Generation Interconnection
System Impact Study Report
For

PJM Generation Interconnection Request Queue Position AA2-039

Kewanee 138kV

April 2019

Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

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 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.

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.

General

The Interconnection Customer (IC) is proposing to install eighty four 1.79MW GE wind turbines to be located in Henry County, Illinois and has requested to be studied as a 150 MW Energy (19.5 MW Capacity) resource interconnecting into the Commonwealth Edison (Transmission Owner or "TO") area. The IC had originally proposed an in-service date of June 1, 2016. The actual date is under review.

Impacts on the MISO member transmission systems are not included in this analysis.

The intent of the System Impact Study is to determine system reinforcements and associated costs and construction time estimates required to facilitate the addition of the new generating plant to the transmission system. The reinforcements include the direct connection of the generator to the system and any network upgrades necessary to maintain the reliability of the transmission system.

Point of Interconnection

AA2-039 will be interconnected with the ComEd transmission system as follows:

The new generators are proposed to be connected to the ComEd transmission system at TSS 74 Kewanee 138kV by way of 94301 Line to the TSS943 Bishop Hill Wind Farm.

Attachment Facilities

No new Transmission Owner Attachment Facilities. This is an addition to an existing facility and only relay setting changes are anticipated.

A one line diagram can be found below in **Figure 1**.

The IC is required to construct all connection facilities in accordance with the TO published standards.

