Generation Interconnection Feasibility Study Report Queue Position AD2-119

Interconnection Customer has proposed a 75 MW solar generating facility to be built in Centre County, Pennsylvania. PJM recognizes 31.5 MW as Capacity Interconnection Rights for this project. The proposed in-service date is December 15, 2021. **This study does not imply a West Penn Power ("Transmission Owner") commitment to this in-service date.**

Point of Interconnection ("POI")

The AD2-119 project will interconnect with the West Penn Power transmission system by tapping the Milesburg – Dale Summit 230 kV transmission line at a point located 40 miles from Milesburg substation and 4.4 miles from Dale Summit substation. The tap will be accomplished by constructing a new 230 kV three (3) breaker ring bus and looping the Milesburg – Dale Summit 230 kV line into the new interconnection substation. The POI will be located outside the new station at the exist side to solar plant. The project will be modeled at bus #235219 (Milesburg) and bus #235970 (Dale Summit).

Network Impacts

The Queue Project AD2-119 was evaluated as a 75.0 MW (Capacity 31.5 MW) injection tapping the Dale to Milesburg 230kV line in the APS area. Project AD2-119 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-119 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

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. (PENELEC - PL) The 26LEWISTWN-JUNI BU1 230 kV line (from bus 200513 to bus 208004 ckt 1) loads from 99.09% to 102.27% (**DC power flow**) of its emergency rating (624 MVA) for the line fault with failed breaker contingency outage of 'PN-P2-3-PN-115-46FT'. This project contributes approximately 25.62 MW to the thermal violation.

```
CONTINGENCY 'PN-P2-3-PN-115-46FT'                    /* 756
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200699 CKT 1      /* 26NO MESHO 115 26MEHOP 3 115
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200678 CKT 1      /* 26NO MESHO 115 26LENOX 115
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200684 CKT 1      /* 26NO MESHO 115 26N MESH 35
  DISCONNECT BRANCH FROM BUS 200706 TO BUS 200708 CKT 1      /* 26N.MESHPN 230 26OXBOW 230
  DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1      /* 26OXBOW 230 LACK 230
  DISCONNECT BRANCH FROM BUS 200825 TO BUS 200706 CKT 3      /* 26MESH2REA 115 26N.MESHPN 230
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200825 CKT 3      /* 26NO MESHO 115 26MESH2REA 115
  DISCONNECT BRANCH FROM BUS 200708 TO BUS 200709 CKT 1      /* 26OXBOW 230 26OXBOW 35
  REDUCE BUS 200677 SHUNT BY 100 PERCENT                     /* 26NO MESHO 115
  END
```

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

2. (PENELEC - PL) The 26LEWISTWN-JUNI BU1 230 kV line (from bus 200513 to bus 208004 ckt 1) loads from 98.58% to 101.76% (**DC power flow**) of its emergency rating (624 MVA) for the line fault with failed breaker contingency outage of 'PN-P2-3-PN-230-17T'. This project contributes approximately 25.60 MW to the thermal violation.

```
CONTINGENCY 'PN-P2-3-PN-230-17T'                     /* 744
  DISCONNECT BRANCH FROM BUS 200825 TO BUS 200706 CKT 3      /* 26MESH2REA 115 26N.MESHPN 230
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200825 CKT 3      /* 26NO MESHO 115 26MESH2REA 115
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200706 CKT 4      /* 26NO MESHO 115 26N.MESHPN 230
  DISCONNECT BRANCH FROM BUS 200706 TO BUS 200708 CKT 1      /* 26N.MESHPN 230 26OXBOW 230
  DISCONNECT BRANCH FROM BUS 200706 TO BUS 200924 CKT 1      /* 26N.MESHPN 230 26CANYON 230
```

```
DISCONNECT BRANCH FROM BUS 200675 TO BUS 200924 CKT 1        /* 26E.TWANDA 230 26CANYON 230
DISCONNECT BRANCH FROM BUS 200708 TO BUS 200709 CKT 1        /* 26OXBOW 230 26OXBOW 35
DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1        /* 26OXBOW 230 LACK 230
END
```

3. (PENELEC - PENELEC) The 26SHADE GP-26ROXBURY 115 kV line (from bus 200522 to bus 200520 ckt 1) loads from 97.64% to 103.07% (**DC power flow**) of its emergency rating (160 MVA) for the line fault with failed breaker contingency outage of 'PL:P42:100577'. This project contributes approximately 8.69 MW to the thermal violation.

```
CONTINGENCY 'PL:P42:100577'                    /* AT JUNIATA 500SUB TR1 230KV CB FAILED
 DISCONNECT BRANCH FROM BUS 200009 TO BUS 200183 CKT 1       /*
 DISCONNECT BRANCH FROM BUS 200009 TO BUS 208004 CKT 1       /*
 DISCONNECT BUS 208004                         /*
 END
```

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

4. (PENELEC - PENELEC) The 26SHADE GP-26ROXBURY 115 kV line (from bus 200522 to bus 200520 ckt 1) loads from 95.03% to 100.46% (**DC power flow**) of its emergency rating (160 MVA) for the line fault with failed breaker contingency outage of 'PL:P42:001131'. This project contributes approximately 8.68 MW to the thermal violation.

```
CONTINGENCY 'PL:P42:001131'                    /* AT JUNIATA SUB LEWISTOWN SOUTH CB FAIL
 DISCONNECT BRANCH FROM BUS 208004 TO BUS 200009 CKT 1       /* DISCONNECT JUNI TR1
 DISCONNECT BRANCH FROM BUS 208004 TO BUS 209997 CKT 3       /* DISCONNECT JUNI TR3
 DISCONNECT BRANCH FROM BUS 200513 TO BUS 208004 CKT 1       /* DISCONNECT JUNI-LEWIS LINE
 END
```

5. (PENELEC - PENELEC) The 26SHADE GP-26ROXBURY 115 kV line (from bus 200522 to bus 200520 ckt 1) loads from 95.03% to 100.46% (**DC power flow**) of its emergency rating (160 MVA) for the line fault with failed breaker contingency outage of 'PL:P42:100547'. This project contributes approximately 8.68 MW to the thermal violation.

```
CONTINGENCY 'PL:P42:100547'                    /* AT JUNIATA SUB LEWISTOWN 230KV CB FAILED
 DISCONNECT BRANCH FROM BUS 208004 TO BUS 200513 CKT 1       /* DISCONNECT JUNI - LEWISTOWN
LINE
 DISCONNECT BRANCH FROM BUS 208004 TO BUS 209997 CKT 4       /* DISCONNECT T4
 DISCONNECT BRANCH FROM BUS 208004 TO BUS 200009 CKT 2       /* DISCONNECT T2
 END
```

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. (AP - AP) The 01KISSNG-01KARNSC 138 kV line (from bus 235203 to bus 235197 ckt 1) loads from 115.88% to 116.55% (**DC power flow**) of its emergency rating (268 MVA) for the

line fault with failed breaker contingency outage of 'ATSI-P2-3-CEI-345-004D'. This project contributes approximately 3.99 MW to the thermal violation.

```
CONTINGENCY 'ATSI-P2-3-CEI-345-004D'                    /* ERIE WEST 345KV BKR 8
  DISCONNECT BRANCH FROM BUS 200599 TO BUS 200600 CKT 1      /* 26ERIE W 345 26ERIE SO 345
  DISCONNECT BRANCH FROM BUS 200599 TO BUS 238547 CKT 1      /* 26ERIE W 345 02AT 345
  DISCONNECT BRANCH FROM BUS 238547 TO BUS 239036 CKT 1      /* 02AT 345 02PERRY 345
  DISCONNECT BRANCH FROM BUS 238547 TO BUS 239082 CKT 1      /* 02AT 345 02S8-ATT 345
  DISCONNECT BUS 200600                             /* 26ERIE SO 345
  DISCONNECT BUS 238547                             /* 02AT 345
  END
```

Please refer to Appendix 5 for a table containing the generators having contribution to this flowgate.

