Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD2-134

Shady Oaks

July 31, 2018

Preface

The intent of the feasibility 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.

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.

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.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is

contained in Attachment G-2 of Manual 14A. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See Section 2.2.2. of Manual 14A for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment G-1 of Manual 14A) in order to document the request for the study.

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

General

The Interconnection Customer ("IC") for Queue **AD2-134 Shady Oaks** project has proposed an additional 117.5 MW Energy Resource, 22.9 MW Capacity Interconnection Right (CIR) wind farm to be located in Lee County, IL.

The IC has proposed a service date for this project of December 31, 2020.

Impacts on the MISO member transmission systems are not included in this analysis, but will be included in the System Impact Study Phase. Winter peak analysis will be performed in the System Impact Study phase.

This Generation Interconnection Feasibility Study provides analysis results to aid the IC in assessing the practicality and cost of incorporating the facility into the PJM system. This study was limited to load flow analyses of probable contingencies. If the IC elects to pursue a System Impact Study, a more comprehensive analysis will be performed.

Point of Interconnection

The Interconnection Customer (IC) AD2-134 proposes interconnection of 117.5 MW to an existing wind farm connected at TSS 100 Shady Oaks. The additional wind generation is behind the existing POI between ComEd and the windfarm. The combined output of this facility would become 227 MW.

Attachment Facilities

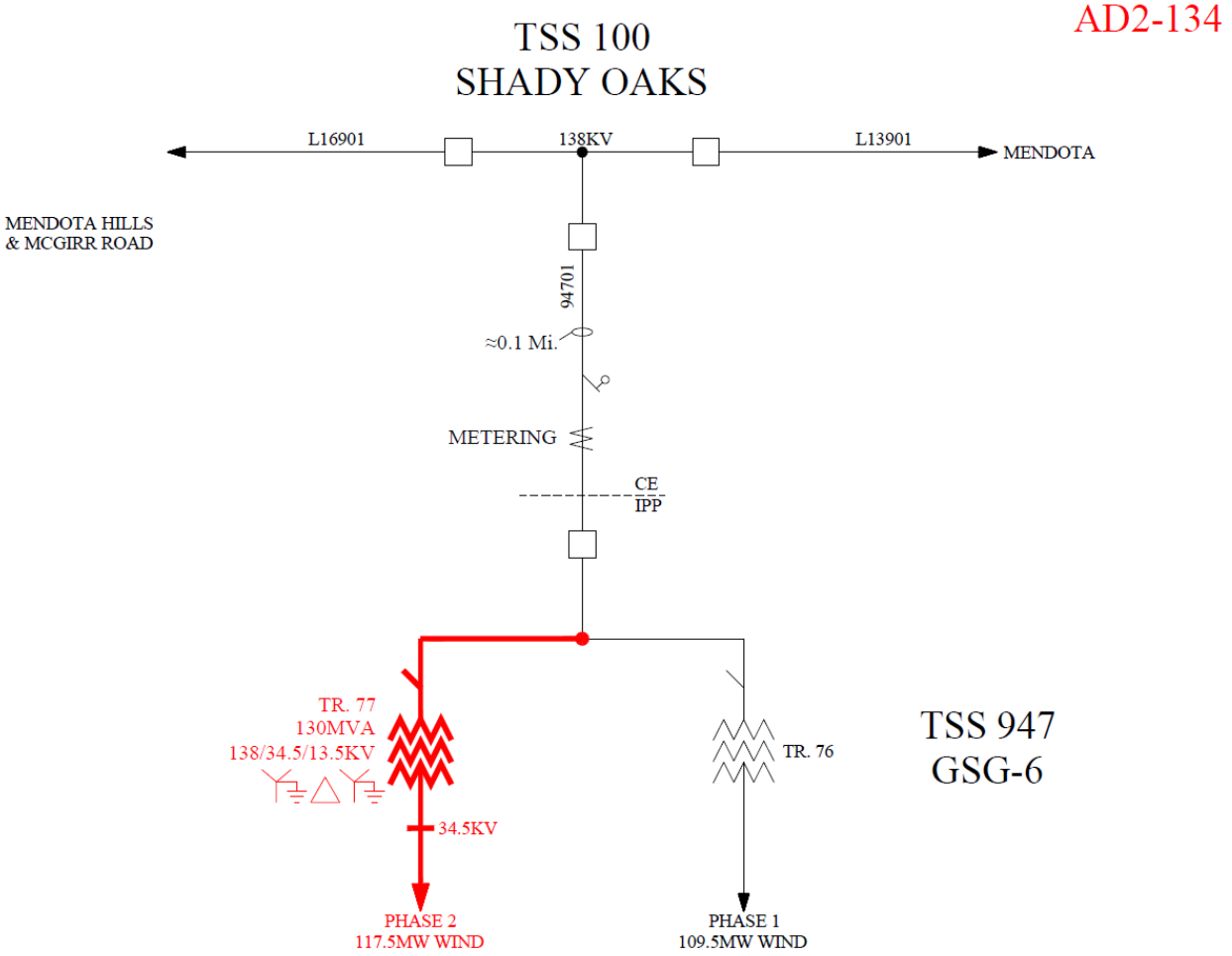
None

Direct Connection Network Upgrades

This is an upgrade to an existing facility, as shown in the one line diagram. Therefore, no direct connection cost is anticipated.

Non-Direct Connection Cost Estimate

None



Network Impacts

The Queue Project AD2-134 was evaluated as a 117.5 MW (Capacity 22.9 MW) injection at the Shady Oak; R 138kV substation in the ComEd area. Project AD2-134 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-134 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

