# *Generation Interconnection*
# *Feasibility Study Report*
# *Queue Position AB2-084*

The Interconnection Customer (IC) has proposed a 10 MW (3.8 MWC) solar generating facility to be located in Pocomoke City, Somerset County, Maryland. PJM studied AB2-084 as a 10 MW injection into the Delmarva Power and Light Company (DPL) system at the Costen 138 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 October 30, 2018.

## Point of Interconnection

The Interconnection Customer requested a distribution level interconnection. Distribution facilities in the area of the AB2-084 project are owned by the Choptank Electric Cooperative (CEC). As a result, AB2-084 will interconnect with the CEC system at the Costen Substation. The DPL system feeds the Costen Substation.

### Transmission Owner Scope of Attachment Facility Work

There is no DPL Attachment Facility work required for the AB2-084 project. The IC must contact CEC for the work scope and schedule.

### Required Relaying and Communications

*(List of impacted substations and estimates for relaying setting changes, replacements)*

**Three phase 69kV Bus PTs and Overvoltage Protection**

The project will require the addition of three phase potential monitoring devices on the 69kV bus in order to sense overvoltages related to backfeeding a single phase to ground fault. This potential should be wired into the voltage input of a relay capable of detecting and tripping for overvoltage.

**Over Voltage Protection**

A relay capable of detecting overvoltage should remove the generation from service.

**The following trip times are required:**

Trip in 0.16 seconds for V < 50%
Trip in 2 seconds for 50% < V < 88%
Trip in 1 second for 110% < V <120%
Trip in 0.16 second for 120% < V

### Metering

Revenue metering specifications will be established by CEC.

**Interconnection Customer Scope of Work**

The Interconnection Customer assumes full responsibility for design and construction of all facilities associated with the AB2-084 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.

# 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 LORETTO 138/69 kV transformer (from bus 232127 to bus 232275 ckt 1) loads from 90.64% to 92.68% (DC power flow) of its emergency rating (71 MVA) for the line fault with failed breaker contingency outage of 'DP56'. This project contributes approximately 1.45 MW to the thermal violation.

   CONTINGENCY 'DP56' /*LORETTO BUS BREAKER
   DISCONNECT BRANCH FROM BUS 232127 TO BUS 232117 CKT 1 /*LORETTO VIENNA 138 1380
   DISCONNECT BRANCH FROM BUS 232127 TO BUS 232128 CKT 1 /*LORETTO PINEY GROVE 138 138
   END

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

2. (DP&L - DP&L) The PRESTON-TANYARD 69 kV line (from bus 232233 to bus 232821 ckt 1) loads from 31.01% to 32.28% (DC power flow) of its emergency rating (93 MVA) for the line

fault with failed breaker contingency outage of 'DP11'. This project contributes approximately 1.18 MW to the thermal violation.

```
CONTINGENCY 'DP11'                                  /*STEELE BUS BREAKER TO
MILFORD
DISCONNECT BRANCH FROM BUS 232004 TO BUS 232000 CKT 1       /*MILFORD
STEELE 230 230
DISCONNECT BRANCH FROM BUS 232000 TO BUS 232005 CKT 1       /*STEELE
VIENNA 230 230
END
```

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

3. (DP&L - DP&L) The TODD-PRESTON 69 kV line (from bus 232234 to bus 232233 ckt 1) loads from 37.03% to 38.3% (DC power flow) of its emergency rating (93 MVA) for the line fault with failed breaker contingency outage of 'DP11'. This project contributes approximately 1.18 MW to the thermal violation.

```
CONTINGENCY 'DP11'                                  /*STEELE BUS BREAKER TO
MILFORD
DISCONNECT BRANCH FROM BUS 232004 TO BUS 232000 CKT 1       /*MILFORD
STEELE 230 230
DISCONNECT BRANCH FROM BUS 232000 TO BUS 232005 CKT 1       /*STEELE
VIENNA 230 230
END
```

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

4. (DP&L - DP&L) The LORET_69-FRUITLND 69 kV line (from bus 232275 to bus 232288 ckt 1) loads from 91.91% to 93.91% (DC power flow) of its emergency rating (137 MVA) for the line fault with failed breaker contingency outage of 'DP56'. This project contributes approximately 2.74 MW to the thermal violation.

```
CONTINGENCY 'DP56'                                  /*LORETTO BUS BREAKER
DISCONNECT BRANCH FROM BUS 232127 TO BUS 232117 CKT 1       /*LORETTO
VIENNA 138 1380
DISCONNECT BRANCH FROM BUS 232127 TO BUS 232128 CKT 1       /*LORETTO
PINEY GROVE 138 138
END
```

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

5. (DP&L - DP&L) The FRUITLND-PEMBERTN 69 kV line (from bus 232288 to bus 232273 ckt 1) loads from 92.88% to 95.89% (DC power flow) of its emergency rating (91 MVA) for the line fault with failed breaker contingency outage of 'DP56'. This project contributes approximately 2.74 MW to the thermal violation.