2. (AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 105.34% to 112.24% (**DC power flow**) of its emergency rating (554 MVA) for the line fault with failed breaker contingency outage of 'PN-P2-3-PN-115-46FT'. This project contributes approximately 38.18 MW to the thermal violation.

```
CONTINGENCY 'PN-P2-3-PN-115-46FT'                       /* 756
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200699 CKT 1      /* 26NO MESHO 115 26MEHOP 3 115
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200678 CKT 1      /* 26NO MESHO 115 26LENOX 115
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200684 CKT 1      /* 26NO MESHO 115 26N MESH 35
  DISCONNECT BRANCH FROM BUS 200706 TO BUS 200708 CKT 1      /* 26N.MESHPN 230 26OXBOW 230
  DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1      /* 26OXBOW 230 LACK 230
  DISCONNECT BRANCH FROM BUS 200825 TO BUS 200706 CKT 3      /* 26MESH2REA 115 26N.MESHPN 230
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200825 CKT 3      /* 26NO MESHO 115 26MESH2REA 115
  DISCONNECT BRANCH FROM BUS 200708 TO BUS 200709 CKT 1      /* 26OXBOW 230 26OXBOW 35
  REDUCE BUS 200677 SHUNT BY 100 PERCENT                /* 26NO MESHO 115
  END
```

Please refer to Appendix 6 for a table containing the generators having contribution to this flowgate.

3. (AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 104.17% to 110.36% (**DC power flow**) of its emergency rating (554 MVA) for the line fault with failed breaker contingency outage of 'AP-P2-3-WP-230-446T'. This project contributes approximately 46.11 MW to the thermal violation.

```
CONTINGENCY 'AP-P2-3-WP-230-446T'                       /* ELKO-MOSHANNON STK BKR AT ELKO
  DISCONNECT BRANCH FROM BUS 200726 TO BUS 235175 CKT 1      /* 26SHAWVL 2 230 01ELKO 230
  DISCONNECT BRANCH FROM BUS 235158 TO BUS 235175 CKT 1      /* 01CARB 230 01ELKO 230
  DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1      /* 01ELKO 230 01QUEHAN 230
  DISCONNECT BRANCH FROM BUS 235220 TO BUS 235236 CKT 1      /* 01MOSHAN 230 01QUEHAN 230
  DISCONNECT BRANCH FROM BUS 235236 TO BUS 236732 CKT 81     /* 01QUEHAN 230 01QUEHANNA 46
  END
```

4. (AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 104.01% to 110.2% (**DC power flow**) of its emergency rating (554 MVA) for the line fault with failed breaker contingency outage of 'AP-P2-3-WP-230-443T'. This project contributes approximately 46.11 MW to the thermal violation.

```
CONTINGENCY 'AP-P2-3-WP-230-443T'                    */ UPDATED CON AJK 3-31-16
 DISCONNECT BRANCH FROM BUS 200726 TO BUS 235175 CKT 1
 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1
 DISCONNECT BUS 235158
 END
```

5. (AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 103.99% to 110.18% (**DC power flow**) of its emergency rating (554 MVA) for the bus fault outage of 'AP-P2-2-WP-230-001T'. This project contributes approximately 46.11 MW to the thermal violation.

```
CONTINGENCY 'AP-P2-2-WP-230-001T'                    /* ELKO #2 230KV BUS
 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235158 CKT 1        /* 01ELKO 230 01CARB 230
 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1        /* 01ELKO 230 01QUEHAN 230
 DISCONNECT BRANCH FROM BUS 235175 TO BUS 200726 CKT 1        /* 01ELKO 230 26SHAWVL 2 230
 REDUCE BUS 237007 SHUNT BY 100 PERCENT                /* 01ELKO CAP 138
 DISCONNECT BUS 237007                          /* 01ELKO CAP 138
 END
```

6. (AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 103.99% to 110.18% (**DC power flow**) of its emergency rating (554 MVA) for the line fault with failed breaker contingency outage of 'AP-P2-2-WP-230-001T'. This project contributes approximately 46.11 MW to the thermal violation.

```
CONTINGENCY 'AP-P2-2-WP-230-001T'
 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235158 CKT 1
 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1
 DISCONNECT BRANCH FROM BUS 235175 TO BUS 200726 CKT 1
 END
```

7. (PENELEC - PENELEC) The 26SHELOCTA-26KEYSTONE 230 kV line (from bus 200795 to bus 200810 ckt 1) loads from 122.33% to 122.91% (**DC power flow**) of its emergency rating (917 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-002A'. This project contributes approximately 11.7 MW to the thermal violation.

```
CONTINGENCY 'PN_P4-500-002A'                    /* CONEMAUGH 500KV BKR 1
 DISCONNECT BRANCH FROM BUS 200005 TO BUS 200912 CKT 3        /* CONEM-GH 500 26CONEMAGH 230
 DISCONNECT BUS 200031                          /* CONE G2 22
 END
```

Please refer to Appendix 7 for a table containing the generators having contribution to this flowgate.

8. (PENELEC - PENELEC) The 26SHELOCTA-26KEYSTONE 230 kV line (from bus 200795 to bus 200810 ckt 1) loads from 122.26% to 122.84% (**DC power flow**) of its emergency rating (917 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-002F'. This project contributes approximately 11.7 MW to the thermal violation.

```
CONTINGENCY 'PN_P4-500-002F'                    /* CONEMAUGH 500KV BKR 6
  DISCONNECT BRANCH FROM BUS 200005 TO BUS 200912 CKT 3        /* CONEM-GH 500 26CONEMAGH 230
  DISCONNECT BUS 200030                         /* CONE G1 22
  END
```

9. (PENELEC - PENELEC) The 26KEYSTONE 230/1 kV transformer (from bus 200810 to bus 999437 ckt 3) loads from 118.96% to 119.51% (**DC power flow**) of its emergency rating (612 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-001F'. This project contributes approximately 7.32 MW to the thermal violation.

```
CONTINGENCY 'PN_P4-500-001F'                    /* KEYSTONE 500KV BKR 6
  DISCONNECT BRANCH FROM BUS 200011 TO BUS 200005 CKT 1        /* KEYSTONE 500 CONEM-GH 500
  DISCONNECT BRANCH FROM BUS 200011 TO BUS 200810 TO BUS 200907 CKT 4/* KEYSTONE 500 26KEYSTONE
230 26KEYSTN#4 20.00
  REDUCE BUS 200011 SHUNT BY 100 PERCENT                /* KEYSTONE 500
  END
```

Please refer to Appendix 8 for a table containing the generators having contribution to this flowgate.

10. (PL - PL) The CUMB TR2-CUMB 230 kV line (from bus 207950 to bus 207948 ckt 1) loads from 100.39% to 100.93% (**DC power flow**) of its emergency rating (624 MVA) for the line fault with failed breaker contingency outage of 'ME_P4-500-001B'. This project contributes approximately 7.47 MW to the thermal violation.

```
CONTINGENCY 'ME_P4-500-001B'                    /* THREE MILE-X4-020 &
TMI-X4 BTM STUCK CB
  DISCONNECT BRANCH FROM BUS 200016 TO BUS 200009 CKT 1        /* 3 MILE I
500 JUNIATA 500
  DISCONNECT BRANCH FROM BUS 200016 TO BUS 912130 CKT 1        /* 3 MILE I
500 X4-020 TAP 500 / PJM FIXED
  END
```

Please refer to Appendix 9 for a table containing the generators having contribution to this flowgate.

Steady-State Voltage Requirements

To be determined at the system impact study stage.

Short Circuit

None.