Generator Deliverability

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

None

Multiple Facility Contingency

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

1. (CE - CE) The WATERMAN ; B-SANDWICH ; R 138 kV line (from bus 272728 to bus 272445 ckt 1) loads from 95.48% to 106.2% (**DC power flow**) of its load dump rating (321 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_111-38-TR82___'. This project contributes approximately 34.41 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_111-38-TR82___'
 TRIP BRANCH FROM BUS 271390 TO BUS 271586 CKT 1          / ELECT; B 138 W541 ; B 138
 TRIP BRANCH FROM BUS 271390 TO BUS 272724 CKT 1          / ELECT; B 138 WARRE;BT 138
 TRIP BRANCH FROM BUS 271390 TO BUS 275239 CKT 1          / ELECT; B 138 ELECT;2M 138
 MOVE 100 PERCENT LOAD FROM BUS 271586 TO BUS 271587        / W541 ; B 138 W541 ; R 138
 MOVE 100 PERCENT LOAD FROM BUS 272522 TO BUS 272523        / SUGAR; B 138 SUGAR; R 138
 CLOSE LINE FROM BUS 272114 TO BUS 272115 CKT 1          / N AUR; B 138 N AUR; R 138
 DISCONNECT BUS 271560                    / GLIDD;BT 138
 DISCONNECT BUS 272522                    / SUGAR; B 138
 DISCONNECT BUS 275239                    / ELECT;2M 138
 REMOVE SWSHUNT FROM BUS 271390
 END
```

2. (CE - CE) The WATERMAN ; B-SANDWICH ; R 138 kV line (from bus 272728 to bus 272445 ckt 1) loads from 95.17% to 106.2% (**DC power flow**) of its load dump rating (433 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_083-38-BT3-4__'. This project contributes approximately 47.76 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_083-38-BT3-4__'
 TRIP BRANCH FROM BUS 271390 TO BUS 271586 CKT 1          / ELECT; B 138 W541 ; B 138
 TRIP BRANCH FROM BUS 271560 TO BUS 271558 CKT 1          / GLIDD;BT 138 GLIDD; B 138
 TRIP BRANCH FROM BUS 271560 TO BUS 272728 CKT 1          / GLIDD;BT 138 WATER; B 138
 TRIP BRANCH FROM BUS 271586 TO BUS 272114 CKT 1          / W541 ; B 138 N AUR; B 138
 TRIP BRANCH FROM BUS 272114 TO BUS 272522 CKT 1          / N AUR; B 138 SUGAR; B 138
 TRIP BRANCH FROM BUS 272522 TO BUS 271560 CKT 1          / SUGAR; B 138 GLIDD;BT 138
 MOVE 100 PERCENT LOAD FROM BUS 271586 TO BUS 271587        / W541 ; B 138 W541 ; R 138
 MOVE 100 PERCENT LOAD FROM BUS 272522 TO BUS 272523        / SUGAR; B 138 SUGAR; R 138
 CLOSE LINE FROM BUS 272114 TO BUS 272115 CKT 1          / N AUR; B 138 N AUR; R 138
 TRIP BRANCH FROM BUS 271558 TO BUS 272730 CKT 1          / GLIDD; B 138 WATER;3B 138
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MOVE 100 PERCENT LOAD FROM BUS 272761 TO BUS 272759          / W DEK;7R 138 W DEK;4R 138
DISCONNECT BUS 271581                                        / B200 ; R 138
DISCONNECT BUS 272757                                        / W DEK;7T 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. (MISO NIPS - AEP) The 17STILLWELL-05DUMONT 345 kV line (from bus 255113 to bus 243219 ckt 1) loads from 164.33% to 164.43% (**DC power flow**) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#2978_05DUMONT 765'. This project contributes approximately 16.34 MW to the thermal violation.

```
CONTINGENCY 'AEP_P4_#2978_05DUMONT 765'
 OPEN BRANCH FROM BUS 243206 TO BUS 907040 CKT 1          / 243206 05DUMONT 765 X1-020
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1          / 243206 05DUMONT 765 270644 WILTON ; 765 1
 END
```

2. (CE - MISO NIPS) The BURNHAM ;0R-17MUNSTER 345 kV line (from bus 270677 to bus 255109 ckt 1) loads from 129.96% to 130.07% (**DC power flow**) of its emergency rating (1195 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#2978_05DUMONT 765'. This project contributes approximately 13.66 MW to the thermal violation.

```
CONTINGENCY 'AEP_P4_#2978_05DUMONT 765'
 OPEN BRANCH FROM BUS 243206 TO BUS 907040 CKT 1          / 243206 05DUMONT 765 X1-020
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1          / 243206 05DUMONT 765 270644 WILTON ; 765 1
 END
```

3. (CE - CE) The E FRANKFO; B-CRETE EC ;BP 345 kV line (from bus 270728 to bus 274750 ckt 1) loads from 109.01% to 109.06% (**DC power flow**) of its load dump rating (1399 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#2978_05DUMONT 765'. This project contributes approximately 14.79 MW to the thermal violation.

```
CONTINGENCY 'AEP_P4_#2978_05DUMONT 765'
 OPEN BRANCH FROM BUS 243206 TO BUS 907040 CKT 1          / 243206 05DUMONT 765 X1-020
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1          / 243206 05DUMONT 765 270644 WILTON ; 765 1
 END
```

4. (CE - CE) The E FRANKFO; B-CRETE EC ;BP 345 kV line (from bus 270728 to bus 274750 ckt 1) loads from 108.5% to 108.56% (**DC power flow**) of its load dump rating (1399 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_023-65-BT2-3__'. This project contributes approximately 14.95 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_023-65-BT2-3__'
 TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1          / WILTO; 765
05DUMONT 765
 TRIP BRANCH FROM BUS 270607 TO BUS 270630 CKT 1          / COLLI; 765
PLANO; 765
```

END

5. (CE - CE) The E FRANKFO; B-CRETE EC ;BP 345 kV line (from bus 270728 to bus 274750 ckt 1) loads from 108.46% to 108.52% (**DC power flow**) of its load dump rating (1399 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT4-5__'. This project contributes approximately 14.87 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_112-65-BT4-5__'
 TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1              / WILTO; 765
05DUMONT 765
 TRIP BRANCH FROM BUS 275233 TO BUS 270644 CKT 1              / WILTO;4M 345
WILTO; 765
 TRIP BRANCH FROM BUS 275233 TO BUS 270927 CKT 1              / WILTO;4M 345
WILTO; R 345
 TRIP BRANCH FROM BUS 275233 TO BUS 275333 CKT 1              / WILTO;4M 345
WILTO;4C 33
 END
```

6. (CE - CE) The E FRANKFO; B-CRETE EC ;BP 345 kV line (from bus 270728 to bus 274750 ckt 1) loads from 108.45% to 108.51% (**DC power flow**) of its load dump rating (1399 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT3-4__'. This project contributes approximately 14.87 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_112-65-BT3-4__'
 TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1              / WILTO; 765
05DUMONT 765
 TRIP BRANCH FROM BUS 275232 TO BUS 270644 CKT 1              / WILTO;3M 345
WILTO; 765
 TRIP BRANCH FROM BUS 275232 TO BUS 270926 CKT 1              / WILTO;3M 345
WILTO; B 345
 TRIP BRANCH FROM BUS 275232 TO BUS 275332 CKT 1              / WILTO;3M 345
WILTO;3C 33
 END
```

