System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC1-204

Elwood

January 2018

REISSUED March 1, 2019

REISSUED April 19, 2019

REVISED April 22, 2019

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 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 AC1-204 project is a J-POWER USA Development Co., Ltd. ("Interconnection Customer" or "IC") proposal to connect a 1200.9 MW Winter Energy (1115.9 MW Summer Energy and Capacity combined cycle to be located in Will County, IL, consisting of two 1x1 CCGT (single shaft). The IC will be calling the facility "Jackson Generation".

The IC has proposed a service date for this project of June 1, 2022.

Impacts on the MISO member transmission systems are included in this analysis.

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 Interconnection Customer (IC) AC1-204 proposes to interconnect to existing TSS 900 345kV Elwood substation's blue (PSSE bus number 270736) and to red (PSSE bus number 270737) buses.

Attachment Facilities

The IC AC1-204 generator leads will interconnect to the existing TSS 900 345kV Elwood substation. This interconnection would require two 345kV line MODs, two dead-end structures and, two revenue-metering as shown in the one line diagram.

Scope of Work	Cost Estimate
Installation of two 345kV line MOD, two dead-end structure and two sets of revenue metering (see notes below on cost estimate)	See below

Direct Connection Network Upgrades

In order to accommodate interconnection of AC1-204, the red and blue busses at TSS 900 Elwood will be expanded by installing one 345 kV Circuit Breakers to create one line positions, on the blue bus as shown in the one line diagram below. A vacant bay (5 Bus) on the red but will be utilized.

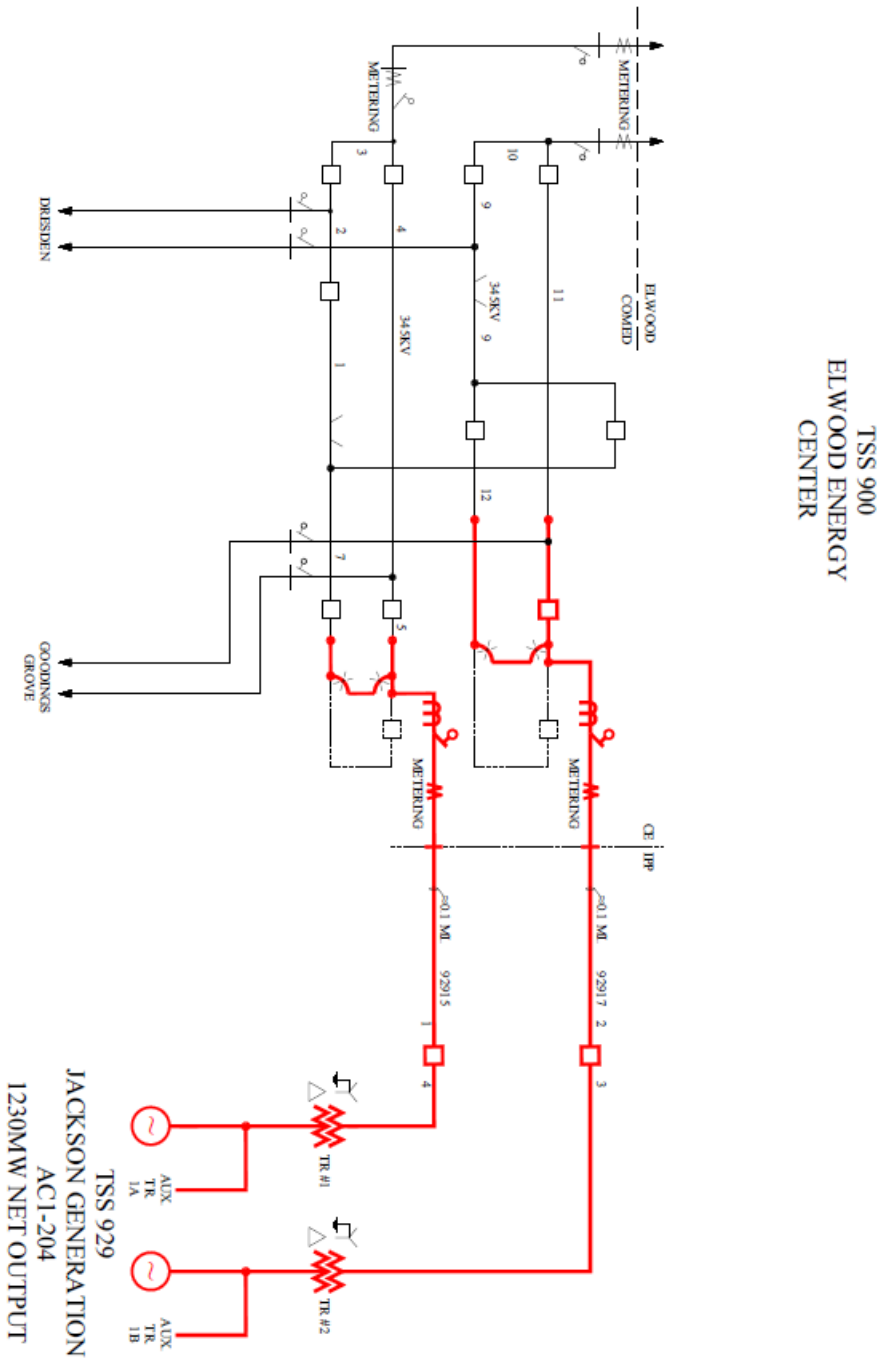
The Interconnection Customer is responsible for constructing all of the facilities on the Interconnection Customer side of the point of interconnection outside of the substation. The preliminary cost estimate for Direct Connection Network Upgrade is given in the following tables.