   CONTINGENCY 'DP56' /*LORETTO BUS BREAKER
   DISCONNECT BRANCH FROM BUS 232127 TO BUS 232117 CKT 1 /*LORETTO VIENNA 138 1380
   DISCONNECT BRANCH FROM BUS 232127 TO BUS 232128 CKT 1 /*LORETTO PINEY GROVE 138 138
   END

   Please refer to Appendix 5 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 PINEY_69-M HERMON 69 kV line (from bus 232274 to bus 232272 ckt 1) loads from 109.06% to 110.49% (DC power flow) of its emergency rating (143 MVA) for the line fault with failed breaker contingency outage of 'DP15'. This project contributes approximately 2.04 MW to the thermal violation.

   CONTINGENCY 'DP15' /*INDIAN RIVER BUS BREAKER TO PINEY GROVE
   DISCONNECT BRANCH FROM BUS 232007 TO BUS 232006 CKT 1 /*PINEY GR INDRIV 4 230 230
   DISCONNECT BRANCH FROM BUS 232007 TO BUS 232128 CKT 1 /*PINEY GR PINEY GR 230 138
   DISCONNECT BRANCH FROM BUS 232006 TO BUS 232004 CKT 1 /*MILFORD INDIAN RIVER 230 230
   END

   Please refer to Appendix 6 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) LORETTO 138/69 kV transformer (from bus 232127 to bus 232275 ckt 1) overload will require replacement of the Loretto AT1 autotransformer, which requires the

reconfiguration of the 138 kV and 69 kV buses at Loretto Substation. The estimate to perform this work is **$4,377,000** and will take approximately **2 years** to complete.

2. To mitigate the (DP&L) PRESTON-TANYARD 69 kV line (from bus 232233 to bus 232821 ckt 1) overload will require the replacement of a disconnect switch at Preston Substation. The estimate to perform this work is **$36,000** and will take approximately **1 year** to complete.

3. To mitigate the (DP&L) TODD-PRESTON 69 kV line (from bus 232234 to bus 232233 ckt 1) overload will require substation reinforcements at Preston Substation and Todd Substation. The estimate to perform this work is **$67,000** and will take approximately **1 year** to complete.

4. To mitigate the (DP&L) LORET_69-FRUITLND 69 kV line (from bus 232275 to bus 232288 ckt 1) overload will require rebuilding of the Loretto – Fruitland 69 kV transmission line and substation reinforcements at Loretto Substation and Fruitland Substation. The estimate to perform this work is **$7,196,000** and will take approximately **3 years** to complete.

   *Note: Queue project AB2-084 is not expected to have cost responsibility for this network upgrade due to cost allocation rules.*

5. To mitigate the (DP&L) FRUITLND-PEMBERTN 69 kV line (from bus 232288 to bus 232273 ckt 1) overload will require completion of PJM Supplemental Project s0820. Current estimated completion date is December 31, 2016.

   *Note: Queue project AB2-084 is not expected to have cost responsibility for this network upgrade due to cost allocation rules.*

**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) The PINEY_69-M HERMON 69 kV line (from bus 232274 to bus 232272 ckt 1) overload will require rebuilding of the Piney Grove – Mount Hermon 69 kV transmission line and substation reinforcements at Piney Grove Substation and Mount Hermon Substation. The estimate to perform this work is **$9,688,000** and will take approximately **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.*

1. (DP&L - DP&L) The PINEY138-LORETTO 138 kV line (from bus 232128 to bus 232127 ckt 1) loads from 92.39% to 94.37% (DC power flow) of its emergency rating (159 MVA) for the single line contingency outage of 'CKT 13713'. This project contributes approximately 3.13 MW to the thermal violation.

   CONTINGENCY 'CKT 13713'
   OPEN LINE FROM BUS 232129 TO BUS 232127 CIRCUIT 1 /KINGS CREEK - LORETTO 138
   END

2. (DP&L - DP&L) The N_CHURCH-AB2-120 TAP 138 kV line (from bus 232131 to bus 924680 ckt 1) loads from 107.52% to 109.8% (DC power flow) of its emergency rating (226 MVA) for the single line contingency outage of 'CKT 13713'. This project contributes approximately 5.16 MW to the thermal violation.

   CONTINGENCY 'CKT 13713'
   OPEN LINE FROM BUS 232129 TO BUS 232127 CIRCUIT 1 /KINGS CREEK - LORETTO 138
   END

3. (DP&L - DP&L) The PINEY_69-M HERMON 69 kV line (from bus 232274 to bus 232272 ckt 1) loads from 108.53% to 109.96% (DC power flow) of its emergency rating (143 MVA) for the single line contingency outage of 'CKT 23002'. This project contributes approximately 2.06 MW to the thermal violation.