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. (AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 104.09% to 110.98% (**DC power flow**) of its emergency rating (554 MVA) for the single line contingency outage of 'PL:P13:100352'. This project contributes approximately 38.15 MW to the thermal violation.

```
CONTINGENCY 'PL:P13:100352'                          /* OXBOW 230/34.5KV T1
  DISCONNECT BRANCH FROM BUS 200706 TO BUS 200825 CKT 3        /* /* N.MESHPN-MESH2REA T3
  DISCONNECT BUS 200708                                /* /* OXBOW
  DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1        /* /* NMES-LACK 230KV LINE
  END
```

2. (AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 97.57% to 105.11% (**DC power flow**) of its normal rating (489 MVA) for non-contingency condition. This project contributes approximately 37.51 MW to the thermal violation.

3. (PENELEC - PL) The 26LEWISTWN-JUNI BU1 230 kV line (from bus 200513 to bus 208004 ckt 1) loads from 102.02% to 107.08% (**DC power flow**) of its normal rating (493 MVA) for non-contingency condition. This project contributes approximately 24.94 MW to the thermal violation.

4. (PENELEC - PL) The 26LEWISTWN-JUNI BU1 230 kV line (from bus 200513 to bus 208004 ckt 1) loads from 98.39% to 101.57% (**DC power flow**) of its emergency rating (624 MVA) for the single line contingency outage of 'PL:P13:100352'. This project contributes approximately 25.59 MW to the thermal violation.

```
CONTINGENCY 'PL:P13:100352'                          /* OXBOW 230/34.5KV T1
  DISCONNECT BRANCH FROM BUS 200706 TO BUS 200825 CKT 3        /* /* N.MESHPN-MESH2REA T3
  DISCONNECT BUS 200708                                /* /* OXBOW
  DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1        /* /* NMES-LACK 230KV LINE
  END
```

5. (PENELEC - PENELEC) The 26GLADE-26WARREN 230 kV line (from bus 200593 to bus 200811 ckt 1) loads from 119.05% to 119.56% (**DC power flow**) of its emergency rating (621 MVA) for the single line contingency outage of 'PN-P1-2-PN-230-100T'. This project contributes approximately 6.97 MW to the thermal violation.

```
CONTINGENCY 'PN-P1-2-PN-230-100T'                    /* ERIE EAST - SOUTH RIPLEY 230KV
 DISCONNECT BRANCH FROM BUS 200654 TO BUS 135251 CKT 1          /* 26ERIE E 230 S RIPLEY 230
 END
```

6. (PENELEC - PENELEC) The 26E.TWANDA-26CANYON 230 kV line (from bus 200675 to bus 200924 ckt 1) loads from 144.54% to 145.02% (**DC power flow**) of its normal rating (515 MVA) for non-contingency condition. This project contributes approximately 5.33 MW to the thermal violation.

7. (PENELEC - PENELEC) The 26HOMER CT-26SHELOCTA 230 kV line (from bus 200767 to bus 200795 ckt 1) loads from 130.61% to 132.31% (**DC power flow**) of its normal rating (731 MVA) for non-contingency condition. This project contributes approximately 7.87 MW to the thermal violation.

8. (PENELEC - PENELEC) The 26HOMER CT-26SHELOCTA 230 kV line (from bus 200767 to bus 200795 ckt 1) loads from 124.89% to 125.43% (**DC power flow**) of its emergency rating (917 MVA) for the single line contingency outage of 'PN-P1-2-PN-230-025'. This project contributes approximately 10.58 MW to the thermal violation.

```
CONTINGENCY 'PN-P1-2-PN-230-025'                    /* CONEMAUGH - SEWARD
230KV
 DISCONNECT BRANCH FROM BUS 200912 TO BUS 200793 CKT 1          /*
26CONEMAGH 230 26SEWARD 2 230
 END
```

9. (PENELEC - PENELEC) The 26SHELOCTA-26KEYSTONE 230 kV line (from bus 200795 to bus 200810 ckt 1) loads from 116.89% to 117.47% (**DC power flow**) of its emergency rating (917 MVA) for the single line contingency outage of 'PN-P1-2-PN-230-025'. This project contributes approximately 11.72 MW to the thermal violation.

```
CONTINGENCY 'PN-P1-2-PN-230-025'                    /* CONEMAUGH - SEWARD 230KV
 DISCONNECT BRANCH FROM BUS 200912 TO BUS 200793 CKT 1          /* 26CONEMAGH 230 26SEWARD 2 230
 END
```

10. (PENELEC - PENELEC) The 26SHELOCTA-26KEYSTONE 230 kV line (from bus 200795 to bus 200810 ckt 1) loads from 116.32% to 116.88% (**DC power flow**) of its normal rating (731 MVA) for non-contingency condition. This project contributes approximately 8.85 MW to the thermal violation.

11. (AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 104.09% to 110.98% (**DC power flow**) of its emergency rating (554

MVA) for the single line contingency outage of 'PN-P1-2-PN-230-102T'. This project contributes approximately 38.15 MW to the thermal violation.

```
CONTINGENCY 'PN-P1-2-PN-230-102T'                    /* NORTH MESHOPPEN - LACKAWANNA 230KV
  DISCONNECT BRANCH FROM BUS 200706 TO BUS 200708 CKT 1      /* 26N.MESHPN 230 26OXBOW 230
  DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1      /* 26OXBOW 230 LACK 230
  DISCONNECT BRANCH FROM BUS 200706 TO BUS 200825 CKT 3      /* 26N.MESHPN 230 26MESH2REA 115
  DISCONNECT BRANCH FROM BUS 200708 TO BUS 200709 CKT 1      /* 26OXBOW 230 26OXBOW 35
  DISCONNECT BRANCH FROM BUS 200825 TO BUS 200677 CKT 3      /* 26MESH2REA 115 26NO MESHO 115
  END
```

Light Load Analysis - 2021

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

System Reinforcements

Short Circuit

None.

Stability and Reactive Power Requirement

To be determined at system impact study stage.

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)

Multiple Facility Contingency

1. (PENELEC - PL) The 26LEWISTWN-JUNI BU1 230 kV line (from bus 200513 to bus 208004 ckt 1) loads from 99.09% to 102.27% (**DC power flow**) of its emergency rating (624 MVA) for the line fault with failed breaker contingency outage of 'PN-P2-3-PN-115-46FT'. This project contributes approximately 25.62 MW to the thermal violation.

PENELEC:
Convert North Meshoppen to a 4 BKR ring bus by installing 2 230kV breakers and modifying bus work. @ North Meshoppen. Estimated Cost: $2,822,600. Estimated Time to Complete: 14 months.

PPL:
Since FE is alleviating the Lewistown – Juniata 230kV line overload by reconfiguring their North Meshoppen substation bus, then the overload at the PPL EU end no longer exists. No PPL reinforcement is required.

2. (PENELEC - PL) The 26LEWISTWN-JUNI BU1 230 kV line (from bus 200513 to bus 208004 ckt 1) loads from 98.58% to 101.76% (**DC power flow**) of its emergency rating (624 MVA) for the line fault with failed breaker contingency outage of 'PN-P2-3-PN-230-17T'. This project contributes approximately 25.6 MW to the thermal violation.

Same as Multiple Facility Contingency #1

3. (PENELEC - PENELEC) The 26SHADE GP-26ROXBURY 115 kV line (from bus 200522 to bus 200520 ckt 1) loads from 97.64% to 103.07% (**DC power flow**) of its emergency rating (160 MVA) for the line fault with failed breaker contingency outage of 'PL:P42:100577'. This project contributes approximately 8.69 MW to the thermal violation.

PENELEC:
Reconductor the Roxbury-Shade Gap 115 kV line with 336.4 kcmil ACSS. Estimated cost excluding tax is $19,049,100. The estimated time to complete is 21 months.

4. (PENELEC - PENELEC) The 26SHADE GP-26ROXBURY 115 kV line (from bus 200522 to bus 200520 ckt 1) loads from 95.03% to 100.46% (**DC power flow**) of its emergency rating (160 MVA) for the line fault with failed breaker contingency outage of 'PL:P42:001131'. This project contributes approximately 8.68 MW to the thermal violation.