Scope of Work	Cost Estimate
Installation of one 345kV circuit breaker at TSS900 Elwood as described above	See Below
Total Cost Estimate (see notes below on cost estimate)	

Estimated cost for work at TSS900 Elwood and TSS 929 Jackson Generation from the draft Facilities Study:

TSS900 Elwood	$24,840,000

Normally it takes about 24-months to engineer, design, procure material and construct 345kV facilities after ISA/ICSA are signed.



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.

2) 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.

3) 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.

4) 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 AC1-204 was evaluated as a 1115.9 MW (Capacity 1115.9 MW) injection into the Elwood 'R' and 'B' 345 kV buses in the ComEd area. Project AC1-204 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-204 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)

1. (CE - CE) The ELWOOD ; B-GOODINGS ;4B 345 kV line (from bus 270736 to bus 270770 ckt 1) loads from 85.61% to 110.1% (AC power flow) of its emergency rating (1479 MVA) for the single line contingency outage of 345-L11622_R-S'. This project contributes approximately 356.47 MW to the thermal violation.

```
CONTINGENCY '345-L11622_R-S'                    / CONTINGENCY # 223
 TRIP BRANCH FROM BUS 270737 TO BUS 270769 CKT 1          / ELWOOD ; R 345 GOODINGS ;1R 345
 END
```

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

2. (CE - CE) The ELWOOD ; B-GOODINGS ;4B 345 kV line (from bus 270736 to bus 270770 ckt 1) loads from 83.64% to 103.54% (AC power flow) of its emergency rating (1479 MVA) for the single line contingency outage of 345-L10805_B-S'. This project contributes approximately 287.48 MW to the thermal violation.

```
CONTINGENCY '345-L10805_B-S'
 TRIP BRANCH FROM BUS 270810 TO BUS 274702 CKT 1          / LOCKP; B 345 KENDA;BU 345
 END
```

3. (CE - CE) The ELWOOD ; B-GOODINGS ;4B 345 kV line (from bus 270736 to bus 270770 ckt 1) loads from 77.89% to 100.37% (AC power flow) of its normal rating (1201 MVA) for non-contingency condition. This project contributes approximately 265.23 MW to the thermal violation.

4. (CE - CE) The ELWOOD ; R-GOODINGS ;2R 345 kV line (from bus 270737 to bus 270769 ckt 1) loads from 86.62% to 111.34% (AC power flow) of its emergency rating (1479 MVA) for the single line contingency outage of 345-L11620_B-S'. This project contributes approximately 356.32 MW to the thermal violation.

```
CONTINGENCY '345-L11620_B-S'                    / CONTINGENCY # 222
 TRIP BRANCH FROM BUS 270736 TO BUS 270770 CKT 1          / ELWOOD ; B 345 GOODINGS ;3B 345
 END
```

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

5. (CE - CE) The ELWOOD ; R-GOODINGS ;2R 345 kV line (from bus 270737 to bus 270769 ckt 1) loads from 80.27% to 103.31% (AC power flow) of its normal rating (1201 MVA) for non-contingency condition. This project contributes approximately 266.69 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 KENDALL ;BU-LOCKPORT ; B 345 kV line (from bus 274702 to bus 270810 ckt 1) loads from 93.87% to 100.39% (AC power flow) of its load dump rating (1768 MVA) for the tower line contingency outage of 345-L1221__B-S_+_345-L1223_TR-S'. This project contributes approximately 136.61 MW to the thermal violation.

```
CONTINGENCY '345-L1221__B-S_+_345-L1223_TR-S'
 TRIP BRANCH FROM BUS 270716 TO BUS 270928 CKT 1          / DRESD; B 345 WOLFS; B 345
 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
```

