Revised Generation Interconnection

Impact Study Report

for

Queue Project AE2-297

MADISON-TANNERS CREEK 138 KV

91.5 MW Capacity / 152.5 MW Energy

June, 2020

Revised: December 2021

Revised: August 2022

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1 Preface

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

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. Cost allocation rules for network upgrades 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 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.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

An Interconnection Customer 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.

2 General

Lightsource Renewable Energy Development LLC, has proposed a Solar generating facility located in Henry County, Indiana. The installed facilities will have a total capability of 152.5 MW with 91.5 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this project is 12.31.2021. This study does not imply a TO commitment to this in-service date.

The objective of this System Impact Study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the AEP transmission system. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required for maintaining the reliability of the AEP transmission system.

Queue Number	**AE2-297**
Project Name	MADISON-TANNERS CREEK 138 KV
Interconnection Customer	Lightsource Renewable Energy Development, LLC
State	Indiana
County	Henry
Transmission Owner	AEP
MFO	152.5
MWE	152.5
MWC	91.5
Fuel	Solar
Basecase Study Year	2022

2.1 Point of Interconnection

AE2-297 will interconnect with the AEP transmission system as a tap of the Madison to Tanners Creek 138 kV line.

To accommodate the interconnection on the Madison to Tanners Creek 138 kV Circuit, a new three (3) circuit breaker 138kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus will be constructed (see Figure 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.

2.2 Cost Summary

This project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 250,000
Direct Connection Network Upgrade	$ 6,000,000
Non Direct Connection Network Upgrades	$ 1,500,000
Allocation for New System Upgrades	$ 125,000
Contribution for Previously Identified Upgrades	$ 0
Total Costs	$ 7,875,000

3 Transmission Owner Scope of Work

4 Attachment Facilities

The total preliminary cost estimate for the Attachment work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
138kV Revenue Metering	$ 250,000
Total Attachment Facility Costs	$ 250,000

5 Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Construct a new three (3) circuit breaker 138 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus (See Figure 1). Installation of associated protection and control equipment, 138 kV line risers and SCADA will also be required.	$ 6,000,000
Total Direct Connection Facility Costs	$ 6,000,000

6 Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Upgrade line protections & Controls at the 138kV Remote end Substation #1	$ 250,000
Upgrade line protections & Controls at the 138kV Remote end Substation #2	$ 250,000
138kV Transmission Line Cut In	$ 1,000,000
Total Non-Direct Connection Facility Costs	$ 1,500,000

7 Incremental Capacity Transfer Rights (ICTRs)

None

8 Schedule

It is anticipated that the time between receipt of executed Agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would generally be between 24 to 36 months after Agreement execution.

9 Interconnection Customer Requirements

It is understood that Lightsource Renewable Energy Development LLC is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of Lightsource Renewable Energy Development LLC's generating plant and the costs for the line connecting the generating plant to the AEP Transmission circuit are not included in this report; these are assumed to be Lightsource Renewable Energy Development LLC's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for American Electric Power to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider to determine if a local service agreement is required.

Requirement from the PJM Open Access Transmission Tariff:

1. 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.
2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

10 Revenue Metering and SCADA Requirements

10.1 PJM Requirements

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

10.2 AEP Requirements

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx

11 Network Impacts

The Queue Project AE2-297 was evaluated as a 152.5 MW (Capacity 91.5 MW) injection into a tap of the Madison – Tanners Creek 138 kV line in the AEP area. Project AE2-297 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-297 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Load Flow

12 Generation Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection) None

13 Multiple Facility Contingency

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

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
1	DCTL	.345.DEO&K-AEP.C5 4504MFTANNERS4512EBTANNERS	OVEC - OVEC	06DEARB1-06PIERCE 345 kV line	248001	248013	1	AC	98.14	100.57	ER	972	23.15	1

14 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)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
2	LFFB	AEP_P4_#8781_05HOGAN 138_B	AEP - AEP	05PIPECK-05GRNTTA 138 kV line	246763	243303	1	AC	109.1	113.47	ER	205	10.24	2
3	LFFB	AEP_P4_#8781_05HOGAN 138_B	AEP - AEP	AD2-071 TAP-05PIPECK 138 kV line	936560	246763	1	AC	110.84	115.21	ER	205	10.24	3

15 Potential Congestion due to Local Energy Deliverability

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.

