System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC1-033

Kewanee 138kV

Revision 0: October 2018
Revision 1: June 2021

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

Queue AC1-033 project is a Heartland Wind, LLC ("Interconnection Customer" or "IC") c/o Avangrid Renewables, LLC (formerly known as Iberdrola Renewables) proposal to connect a 100.8 MW Energy (13.1 MW Capacity) windfarm to be located in Henry County, IL, consisting of forty eight 2.1 MW Gamesa G114 wind turbines. The project will have 13% class average capacity factor as specified in PJM Manual 21 Appendix B at the time of entering the queue. The IC will be calling the facility Midland Windfarm. The IC has proposed a service date for this project as stated in the Generation Interconnection Feasibility Study Agreement (Attachment N) is December 31, 2019. The final in-service date will be determined based on the Transmission Owner's construction schedule.

Revision History:

- Revision 0 (Issued October 26, 2018)
- Revision 1 (Issued June 22, 2021)

The June 2021 report includes the following updates:

1. Added Contingent Facilities in the MISO region to the Affected System Analysis and Mitigation section
2. Deleted requirement for Relay upgrades identified in the Stability and Steady State Voltage requirement of the original report. The modifications are not required based on the retooled stability analysis results.
3. Deleted the overdutied short circuit breaker violation and reinforcement Short Circuit section of the report. The reinforcement is not required based on the retooled Short Circuit analysis results.
4. Added baseline in service dates to the Light Load Flow Analysis Reinforcement Section of the report.

Point of Interconnection

AC1-033 proposes to interconnect to the 138kV bus at TSS 74 Kewanee via an 11 mile long generator lead.

Attachment Facilities

The AC1-033 generator lead will interconnect to the 138kV bus-1 at TSS 74 Kewanee. This interconnection would require one 138kV circuit breaker, a dead-end structure and revenue metering as shown in the one line diagram.

The cost for the attachment facilities is estimated at $4.0M.

Scope of Work	Cost Estimate
Installation of one 138kV circuit breaker, one dead-end structure and one set of revenue metering (see notes below on cost estimate)	$ 4.0M

ComEd would take 24-months to construct after ISA and ICSA are signed.

The Interconnection Customer is responsible for constructing all of the facilities on the Interconnection Customer side of the point of interconnection, outside of the substation.