7. (CE - CE) The WILTON ; B-WILTON ;3M 345 kV line (from bus 270926 to bus 275232 ckt 1) loads from 146.1% to 146.31% (**DC power flow**) of its load dump rating (1379 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT5-6__'. This project contributes approximately 17.16 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_112-65-BT5-6__'
 TRIP BRANCH FROM BUS 270644 TO BUS 270607 CKT 1              / WILTO; 765 COLLI; 765
 TRIP BRANCH FROM BUS 275233 TO BUS 270644 CKT 1              / WILTO;4M 345 WILTO; 765
 TRIP BRANCH FROM BUS 275233 TO BUS 270927 CKT 1              / WILTO;4M 345 WILTO; R 345
 TRIP BRANCH FROM BUS 275233 TO BUS 275333 CKT 1              / WILTO;4M 345 WILTO;4C 33
 END
```

8. (CE - CE) The WILTON ; R-WILTON ;4M 345 kV line (from bus 270927 to bus 275233 ckt 1) loads from 148.94% to 149.12% (**DC power flow**) of its load dump rating (1379 MVA) for

the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT2-3__'. This project contributes approximately 17.53 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_112-65-BT2-3__'
 TRIP BRANCH FROM BUS 270644 TO BUS 270607 CKT 1          / WILTO; 765 COLLI; 765
 TRIP BRANCH FROM BUS 275232 TO BUS 270644 CKT 1          / WILTO;3M 345 WILTO; 765
 TRIP BRANCH FROM BUS 275232 TO BUS 270926 CKT 1          / WILTO;3M 345 WILTO; B 345
 TRIP BRANCH FROM BUS 275232 TO BUS 275332 CKT 1          / WILTO;3M 345 WILTO;3C 33
 END
```

9. (CE - CE) The WATERMAN ; B-GLIDDEN ;BT 138 kV line (from bus 272728 to bus 271560 ckt 1) loads from 105.11% to 116.95% (**DC power flow**) of its load dump rating (344 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_146-38-BT_____'. This project contributes approximately 40.7 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_146-38-BT_____'
 TRIP BRANCH FROM BUS 271116 TO BUS 272250 CKT 1          / BRIST; B 138 PLANO; B 138
 TRIP BRANCH FROM BUS 272024 TO BUS 271182 CKT 1          / MONTG; B 138 W507 ; B 138
 TRIP BRANCH FROM BUS 272026 TO BUS 271116 CKT 1          / MONTG;BT 138 BRIST; B 138
 TRIP BRANCH FROM BUS 272026 TO BUS 272024 CKT 1          / MONTG;BT 138 MONTG; B 138
 TRIP BRANCH FROM BUS 272202 TO BUS 272026 CKT 1          / OSWEG; B 138 MONTG;BT 138
 TRIP BRANCH FROM BUS 272794 TO BUS 272202 CKT 1          / WOLFS; B 138 OSWEG; B 138
 MOVE 100 PERCENT LOAD FROM BUS 271116 TO BUS 271117        / BRIST; B 138 BRIST; R 138
 MOVE 100 PERCENT LOAD FROM BUS 272202 TO BUS 272203        / OSWEG; B 138 OSWEG; R 138
 CLOSE LINE FROM BUS 271182 TO BUS 271183 CKT 1           / W507 ; B 138 W507 ; R 138
 CLOSE LINE FROM BUS 272024 TO BUS 272025 CKT 1           / MONTG; B 138 MONTG; R 138
 TRIP BRANCH FROM BUS 272728 TO BUS 272445 CKT 1          / WATER; B 138 SANDW; R 138
 END
```

10. (CE - MISO NIPS) The CRETE EC ;BP-17STJOHN 345 kV line (from bus 274750 to bus 255112 ckt 1) loads from 126.57% to 126.63% (**DC power flow**) of its emergency rating (1399 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#2978_05DUMONT 765'. This project contributes approximately 14.61 MW to the thermal violation.

```
CONTINGENCY 'AEP_P4_#2978_05DUMONT 765'
 OPEN BRANCH FROM BUS 243206 TO BUS 907040 CKT 1          / 243206 05DUMONT 765 X1-020
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1          / 243206 05DUMONT 765 270644 WILTON ; 765 1
 END
```

11. (CE - MISO NIPS) The CRETE EC ;BP-17STJOHN 345 kV line (from bus 274750 to bus 255112 ckt 1) loads from 126.09% to 126.14% (**DC power flow**) of its emergency rating (1399 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_023-65-BT2-3__'. This project contributes approximately 14.77 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_023-65-BT2-3__'
 TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1          / WILTO; 765 05DUMONT 765
 TRIP BRANCH FROM BUS 270607 TO BUS 270630 CKT 1          / COLLI; 765 PLANO; 765
 END
```

12. (CE - MISO NIPS) The CRETE EC ;BP-17STJOHN 345 kV line (from bus 274750 to bus 255112 ckt 1) loads from 126.05% to 126.1% (**DC power flow**) of its emergency rating (1399 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT4-5__'. This project contributes approximately 14.69 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_112-65-BT4-5__'
 TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1          / WILTO; 765 05DUMONT 765
 TRIP BRANCH FROM BUS 275233 TO BUS 270644 CKT 1          / WILTO;4M 345 WILTO; 765
 TRIP BRANCH FROM BUS 275233 TO BUS 270927 CKT 1          / WILTO;4M 345 WILTO; R 345
 TRIP BRANCH FROM BUS 275233 TO BUS 275333 CKT 1          / WILTO;4M 345 WILTO;4C 33
 END
```

13. (CE - MISO NIPS) The CRETE EC ;BP-17STJOHN 345 kV line (from bus 274750 to bus 255112 ckt 1) loads from 126.03% to 126.09% (**DC power flow**) of its emergency rating (1399 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT3-4__'. This project contributes approximately 14.69 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_112-65-BT3-4__'
 TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1          / WILTO; 765 05DUMONT 765
 TRIP BRANCH FROM BUS 275232 TO BUS 270644 CKT 1          / WILTO;3M 345 WILTO; 765
 TRIP BRANCH FROM BUS 275232 TO BUS 270926 CKT 1          / WILTO;3M 345 WILTO; B 345
 TRIP BRANCH FROM BUS 275232 TO BUS 275332 CKT 1          / WILTO;3M 345 WILTO;3C 33
 END
```

14. (CE - AEP) The UNIV PK N;RP-05OLIVE 345 kV line (from bus 274804 to bus 243229 ckt 1) loads from 133.48% to 133.57% (**DC power flow**) of its emergency rating (971 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#2978_05DUMONT 765'. This project contributes approximately 11.41 MW to the thermal violation.

```
CONTINGENCY 'AEP_P4_#2978_05DUMONT 765'
 OPEN BRANCH FROM BUS 243206 TO BUS 907040 CKT 1          / 243206 05DUMONT 765 X1-020
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1          / 243206 05DUMONT 765 270644 WILTON ; 765 1
 END
```

