVA) for the operational contingency 'CKT 137AC'. This project contributes approximately 15.80 MW to the thermal violation.

7. The (DP&L) Oak Hall-Wattsville 69 kV line (from bus 232280 to bus 232281 ckt 1) loads from 82.30% to 105.46% (DC power flow) of its normal rating (68 MVA) for non contingency condition. This project contributes approximately 15.75 MW to the thermal violation.

8. The (DP&L) Wattsville-Stockton 69 kV line (from bus 232281 to bus 232278 ckt 1) loads from 102.61% to 103.81% (DC power flow) of its emergency rating (58 MVA) for the operational contingency 'PINEY GR AT1'. This project contributes approximately 4.31 MW to the thermal violation.

9. The (PJM) U2-74 TAP-Peach Bottom 500 kV line (from bus 293025 to bus 200013 ckt 1) loads from 101.30% to 101.46% (DC power flow) of its emergency rating (2611 MVA) for the operational contingency 'CHIC125'. This project contributes approximately 26.40 MW to the thermal violation.

10. The (PJM) U2-74 TAP-Peach Bottom 500 kV line (from bus 293025 to bus 200013 ckt 1) loads from 98.92% to 99.09% (DC power flow) of its normal rating (2261 MVA) for non contingency condition. This project contributes approximately 23.87 MW to the thermal violation.

11. The (DP&L) Weirwood-Kellam 69 kV line (from bus 232847 to bus 232286 ckt 1) loads from 28.87% to 195.53% (DC power flow) of its normal rating (30 MVA) for non contingency condition. This project contributes approximately 50.00 MW to the thermal violation.

12. The (DP&L) Tasley-Parksley 69 kV line (from bus 232284 to bus 232845 ckt 1) loads from 55.15% to 118.42% (DC power flow) of its emergency rating (79 MVA) for the operational contingency 'CKT 6778'. This project contributes approximately 49.99 MW to the thermal violation.

13. The (DP&L/PECO) Claymont-Linwood 230 kV line (from bus 231000 to bus 213750 ckt 1) loads from 101.23% to 101.41% (DC power flow) of its emergency rating (805 MVA) for the operational contingency '220-85'. This project contributes approximately 8.72 MW to the thermal violation.

14. The (DP&L) Kings Creek-Loretto 138 kV line (from bus 232129 to bus 232127 ckt 1) loads from 122.80% to 132.48% (DC power flow) of its emergency rating (351 MVA) for the operational contingency 'CKT 23002'. This project contributes approximately 33.99 MW to the thermal violation.

15. The (DP&L) Kings Creek-Loretto 138 kV line (from bus 232129 to bus 232127 ckt 1) loads from 118.80% to 125.92% (DC power flow) of its normal rating (275 MVA) for non contingency condition. This project contributes approximately 19.60 MW to the thermal violation.

16. The (DP&L) T-144 TAP-Costen 138 kV line (from bus 886230 to bus 232807 ckt 1) loads from 104.48% to 118.25% (DC power flow) of its emergency rating (247 MVA) for the operational contingency 'CKT 23002'. This project contributes approximately 33.99 MW to the thermal violation.

17. The (DP&L) Pocomoke-T-144 TAP 138 kV line (from bus 232130 to bus 886230 ckt 1) loads from 98.23% to 111.99% (DC power flow) of its emergency rating (247 MVA) for the operational contingency 'CKT 23002'. This project contributes approximately 33.99 MW to the thermal violation.

18. The (DP&L) Mount Hermon-North Salisbury 69 kV line (from bus 232272 to bus 232271 ckt 1) loads from 104.78% to 116.15% (DC power flow) of its emergency rating (140 MVA) for the operational contingency 'CKT 23002'. This project contributes approximately 15.92 MW to the thermal violation.

19. The (DP&L) Stockton-Kenney 69 kV line (from bus 232278 to bus 232277 ckt 1) loads from 102.39% to 103.59% (DC power flow) of its emergency rating (58 MVA) for the operational contingency 'PINEY GR AT1'. This project contributes approximately 4.31 MW to the thermal violation.

20. The (DP&L) Tasley-Perdue 69 kV line (from bus 232284 to bus 232846 ckt 1) loads from 46.85% to 100.6% (DC power flow) of its emergency rating (93 MVA) for the operational

contingency 'CKT 6790'. This project contributes approximately 49.99 MW to the thermal violation.

21. The (DP&L) New Church-Piney Grove 138 kV line (from bus 232131 to bus 232128 ckt 1) loads from 154.41% to 165.37% (DC power flow) of its emergency rating (226 MVA) for the operational contingency 'CKT 13713'. This project contributes approximately 24.76 MW to the thermal violation.

