Generation Interconnection
Feasibility Study Report
Queue Position AC1-095

The Interconnection Customer (IC) has proposed a 10.9 MW (6.2 MWC) solar generating facility to be located in New Castle County, Delaware. PJM studied AC1-095 as a 10.9 MW injection into the Delmarva Power and Light Company (DPL) system at the Cedar Creek 25 kV Substation and evaluated it for compliance with reliability criteria for summer peak conditions in 2020. The planned in-service date, as stated during the project kick-off call, is June 30, 2018. This date may not be attainable due to continued PJM studies and the Transmission Owner's construction schedule.

Point of Interconnection

The Interconnection Customer requested a distribution level interconnection. As a result, AC1-095 will interconnect with the Delmarva Power and Light distribution system as follows:

> The first 6 MWs will connect to the existing DE2500 25 kV feeder from the T1 transformer at the Cedar Creek Substation; the next 4 MWs will connect to the T1 transformer at the Cedar Creek Substation via a new 25 kV express feeder; the last 0.9 MWs will connect to a new T2 transformer at the Cedar Creek Substation via a new express feeder.

Direct Connection Requirements

Criteria Limits for Distributed Energy Resource (DER) Connections to the ACE, DPL and Pepco Distribution Systems (less than 69kV)

1. Single Phase Limit

Any DER with a capacity that exceeds 100kW shall be a balanced 3 phase system.

2. Voltage Limits

DER's are permitted to cause a voltage fluctuation of up to 2% at the Point of Interconnection, ½ the band width of any voltage regulator at its terminals, and ½ the net dead band of a switched capacitor bank at its connection point. When a DER is at maximum output, it shall not raise the feeder voltage above the ANSI C84.1 or state limit, whichever is more conservative.

3. Existing Distribution Circuit Capacity Limits

The aggregate limit of large (250 kW and over) generators running in parallel with a single, existing distribution circuit is 0.5 MWs on the 4kV, 3MWs on the 12 kV, 6 MWs on the 25 kV, and 10 MWs on the 34 kV.

4. Express Circuit Capacity Limits

Distributed generation installations which exceed the limit for an existing circuit require an express circuit.

The maximum generator size for express circuits shall be:

- 4 kV 0.5 MW

- 12 – 13.8 kV 10 MW
- 23 – 25 kV 10 MW
- 33.26 – 34.5 kV 15 MW

5. Distribution Power Transformer Limit

The aggregate limit of large (250 kW and over) generator injection to a single distribution transformer of 22.5 MVA nameplate or larger is 10 MWs. Transformers with nameplate ratings lower than 22.5 MVA will be given lower ratings on an individual basis. If the transformer rating is significantly greater than 40 MVA it may be possible to consider a greater generation capacity.

Adding a new transformer will be considered if there is no availability on any of the existing transformers and space is available in an existing substation. Any proposed transformers would be PHI's standard distribution transformer.

6. Express Circuit Length Limit

If there is no space for an additional transformer at the closest substation, the next closest substation will be considered. The length of an express circuit is limited to 5 miles, or for the sake of the feasibility study, 3.8 straight line miles to the substation. This simplification is used because the feasibility study phase does not allow for the time and resources to examine routes in detail (including existing pole lines, easements, ROW, and environmental issues etc.)

7. When a New Substation is Required

If a distribution express circuit can't be built from an existing substation for a project, it will be necessary to construct a new distribution substation with a standard ring bus design. It will be supplied by extending existing transmission lines. It is the developer's responsibility to verify eligibility of this configuration for solar renewable energy certificates.

All limits, given above in MWs, are subject to more detailed study to ensure feasibility.

Transmission Owner Scope of Attachment Facility Work

TO work required to accommodate 6.0 MW of generation on existing feeder DE2500 from Cedar Creek Substation T1:

1. A utility operated recloser equipped with the proper relaying and communications will be required.
2. Utility grade primary metering will be required.
3. Generation telemetry and remote trip capability will be provided to the control center.
4. A detailed, time-based study may be performed during later study phases.
5. Protection, Planning, and other engineering departments will perform studies, design work, and prepare engineering estimates.
6. Transfer trip will be required. The cost included below is to install 48SM ADSS fiber optic cable in conduit from Cedar Creek Substation to the POI, a total distance of approximately 1.5 miles. 138 kV potential transformers will need to be installed if none already in-service.