Direct Connection Network Upgrades

None

Non-Direct Connection Network Upgrades

None

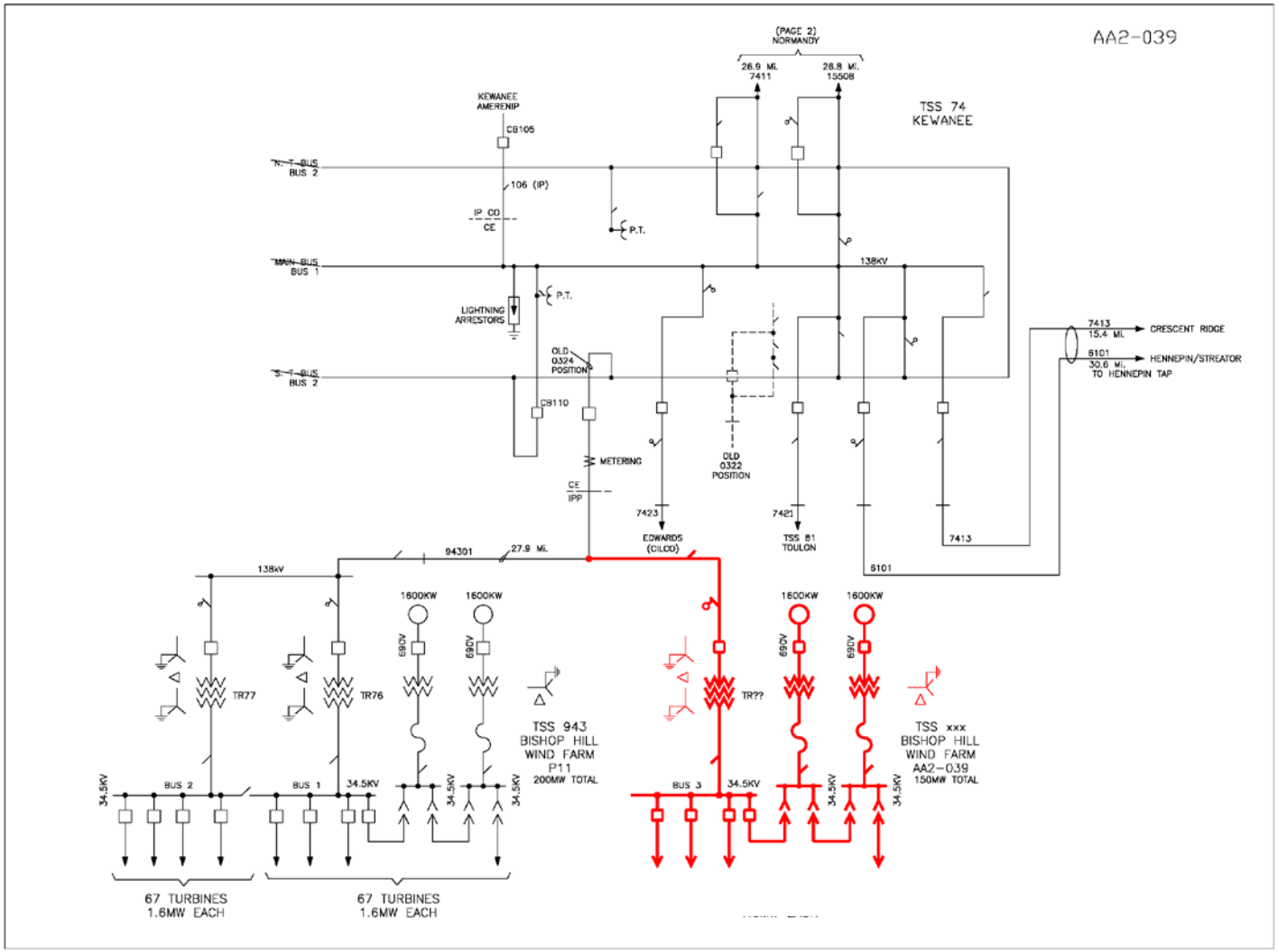
Revenue Metering and SCADA Requirements

For PJM: IC will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and Section 8 of Attachment O to the PJM Open Access Transmission Tariff.

For ComEd:

The Interconnection Customer will be required to comply with all ComEd Revenue Metering Requirements for Generation Interconnection Customers.

Figure 1. Single Line Diagram



Network Impacts

The Queue Project AA2-039 was evaluated as a 150.0 MW (Capacity 19.5 MW) injection into the Bishop Hill 138 kV (Kewanee) substation in the ComEd area. Project AA2-039 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA2-039 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2019

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. (CE - CE) The KEWANEE ;23-HENNEPIN ; T 138 kV line (from bus 271835 to bus 271655 ckt 1) loads from 89.91% to 114.26% (AC power flow) of its applicable load dump rating (238 MVA) for the bus fault outage of '074_KE-138___1'. This project contributes approximately 53.97 MW to the thermal violation.

```
CONTINGENCY '074_KE-138___1'
 DISCONNECT BUS 271836                    / KEWAN; 1 138
 DISCONNECT BUS 271837                    / KEWAN; 5 138
 DISCONNECT BUS 271838                    / KEWAN; 4 138
 END
```

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

2. (CE - CE) The KEWANEE ;23-HENNEPIN ; T 138 kV line (from bus 271835 to bus 271655 ckt 1) loads from 89.91% to 114.26% (AC power flow) of its applicable load dump rating (238 MVA) for the line fault with failed breaker contingency outage of '074-38-L7413__'. This project contributes approximately 53.97 MW to the thermal violation.

```
CONTINGENCY '074-38-L7413__'
 TRIP BRANCH FROM BUS 271836 TO BUS 271241 CKT 1          / KEWAN; 1 138 CRESC; R 138
 DISCONNECT BUS 271836                    / KEWAN; 1 138
 DISCONNECT BUS 271837                    / KEWAN; 5 138
 DISCONNECT BUS 271838                    / KEWAN; 4 138
 END
```

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. (CE - CE) The NELSON ; B-WALTO; B 345 kV line (from bus 270828 to bus 270932 ckt 1) loads from 117.41% to 118.21% (AC power flow) of its emergency rating (1528 MVA) for the single line contingency outage of '345-L0627__B-R'. This project contributes approximately 15.98 MW to the thermal violation.

```
CONTINGENCY '345-L0627__B-R'
 TRIP BRANCH FROM BUS 274768 TO BUS 270678 CKT 1              / LEECO;BP 345 BYRON; B 345
 END
```