Direct Connection Network Upgrades

None

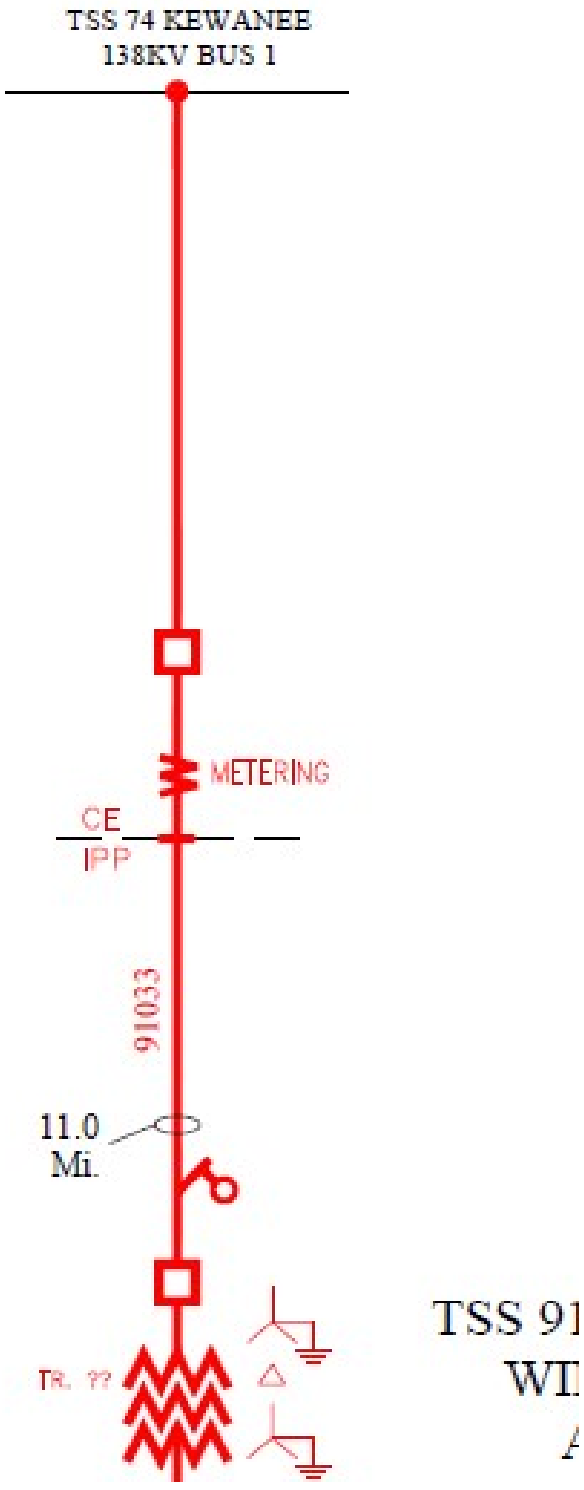

Figure 1. Single Line Diagram

Notes on Cost Estimate:

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.

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 AC1-033 was evaluated as a 100.8 MW (Capacity 13.1 MW) injection into the Kewanee 138 kV substation in the ComEd area. Project AC1-033 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-033 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

Affected System Analysis & Mitigation

MISO Impacts:

MISO analysis as reported in PJM April 2017 Queue Generation Affected System Impact Study dated September 18, 2017 did not identify any impacts by AC1-033.

Contingent Facilities:

The following table describes transmission assumptions modeled in the studies that were deemed necessary to allow for the Interconnection Service of PJM study units. If the transmission assumptions are not completed or significantly modified, the Interconnection Service of PJM units may be restricted until a re-study is performed to determine the applicable service level that results. In the event that any of the higher queued and/or same group study generators in MISO and/or PJM were to drop out, then the Interconnection Customer may be subject to restudy. If there are no modifications to this table, AC1-033 will be included in

MISO's Annual studies to determine available injection until assumptions reach their expected In-Service Date.

MTEP ID	MTEP Cycle	Project Name	Project Description	Expected Completion Date	Status
4480	MTEP14	Oglesby 138 kV Substation - Rebuild	Rebuild Oglesby Substation. Utilize a breaker-and-a-half arrangement.	6/1/2023	Proposed

Light Load Analysis - 2020

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 100.0% to 107.67% (AC power flow) of its emergency rating (223 MVA) for the single line contingency outage of '138-L15508_R-R'. This project contributes approximately 17.71 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
 TRIP BRANCH FROM BUS 272097 TO BUS 293710 CKT 1          / NELSO;RT 138 O29 138
 MOVE 100 PERCENT LOAD FROM BUS 271331 TO BUS 271330        / DIXON;8R 138 DIXON;7B 138
 END
```

2. (CE - CE) The O09 OP1 138-ROCK FALL; R 138 kV line (from bus 293510 to bus 272367 ckt 1) loads from 96.24% to 102.91% (AC power flow) of its normal rating (173 MVA) for non-contingency condition. This project contributes approximately 11.99 MW to the thermal violation.

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 95.83% to 103.24% (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 17.67 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
 TRIP BRANCH FROM BUS 272097 TO BUS 293710 CKT 1          / NELSO;RT 138 O29 138
 MOVE 100 PERCENT LOAD FROM BUS 271331 TO BUS 271330          / DIXON;8R 138 DIXON;7B 138
 END
```