22. The (DP&L) New Church-Piney Grove 138 kV line (from bus 232131 to bus 232128 ckt 1) loads from 102.36% to 110.76% (DC power flow) of its normal rating (172 MVA) for non contingency condition. This project contributes approximately 14.46 MW to the thermal violation.

23. The (DP&L) Piney Grove-Piney Grove 138/230 kV transformer (from bus 232128 to bus 232007 ckt 1) loads from 111.13% to 120.99% (DC power flow) of its emergency rating (424 MVA) for the operational contingency 'CKT 13713'. This project contributes approximately 41.83 MW to the thermal violation.

24. The (DP&L) W3-054A TAP-Oak Hall 69 kV line (from bus 903690 to bus 232280 ckt 1) loads from 98.69% to 142.93% (DC power flow) of its emergency rating (113 MVA) for the operational contingency 'CKT 6778'. This project contributes approximately 49.99 MW to the thermal violation.

25. The (DP&L) W3-054A TAP-Oak Hall 69 kV line (from bus 903690 to bus 232280 ckt 1) loads from 101.70% to 130.73% (DC power flow) of its normal rating (86 MVA) for non contingency condition. This project contributes approximately 24.97 MW to the thermal violation.

26. The (PECO) Peach Bottom-Cooper 230 kV line (from bus 213869 to bus 214089 ckt 1) loads from 198.07% to 198.25% (DC power flow) of its emergency rating (485 MVA) for the operational contingency 'PJM17'. This project contributes approximately 5.48 MW to the thermal violation.

27. The (DP&L) V3-061 TAP-Weirwood 69 kV line (from bus 894820 to bus 232847 ckt 1) loads from 22.78% to 100.9% (DC power flow) of its normal rating (64 MVA) for non contingency condition. This project contributes approximately 50.00 MW to the thermal violation.

Secondary POI Option

PJM studied X3-040 as a 50 MW injection at the Weirwood 69kV substation.

Transmission Network Impacts

Potential transmission network impacts are as follows:

Generator Deliverability

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

None

Multiple Facility Contingency

*(Double Circuit Tower Line, Line with Failed Breaker and, Bus Fault contingencies for the **Full** energy output.*

1. The (DP&L) Steele-Oil City 138 kV line (from bus 232103 to bus 232801 ckt 1) loads from 98.35% to 102.07% (DC power flow) of its emergency rating (159 MVA) for the tower contingency 'DBL_1NCB'. This project contributes approximately 5.92 MW to the thermal violation.

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. The (DP&L) The Milford-Steele 230 kV line (from bus 232004 to bus 232000 ckt 1) loads from 182.17% to 182.66% (DC power flow) of its emergency rating (551 MVA) for the tower contingency 'DBL_4NC'. This project contributes approximately 16.44 MW to the thermal violation.

Transmission Owner Identifed Overloads

The following overloads were identified by the Old Dominion Electric Cooperative (ODEC) during their evaluation of the X3-040 project.

New Overloads

X3-040 causes the following overloads:

1. The (ODEC) Tasley-W1-008 tap 69kV line loads from 85% to 149% of its normal rating (59 MVA) for non contingency condition.

2. The (ODEC) V4-064 tap-W1-008 tap 69kV line loads from 46% to 117% of its normal rating (59 MVA) for non-contingency condition.

   To mitigate the overloads in items **#1 and #2** above will require rebuilding the V4-064-Tasley 69kV circuit (6721). The estimated cost to perform this work is **$7,000,000** and will take **48 months** to complete.

3. The (ODEC) Kellam-Weirwood 69kV line loads from 32% to 101% of its normal rating (64 MVA) for the loss of the Bayview–Kendall Grove 69kV line.

4. The (ODEC) Weirwood-Kendall Grove 69kV line loads from 36% to 107% of its normal rating (64 MVA) for the loss of the Bayview–Kendall Grove 69kV line.

To mitigate the overloads in items **#3 and #4** above will require rebuilding the Kendall Grove-Kellam 69kV circuit (6750). The estimated cost to perform this work is **$7,000,000** and will take **48 months** to complete.

Contribution to Existing Overloads

X3-040 further contributes to the overloading of the following circuits:

5. The (ODEC) Oak Hall-W3-054A tap 69kV line loads from 118% to 141% of its normal rating (86 MVA) for non-contingency condition.