2. (MISO NIPS - AEP) The 17STILLWELL-05DUMONT 345 kV line (from bus 255113 to bus 243219 ckt 1) loads from 95.79% to 105.96% (AC power flow) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of 2978_C2_05DUMONT 765-B_A'. This project contributes approximately 168.59 MW to the thermal violation.

```
CONTINGENCY '2978_C2_05DUMONT 765-B_A'
 OPEN BRANCH FROM BUS 243206 TO BUS 920251 CKT 1          / 243206 05DUMONT 765 920251 X1-020 TAP 765 1
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1          / 243206 05DUMONT 765 270644 WILTON ; 765 1
 END
```

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

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

1. (CE - CE) The KENDALL ;BU-LOCKPORT ; B 345 kV line (from bus 274702 to bus 270810 ckt 1) loads from 106.35% to 115.87% (AC power flow) of its emergency rating (1479 MVA) for the single line contingency outage of 345-L1221__B-S'. This project contributes approximately 129.9 MW to the thermal violation.

```
CONTINGENCY '345-L1221__B-S'
 TRIP BRANCH FROM BUS 270716 TO BUS 270928 CKT 1          / DRESD; B 345 WOLFS; B 345
 END
```

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

2. (CE - CE) The KENDALL ;BU-LOCKPORT ; B 345 kV line (from bus 274702 to bus 270810 ckt 1) loads from 106.12% to 115.63% (AC power flow) of its emergency rating (1479 MVA) for the single line contingency outage of 345-L14321TB-N'. This project contributes approximately 129.98 MW to the thermal violation.

```
CONTINGENCY '345-L14321TB-N'
 TRIP BRANCH FROM BUS 270928 TO BUS 270730 CKT 1              / WOLFS; B 345 ELECT; B 345
 TRIP BRANCH FROM BUS 270928 TO BUS 272794 TO BUS 275334 CKT 1   / WOLFS; B 345 WOLFS; B 138 WOLFS;1C 34.5
 END
```

3. (CE - CE) The KENDALL ;BU-LOCKPORT ; B 345 kV line (from bus 274702 to bus 270810 ckt 1) loads from 106.68% to 115.34% (AC power flow) of its normal rating (1201 MVA) for non-contingency condition. This project contributes approximately 95.92 MW to the thermal violation.

4. (CE - CE) The KENDALL ;BU-LOCKPORT ; B 345 kV line (from bus 274702 to bus 270810 ckt 1) loads from 103.32% to 115.21% (AC power flow) of its load dump rating (1768 MVA) for the tower line contingency outage of 345-L11620_B-S_+_345-L11622_R-S'. This project contributes approximately 248.23 MW to the thermal violation.

```
CONTINGENCY '345-L11620_B-S_+_345-L11622_R-S'              / CONTINGENCY # 60
 TRIP BRANCH FROM BUS 270736 TO BUS 270770 CKT 1           / ELWOOD ; B 345 GOODINGS ;3B 345
 TRIP BRANCH FROM BUS 270737 TO BUS 270769 CKT 1           / ELWOOD ; R 345 GOODINGS ;1R 345
 END
```

5. (MISO AMIL - AEP) The 7CASEY-05SULLIVAN 345 kV line (from bus 346809 to bus 247712 ckt 1) loads from 106.53% to 110.93% (AC power flow) of its emergency rating (1466 MVA) for the line fault with failed breaker contingency outage of 1750_C2_05DUMONT 765-B1'. This project contributes approximately 74.52 MW to the thermal violation.

```
CONTINGENCY '1750_C2_05DUMONT 765-B1'
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1           / 243206 05DUMONT 765 270644 WILTON ; 765 1
 OPEN BRANCH FROM BUS 243206 TO BUS 243219 CKT 1           / 243206 05DUMONT 765 243219 05DUMONT 345 1
 END
```

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

Steady-State Voltage Requirements

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

No issues identified. To be revisited during Facilities Study phase.

Short Circuit
(Summary of impacted circuit breakers)

The TSS 116 Goodings Grove BT3-4 goes from 98.9% to 100.6% of its rating (40kA) with the addition of AC1-204.

Affected System Analysis & Mitigation

MISO Impacts:

Steady state thermal, steady state voltage, stability, and short circuit screening analyses were performed to identify any reliability criteria violations caused by the study generators.

No thermal or voltage violations were identified in the 2022 summer peak and shoulder summer peak scenarios. No stability violations were identified in the 2022 shoulder summer peak scenario. No Network Upgrades were identified from the steady state and stability analyses.

A short circuit screening analysis was conducted by comparing three phase fault currents in the benchmark and study cases for a selected list of AC1 projects. No short circuit violations are identified from NIPSCO's additional analysis. Other MISO Transmission Owners are not planning to conduct additional studies.

The table below 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, PJM projects will be included in MISO's Annual studies to determine available injection until assumptions reach their expected In-Service Date.