7. The feeder will require reconducting from single phase #2 AL to three phases of 477 AAC. The reconducting is approximately 1.5 miles long from grid location 47947/3016 to grid location 47270/30131.
8. If the voltage regulators in the substation are not properly equipped to handle the reverse power flow that the generator will cause, adjustments to their controllers will be required. If regulator cannot operate with controller, entire regulator will be upgraded.

Estimated Costs			
Cedar Creek Substation T1			
Fiber Installation	1.5	miles	$75,000
Reconduct from 1ph to 3ph	1.5	miles	$600,000
substation Relaying & 138kV PTs			$300,000
Recloser & Metering			$80,000
SCADA Integration into EMS			$10,000
Dynamic Study			$30,000
Various Departments Work			$60,000
Subtotal Cost			$1,155,000
Approximate Total Cost with 18% Contingency			$1,328,250

The estimated time to complete this work is **18-24 months** after receipt of a fully executed interconnection agreement.

TO work required to accommodate 4.0 MW of generation on a new express feeder from Cedar Creek Substation T1:

1. Design and construct one new 25 kV feeders with 477 aluminum conductor from Cedar Creek Substation to the generation site – approximately 1.5 miles.
2. One new 25 kV feeder terminal position will be constructed.
3. A utility operated recloser equipped with the proper relaying and communications will be required.
4. Utility grade primary metering will be required for each feeder.
5. Generation telemetry and remote trip capability will be provided to the control center.
6. A detailed, time-based study may be performed during later study phases.
7. Protection, Planning, and other engineering departments will perform studies, design work, and prepare engineering estimates.
8. Transfer trip will be required. The cost included below is to install 48SM ADSS fiber optic cable in conduit from Cedar Creek Substation to the POI, a total distance of approximately 1.5 miles. 138 kV potential transformers will need to be installed if none already in-service.
9. If the voltage regulators in the substation are not properly equipped to handle the reverse power flow that the generator will cause, adjustments to their controllers will be required. If regulator cannot operate with controller, entire regulator will be upgraded.

Estimated Costs			
Cedar Creek Substation T1			
477 AAC Express Feeder	1.5	Miles	$600,000
Fiber Installation			$75,000
Substation Relaying & 138 kV PTs			$300,000
Recloser & Metering			$80,000
SCADA Integration into EMS			$10,000
Dynamic Study			$30,000
Various Departments Work			$90,000
Subtotal Cost			$1,185,000
Approximate Total Cost with 18% Contingency			$1,362,750

The estimated time to complete this work is **18-24 months** after receipt of a fully executed interconnection agreement.

TO work required to accommodate 0.9 MW of generation on a new express feeder from Cedar Creek Substation New T2:

1. Design and construct one new 25 kV feeders with 477 aluminum conductor from Cedar Creek Substation to the generation site – approximately 1.5 miles.
2. One new 138/25 kV 37 MVA transformer will be constructed.
3. One new 25 kV feeder terminal position will be constructed.
4. A utility operated recloser equipped with the proper relaying and communications will be required.
5. Utility grade primary metering will be required for each feeder.
6. Generation telemetry and remote trip capability will be provided to the control center.
7. A detailed, time-based study may be performed during later study phases.
8. Protection, Planning, and other engineering departments will perform studies, design work, and prepare engineering estimates.
9. Transfer trip will be required. The cost included below is to install 48SM ADSS fiber optic cable in conduit from Cedar Creek Substation to the POI, a total distance of approximately 1.5 miles. 138 kV potential transformers will need to be installed if none already in-service.
10. If the voltage regulators in the substation are not properly equipped to handle the reverse power flow that the generator will cause, adjustments to their controllers will be required. If regulator cannot operate with controller, entire regulator will be upgraded.

Estimated Costs			
Cedar Creek Substation New T2			
477 AAC Express Feeder	1.5	Miles	$600,000
Fiber Installation			$75,000
138 & 25 kV Feeder Terminals			$600,000
Substation Relaying & 138 kV PTs			$300,000
Recloser & Metering			$80,000
SCADA Integration into EMS			$10,000
Transformer			$3,000,000
Dynamic Study			$30,000
Various Departments Work			$90,000
Subtotal Cost			$4,785,000
Approximate Total Cost with 18% Contingency			$5,502,750

The estimated time to complete this work is **36-48 months** after receipt of a fully executed interconnection agreement.