Note: Only the most severely overloaded conditions are listed below. 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 shall study all overload conditions associated with the overloaded element(s) identified.

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
4	N-1	AEP_P1-2_#6957	AEP - AEP	05PIPECK-05GRNTTA 138 kV line	246763	243303	1	AC	104.51	108.31	ER	205	8.86	
5	N-1	AEP_P1-2_#6957	AEP - AEP	AD2-071 TAP-05PIPECK 138 kV line	936560	246763	1	AC	106.25	110.05	ER	205	8.86	

16 Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

See Attachment 2

17 Stability and Reactive Power Requirements for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

See Attachment 2

18 Light Load Analysis

Light Load Studies (applicable to wind, coal, nuclear, and pumped storage projects).

Not required for Solar projects

19 System Reinforcements

Facility	Upgrade Description	Cost	Cost Allocation	Upgrade Number
06DEARB1-06PIERCE 345 kV line (from bus 248001 to bus 248013 ckt 1)	OVEC Reinforcement: **Project ID**: N6759.1 **Description**: Perform a sag study. **Type**: FAC **Cost:** $125,000 **Time Estimate**: 6-12 Months **Ratings**: 1204 MVA SE AE2-297 is the driver for this upgrade.	$125,000	$125,000	N6759.1
	Total	**$125,000**	**$125,000**	

20 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)

Facility	Upgrade Description	Cost	Cost Allocation	Upgrade Number
05PIPECK-05GRNTTA 138 kV line (from bus 246763 to bus 243303 ckt 1)	AEP Reinforcement: **Project ID**: N6329 **Description**: A Sag Study will be required on the 1.9 miles of ACSR ~ 556.5 ~ 26/7 ~ DOVE - Conductor Section 1 to determine any mitigations required for the overload. **Type**: FAC **Cost:** $20,000 **Time Estimate**: 6-12 Months **Ratings**: 284 MVA SE **Notes:** 1. The upgrade N6329 is driven in a prior queue cycle. Since the cost of the upgrade is less than $5M, based on PJM cost allocation criteria, AE2-297 currently does not receive cost allocation towards this upgrade. 2. As changes to the PJM queue process occur (such as prior queued projects withdrawing from the queue, reducing in size, etc.) AE2-297 could receive cost allocation. 3. Although Queue Project AE2-297 may not presently have cost responsibility for this upgrade, Queue Project AE2-297 may need this upgrade in-service to be deliverable to the PJM system.	$20,000	$0	N6329

	4. If Queue Project AE2-297 comes into service prior to completion of the upgrade, Queue Project AE2-297 will need an interim study.			
AD2-071 TAP-05PIPECK 138 kV line (from bus 936560 to bus 246763 ckt 1)	AEP Reinforcement: **Project ID**: N6330 **Description**: A Sag Study will be required on the 8.2 miles of ACSR ~ 556.5 ~ 26/7 ~ DOVE - Conductor Section 1 to determine any mitigations required for the overload. **Type**: FAC **Cost:** $32,800 **Time Estimate**: 6-12 Months **Ratings**: 284 MVA SE **Notes:** 1. The upgrade N6330 is driven in a prior queue cycle. Since the cost of the upgrade is less than $5M, based on PJM cost allocation criteria, AE2-297 currently does not receive cost allocation towards this upgrade. 2. As changes to the PJM queue process occur (such as prior queued projects withdrawing from the queue, reducing in size, etc.) AE2-297 could receive cost allocation. 3. Although Queue Project AE2-297 may not presently have cost responsibility for this upgrade, Queue Project AE2-297 may need this upgrade in-service to be deliverable to the PJM system. 4. If Queue Project AE2-297 comes into service prior to completion of the upgrade, Queue Project AE2-297 will need an interim study.	$32,800	$0	N6330
	Total	**$52,800**	**$0**	