2. (CE - CE) The WALTO; B-ELECT JCT; B 345 kV line (from bus 270932 to bus 270730 ckt 1) loads from 117.46% to 118.26% (AC power flow) of its emergency rating (1528 MVA) for the single line contingency outage of '345-L0627__B-R'. This project contributes approximately 15.98 MW to the thermal violation.

```
CONTINGENCY '345-L0627__B-R'
 TRIP BRANCH FROM BUS 274768 TO BUS 270678 CKT 1              / LEECO;BP 345 BYRON; B 345
 END
```

3. (CE - CE) The CRESCENT ; R-OGLESBY ; T 138 kV line (from bus 271241 to bus 272189 ckt 1) loads from 112.4% to 123.38% (AC power flow) of its emergency rating (174 MVA) for the single line contingency outage of 'KEWANEE ;13-4KEWANEE N'. This project contributes approximately 20.39 MW to the thermal violation.

```
CONTINGENCY 'KEWANEE ;13-4KEWANEE N'
 DISCONNECT BRANCH FROM BUS 271838 TO BUS 348923 CKT 1
 END
```

4. (CE - CE) The KEWANEE ;23-HENNEPIN ; T 138 kV line (from bus 271835 to bus 271655 ckt 1) loads from 105.85% to 119.8% (AC power flow) of its emergency rating (190 MVA) for the single line contingency outage of 'KEWANEE ;13-4KEWANEE N'. This project contributes approximately 28.22 MW to the thermal violation.

```
CONTINGENCY 'KEWANEE ;13-4KEWANEE N'
 DISCONNECT BRANCH FROM BUS 271838 TO BUS 348923 CKT 1
 END
```

5. (CE - MISO AMIL) The KEWANEE ;13-4KEWANEE N 138 kV line (from bus 271838 to bus 348923 ckt 1) loads from 88.34% to 104.11% (AC power flow) of its normal rating (244 MVA) for non-contingency condition. This project contributes approximately 42.21 MW to the thermal violation.

6. (CE - CE) The KEWANEE ;21-KEWANEE ;13 138 kV line (from bus 271845 to bus 271838 ckt 1) loads from 78.75% to 100.57% (AC power flow) of its emergency rating (449 MVA) for

the single line contingency outage of '074-L6101___'. This project contributes approximately 105.56 MW to the thermal violation.

```
CONTINGENCY '074-L6101___'
 TRIP BRANCH FROM BUS 271835 TO BUS 271655 CKT 1              / KEWAN; 2 138 HENNE; T 138
 END
```

7. (CE - CE) The OGLESBY ; T-MAZON ; R 138 kV line (from bus 272189 to bus 271987 ckt 1) loads from 123.82% to 134.23% (AC power flow) of its emergency rating (115 MVA) for the single line contingency outage of '138-L0112__B-S'. This project contributes approximately 14.08 MW to the thermal violation.

```
CONTINGENCY '138-L0112__B-S'
 TRIP BRANCH FROM BUS 271844 TO BUS 271908 CKT 1              / KICKA; B 138 LASCO; B 138
 END
```

8. (CE - CE) The ROCK FALL; R-NELSON ; R 138 kV line (from bus 272367 to bus 272095 ckt 1) loads from 128.82% to 141.16% (AC power flow) of its emergency rating (223 MVA) for the single line contingency outage of '187-L15508__'. This project contributes approximately 32.39 MW to the thermal violation.

```
CONTINGENCY '187-L15508__'
 TRIP BRANCH FROM BUS 293710 TO BUS 272097 CKT 1              / O29 ; 138 NELSO;RT 138
 END
```

