System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AB2-070

Brokaw-Lanesville

September 2018

Preface

The intent of the System Impact Study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement.

For Local and Network Upgrades which are required due to overloads associated with the System Impact Studies of an individual New Services Queue, and have a cost less than $5,000,000, the cost of the Local and Network Upgrades will be shared by all proposed projects which have been assigned a Queue Position in the New Services Queue in which the need for the Local and Network Upgrades was identified. The Load Flow Cost Allocation methods discussed in this manual, including cutoffs, still apply to the individual projects. •

For Local and Network Upgrades which are required due to the overloads associated with the System Impact Studies of an individual New Services Queue, and have a cost of $5,000,000 or greater, the cost of the Local and Network Upgrades will be allocated according to the order of the New Service Requests in the New Services Queue and the MW contribution of each individual Interconnection Request for those projects which cause or contribute to the need for the Local or Network Upgrades. The Load Flow Cost Allocation methods discussed in this manual, including cutoffs, still apply to the individual projects.

Cost allocation rules can be found in PJM Manual 14A, Attachment B. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

The System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

The Interconnection Customer (IC) is proposing to connect a 200 MW Energy (26MW Capacity with a 13% class average capacity factor as specified in PJM Manual 21 Appendix B) windfarm to be located in DeWitt County, IL, consisting of 100 Vestas V110 2MW wind turbines. The IC has proposed a service date for this project of December 31, 2018. They have requested a backfeed date of mid September 2018. This is currently under review.

This Generation Interconnection System Impact Study provides analysis results to aid the IC in assessing the practicality and cost of incorporating the facility into the PJM system.

Point of Interconnection

The IC proposes to interconnect AB2-070 with the ComEd transmission system by tapping into 345kV Brokaw-Lanesville Line 2107 approximately 22.7 miles from Brokaw.

Attachment Facilities

The AB2-070 generator lead will interconnect to a new 345kV Interconnection Substation. This interconnection would require one 345kV line motor operated disconnect (MOD), a dead-end structure and revenue metering as shown in the one line diagram.

The cost for the attachment facilities is estimated at $1M.

Scope of Work	Cost Estimate
Installation of one 345kV line MOD, one dead-end structures and one set of revenue metering (see notes below on cost estimate)	$1.0M

Direct Connection Network Upgrades

In order to accommodate interconnection of AB2-070, a new 345kV Interconnection Substation would need to be built close to 345kV Brokaw-Lanesville Line 2107 approximately 23 miles from Brokaw.

The scope of work includes installation of three 345kV circuit breakers in “breaker-and-a-half” bus configuration and tie in the Interconnection Substation to 345kV Brokaw- Lanesville Line 2107, as shown in the one line diagram below.

There is a ‘yet-to-be-built’ Mt Pulaski Substation to interconnect W2-048 Wind Farm that would be interconnected on 345kV line 2107 approximately 38 miles from Brokaw should W2-048 proceed. If TSS188 Mt Pulaski is built before or coincidentally with AB2-070, then AB2-070 Interconnection Substation would be tapped into Brokaw- Mt Pulaski line 18806 approximately 23 miles from Brokaw.

The IC is responsible for constructing all of the facilities on the IC side of the Point Of Interconnection (POI) outside of the substation. It is assumed for the purposes of this report that the IC will obtain the site for the Interconnection Substation and right-of-way between the Interconnection Substation and the 345kV transmission line.

In the event that the IC exercises the option to build the interconnecting substation, the IC will be required to construct all interconnection facilities that will be turned over to ComEd in accordance with ComEd published standards and the PJM Tariff.

ComEd would design, engineer and construct the tie in of the Interconnection Substation to the 345kV Brokaw-Lanesville Line 2107.

The preliminary cost estimate for Direct Connection Network Upgrade is given in the following tables.