Same as Multiple Facility Contingency #3

5. (PENELEC - PENELEC) The 26SHADE GP-26ROXBURY 115 kV line (from bus 200522 to bus 200520 ckt 1) loads from 95.03% to 100.46% (**DC power flow**) of its emergency rating (160 MVA) for the line fault with failed breaker contingency outage of 'PL:P42:100547'. This project contributes approximately 8.68 MW to the thermal violation.

Same as Multiple Facility Contingency #3

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. (AP - AP) The 01KISSNG-01KARNSC 138 kV line (from bus 235203 to bus 235197 ckt 1) loads from 115.88% to 116.55% (**DC power flow**) of its emergency rating (268 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-CEI-345-004D'. This project contributes approximately 3.99 MW to the thermal violation.

AP:
Reconductor Karns City-Kissinger Jct 138 kV Line. Replace 336.4 kcmil ACSR conductor with 954 kcmil ACSR. The estimated cost excluding tax is $13,389,200. The estimated time to complete is 21 months.

2. (AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 105.34% to 112.24% (**DC power flow**) of its emergency rating (554 MVA) for the line fault with failed breaker contingency outage of 'PN-P2-3-PN-115-46FT'. This project contributes approximately 38.18 MW to the thermal violation.

PENELEC / AP:
Replace wavetrap, breaker and limiting conductor for Lewistown line exit @ Shingletown SS. The estimated cost excluding tax is $445,200. The estimated time to complete is 21 months.

3. (AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 104.17% to 110.36% (**DC power flow**) of its emergency rating (554 MVA) for the line fault with failed breaker contingency outage of 'AP-P2-3-WP-230-446T'. This project contributes approximately 46.11 MW to the thermal violation.

Same as Contribution to Previously Identified #2

4. (AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 104.01% to 110.2% (**DC power flow**) of its emergency rating (554 MVA) for the line fault with failed breaker contingency outage of 'AP-P2-3-WP-230-443T'. This project contributes approximately 46.11 MW to the thermal violation.

Same as Contribution to Previously Identified #2

5. (AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 103.99% to 110.18% (**DC power flow**) of its emergency rating (554 MVA) for the bus fault outage of 'AP-P2-2-WP-230-001T'. This project contributes approximately 46.11 MW to the thermal violation.

Same as Contribution to Previously Identified #2

6. (AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 103.99% to 110.18% (**DC power flow**) of its emergency rating (554 MVA) for the line fault with failed breaker contingency outage of 'AP-P2-2-WP-230-001T'. This project contributes approximately 46.11 MW to the thermal violation.

Same as Contribution to Previously Identified #2

7. (PENELEC - PENELEC) The 26SHELOCTA-26KEYSTONE 230 kV line (from bus 200795 to bus 200810 ckt 1) loads from 122.33% to 122.91% (**DC power flow**) of its emergency rating (917 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-002A'. This project contributes approximately 11.7 MW to the thermal violation.

PENELEC:
Replace the #3 500/230 kV transformer, upgrade the circuit loadability and replace the transformer relaying & control. Replace the #3 transformer tertiary source to the plant station power with a 30 MVA, 230-20 kV transformer and 230 kV circuit breaker. @ Keystone. Estimated Cost: $18,341,200. The estimated time to complete is 21 months.

8. (PENELEC - PENELEC) The 26SHELOCTA-26KEYSTONE 230 kV line (from bus 200795 to bus 200810 ckt 1) loads from 122.26% to 122.84% (**DC power flow**) of its emergency rating (917 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-002F'. This project contributes approximately 11.7 MW to the thermal violation.

Same as Contribution to Previously Identified #7

9. (PENELEC - PENELEC) The 26KEYSTONE 230/1 kV transformer (from bus 200810 to bus 999437 ckt 3) loads from 118.96% to 119.51% (**DC power flow**) of its emergency rating (612 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-001F'. This project contributes approximately 7.32 MW to the thermal violation.

Same as Contribution to Previously Identified #7

10. (PL - PL) The CUMB TR2-CUMB 230 kV line (from bus 207950 to bus 207948 ckt 1) loads from 100.39% to 100.93% (**DC power flow**) of its emergency rating (624 MVA) for the line fault with failed breaker contingency outage of 'ME_P4-500-001B'. This project contributes approximately 7.47 MW to the thermal violation.

PPL:
Rebuild the Juniata - Cumberland 230 kV Line (14.2 mi). [PJM Upgrade Id: s0945.8]. The estimated in-service date is 08/31/2024.

Light Load 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)

None

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)

None

Appendix 3

Flowgate Contingency – The 26LEWISTWN-JUNI BU1 230 kV line
PJM Queue Position: AD2-119

This appendix contains additional information about the flowgate presented in the body of the report. The intent of this 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.

(PENELEC - PL) The 26LEWISTWN-JUNI BU1 230 kV line (from bus 200513 to bus 208004 ckt 1) loads from 99.09% to 102.27% (**DC power flow**) of its emergency rating (624 MVA) for the line fault with failed breaker contingency outage of 'PN-P2-3-PN-115-46FT'. This project contributes approximately 25.62 MW to the thermal violation.

CONTINGENCY 'PN-P2-3-PN-115-46FT' /* 756
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200699 CKT 1 /* 26NO MESHO 115 26MEHOP 3 115
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200678 CKT 1 /* 26NO MESHO 115 26LENOX 115
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200684 CKT 1 /* 26NO MESHO 115 26N MESH 35
DISCONNECT BRANCH FROM BUS 200706 TO BUS 200708 CKT 1 /* 26N.MESHPN 230 26OXBOW 230
DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1 /* 26OXBOW 230 LACK 230
DISCONNECT BRANCH FROM BUS 200825 TO BUS 200706 CKT 3 /* 26MESH2REA 115 26N.MESHPN 230
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200825 CKT 3 /* 26NO MESHO 115 26MESH2REA 115
DISCONNECT BRANCH FROM BUS 200708 TO BUS 200709 CKT 1 /* 26OXBOW 230 26OXBOW 35
REDUCE BUS 200677 SHUNT BY 100 PERCENT /* 26NO MESHO 115
END

Appendix 3 – Continued from previous page

Flowgate Contingency – The 26LEWISTWN-JUNI BU1 230 kV line
PJM Queue Position: AD2-119

Bus Number	Gen. Bus Name	Full Contribution
LTF	CBM-N	1.97
LTF	CBM-S1	3.98
LTF	CBM-S2	2.54
LTF	CBM-W1	17.81
LTF	CBM-W2	24.7
LTF	CIN	3.68
LTF	CPLE	0.54
LTF	G-007	4.14
LTF	IPL	2.37
LTF	LGEE	0.76
LTF	MEC	6.79
LTF	MECS	6.21
LTF	NYISO	29.59
LTF	O-066	26.83
936992	AD2-133 E	14.49
936991	AD2-133 C	3.17
936942	AD2-119 E	14.86
936941	AD2-119 C	10.76
936472	AD2-062 E O1	2.48
936471	AD2-062 C O1	4.96
936421	AD2-055	7.32
935191	AD1-154	1.76
935061	AD1-142	0.11
934951	AD1-127	25.89
934821	AD1-110	0.15
934811	AD1-109	0.13
934801	AD1-108	0.18
932571	AC2-077	2.07
903643	W3-099 C OP1	0.99

Please continue on the right

Bus Number	Gen. Bus Name	Full Contribution
901242	W1-045E OP1	1.42
901241	W1-045C OP1	0.87
297050	V2-019 E	0.05
296332	R-032 E	6.2
294903	P-060 E	3.75
294573	P-028 E	11.79
294515	P-022 E	2.79
293802	O-038 E	6.97
293603	O-018 E	5.37
293393	V3-030E	3.2
293301	N-039 E	11.15
291409	S-029B E	0.08
290086	Q-036 E	7.04
236828	01GRAYMONT	1.34
203999	P-047 E	7.82
200913	26SHAW-D	0.24
200905	26Q36	0.33
200894	26K02	12.19
200883	Q-053 E	6.54
200852	26WARR RDG	0.4
200846	26FORWARD	2.04
200823	26MHP_X3-003	4.32
200812	26ALY HYDR	1.41
200805	26COLVER13	10.62
200722	26SHAWVL 2	1.22
200715	26SHAWVL 1	1.19
200666	26SHAWVL 4	1.83
200665	26SHAWVL 3	1.83

End.