9. (CE - CE) The LEE CO EC;BP-BYRON ; B 345 kV line (from bus 274768 to bus 270678 ckt 1) loads from 104.58% to 105.44% (AC power flow) of its emergency rating (1726 MVA) for the single line contingency outage of '345-L15502_B-R'. This project contributes approximately 18.46 MW to the thermal violation.

```
CONTINGENCY '345-L15502_B-R'
 TRIP BRANCH FROM BUS 270828 TO BUS 270932 CKT 1              / NELSO; B 345 WALTO; B 345
 END
```

10. (CE - CE) The O-09 OP1 138-ROCK FALL; R 138 kV line (from bus 293510 to bus 272367 ckt 1) loads from 160.97% to 174.43% (AC power flow) of its emergency rating (214 MVA) for the single line contingency outage of '187-L15508__'. This project contributes approximately 33.87 MW to the thermal violation.

```
CONTINGENCY '187-L15508__'
 TRIP BRANCH FROM BUS 293710 TO BUS 272097 CKT 1              / O29 ; 138 NELSO;RT 138
 END
```

11. (CE - CE) The O-09 OP1 138-ROCK FALL; R 138 kV line (from bus 293510 to bus 272367 ckt 1) loads from 106.23% to 115.86% (AC power flow) of its normal rating (173 MVA) for non-contingency condition. This project contributes approximately 19.61 MW to the thermal violation.

12. (CE - CE) The O-029-NELSON ;RT 138 kV line (from bus 293710 to bus 272097 ckt 1) loads from 134.2% to 145.06% (AC power flow) of its emergency rating (264 MVA) for the

single line contingency outage of '133-CB_23___'. This project contributes approximately 33.73 MW to the thermal violation.

```
CONTINGENCY '133-CB_23___'
 TRIP BRANCH FROM BUS 272367 TO BUS 293510 CKT 1              / R FAL; R 138 O9 138
 END
```

13. (CE - CE) The O-029-NELSON ;RT 138 kV line (from bus 293710 to bus 272097 ckt 1) loads from 107.48% to 115.39% (AC power flow) of its normal rating (208 MVA) for non-contingency condition. This project contributes approximately 19.36 MW to the thermal violation.

14. (MISO AMIL - AEP) The 7CASEY-05BREED 345 kV line (from bus 346809 to bus 243213 ckt 1) loads from 130.08% to 130.74% (AC power flow) of its normal rating (1332 MVA) for the single line contingency outage of '286_B2_TOR1687'. This project contributes approximately 18.4 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
 OPEN BRANCH FROM BUS 348885 TO BUS 348887 CKT 1          / 348885 7BUNSONVILLE 345 348887 7SIDNEY 345 1
 OPEN BRANCH FROM BUS 348885 TO BUS 348886 CKT 1          / 348885 7BUNSONVILLE 345 348886 4BUNSONVILLE 138 1
 END
```

15. (MISO AMIL - AEP) The 7BUNSONVILLE-05EUGENE 345 kV line (from bus 348885 to bus 243221 ckt 1) loads from 132.99% to 133.86% (AC power flow) of its normal rating (822 MVA) for the single line contingency outage of '685_B2_TOR1686'. This project contributes approximately 16.52 MW to the thermal violation.

