Generation Interconnection

Feasibility Study Report

for

Queue Project AE2-090

RANDOLPH-HODGIN 138 KV

86.4 MW Capacity / 144 MW Energy

December, 2019

Table Of Contents

1 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. 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.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. 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 4.3 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 B-1 of Manual 14G) 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.

2 General

The Interconnection Customer has proposed a Solar generating facility located in Randolph County, Indiana. The installed facilities will have a total capability of 144 MW with 86.4 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 12/31/2022. This study does not imply a TO commitment to this in-service date.

The objective of this Feasibility 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.

The Feasibility Study includes Short Circuit and Peak Load steady state power flow analyses. The conduct of power flow studies at other load levels, stability analysis, and coordination with non-PJM Transmission Planners, as required under the PJM planning process, is not performed during the Generation Interconnection Feasibility Study phase of the PJM study process. Additional reinforcement requirements for this Interconnection Request may be defined during the conduct of these additional analyses which shall be performed following execution of the System Impact Study agreement

Queue Number	**AE2-090**
Project Name	RANDOLPH-HODGIN 138 KV
State	Indiana
County	Randolph
Transmission Owner	AEP
MFO	144
MWE	144
MWC	86.4
Fuel	Solar
Basecase Study Year	2022

2.1 Point of Interconnection

AE2-090 will interconnect with the AEP transmission system via a new station cut into the Randolph to Hodgin 138kV section of the Randolph – College Corner 138kV Circuit.

To accommodate the interconnection on the Randolph to Hodgin 138kV section of Randolph – College Corner 138kV 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.

Cost Summary

The AE2-090 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 250,000
Direct Connection Network Upgrade	$ 7,000,000
Non Direct Connection Network Upgrades	$ 500,000
Total Costs	$ 7,750,000

In addition, the AE2-090 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$24,289,461 + TBD

Cost allocations for these upgrades will be provided in the System Impact Study Report.

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
Randolph – Hodgin 138kV T-Line Cut In	$ 1,000,000
Total Direct Connection Facility Costs	$7,000,000

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 Randolph 138kV Substation	$ 250,000
Upgrade line protections & Controls at the College Corner 138kV Substation	$ 250,000
Total Non-Direct Connection Facility Costs	$500,000

7 Incremental Capacity Transfer Rights (ICTRs)

Will be determined at a later study phase

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 Transmission Owner Analysis

An AEP supplemental project will rebuild the College Corner- Jay 138kV line with the current projected ISD is 12/1/2023.PJM has assigned this project number S2014. A summary of this project is available at https://www.pjm.com/-/media/committees-groups/committees/srrtep-w/20190520/20190520-reliability-analysis-update.ashx. Determination of allocation of cost for the scope of S2014 to AE2-090 (if any) or other queue positions will occur during the System Impact Study.

10 Interconnection Customer Requirements

It is understood that the Interconnection Customer is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of the Interconnection Customer's generating plant and the costs for the line connecting the generating plant to the Randolph – Hodgin section of the Randolph – College Corner 138kV Circuit are not included in this report; these are assumed to be the Interconnection Customer'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.

11 Revenue Metering and SCADA Requirements

11.1 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.

11.2 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

12 Network Impacts

The Queue Project AE2-090 was evaluated as a 144 MW (Capacity 86.4 MW) injection via a new station cut into Randolph to Hodgin 138kV section of Randolph to College Corner 138kV Circuit in the AEP area. Project AE2-090 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-090 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

13 Generation Deliverability

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

None

14 Multiple Facility Contingency

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

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
1423961	243253	05BLUFFP	AEP	243319	05JAY	AEP	1	AEP_P4_#6924_05COLLCO 138_C	breaker	284.0	68.48	104.66	DC	102.75
1424018	243310	05HODGIN	AEP	243262	05COLLCO	AEP	1	AEP_P4_#10527_05BLUFFP 138_E2	breaker	284.0	67.02	99.34	DC	91.8
2172172	250001	08COLINV	DEO&K	250144	08HUSTRC	DEO&K	1	AEP_P4_#10527_05BLUFFP 138_E2	breaker	178.0	80.28	97.27	DC	30.24
2172180	250144	08HUSTRC	DEO&K	250116	08TRENTO	DEO&K	1	AEP_P4_#10527_05BLUFFP 138_E2	breaker	178.0	79.21	96.2	DC	30.24
1423732	940990	AE2-090 TAP	AEP	243310	05HODGIN	AEP	1	AEP_P4_#10527_05BLUFFP 138_E2	breaker	284.0	78.58	119.41	DC	115.98
6941659	942070	AE2-219 TAP	AEP	243253	05BLUFFP	AEP	1	AEP_P4_#6924_05COLLCO 138_C	breaker	284.0	53.63	95.48	DC	118.87