Transmission Assumptions

MTEP ID	MTEP Cycle	Project Name	Project Description	Expected Completion Date	Status
2237	MTEP11	Proposed MVP Portfolio 1 - Pana - Mt. Zion - Kansas - Sugar Creek 345 kV line	Pana to Mt. Zion to Kansas to Sugar Creek 345 kV line. Install transformers at Mt. Zion and Kansas	12/1/2020	M3_Long Lead Materials

For additional details, please reference the MISO supplied Affected System Impact Study report.

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.

Not Applicable

Light Load Analysis - 2020

Not Applicable

System Reinforcements

Short Circuit

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

To be determined as part of the Facilities Study phase.

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

The load flow scenarios for the analysis were based on the RTEP 2020 Light Load case, modified to include applicable queue projects. AC1-204 was set to maximum power output, with leading power factor and less than 1.0 pu voltage at the generator terminal bus.

a) Steady state operation (20 seconds);

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

c) Three-phase faults with three-phase delayed clearing due to a stuck breaker (gang-operated breakers);

d) Three-phase faults with single-phase delayed clearing due to a stuck breaker (independent pole-operated breakers);

e) Single-phase bus faults with normal clearing time;

f) Three-phase faults with loss of multi-circuit tower line.

Three phase faults placed at 80% of the line with delayed (Zone 2) clearing were not studied due to the presence of redundant protection relays on the ComEd 345 kV network.
The three phase faults with normal clearing time were performed under network intact conditions and with prior outage of:

a) Elwood – Goodings Grove 345 kV circuit 11622

b) Elwood – Dresden 345 kV circuit 1222

c) Elwood – Goodings Grove 345 kV circuit 11620

d) Elwood – Dresden 345 kV circuit 1220

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 all contingencies tested on the 2020 light load case:

a) AC1-204 is able to ride through the faults (except for faults where protective action trips a generator(s)),

b) The system with AC1-204 included is transiently stable and post-contingency oscillations are positively damped with a damping margin of at least 3%.

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 that fault.

No mitigation was found to be required.

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

1. To relieve the Elwood; B – Goodings; 4B 345 kV line overload: The upgrade will be to re-conductor a portion of the line along with sag mitigation on another portion of the line. A preliminary estimate for this is $42.2M with a 30 month estimated construction timeline.

Additional transmission tower work may be required. The cost for this work will be determined during the Facilities Study phase.

The required ratings (minimum) for 11620 are 1205/1479/1628/1768 SN/SLTE/SSTE/ALDR

Upon completion of the work the ratings are expected to be 1334/1726/1837/2084 MVA (SN/SLTE/SSTE/SLD) to be confirmed in the Facilities Study. PJM Network Upgrade N5915. AC1-204 is responsible for this cost.

2. To relieve the Elwood; R – Goodings; 2R 345 kV line overloads: The upgrade will be to re-conductor a portion of the line along with sag mitigation on another portion of the line. A preliminary estimate for this is $42.2 M with a 30 month estimated construction timeline. Additional transmission tower work may be required. The cost for this work will be determined during the Facilities Study phase.

   The required ratings (minimum) for 11622 are 1241/1479/1646/1768 SN/SLTE/SSTE/ALDR

   Upon completion of the work the ratings are expected to be 1334/1726/1837/2084 MVA (SN/SLTE/SSTE/SLD) to be confirmed in the Facilities Study. PJM Network Upgrade N5916. AC1-204 is responsible for this cost.

3. To relieve the Stillwell - Dumont 345 kV line overloads:

   - AEP-end – SE rating is 1409 MVA. (Network Upgrade N4058) AEP Sag study results: Stillwell - Dumont 345 kV line work will include the replacement of tower 20 with a custom steel pole, replacement of tower 24 with a custom H-frame and the removal of swing angle brackets on 2 structures. Cost estimate is $1.613M. Scope to be confirmed during Facilities Study phase.

     Post AC1-204 SE minimum rating required is 1493 MVA.

   - New SE rating will be 1718 MVA limited by a Dumont wavetrap and the conductor.

     AC1-204 is responsible for this cost.

   - MISO end – ratings are 1409/1779 MVA SN/SE and are sufficient.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

1. To relieve the Kendall – Lockport 'B' 345 kV line overloads:

   Reconductor a portion of the line L10805 along with sag mitigation on a separate portion. Preliminary estimate is $38.6M with a construction time of 30 months. Additional transmission tower work may be required. The cost for this work will be determined during the Facilities Study phase.

   New ratings to be 1334/1726/1837/2084 MVA SN/SLTE/SSTE/SLD. PJM Network Upgrade N5144.