```
CONTINGENCY '685_B2_TOR1686'
 OPEN BRANCH FROM BUS 243213 TO BUS 346809 CKT 1          / 243213 05BREED 345 346809 7CASEY 345 1
 END
```

Stability and Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

Insufficiently damped power oscillations with a frequency of approximately 1.3 Hz were observed on local synchronous machines after the majority of contingencies. The same oscillations were observed with AA2-039 out of service, therefore this instability cannot be attributed to the addition of AA2-039.

Several contingencies at Kewanee showed instability at U4-027. The breaker faults at Kewanee were re-tested at the suggested lower clearing time of 6/11 cycles and the results show U4-027 is stable. ComEd equipment experts have confirmed that all existing 138kV circuit breakers at Kewanee are 3-cycle devices; therefore, 6/11 clearing times are achievable at Kewanee. Relay upgrades on 6 lines will be required to support this clearing time - L6101, L7411, L7421, L7423, L94301, and the segment of L15508 from Kewanee to U4-027 (new line number 7408). Estimate cost for this work is **$840,000**. Delayed clearing fault 3D.17 showed instability at U4-027, dual primary relaying will be installed at an estimated cost of **$2.8M**.

With these mitigations in place, the U4-027 is stable. The contingencies were re-tested with AA2-039 out of service and the instabilities still showed up. Since this is a pre-existing issue and not aggravated by AA2-039, the project does not get any cost responsibility for the reinforcements.

This will be reevaluated in the Facilities Study phase. Should U4-027 withdraw, this analysis will need to be repeated.

Short Circuit

(Summary of impacted circuit breakers)

PJM has completed the short circuit analysis of the AA2-039 queue project. One option was considered during this study: the option was a direct connect to Bishop Hill 138 kV substation. Our analysis found **1 new breaker**, to be over-duty in the ComEd transmission area.

The new over-duty breaker is listed below:

Bus Number	Bus Name	BREAKER	Rating Type	Breaker Capacity (Amps)	Duty Percent With AA2-039_ComEd	Duty Percent Without AA2-039_ComEd	Duty Percent Difference	Duty Amps With AA2-039_ComEd	Duty Amps Without AA2-039_ComEd	Notes
0	Kewanee 2 138.kV	74 7411	T	19469.6	100.25%	97.21%	3.04%	19518.1	18926.2	New Over-duty

Affected System Analysis & Mitigation

MISO Impacts:

The Affected system study did not identify any Steady State - Thermal or Voltage violations with the interconnection of the AA2-039 project on the monitored MISO transmission system. Both Out-year Summer Shoulder (2021) and Out-year Summer Peak (2021) analysis were performed as part of the study. These study projects have full injection capability conditional to the transmission and generation assumptions in this study.

Light Load Analysis - 2019

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

Generator Deliverability

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

1. (CE - CE) The ROCK FALL; R-NELSON ; R 138 kV line (from bus 272367 to bus 272095 ckt 1) loads from 95.68% to 105.82% (AC power flow) of its emergency rating (223 MVA) for the single line contingency outage of '138-L15508_R-R'. This project contributes approximately 24.28 MW to the thermal violation.

```
CONTINGENCY '138-L15508_R-R'
 TRIP BRANCH FROM BUS 271331 TO BUS 271333 CKT 1          / DIXON;8R 138 DIXON; R 138
 TRIP BRANCH FROM BUS 272097 TO BUS 271331 CKT 1          / NELSO;RT 138 DIXON;8R 138
 TRIP BRANCH FROM BUS 272097 TO BUS 272095 CKT 1          / NELSO;RT 138 NELSO; R 138
 MOVE 100 PERCENT LOAD FROM BUS 271331 TO BUS 271330        / DIXON;8R 138 DIXON;7B 138
 END
```

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

2. (CE - CE) The O29-NELSON ;RT 138 kV line (from bus 293710 to bus 272097 ckt 1) loads from 98.98% to 108.18% (AC power flow) of its emergency rating (264 MVA) for the single line contingency outage of '138-L15509GR-R'. This project contributes approximately 26.09 MW to the thermal violation.

```
CONTINGENCY '138-L15509GR-R'
 TRIP BRANCH FROM BUS 272095 TO BUS 272367 CKT 1          / NELSO; R 138 R FAL; R 138
 TRIP BRANCH FROM BUS 272367 TO BUS 274244 CKT 7          / R FAL; R 138 R FAL; 34.5
 END
```

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

1. (CE - CE) The ROCK FALL; R-NELSON ; R 138 kV line (from bus 272367 to bus 272095 ckt 1) loads from 92.12% to 101.95% (AC power flow) of its load dump rating (230 MVA) for the line fault with failed breaker contingency outage of '107-38-L15508_'. This project contributes approximately 24.24 MW to the thermal violation.