For Option to Build Direct Connection cost estimates:

Scope of Work	Cost Estimate
Installation of a new 345kV substation as described above	N/A
Transmission line tie in work (foundations, structures, conductors)	$3,200,000
ComEd oversight and testing	$1,500,000
Total Cost Estimate (see notes below on cost estimate)	$4,700,000

For ComEd building the interconnecting substation cost estimates:

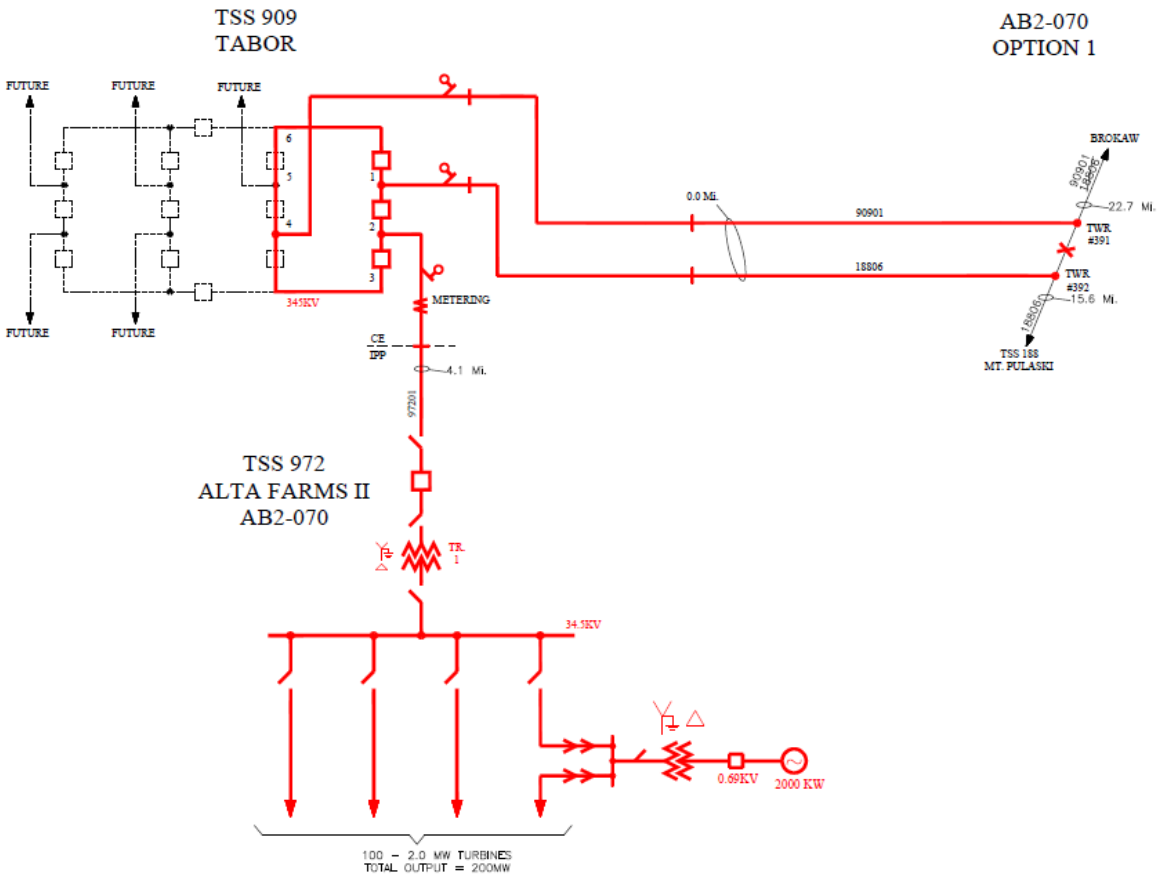
Scope of Work	Cost Estimate
Installation of a new 345kV substation as described above	$19,800,000
Transmission line tie in work (foundations, structures, conductors)	$3,200,000
Total Cost Estimate (see notes below on cost estimate)	$23,000,000

ComEd would take approximately 24-months to construct after the ISA / ICSA are signed.

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for Non-Direct Connection work is given in the following table below:

Scope of Work	Cost Estimate
Relay/communications/SCADA upgrades at Mt Pulaski	$1,000,000
Total Cost Estimate (see notes below on cost estimate)	$1,000,000



Notes on Cost Estimates:

1) These estimates are Order-of-Magnitude estimates of the costs that ComEd would bill to the customer for this interconnection. These estimates are based on a one-line electrical diagram of the project and the information provided by the Interconnection Customer.

2) These cost estimates do not include cost of acquiring right-of-way for the transmission line and purchasing any additional land, if needed, for the line terminations. The need and cost of acquiring property and associated legal costs will be investigated during Facilities Study for this project.