Interconnection Customer Scope of Work

The Interconnection Customer assumes full responsibility for design and construction of all facilities associated with the AC1-095 generating station and the direct connection line on the IC side of the Point of Interconnection.

The IC will be required to install metering and telemetry equipment 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.

It is the IC's responsibility to send the data that PJM and DPL requires directly to PJM. The IC will grant permission for PJM to send DPL the following telemetry that the IC sends to PJM: real time MW, MVAR, volts, amperes, generator status, and interval MWH and MVARH.

Equipment Requirements

Any transformers on the customer's side must be Wye grounded on the utility side or alternatively 3 phase potential transformers and a relay capable of detecting over/under voltage shall be installed to detect an undesirable condition on the high side of the customer's transformer.

The inverter at the DG location shall have the following capabilities:

- Voltage flicker reduction through dynamic VAR or fixed PF response
- Ramp rate control
- SCADA communications
- Curtailment or other mitigation ability if high voltage were to occur
- Low voltage and system disturbance ride through
- Ability to receive and respond to a transfer trip signal

- Ability to adjust PF or VARs based on utility signal
- Ability to Adjust Real Power Output based on utility signal

The inverter shall operate in accordance with the IEEE 1547 series of standards that have been approved. While inverters should be capable of voltage stabilization thru dynamic VAR response and capable of low voltage and system disturbance ride through, neither of these capabilities shall be implemented until such time that the IEEE 1547 series of standards are revised and approved to include standards for these capabilities. At such time as these revised standards become available, the PV owner/operator shall cooperate with the Company (the 'Company' referring to ACE, DPL, or PEPCO) to implement these capabilities with settings acceptable to the Company. It is the responsibility of the owner to secure the inverter from any unauthorized access (including physical and remote access) which could alter settings or adversely affect the inverter's ability to operate as required. Security measures should include utilizing secure password settings and/or physical locks on cabinet doors.

Additional Operating Requirements

1. The Company (Pepco, ACE, DPL) will require the capability to remotely disconnect the generator from the grid by communication from its System Operations facility. This will be accomplished with a line recloser.

2. It is the Interconnection Customer's responsibility to send the data that PJM and the Company requires directly to PJM. The Interconnection Customer will grant permission for PJM to send the Company the following telemetry that the Interconnection Customer sends to PJM: real time MW, MVAR, volts, amperes, generator breaker status or inverter status, and interval MWH and MVARH.

3. The Interconnection Customer will be required to make provisions for a voice quality phone line within approximately 3 feet of each Company metering position to facilitate remote interrogation and data collection.

4. A mutually acceptable means of interrupting and disconnecting the generator with a visible break, able to be tagged and locked out, shall be worked out with Company Distribution Engineering.

5. Company reserves the right to charge the Interconnection Customer operation and maintenance expenses to maintain the Interconnection Customer attachment facilities, including metering and telecommunications facilities, owned by Company.

6. Study was performed with the generator on the transformer that it will be served from during normal conditions. Customer will not be allowed to generate when the feeder is served by an alternate transformer.

High Voltage Warning

Voltage received at the meter from the utility can be 104% or 105% of nominal. Normal operating procedures dictate that voltage at the substation be raised to the higher end of an acceptable bandwidth in order to provide adequate supply to distant customers. Transformers with no load taps

should be used to reduce the voltage by 2.5% to avoid the possibility of inverter trips. Failure to account for this may result in lost energy production.

Summer Peak Analysis - 2020

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, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

1. (DP&L - DP&L) The NMEREDTH-AB2-135 TAP 69 kV line (from bus 232812 to bus 924820 ckt 1) loads from 97.62% to 99.35% (DC power flow) of its emergency rating (93 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 1.61 MW to the thermal violation.

   CONTINGENCY 'DBL_4NC'/* RED LION-CEDAR CREEK 230;RED LION-CARTANZA 230
   OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
   OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
   END

   Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

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. (DP&L - DP&L) The MILF_230-STEELE 230 kV line (from bus 232004 to bus 232000 ckt 1) loads from 168.8% to 170.11% (DC power flow) of its emergency rating (551 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 7.25 MW to the thermal violation.

   CONTINGENCY 'DBL_4NC'/* RED LION-CEDAR CREEK 230;RED LION-CARTANZA 230
   OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
   OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
   END

Please refer to Appendix 2 for a table containing the generators having contribution to this flowgate.