```
CONTINGENCY '107-38-L15508_'
 TRIP BRANCH FROM BUS 271331 TO BUS 271333 CKT 1          / DIXON;8R 138 DIXON; R 138
 TRIP BRANCH FROM BUS 272097 TO BUS 271331 CKT 1          / NELSO;RT 138 DIXON;8R 138
 TRIP BRANCH FROM BUS 272097 TO BUS 272095 CKT 1          / NELSO;RT 138 NELSO; R 138
 MOVE 100 PERCENT LOAD FROM BUS 271331 TO BUS 271330       / DIXON;8R 138 DIXON;7B 138
 MOVE 100 PERCENT LOAD FROM BUS 271333 TO BUS 271332       / DIXON; R 138 DIXON; B 138
 DISCONNECT BUS 271333                    / DIXON; R 138
 END
```

2. (CE - CE) The ROCK FALL; R-NELSON ; R 138 kV line (from bus 272367 to bus 272095 ckt 1) loads from 91.47% to 101.29% (AC power flow) of its load dump rating (230 MVA) for the tower line contingency outage of '138-L15507_B-R_+_138-L15508_R-R'. This project contributes approximately 24.24 MW to the thermal violation.

```
CONTINGENCY '138-L15507_B-R_+_138-L15508_R-R'
 TRIP BRANCH FROM BUS 271330 TO BUS 271332 CKT 1          / DIXON;7B 138 DIXON; B 138
 TRIP BRANCH FROM BUS 272094 TO BUS 271330 CKT 1          / NELSO; B 138 DIXON;7B 138
 MOVE 100 PERCENT LOAD FROM BUS 271330 TO BUS 271331       / DIXON;7B 138 DIXON;8R 138
 TRIP BRANCH FROM BUS 271331 TO BUS 271333 CKT 1          / DIXON;8R 138 DIXON; R 138
 TRIP BRANCH FROM BUS 272097 TO BUS 271331 CKT 1          / NELSO;RT 138 DIXON;8R 138
 TRIP BRANCH FROM BUS 272097 TO BUS 272095 CKT 1          / NELSO;RT 138 NELSO; R 138
 MOVE 100 PERCENT LOAD FROM BUS 271331 TO BUS 271330       / DIXON;8R 138 DIXON;7B 138
 END
```

3. (CE - CE) The O09 OP1 138-ROCK FALL; R 138 kV line (from bus 293510 to bus 272367 ckt 1) loads from 94.1% to 102.84% (AC power flow) of its load dump rating (275 MVA) for the line fault with failed breaker contingency outage of '107-38-L15508_'. This project contributes approximately 25.64 MW to the thermal violation.

```
CONTINGENCY '107-38-L15508_'
 TRIP BRANCH FROM BUS 271331 TO BUS 271333 CKT 1          / DIXON;8R 138 DIXON; R 138
 TRIP BRANCH FROM BUS 272097 TO BUS 271331 CKT 1          / NELSO;RT 138 DIXON;8R 138
 TRIP BRANCH FROM BUS 272097 TO BUS 272095 CKT 1          / NELSO;RT 138 NELSO; R 138
```

```
MOVE 100 PERCENT LOAD FROM BUS 271331 TO BUS 271330          / DIXON;8R 138 DIXON;7B 138
MOVE 100 PERCENT LOAD FROM BUS 271333 TO BUS 271332          / DIXON; R 138 DIXON; B 138
DISCONNECT BUS 271333                          / DIXON; R 138
END
```

4. (CE - CE) The O09 OP1 138-ROCK FALL; R 138 kV line (from bus 293510 to bus 272367 ckt 1) loads from 93.25% to 101.99% (AC power flow) of its load dump rating (275 MVA) for the tower line contingency outage of '138-L15507_B-R_+_138-L15508_R-R'. This project contributes approximately 25.64 MW to the thermal violation.