15 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)

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
1423542	243262	05COLLCO	AEP	250001	08COLINV	DEO&K	1	AEP_P4_#10527_05BLUFFP 138_E2	breaker	167.0	120.6	138.7	DC	30.24
2172635	248001	06DEARB1	OVEC	248013	06PIERCE	OVEC	1	.345.DEO&K-AEP.C5 4504MFTANNERS4512EBTANNERS	tower	972.0	106.81	107.41	DC	12.96
1425035	940980	AE2-089 TAP	AEP	243237	05ADAM	AEP	1	AEP_P7-1_#11019	tower	205.0	103.57	106.04	DC	11.22

16 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.

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
1424768	243218	05DESOTO	AEP	243232	05SORENS	AEP	2	AEP_P1-2_#4817	operation	971.0	93.87	95.51	DC	16.21
1424706	243253	05BLUFFP	AEP	243319	05JAY	AEP	1	Base Case	operation	205.0	77.12	104.81	DC	56.76
1424707	243253	05BLUFFP	AEP	243319	05JAY	AEP	1	AEP_P1-2_#10142-A	operation	284.0	67.97	104.14	DC	102.7
1424360	243262	05COLLCO	AEP	250001	08COLINV	DEO&K	1	AEP_P1-2_#6372A	operation	167.0	118.72	131.31	DC	21.01
1424361	243262	05COLLCO	AEP	250001	08COLINV	DEO&K	1	.138.DEO&K-AEP-DAY.B2 TODHUNTER JCT 138	operation	167.0	118.72	131.31	DC	21.01
1424365	243262	05COLLCO	AEP	250001	08COLINV	DEO&K	1	Base Case	operation	167.0	89.38	100.1	DC	17.91
6942706	934960	AD1-128 TAP	AEP	243275	05DELAWR	AEP	1	AEP_P1-2_#10526-B	operation	185.0	103.44	113.82	DC	19.2
1424734	940980	AE2-089 TAP	AEP	243237	05ADAM	AEP	1	AEP_P1-2_#5598	operation	205.0	85.25	96.41	DC	22.88
6942717	940990	AE2-090 TAP	AEP	243310	05HODGIN	AEP	1	AEP_P1-2_#10526-A	operation	284.0	46.26	87.1	DC	115.99
6942496	942070	AE2-219 TAP	AEP	243253	05BLUFFP	AEP	1	Base Case	operation	205.0	66.84	98.91	DC	65.74
6942497	942070	AE2-219 TAP	AEP	243253	05BLUFFP	AEP	1	AEP_P1-2_#10142-A	operation	284.0	52.91	94.75	DC	118.81

17 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
2172172	3	08COLINV 138.0 kV - 08HUSTRC 138.0 kV Ckt 1	DEO&K No violation. Post queue loading less than 100%.	$0
1425035	9	AE2-089 TAP 138.0 kV - 05ADAM 138.0 kV Ckt 1	AEP b3119 (99) : PJM Baseline Upgrade b3119. Rebuild the 138kV Jay Pennville line as double circuit 138/69kV. Build a new 9.8 mile single circuit 69 kV line from near Pennville station to North Portland station. The baseline project has a projected in-service date of 06/17/2019. Additionally, the Jay- Allen project (waiting for a Supplemental ID# for this project) will be required to mitigate the identified overloads. Project Type : FAC Cost : $0 Time Estimate : N/A Months	$0
1424018	2	05HODGIN 138.0 kV - 05COLLCO 138.0 kV Ckt 1	AEP No violation. Post queue loading less than 100%.	$0
1423542	7	05COLLCO 138.0 kV - 08COLINV 138.0 kV Ckt 1	AEP AEPI0005a (261) : A Sag Study will be required on the 0.15 mile section of line to mitigate the overload . New Rating after the Sag Study : S/N: 167 MVA S/E: 245 MVA. Depending on the sag study results, cost for this upgrade is expected to be between $600 (no remediations required just sag study) and $0.3 million (complete line reconductor/rebuild required). Time Estimate: a) Sag Study: 6-12 months b) Rebuild: The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement. Project Type : FAC Cost : $600 Time Estimate : 6-12 Months DEO&K r3281 (495) : Rebuild the line Project Type : FAC Cost : $24,163,861 Time Estimate : 36.0 Months	$24,164,461