2. (DP&L - DP&L) The KENT-NMEREDTH 69 kV line (from bus 232215 to bus 232812 ckt 1) loads from 122.67% to 124.41% (DC power flow) of its emergency rating (93 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 1.61 MW to the thermal violation.

   CONTINGENCY 'DBL_4NC'/* RED LION-CEDAR CREEK 230;RED LION-CARTANZA 230
   OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
   OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
   END

   Please refer to Appendix 3 for a table containing the generators having contribution to this flowgate.

3. (DP&L - DP&L) The AB2-135 TAP-CHURC_69 69 kV line (from bus 924820 to bus 232203 ckt 1) loads from 148.34% to 150.07% (DC power flow) of its emergency rating (93 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 1.61 MW to the thermal violation.

   CONTINGENCY 'DBL_4NC'/* RED LION-CEDAR CREEK 230;RED LION-CARTANZA 230
   OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
   OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
   END

   Please refer to Appendix 4 for a table containing the generators having contribution to this flowgate.

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements

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

1. To mitigate the (DP&L) NMEREDTH-AB2-135 TAP 69 kV line (from bus 232812 to bus 924820 ckt 1) overload will require increasing the emergency rating of the AB2-135 to New Meredith 69 kV line rebuilding the circuit. The rebuild includes the installation of new poles and a new disconnect switch. The estimate to perform this work is **$8,674,000** and will take **3 years** to complete.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

1. To mitigate the (DP&L) MILF_230-STEELE 230 kV line (from bus 232004 to bus 232000 ckt 1) overload will require increasing the emergency rating of the Milford to Steele 230 kV line by rebuilding the circuit. The rebuild includes the replacement of poles. The estimate to perform this work is **$43,965,000** and will take **4 years** to complete.

2. To mitigate the (DP&L) KENT-NMEREDTH 69 kV line (from bus 232215 to bus 232812 ckt 1) overload will require increasing the emergency rating of the Kent to New Meredith 69 kV line by rebuilding of the circuit. The rebuild includes the installation of new poles, new disconnect switches, and new relays. The estimate to perform this work is **$9,720,000** and will take **24-36 months** to complete.

3. To mitigate the (DP&L) AB2-135 TAP-CHURC_69 69 kV line (from bus 924820 to bus 232203 ckt 1) overloads will require increasing the emergency rating of the AB2-135 to Church 69 kV line by rebuilding the circuit. The rebuild includes the installation of new poles and a new disconnect switch. The estimate to perform this work is **$8,674,000** and will take **3 years** to complete.

Steady-State Voltage Requirements
(Results of the steady-state voltage studies should be inserted here)

To be performed during later study phases.

Short Circuit
(Summary of impacted circuit breakers)

No issues identified.

Stability and Reactive Power Requirement
(Results of the dynamic studies should be inserted here)

To be performed during later study phases.

Light Load Analysis - 2020
Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

Facilities Study Estimate
(If a Facilities Study is required, provide the estimated duration and cost estimate to perform Facilities Study)

7 months; $50,000

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any 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 Merchant Transmission Interconnection request.
Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed, which will study all overload conditions associated with the overloaded element(s) identified.

None

Delmarva Power and Light Costs

Cost estimates will further be refined as a part of the Impact Study and Facilities Study for this project. The Interconnection Customer will be responsible for all costs incurred by DPL in connection with the AC1-095 project. Such costs may include, but are not limited to, any transmission system assets currently in DPL's rate base that are prematurely retired due to the AC1-095 project. PJM shall work with DPL to identify these retirement costs and any additional expenses. DPL reserves the right to reassess issues presented in this document and, upon appropriate justification, submit additional costs related to the AC1-095 project.

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.
It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(DP&L - DP&L) The NMEREDTH-AB2-135 TAP 69 kV line (from bus 232812 to bus 924820 ckt 1) loads from 97.62% to 99.35% (DC power flow) of its emergency rating (93 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 1.61 MW to the thermal violation.

```
CONTINGENCY 'DBL_4NC'                                  /* RED LION-CEDAR CREEK
230;RED LION-CARTANZA 230
  OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
  OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
  END
```