3) There were no site visits performed for these estimates. There may be costs related to specific site related issues that are not identified in these estimates. The site reviews will be performed during the Facilities Study or during detailed engineering.

4) These estimates are not a guarantee of the maximum amount payable by the Interconnection Customer and the actual costs of ComEd's work may differ significantly from these estimates. Per the PJM Tariff, Interconnection Customer will be responsible for paying all actual costs of ComEd's work.

5) The Interconnection Customer is responsible for all engineering, procurement, testing and construction of all equipment on the Interconnection Customer's side of the Point of Interconnection (POI).

Network Impacts

The Queue Project AB2-070 was evaluated as a 200.0 MW (Capacity 26.0 MW) injection into a tap of the Brokaw – Mt Pulaski (W2-048) 345 kV line (along the Brokaw – Lanesville 345 kV line) in the ComEd area. Project AB2-070 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB2-070 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

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)

None

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)

None

Light Load Analysis – 2020

Network Impacts

The Queue Project AB2-070 was evaluated as a 200.0 MW (Capacity 26.0 MW) injection into a tap of the Brokaw – W2-048 345 kV line (along the Brokaw – Lanesville 345 kV line) in the ComEd area. Project AB2-070 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB2-070 was studied with a commercial probability of 100%. Potential network impacts were 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)

None

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. (CE - CE) The LORETTO ; B-WILTON ; B 345 kV line (from bus 270704 to bus 270926 ckt 1) loads from 111.16% to 114.05% (AC power flow) of its emergency rating (1280 MVA) for the single line contingency outage of '345-L8014_T_-S'. This project contributes approximately 41.73 MW to the thermal violation.

```
CONTINGENCY '345-L8014_T_-S'
 TRIP BRANCH FROM BUS 270853 TO BUS 270717 CKT 1          / PONTIAC ; R 345 DRESDEN ; R 345
 TRIP BRANCH FROM BUS 275210 TO BUS 270853 CKT 1          / PONTIAC ;2M 138 PONTIAC ; R 345
 TRIP BRANCH FROM BUS 275210 TO BUS 272261 CKT 1          / PONTIAC ;2M 138 PONTIAC ; R 138
 TRIP BRANCH FROM BUS 275210 TO BUS 275310 CKT 1          / PONTIAC ;2M 138 PONTIAC ;2C 34.5
 CLOSE BRANCH FROM BUS 272260 TO BUS 272261 CKT 1          / PONTIAC ; B 138 PONTIAC ; R 138
 END
```

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

2. (CE - CE) The LORETTO ; B-WILTON ; B 345 kV line (from bus 270704 to bus 270926 ckt 1) loads from 104.42% to 107.13% (AC power flow) of its load dump rating (1371 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_012-45-BT13-14'. This project contributes approximately 41.99 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_012-45-BT13-14'
 TRIP BRANCH FROM BUS 270853 TO BUS 270717 CKT 1          / PONTIAC ; R 345 DRESDEN ; R 345
 TRIP BRANCH FROM BUS 275210 TO BUS 270853 CKT 1          / PONTIAC ;2M 138 PONTIAC ; R 345
 TRIP BRANCH FROM BUS 275210 TO BUS 272261 CKT 1          / PONTIAC ;2M 138 PONTIAC ; R 138
 TRIP BRANCH FROM BUS 275210 TO BUS 275310 CKT 1          / PONTIAC ;2M 138 PONTIAC ;2C 34.5
 CLOSE BRANCH FROM BUS 272260 TO BUS 272261 CKT 1          / PONTIAC ; B 138 PONTIAC ; R 138
 TRIP BRANCH FROM BUS 270717 TO BUS 930760 CKT 1          / *DRESDEN RED* TAZEWELL 345
 END
```

3. (CE - CE) The LORETTO ; B-WILTON ; B 345 kV line (from bus 270704 to bus 270926 ckt 1) loads from 103.4% to 106.1% (AC power flow) of its load dump rating (1371 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_012-45-BT14-15'. This project contributes approximately 41.76 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_012-45-BT14-15'
 TRIP BRANCH FROM BUS 270697 TO BUS 270717 CKT 1          / COLLI; R 345 DRESD; R 345
 TRIP BRANCH FROM BUS 270853 TO BUS 270717 CKT 1          / PONTIAC ; R 345 DRESDEN ; R 345
 TRIP BRANCH FROM BUS 275210 TO BUS 270853 CKT 1          / PONTIAC ;2M 138 PONTIAC ; R 345
 TRIP BRANCH FROM BUS 275210 TO BUS 272261 CKT 1          / PONTIAC ;2M 138 PONTIAC ; R 138
 TRIP BRANCH FROM BUS 275210 TO BUS 275310 CKT 1          / PONTIAC ;2M 138 PONTIAC ;2C 34.5
 CLOSE BRANCH FROM BUS 272260 TO BUS 272261 CKT 1          / PONTIAC ; B 138 PONTIAC ; R 138
 END
```