ID	Index	Facility	Upgrade Description	Cost
1423961	1	05BLUFFP 138.0 kV - 05JAY 138.0 kV Ckt 1	**AEP** **(sXXXX): Jay - College Corner Rebuild raises limit to 359 MVA (waiting for a Supplemental ID# for this project). Note: This queue project may have a cost responsibility for upgrading the overloaded element if the supplemental project is not approved. Further information will be provided during the Impact Study Phase.** **Project Type : FAC** **Cost : TBD** **Time Estimate : TBD** **An AEP supplemental project will rebuild the College Corner- Jay 138kV line with the current projected ISD is 12/1/2023. PJM has assigned this project number S2014. A summary of this project is available at https://www.pjm.com/-/media/committees-groups/committees/srrtep-w/20190520/20190520-reliability-analysis-update.ashx. Determination of allocation of cost for the scope of S2014 to AE2-090 (if any) or other queue positions will occur during the System Impact Study.**	TBD
1423732	5	AE2-090 TAP 138.0 kV - 05HODGIN 138.0 kV Ckt 1	**AEP** **b3103.1 : PJM Baseline Upgrade b3103.1. Install a 138/69 kV transformer at Royerton station. Install a 69 kV bus with one 69 kV breaker toward Bosman station. Rebuild the 138 kV portion into a ring bus configuration built for future breaker and a half with four 138 kV breakers.** **b3103.2 : PJM Baseline Upgrade b3103.2. Rebuild the Bosman/Strawboard station in the clear across the road to move it out of the flood plain and bring it up to 69kV standards.** **b3103.3 : PJM Baseline Upgrade b3103.3. Retire 138 kV breaker L at Delaware station and re-purpose 138 kV breaker M for the Jay line.** **b3103.4 : PJM Baseline Upgrade b3103.4. Retire all 34.5 kV equipment at Hartford City station. Re-purpose breaker M for the Bosman line 69 kV exit.** **b3103.5 : PJM Baseline Upgrade b3103.5. Rebuild the 138 kV portion of Jay station as a 6 breaker, breaker and a**	TBD

ID	Index	Facility	Upgrade Description	Cost
6941659	6	AE2-219 TAP 138.0 kV - 05BLUFFP 138.0 kV Ckt 1	half station re-using the existing breakers "A", "B" and "G". Rebuild the 69 kV portion of this station as a 6 breaker ring bus re-using the 2 existing 69 kV breakers. Install a new 138/69kV transformer. **b3103.6** : PJM Baseline Upgrade b3103.6. Rebuild the 69 kV Hartford City – Armstrong Cork line but instead of terminating it into Armstrong Cork, terminate it into Jay station. **b3103.7** : PJM Baseline Upgrade b3103.7. Build a new 69 kV line from Armstrong Cork – Jay station. **b3103.8** : PJM Baseline Upgrade b3103.8. Rebuild the 34.5 kV Delaware – Bosman line as the 69 kV Royerton – Strawboard line. Retire the line section from Royerton to Delaware stations. B3103 Raises limit to 284 MVA. The baseline projects have a projected in-service date of 06/01/2022. **Project Type** : CON **Cost** : $0 **Time Estimate** : N/A **AEP** (sXXXX): Jay - College Corner Rebuild raises limit to 359 MVA (waiting for a Supplemental ID# for this project). Note: This queue project may have a cost responsibility for upgrading the overloaded element if the supplemental project is not approved. Further information will be provided during the Impact Study Phase. **Project Type** : FAC **Cost** : TBD **Time Estimate** : TBD An AEP supplemental project will rebuild the College Corner- Jay 138kV line with the current projected ISD is 12/1/2023. PJM has assigned this project number S2014. A summary of this project is available at https://www.pjm.com/-/media/committees-groups/committees/srrtep-w/20190520/20190520-reliability-analysis-update.ashx. Determination of allocation of cost for the scope of S2014 to AE2-090 (if any) or other queue positions will occur during the System Impact Study.	
2172635	8	06DEARB1 345.0 kV - 06PIERCE 345.0 kV Ckt 1	**OVEC** **OVEC_CPI_r0003 (913)** : Perform a sag study. OVECs cost estimate for performing the sag study is $125K. **Project Type** : FAC **Cost** : $125,000 **Time Estimate** : 6-12 Months	$125,000
2172180	4	08HUSTRC 138.0 kV - 08TRENTO 138.0 kV Ckt 1	**DEO&K** No violation. Post queue loading less than 100%.	$0
			TOTAL COST	**$24,289,461 + TBD**