Bus Number	*Bus Name*	*Full Contribution*
232900	*DEMECSMY*	*1.59*
232851	*DUP-SFR1*	*0.19*
232923	*MR1*	*1.32*
232924	*MR2*	*1.32*
232910	*NRG_G1*	*2.93*
232911	*NRG_G2*	*2.93*
297077	*V2-028 E*	*0.2*
904212	*V4-022E*	*0.21*
232813	*VAUGHN*	*0.16*
901004	*W1-003 E*	*0.3*
901014	*W1-004 E*	*0.3*
901024	*W1-005 E*	*0.3*
901034	*W1-006 E*	*0.3*
901411	*W1-062*	*1.69*
907052	*X1-032 E*	*0.26*
907324	*X1-096 E*	*5.97*
913412	*Y1-080 E*	*0.11*
915542	*Y3-058 E*	*0.6*
920582	*Z1-076 C*	*0.36*
920583	*Z1-076 E*	*0.58*
920592	*Z1-077 C*	*0.25*
920593	*Z1-077 E*	*0.41*
917082	*Z2-012 E*	*0.82*
920763	*Z2-076 E*	*0.15*
920773	*Z2-077 E*	*0.15*
921122	*AA1-059 C*	*0.28*
921123	*AA1-059 E*	*0.11*
921592	*AA1-140 C*	*0.58*
921593	*AA1-140 E*	*0.95*
921602	*AA1-141 C*	*0.38*
921603	*AA1-141 E*	*0.62*
921872	*AA2-069*	*41.18*
922213	*AA2-129 E*	*1.33*
922222	*AA2-130*	*0.13*
922752	*AB1-056 C OP*	*4.98*
922753	*AB1-056 E OP*	*14.19*
922762	*AB1-057 C*	*5.06*
922763	*AB1-057 E*	*14.42*
923282	*AB1-137 C*	*1.1*
923283	*AB1-137 E*	*0.47*
923902	*AB2-030 E*	*0.27*
923931	*AB2-033 C*	*0.47*
923932	*AB2-033 E*	*0.19*
924361	*AB2-084 C*	*0.25*

924362	*AB2-084 E*	*0.4*
924681	*AB2-120 C OP*	*2.53*
924682	*AB2-120 E OP*	*4.13*
924781	*AB2-130 C OP*	*3.13*
924782	*AB2-130 E OP*	*5.11*
925091	*AB2-166 C*	*0.14*
925092	*AB2-166 E*	*0.24*
925101	*AB2-167 C*	*0.35*
925102	*AB2-167 E*	*0.58*
925231	*AB2-177 C*	*0.17*
925232	*AB2-177 E*	*0.28*
925261	*AB2-180 C*	*0.9*
925262	*AB2-180 E*	*0.38*
925381	*AC1-009 C*	*0.5*
925382	*AC1-009 E*	*0.82*
925531	*AC1-028*	*0.25*
925651	*AC1-041 C*	*0.13*
925652	*AC1-041 E*	*0.21*
925731	*AC1-049 C*	*0.12*
925732	*AC1-049 E*	*0.19*
925741	*AC1-050 C*	*0.11*
925742	*AC1-050 E*	*0.18*
925761	*AC1-052 C*	*0.66*
925762	*AC1-052 E*	*0.27*
926131	*AC1-091 C*	*1.11*
926132	*AC1-091 E*	*1.82*
926141	*AC1-092 C*	*1.11*
926142	*AC1-092 E*	*1.82*
926151	*AC1-093 C*	*1.05*
926152	*AC1-093 E*	*1.73*
926161	*AC1-094 C*	*0.89*
926162	*AC1-094 E*	*1.46*
926171	*AC1-095 C*	*0.92*
926172	*AC1-095 E*	*0.69*
926911	*AC1-177*	*0.26*
926931	*AC1-180*	*0.38*
927191	*AC1-213 C*	*0.23*
927192	*AC1-213 E*	*0.12*
927321	*AC1-229 C*	*0.3*
927322	*AC1-229 E*	*0.49*

Appendix 2

(DP&L - DP&L) The MILF_230-STEELE 230 kV line (from bus 232004 to bus 232000 ckt 1) loads from 168.8% to 170.11% (DC power flow) of its emergency rating (551 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 7.25 MW to the thermal violation.

```
CONTINGENCY 'DBL_4NC'                                   /* RED LION-CEDAR CREEK
230;RED LION-CARTANZA 230
  OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
  OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
  END
```