Affected Systems

21 Affected Systems

21.1 LG&E

None

21.2 MISO

None

21.3 TVA

None

21.4 Duke Energy Progress

None

22 Contingency Descriptions:

Contingency Name	Contingency Definition
.345.DEO&K-AEP.C5 4504MFTANNERS4512EBTANNERS	CONTINGENCY '.345.DEO&K-AEP.C5 4504MFTANNERS4512EBTANNERS' OPEN BRANCH FROM BUS 243233 TO BUS 249567 CKT 1 OPEN BRANCH FROM BUS 243233 TO BUS 249565 CKT 1 END
AEP_P1-2_#6957	CONTINGENCY 'AEP_P1-2_#6957' OPEN BRANCH FROM BUS 247116 TO BUS 246913 CKT 1 / 247116 05ALADDIN 138 246913 05JONES 138 1 OPEN BRANCH FROM BUS 247116 TO BUS 246988 CKT 1 / 247116 05ALADDIN 138 246988 05STRWTN 138 1 OPEN BRANCH FROM BUS 243311 TO BUS 246913 CKT 1 / 243311 05HOGAN 138 246913 05JONES 138 1 END
AEP_P4_#8781_05HOGAN 138_B	CONTINGENCY 'AEP_P4_#8781_05HOGAN 138_B' OPEN BRANCH FROM BUS 247116 TO BUS 246913 CKT 1 / 247116 05ALADDIN 138 246913 05JONES 138 1 OPEN BRANCH FROM BUS 247116 TO BUS 246988 CKT 1 / 247116 05ALADDIN 138 246988 05STRWTN 138 1 OPEN BRANCH FROM BUS 247420 TO BUS 243311 CKT 1 / 247420 05CROSS ST Z 138 243311 05HOGAN 138 1 OPEN BRANCH FROM BUS 243275 TO BUS 243311 CKT 1 / 243275 05DELAWR 138 243311 05HOGAN 138 1 OPEN BRANCH FROM BUS 243311 TO BUS 246913 CKT 1 / 243311 05HOGAN 138 246913 05JONES 138 1 OPEN BRANCH FROM BUS 243311 TO BUS 246046 CKT 1 / 243311 05HOGAN 138 246046 05HOGAN 34.5 1 OPEN BRANCH FROM BUS 243311 TO BUS 246047 CKT 1 / 243311 05HOGAN 138 246047 05HOGAN L 12.0 1 END

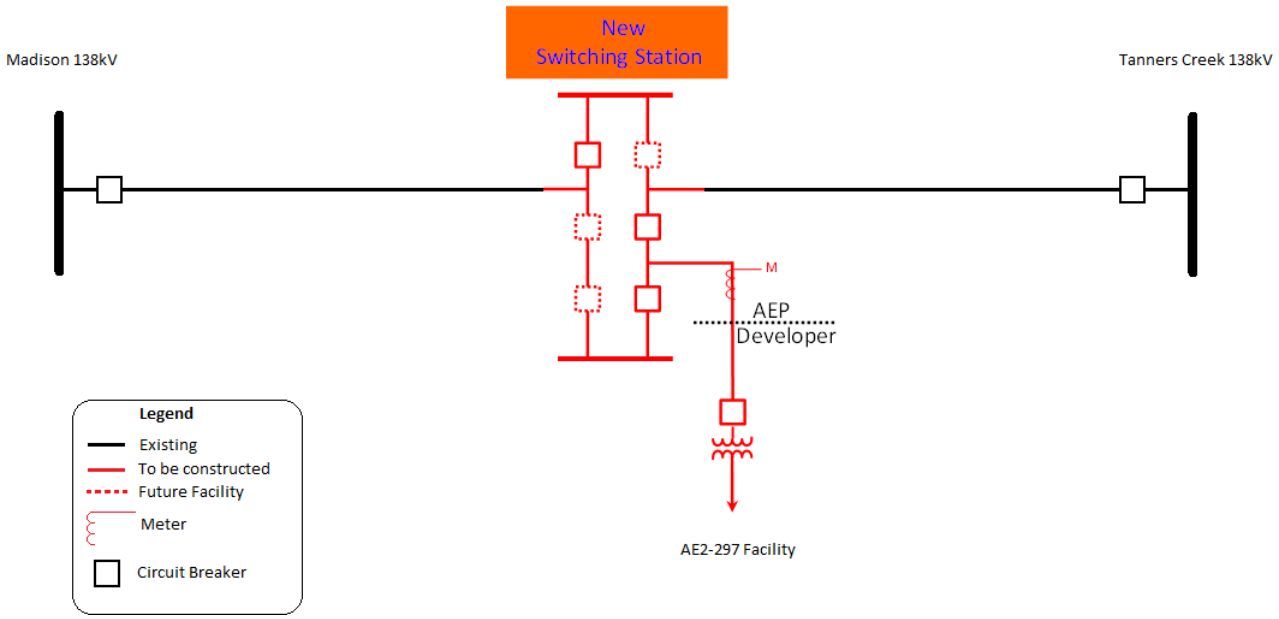
Short Circuit

23 Short Circuit

The following Breakers are overduty

None.