   CONTINGENCY 'CKT 23002'
   DISCONNECT BUS 232007 /INDIAN RIVER - PINEY GROVE 230 & PNY GRV AT-20 XFMER
   END

4. (DP&L - DP&L) The OAKHL_69-WATTSVIL 69 kV line (from bus 232280 to bus 232281 ckt 1) loads from 101.93% to 103.24% (DC power flow) of its emergency rating (89 MVA) for the single line contingency outage of 'CKT 13789'. This project contributes approximately 1.17 MW to the thermal violation.

   CONTINGENCY 'CKT 13789'
   OPEN LINE FROM BUS 232132 TO BUS 232133 CIRCUIT 1 /OAK HALL - WATTSVILLE 138
   END

5. (DP&L - DP&L) The SHORT 1-LAUREL 69 kV line (from bus 232828 to bus 232249 ckt 1) loads from 70.53% to 71.31% (DC power flow) of its emergency rating (57 MVA) for the single line contingency outage of 'CKT 23002'. This project contributes approximately 0.98 MW to the thermal violation.

   CONTINGENCY 'CKT 23002'
   DISCONNECT BUS 232007 /INDIAN RIVER - PINEY GROVE 230 & PNY GRV AT-20 XFMER
   END

6. (DP&L - DP&L) The AB2-120 TAP-PINEY138 138 kV line (from bus 924680 to bus 232128 ckt 1) loads from 107.43% to 109.72% (DC power flow) of its emergency rating (226 MVA) for the single line contingency outage of 'CKT 13713'. This project contributes approximately 5.16 MW to the thermal violation.

   CONTINGENCY 'CKT 13713'
   OPEN LINE FROM BUS 232129 TO BUS 232127 CIRCUIT 1 /KINGS CREEK - LORETTO 138
   END

7. (DP&L - DP&L) The AB2-120 TAP-PINEY138 138 kV line (from bus 924680 to bus 232128 ckt 1) loads from 82.14% to 83.33% (DC power flow) of its normal rating (172 MVA) for non-contingency condition. This project contributes approximately 2.04 MW to the thermal violation.

**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 AB2-084 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 AB2-084 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 AB2-084 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 LORETTO 138/69 kV transformer (from bus 232127 to bus 232275 ckt 1) loads from 90.64% to 92.68% (DC power flow) of its emergency rating (71 MVA) for the line fault with failed breaker contingency outage of 'DP56'. This project contributes approximately 1.45 MW to the thermal violation.

```
CONTINGENCY 'DP56'                                    /*LORETTO BUS BREAKER
  DISCONNECT BRANCH FROM BUS 232127 TO BUS 232117 CKT 1          /*LORETTO
VIENNA 138 1380
  DISCONNECT BRANCH FROM BUS 232127 TO BUS 232128 CKT 1          /*LORETTO
PINEY GROVE 138 138
  END
```

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *232926* | *CRISFLD1* | *0.34* |
| *904212* | *V4-022E* | *0.28* |
| *901004* | *W1-003 E* | *0.43* |
| *901014* | *W1-004 E* | *0.43* |
| *901024* | *W1-005 E* | *0.43* |
| *901034* | *W1-006 E* | *0.43* |
| *907052* | *X1-032 E* | *0.58* |
| *907323* | *X1-096 C* | *0.66* |
| *907324* | *X1-096 E* | *16.04* |

| | | |
|---|---|---|
| *920582* | *Z1-076 C* | *0.35* |
| *920583* | *Z1-076 E* | *0.57* |
| *920592* | *Z1-077 C* | *0.25* |
| *920593* | *Z1-077 E* | *0.41* |
| *917082* | *Z2-012 E* | *1.14* |
| *921122* | *AA1-059 C* | *0.74* |
| *921123* | *AA1-059 E* | *0.29* |
| *918831* | *AA1-102* | *1.27* |
| *922213* | *AA2-129 E* | *1.83* |
| *922222* | *AA2-130* | *0.35* |
| *923902* | *AB2-030 E* | *0.37* |
| *923931* | *AB2-033 C* | *0.66* |
| *923932* | *AB2-033 E* | *0.26* |
| *924361* | *AB2-084 C* | *0.55* |
| *924362* | *AB2-084 E* | *0.9* |
| *924681* | *AB2-120 C OP* | *3.12* |
| *924682* | *AB2-120 E OP* | *5.1* |
| *925071* | *AB2-164 C OP* | *0.7* |
| *925072* | *AB2-164 E OP* | *1.14* |
| *925081* | *AB2-165 C OP* | *0.7* |
| *925082* | *AB2-165 E OP* | *1.14* |
| *925101* | *AB2-167 C* | *0.35* |
| *925102* | *AB2-167 E* | *0.58* |
| *925311* | *AB2-192 C OP* | *0.7* |
| *925312* | *AB2-192 E OP* | *1.14* |