Appendix 4

Flowgate Contingency – The 26SHADE GP-26ROXBURY 115 kV line
PJM Queue Position: AD2-119

This appendix contains additional information about the flowgate presented in the body of the report. The intent of this 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.

(PENELEC - PENELEC) The 26SHADE GP-26ROXBURY 115 kV line (from bus 200522 to bus 200520 ckt 1) loads from 97.64% to 103.07% (**DC power flow**) of its emergency rating (160 MVA) for the line fault with failed breaker contingency outage of 'PL:P42:100577'. This project contributes approximately 8.69 MW to the thermal violation.

```
CONTINGENCY 'PL:P42:100577'                    /* AT JUNIATA 500SUB TR1 230KV CB FAILED
  DISCONNECT BRANCH FROM BUS 200009 TO BUS 200183 CKT 1      /*
  DISCONNECT BRANCH FROM BUS 200009 TO BUS 208004 CKT 1      /*
  DISCONNECT BUS 208004                        /*
  END
```

Bus Number	*Gen. Bus Name*	*Full Contribution*
LTF	*CATAWBA*	*0.03*
LTF	*CBM-N*	*0.56*
LTF	*CBM-S1*	*0.21*
LTF	*CBM-W1*	*2.18*
LTF	*CBM-W2*	*1.75*
LTF	*CELEVELAND*	*0.09*
LTF	*CIN*	*0.39*
LTF	*G-007*	*0.36*
LTF	*HAMLET*	*0.17*
LTF	*IPL*	*0.25*
LTF	*LGEE*	*0.07*
LTF	*MEC*	*0.65*
LTF	*MECS*	*0.98*
LTF	*NYISO*	*8.44*
LTF	*O-066*	*2.11*
LTF	*ROWAN*	*0.08*
LTF	*UNIONPOWER*	*0.02*

Please continue on the right

Bus Number	*Gen. Bus Name*	*Full Contribution*
LTF	*WEC*	*0.11*
936992	*AD2-133 E*	*4.87*
936991	*AD2-133 C*	*1.07*
936942	*AD2-119 E*	*5.04*
936941	*AD2-119 C*	*3.65*
936421	*AD2-055*	*2.36*
936224	*AD2-028 E2*	*2.66*
936223	*AD2-028 C2*	*0.53*
930511	*AB1-092*	*1.14*
925512	*AC1-025 E*	*0.18*
919491	*AA2-000*	*31.16*
918702	*AA1-085 E*	*7.09*
918701	*AA1-085 C*	*1.06*
294515	*P-022 E*	*0.95*
293802	*O-038 E*	*2.39*
293301	*N-039 E*	*3.82*
290086	*Q-036 E*	*2.37*
236828	*01GRAYMONT*	*0.45*
200894	*26K02*	*3.72*
200852	*26WARR RDG*	*0.14*
200812	*26ALY HYDR*	*0.49*

End.

Appendix 5

Flowgate Contingency – ERIE WEST 345KV BKR 8

PJM Queue Position: AD2-119

This appendix contains additional information about the flowgate presented in the body of the report. The intent of this 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.

```
CONTINGENCY 'ATSI-P2-3-CEI-345-004D'                    /* ERIE WEST 345KV BKR 8
  DISCONNECT BRANCH FROM BUS 200599 TO BUS 200600 CKT 1         /* 26ERIE W 345
26ERIE SO 345
  DISCONNECT BRANCH FROM BUS 200599 TO BUS 238547 CKT 1         /* 26ERIE W 345
02AT 345
  DISCONNECT BRANCH FROM BUS 238547 TO BUS 239036 CKT 1         /* 02AT 345 02PERRY
345
  DISCONNECT BRANCH FROM BUS 238547 TO BUS 239082 CKT 1         /* 02AT 345 02S8-ATT
345
  DISCONNECT BUS 200600                         /* 26ERIE SO 345
  DISCONNECT BUS 238547                         /* 02AT 345
  END
```

Appendix 5 – Continued from previous page

Flowgate Contingency – ERIE WEST 345KV BKR 8
PJM Queue Position: AD2-119

Bus Number	Gen. Bus Name	Full Contribution
LTF	AMIL	0.21
LTF	BAYOU	0.67
LTF	BIG_CAJUN1	1.03
LTF	BIG_CAJUN2	2.07
LTF	BLUEG	1.26
LTF	CALDERWOOD	0.33
LTF	CANNELTON	0.22
LTF	CATAWBA	0.18
LTF	CBM-N	1.23
LTF	CELEVELAND	0.53
LTF	CHEOAH	0.3
LTF	CHILHOWEE	0.11
LTF	CHOCTAW	0.68
LTF	CLIFTY	5.21
LTF	COTTONWOOD	2.67
LTF	DEARBORN	0.73
LTF	EDWARDS	0.38
LTF	ELMERSMITH	0.62
LTF	FARMERCITY	0.25
LTF	G-007A	1.91
LTF	GIBSON	0.42
LTF	HAMLET	0.54
LTF	MORGAN	1.1
LTF	NEWTON	0.95
LTF	NYISO	18.58
LTF	PRAIRIE	1.79
LTF	ROWAN	0.35
LTF	SANTEETLA	0.09
LTF	SMITHLAND	0.14
LTF	TATANKA	0.45
LTF	TILTON	0.46
LTF	TRIMBLE	0.24
LTF	TVA	0.49
LTF	UNIONPOWER	0.44
LTF	VFT	5.26

Please continue on the right

Bus Number	Gen. Bus Name	Full Contribution
936992	AD2-133 E	4.44
936991	AD2-133 C	0.97
936942	AD2-119 E	2.32
936941	AD2-119 C	1.68
936421	AD2-055	2.14
935191	AD1-154	2.54
932571	AC2-077	1.17
931092	AB1-160 E	0.96
931091	AB1-160 C	0.23
930511	AB1-092	1.04
930411	AB1-082	1.26
927002	AC1-187 E	6.3
927001	AC1-187 C	0.93
925512	AC1-025 E	0.08
919491	AA2-000	28.34
918702	AA1-085 E	4.24
918701	AA1-085 C	0.64
916202	Z1-069 E	3.29
915951	Y3-092 FTIR	101.88
914101	Y2-055	2.18
903644	W3-099 E OP1	6.54
903643	W3-099 C OP1	0.98
297050	V2-019 E	0.03
293393	V3-030E	1.62
290086	Q-036 E	2.16
236828	01GRAYMONT	0.22
203999	P-047 E	4.04
200894	26K02	3.87
200832	26HNSMLK 5	1.07
200831	26HNSMLK 4	1.07
200830	26HNSMLK 3	1.07
200829	26HNSMLK 2	1.07
200828	26HNSMLK 1	1.07
200805	26COLVER13	7.86
200662	26SCRUB GR	2.2
200608	26PINEY #1	1.03

End.

Appendix 6

Flowgate Contingency – The 01SHINGL-26LEWISTWN 230 kV line

PJM Queue Position: AD2-119

This appendix contains additional information about the flowgate presented in the body of the report. The intent of this 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.

(AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 105.34% to 112.24% (**DC power flow**) of its emergency rating (554 MVA) for the line fault with failed breaker contingency outage of 'PN-P2-3-PN-115-46FT'. This project contributes approximately 38.18 MW to the thermal violation.

```
CONTINGENCY 'PN-P2-3-PN-115-46FT'                    /* 756
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200699 CKT 1      /* 26NO MESHO 115 26MEHOP 3 115
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200678 CKT 1      /* 26NO MESHO 115 26LENOX 115
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200684 CKT 1      /* 26NO MESHO 115 26N MESH 35
  DISCONNECT BRANCH FROM BUS 200706 TO BUS 200708 CKT 1      /* 26N.MESHPN 230 26OXBOW 230
  DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1      /* 26OXBOW 230 LACK 230
  DISCONNECT BRANCH FROM BUS 200825 TO BUS 200706 CKT 3      /* 26MESH2REA 115 26N.MESHPN 230
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200825 CKT 3      /* 26NO MESHO 115 26MESH2REA 115
  DISCONNECT BRANCH FROM BUS 200708 TO BUS 200709 CKT 1      /* 26OXBOW 230 26OXBOW 35
  REDUCE BUS 200677 SHUNT BY 100 PERCENT                     /* 26NO MESHO 115
  END
```

Appendix 6 – Continued from previous page

Flowgate Contingency – The 01SHINGL-26LEWISTWN 230 kV line

PJM Queue Position: AD2-119

Bus Number	*Gen. Bus Name*	*Full Contribution*
LTF	*CBM-N*	*1.93*
LTF	*CBM-S1*	*1.81*
LTF	*CBM-S2*	*0.79*
LTF	*CBM-W1*	*9.35*
LTF	*CBM-W2*	*11.65*
LTF	*CIN*	*1.84*
LTF	*CPLE*	*0.12*
LTF	*G-007*	*2.25*
LTF	*IPL*	*1.19*
LTF	*LGEE*	*0.37*
LTF	*MEC*	*3.36*
LTF	*MECS*	*3.53*
LTF	*NYISO*	*28.96*
LTF	*O-066*	*14.39*
LTF	*WEC*	*0.52*
936992	*AD2-133 E*	*12.63*
936991	*AD2-133 C*	*2.76*
936942	*AD2-119 E*	*22.15*
936941	*AD2-119 C*	*16.04*
936421	*AD2-055*	*10*
935191	*AD1-154*	*1.42*
935061	*AD1-142*	*0.11*
934821	*AD1-110*	*0.17*
934811	*AD1-109*	*0.16*
934801	*AD1-108*	*0.21*
932571	*AC2-077*	*2.1*
931092	*AB1-160 E*	*1.74*
931091	*AB1-160 C*	*0.41*
930511	*AB1-092*	*4.86*
930411	*AB1-082*	*2.32*
927002	*AC1-187 E*	*11.49*
927001	*AC1-187 C*	*1.69*

Please continue on the right

Bus Number	*Gen. Bus Name*	*Full Contribution*
925512	*AC1-025 E*	*0.77*
920351	*AA2-133*	*2.22*
920341	*AA2-132*	*1.5*
919491	*AA2-000*	*132.3*
919201	*AA1-144 OP*	*20.12*
918871	*AA1-106*	*2.85*
918702	*AA1-085 E*	*30.61*
918701	*AA1-085 C*	*4.59*
918682	*AA1-082 E*	*6.88*
917631	*Z2-104*	*0.16*
916351	*Z1-091*	*1.38*
916202	*Z1-069 E*	*5.94*
916051	*Z1-038*	*2.16*
914101	*Y2-055*	*3.72*
914041	*Y2-042*	*0.07*
910522	*X3-003 E*	*2.27*
907462	*X1-109 E*	*10.18*
903644	*W3-099 E OP1*	*6.42*
903643	*W3-099 C OP1*	*0.96*
297050	*V2-019 E*	*0.05*
294573	*P-028 E*	*13.6*
293393	*V3-030E*	*1.88*
290086	*Q-036 E*	*6.14*
236828	*01GRAYMONT*	*1.99*
203999	*P-047 E*	*8.05*
200913	*26SHAW-D*	*0.3*
200894	*26K02*	*16.13*
200823	*26MHP_X3-003*	*4.99*
200805	*26COLVER13*	*7.57*
200722	*26SHAWVL 2*	*1.63*
200715	*26SHAWVL 1*	*1.59*
200666	*26SHAWVL 4*	*2.54*
200665	*26SHAWVL 3*	*2.54*

End.

Appendix 7

Flowgate Contingency – The 26SHELOCTA-26KEYSTONE 230 kV line

PJM Queue Position: AD2-119

This appendix contains additional information about the flowgate presented in the body of the report. The intent of this 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.

(PENELEC - PENELEC) The 26SHELOCTA-26KEYSTONE 230 kV line (from bus 200795 to bus 200810 ckt 1) loads from 122.33% to 122.91% (**DC power flow**) of its emergency rating (917 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-002A'. This project contributes approximately 11.7 MW to the thermal violation.

```
CONTINGENCY 'PN_P4-500-002A'                    /* CONEMAUGH 500KV BKR 1
  DISCONNECT BRANCH FROM BUS 200005 TO BUS 200912 CKT 3        /* CONEM-GH 500
26CONEMAGH 230
  DISCONNECT BUS 200031                         /* CONE G2 22
  END
```

Bus Number	Gen. Bus Name	Full Contribution
LTF	AMIL	0.16
LTF	BAYOU	0.69
LTF	BIG_CAJUN1	1.08
LTF	BIG_CAJUN2	2.18
LTF	BLUEG	0.98
LTF	CALDERWOOD	0.4
LTF	CANNELTON	0.17
LTF	CATAWBA	0.3
LTF	CBM-N	4.69
LTF	CELEVELAND	0.86
LTF	CHEOAH	0.37
LTF	CHILHOWEE	0.13
LTF	CHOCTAW	0.73
LTF	CLIFTY	4.23
LTF	COTTONWOOD	2.73
LTF	EDWARDS	0.26
LTF	ELMERSMITH	0.5
LTF	FARMERCITY	0.19
LTF	G-007	0.65
LTF	GIBSON	0.32
LTF	HAMLET	1.05
LTF	MORGAN	1.2
LTF	NEWTON	0.72
LTF	NYISO	70.21

Please continue on the right

Bus Number	Gen. Bus Name	Full Contribution
LTF	O-066	3.4
LTF	PRAIRIE	1.46
LTF	ROWAN	0.61
LTF	SANTEETLA	0.11
LTF	SMITHLAND	0.13
LTF	TATANKA	0.33
LTF	TILTON	0.32
LTF	TRIMBLE	0.19
LTF	TVA	0.53
LTF	UNIONPOWER	0.6
LTF	AA2-300	31.8
936992	AD2-133 E	21.35
936991	AD2-133 C	4.67
936942	AD2-119 E	6.78
936941	AD2-119 C	4.91
936421	AD2-055	6.03
935191	AD1-154	4.85
935061	AD1-142	0.21
934951	AD1-127	78.37
934821	AD1-110	0.2
934811	AD1-109	0.19
934801	AD1-108	0.26
932982	AC2-122 E	7.63
932571	AC2-077	4.68

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Appendix 7 – Continued from previous page