24 Attachment 1: Single Line Diagram



25 Attachment 2: Dynamic Simulation Analysis

Executive Summary

Generator Interconnection Request AE2-297 is for a 152.5 MW Maximum Facility Output (MFO) solar generation plant. AE2-297 consists of 65 × 2.37 MW, Sungrow SG2500PV solar PV inverters with a total capacity of 154.03 MW. The Point of Interconnection (POI) is a tap on the Madison – Tanner 138 kV circuit in the American Electric and Power (AEP) transmission system, Henry county, Indiana.

This report describes a dynamic simulation analysis of AE2-297 as part of the overall system impact study.

The load flow scenario for the analysis was based on the RTEP 2023 peak load case, modified to include applicable queue projects. AE2-297 has been dispatched online at maximum power output, with 1.0 p.u. voltage at the generator bus.

AE2-297 was tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. Steady-state condition and 60 contingencies were studied, each with a 20 second simulation time period. Studied faults included:

a) Steady-state operation (20 second run),

b) Three-phase faults with normal clearing time and with high speed reclosing (HSR),

c) Single-phase bus faults with normal clearing time,

d) Single-phase faults with delayed clearing due to a stuck breaker,

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

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

High speed reclosing (HSR) contingencies were identified. Only unsuccessful high speed reclosing into a fault was considered.

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 of the fault contingencies tested on the 2023 peak load case:

a) AE2-297 was able to ride through the faults (except for faults where protective action trips a generator(s)),

b) The system with AE2-297 included is transiently stable and post-contingency oscillations were positively damped with a damping margin of at least 3% for interarea and local modes.

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

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

The reactive power capability of AE2-297 meets the 0.95 lagging and leading PF requirement at the high side of the main transformer.

When a fault was applied on either AE2-297 POI or Madison bus, and the Madison – AE2-297 POI 138 kV circuit was lost, the simulation output results for AE2-297 become unstable. The proportional (Kp) and integral (Ki) gains of reactive power PI control in REPCAU1 model were changed from to 0.1 and 0.5 from 5 and 0.1, respectively.

The IPCMD and IQCMD states in the REGCAU model of AE2-297 showed erratic behavior for some contingencies in which AE2-297 has been disconnected as part of the contingency event. Since the machine is disconnected and no active or reactive power is injected into the system, this behavior is likely fictitious and a limitation of the software. This does not cause instability in the system.

AE2-297 exhibited slow reactive power recovery within the 20 second simulation time window for several contingencies. This issue did not cause instability in the system and the models can be tuned to achieve a faster reactive power output settlement upon request.

No mitigations were found to be required.

26 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. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the Appendices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the Appendices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators.

It should be noted the project/generator MW contributions presented in the body of the report and appendices sections are full contributions, whereas the loading percentages reported in the body of the report, take into consideration the commercial probability of each project as well as the ramping impact of "Adder" contributions.

Appendix 1

(OVEC - OVEC) The 06DEARB1-06PIERCE 345 kV line (from bus 248001 to bus 248013 ckt 1) loads from 98.14% to 100.57% (AC power flow) of its emergency rating (972 MVA) for the tower line contingency outage of '.345.DEO&K-AEP.C5 4504MFTANNERS4512EBTANNERS'. This project contributes approximately 23.15 MW to the thermal violation.

CONTINGENCY '.345.DEO&K-AEP.C5 4504MFTANNERS4512EBTANNERS'
OPEN BRANCH FROM BUS 243233 TO BUS 249567 CKT 1
OPEN BRANCH FROM BUS 243233 TO BUS 249565 CKT 1
END