```
CONTINGENCY '138-L15507_B-R_+_138-L15508_R-R'
 TRIP BRANCH FROM BUS 271330 TO BUS 271332 CKT 1              / DIXON;7B 138 DIXON; B 138
 TRIP BRANCH FROM BUS 272094 TO BUS 271330 CKT 1              / NELSO; B 138 DIXON;7B 138
 MOVE 100 PERCENT LOAD FROM BUS 271330 TO BUS 271331          / DIXON;7B 138 DIXON;8R 138
 TRIP BRANCH FROM BUS 271331 TO BUS 271333 CKT 1              / DIXON;8R 138 DIXON; R 138
 TRIP BRANCH FROM BUS 272097 TO BUS 271331 CKT 1              / NELSO;RT 138 DIXON;8R 138
 TRIP BRANCH FROM BUS 272097 TO BUS 272095 CKT 1              / NELSO;RT 138 NELSO; R 138
 MOVE 100 PERCENT LOAD FROM BUS 271331 TO BUS 271330          / DIXON;8R 138 DIXON;7B 138
 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. (CE - CE) The O09 OP1 138-ROCK FALL; R 138 kV line (from bus 293510 to bus 272367 ckt 1) loads from 105.35% to 115.06% (AC power flow) of its emergency rating (248 MVA) for the single line contingency outage of '138-L15508_R-R'. This project contributes approximately 25.71 MW to the thermal violation.

```
CONTINGENCY '138-L15508_R-R'
 TRIP BRANCH FROM BUS 271331 TO BUS 271333 CKT 1              / DIXON;8R 138 DIXON; R 138
 TRIP BRANCH FROM BUS 272097 TO BUS 271331 CKT 1              / NELSO;RT 138 DIXON;8R 138
 TRIP BRANCH FROM BUS 272097 TO BUS 272095 CKT 1              / NELSO;RT 138 NELSO; R 138
 MOVE 100 PERCENT LOAD FROM BUS 271331 TO BUS 271330          / DIXON;8R 138 DIXON;7B 138
 END
```

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

2. (CE - CE) The O29-NELSON ;RT 138 kV line (from bus 293710 to bus 272097 ckt 1) loads from 104.0% to 113.21% (AC power flow) of its emergency rating (264 MVA) for the single line contingency outage of '133-CB_23___'. This project contributes approximately 26.11 MW to the thermal violation.

```
CONTINGENCY '133-CB_23___'
 TRIP BRANCH FROM BUS 272367 TO BUS 293510 CKT 1              / R FAL; R 138 O9 138
 END
```

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

3. (CE - CE) The O29-NELSON ;RT 138 kV line (from bus 293710 to bus 272097 ckt 1) loads from 104.06% to 110.65% (AC power flow) of its load dump rating (275 MVA) for the line fault

with failed breaker contingency outage of '187-38-BT2-3__'. This project contributes approximately 19.44 MW to the thermal violation.

```
CONTINGENCY '187-38-BT2-3__'
 TRIP BRANCH FROM BUS 272367 TO BUS 293510 CKT 1              / R FAL; R 138 O9 138
 MOVE 100 PERCENT LOAD FROM BUS 272111 TO BUS 272110          / NORMA; R 138 NORMA; B 138
 DISCONNECT BUS 272111                                        / NORMA; R 138
 END
```

System Reinforcements

Short Circuit

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

The preliminary estimate to replace the 7411 breaker at Kewanee is $2M with a 24 month preliminary construction timeline (PJM network upgrade N5970).

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

Relay upgrades on 6 lines will be required to support this clearing time - L6101, L7411, L7421, L7423, L94301, and the segment of L15508 from Kewanee to U4-027 (new line number 7408). Estimate cost for this work is $840,000. Delayed clearing fault 3D.17 showed instability at U4-027, dual primary relaying will be installed at an estimated cost of $2.8M.