## Appendix 2

(DP&L - DP&L) The PRESTON-TANYARD 69 kV line (from bus 232233 to bus 232821 ckt 1) loads from 31.01% to 32.28% (DC power flow) of its emergency rating (93 MVA) for the line fault with failed breaker contingency outage of 'DP11'. This project contributes approximately 1.18 MW to the thermal violation.

```
CONTINGENCY 'DP11'                                  /*STEELE BUS BREAKER TO MILFORD
  DISCONNECT BRANCH FROM BUS 232004 TO BUS 232000 CKT 1          /*MILFORD
STEELE 230 230
  DISCONNECT BRANCH FROM BUS 232000 TO BUS 232005 CKT 1          /*STEELE
VIENNA 230 230
  END
```

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *232926* | *CRISFLD1* | *0.24* |
| *293670* | *O-025 C* | *0.16* |
| *297076* | *V2-028 C* | *0.1* |
| *297077* | *V2-028 E* | *0.81* |

| | | |
|---|---|---|
| *904212* | *V4-022E* | *0.36* |
| *232919* | *VN10* | *0.61* |
| *232907* | *VN8* | *4.45* |
| *901003* | *W1-003 C* | *0.07* |
| *901004* | *W1-003 E* | *0.52* |
| *901013* | *W1-004 C* | *0.07* |
| *901014* | *W1-004 E* | *0.52* |
| *901023* | *W1-005 C* | *0.07* |
| *901024* | *W1-005 E* | *0.52* |
| *901033* | *W1-006 C* | *< 0.01* |
| *901034* | *W1-006 E* | *0.52* |
| *907052* | *X1-032 E* | *0.47* |
| *907323* | *X1-096 C* | *0.46* |
| *907324* | *X1-096 E* | *11.19* |
| *910571* | *X3-008 C* | *0.57* |
| *910572* | *X3-008 E* | *4.78* |
| *910591* | *X3-015 C* | *0.41* |
| *910592* | *X3-015 E* | *3.43* |
| *913411* | *Y1-080 C* | *0.07* |
| *913412* | *Y1-080 E* | *0.56* |
| *915541* | *Y3-058 C* | *0.17* |
| *915542* | *Y3-058 E* | *1.43* |
| *920582* | *Z1-076 C* | *0.61* |
| *920583* | *Z1-076 E* | *1.* |
| *920592* | *Z1-077 C* | *0.44* |
| *920593* | *Z1-077 E* | *0.71* |
| *916441* | *Z1-100* | *0.09* |
| *916451* | *Z1-101* | *0.09* |
| *916461* | *Z1-102* | *0.09* |
| *920602* | *Z1-103* | *0.09* |
| *917082* | *Z2-012 E* | *1.42* |
| *920763* | *Z2-076 E* | *0.18* |
| *920773* | *Z2-077 E* | *0.18* |
| *920952* | *AA1-025* | *0.08* |
| *920962* | *AA1-026* | *0.08* |
| *920972* | *AA1-027* | *0.08* |
| *920982* | *AA1-028* | *0.08* |
| *921122* | *AA1-059 C* | *0.52* |
| *921123* | *AA1-059 E* | *0.2* |
| *921142* | *AA1-061 C* | *4.87* |
| *921143* | *AA1-061 E* | *2.4* |
| *918831* | *AA1-102* | *0.88* |
| *921592* | *AA1-140 C* | *0.67* |
| *921593* | *AA1-140 E* | *1.1* |
| *921602* | *AA1-141 C* | *0.65* |

| | | |
|---|---|---|
| *921603* | *AA1-141 E* | *1.07* |
| *922213* | *AA2-129 E* | *2.29* |
| *922222* | *AA2-130* | *0.24* |
| *922752* | *AB1-056 C OP* | *4.91* |
| *922753* | *AB1-056 E OP* | *14.* |
| *922762* | *AB1-057 C* | *4.99* |
| *922763* | *AB1-057 E* | *14.23* |
| *923282* | *AB1-137 C* | *1.14* |
| *923283* | *AB1-137 E* | *0.49* |
| *923902* | *AB2-030 E* | *0.46* |
| *923931* | *AB2-033 C* | *0.82* |
| *923932* | *AB2-033 E* | *0.33* |
| *924361* | *AB2-084 C* | *0.45* |
| *924362* | *AB2-084 E* | *0.73* |
| *924461* | *AB2-095 C* | *1.16* |
| *924462* | *AB2-095 E* | *1.89* |
| *924681* | *AB2-120 C OP* | *4.32* |
| *924682* | *AB2-120 E OP* | *7.04* |
| *924781* | *AB2-130 C OP* | *4.57* |
| *924782* | *AB2-130 E OP* | *7.46* |
| *924831* | *AB2-136 C OP* | *7.47* |
| *924832* | *AB2-136 E OP* | *10.6* |
| *925071* | *AB2-164 C OP* | *0.87* |
| *925072* | *AB2-164 E OP* | *1.42* |
| *925081* | *AB2-165 C OP* | *0.87* |
| *925082* | *AB2-165 E OP* | *1.42* |
| *925091* | *AB2-166 C* | *0.26* |
| *925092* | *AB2-166 E* | *0.45* |
| *925101* | *AB2-167 C* | *0.61* |
| *925102* | *AB2-167 E* | *1.* |
| *925151* | *AB2-172 C OP* | *7.33* |
| *925152* | *AB2-172 E OP* | *11.96* |
| *925231* | *AB2-177 C* | *0.29* |
| *925232* | *AB2-177 E* | *0.47* |
| *925261* | *AB2-180 C* | *2.15* |
| *925262* | *AB2-180 E* | *0.92* |
| *925311* | *AB2-192 C OP* | *0.87* |
| *925312* | *AB2-192 E OP* | *1.42* |