2. (CE - CE) The O29-NELSON ;RT 138 kV line (from bus 293710 to bus 272097 ckt 1) loads from 91.0% to 97.62% (AC power flow) of its load dump rating (275 MVA) for the tower line contingency outage of '138-L15509GR-R_+_138-L15518GB-R'. This project contributes approximately 18.98 MW to the thermal violation.

```
CONTINGENCY '138-L15509GR-R_+_138-L15518GB-R'              / CONTINGENCY # 123
 TRIP BRANCH FROM BUS 272095 TO BUS 272367 CKT 1          / NELSON ; R 138 ROCK FALL; R 138
 TRIP BRANCH FROM BUS 272367 TO BUS 274244 CKT 7          / ROCK FALL; R 138 ROCK FALL; 34.5
 TRIP BRANCH FROM BUS 272094 TO BUS 272366 CKT 1          / NELSON ; B 138 ROCK FALL; B 138
 TRIP BRANCH FROM BUS 272366 TO BUS 272512 CKT 1          / ROCK FALL; B 138 ESS H71 ;BT 138
 TRIP BRANCH FROM BUS 272512 TO BUS 271543 CKT 1          / ESS H71 ;BT 138 GARDEN PL; 138
 TRIP BRANCH FROM BUS 272512 TO BUS 272514 CKT 1          / ESS H71 ;BT 138 ESS H71 ; B 138
 MOVE 100 PERCENT LOAD FROM BUS 272514 TO BUS 272515          / ESS H71 ; B 138 ESS H71 ; R 138
 CLOSE LINE FROM BUS 272366 TO BUS 272367 CKT 1          / ROCK FALL; B 138 ROCK FALL; R 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 ROCK FALL; R-NELSON ; R 138 kV line (from bus 272367 to bus 272095 ckt 1) loads from 108.35% to 116.36% (AC power flow) of its emergency rating (223 MVA) for the single line contingency outage of '187-L15508__'. This project contributes approximately 18.54 MW to the thermal violation.

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

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

2. (CE - CE) The O09 OP1 138-ROCK FALL; R 138 kV line (from bus 293510 to bus 272367 ckt 1) loads from 128.22% to 136.95% (AC power flow) of its emergency rating (214 MVA) for the single line contingency outage of '187-L15508__'. This project contributes approximately 19.39 MW to the thermal violation.

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

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

3. (CE - CE) The O09 OP1 138-ROCK FALL; R 138 kV line (from bus 293510 to bus 272367 ckt 1) loads from 121.58% to 130.04% (AC power flow) of its emergency rating (214 MVA) for the single line contingency outage of '138-L15508_R-R'. This project contributes approximately 18.75 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
 TRIP BRANCH FROM BUS 272097 TO BUS 293710 CKT 1          / NELSO;RT 138 O29 138
 MOVE 100 PERCENT LOAD FROM BUS 271331 TO BUS 271330        / DIXON;8R 138 DIXON;7B 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 111.35% to 119.2% (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 18.69 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
 TRIP BRANCH FROM BUS 272097 TO BUS 293710 CKT 1          / NELSO;RT 138 O29 138
 MOVE 100 PERCENT LOAD FROM BUS 271331 TO BUS 271330        / DIXON;8R 138 DIXON;7B 138
 END
```

5. (CE - CE) The O29-NELSON ;RT 138 kV line (from bus 293710 to bus 272097 ckt 1) loads from 103.07% to 109.99% (AC power flow) of its emergency rating (264 MVA) for the single line contingency outage of '133-CB_23___'. This project contributes approximately 19.01 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 5 for a table containing the generators having contribution to this flowgate.

6. (CE - CE) The O29-NELSON ;RT 138 kV line (from bus 293710 to bus 272097 ckt 1) loads from 100.51% to 107.43% (AC power flow) of its emergency rating (264 MVA) for the single line contingency outage of '138-L15509GR-R'. This project contributes approximately 18.99 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
```

7. (CE - CE) The O29-NELSON ;RT 138 kV line (from bus 293710 to bus 272097 ckt 1) loads from 105.51% to 110.05% (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 12.86 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
```

MISO-MISO Overload (Information Purposes Only)

3. (MISO AMIL - MISO AMIL) The 4KEWANEE S-4KEWANEE STP 138 kV line (from bus 348974 to bus 348924 ckt 1) loads from 89.0% to 97.4% (AC power flow) of its emergency rating (202 MVA) for the line fault with failed breaker contingency outage of '155-38-L15508_'. This project contributes approximately 18.49 MW to the thermal violation.

```
CONTINGENCY '155-38-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
 TRIP BRANCH FROM BUS 272097 TO BUS 293710 CKT 1          / NELSO;RT 138 O29 138
 MOVE 100 PERCENT LOAD FROM BUS 271331 TO BUS 271330        / DIXON;8R 138 DIXON;7B 138
 DISCONNECT BUS 272095                        / NELSO; R 138
 END
```

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

Stability and Steady-State Voltage Requirements

Mitigations are not required. Stability Study report is available on request.

Short Circuit

(Summary of impacted circuit breakers)

None

.

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.

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

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 **B2959** - 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.

   AC1-033 is currently not responsible for cost towards this baseline upgrade.

   B2959 went in service in November 2019

2. **To relieve the O09 – Rock Fall 138 kV line overload**

   Reinforcement: Baseline Upgrade **B2959** - 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.