Flowgate Contingency – The 26SHELOCTA-26KEYSTONE 230 kV line

PJM Queue Position: AD2-119

Bus Number	***Gen. Bus Name***	***Full Contribution***
932002	*AC2-004 E*	*10.86*
932001	*AC2-004 C*	*1.62*
931092	*AB1-160 E*	*3.8*
931091	*AB1-160 C*	*0.89*
930511	*AB1-092*	*2.93*
930411	*AB1-082*	*4.72*
927002	*AC1-187 E*	*24.09*
927001	*AC1-187 C*	*3.54*
926992	*AC1-186 E*	*39.94*
926991	*AC1-186 C*	*5.95*
925512	*AC1-025 E*	*0.23*
920351	*AA2-133*	*2.85*
920341	*AA2-132*	*3.55*
919491	*AA2-000*	*79.8*
919201	*AA1-144 OP*	*25.34*
918871	*AA1-106*	*3.5*
918702	*AA1-085 E*	*11.82*
918701	*AA1-085 C*	*1.77*
918682	*AA1-082 E*	*8.91*
918332	*AA1-046 E*	*21.06*
918331	*AA1-046 C*	*3.15*
916351	*Z1-091*	*3.24*
916202	*Z1-069 E*	*12.99*
916051	*Z1-038*	*2.52*
914101	*Y2-055*	*5.39*
913142	*Y1-033 E OP1*	*7.55*
910522	*X3-003 E*	*2.6*
907462	*X1-109 E*	*13.17*
903644	*W3-099 E OP1*	*13.67*
903643	*W3-099 C OP1*	*2.04*
297050	*V2-019 E*	*0.1*
296332	*R-032 E*	*20.12*
294903	*P-060 E*	*12.99*
294573	*P-028 E*	*15.62*
294515	*P-022 E*	*5.15*
293902	*O-048 E*	*7.09*
293802	*O-038 E*	*12.88*
293603	*O-018 E*	*17.44*
293432	*R-040 E*	*0.44*
293393	*V3-030E*	*8.79*
293301	*N-039 E*	*20.61*
292542	*L-013 1*	*7.87*
292350	*K-023*	*0.28*
292340	*K-022*	*0.1*
291409	*S-029B E*	*0.31*
290086	*Q-036 E*	*10.38*
236828	*01GRAYMONT*	*0.63*
932002	*AC2-004 E*	*10.86*
932001	*AC2-004 C*	*1.62*
931092	*AB1-160 E*	*3.8*
931091	*AB1-160 C*	*0.89*
930511	*AB1-092*	*2.93*

Please continue on the right

Bus Number	*Gen. Bus Name*	*Full Contribution*
930411	*AB1-082*	*4.72*
927002	*AC1-187 E*	*24.09*
927001	*AC1-187 C*	*3.54*
926992	*AC1-186 E*	*39.94*
926991	*AC1-186 C*	*5.95*
925512	*AC1-025 E*	*0.23*
920351	*AA2-133*	*2.85*
920341	*AA2-132*	*3.55*
919491	*AA2-000*	*79.8*
919201	*AA1-144 OP*	*25.34*
918871	*AA1-106*	*3.5*
918702	*AA1-085 E*	*11.82*
918701	*AA1-085 C*	*1.77*
918682	*AA1-082 E*	*8.91*
918332	*AA1-046 E*	*21.06*
918331	*AA1-046 C*	*3.15*
916351	*Z1-091*	*3.24*
916202	*Z1-069 E*	*12.99*
916051	*Z1-038*	*2.52*
914101	*Y2-055*	*5.39*
913142	*Y1-033 E OP1*	*7.55*
910522	*X3-003 E*	*2.6*
907462	*X1-109 E*	*13.17*
903644	*W3-099 E OP1*	*13.67*
903643	*W3-099 C OP1*	*2.04*
297050	*V2-019 E*	*0.1*
296332	*R-032 E*	*20.12*
294903	*P-060 E*	*12.99*
294573	*P-028 E*	*15.62*
294515	*P-022 E*	*5.15*
293902	*O-048 E*	*7.09*
293802	*O-038 E*	*12.88*
293603	*O-018 E*	*17.44*
293432	*R-040 E*	*0.44*
293393	*V3-030E*	*8.79*
293301	*N-039 E*	*20.61*
292542	*L-013 1*	*7.87*
292350	*K-023*	*0.28*
292340	*K-022*	*0.1*
291409	*S-029B E*	*0.31*
290086	*Q-036 E*	*10.38*
236828	*01GRAYMONT*	*0.63*
203999	*P-047 E*	*16.74*
203034	*26NA_O38_P22*	*0.85*
202225	*26SCI_S29B*	*0.32*
202160	*26CON.GEN2*	*0.15*
202158	*26CON.GEN1*	*0.2*
200945	*26CT_V3-030*	*0.31*
200925	*26R32*	*0.95*
200915	*26CHSTN_FL*	*0.58*
200905	*26Q36*	*0.49*
200894	*26K02*	*11.7*

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Appendix 7 – Continued from previous page

Flowgate Contingency – The 26SHELOCTA-26KEYSTONE 230 kV line

PJM Queue Position: AD2-119

Bus Number	*Gen. Bus Name*	*Full Contribution*
200894	*26K02*	*11.7*
200892	*26LOOKOUT*	*0.35*
200891	*26CSLMN_L13*	*0.37*
200890	*26BF_G21_K23*	*10.33*
200889	*26STNY CRK*	*0.61*
200888	*26HIGHLAND*	*0.82*
200886	*26ARWF_N39*	*0.97*
200883	*Q-053 E*	*14.83*
200864	*K-013 E*	*0.43*
200846	*26FORWARD*	*7.79*
200839	*26HOMER C3*	*43.11*
200838	*26HOMER C2*	*40.72*
200837	*26HOMER C1*	*49.04*
200835	*26DSGENWIN*	*0.48*
200834	*26SW_E13_K22*	*0.56*
200833	*26SEWRDB34*	*37.28*
200823	*26MHP_X3-003*	*5.73*
200809	*26SITHE*	*2.85*
200805	*26COLVER13*	*34.27*
200636	*26IUP CO-G*	*0.9*
200503	*26C.SLOPE*	*8.69*

End.

Appendix 8

Flowgate Contingency – The 26KEYSTONE 230/1 kV transformer

PJM Queue Position: AD2-119

This appendix contains additional information about the flowgate presented in the body of the report. The intent of this 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.

(PENELEC - PENELEC) The 26KEYSTONE 230/1 kV transformer (from bus 200810 to bus 999437 ckt 3) loads from 118.96% to 119.51% (**DC power flow**) of its emergency rating (612 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-001F'. This project contributes approximately 7.32 MW to the thermal violation.

```
CONTINGENCY 'PN_P4-500-001F'                    /* KEYSTONE 500KV BKR 6
  DISCONNECT BRANCH FROM BUS 200011 TO BUS 200005 CKT 1        /* KEYSTONE 500 CONEM-GH 500
  DISCONNECT BRANCH FROM BUS 200011 TO BUS 200810 TO BUS 200907 CKT 4/* KEYSTONE 500 26KEYSTONE
230 26KEYSTN#4 20.00
  REDUCE BUS 200011 SHUNT BY 100 PERCENT                /* KEYSTONE 500
  END
```

Bus Number	*Gen. Bus Name*	*Full Contribution*
LTF	*AMIL*	*0.49*
LTF	*BAYOU*	*1.69*
LTF	*BIG_CAJUN1*	*2.59*
LTF	*BIG_CAJUN2*	*5.21*
LTF	*BLUEG*	*3.03*
LTF	*CALDERWOOD*	*0.86*
LTF	*CANNELTON*	*0.52*
LTF	*CATAWBA*	*0.5*
LTF	*CBM-N*	*2.9*
LTF	*CELEVELAND*	*1.45*
LTF	*CHEOAH*	*0.78*
LTF	*CHILHOWEE*	*0.28*
LTF	*CHOCTAW*	*1.72*
LTF	*CLIFTY*	*12.76*
LTF	*COTTONWOOD*	*6.7*
LTF	*DEARBORN*	*1.34*
LTF	*EDWARDS*	*0.89*
LTF	*ELMERSMITH*	*1.49*
LTF	*FARMERCITY*	*0.58*
LTF	*G-007A*	*4.37*
LTF	*GIBSON*	*1.01*
LTF	*HAMLET*	*1.56*
LTF	*MORGAN*	*2.79*
LTF	*NEWTON*	*2.26*