# Appendix 3

(DP&L - DP&L) The TODD-PRESTON 69 kV line (from bus 232234 to bus 232233 ckt 1) loads from 37.03% to 38.3% (DC power flow) of its emergency rating (93 MVA) for the line fault with

failed breaker contingency outage of 'DP11'. This project contributes approximately 1.18 MW to the thermal violation.

```
CONTINGENCY 'DP11'                                  /*STEELE BUS BREAKER TO MILFORD
  DISCONNECT BRANCH FROM BUS 232004 TO BUS 232000 CKT 1          /*MILFORD
STEELE 230 230
  DISCONNECT BRANCH FROM BUS 232000 TO BUS 232005 CKT 1          /*STEELE
VIENNA 230 230
  END
```

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *232926* | *CRISFLD1* | *0.24* |
| *293670* | *O-025 C* | *0.16* |
| *297076* | *V2-028 C* | *0.1* |
| *297077* | *V2-028 E* | *0.81* |
| *904212* | *V4-022E* | *0.36* |
| *232919* | *VN10* | *0.61* |
| *232907* | *VN8* | *4.45* |
| *901003* | *W1-003 C* | *0.07* |
| *901004* | *W1-003 E* | *0.52* |
| *901013* | *W1-004 C* | *0.07* |
| *901014* | *W1-004 E* | *0.52* |
| *901023* | *W1-005 C* | *0.07* |
| *901024* | *W1-005 E* | *0.52* |
| *901033* | *W1-006 C* | *< 0.01* |
| *901034* | *W1-006 E* | *0.52* |
| *907052* | *X1-032 E* | *0.47* |
| *907323* | *X1-096 C* | *0.46* |
| *907324* | *X1-096 E* | *11.19* |
| *910571* | *X3-008 C* | *0.57* |
| *910572* | *X3-008 E* | *4.78* |
| *910591* | *X3-015 C* | *0.41* |
| *910592* | *X3-015 E* | *3.43* |
| *913411* | *Y1-080 C* | *0.07* |
| *913412* | *Y1-080 E* | *0.56* |
| *915541* | *Y3-058 C* | *0.17* |
| *915542* | *Y3-058 E* | *1.43* |
| *920582* | *Z1-076 C* | *0.61* |
| *920583* | *Z1-076 E* | *1.* |
| *920592* | *Z1-077 C* | *0.44* |
| *920593* | *Z1-077 E* | *0.71* |
| *916441* | *Z1-100* | *0.09* |
| *916451* | *Z1-101* | *0.09* |
| *916461* | *Z1-102* | *0.09* |
| *920602* | *Z1-103* | *0.09* |
| *917082* | *Z2-012 E* | *1.42* |

| | | |
|---|---|---|
| *920763* | *Z2-076 E* | *0.18* |
| *920773* | *Z2-077 E* | *0.18* |
| *920952* | *AA1-025* | *0.08* |
| *920962* | *AA1-026* | *0.08* |
| *920972* | *AA1-027* | *0.08* |
| *920982* | *AA1-028* | *0.08* |
| *921122* | *AA1-059 C* | *0.52* |
| *921123* | *AA1-059 E* | *0.2* |
| *921142* | *AA1-061 C* | *4.87* |
| *921143* | *AA1-061 E* | *2.4* |
| *918831* | *AA1-102* | *0.88* |
| *921592* | *AA1-140 C* | *0.67* |
| *921593* | *AA1-140 E* | *1.1* |
| *921602* | *AA1-141 C* | *0.65* |
| *921603* | *AA1-141 E* | *1.07* |
| *922213* | *AA2-129 E* | *2.29* |
| *922222* | *AA2-130* | *0.24* |
| *922752* | *AB1-056 C OP* | *4.91* |
| *922753* | *AB1-056 E OP* | *14.* |
| *922762* | *AB1-057 C* | *4.99* |
| *922763* | *AB1-057 E* | *14.23* |
| *923282* | *AB1-137 C* | *1.14* |
| *923283* | *AB1-137 E* | *0.49* |
| *923902* | *AB2-030 E* | *0.46* |
| *923931* | *AB2-033 C* | *0.82* |
| *923932* | *AB2-033 E* | *0.33* |
| *924361* | *AB2-084 C* | *0.45* |
| *924362* | *AB2-084 E* | *0.73* |
| *924461* | *AB2-095 C* | *1.16* |
| *924462* | *AB2-095 E* | *1.89* |
| *924681* | *AB2-120 C OP* | *4.32* |
| *924682* | *AB2-120 E OP* | *7.04* |
| *924781* | *AB2-130 C OP* | *4.57* |
| *924782* | *AB2-130 E OP* | *7.46* |
| *924831* | *AB2-136 C OP* | *7.47* |
| *924832* | *AB2-136 E OP* | *10.6* |
| *925071* | *AB2-164 C OP* | *0.87* |
| *925072* | *AB2-164 E OP* | *1.42* |
| *925081* | *AB2-165 C OP* | *0.87* |
| *925082* | *AB2-165 E OP* | *1.42* |
| *925091* | *AB2-166 C* | *0.26* |
| *925092* | *AB2-166 E* | *0.45* |
| *925101* | *AB2-167 C* | *0.61* |
| *925102* | *AB2-167 E* | *1.* |
| *925151* | *AB2-172 C OP* | *7.33* |