18 Flow Gate Details

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.

18.1 Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
1423961	243253	05BLUFFP	AEP	243319	05JAY	AEP	1	AEP_P4_#6924_05COLLCO 138_C	breaker	284.0	68.48	104.66	DC	102.75

Bus #	Bus	MW Impact
247536	S-071 C	2.27
247621	Y3-024	0.2
247929	S-071 E	74.6
936681	AD2-087 C O1	25.12
936682	AD2-087 E O1	117.6
940991	AE2-090 C	61.65
940992	AE2-090 E	41.1
942071	AE2-219 C	31.07
942072	AE2-219 E	42.9
CALDERWOOD	CALDERWOOD	0.0
CARR	CARR	0.01
CATAWBA	CATAWBA	0.0
CHEOAH	CHEOAH	0.0
CHILHOWEE	CHILHOWEE	0.0
COFFEEN	COFFEEN	0.0
COTTONWOOD	COTTONWOOD	0.01
DUCKCREEK	DUCKCREEK	0.01
EDWARDS	EDWARDS	0.01
FARMERCITY	FARMERCITY	0.0
G-007	G-007	0.02
GIBSON	GIBSON	0.0
HAMLET	HAMLET	0.01
LGEE	LGEE	0.01
NEWTON	NEWTON	0.01
O-066	O-066	0.11
PRAIRIE	PRAIRIE	0.02
RENSSELAER	RENSSELAER	0.0
SANTEETLA	SANTEETLA	0.0
SMITHLAND	SMITHLAND	0.0
TATANKA	TATANKA	0.01
TILTON	TILTON	0.01
TVA	TVA	0.01
UNIONPOWER	UNIONPOWER	0.0

18.2 Index 2

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
1424018	243310	05HODGIN	AEP	243262	05COLLCO	AEP	1	AEP_P4_#10527_05BLUFFP 138_E2	breaker	284.0	67.02	99.34	DC	91.8

Bus #	Bus	MW Impact
243415	05WWVSTA	2.71
247288	05RICHG1	0.68
247289	05RICHG2	0.68
247536	S-071 C	1.78
247929	S-071 E	58.32
936681	AD2-087 C O1	21.38
936682	AD2-087 E O1	100.11
940991	AE2-090 C	55.08
940992	AE2-090 E	36.72
942071	AE2-219 C	25.51
942072	AE2-219 E	35.23
CARR	CARR	0.02
CATAWBA	CATAWBA	0.01
CBM-S1	CBM-S1	0.11
CBM-W1	CBM-W1	0.56
CBM-W2	CBM-W2	2.38
CIN	CIN	0.52
G-007	G-007	0.05
HAMLET	HAMLET	0.01
IPL	IPL	0.39
LGEE	LGEE	0.02
MEC	MEC	0.52
MECS	MECS	0.22
O-066	O-066	0.31
RENSSELAER	RENSSELAER	0.01
WEC	WEC	0.08