6. The (ODEC) Oak Hall-Perdue 69kV line loads from 103% to 136% of its normal rating (121 MVA) for the loss of the Oak Hall-W3-054 tap 69kV line.

7. The (ODEC) Tasley-Perdue 69kV line loads from 138% to 183% of its normal rating (93 MVA) for the loss of the Oak Hall-W3-054 tap 69kV line.

8. The (ODEC) Oak Hall-W3-054A tap 69kV line loads from 110% to 149% of its normal rating (113 MVA) for the loss of the Oak Hall-Perdue 69kV line.

   Note: The reinforcements, along with costs and schedule, for the above items 5,6,7, and 8 are currently under development and will be provided in the System Impact Study Report for X3-040. It is anticipated that queue project X3-040 will have cost allocation to these reinforcements.

Short Circuit

No issues identified.

Potential Congestion due to Local Energy Deliverability

(PJM also studied the delivery of the energy portion of the surrounding generation. Any potential problems identified below are likely to 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 Transmission Interconnection Request. Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full deliverability for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the identified overloaded element(s). As a result of the aggregate energy resources in the area, the following violations were identified:

These are ***not*** required reliability upgrades.

1. The (DP&L) Milford-Steele 230 kV line (from bus 232004 to bus 232000 ckt 1) loads from 116.35% to 116.55% (DC power flow) of its emergency rating (551 MVA) for the operational contingency 'CKT 23032'. This project contributes approximately 6.64 MW to the thermal violation.

2. The (PECO/BG&E) Cooper-Graceton 230 kV line (from bus 214089 to bus 220964 ckt 1) loads from 198.70% to 198.89% (DC power flow) of its emergency rating (485 MVA) for the operational contingency 'PJM17_X3-068A'. This project contributes approximately 5.48 MW to the thermal violation.

3. The (DP&L) Piney Grove-Mount Hermon 69 kV line (from bus 232274 to bus 232272 ckt 1) loads from 148.35% to 159.48% (DC power flow) of its emergency rating (143 MVA) for the operational contingency 'CKT 23002'. This project contributes approximately 15.92 MW to the thermal violation.

4. The (DP&L) W1-008 TAP-Tasley 69 kV line (from bus 901040 to bus 232284 ckt 1) loads from 40.03% to 124.77% (DC power flow) of its normal rating (59 MVA) for non contingency condition. This project contributes approximately 50.00 MW to the thermal violation.

5. The (DP&L) Oak Hall-Pocomoke 138 kV line (from bus 232132 to bus 232130 ckt 1) loads from 89.67% to 101.43% (DC power flow) of its emergency rating (289 MVA) for the operational contingency 'CKT 23002'. This project contributes approximately 33.99 MW to the thermal violation.

6. The (DP&L) Oak Hall-Wattsville 69 kV line (from bus 232280 to bus 232281 ckt 1) loads from 138.16% to 155.92% (DC power flow) of its emergency rating (89 MVA) for the operational contingency 'CKT 137AC'. This project contributes approximately 15.80 MW to the thermal violation.

7. The (DP&L) Oak Hall-Wattsville 69 kV line (from bus 232280 to bus 232281 ckt 1) loads from 82.30% to 105.46% (DC power flow) of its normal rating (68 MVA) for non contingency condition. This project contributes approximately 15.75 MW to the thermal violation.

8. The (DP&L) The Wattsville-Stockton 69 kV line (from bus 232281 to bus 232278 ckt 1) loads from 102.61% to 103.81% (DC power flow) of its emergency rating (58 MVA) for the operational contingency 'PINEY GR AT1'. This project contributes approximately 4.31 MW to the thermal violation.

9. The (DP&L) Piney Grove-Piney Grove 138/230 kV transformer (from bus 232128 to bus 232007 ckt 1) loads from 111.13% to 120.99% (DC power flow) of its emergency rating (424 MVA) for the operational contingency 'CKT 13713'. This project contributes approximately 41.83 MW to the thermal violation.

10. The (PJM) U2-74 TAP-Peach Bottom 500 kV line (from bus 293025 to bus 200013 ckt 1) loads from 101.30% to 101.46% (DC power flow) of its emergency rating (2611 MVA) for the operational contingency 'CHIC125'. This project contributes approximately 26.40 MW to the thermal violation.

11. The (PJM) U2-74 TAP-Peach Bottom 500 kV line (from bus 293025 to bus 200013 ckt 1) loads from 98.92% to 99.09% (DC power flow) of its normal rating (2261 MVA) for non contingency condition. This project contributes approximately 23.87 MW to the thermal violation.