   AC1-204 receives cost allocation as follows:

Queue	MW contribution	Percentage of Cost	$ cost ($ 38.6 M)
AB1-122	56.6	37.11%	14.32
AC1-204	95.9	62.89%	24.28

   The previous upgrade is not sufficient for AC1-204. The additional upgrade is to upgrade L10805 station conductor. Preliminary estimate is $1.28M with a construction time of 24-30 months.

   The required post AC1-204 ratings (minimum) for 10805 are 1386/1479/1713/2037 SN/SLTE/SSTE/ALDR.

   Upon completion of the upgrades the new ratings are expected to be 2293/2293/2293/2436 MVA SN/SLTE/SSTE/SLD to be confirmed during the Facilities Study phase. PJM Network Upgrade N5918. AC1-204 is responsible for this cost.

2. To relieve the Casey - Sullivan 345 kV line overload:

   The AEP-end SE rating is 1685 MVA and is sufficient.

   The Ameren-end SE rating is 1466 MVA. Reconductor/Rebuild the Ameren-owned portion of the line to achieve an Ameren-end SE rating of 1793 MVA (3000 A). Cost estimate is $20-30 M.

   AC1-204 will need to enter into an applicable MISO Facilities Study agreement for this Ameren work.

AC1-204 receives cost allocation as follows:

Queue	MW contribution	Percentage of cost	Cost ($30M)
AB2-096	19.9	16.56%	4.967
AC1-053	25.8	21.46%	6.439
AC1-204	74.5	61.98%	18.594

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 ELWOOD ; B-GOODINGS ;4B 345 kV line (from bus 270736 to bus 270770 ckt 1) loads from 85.61% to 110.1% (AC power flow) of its emergency rating (1479 MVA) for the single line contingency outage of 345-L11622_R-S'. This project contributes approximately 356.47 MW to the thermal violation.

```
CONTINGENCY '345-L11622_R-S'                    / CONTINGENCY # 223
 TRIP BRANCH FROM BUS 270737 TO BUS 270769 CKT 1          / ELWOOD ; R 345 GOODINGS ;1R 345
 END
```

Bus Number	*Bus Name*	*Full Contribution*
274658	*DRESDEN ;2U*	*22.94*
274659	*DRESDEN ;3U*	*25.22*
274729	*ELWOOD EC;1P*	*9.18*
274731	*ELWOOD EC;2P*	*9.18*
274733	*ELWOOD EC;3P*	*9.18*
274735	*ELWOOD EC;4P*	*9.18*
274728	*ELWOOD EC;5P*	*9.24*
274730	*ELWOOD EC;6P*	*9.24*
274732	*ELWOOD EC;7P*	*9.24*
274734	*ELWOOD EC;8P*	*9.24*
274736	*ELWOOD EC;9P*	*9.24*
274837	*EQUISTAR ; B*	*0.72*
274836	*EQUISTAR ; R*	*1.17*
274704	*KENDALL ;1C*	*4.24*
274705	*KENDALL ;1S*	*2.83*
274706	*KENDALL ;2C*	*4.24*
274707	*KENDALL ;2S*	*2.83*
274879	*MINONK ;1U*	*0.56*
904211	*W3-135*	*0.2*
905493	*W4-086*	*0.03*
920272	*X1-045*	*2.23*
915601	*Y3-088*	*0.46*
915611	*Y3-089*	*0.46*
921012	*AA1-040 1*	*0.16*
921022	*AA1-040 2*	*0.15*
930761	*AB1-122 1*	*71.81*
930762	*AB1-122 2*	*78.85*
928141	*AC1-204*	*178.24*
928142	*AC1-204*	*177.03*

Appendix 2

(CE - CE) The ELWOOD ; R-GOODINGS ;2R 345 kV line (from bus 270737 to bus 270769 ckt 1) loads from 86.62% to 111.34% (AC power flow) of its emergency rating (1479 MVA) for the single line contingency outage of 345-L11620_B-S'. This project contributes approximately 356.32 MW to the thermal violation.

```
CONTINGENCY '345-L11620_B-S'                    / CONTINGENCY # 222
 TRIP BRANCH FROM BUS 270736 TO BUS 270770 CKT 1          / ELWOOD ; B 345 GOODINGS ;3B 345
 END
```