   AC1-033 is currently not responsible for cost towards this baseline upgrade.

   B2959 went in service in November 2019

3. **To relieve the O29 – Nelson 138 kV line overload**

   Reinforcement: Baseline Upgrade **B2959** - 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.

   AC1-033 is currently not responsible for cost towards this baseline upgrade.

   B2959 went in service in November 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 2

(MISO AMIL - MISO AMIL) The 4KEWANEE S-4KEWANEE STP 138 kV line (from bus 348974 to bus 348924 ckt 1) loads from 89.0% to 97.4% (AC power flow) of its emergency rating (202 MVA) for the line fault with failed breaker contingency outage of '155-38-L15508_'. This project contributes approximately 18.49 MW to the thermal violation.

```
CONTINGENCY '155-38-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
 TRIP BRANCH FROM BUS 272097 TO BUS 293710 CKT 1          / NELSO;RT 138 O29 138
 MOVE 100 PERCENT LOAD FROM BUS 271331 TO BUS 271330      / DIXON;8R 138 DIXON;7B 138
 DISCONNECT BUS 272095                          / NELSO; R 138
 END
```

Bus Number	*Bus Name*	*Full Contribution*
274877	*BISHOP HL;1U*	*1.83*
274878	*BISHOP HL;2U*	*1.83*
294401	*BSHIL;1U E*	*2.02*
294410	*BSHIL;2U E*	*2.02*
274848	*CAMPGROVE;RU*	*2.42*
274849	*CRESCENT ;1U*	*1.15*
990901	*L-005 E*	*2.66*
293513	*O-009 C1*	*3.47*
293514	*O-009 C2*	*1.76*
293515	*O-009 C3*	*1.94*
293516	*O-009 E1*	*13.87*
293517	*O-009 E2*	*7.04*
293518	*O-009 E3*	*7.76*
293712	*O-029 C*	*1.85*
293713	*O-029 C*	*1.02*
293714	*O-029 C*	*0.94*
293715	*O-029 E*	*2.04*
293716	*O-029 E*	*1.12*
293717	*O-029 E*	*1.03*
293771	*O-035 E*	*1.25*
274851	*PROVIDENC;RU*	*1.13*
916211	*Z1-072*	*0.21*
919621	*AA2-039 C*	*3.58*
919622	*AA2-039 E*	*23.93*
926051	*AC1-033 C*	*2.4*
926052	*AC1-033 E*	*16.09*
LTF	*AC1-133*	*0.09*
926491	*AC1-168 C OP*	*0.94*
926492	*AC1-168 E OP*	*6.34*

926501	*AC1-171 C OP*	*0.8*
926502	*AC1-171 E OP*	*5.37*
926641	*AC1-214 C OP*	*3.02*
926642	*AC1-214 E OP*	*9.14*

Appendix 3

(CE - CE) The ROCK FALL; R-NELSON ; R 138 kV line (from bus 272367 to bus 272095 ckt 1) loads from 108.35% to 116.36% (AC power flow) of its emergency rating (223 MVA) for the single line contingency outage of '187-L15508__'. This project contributes approximately 18.54 MW to the thermal violation.

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

Bus Number	*Bus Name*	*Full Contribution*
274877	*BISHOP HL;1U*	*1.84*
274878	*BISHOP HL;2U*	*1.84*
294401	*BSHIL;1U E*	*2.03*
294410	*BSHIL;2U E*	*2.03*
274848	*CAMPGROVE;RU*	*2.46*
274849	*CRESCENT ;1U*	*1.16*
990901	*L-005 E*	*2.71*
293513	*O-009 C1*	*8.32*
293514	*O-009 C2*	*4.22*
293515	*O-009 C3*	*4.67*
293516	*O-009 E1*	*33.28*
293517	*O-009 E2*	*16.91*
293518	*O-009 E3*	*18.62*
293712	*O-029 C*	*4.41*
293713	*O-029 C*	*2.41*
293714	*O-029 C*	*2.23*
293715	*O-029 E*	*4.86*
293716	*O-029 E*	*2.66*
293717	*O-029 E*	*2.45*
293771	*O-035 E*	*1.26*
274851	*PROVIDENC;RU*	*1.14*
916211	*Z1-072*	*0.21*
919621	*AA2-039 C*	*3.59*
919622	*AA2-039 E*	*24.01*
926051	*AC1-033 C*	*2.41*
926052	*AC1-033 E*	*16.13*
926491	*AC1-168 C OP*	*0.97*
926492	*AC1-168 E OP*	*6.51*
926501	*AC1-171 C OP*	*0.92*
926502	*AC1-171 E OP*	*6.12*
926641	*AC1-214 C OP*	*3.04*
926642	*AC1-214 E OP*	*9.22*