15. (CE - AEP) The UNIV PK N;RP-05OLIVE 345 kV line (from bus 274804 to bus 243229 ckt 1) loads from 132.35% to 132.44% (**DC power flow**) of its emergency rating (971 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_023-65-BT4-5__'. This project contributes approximately 11.49 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_023-65-BT4-5__'
 TRIP BRANCH FROM BUS 275168 TO BUS 270607 CKT 1          / COLLI;2M 345 COLLI; 765
 TRIP BRANCH FROM BUS 275168 TO BUS 270697 CKT 1          / COLLI;2M 345 COLLI; R 345
 TRIP BRANCH FROM BUS 275168 TO BUS 275268 CKT 1          / COLLI;2M 345 COLLI;2C 33
 TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1          / WILTO; 765 05DUMONT 765
 END
```

16. (CE - AEP) The UNIV PK N;RP-05OLIVE 345 kV line (from bus 274804 to bus 243229 ckt 1) loads from 132.35% to 132.44% (**DC power flow**) of its emergency rating (971 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT4-5__'. This project contributes approximately 11.5 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_112-65-BT4-5__'
 TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1          / WILTO; 765 05DUMONT 765
 TRIP BRANCH FROM BUS 275233 TO BUS 270644 CKT 1          / WILTO;4M 345 WILTO; 765
 TRIP BRANCH FROM BUS 275233 TO BUS 270927 CKT 1          / WILTO;4M 345 WILTO; R 345
 TRIP BRANCH FROM BUS 275233 TO BUS 275333 CKT 1          / WILTO;4M 345 WILTO;4C 33
 END
```

17. (CE - AEP) The UNIV PK N;RP-05OLIVE 345 kV line (from bus 274804 to bus 243229 ckt 1) loads from 132.35% to 132.44% (**DC power flow**) of its emergency rating (971 MVA) for the

line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT3-4__'. This project contributes approximately 11.5 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_112-65-BT3-4__'
 TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1          / WILTO; 765 05DUMONT 765
 TRIP BRANCH FROM BUS 275232 TO BUS 270644 CKT 1          / WILTO;3M 345 WILTO; 765
 TRIP BRANCH FROM BUS 275232 TO BUS 270926 CKT 1          / WILTO;3M 345 WILTO; B 345
 TRIP BRANCH FROM BUS 275232 TO BUS 275332 CKT 1          / WILTO;3M 345 WILTO;3C 33
 END
```

18. (CE - AEP) The UNIV PK N;RP-05OLIVE 345 kV line (from bus 274804 to bus 243229 ckt 1) loads from 132.33% to 132.43% (**DC power flow**) of its emergency rating (971 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_023-65-BT2-3__'. This project contributes approximately 11.51 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_023-65-BT2-3__'
 TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1          / WILTO; 765 05DUMONT 765
 TRIP BRANCH FROM BUS 270607 TO BUS 270630 CKT 1          / COLLI; 765 PLANO; 765
 END
```

19. (CE - CE) The WILTON ; 765/345 kV transformer (from bus 275232 to bus 270644 ckt 1) loads from 146.1% to 146.31% (**DC power flow**) of its load dump rating (1379 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT5-6__'. This project contributes approximately 17.16 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_112-65-BT5-6__'
 TRIP BRANCH FROM BUS 270644 TO BUS 270607 CKT 1          / WILTO; 765 COLLI; 765
 TRIP BRANCH FROM BUS 275233 TO BUS 270644 CKT 1          / WILTO;4M 345 WILTO; 765
 TRIP BRANCH FROM BUS 275233 TO BUS 270927 CKT 1          / WILTO;4M 345 WILTO; R 345
 TRIP BRANCH FROM BUS 275233 TO BUS 275333 CKT 1          / WILTO;4M 345 WILTO;4C 33
 END
```

20. (CE - CE) The WILTON ; 765/345 kV transformer (from bus 275233 to bus 270644 ckt 1) loads from 148.94% to 149.11% (**DC power flow**) of its load dump rating (1379 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT2-3__'. This project contributes approximately 17.53 MW to the thermal violation.

```
CONTINGENCY 'COMED_P4_112-65-BT2-3__'
 TRIP BRANCH FROM BUS 270644 TO BUS 270607 CKT 1          / WILTO; 765 COLLI; 765
 TRIP BRANCH FROM BUS 275232 TO BUS 270644 CKT 1          / WILTO;3M 345 WILTO; 765
 TRIP BRANCH FROM BUS 275232 TO BUS 270926 CKT 1          / WILTO;3M 345 WILTO; B 345
 TRIP BRANCH FROM BUS 275232 TO BUS 275332 CKT 1          / WILTO;3M 345 WILTO;3C 33
 END
```

Steady-State Voltage Requirements

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

To be determined

Short Circuit

(Summary of impacted circuit breakers)

None

Affected System Analysis & Mitigation

MISO Impacts:

MISO Impacts to be determined during later study phases (as applicable).

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. (MISO NIPS - AEP) The 17STILLWELL-05DUMONT 345 kV line (from bus 255113 to bus 243219 ckt 1) loads from 161.0% to 161.11% (**DC power flow**) of its normal rating (1409 MVA) for the single line contingency outage of 'COMED_P1-2_695_B2'. This project contributes approximately 16.72 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_695_B2'
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1              / 243206 05DUMONT 765 270644 WILTO; 765 1
 END
```

2. (CE - MISO NIPS) The BURNHAM ;0R-17MUNSTER 345 kV line (from bus 270677 to bus 255109 ckt 1) loads from 129.01% to 129.12% (**DC power flow**) of its emergency rating (1195 MVA) for the single line contingency outage of 'COMED_P1-2_695_B2'. This project contributes approximately 13.74 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_695_B2'
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1              / 243206 05DUMONT 765 270644 WILTO; 765 1
 END
```

3. (CE - CE) The E FRANKFO; B-CRETE EC ;BP 345 kV line (from bus 270728 to bus 274750 ckt 1) loads from 108.36% to 108.41% (**DC power flow**) of its emergency rating (1399 MVA) for the single line contingency outage of 'COMED_P1-2_695_B2'. This project contributes approximately 14.85 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_695_B2'
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1              / 243206 05DUMONT 765 270644 WILTO; 765 1
 END
```

4. (CE - CE) The WALTO; B-ELECT JCT; B 345 kV line (from bus 270932 to bus 270730 ckt 1) loads from 99.85% to 100.18% (**DC power flow**) of its emergency rating (1528 MVA) for the single line contingency outage of 'COMED_P1-2_345-L0626__B-R-B-A'. This project contributes approximately 11.06 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_345-L0626__B-R-B-A'
```