Bus Number	*Bus Name*	*Full Contribution*
274658	*DRESDEN ;2U*	*25.08*
274659	*DRESDEN ;3U*	*24.68*
274729	*ELWOOD EC;1P*	*9.3*
274731	*ELWOOD EC;2P*	*9.3*
274733	*ELWOOD EC;3P*	*9.3*
274735	*ELWOOD EC;4P*	*9.3*
274728	*ELWOOD EC;5P*	*9.24*
274730	*ELWOOD EC;6P*	*9.24*
274732	*ELWOOD EC;7P*	*9.24*
274734	*ELWOOD EC;8P*	*9.24*
274736	*ELWOOD EC;9P*	*9.24*
274837	*EQUISTAR ; B*	*0.7*
274836	*EQUISTAR ; R*	*1.22*
274704	*KENDALL ;1C*	*4.7*
274705	*KENDALL ;1S*	*3.13*
274706	*KENDALL ;2C*	*4.7*
274707	*KENDALL ;2S*	*3.13*
274879	*MINONK ;1U*	*0.61*
904211	*W3-135*	*0.2*
905493	*W4-086*	*0.03*
920272	*X1-045*	*2.44*
915601	*Y3-088*	*0.51*
915611	*Y3-089*	*0.51*
921012	*AA1-040 1*	*0.17*
921022	*AA1-040 2*	*0.15*
930761	*AB1-122 1*	*78.53*
930762	*AB1-122 2*	*77.21*
928141	*AC1-204*	*178.16*
928142	*AC1-204*	*179.35*

Appendix 5

(MISO NIPS - AEP) The 17STILLWELL-05DUMONT 345 kV line (from bus 255113 to bus 243219 ckt 1) loads from 95.79% to 105.96% (AC power flow) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of '2978_C2_05DUMONT 765-B_A'. This project contributes approximately 168.58 MW to the thermal violation.

```
CONTINGENCY '2978_C2_05DUMONT 765-B_A'
 OPEN BRANCH FROM BUS 243206 TO BUS 920251 CKT 1          / 243206 05DUMONT 765 920251 X1-020 TAP 765 1
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1          / 243206 05DUMONT 765 270644 WILTON ; 765 1
 END
```

Bus Number	*Bus Name*	*Full Contribution*
274832	*ANNAWAN ; 1U*	*12.68*
294401	*BSHIL;1U E*	*9.98*
294410	*BSHIL;2U E*	*9.98*
274890	*CAYUG;1U E*	*15.34*
274891	*CAYUG;2U E*	*15.34*
274849	*CRESCENT ;1U*	*6.85*
274859	*EASYR;U1 E*	*12.8*
274860	*EASYR;U2 E*	*12.8*
290051	*GSG-6; E*	*12.15*
998100	*J351*	*434.83*
961131	*J643*	*25.99*
275149	*KEMPTON ;1E*	*22.95*
990901	*L-005 E*	*14.66*
290108	*LEEDK;1U E*	*28.24*
274850	*MENDOTA H;RU*	*6.99*
275148	*MILKS GRV;1E*	*22.95*
293061	*N-015 E*	*17.99*
293516	*O-009 E1*	*10.57*
293517	*O-009 E2*	*5.37*
293518	*O-009 E3*	*5.91*
293715	*O-029 E*	*11.3*
293716	*O-029 E*	*6.2*
293717	*O-029 E*	*5.7*
293771	*O-035 E*	*7.45*
293644	*O22 E1*	*12.1*
293645	*O22 E2*	*23.49*
290021	*O50 E*	*22.6*
294392	*P-010 E*	*22.85*
294763	*P-046 E*	*10.92*
274830	*PWR VTREC;1U*	*7.1*
274831	*PWR VTREC;2U*	*7.1*
296308	*R-030 C1*	*3.99*

296271	*R-030 C2*	*3.99*
296125	*R-030 C3*	*4.04*
296309	*R-030 E1*	*15.95*
296272	*R-030 E2*	*15.95*
296128	*R-030 E3*	*16.14*
274724	*RIVER EC ;11*	*5.73*
274723	*RIVER EC ;12*	*5.77*
274722	*S-055 E*	*13.09*
274793	*SE CHICAG;0U*	*1.35*
274794	*SE CHICAG;1U*	*1.35*
274795	*SE CHICAG;2U*	*1.35*
274788	*SE CHICAG;5U*	*1.37*
274789	*SE CHICAG;6U*	*1.37*
274790	*SE CHICAG;7U*	*1.37*
274791	*SE CHICAG;8U*	*1.37*
274792	*SE CHICAG;9U*	*1.35*
295111	*SUBLETTE E*	*3.16*
295109	*WESTBROOK E*	*6.51*
910541	*X3-005 C*	*0.11*
910542	*X3-005 E*	*1.01*
920462	*Y2-103*	*52.36*
920472	*Y3-013 1*	*4.36*
920482	*Y3-013 2*	*4.36*
920492	*Y3-013 3*	*4.36*
LTF	*Z1-043*	*33.36*
916502	*Z1-106 E1*	*1.47*
916504	*Z1-106 E2*	*1.47*
916512	*Z1-107 E*	*3.07*
916522	*Z1-108 E*	*2.9*
LTF	*Z1-112*	*11.21*
916651	*Z1-127 1*	*2.22*
916652	*Z1-127 2*	*1.02*
920782	*Z2-081*	*1.87*
920792	*Z2-087 C*	*3.12*
920793	*Z2-087 E*	*20.87*
LTF	*AA1-001*	*4.02*
920932	*AA1-018 C*	*2.83*
920933	*AA1-018 E*	*18.94*
LTF	*AA1-071*	*7.47*
921632	*AA1-146*	*20.47*
921682	*AA2-030*	*20.47*
921702	*AA2-039 C*	*2.43*
921703	*AA2-039 E*	*16.28*
922183	*AA2-123 E*	*2.85*
923002	*AB1-089 C*	*76.56*