Stability and Steady-State Voltage Requirements

Generation Interconnection Request AB2-070 is for 200 MW Maximum Facility Output (MFO) wind generating facility. AB2-070 has a Point of Interconnection (POI) at a tap of Brokaw – W2-048 POI 345 kV circuit, in the ComEd transmission system, McLean County, Illinois.

The load flow scenarios for the analysis were based on the RTEP 2020 Summer Peak case, modified to include applicable queue projects. AB2-070 was set to maximum power output, with leading power factor and less than 1.0 pu voltage at the generator terminal bus.
AB2-070 was tested for compliance with NERC, ComEd, PJM and other applicable criteria. 117 contingencies were studied, each with at least a 20 second simulation time period. Studied scenarios included:

a) Steady state operation (20 second simulation).

b) Three-phase faults with normal clearing time on the intact network and during a scheduled outage of a transmission or generation element.

c) Single-phase faults with stuck breaker (For Ameren stations only).

d) Single-phase faults placed at 80% of the line with delayed (Zone 2) clearing at line end remote from fault due to primary communications/relaying failure.

e) Three-phase faults with three-phase delayed clearing due to a stuck breaker (all gang-operated breakers).

f) Three-phase faults with single line to ground delayed clearing due to a stuck breaker (for independent pole breakers and gang-operated breakers with A-contact logic).

No relevant bus, tower or High Speed Reclosing (HSR) contingencies were identified.
The three phase faults with normal clearing time will be performed under network intact conditions and with prior outage of:

a) AB2-070 POI - Brokaw circuit 90101.

b) AB2-070 POI - W2-048 POI circuit 18806.

Additionally, to test the impact on Kincaid stability, the following scenarios will be studied:

c) Prior outage of Kincaid – Latham – W4-005 circuit 2102 with a 3-phase fault on Kincaid – Pana North circuit 2105 (bus 6). Contingency MC.3N.01.

d) Prior outage of AB2-047 – Brokaw circuit 9102 with a 3-phase fault on Kincaid – Pana North circuit 2105 (bus 6). Contingency MD.3N.01.

e) Prior outage of AB2-047 – Brokaw circuit 9102 with a 3-phase fault on Kincaid – Latham – W4-005 circuit 2102 (bus 5). Contingency MD.3N.02.

f) Prior outage of Pontiac Midpoint – Blue Mound circuit 8002 with a 3-phase fault on Kincaid – Pana North circuit 2105 (bus 6). Contingency ME.3N.01.

g) Prior outage of Kincaid – Pana North circuit 2105 with a 3-phase fault on Kincaid – Latham – W4-005 circuit 2102 (bus 5). Contingency MF.3N.01.

h) Prior outage of Kincaid – Pana North circuit 2105 with a 3-phase fault on AB2-070 POI – Brokaw circuit 90901. Contingency MF.3N.02.

i) Prior outage of Kincaid – Pana North circuit 2105 with a 3-phase fault on Pontiac Midpoint – Blue Mound circuit 8002. Contingency MF.3N.03.

j) Prior outage of Kincaid – Lanesville 2101 with a 3-phase fault on Kincaid – Pana North circuit 2105 (bus 6) – contingency MG.3N.01.

For all simulations, the queue project under study along with the rest of the PJM system were required to maintain synchronism and with all states returning to an acceptable new condition following the disturbance.
For the all 117 fault contingencies tested on the 2020 Summer Peak case:

a) Post-contingency oscillations were positively damped with a damping margin of at least 3%.

b) The AB2-070 generator was able to ride through all faults (except for faults where protective action trips a generator(s)).