| | | |
|---|---|---|
| *925152* | *AB2-172 E OP* | *11.96* |
| *925231* | *AB2-177 C* | *0.29* |
| *925232* | *AB2-177 E* | *0.47* |
| *925261* | *AB2-180 C* | *2.15* |
| *925262* | *AB2-180 E* | *0.92* |
| *925311* | *AB2-192 C OP* | *0.87* |
| *925312* | *AB2-192 E OP* | *1.42* |

# Appendix 4

(DP&L - DP&L) The LORET_69-FRUITLND 69 kV line (from bus 232275 to bus 232288 ckt 1) loads from 91.91% to 93.91% (DC power flow) of its emergency rating (137 MVA) for the line fault with failed breaker contingency outage of 'DP56'. This project contributes approximately 2.74 MW to the thermal violation.

CONTINGENCY 'DP56' /*LORETTO BUS BREAKER
DISCONNECT BRANCH FROM BUS 232127 TO BUS 232117 CKT 1 /*LORETTO VIENNA 138 1380
DISCONNECT BRANCH FROM BUS 232127 TO BUS 232128 CKT 1 /*LORETTO PINEY GROVE 138 138
END

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *232905* | *BAYVIEW1* | *0.42* |
| *232926* | *CRISFLD1* | *0.64* |
| *232912* | *OH NUG1* | *1.52* |
| *232913* | *OH NUG2* | *1.5* |
| *232914* | *OH NUG3* | *1.52* |
| *232915* | *OH NUG4* | *1.52* |
| *232916* | *OH NUG5* | *1.52* |
| *232917* | *OH NUG6* | *1.52* |
| *232918* | *OH NUG7* | *1.51* |
| *232921* | *TASLEY2G* | *1.05* |
| *904210* | *V4-022C* | *0.06* |
| *904212* | *V4-022E* | *0.54* |
| *901003* | *W1-003 C* | *0.12* |
| *901004* | *W1-003 E* | *0.82* |
| *901013* | *W1-004 C* | *0.12* |
| *901014* | *W1-004 E* | *0.82* |
| *901023* | *W1-005 C* | *0.12* |
| *901024* | *W1-005 E* | *0.82* |
| *901033* | *W1-006 C* | *< 0.01* |
| *901034* | *W1-006 E* | *0.82* |
| *907052* | *X1-032 E* | *1.1* |

| | | |
|---|---|---|
| *907323* | *X1-096 C* | *1.25* |
| *907324* | *X1-096 E* | *30.34* |
| *920582* | *Z1-076 C* | *0.67* |
| *920583* | *Z1-076 E* | *1.09* |
| *920592* | *Z1-077 C* | *0.48* |
| *920593* | *Z1-077 E* | *0.78* |
| *916441* | *Z1-100* | *0.15* |
| *916451* | *Z1-101* | *0.15* |
| *916461* | *Z1-102* | *0.15* |
| *920602* | *Z1-103* | *0.15* |
| *917081* | *Z2-012 C* | *0.26* |
| *917082* | *Z2-012 E* | *2.15* |
| *920952* | *AA1-025* | *0.13* |
| *920962* | *AA1-026* | *0.13* |
| *920972* | *AA1-027* | *0.13* |
| *920982* | *AA1-028* | *0.13* |
| *921122* | *AA1-059 C* | *1.4* |
| *921123* | *AA1-059 E* | *0.55* |
| *918831* | *AA1-102* | *2.4* |
| *921602* | *AA1-141 C* | *0.52* |
| *921603* | *AA1-141 E* | *0.85* |
| *922213* | *AA2-129 E* | *3.46* |
| *922222* | *AA2-130* | *0.65* |
| *923902* | *AB2-030 E* | *0.69* |
| *923931* | *AB2-033 C* | *1.24* |
| *923932* | *AB2-033 E* | *0.49* |
| *924361* | *AB2-084 C* | *1.04* |
| *924362* | *AB2-084 E* | *1.7* |
| *924681* | *AB2-120 C OP* | *5.91* |
| *924682* | *AB2-120 E OP* | *9.64* |
| *925071* | *AB2-164 C OP* | *1.32* |
| *925072* | *AB2-164 E OP* | *2.15* |
| *925081* | *AB2-165 C OP* | *1.32* |
| *925082* | *AB2-165 E OP* | *2.15* |
| *925101* | *AB2-167 C* | *0.66* |
| *925102* | *AB2-167 E* | *1.09* |
| *925231* | *AB2-177 C* | *0.23* |
| *925232* | *AB2-177 E* | *0.38* |
| *925311* | *AB2-192 C OP* | *1.32* |
| *925312* | *AB2-192 E OP* | *2.15* |