```
 TRIP BRANCH FROM BUS 930480 TO BUS 934400 CKT 1          / AB1-089 TAP 345 AD1-064 TAP 345
 END
```

5. (CE - CE) The DIXON ; R-DIXON ; B 138 kV line (from bus 271333 to bus 271332 ckt 1) loads from 123.56% to 142.45% (**DC power flow**) of its emergency rating (332 MVA) for the single line contingency outage of 'COMED_P1-2_138-L11323_R-R-A'. This project contributes approximately 62.73 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_138-L11323_R-R-A'
 TRIP BRANCH FROM BUS 271680 TO BUS 272756 CKT 1          / HAUME; B 138 W DEK;3T 138
 TRIP BRANCH FROM BUS 272730 TO BUS 271558 CKT 1          / WATER;3B 138 GLIDD; B 138
 TRIP BRANCH FROM BUS 272730 TO BUS 272728 CKT 1          / WATER;3B 138 WATER; B 138
 TRIP BRANCH FROM BUS 272756 TO BUS 272730 CKT 1          / W DEK;3T 138 WATER;3B 138
 TRIP BRANCH FROM BUS 272756 TO BUS 934940 CKT 1          / W DEK;3T 138 AD1-126 TAP 138
 END
```

6. (CE - CE) The GLIDDEN ;BT-SUGAR GRV; B 138 kV line (from bus 271560 to bus 272522 ckt 1) loads from 105.94% to 117.79% (**DC power flow**) of its emergency rating (264 MVA) for the single line contingency outage of 'COMED_P1-2_138-L11301_R-R'. This project contributes approximately 31.27 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_138-L11301_R-R'
 TRIP BRANCH FROM BUS 272728 TO BUS 272445 CKT 1          / WATER; B 138 SANDW; R 138
 END
```

7. (CE - CE) The GLIDDEN ;BT-SUGAR GRV; B 138 kV line (from bus 271560 to bus 272522 ckt 1) loads from 94.39% to 104.68% (**DC power flow**) of its normal rating (208 MVA) for non-contingency condition. This project contributes approximately 21.4 MW to the thermal violation.

8. (CE - CE) The HAUMESSER; B-W DEKALB ;3T 138 kV line (from bus 271680 to bus 272756 ckt 1) loads from 134.41% to 160.39% (**DC power flow**) of its emergency rating (452 MVA) for the single line contingency outage of 'COMED_P1-2_138-L10714_R-R-A'. This project contributes approximately 117.43 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_138-L10714_R-R-A'
 TRIP BRANCH FROM BUS 271333 TO BUS 934700 CKT 1          / DIXON; R 138 AD1-098 TAP 138
 END
```

9. (CE - CE) The HAUMESSER; B-W DEKALB ;3T 138 kV line (from bus 271680 to bus 272756 ckt 1) loads from 117.65% to 132.1% (**DC power flow**) of its normal rating (438 MVA) for non-contingency condition. This project contributes approximately 63.27 MW to the thermal violation.

10. (CE - CE) The MEND HILL; R-MCGIRR RD; 138 kV line (from bus 272001 to bus 272002 ckt 1) loads from 71.13% to 104.6% (**DC power flow**) of its normal rating (351 MVA) for non-contingency condition. This project contributes approximately 117.48 MW to the thermal violation.

11. (CE - CE) The MCGIRR RD;-ESS H440 ;RT 138 kV line (from bus 272002 to bus 272365 ckt 1) loads from 96.16% to 114.2% (**DC power flow**) of its normal rating (351 MVA) for non-contingency condition. This project contributes approximately 63.32 MW to the thermal violation.

12. (CE - CE) The MCGIRR RD;-ESS H440 ;RT 138 kV line (from bus 272002 to bus 272365 ckt 1) loads from 77.5% to 103.66% (**DC power flow**) of its emergency rating (449 MVA) for the single line contingency outage of 'COMED_P1-2_138-L10714_R-R-A'. This project contributes approximately 117.48 MW to the thermal violation.

CONTINGENCY 'COMED_P1-2_138-L10714_R-R-A'
 TRIP BRANCH FROM BUS 271333 TO BUS 934700 CKT 1 / DIXON; R 138 AD1-098 TAP 138
 END

13. (CE - CE) The MCGIRR RD;-AD1-098 TAP 138 kV line (from bus 272002 to bus 934700 ckt 1) loads from 113.41% to 139.56% (**DC power flow**) of its emergency rating (449 MVA) for the single line contingency outage of 'COMED_P2-1_094-L11323__'. This project contributes approximately 117.43 MW to the thermal violation.

CONTINGENCY 'COMED_P2-1_094-L11323__'
 TRIP BRANCH FROM BUS 271680 TO BUS 272756 CKT 1 / HAUME; B 138 W DEK;3T 138
 END

14. (CE - CE) The ESS H445 ;3B-STEWARD ; B 138 kV line (from bus 272362 to bus 272516 ckt 1) loads from 126.3% to 150.31% (**DC power flow**) of its emergency rating (197 MVA) for the single line contingency outage of 'COMED_P2-1_186-L16914__'. This project contributes approximately 47.3 MW to the thermal violation.

CONTINGENCY 'COMED_P2-1_186-L16914__'
 TRIP BRANCH FROM BUS 272365 TO BUS 272516 CKT 1 / H440 ;RT 138 STEWA; B 138
 END

15. (CE - CE) The ESS H440 ; R-ESS H440N ;R 138 kV line (from bus 272363 to bus 272364 ckt 1) loads from 104.93% to 125.84% (**DC power flow**) of its emergency rating (226 MVA) for the single line contingency outage of 'COMED_P2-1_186-L16914__'. This project contributes approximately 47.31 MW to the thermal violation.

CONTINGENCY 'COMED_P2-1_186-L16914__'
 TRIP BRANCH FROM BUS 272365 TO BUS 272516 CKT 1 / H440 ;RT 138 STEWA; B 138
 END

16. (CE - CE) The ESS H440N ;R-ESS H445 ;3B 138 kV line (from bus 272364 to bus 272362 ckt 1) loads from 104.88% to 125.78% (**DC power flow**) of its emergency rating (226 MVA) for the single line contingency outage of 'COMED_P2-1_186-L16914__'. This project contributes approximately 47.3 MW to the thermal violation.