With these mitigations in place, the U4-027 is stable. The contingencies were re-tested with AA2-039 out of service and the instabilities still showed up. Since this is a pre-existing issue and not aggravated by AA2-039, the project does not get any cost responsibility for the reinforcements.

To be confirmed in Facilities Study phase

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)

To relieve the KEWANEE ;23-HENNEPIN ; T 138 kV line overloads: Reconfigure the Kewanee 138 kV bus by swapping the Bishop Hill & Edwards line terminals. Preliminary estimate is $7.5 M with a construction time estimate of 24 months. AA2-039 is responsible for this cost. PJM Network Upgrade N5008.

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

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

1. **To relieve the Rock Fall - Nelson 138 kV line overload**
   Reinforcement: Baseline Upgrade - Install a new 138 kV circuit 18702 from Schauff Road to Rock Falls and install a fourth breaker and a half run at Schauff Road. This Baseline is currently in the process of being approved through the PJM Stakeholder Process.

   AA2-039 is currently not responsible for cost towards this baseline upgrade.
   AA2-039 may need this upgrade in-service to be deliverable to the PJM system and an interim study may be required.

   Estimated Cost: $20,000,000
   Required IS Date: 11/1/2019

2. **To relieve the O09 – Rock Fall 138 kV line overload**
   Reinforcement: Baseline Upgrade - Install a new 138 kV circuit 18702 from Schauff Road to Rock Falls and install a fourth breaker and a half run at Schauff Road. This Baseline is currently in the process of being approved through the PJM Stakeholder Process.

   AA2-039 is currently not responsible for cost towards this baseline upgrade.
   AA2-039 may need this upgrade in-service to be deliverable to the PJM system and an interim study may be required.

   Estimated Cost: $20,000,000
   Required IS Date: 11/1/2019

3. **To relieve the O29 – Nelson 138 kV line overload**
   Reinforcement: Baseline Upgrade - Install a new 138 kV circuit 18702 from Schauff Road to Rock Falls and install a fourth breaker and a half run at Schauff Road. This Baseline is currently in the process of being approved through the PJM Stakeholder Process.

AA2-039 is currently not responsible for cost towards this baseline upgrade.
AA2-039 may need this upgrade in-service to be deliverable to the PJM system and an interim study may be required.

Estimated Cost: $20,000,000
Required IS Date: 11/1/2019

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

(CE - CE) The KEWANEE ;23-HENNEPIN ; T 138 kV line (from bus 271835 to bus 271655 ckt 1) loads from 133.9% to 162.13% (AC power flow) of its load dump rating (202 MVA) for the bus fault outage of '074_KE-138___1'. This project contributes approximately 53.97 MW to the thermal violation.

```
CONTINGENCY '074_KE-138___1'
 DISCONNECT BUS 271836                  / KEWAN; 1 138
 DISCONNECT BUS 271837                  / KEWAN; 5 138
 DISCONNECT BUS 271838                  / KEWAN; 4 138
 END
```

Bus Number	*Bus Name*	*Full Contribution*
274832	*ANNAWAN ; 1U*	*8.46*
274877	*BISHOP HL;1U*	*0.82*
274878	*BISHOP HL;2U*	*0.82*
294401	*BSHIL;1U E*	*28.78*
294410	*BSHIL;2U E*	*28.78*
274848	*CAMPGROVE;RU*	*1.08*
990901	*L-005 E*	*38.07*
293516	*O-009 E1*	*7.04*
293517	*O-009 E2*	*3.58*
293518	*O-009 E3*	*3.94*
293715	*O-029 E*	*7.37*
293716	*O-029 E*	*4.04*
293717	*O-029 E*	*3.71*
919621	*AA2-039 C*	*7.02*
919622	*AA2-039 E*	*46.95*