Bus Number	*Bus Name*	*Full Contribution*
232900	*DEMECSMY*	*5.8*
232616	*GEN FOOD*	*2.12*
232904	*IR4*	*51.07*
232923	*MR1*	*12.53*
232924	*MR2*	*12.53*
232922	*MR3*	*14.25*
232901	*NORTHST*	*6.29*
297077	*V2-028 E*	*1.28*
904212	*V4-022E*	*1.52*
901004	*W1-003 E*	*2.22*
901014	*W1-004 E*	*2.22*
901024	*W1-005 E*	*2.22*
901034	*W1-006 E*	*2.22*
901411	*W1-062*	*6.16*
903511	*W3-032A*	*43.16*
907052	*X1-032 E*	*1.89*
907324	*X1-096 E*	*42.96*
910572	*X3-008 E*	*3.32*
910592	*X3-015 E*	*3.81*
913412	*Y1-080 E*	*0.68*
915542	*Y3-058 E*	*4.1*
920582	*Z1-076 C*	*2.64*
920583	*Z1-076 E*	*4.3*
920592	*Z1-077 C*	*1.88*
920593	*Z1-077 E*	*3.07*
917082	*Z2-012 E*	*6.09*
920763	*Z2-076 E*	*1.22*
920773	*Z2-077 E*	*1.22*
921122	*AA1-059 C*	*1.99*
921123	*AA1-059 E*	*0.79*
921142	*AA1-061 C*	*3.72*
921143	*AA1-061 E*	*1.83*
921592	*AA1-140 C*	*4.6*

921593	*AA1-140 E*	*7.51*
921602	*AA1-141 C*	*2.84*
921603	*AA1-141 E*	*4.63*
921872	*AA2-069*	*390.53*
922213	*AA2-129 E*	*9.83*
922222	*AA2-130*	*0.92*
922752	*AB1-056 C OP*	*41.89*
922753	*AB1-056 E OP*	*119.31*
922762	*AB1-057 C*	*42.55*
922763	*AB1-057 E*	*121.26*
923282	*AB1-137 C*	*8.78*
923283	*AB1-137 E*	*3.76*
923902	*AB2-030 E*	*1.96*
923931	*AB2-033 C*	*3.52*
923932	*AB2-033 E*	*1.39*
924361	*AB2-084 C*	*1.79*
924362	*AB2-084 E*	*2.93*
924681	*AB2-120 C OP*	*18.79*
924682	*AB2-120 E OP*	*30.65*
924781	*AB2-130 C OP*	*19.74*
924782	*AB2-130 E OP*	*32.21*
924831	*AB2-136 C OP*	*7.6*
924832	*AB2-136 E OP*	*10.79*
925091	*AB2-166 C*	*0.95*
925092	*AB2-166 E*	*1.66*
925101	*AB2-167 C*	*2.63*
925102	*AB2-167 E*	*4.31*
925151	*AB2-172 C OP*	*5.08*
925152	*AB2-172 E OP*	*8.29*
925231	*AB2-177 C*	*1.25*
925232	*AB2-177 E*	*2.04*
925261	*AB2-180 C*	*6.18*
925262	*AB2-180 E*	*2.65*
925381	*AC1-009 C*	*3.73*
925382	*AC1-009 E*	*6.09*
925531	*AC1-028*	*1.79*
925651	*AC1-041 C*	*0.95*
925652	*AC1-041 E*	*1.55*
925731	*AC1-049 C*	*0.91*
925732	*AC1-049 E*	*1.51*
925741	*AC1-050 C*	*0.74*
925742	*AC1-050 E*	*1.21*
925761	*AC1-052 C*	*4.91*
925762	*AC1-052 E*	*1.96*
926131	*AC1-091 C*	*4.99*

926132	*AC1-091 E*	*8.18*
926141	*AC1-092 C*	*4.99*
926142	*AC1-092 E*	*8.18*
926151	*AC1-093 C*	*4.72*
926152	*AC1-093 E*	*7.78*
926161	*AC1-094 C*	*3.99*
926162	*AC1-094 E*	*6.59*
926171	*AC1-095 C*	*4.13*
926172	*AC1-095 E*	*3.13*
926911	*AC1-177*	*1.85*
926931	*AC1-180*	*2.77*
927031	*AC1-190 C*	*9.61*
927032	*AC1-190 E*	*4.12*
927191	*AC1-213 C*	*1.65*
927192	*AC1-213 E*	*0.85*
927311	*AC1-228 C*	*0.29*
927312	*AC1-228 E*	*0.51*
927321	*AC1-229 C*	*2.39*
927322	*AC1-229 E*	*3.89*