CONTINGENCY 'COMED_P2-1_186-L16914__'
 TRIP BRANCH FROM BUS 272365 TO BUS 272516 CKT 1 / H440 ;RT 138 STEWA; B 138
 END

17. (CE - CE) The ESS H440 ;RT-ESS H440 ; R 138 kV line (from bus 272365 to bus 272363 ckt 1) loads from 130.59% to 154.61% (**DC power flow**) of its emergency rating (197 MVA) for

the single line contingency outage of 'COMED_P2-1_186-L16914__'. This project contributes approximately 47.31 MW to the thermal violation.

```
CONTINGENCY 'COMED_P2-1_186-L16914__'
 TRIP BRANCH FROM BUS 272365 TO BUS 272516 CKT 1          / H440 ;RT 138 STEWA; B 138
 END
```

18. (CE - CE) The ESS H440 ;RT-STEWARD ; B 138 kV line (from bus 272365 to bus 272516 ckt 1) loads from 86.04% to 103.0% (**DC power flow**) of its normal rating (351 MVA) for non-contingency condition. This project contributes approximately 59.53 MW to the thermal violation.

19. (CE - CE) The STEWARD ; B-HAUMESSER; B 138 kV line (from bus 272516 to bus 271680 ckt 1) loads from 94.05% to 112.09% (**DC power flow**) of its normal rating (351 MVA) for non-contingency condition. This project contributes approximately 63.31 MW to the thermal violation.

20. (CE - CE) The STEWARD ; B-HAUMESSER; B 138 kV line (from bus 272516 to bus 271680 ckt 1) loads from 80.27% to 106.43% (**DC power flow**) of its emergency rating (449 MVA) for the single line contingency outage of 'COMED_P1-2_138-L10714_R-R-A'. This project contributes approximately 117.46 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_138-L10714_R-R-A'
  TRIP BRANCH FROM BUS 271333 TO BUS 934700 CKT 1                / DIXON; R 138
AD1-098 TAP 138
  END
```

21. (CE - CE) The WATERMAN ; B-GLIDDEN ;BT 138 kV line (from bus 272728 to bus 271560 ckt 1) loads from 136.96% to 152.38% (**DC power flow**) of its emergency rating (264 MVA) for the single line contingency outage of 'COMED_P1-2_138-L11301_R-R'. This project contributes approximately 40.7 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_138-L11301_R-R'
 TRIP BRANCH FROM BUS 272728 TO BUS 272445 CKT 1          / WATER; B 138 SANDW; R 138
 END
```

22. (CE - CE) The WATERMAN ; B-GLIDDEN ;BT 138 kV line (from bus 272728 to bus 271560 ckt 1) loads from 123.33% to 136.7% (**DC power flow**) of its normal rating (208 MVA) for non-contingency condition. This project contributes approximately 27.81 MW to the thermal violation.

23. (CE - CE) The WATERMAN ; B-SANDWICH ; R 138 kV line (from bus 272728 to bus 272445 ckt 1) loads from 94.06% to 104.8% (**DC power flow**) of its emergency rating (321 MVA) for the single line contingency outage of 'COMED_P1-2_138-L11106_B-R'. This project contributes approximately 34.49 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_138-L11106_B-R'
 TRIP BRANCH FROM BUS 271390 TO BUS 271586 CKT 1          / ELECT; B 138 W541 ; B 138
 TRIP BRANCH FROM BUS 271560 TO BUS 271558 CKT 1          / GLIDD;BT 138 GLIDD; B 138
 TRIP BRANCH FROM BUS 271560 TO BUS 272728 CKT 1          / GLIDD;BT 138 WATER; B 138
```

```
 TRIP BRANCH FROM BUS 271586 TO BUS 272114 CKT 1          / W541 ; B 138 N AUR; B 138
 TRIP BRANCH FROM BUS 272114 TO BUS 272522 CKT 1          / N AUR; B 138 SUGAR; B 138
 TRIP BRANCH FROM BUS 272522 TO BUS 271560 CKT 1          / SUGAR; B 138 GLIDD;BT 138
 MOVE 100 PERCENT LOAD FROM BUS 271586 TO BUS 271587          / W541 ; B 138 W541 ; R 138
 MOVE 100 PERCENT LOAD FROM BUS 272522 TO BUS 272523          / SUGAR; B 138 SUGAR; R 138
 CLOSE LINE FROM BUS 272114 TO BUS 272115 CKT 1          / N AUR; B 138 N AUR; R 138
 END
```

24. (CE - CE) The WATERMAN ;3B-GLIDDEN ; B 138 kV line (from bus 272730 to bus 271558 ckt 1) loads from 100.28% to 112.08% (**DC power flow**) of its emergency rating (449 MVA) for the single line contingency outage of 'COMED_P2-1_113-L11323__'. This project contributes approximately 52.99 MW to the thermal violation.

```
CONTINGENCY 'COMED_P2-1_113-L11323__'
 TRIP BRANCH FROM BUS 272730 TO BUS 272728 CKT 1          / WATER;3B 138 WATER; B 138
 END
```

25. (CE - CE) The WATERMAN ;3B-WATERMAN ; B 138 kV line (from bus 272730 to bus 272728 ckt 1) loads from 107.67% to 126.71% (**DC power flow**) of its emergency rating (504 MVA) for the single line contingency outage of 'COMED_P1-2_138-L10714_R-R-A'. This project contributes approximately 95.98 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_138-L10714_R-R-A'
 TRIP BRANCH FROM BUS 271333 TO BUS 934700 CKT 1          / DIXON; R 138 AD1-098 TAP 138
 END
```

26. (CE - CE) The WATERMAN ;3B-WATERMAN ; B 138 kV line (from bus 272730 to bus 272728 ckt 1) loads from 92.13% to 102.89% (**DC power flow**) of its normal rating (487 MVA) for non-contingency condition. This project contributes approximately 52.38 MW to the thermal violation.

27. (CE - CE) The W DEKALB ;3T-WATERMAN ;3B 138 kV line (from bus 272756 to bus 272730 ckt 1) loads from 144.14% to 170.12% (**DC power flow**) of its emergency rating (452 MVA) for the single line contingency outage of 'COMED_P1-2_138-L10714_R-R-A'. This project contributes approximately 117.43 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_138-L10714_R-R-A'
 TRIP BRANCH FROM BUS 271333 TO BUS 934700 CKT 1          / DIXON; R 138 AD1-098 TAP 138
 END
```

28. (CE - CE) The W DEKALB ;3T-WATERMAN ;3B 138 kV line (from bus 272756 to bus 272730 ckt 1) loads from 118.97% to 132.97% (**DC power flow**) of its normal rating (452 MVA) for non-contingency condition. This project contributes approximately 63.27 MW to the thermal violation.

29. (CE - MISO NIPS) The CRETE EC ;BP-17STJOHN 345 kV line (from bus 274750 to bus 255112 ckt 1) loads from 125.94% to 126.0% (**DC power flow**) of its emergency rating (1399 MVA) for the single line contingency outage of 'COMED_P1-2_695_B2'. This project contributes approximately 14.67 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_695_B2'
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1          / 243206 05DUMONT 765 270644 WILTO; 765 1
 END
```