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of the fault.

In scenarios MB.3N.06 and MA.3N.07, AB2-047 terminal voltage does not stabilize – continues ramping up after event even at 20s. This pattern was observed for several GE models and this is not attributable to AB2-070 project.

No mitigations were found to be required.

Short Circuit
(Summary of impacted circuit breakers)

No issues identified

Affected System Analysis & Mitigation

MISO Impacts:

MISO analysis has identified that AB2-070 is responsible for an upgrade on the Brokaw – N Leroy Tap 138 kV line in MISO. The upgrade is to reconductor the line with 477 ACSS to achieve new ratings of 243/276 MVA SN/SE. The estimated cost is $5M.

MISO analysis details:

2021 Summer Shoulder Analysis:
The Brokaw – N Leroy Tap 138 kV line is loaded to 101.95% of its emergency rating (202 MVA) for the following contingency:

P71:345:AMIL::CLINTON:
GOOSECREEK:45:CLINTON:OREANA

System Reinforcements

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)

None identified.

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)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

None identified.

Short Circuit

(Summary form of Cost allocation for breakers will be inserted here if any)

None identified.

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

None identified.

Light Load Flow 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)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

1. **To relieve the Loretto - Wilton 345kV line overload:**

Existing baseline **B2728**: Mitigate sag limitations on Loretto - Wilton Center 345 kV Line and replace station conductor at Wilton Center. Based on PJM cost allocation criteria, AB2-070 does not have any cost responsibility for this upgrade.

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. (AEP - AEP) The 05EUGENE-05DEQUIN 345 kV line (from bus 243221 to bus 243217 ckt 1) loads from 145.83% to 146.72% (AC power flow) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 10.07 MW to the thermal violation.

```
CONTINGENCY '363_B2_TOR1682'
 OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1              / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
 END
```

2. (CE - CE) The BLUEMOUND; B-PONTIAC ; B 345 kV line (from bus 270668 to bus 270852 ckt 1) loads from 104.17% to 106.45% (AC power flow) of its emergency rating (1528 MVA) for the single line contingency outage of '345-L8001___-S_A'. This project contributes approximately 32.58 MW to the thermal violation.

```
CONTINGENCY '345-L8001___-S_A'
 TRIP BRANCH FROM BUS 270853 TO BUS 920791 CKT 1             / PONTI; R 345 Z2-087 TAP
 END
```

3. (CE - CE) The LORETTO ; B-WILTON ; B 345 kV line (from bus 270704 to bus 270926 ckt 1) loads from 137.86% to 141.5% (AC power flow) of its emergency rating (1528 MVA) for the single line contingency outage of '345-L8014_T_-S'. This project contributes approximately 51.69 MW to the thermal violation.

```
CONTINGENCY '345-L8014_T_-S'
 TRIP BRANCH FROM BUS 270853 TO BUS 270717 CKT 1             / PONTIAC ; R 345 DRESDEN ; R 345
 TRIP BRANCH FROM BUS 275210 TO BUS 270853 CKT 1             / PONTIAC ;2M 138 PONTIAC ; R 345
 TRIP BRANCH FROM BUS 275210 TO BUS 272261 CKT 1             / PONTIAC ;2M 138 PONTIAC ; R 138
 TRIP BRANCH FROM BUS 275210 TO BUS 275310 CKT 1             / PONTIAC ;2M 138 PONTIAC ;2C 34.5
 CLOSE BRANCH FROM BUS 272260 TO BUS 272261 CKT 1             / PONTIAC ; B 138 PONTIAC ; R 138
 END
```

4. (CE - CE) The LORETTO ; B-WILTON ; B 345 kV line (from bus 270704 to bus 270926 ckt 1) loads from 104.59% to 107.28% (AC power flow) of its normal rating (1364 MVA) for non-contingency condition. This project contributes approximately 34.91 MW to the thermal violation.