18.3 Index 3

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
2172172	250001	08COLINV	DEO&K	250144	08HUSTRC	DEO&K	1	AEP_P4_#10527_05BLUFFP 138_E2	breaker	178.0	80.28	97.27	DC	30.24

Bus #	Bus	MW Impact
243415	05WWVSTA	2.13
247288	05RICHG1	0.7
247289	05RICHG2	0.7
247536	S-071 C	0.6
247929	S-071 E	19.7
932841	AC2-111 C O1	7.51
932842	AC2-111 E O1	12.26
934961	AD1-128 C O1	6.2
934962	AD1-128 E O1	10.12
936681	AD2-087 C O1	7.22
936682	AD2-087 E O1	33.81
938061	AE1-008 C	1.88
938062	AE1-008 E	3.07
939781	AE1-209 C O1	1.41
939782	AE1-209 E O1	9.47
940991	AE2-090 C	18.14
940992	AE2-090 E	12.1
942071	AE2-219 C	8.62
942072	AE2-219 E	11.9
BLUEG	BLUEG	0.11
CALDERWOOD	CALDERWOOD	0.0
CARR	CARR	0.03
CATAWBA	CATAWBA	0.02
CBM-S1	CBM-S1	0.17
CBM-W1	CBM-W1	1.99
CBM-W2	CBM-W2	6.44
CHEOAH	CHEOAH	0.0
CHILHOWEE	CHILHOWEE	0.0
CIN	CIN	1.28
G-007	G-007	0.07
HAMLET	HAMLET	0.03
IPL	IPL	1.07
MEC	MEC	1.64
MECS	MECS	1.02
O-066	O-066	0.48
RENSSELAER	RENSSELAER	0.02
SANTEETLA	SANTEETLA	0.0
TRIMBLE	TRIMBLE	0.03
WEC	WEC	0.28

18.4 Index 4

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
2172180	250144	08HUSTRC	DEO&K	250116	08TRENTO	DEO&K	1	AEP_P4_#10527_05BLUFFP 138_E2	breaker	178.0	79.21	96.2	DC	30.24

Bus #	Bus	MW Impact
243415	05WWVSTA	2.13
247288	05RICHG1	0.7
247289	05RICHG2	0.7
247536	S-071 C	0.6
247929	S-071 E	19.7
932841	AC2-111 C O1	7.51
932842	AC2-111 E O1	12.26
934961	AD1-128 C O1	6.2
934962	AD1-128 E O1	10.12
936681	AD2-087 C O1	7.22
936682	AD2-087 E O1	33.81
938061	AE1-008 C	1.88
938062	AE1-008 E	3.07
939781	AE1-209 C O1	1.41
939782	AE1-209 E O1	9.47
940991	AE2-090 C	18.14
940992	AE2-090 E	12.1
942071	AE2-219 C	8.62
942072	AE2-219 E	11.9
BLUEG	BLUEG	0.11
CALDERWOOD	CALDERWOOD	0.0
CARR	CARR	0.03
CATAWBA	CATAWBA	0.02
CBM-S1	CBM-S1	0.17
CBM-W1	CBM-W1	1.99
CBM-W2	CBM-W2	6.44
CHEOAH	CHEOAH	0.0
CHILHOWEE	CHILHOWEE	0.0
CIN	CIN	1.28
G-007	G-007	0.07
HAMLET	HAMLET	0.03
IPL	IPL	1.07
MEC	MEC	1.64
MECS	MECS	1.02
O-066	O-066	0.48
RENSSELAER	RENSSELAER	0.02
SANTEETLA	SANTEETLA	0.0
TRIMBLE	TRIMBLE	0.03
WEC	WEC	0.28

18.5 Index 5

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
1423732	940990	AE2-090 TAP	AEP	243310	05HODGIN	AEP	1	AEP_P4_#10527_05BLUFFP 138_E2	breaker	284.0	78.58	119.41	DC	115.98