30. (CE - AEP) The UNIV PK N;RP-05OLIVE 345 kV line (from bus 274804 to bus 243229 ckt 1) loads from 132.31% to 132.41% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of 'COMED_P1-2_695_B2'. This project contributes approximately 11.49 MW to the thermal violation.

```
CONTINGENCY 'COMED_P1-2_695_B2'
 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1              / 243206 05DUMONT 765 270644 WILTO; 765 1
 END
```

31. (CE - CE) The AD1-098 TAP-DIXON ; R 138 kV line (from bus 934700 to bus 271333 ckt 1) loads from 135.31% to 161.47% (**DC power flow**) of its emergency rating (449 MVA) for the single line contingency outage of 'COMED_P2-1_094-L11323__'. This project contributes approximately 117.43 MW to the thermal violation.

```
CONTINGENCY 'COMED_P2-1_094-L11323__'
 TRIP BRANCH FROM BUS 271680 TO BUS 272756 CKT 1              / HAUME; B 138 W DEK;3T 138
 END
```

Light Load Analysis - 2021

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

System Reinforcements

Short Circuit

(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)

To be determined

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements

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

Multiple Facility Contingency

1. (CE - CE) The WATERMAN ; B-SANDWICH ; R 138 kV line (from bus 272728 to bus 272445 ckt 1) loads from 95.48% to 106.2% (**DC power flow**) of its load dump rating (321 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_111-38-TR82___'. This project contributes approximately 34.41 MW to the thermal violation.

COMED:

ComEd 138kV L11301 ALDR rating is 381 MVA. Upgrade is required. The upgrade will be station conductor at Waterman TSS. A preliminary estimate for this upgrade is $250K with a preliminary construction timeline of 24 months. Upon completion the new SLD & ALDR ratings will be 433 MVA & 480 MVA respectively.

2. (CE - CE) The WATERMAN ; B-SANDWICH ; R 138 kV line (from bus 272728 to bus 272445 ckt 1) loads from 95.17% to 106.2% (**DC power flow**) of its load dump rating (433 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_083-38-BT3-4__'. This project contributes approximately 47.76 MW to the thermal violation.

Same as Multiple Facility Contingency #1

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. (MISO NIPS - AEP) The 17STILLWELL-05DUMONT 345 kV line (from bus 255113 to bus 243219 ckt 1) loads from 164.33% to 164.43% (**DC power flow**) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#2978_05DUMONT 765'. This project contributes approximately 16.34 MW to the thermal violation.

AEP / MISO:

1) **(N4058) 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 $1.613 million. New SE rating will be 1718 MVA limited by a Dumont wavetrap and possibly the conductor. This upgrade is driven by a prior queue. Per PJM cost allocation rules, AC1-002 LTF presently does not receive cost allocation for this upgrade. Note: as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, AC1-002 LTF could receive cost allocation.**

2) **Additional AEP-end upgrade: Rebuild 8.6 miles of the AEP owned line and upgrade necessary Dumont terminal equipment (wavetrap) at a cost of $20 million. PJM Network Upgrade N4790. New AEP-end ratings to be 1409/2045 MVA (SN/SE). Limited by Dumont risers.**

3) **Additional AEP-end upgrade: In addition to upgrading the Dumont risers, a different conductor (compared to the prior upgrade) will need to be selected to**

achieve the desired rating. The new conductor would be 1272 dual ACSR conductor. The additional cost for this work scope is $2 million. The new AEP-end ratings to be 1690/2278 MVA SN/SE (limited by the conductor). PJM Network Upgrade N5064.

4) **Additional AEP-end upgrade: AEP said it would cost $4.8 million to string a second Stillwell- Dumont 345 kV line on the existing tower. The $4.8 million is for 8.5 miles of the AEP portion. Would need a NIPSCO portion (2.87 miles) cost estimate.**

5) **MISO end – ratings are 1409/1779 MVA. MISO end upgrade: Rebuild NIPSCO portion of line (2.87 miles) at a cost of $6.5 million and upgrade Stillwell substation equipment at a cost of $1.5 million. Total cost is $8.0 million. New expected MISO end ratings will be 1582/1898 MVA SN/SE.**

6) **Additional MISO-end upgrade: Reconductor 2.87 miles of transmission conductor to bundled 954 ACSS, replace substation conductor to bundled 2500 AL, and replace wavetrap. $12 million. New MISO-end ratings to be 2550/2923 MVA SN/SE.**

2. (CE - MISO NIPS) The BURNHAM ;0R-17MUNSTER 345 kV line (from bus 270677 to bus 255109 ckt 1) loads from 129.96% to 130.07% (**DC power flow**) of its emergency rating (1195 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#2978_05DUMONT 765'. This project contributes approximately 13.66 MW to the thermal violation.

COMED:
ComEd L17703 SSTE rating is 1251 MVA. The post contingency flow exceeds the rating therefore an upgrade is required. Upgrades include line reconductoring and station conductor work at Burnham. A preliminary estimate for the upgrades is $8.1 million with a preliminary construction timeline of 30 months. Upon completion the new ratings will be 1248/1441/1667/1982 MVA (SN/SLTE/SSTE/SLD)

3. (CE - CE) The E FRANKFO; B-CRETE EC ;BP 345 kV line (from bus 270728 to bus 274750 ckt 1) loads from 109.01% to 109.06% (**DC power flow**) of its load dump rating (1399 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#2978_05DUMONT 765'. This project contributes approximately 14.79 MW to the thermal violation.

COMED:
ComEd 345kV L6607 SSTE rating is 1483 MVA. The post contingency flow for this event exceeds the rating therefore an upgrade is required. The upgrade will be to reconductor the line. A preliminary estimate for this upgrade is $11.2 million with a preliminary construction timeline of 30-36 months. Upon completion of this upgrade the new ratings will be 1334/1726/1837/2084 MVA (SN/SLTE/SSTE/SLD)

4. (CE - CE) The E FRANKFO; B-CRETE EC ;BP 345 kV line (from bus 270728 to bus 274750 ckt 1) loads from 108.5% to 108.56% (**DC power flow**) of its load dump rating (1399 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_023-65-BT2-3__'. This project contributes approximately 14.95 MW to the thermal violation.

Same as Contribution to Previously Identified #3

5. (CE - CE) The E FRANKFO; B-CRETE EC ;BP 345 kV line (from bus 270728 to bus 274750 ckt 1) loads from 108.46% to 108.52% (**DC power flow**) of its load dump rating (1399 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT4-5__'. This project contributes approximately 14.87 MW to the thermal violation.