923022	*AB1-091 C OP*	*91.09*
930761	*AB1-122 1*	*86.25*
930762	*AB1-122 2*	*83.14*
LTF	*AB2-013*	*18.79*
924041	*AB2-047 C OP*	*3.86*
924042	*AB2-047 E OP*	*25.83*
924471	*AB2-096*	*49.31*
925161	*AB2-173 C*	*3.65*
925301	*AB2-191 C*	*1.17*
925302	*AB2-191 E*	*1.61*
926321	*AC1-033 C*	*1.63*
926322	*AC1-033 E*	*10.94*
927081	*AC1-109*	*4.44*
927101	*AC1-110*	*4.43*
927121	*AC1-111*	*5.33*
927191	*AC1-113*	*2.77*
927211	*AC1-114*	*2.77*
927501	*AC1-142A*	*9.79*
927781	*AC1-168 C OP*	*1.34*
927782	*AC1-168 E OP*	*8.97*
927811	*AC1-171 C OP*	*1.16*
927812	*AC1-171 E OP*	*7.74*
927951	*AC1-185*	*6.4*
928141	*AC1-204*	*84.29*
928142	*AC1-204*	*84.26*
928251	*AC1-214 C OP*	*2.39*
928252	*AC1-214 E OP*	*7.6*

Appendix 7

(CE - CE) The KENDALL ;BU-LOCKPORT ; B 345 kV line (from bus 274702 to bus 270810 ckt 1) loads from 106.35% to 115.87% (AC power flow) of its emergency rating (1479 MVA) for the single line contingency outage of 345-L1221__B-S'. This project contributes approximately 129.9 MW to the thermal violation.

```
CONTINGENCY '345-L1221__B-S'
 TRIP BRANCH FROM BUS 270716 TO BUS 270928 CKT 1          / DRESD; B 345 WOLFS; B 345
 END
```

Bus Number	*Bus Name*	*Full Contribution*
274658	*DRESDEN ;2U*	*68.1*
274729	*ELWOOD EC;1P*	*3.32*
274731	*ELWOOD EC;2P*	*3.32*
274733	*ELWOOD EC;3P*	*3.32*
274735	*ELWOOD EC;4P*	*3.32*
274728	*ELWOOD EC;5P*	*3.37*
274730	*ELWOOD EC;6P*	*3.37*
274732	*ELWOOD EC;7P*	*3.37*
274734	*ELWOOD EC;8P*	*3.37*
274736	*ELWOOD EC;9P*	*3.37*
274836	*EQUISTAR ; R*	*3.22*
274704	*KENDALL ;1C*	*13.98*
274705	*KENDALL ;1S*	*9.32*
274706	*KENDALL ;2C*	*13.98*
274707	*KENDALL ;2S*	*9.32*
274879	*MINONK ;1U*	*1.6*
274677	*POWERTON ;5U*	*11.23*
274678	*POWERTON ;6U*	*11.15*
904211	*W3-135*	*0.33*
920272	*X1-045*	*6.62*
915601	*Y3-088*	*1.53*
915611	*Y3-089*	*1.53*
921012	*AA1-040 1*	*0.44*
930761	*AB1-122 1*	*213.07*
928141	*AC1-204*	*64.95*
928142	*AC1-204*	*63.97*

Appendix 8

(MISO AMIL - AEP) The 7CASEY-05SULLIVAN 345 kV line (from bus 346809 to bus 247712 ckt 1) loads from 106.53% to 110.93% (AC power flow) of its emergency rating (1466 MVA) for the line fault with failed breaker contingency outage of 1750_C2_05DUMONT 765-B1'. This project contributes approximately 74.52 MW to the thermal violation.

```
CONTINGENCY '1750_C2_05DUMONT 765-B1'
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1          / 243206 05DUMONT 765 270644 WILTON ; 765 1
 OPEN BRANCH FROM BUS 243206 TO BUS 243219 CKT 1          / 243206 05DUMONT 765 243219 05DUMONT 345 1
 END
```