## Appendix 5

(DP&L - DP&L) The FRUITLND-PEMBERTN 69 kV line (from bus 232288 to bus 232273 ckt 1) loads from 92.88% to 95.89% (DC power flow) of its emergency rating (91 MVA) for the line fault

with failed breaker contingency outage of 'DP56'. This project contributes approximately 2.74 MW to the thermal violation.

```
CONTINGENCY 'DP56'                                  /*LORETTO BUS BREAKER
  DISCONNECT BRANCH FROM BUS 232127 TO BUS 232117 CKT 1          /*LORETTO
VIENNA 138 1380
  DISCONNECT BRANCH FROM BUS 232127 TO BUS 232128 CKT 1          /*LORETTO
PINEY GROVE 138 138
  END
```

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *232905* | *BAYVIEW1* | *0.42* |
| *232926* | *CRISFLD1* | *0.64* |
| *232912* | *OH NUG1* | *1.52* |
| *232913* | *OH NUG2* | *1.5* |
| *232914* | *OH NUG3* | *1.52* |
| *232915* | *OH NUG4* | *1.52* |
| *232916* | *OH NUG5* | *1.52* |
| *232917* | *OH NUG6* | *1.52* |
| *232918* | *OH NUG7* | *1.51* |
| *232921* | *TASLEY2G* | *1.05* |
| *904210* | *V4-022C* | *0.06* |
| *904212* | *V4-022E* | *0.54* |
| *901003* | *W1-003 C* | *0.12* |
| *901004* | *W1-003 E* | *0.82* |
| *901013* | *W1-004 C* | *0.12* |
| *901014* | *W1-004 E* | *0.82* |
| *901023* | *W1-005 C* | *0.12* |
| *901024* | *W1-005 E* | *0.82* |
| *901033* | *W1-006 C* | *< 0.01* |
| *901034* | *W1-006 E* | *0.82* |
| *907052* | *X1-032 E* | *1.1* |
| *907323* | *X1-096 C* | *1.25* |
| *907324* | *X1-096 E* | *30.34* |
| *920582* | *Z1-076 C* | *0.67* |
| *920583* | *Z1-076 E* | *1.09* |
| *920592* | *Z1-077 C* | *0.48* |
| *920593* | *Z1-077 E* | *0.78* |
| *916441* | *Z1-100* | *0.15* |
| *916451* | *Z1-101* | *0.15* |
| *916461* | *Z1-102* | *0.15* |
| *920602* | *Z1-103* | *0.15* |
| *917081* | *Z2-012 C* | *0.26* |
| *917082* | *Z2-012 E* | *2.15* |
| *920952* | *AA1-025* | *0.13* |

| | | |
|---|---|---|
| *920962* | *AA1-026* | *0.13* |
| *920972* | *AA1-027* | *0.13* |
| *920982* | *AA1-028* | *0.13* |
| *921122* | *AA1-059 C* | *1.4* |
| *921123* | *AA1-059 E* | *0.55* |
| *918831* | *AA1-102* | *2.4* |
| *921602* | *AA1-141 C* | *0.52* |
| *921603* | *AA1-141 E* | *0.85* |
| *922213* | *AA2-129 E* | *3.46* |
| *922222* | *AA2-130* | *0.65* |
| *923902* | *AB2-030 E* | *0.69* |
| *923931* | *AB2-033 C* | *1.24* |
| *923932* | *AB2-033 E* | *0.49* |
| *924361* | *AB2-084 C* | *1.04* |
| *924362* | *AB2-084 E* | *1.7* |
| *924681* | *AB2-120 C OP* | *5.91* |
| *924682* | *AB2-120 E OP* | *9.64* |
| *925071* | *AB2-164 C OP* | *1.32* |
| *925072* | *AB2-164 E OP* | *2.15* |
| *925081* | *AB2-165 C OP* | *1.32* |
| *925082* | *AB2-165 E OP* | *2.15* |
| *925101* | *AB2-167 C* | *0.66* |
| *925102* | *AB2-167 E* | *1.09* |
| *925231* | *AB2-177 C* | *0.23* |
| *925232* | *AB2-177 E* | *0.38* |
| *925311* | *AB2-192 C OP* | *1.32* |
| *925312* | *AB2-192 E OP* | *2.15* |