5. (CE - CE) The DRESDEN ; R-ELWOOD ; R 345 kV line (from bus 270717 to bus 270737 ckt 1) loads from 122.75% to 124.85% (AC power flow) of its emergency rating (1479 MVA) for the single line contingency outage of '345-L1223_TR-S'. This project contributes approximately 29.03 MW to the thermal violation.

```
CONTINGENCY '345-L1223_TR-S'
 TRIP BRANCH FROM BUS 270717 TO BUS 270731 CKT 1          / DRESD; R 345 ELECT;4R 345
 TRIP BRANCH FROM BUS 275180 TO BUS 270717 CKT 1          / DRESD;3M 138 DRESD; R 345
 TRIP BRANCH FROM BUS 275180 TO BUS 271336 CKT 1          / DRESD;3M 138 DRESD; B 138
 TRIP BRANCH FROM BUS 275180 TO BUS 275280 CKT 1          / DRESD;3M 138 DRESD;3C 34.5
 END
```

6. (CE - CE) The PONTIAC ; B-LORETTO ; B 345 kV line (from bus 270852 to bus 270704 ckt 1) loads from 124.94% to 128.49% (AC power flow) of its emergency rating (1528 MVA) for the single line contingency outage of '345-L8014_T_-S'. This project contributes approximately 51.75 MW to the thermal violation.

```
CONTINGENCY '345-L8014_T_-S'
 TRIP BRANCH FROM BUS 270853 TO BUS 270717 CKT 1          / PONTIAC ; R 345 DRESDEN ; R 345
 TRIP BRANCH FROM BUS 275210 TO BUS 270853 CKT 1          / PONTIAC ;2M 138 PONTIAC ; R 345
 TRIP BRANCH FROM BUS 275210 TO BUS 272261 CKT 1          / PONTIAC ;2M 138 PONTIAC ; R 138
 TRIP BRANCH FROM BUS 275210 TO BUS 275310 CKT 1          / PONTIAC ;2M 138 PONTIAC ;2C 34.5
 CLOSE BRANCH FROM BUS 272260 TO BUS 272261 CKT 1          / PONTIAC ; B 138 PONTIAC ; R 138
 END
```

7. (CE - CE) The PONTIAC ; R-DRESDEN ; R 345 kV line (from bus 270853 to bus 270717 ckt 1) loads from 139.21% to 142.91% (AC power flow) of its emergency rating (1481 MVA) for the single line contingency outage of '345-L11212_B-S'. This project contributes approximately 51.35 MW to the thermal violation.

```
CONTINGENCY '345-L11212_B-S'
 TRIP BRANCH FROM BUS 270926 TO BUS 270704 CKT 1          / WILTO; B 345 LORET; B 345
 END
```

8. (CE - CE) The PONTIAC ; R-DRESDEN ; R 345 kV line (from bus 270853 to bus 270717 ckt 1) loads from 99.29% to 101.94% (AC power flow) of its normal rating (1334 MVA) for non-contingency condition. This project contributes approximately 33.6 MW to the thermal violation.

9. (MISO AMIL - AEP) The 7CASEY-05SULLIVAN 345 kV line (from bus 346809 to bus 247712 ckt 1) loads from 103.92% to 106.18% (AC power flow) of its normal rating (1334 MVA) for the single line contingency outage of '286_B2_TOR1687'. This project contributes approximately 30.07 MW to the thermal violation.

```
CONTINGENCY '286_B2_TOR1687'
 OPEN BRANCH FROM BUS 243221 TO BUS 348885 CKT 1          / 243221 05EUGENE 345 348885 7BUNSONVILLE 345 1
 END
```

10. (MISO AMIL - CE) The 7BROKAW-AB2-047 TAP 345 kV line (from bus 348847 to bus 924040 ckt 1) loads from 105.47% to 109.87% (AC power flow) of its emergency rating (1528 MVA) for the single line contingency outage of '345-L8002___-S'. This project contributes approximately 65.97 MW to the thermal violation.

```
CONTINGENCY '345-L8002___-S'
 TRIP BRANCH FROM BUS 270852 TO BUS 270668 CKT 1          / PONTI; B 345 BLUEM; B 345
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 END
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11. (CE - CE) The W4-005 TAP-BLUEMOUND; B 345 kV line (from bus 905080 to bus 270668 ckt 1) loads from 100.26% to 102.8% (AC power flow) of its emergency rating (1334 MVA) for the single line contingency outage of '345-L8001___-S_A'. This project contributes approximately 32.66 MW to the thermal violation.