Bus #	Bus	MW Impact
247536	S-071 C	2.24
247929	S-071 E	73.59
936681	AD2-087 C O1	26.98
936682	AD2-087 E O1	126.33
940991	AE2-090 C	69.59
940992	AE2-090 E	46.39
942071	AE2-219 C	32.2
942072	AE2-219 E	44.46
BLUEG	BLUEG	0.18
CALDERWOOD	CALDERWOOD	0.01
CANNELTON	CANNELTON	0.0
CARR	CARR	0.01
CATAWBA	CATAWBA	0.01
CBM-W1	CBM-W1	0.28
CBM-W2	CBM-W2	0.52
CHEOAH	CHEOAH	0.01
CHILHOWEE	CHILHOWEE	0.0
CIN	CIN	0.11
ELMERSMITH	ELMERSMITH	0.0
G-007	G-007	0.02
HAMLET	HAMLET	0.01
IPL	IPL	0.08
MEC	MEC	0.21
MECS	MECS	0.16
O-066	O-066	0.11
RENSSELAER	RENSSELAER	0.0
SANTEETLA	SANTEETLA	0.0
TRIMBLE	TRIMBLE	0.02
TVA	TVA	0.0
WEC	WEC	0.04

18.6 Index 6

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
6941659	942070	AE2-219 TAP	AEP	243253	05BLUFFP	AEP	1	AEP_P4_#6924_05COLLCO 138_C	breaker	284.0	53.63	95.48	DC	118.87

Bus #	Bus	MW Impact
936681	AD2-087 C O1	29.06
936682	AD2-087 E O1	136.04
940991	AE2-090 C	71.32
940992	AE2-090 E	47.55
942071	AE2-219 C	35.94
942072	AE2-219 E	49.63
CARR	CARR	0.0
CBM-S1	CBM-S1	0.12
CBM-S2	CBM-S2	0.03
CBM-W2	CBM-W2	0.59
CIN	CIN	0.13
CPLE	CPLE	0.01
DUCKCREEK	DUCKCREEK	0.02
EDWARDS	EDWARDS	0.01
FARMERCITY	FARMERCITY	0.0
G-007	G-007	0.0
IPL	IPL	0.11
LGEE	LGEE	0.06
O-066	O-066	0.01
RENSSELAER	RENSSELAER	0.0
TATANKA	TATANKA	0.01

18.7 Index 7

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
1423542	243262	05COLLCO	AEP	250001	08COLINV	DEO&K	1	AEP_P4_#10527_05BLUFFP 138_E2	breaker	167.0	120.6	138.7	DC	30.24

Bus #	Bus	MW Impact
243415	05WWVSTA	2.13
247288	05RICHG1	0.7
247289	05RICHG2	0.7
247536	S-071 C	0.6
247929	S-071 E	19.7
932841	AC2-111 C O1	7.51
932842	AC2-111 E O1	12.26
934961	AD1-128 C O1	6.2
934962	AD1-128 E O1	10.12
936681	AD2-087 C O1	7.22
936682	AD2-087 E O1	33.81
938061	AE1-008 C	1.88
938062	AE1-008 E	3.07
939781	AE1-209 C O1	1.41
939782	AE1-209 E O1	9.47
940991	AE2-090 C	18.14
940992	AE2-090 E	12.1
942071	AE2-219 C	8.62
942072	AE2-219 E	11.9
BLUEG	BLUEG	0.11
CALDERWOOD	CALDERWOOD	0.0
CARR	CARR	0.03
CATAWBA	CATAWBA	0.02
CBM-S1	CBM-S1	0.17
CBM-W1	CBM-W1	1.99
CBM-W2	CBM-W2	6.44
CHEOAH	CHEOAH	0.0
CHILHOWEE	CHILHOWEE	0.0
CIN	CIN	1.28
G-007	G-007	0.07
HAMLET	HAMLET	0.03
IPL	IPL	1.07
MEC	MEC	1.64
MECS	MECS	1.02
O-066	O-066	0.48
RENSSELAER	RENSSELAER	0.02
SANTEETLA	SANTEETLA	0.0
TRIMBLE	TRIMBLE	0.03
WEC	WEC	0.28

18.8 Index 8

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
2172635	248001	06DEARB1	OVEC	248013	06PIERCE	OVEC	1	.345.DEO&K-AEP.C5 4504MFTANNERS4512EBTANNERS	tower	972.0	106.81	107.41	DC	12.96