# Appendix 6

(DP&L - DP&L) The PINEY_69-M HERMON 69 kV line (from bus 232274 to bus 232272 ckt 1) loads from 109.06% to 110.49% (DC power flow) of its emergency rating (143 MVA) for the line fault with failed breaker contingency outage of 'DP15'. This project contributes approximately 2.04 MW to the thermal violation.

CONTINGENCY 'DP15' /*INDIAN RIVER BUS BREAKER TO PINEY GROVE
  DISCONNECT BRANCH FROM BUS 232007 TO BUS 232006 CKT 1 /*PINEY GR INDRIV 4 230 230
  DISCONNECT BRANCH FROM BUS 232007 TO BUS 232128 CKT 1 /*PINEY GR PINEY GR 230 138
  DISCONNECT BRANCH FROM BUS 232006 TO BUS 232004 CKT 1 /*MILFORD INDIAN RIVER 230 230
  END

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|

| | | |
|---|---|---|
| *232905* | *BAYVIEW1* | *0.59* |
| *232926* | *CRISFLD1* | *0.36* |
| *232912* | *OH NUG1* | *2.1* |
| *232913* | *OH NUG2* | *2.07* |
| *232914* | *OH NUG3* | *2.1* |
| *232915* | *OH NUG4* | *2.1* |
| *232916* | *OH NUG5* | *2.1* |
| *232917* | *OH NUG6* | *2.09* |
| *232918* | *OH NUG7* | *2.09* |
| *232921* | *TASLEY2G* | *1.46* |
| *904210* | *V4-022C* | *0.09* |
| *904212* | *V4-022E* | *0.75* |
| *901003* | *W1-003 C* | *0.15* |
| *901004* | *W1-003 E* | *1.07* |
| *901013* | *W1-004 C* | *0.15* |
| *901014* | *W1-004 E* | *1.07* |
| *901023* | *W1-005 C* | *0.15* |
| *901024* | *W1-005 E* | *1.07* |
| *901033* | *W1-006 C* | *< 0.01* |
| *901034* | *W1-006 E* | *1.07* |
| *907052* | *X1-032 E* | *0.82* |
| *907323* | *X1-096 C* | *0.71* |
| *907324* | *X1-096 E* | *17.31* |
| *920582* | *Z1-076 C* | *1.54* |
| *920583* | *Z1-076 E* | *2.52* |
| *920592* | *Z1-077 C* | *1.1* |
| *920593* | *Z1-077 E* | *1.8* |
| *916441* | *Z1-100* | *0.19* |
| *916451* | *Z1-101* | *0.19* |
| *916461* | *Z1-102* | *0.19* |
| *920602* | *Z1-103* | *0.19* |
| *917081* | *Z2-012 C* | *0.36* |
| *917082* | *Z2-012 E* | *2.99* |
| *920952* | *AA1-025* | *0.17* |
| *920962* | *AA1-026* | *0.17* |
| *920972* | *AA1-027* | *0.17* |
| *920982* | *AA1-028* | *0.17* |
| *921122* | *AA1-059 C* | *0.8* |
| *921123* | *AA1-059 E* | *0.32* |
| *918831* | *AA1-102* | *1.37* |
| *921602* | *AA1-141 C* | *1.86* |
| *921603* | *AA1-141 E* | *3.04* |
| *922213* | *AA2-129 E* | *4.76* |
| *922222* | *AA2-130* | *0.37* |
| *923902* | *AB2-030 E* | *0.97* |

| | | |
|---|---|---|
| *923931* | *AB2-033 C* | *1.73* |
| *923932* | *AB2-033 E* | *0.68* |
| *924361* | *AB2-084 C* | *0.78* |
| *924362* | *AB2-084 E* | *1.27* |
| *924681* | *AB2-120 C OP* | *9.21* |
| *924682* | *AB2-120 E OP* | *15.02* |
| *925071* | *AB2-164 C OP* | *1.83* |
| *925072* | *AB2-164 E OP* | *2.99* |
| *925081* | *AB2-165 C OP* | *1.83* |
| *925082* | *AB2-165 E OP* | *2.99* |
| *925101* | *AB2-167 C* | *1.54* |
| *925102* | *AB2-167 E* | *2.53* |
| *925231* | *AB2-177 C* | *0.82* |
| *925232* | *AB2-177 E* | *1.34* |
| *925311* | *AB2-192 C OP* | *1.83* |
| *925312* | *AB2-192 E OP* | *2.99* |