Bus Number	*Bus Name*	*Full Contribution*
243795	*05HDWTR1G C*	*0.62*
247963	*05HDWTR1G E*	*9.66*
247264	*05LAWG1A*	*7.74*
247265	*05LAWG1B*	*7.74*
247266	*05LAWG1S*	*12.36*
247267	*05LAWG2A*	*7.74*
247268	*05LAWG2B*	*7.74*
247269	*05LAWG2S*	*12.36*
247914	*05WLD G1 E*	*8.*
247958	*05WLD G2 E*	*8.39*
932461	*AC2-066 C*	*-1.78*
932681	*AC2-090 C*	*5.86*
932682	*AC2-090 E*	*9.56*
932841	*AC2-111 C O1*	*2.77*
932842	*AC2-111 E O1*	*4.51*
933591	*AC2-176 C O1*	*1.51*
933592	*AC2-176 E O1*	*10.13*
934161	*AD1-043 C O1*	*4.46*
934162	*AD1-043 E O1*	*7.28*
934961	*AD1-128 C O1*	*5.62*
934962	*AD1-128 E O1*	*9.16*
936561	*AD2-071 C*	*5.93*
936562	*AD2-071 E*	*2.92*
938921	*AE1-120*	*-2.74*
939761	*AE1-207 C*	*5.95*
939762	*AE1-207 E*	*8.22*
939771	*AE1-208 C*	*5.23*
939772	*AE1-208 E*	*7.14*
939781	*AE1-209 C O1*	*1.61*
939782	*AE1-209 E O1*	*10.75*
939791	*AE1-210 C O1*	*1.61*
939792	*AE1-210 E O1*	*10.75*
940981	*AE2-089 C O1*	*7.24*

940982	*AE2-089 E O1*	*4.82*
941691	*AE2-169*	*3.14*
941721	*AE2-172*	*3.54*
942071	*AE2-219 C*	*3.76*
942072	*AE2-219 E*	*5.2*
942081	*AE2-220 C*	*8.09*
942082	*AE2-220 E*	*11.18*
942221	*AE2-234 C O1*	*1.8*
942222	*AE2-234 E O1*	*0.81*
942791	*AE2-297 C O1*	*13.89*
942792	*AE2-297 E O1*	*9.26*
LTF	*CARR*	*0.33*
LTF	*CATAWBA*	*0.09*
LTF	*CBM-S1*	*4.27*
LTF	*CBM-W1*	*16.99*
LTF	*CBM-W2*	*71.78*
LTF	*CHOCTAW /* 35% REVERSE 4566958 4511400*	*< 0.01*
LTF	*CIN*	*13.63*
LTF	*G-007*	*0.95*
LTF	*HAMLET*	*0.2*
LTF	*IPL*	*12.54*
950161	*J401*	*1.31*
LTF	*LGEE*	*1.08*
LTF	*MEC*	*15.33*
LTF	*MECS*	*7.2*
LTF	*O-066*	*6.08*
LTF	*RENSSELAER*	*0.26*
247929	*S-071 E*	*8.55*
247543	*V3-007 C*	*4.01*
247935	*V3-007 E*	*26.82*
LTF	*WEC*	*2.42*
913222	*Y1-054 E*	*-1.5*
915662	*Y3-099 E*	*0.2*
915672	*Y3-100 E*	*0.2*
916182	*Z1-065 E*	*0.38*
247968	*Z2-115 E*	*0.16*
930061	*AB1-014 C*	*-2.96*
926691	*AC1-152*	*2.44*
926851	*AC1-172*	*2.44*
926881	*AC1-175 C*	*11.72*
926882	*AC1-175 E*	*19.11*
926951	*AC1-182*	*-1.27*

Appendix 2

(AEP - AEP) The 05PIPECK-05GRNTTA 138 kV line (from bus 246763 to bus 243303 ckt 1) loads from 109.1% to 113.47% (AC power flow) of its emergency rating (205 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#8781_05HOGAN 138_B'. This project contributes approximately 10.24 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#8781_05HOGAN 138_B'
OPEN BRANCH FROM BUS 247116 TO BUS 246913 CKT 1 / 247116 05ALADDIN 138 246913 05JONES 138 1
OPEN BRANCH FROM BUS 247116 TO BUS 246988 CKT 1 / 247116 05ALADDIN 138 246988 05STRWTN 138 1
OPEN BRANCH FROM BUS 247420 TO BUS 243311 CKT 1 / 247420 05CROSS ST Z 138 243311 05HOGAN 138 1
OPEN BRANCH FROM BUS 243275 TO BUS 243311 CKT 1 / 243275 05DELAWR 138 243311 05HOGAN 138 1
OPEN BRANCH FROM BUS 243311 TO BUS 246913 CKT 1 / 243311 05HOGAN 138 246913 05JONES 138 1
OPEN BRANCH FROM BUS 243311 TO BUS 246046 CKT 1 / 243311 05HOGAN 138 246046 05HOGAN 34.5 1
OPEN BRANCH FROM BUS 243311 TO BUS 246047 CKT 1 / 243311 05HOGAN 138 246047 05HOGAN L 12.0 1
END