Please continue on the right

Bus Number	*Gen. Bus Name*	*Full Contribution*
LTF	*NYISO*	*43.35*
LTF	*PRAIRIE*	*4.32*
LTF	*ROWAN*	*0.99*
LTF	*SANTEETLA*	*0.23*
LTF	*SMITHLAND*	*0.34*
LTF	*TATANKA*	*1.06*
LTF	*TILTON*	*1.07*
LTF	*TRIMBLE*	*0.58*
LTF	*TVA*	*1.25*
LTF	*UNIONPOWER*	*1.17*
LTF	*VFT*	*11.98*
LTF	*AA2-300*	*19.62*
936992	*AD2-133 E*	*12.37*
936991	*AD2-133 C*	*2.71*
936942	*AD2-119 E*	*4.25*
936941	*AD2-119 C*	*3.08*
936421	*AD2-055*	*3.73*
935191	*AD1-154*	*2.76*
935061	*AD1-142*	*0.13*
934951	*AD1-127*	*44.02*
934821	*AD1-110*	*0.13*
934811	*AD1-109*	*0.12*
934801	*AD1-108*	*0.17*
932982	*AC2-122 E*	*4.23*

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Appendix 8 – Continued from previous page

Flowgate Contingency – The 26KEYSTONE 230/1 kV transformer

PJM Queue Position: AD2-119

Bus Number	***Gen. Bus Name***	***Full Contribution***
932981	*AC2-122 C*	*2.6*
932571	*AC2-077*	*2.88*
932002	*AC2-004 E*	*6.03*
932001	*AC2-004 C*	*0.9*
931092	*AB1-160 E*	*2.34*
931091	*AB1-160 C*	*0.55*
930511	*AB1-092*	*1.81*
930411	*AB1-082*	*2.87*
927002	*AC1-187 E*	*14.71*
927001	*AC1-187 C*	*2.16*
926992	*AC1-186 E*	*22.79*
926991	*AC1-186 C*	*3.4*
925512	*AC1-025 E*	*0.15*
920351	*AA2-133*	*1.92*
920341	*AA2-132*	*2.28*
919491	*AA2-000*	*49.41*
919201	*AA1-144 OP*	*16.68*
918871	*AA1-106*	*2.24*
918702	*AA1-085 E*	*7.3*
918701	*AA1-085 C*	*1.1*
918682	*AA1-082 E*	*5.88*
918332	*AA1-046 E*	*11.92*
918331	*AA1-046 C*	*1.78*
917631	*Z2-104*	*0.11*
916351	*Z1-091*	*2.12*
916202	*Z1-069 E*	*7.97*
916051	*Z1-038*	*1.74*
914101	*Y2-055*	*3.13*
914041	*Y2-042*	*0.05*
913142	*Y1-033 E OP1*	*4.15*
910522	*X3-003 E*	*1.79*
907462	*X1-109 E*	*8.69*
903644	*W3-099 E OP1*	*7.65*
903643	*W3-099 C OP1*	*1.14*
297050	*V2-019 E*	*0.07*
296332	*R-032 E*	*11.36*
294903	*P-060 E*	*7.36*
294573	*P-028 E*	*10.73*
294515	*P-022 E*	*2.93*
293902	*O-048 E*	*3.93*
293802	*O-038 E*	*7.31*
293603	*O-018 E*	*9.85*
293432	*R-040 E*	*0.25*
293393	*V3-030E*	*5.05*
293301	*N-039 E*	*11.7*
292542	*L-013 1*	*4.37*
292340	*K-022*	*0.06*
291409	*S-029B E*	*0.18*
290086	*Q-036 E*	*6.01*

Please continue on the right

Bus Number	*Gen. Bus Name*	*Full Contribution*
236828	*01GRAYMONT*	*0.39*
203999	*P-047 E*	*10.57*
203034	*26NA_O38_P22*	*0.48*
202225	*26SCI_S29B*	*0.18*
202160	*26CON.GEN2*	*0.09*
202158	*26CON.GEN1*	*0.13*
200945	*26CT_V3-030*	*0.18*
200925	*26R32*	*0.54*
200915	*26CHSTN_FL*	*0.33*
200905	*26Q36*	*0.28*
200894	*26K02*	*7.39*
200890	*26BF_G21_K23*	*5.74*
200889	*26STNY CRK*	*0.35*
200888	*26HIGHLAND*	*0.46*
200886	*26ARWF_N39*	*0.55*
200883	*Q-053 E*	*8.42*
200864	*K-013 E*	*0.25*
200846	*26FORWARD*	*4.45*
200839	*26HOMER C3*	*26.3*
200838	*26HOMER C2*	*24.85*
200837	*26HOMER C1*	*30.19*
200834	*26SW_E13_K22*	*0.32*
200833	*26SEWRDB34*	*19.87*
200823	*26MHP_X3-003*	*3.93*
200809	*26SITHE*	*1.75*
200805	*26COLVER13*	*20.03*
200636	*26IUP CO-G*	*0.55*
200503	*26C.SLOPE*	*4.88*

End.

Appendix 9

Flowgate Contingency – The CUMB TR2-CUMB 230 kV line

PJM Queue Position: AD2-119

This appendix contains additional information about the flowgate presented in the body of the report. The intent of this 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.

(PL - PL) The CUMB TR2-CUMB 230 kV line (from bus 207950 to bus 207948 ckt 1) loads from 100.39% to 100.93% (**DC power flow**) of its emergency rating (624 MVA) for the line fault with failed breaker contingency outage of 'ME_P4-500-001B'. This project contributes approximately 7.47 MW to the thermal violation.

```
CONTINGENCY 'ME_P4-500-001B'                    /* THREE MILE-X4-020 & TMI-X4 BTM STUCK
CB
  DISCONNECT BRANCH FROM BUS 200016 TO BUS 200009 CKT 1      /* 3 MILE I 500 JUNIATA 500
  DISCONNECT BRANCH FROM BUS 200016 TO BUS 912130 CKT 1      /* 3 MILE I 500 X4-020 TAP 500
/ PJM FIXED
  END
```

Bus Number	*Gen. Bus Name*	*Full Contribution*
236828	*01GRAYMONT*	*0.39*
200812	*26ALY HYDR*	*0.42*
200894	*26K02*	*3.73*
200852	*26WARR RDG*	*0.12*
933771	*AC2-170*	*-0.06*
933974	*AD1-020 BAT*	*1.66*
936421	*AD2-055*	*2.25*
936941	*AD2-119 C*	*3.14*
936942	*AD2-119 E*	*4.33*
936991	*AD2-133 C*	*1.09*
936992	*AD2-133 E*	*4.98*
LTF	*CBM-N*	*0.75*
LTF	*CBM-S1*	*2.41*
LTF	*CBM-S2*	*1.07*
LTF	*CBM-W1*	*11.73*
LTF	*CBM-W2*	*15.35*
LTF	*CIN*	*2.42*
LTF	*CPLE*	*0.17*
LTF	*G-007*	*1.62*
LTF	*IPL*	*1.56*
LTF	*LGEE*	*0.5*
LTF	*MEC*	*4.38*
LTF	*MECS*	*4.17*
293301	*N-039 E*	*3.98*

Please continue on the right

Bus Number	*Gen. Bus Name*	*Full Contribution*
LTF	*NYISO*	*11.26*
293802	*O-038 E*	*2.49*
LTF	*O-066*	*9.13*
294515	*P-022 E*	*0.99*
290086	*Q-036 E*	*2.42*
200883	*Q-053 E*	*2.5*
205900	*Q73E R57E*	*-0.33*
208769	*SISO*	*-0.19*
208850	*U1-067_E*	*-0.14*
904512	*V4-052 E*	*-0.26*
LTF	*WEC*	*0.67*
918701	*AA1-085 C*	*0.94*
918702	*AA1-085 E*	*6.26*
919491	*AA2-000*	*29.72*
930511	*AB1-092*	*1.09*
925512	*AC1-025 E*	*0.15*
925601	*AC1-035*	*-3.02*

End.

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(AD2-119)