Bus #	Bus	MW Impact
243795	05HDWTR1G C	0.49
247264	05LAWG1A	6.07
247265	05LAWG1B	6.07
247266	05LAWG1S	9.7
247267	05LAWG2A	6.07
247268	05LAWG2B	6.07
247269	05LAWG2S	9.7
247543	V3-007 C	0.49
247914	05WLD G1 E	8.0
247929	S-071 E	8.56
247935	V3-007 E	26.83
247958	05WLD G2 E	8.4
247963	05HDWTR1G E	9.66
247968	Z2-115 E	0.16
915662	Y3-099 E	0.2
915672	Y3-100 E	0.2
916182	Z1-065 E	0.38
920501	AA2-148 C O1	3.54
920502	AA2-148 E O1	23.67
923881	AB2-028 C	2.91
923882	AB2-028 E	19.46
925242	AB2-178 E	1.98
926691	AC1-152	15.72
926851	AC1-172	15.72
926881	AC1-175 C	11.72
926882	AC1-175 E	19.12
932681	AC2-090 C	5.86
932682	AC2-090 E	9.56
932841	AC2-111 C O1	2.77
932842	AC2-111 E O1	4.52
933591	AC2-176 C O1	1.52
933592	AC2-176 E O1	10.14
933601	AC2-177 C O1	4.01
933602	AC2-177 E O1	26.83
934161	AD1-043 C O1	4.47
934162	AD1-043 E O1	7.29
934961	AD1-128 C O1	5.62
934962	AD1-128 E O1	9.17
936561	AD2-071 C	5.94
936562	AD2-071 E	2.92
936681	AD2-087 C O1	3.17

Bus #	Bus	MW Impact
936682	AD2-087 E O1	14.83
938061	AE1-008 C	0.69
938062	AE1-008 E	1.13
939761	AE1-207 C	5.95
939762	AE1-207 E	8.22
939771	AE1-208 C	5.24
939772	AE1-208 E	7.14
939781	AE1-209 C O1	1.28
939782	AE1-209 E O1	8.58
939791	AE1-210 C O1	1.61
939792	AE1-210 E O1	10.76
939811	AE1-217 C O1	7.95
939812	AE1-217 E O1	10.98
940981	AE2-089 C O1	7.24
940982	AE2-089 E O1	4.83
940991	AE2-090 C	7.78
940992	AE2-090 E	5.19
941691	AE2-169	3.15
941701	AE2-170	4.74
941711	AE2-171	2.95
941721	AE2-172	3.55
942071	AE2-219 C	3.77
942072	AE2-219 E	5.2
942081	AE2-220 C	8.1
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	13.9
942792	AE2-297 E O1	9.26
950161	J401	1.31
CARR	CARR	0.32
CATAWBA	CATAWBA	0.09
CBM-S1	CBM-S1	4.29
CBM-W1	CBM-W1	17.07
CBM-W2	CBM-W2	71.97
CIN	CIN	13.65
G-007	G-007	0.94
HAMLET	HAMLET	0.19
IPL	IPL	12.55
LGEE	LGEE	1.08
MEC	MEC	15.37
MECS	MECS	7.23
O-066	O-066	6.01
RENSSELAER	RENSSELAER	0.25
WEC	WEC	2.43
Z1-043	Z1-043	9.75

18.9 Index 9

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
1425035	940980	AE2-089 TAP	AEP	243237	05ADAM	AEP	1	AEP_P7-1_#11019	tower	205.0	103.57	106.04	DC	11.22

Bus #	Bus	MW Impact
247536	S-071 C	0.33
247929	S-071 E	10.76
933591	AC2-176 C O1	2.64
933592	AC2-176 E O1	17.7
936681	AD2-087 C O1	3.11
936682	AD2-087 E O1	14.58
940981	AE2-089 C O1	37.91
940982	AE2-089 E O1	25.27
940991	AE2-090 C	6.73
940992	AE2-090 E	4.49
942071	AE2-219 C	4.12
942072	AE2-219 E	5.7
CARR	CARR	0.01
CBM-S1	CBM-S1	1.3
CBM-S2	CBM-S2	0.31
CBM-W2	CBM-W2	8.49
CIN	CIN	2.11
CPLE	CPLE	0.1
DUCKCREEK	DUCKCREEK	0.2
EDWARDS	EDWARDS	0.12
FARMERCITY	FARMERCITY	0.0
G-007	G-007	0.01
IPL	IPL	1.88
LGEE	LGEE	0.55
O-066	O-066	0.05
RENSSELAER	RENSSELAER	0.01
TATANKA	TATANKA	0.08

Affected Systems

19 Affected Systems

19.1 LG&E

LG&E Impacts to be determined during later study phases (as applicable).