Same as Contribution to Previously Identified #3

6. (CE - CE) The E FRANKFO; B-CRETE EC ;BP 345 kV line (from bus 270728 to bus 274750 ckt 1) loads from 108.45% to 108.51% (**DC power flow**) of its load dump rating (1399 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT3-4__'. This project contributes approximately 14.87 MW to the thermal violation.

Same as Contribution to Previously Identified #3

7. (CE - CE) The WILTON ; B-WILTON ;3M 345 kV line (from bus 270926 to bus 275232 ckt 1) loads from 146.1% to 146.31% (**DC power flow**) of its load dump rating (1379 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT5-6__'. This project contributes approximately 17.16 MW to the thermal violation.

COMED:
ComEd post contingency facility overloaded by this event is Tr. 93 @ Station 112 Wilton Center. The upgrade will be to build out the 765kV ring bus at Wilton Center, installation of two 765 kV Bus Tie Circuit Breakers (BT 6-8 & 8-2) along with a relocation of 765kV L11216 from bus 6 to bus 8. Preliminary estimate for upgrade is $12 million with an estimated construction time line of 30 months. Note, the rating for Tr. 93 at Wilton Center will remain current however with this upgrade the 112-65-BT5-6 contingency file will no longer include the Wilton Center Tr. 94 and will allow both transformers to remain in service eliminating the overload.

8. (CE - CE) The WILTON ; R-WILTON ;4M 345 kV line (from bus 270927 to bus 275233 ckt 1) loads from 148.94% to 149.12% (**DC power flow**) of its load dump rating (1379 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT2-3__'. This project contributes approximately 17.53 MW to the thermal violation.

Same as Contribution to Previously Identified #7

9. (CE - CE) The WATERMAN ; B-GLIDDEN ;BT 138 kV line (from bus 272728 to bus 271560 ckt 1) loads from 105.11% to 116.95% (**DC power flow**) of its load dump rating (344

MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_146-38-BT_____'. This project contributes approximately 40.7 MW to the thermal violation.

COMED:
ComEd 138kV L11106 ALDR rating is 396 MVA. Upgrade is required. The upgrade will be a line relay package at Waterman TSS. A preliminary estimate for the upgrade is $300K with a preliminary construction timeline of 24 months. Upon completion the new SLD & ALDR ratings will be 433 MVA 7& 480 MVA respectively.

10. (CE - MISO NIPS) The CRETE EC ;BP-17STJOHN 345 kV line (from bus 274750 to bus 255112 ckt 1) loads from 126.57% to 126.63% (**DC power flow**) of its emergency rating (1399 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#2978_05DUMONT 765'. This project contributes approximately 14.61 MW to the thermal violation.

Same as Contribution to Previously Identified #3

11. (CE - MISO NIPS) The CRETE EC ;BP-17STJOHN 345 kV line (from bus 274750 to bus 255112 ckt 1) loads from 126.09% to 126.14% (**DC power flow**) of its emergency rating (1399 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_023-65-BT2-3__'. This project contributes approximately 14.77 MW to the thermal violation.

Same as Contribution to Previously Identified #3

12. (CE - MISO NIPS) The CRETE EC ;BP-17STJOHN 345 kV line (from bus 274750 to bus 255112 ckt 1) loads from 126.05% to 126.1% (**DC power flow**) of its emergency rating (1399 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT4-5__'. This project contributes approximately 14.69 MW to the thermal violation.

Same as Contribution to Previously Identified #3

13. (CE - MISO NIPS) The CRETE EC ;BP-17STJOHN 345 kV line (from bus 274750 to bus 255112 ckt 1) loads from 126.03% to 126.09% (**DC power flow**) of its emergency rating (1399 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT3-4__'. This project contributes approximately 14.69 MW to the thermal violation.

Same as Contribution to Previously Identified #3

14. (CE - AEP) The UNIV PK N;RP-05OLIVE 345 kV line (from bus 274804 to bus 243229 ckt 1) loads from 133.48% to 133.57% (**DC power flow**) of its emergency rating (971 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#2978_05DUMONT 765'. This project contributes approximately 11.41 MW to the thermal violation.

COMED:

ComEd 345kV L97008 SSTE rating is 1134 MVA. The post contingency flow exceeds the rating therefore an upgrade is required. The upgrade will be to mitigate the sag on the line. A preliminary estimate for this upgrade is $ 22.6 million with a construction timeline of 30 months. Upon completion of the upgrade the ratings will be 1334/1334/1391/1523 MVA (SN/SLTE/SSTE/SLD).

15. (CE - AEP) The UNIV PK N;RP-05OLIVE 345 kV line (from bus 274804 to bus 243229 ckt 1) loads from 132.35% to 132.44% (**DC power flow**) of its emergency rating (971 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_023-65-BT4-5__'. This project contributes approximately 11.49 MW to the thermal violation.

Same as Contribution to Previously Identified #14

16. (CE - AEP) The UNIV PK N;RP-05OLIVE 345 kV line (from bus 274804 to bus 243229 ckt 1) loads from 132.35% to 132.44% (**DC power flow**) of its emergency rating (971 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT4-5__'. This project contributes approximately 11.5 MW to the thermal violation.

Same as Contribution to Previously Identified #14

17. (CE - AEP) The UNIV PK N;RP-05OLIVE 345 kV line (from bus 274804 to bus 243229 ckt 1) loads from 132.35% to 132.44% (**DC power flow**) of its emergency rating (971 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT3-4__'. This project contributes approximately 11.5 MW to the thermal violation.

Same as Contribution to Previously Identified #14

18. (CE - AEP) The UNIV PK N;RP-05OLIVE 345 kV line (from bus 274804 to bus 243229 ckt 1) loads from 132.33% to 132.43% (**DC power flow**) of its emergency rating (971 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_023-65-BT2-3__'. This project contributes approximately 11.51 MW to the thermal violation.

Same as Contribution to Previously Identified #14

19. (CE - CE) The WILTON ; 765/345 kV transformer (from bus 275232 to bus 270644 ckt 1) loads from 146.1% to 146.31% (**DC power flow**) of its load dump rating (1379 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT5-6__'. This project contributes approximately 17.16 MW to the thermal violation.

Same as Contribution to Previously Identified #7

20. (CE - CE) The WILTON ; 765/345 kV transformer (from bus 275233 to bus 270644 ckt 1) loads from 148.94% to 149.11% (**DC power flow**) of its load dump rating (1379 MVA) for the line fault with failed breaker contingency outage of 'COMED_P4_112-65-BT2-3__'. This project contributes approximately 17.53 MW to the thermal violation.

Same as Contribution to Previously Identified #7