Appendix 3

(DP&L - DP&L) The KENT-NMEREDTH 69 kV line (from bus 232215 to bus 232812 ckt 1) loads from 122.67% to 124.41% (DC power flow) of its emergency rating (93 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 1.61 MW to the thermal violation.

```
CONTINGENCY 'DBL_4NC'                          /* RED LION-CEDAR CREEK
230;RED LION-CARTANZA 230
  OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
  OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
  END
```

Bus Number	*Bus Name*	*Full Contribution*
232900	*DEMECSMY*	*1.59*
232851	*DUP-SFR1*	*0.19*
232923	*MR1*	*1.32*
232924	*MR2*	*1.32*
232910	*NRG_G1*	*2.93*
232911	*NRG_G2*	*2.93*
297077	*V2-028 E*	*0.2*
904212	*V4-022E*	*0.21*
232813	*VAUGHN*	*0.16*
901004	*W1-003 E*	*0.3*
901014	*W1-004 E*	*0.3*

901024	*W1-005 E*	*0.3*
901034	*W1-006 E*	*0.3*
901411	*W1-062*	*1.69*
907052	*X1-032 E*	*0.26*
907324	*X1-096 E*	*5.97*
913412	*Y1-080 E*	*0.11*
915542	*Y3-058 E*	*0.6*
920582	*Z1-076 C*	*0.36*
920583	*Z1-076 E*	*0.58*
920592	*Z1-077 C*	*0.25*
920593	*Z1-077 E*	*0.41*
917082	*Z2-012 E*	*0.82*
920763	*Z2-076 E*	*0.15*
920773	*Z2-077 E*	*0.15*
921122	*AA1-059 C*	*0.28*
921123	*AA1-059 E*	*0.11*
921592	*AA1-140 C*	*0.58*
921593	*AA1-140 E*	*0.95*
921602	*AA1-141 C*	*0.38*
921603	*AA1-141 E*	*0.62*
921872	*AA2-069*	*41.18*
922213	*AA2-129 E*	*1.33*
922222	*AA2-130*	*0.13*
922752	*AB1-056 C OP*	*4.98*
922753	*AB1-056 E OP*	*14.19*
922762	*AB1-057 C*	*5.06*
922763	*AB1-057 E*	*14.42*
923282	*AB1-137 C*	*1.1*
923283	*AB1-137 E*	*0.47*
923902	*AB2-030 E*	*0.27*
923931	*AB2-033 C*	*0.47*
923932	*AB2-033 E*	*0.19*
924361	*AB2-084 C*	*0.25*
924362	*AB2-084 E*	*0.4*
924681	*AB2-120 C OP*	*2.53*
924682	*AB2-120 E OP*	*4.13*
924781	*AB2-130 C OP*	*3.13*
924782	*AB2-130 E OP*	*5.11*
925091	*AB2-166 C*	*0.14*
925092	*AB2-166 E*	*0.24*
925101	*AB2-167 C*	*0.35*
925102	*AB2-167 E*	*0.58*
925231	*AB2-177 C*	*0.17*
925232	*AB2-177 E*	*0.28*
925261	*AB2-180 C*	*0.9*

925262	*AB2-180 E*	*0.38*
925381	*AC1-009 C*	*0.5*
925382	*AC1-009 E*	*0.82*
925531	*AC1-028*	*0.25*
925651	*AC1-041 C*	*0.13*
925652	*AC1-041 E*	*0.21*
925731	*AC1-049 C*	*0.12*
925732	*AC1-049 E*	*0.19*
925741	*AC1-050 C*	*0.11*
925742	*AC1-050 E*	*0.18*
925761	*AC1-052 C*	*0.66*
925762	*AC1-052 E*	*0.27*
926131	*AC1-091 C*	*1.11*
926132	*AC1-091 E*	*1.82*
926141	*AC1-092 C*	*1.11*
926142	*AC1-092 E*	*1.82*
926151	*AC1-093 C*	*1.05*
926152	*AC1-093 E*	*1.73*
926161	*AC1-094 C*	*0.89*
926162	*AC1-094 E*	*1.46*
926171	*AC1-095 C*	*0.92*
926172	*AC1-095 E*	*0.69*
926911	*AC1-177*	*0.26*
926931	*AC1-180*	*0.38*
927191	*AC1-213 C*	*0.23*
927192	*AC1-213 E*	*0.12*
927321	*AC1-229 C*	*0.3*
927322	*AC1-229 E*	*0.49*