Bus Number	*Bus Name*	*Full Contribution*
246991	*05WLD G1 C*	*1.*
247914	*05WLD G1 E*	*43.28*
247255	*05WLD G2 C*	*1.05*
247958	*05WLD G2 E*	*45.41*
934161	*AD1-043 C O1*	*19.67*
934162	*AD1-043 E O1*	*32.1*
936561	*AD2-071 C*	*39.86*
936562	*AD2-071 E*	*19.63*
941722	*AE2-172 BAT*	*3.42*
942791	*AE2-297 C O1*	*6.14*
942792	*AE2-297 E O1*	*4.1*
LTF	*CBM-N*	*0.02*
LTF	*CBM-S1*	*0.68*
LTF	*CBM-S2*	*0.15*
LTF	*CBM-W2*	*4.88*
LTF	*CIN*	*1.62*
LTF	*CPLE*	*0.05*
LTF	*DUCKCREEK*	*0.23*
LTF	*EDWARDS*	*0.13*
LTF	*FARMERCITY*	*0.03*
LTF	*G-007A*	*0.06*
LTF	*IPL*	*1.62*

LTF	*LGEE*	*0.3*
LTF	*NYISO*	*0.07*
LTF	*VFT*	*0.17*

Appendix 3

(AEP - AEP) The AD2-071 TAP-05PIPECK 138 kV line (from bus 936560 to bus 246763 ckt 1) loads from 110.84% to 115.21% (AC power flow) of its emergency rating (205 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#8781_05HOGAN 138_B'. This project contributes approximately 10.24 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#8781_05HOGAN 138_B'
OPEN BRANCH FROM BUS 247116 TO BUS 246913 CKT 1 / 247116 05ALADDIN 138 246913 05JONES 138 1
OPEN BRANCH FROM BUS 247116 TO BUS 246988 CKT 1 / 247116 05ALADDIN 138 246988 05STRWTN 138 1
OPEN BRANCH FROM BUS 247420 TO BUS 243311 CKT 1 / 247420 05CROSS ST Z 138 243311 05HOGAN 138 1
OPEN BRANCH FROM BUS 243275 TO BUS 243311 CKT 1 / 243275 05DELAWR 138 243311 05HOGAN 138 1
OPEN BRANCH FROM BUS 243311 TO BUS 246913 CKT 1 / 243311 05HOGAN 138 246913 05JONES 138 1
OPEN BRANCH FROM BUS 243311 TO BUS 246046 CKT 1 / 243311 05HOGAN 138 246046 05HOGAN 34.5 1
OPEN BRANCH FROM BUS 243311 TO BUS 246047 CKT 1 / 243311 05HOGAN 138 246047 05HOGAN L 12.0 1
END

Bus Number	*Bus Name*	*Full Contribution*
246991	*05WLD G1 C*	*1.*
247914	*05WLD G1 E*	*43.28*
247255	*05WLD G2 C*	*1.05*
247958	*05WLD G2 E*	*45.41*
934161	*AD1-043 C O1*	*19.67*
934162	*AD1-043 E O1*	*32.1*
936561	*AD2-071 C*	*39.86*
936562	*AD2-071 E*	*19.63*
941722	*AE2-172 BAT*	*3.42*
942791	*AE2-297 C O1*	*6.14*
942792	*AE2-297 E O1*	*4.1*
LTF	*CBM-N*	*0.02*
LTF	*CBM-S1*	*0.68*
LTF	*CBM-S2*	*0.15*
LTF	*CBM-W2*	*4.88*
LTF	*CIN*	*1.62*
LTF	*CPLE*	*0.05*
LTF	*DUCKCREEK*	*0.23*
LTF	*EDWARDS*	*0.13*
LTF	*FARMERCITY*	*0.03*
LTF	*G-007A*	*0.06*
LTF	*IPL*	*1.62*

LTF	*LGEE*	*0.3*
LTF	*NYISO*	*0.07*
LTF	*VFT*	*0.17*