12. The (DP&L) Weirwood-Kellam 69 kV line (from bus 232847 to bus 232286 ckt 1) loads from 28.87% to 195.53% (DC power flow) of its normal rating (30 MVA) for non contingency condition. This project contributes approximately 50.00 MW to the thermal violation.

13. The (DP&L) Tasley-Parksley 69 kV line (from bus 232284 to bus 232845 ckt 1) loads from 55.15% to 118.42% (DC power flow) of its emergency rating (79 MVA) for the operational contingency 'CKT 6778'. This project contributes approximately 49.99 MW to the thermal violation.

14. The (DP&L/PECO) The Claymont-Linwood 230 kV line (from bus 231000 to bus 213750 ckt 1) loads from 101.23% to 101.41% (DC power flow) of its emergency rating (805 MVA) for the operational contingency '220-85'. This project contributes approximately 8.72 MW to the thermal violation.

15. The (DP&L) Kings Creek-Loretto 138 kV line (from bus 232129 to bus 232127 ckt 1) loads from 122.80% to 132.48% (DC power flow) of its emergency rating (351 MVA) for the operational contingency 'CKT 23002'. This project contributes approximately 33.99 MW to the thermal violation.

16. The (DP&L) Kings Creek-Loretto 138 kV line (from bus 232129 to bus 232127 ckt 1) loads from 118.80% to 125.92% (DC power flow) of its normal rating (275 MVA) for non contingency condition. This project contributes approximately 19.60 MW to the thermal violation.

17. The (DP&L) T-144 TAP-Costen 138 kV line (from bus 886230 to bus 232807 ckt 1) loads from 104.48% to 118.25% (DC power flow) of its emergency rating (247 MVA) for the operational contingency 'CKT 23002'. This project contributes approximately 33.99 MW to the thermal violation.

18. The (DP&L) Pocomoke-T-144 TAP 138 kV line (from bus 232130 to bus 886230 ckt 1) loads from 98.23% to 111.99% (DC power flow) of its emergency rating (247 MVA) for the operational contingency 'CKT 23002'. This project contributes approximately 33.99 MW to the thermal violation.

19. The (DP&L) Mount Hermon-North Salisbury 69 kV line (from bus 232272 to bus 232271 ckt 1) loads from 104.78% to 116.15% (DC power flow) of its emergency rating (140 MVA) for the operational contingency 'CKT 23002'. This project contributes approximately 15.92 MW to the thermal violation.

20. The (DP&L) Stockton-Kenney 69 kV line (from bus 232278 to bus 232277 ckt 1) loads from 102.39% to 103.59% (DC power flow) of its emergency rating (58 MVA) for the operational contingency 'PINEY GR AT1'. This project contributes approximately 4.31 MW to the thermal violation.

21. The (DP&L) Tasley-Perdue 69 kV line (from bus 232284 to bus 232846 ckt 1) loads from 46.85% to 100.6% (DC power flow) of its emergency rating (93 MVA) for the operational contingency 'CKT 6790'. This project contributes approximately 49.99 MW to the thermal violation.

22. The (DP&L) New Church-Piney Grove 138 kV line (from bus 232131 to bus 232128 ckt 1) loads from 154.41% to 165.37% (DC power flow) of its emergency rating (226 MVA) for the operational contingency 'CKT 13713'. This project contributes approximately 24.76 MW to the thermal violation.

23. The (DP&L) New Church-Piney Grove 138 kV line (from bus 232131 to bus 232128 ckt 1) loads from 102.36% to 110.76% (DC power flow) of its normal rating (172 MVA) for non contingency condition. This project contributes approximately 14.46 MW to the thermal violation.

24. The (DP&L) W3-054A TAP-Oak Hall 69 kV line (from bus 903690 to bus 232280 ckt 1) loads from 98.69% to 142.93% (DC power flow) of its emergency rating (113 MVA) for the operational contingency 'CKT 6778'. This project contributes approximately 49.99 MW to the thermal violation.

25. The (DP&L) W3-054A TAP-Oak Hall 69 kV line (from bus 903690 to bus 232280 ckt 1) loads from 101.70% to 130.73% (DC power flow) of its normal rating (86 MVA) for non contingency condition. This project contributes approximately 24.97 MW to the thermal violation.

26. The (PECO) Peach Bottom-Cooper 230 kV line (from bus 213869 to bus 214089 ckt 1) loads from 198.07% to 198.26% (DC power flow) of its emergency rating (485 MVA) for the operational contingency 'PJM17_X3-068A'. This project contributes approximately 5.48 MW to the thermal violation.