Appendix 4

(DP&L - DP&L) The AB2-135 TAP-CHURC_69 69 kV line (from bus 924820 to bus 232203 ckt 1) loads from 148.34% to 150.07% (DC power flow) of its emergency rating (93 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 1.61 MW to the thermal violation.

```
CONTINGENCY 'DBL_4NC'                          /* RED LION-CEDAR CREEK
230;RED LION-CARTANZA 230
  OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
  OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
  END
```

Bus Number	*Bus Name*	*Full Contribution*
232900	*DEMECSMY*	*1.59*

232851	*DUP-SFR1*	*0.19*
232923	*MR1*	*1.32*
232924	*MR2*	*1.32*
232910	*NRG_G1*	*2.93*
232911	*NRG_G2*	*2.93*
904212	*V4-022E*	*0.21*
232813	*VAUGHN*	*0.16*
901004	*W1-003 E*	*0.3*
901014	*W1-004 E*	*0.3*
901024	*W1-005 E*	*0.3*
901034	*W1-006 E*	*0.3*
901411	*W1-062*	*1.69*
907052	*X1-032 E*	*0.26*
907324	*X1-096 E*	*5.97*
915542	*Y3-058 E*	*0.6*
920582	*Z1-076 C*	*0.36*
920583	*Z1-076 E*	*0.58*
920592	*Z1-077 C*	*0.25*
920593	*Z1-077 E*	*0.41*
917082	*Z2-012 E*	*0.82*
920763	*Z2-076 E*	*0.15*
920773	*Z2-077 E*	*0.15*
921122	*AA1-059 C*	*0.28*
921123	*AA1-059 E*	*0.11*
921592	*AA1-140 C*	*0.58*
921593	*AA1-140 E*	*0.95*
921602	*AA1-141 C*	*0.38*
921603	*AA1-141 E*	*0.62*
921872	*AA2-069*	*41.18*
922213	*AA2-129 E*	*1.33*
922222	*AA2-130*	*0.13*
922752	*AB1-056 C OP*	*4.98*
922753	*AB1-056 E OP*	*14.19*
922762	*AB1-057 C*	*5.06*
922763	*AB1-057 E*	*14.42*
923282	*AB1-137 C*	*1.1*
923283	*AB1-137 E*	*0.47*
923902	*AB2-030 E*	*0.27*
923931	*AB2-033 C*	*0.47*
923932	*AB2-033 E*	*0.19*
924361	*AB2-084 C*	*0.25*
924362	*AB2-084 E*	*0.4*
924681	*AB2-120 C OP*	*2.53*
924682	*AB2-120 E OP*	*4.13*
924781	*AB2-130 C OP*	*3.13*

924782	*AB2-130 E OP*	*5.11*
924821	*AB2-135 C*	*22.27*
924822	*AB2-135 E*	*25.4*
925091	*AB2-166 C*	*0.14*
925092	*AB2-166 E*	*0.24*
925101	*AB2-167 C*	*0.35*
925102	*AB2-167 E*	*0.58*
925231	*AB2-177 C*	*0.17*
925232	*AB2-177 E*	*0.28*
925261	*AB2-180 C*	*0.9*
925262	*AB2-180 E*	*0.38*
925381	*AC1-009 C*	*0.5*
925382	*AC1-009 E*	*0.82*
925531	*AC1-028*	*0.25*
925651	*AC1-041 C*	*0.13*
925652	*AC1-041 E*	*0.21*
925731	*AC1-049 C*	*0.12*
925732	*AC1-049 E*	*0.19*
925761	*AC1-052 C*	*0.66*
925762	*AC1-052 E*	*0.27*
926131	*AC1-091 C*	*1.11*
926132	*AC1-091 E*	*1.82*
926141	*AC1-092 C*	*1.11*
926142	*AC1-092 E*	*1.82*
926151	*AC1-093 C*	*1.05*
926152	*AC1-093 E*	*1.73*
926161	*AC1-094 C*	*0.89*
926162	*AC1-094 E*	*1.46*
926171	*AC1-095 C*	*0.92*
926172	*AC1-095 E*	*0.69*
926911	*AC1-177*	*0.26*
926931	*AC1-180*	*0.38*
927191	*AC1-213 C*	*0.23*
927192	*AC1-213 E*	*0.12*
927321	*AC1-229 C*	*0.3*
927322	*AC1-229 E*	*0.49*