Appendix 4

(CE - CE) The O09 OP1 138-ROCK FALL; R 138 kV line (from bus 293510 to bus 272367 ckt 1) loads from 128.22% to 136.95% (AC power flow) of its emergency rating (214 MVA) for the single line contingency outage of '187-L15508__'. This project contributes approximately 19.39 MW to the thermal violation.

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

Bus Number	*Bus Name*	*Full Contribution*
274877	*BISHOP HL;1U*	*1.92*
274878	*BISHOP HL;2U*	*1.92*
294401	*BSHIL;1U E*	*2.12*
294410	*BSHIL;2U E*	*2.12*
274848	*CAMPGROVE;RU*	*2.57*
274849	*CRESCENT ;1U*	*1.21*
990901	*L-005 E*	*2.83*
293513	*O-009 C1*	*8.7*
293514	*O-009 C2*	*4.41*
293515	*O-009 C3*	*4.88*
293516	*O-009 E1*	*34.82*
293517	*O-009 E2*	*17.69*
293518	*O-009 E3*	*19.48*
293712	*O-029 C*	*4.61*
293713	*O-029 C*	*2.53*
293714	*O-029 C*	*2.34*
293715	*O-029 E*	*5.08*
293716	*O-029 E*	*2.79*
293717	*O-029 E*	*2.56*
293771	*O-035 E*	*1.32*
274851	*PROVIDENC;RU*	*1.19*
916211	*Z1-072*	*0.22*
919621	*AA2-039 C*	*3.75*
919622	*AA2-039 E*	*25.11*
926051	*AC1-033 C*	*2.52*
926052	*AC1-033 E*	*16.87*
926491	*AC1-168 C OP*	*1.01*
926492	*AC1-168 E OP*	*6.81*
926501	*AC1-171 C OP*	*0.96*
926502	*AC1-171 E OP*	*6.4*
926641	*AC1-214 C OP*	*3.18*
926642	*AC1-214 E OP*	*9.64*

Appendix 5

(CE - CE) The O29-NELSON ;RT 138 kV line (from bus 293710 to bus 272097 ckt 1) loads from 103.07% to 109.99% (AC power flow) of its emergency rating (264 MVA) for the single line contingency outage of '133-CB_23___'. This project contributes approximately 19.01 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
```

Bus Number	*Bus Name*	*Full Contribution*
274877	*BISHOP HL;1U*	*1.89*
274878	*BISHOP HL;2U*	*1.89*
294401	*BSHIL;1U E*	*2.08*
294410	*BSHIL;2U E*	*2.08*
274848	*CAMPGROVE;RU*	*2.52*
274849	*CRESCENT ;1U*	*1.19*
990901	*L-005 E*	*2.78*
293513	*O-009 C1*	*8.46*
293514	*O-009 C2*	*4.29*
293515	*O-009 C3*	*4.74*
293516	*O-009 E1*	*33.84*
293517	*O-009 E2*	*17.19*
293518	*O-009 E3*	*18.93*
293712	*O-029 C*	*4.58*
293713	*O-029 C*	*2.51*
293714	*O-029 C*	*2.32*
293715	*O-029 E*	*5.05*
293716	*O-029 E*	*2.77*
293717	*O-029 E*	*2.54*
293771	*O-035 E*	*1.29*
274851	*PROVIDENC;RU*	*1.17*
916211	*Z1-072*	*0.22*
919621	*AA2-039 C*	*3.68*
919622	*AA2-039 E*	*24.63*
926051	*AC1-033 C*	*2.47*
926052	*AC1-033 E*	*16.54*
926491	*AC1-168 C OP*	*0.99*
926492	*AC1-168 E OP*	*6.67*
926501	*AC1-171 C OP*	*0.94*
926502	*AC1-171 E OP*	*6.28*
926641	*AC1-214 C OP*	*3.12*
926642	*AC1-214 E OP*	*9.45*