```
CONTINGENCY '345-L8001___-S_A'
 TRIP BRANCH FROM BUS 270853 TO BUS 920791 CKT 1              / PONTI; R 345 Z2-087 TAP
 END
```

12. (CE - CE) The Z2-087 TAP-PONTIAC ; R 345 kV line (from bus 920791 to bus 270853 ckt 1) loads from 124.25% to 128.61% (AC power flow) of its emergency rating (1528 MVA) for the single line contingency outage of '345-L8002___-S'. This project contributes approximately 65.97 MW to the thermal violation.

```
CONTINGENCY '345-L8002___-S'
 TRIP BRANCH FROM BUS 270852 TO BUS 270668 CKT 1              / PONTI; B 345 BLUEM; B 345
 END
```

13. (CE - CE) The Z2-087 TAP-PONTIAC ; R 345 kV line (from bus 920791 to bus 270853 ckt 1) loads from 101.22% to 105.92% (AC power flow) of its normal rating (1334 MVA) for non-contingency condition. This project contributes approximately 62.65 MW to the thermal violation.

14. (CE - CE) The AB2-047 TAP-Z2-087 TAP 345 kV line (from bus 924040 to bus 920791 ckt 1) loads from 115.87% to 120.2% (AC power flow) of its emergency rating (1528 MVA) for the single line contingency outage of '345-L8002___-S'. This project contributes approximately 65.97 MW to the thermal violation.

```
CONTINGENCY '345-L8002___-S'
 TRIP BRANCH FROM BUS 270852 TO BUS 270668 CKT 1              / PONTI; B 345 BLUEM; B 345
 END
```

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 for Light Load

(CE - CE) The LORETTO ; B-WILTON ; B 345 kV line (from bus 270704 to bus 270926 ckt 1) loads from 111.16% to 114.05% (AC power flow) of its emergency rating (1280 MVA) for the single line contingency outage of '345-L8014_T_-S'. This project contributes approximately 41.73 MW to the thermal violation.

```
CONTINGENCY '345-L8014_T_-S'
 TRIP BRANCH FROM BUS 270853 TO BUS 270717 CKT 1          / PONTIAC ; R 345 DRESDEN ; R 345
 TRIP BRANCH FROM BUS 275210 TO BUS 270853 CKT 1          / PONTIAC ;2M 138 PONTIAC ; R 345
 TRIP BRANCH FROM BUS 275210 TO BUS 272261 CKT 1          / PONTIAC ;2M 138 PONTIAC ; R 138
 TRIP BRANCH FROM BUS 275210 TO BUS 275310 CKT 1          / PONTIAC ;2M 138 PONTIAC ;2C 34.5
 CLOSE BRANCH FROM BUS 272260 TO BUS 272261 CKT 1          / PONTIAC ; B 138 PONTIAC ; R 138
 END
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Bus Number	*Bus Name*	*Full Contribution*
274890	*CAYUG;1U E*	*7.08*
274891	*CAYUG;2U E*	*7.08*
274863	*CAYUGA RI;1U*	*6.43*
274864	*CAYUGA RI;2U*	*6.43*
927331	*J196*	*4.82*
927641	*J339*	*13.77*
900500	*J468*	*17.37*
296308	*R-030 C1*	*11.76*
296271	*R-030 C2*	*11.76*
296125	*R-030 C3*	*11.9*
296309	*R-030 E1*	*47.04*
296272	*R-030 E2*	*47.04*
296128	*R-030 E3*	*47.61*
290261	*S-027 C*	*5.75*
290265	*S-028 C*	*5.75*
274853	*TWINGROVE;U1*	*6.33*
274854	*TWINGROVE;U2*	*6.33*
276150	*W2-048 E*	*12.26*
905081	*W4-005 C*	*1.52*
905082	*W4-005 E*	*10.16*
909052	*X2-022 E*	*37.08*
900404	*X3-028 C*	*76.86*
916502	*Z1-106 E1*	*0.5*
916504	*Z1-106 E2*	*0.5*
916512	*Z1-107 E*	*1.13*
917501	*Z2-087 C*	*9.19*
917502	*Z2-087 E*	*61.48*
918972	*AA1-116 E*	*1.22*
918982	*AA1-117 E*	*1.22*
924041	*AB2-047 C OP*	*11.28*
924042	*AB2-047 E OP*	*75.48*
924261	*AB2-070 C OP*	*5.43*
924262	*AB2-070 E OP*	*36.31*