Bus Number	*Bus Name*	*Full Contribution*
274832	*ANNAWAN ; 1U*	*9.02*
294401	*BSHIL;1U E*	*7.26*
294410	*BSHIL;2U E*	*7.26*
274890	*CAYUG;1U E*	*11.09*
274891	*CAYUG;2U E*	*11.09*
274849	*CRESCENT ;1U*	*4.89*
274859	*EASYR;U1 E*	*7.72*
274860	*EASYR;U2 E*	*7.72*
290051	*GSG-6; E*	*6.7*
998111	*J468*	*3.17*
998112	*J468*	*17.94*
961151	*J474*	*1.87*
961152	*J474*	*7.49*
961641	*J641 C*	*7.05*
961642	*J641 E*	*1.84*
961661	*J644*	*8.05*
274650	*KINCAID ;1U*	*17.11*
274651	*KINCAID ;2U*	*17.11*
990901	*L-005 E*	*11.24*
290108	*LEEDK;1U E*	*14.88*
274850	*MENDOTA H;RU*	*3.85*
293061	*N-015 E*	*8.01*
293516	*O-009 E1*	*7.01*
293517	*O-009 E2*	*3.56*
293518	*O-009 E3*	*3.92*
293715	*O-029 E*	*7.49*
293716	*O-029 E*	*4.11*
293717	*O-029 E*	*3.77*
293771	*O-035 E*	*5.32*
293644	*O22 E1*	*5.76*
293645	*O22 E2*	*11.19*
290021	*O50 E*	*12.24*

294392	*P-010 E*	*10.17*
294763	*P-046 E*	*6.21*
274830	*PWR VTREC;1U*	*3.74*
274831	*PWR VTREC;2U*	*3.74*
296308	*R-030 C1*	*3.3*
296271	*R-030 C2*	*3.3*
296125	*R-030 C3*	*3.34*
296309	*R-030 E1*	*13.2*
296272	*R-030 E2*	*13.2*
296128	*R-030 E3*	*13.36*
290261	*S-027 C*	*0.87*
290265	*S-028 C*	*0.87*
274722	*S-055 E*	*6.34*
295111	*SUBLETTE E*	*1.74*
274853	*TWINGROVE;U1*	*18.*
274854	*TWINGROVE;U2*	*18.*
276150	*W2-048 E*	*8.26*
905081	*W4-005 C*	*1.09*
905082	*W4-005 E*	*37.98*
295109	*WESTBROOK E*	*3.58*
909052	*X2-022 E*	*24.77*
920462	*Y2-103*	*25.37*
920472	*Y3-013 1*	*2.11*
920482	*Y3-013 2*	*2.11*
920492	*Y3-013 3*	*2.11*
701831	*Y4-084*	*2.74*
916502	*Z1-106 E1*	*0.7*
916504	*Z1-106 E2*	*0.7*
916512	*Z1-107 E*	*1.29*
916522	*Z1-108 E*	*1.42*
920782	*Z2-081*	*1.01*
920792	*Z2-087 C*	*2.59*
920793	*Z2-087 E*	*17.32*
920932	*AA1-018 C*	*1.39*
920933	*AA1-018 E*	*9.3*
921632	*AA1-146*	*13.*
921682	*AA2-030*	*13.*
921702	*AA2-039 C*	*1.77*
921703	*AA2-039 E*	*11.85*
922183	*AA2-123 E*	*1.46*
923002	*AB1-089 C*	*41.59*
930761	*AB1-122 1*	*39.02*
930762	*AB1-122 2*	*42.23*
923562	*AB1-172*	*0.4*
924041	*AB2-047 C OP*	*3.27*

924042	*AB2-047 E OP*	*21.88*
924261	*AB2-070 C OP*	*3.32*
924262	*AB2-070 E OP*	*22.19*
924471	*AB2-096*	*25.98*
925161	*AB2-173 C*	*2.32*
925301	*AB2-191 C*	*0.64*
925302	*AB2-191 E*	*0.89*
926321	*AC1-033 C*	*1.19*
926322	*AC1-033 E*	*7.96*
926521	*AC1-053 C*	*3.35*
926522	*AC1-053 E*	*22.44*
927081	*AC1-109*	*2.08*
927101	*AC1-110*	*2.08*
927121	*AC1-111*	*2.49*
927191	*AC1-113*	*1.52*
927211	*AC1-114*	*1.52*
927501	*AC1-142A*	*4.14*
927781	*AC1-168 C OP*	*0.87*
927782	*AC1-168 E OP*	*5.82*
927811	*AC1-171 C OP*	*1.08*
927812	*AC1-171 E OP*	*7.19*
927951	*AC1-185*	*3.86*
928141	*AC1-204*	*37.26*
928142	*AC1-204*	*37.28*
928251	*AC1-214 C OP*	*1.71*
928252	*AC1-214 E OP*	*5.42*