19.2 MISO

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

19.3 TVA

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

19.4 Duke Energy Progress

Duke Energy Progress Impacts to be determined during later study phases (as applicable).

19.5 NYISO

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

20 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P1-2_#6372A	CONTINGENCY 'AEP_P1-2_#6372A' OPEN BRANCH FROM BUS 243262 TO BUS 250106 CKT 1 / 243262 05COLLCO 138 250106 08TODHJT 138 1 END
AEP_P4_#10527_05BLUFFP 138_E2	CONTINGENCY 'AEP_P4_#10527_05BLUFFP 138_E2' OPEN BRANCH FROM BUS 243253 TO BUS 243319 CKT 1 / 243253 05BLUFFP 138 243319 05JAY 138 1 OPEN BRANCH FROM BUS 243253 TO BUS 246014 CKT 1 / 243253 05BLUFFP 138 246014 05BLUFFPNT 69.0 1 END
AEP_P1-2_#10526-B	CONTINGENCY 'AEP_P1-2_#10526-B' OPEN BRANCH FROM BUS 942070 TO BUS 243362 CKT 1 / 942070 AE2-219 TAP 138 243362 05RANDOL 138 1 END
AEP_P1-2_#10526-A	CONTINGENCY 'AEP_P1-2_#10526-A' OPEN BRANCH FROM BUS 243253 TO BUS 942070 CKT 1 / 243253 05BLUFFP 138 942070 AE2-219 TAP 138 1 END
AEP_P4_#6924_05COLLCO 138_C	CONTINGENCY 'AEP_P4_#6924_05COLLCO 138_C' OPEN BRANCH FROM BUS 243262 TO BUS 243310 CKT 1 / 243262 05COLLCO 138 243310 05HODGIN 138 1 OPEN BRANCH FROM BUS 243262 TO BUS 250106 CKT 1 / 243262 05COLLCO 138 250106 08TODHJT 138 1 OPEN BRANCH FROM BUS 243310 TO BUS 940990 CKT 1 / 243310 05HODGIN 138 940990 AE2-090 TAP 138 1 /* CONTINGENCY LINE ADDED FOR AE2 BUILD OPEN BRANCH FROM BUS 243310 TO BUS 243400 CKT 1 / 243310 05HODGIN 138 243400 05HODGIN 69.0 1 END
AEP_P1-2_#4817	CONTINGENCY 'AEP_P1-2_#4817' OPEN BRANCH FROM BUS 243225 TO BUS 243232 CKT 1 / 243225 05KEYSTN 345 243232 05SORENS 345 1 END
.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

Contingency Name	Contingency Definition
AEP_P1-2_#10142-A	CONTINGENCY 'AEP_P1-2_#10142-A' OPEN BRANCH FROM BUS 243262 TO BUS 243310 CKT 1 / 243262 05COLLCO 138 243310 05HODGIN 138 1 OPEN BRANCH FROM BUS 243310 TO BUS 940990 CKT 1 / 243310 05HODGIN 138 940990 AE2-090 TAP 138 1 OPEN BRANCH FROM BUS 243310 TO BUS 243400 CKT 1 / 243310 05HODGIN 138 243400 05HODGIN 69.0 1 END
AEP_P1-2_#5598	CONTINGENCY 'AEP_P1-2_#5598' OPEN BRANCH FROM BUS 243278 TO BUS 243319 CKT 1 / 243278 05DESOTO 138 243319 05JAY 138 1 END
.138.DEO&K-AEP-DAY.B2 TODHUNTER JCT 138	CONTINGENCY '.138.DEO&K-AEP-DAY.B2 TODHUNTER JCT 138' OPEN BUS 250106 END
Base Case	
AEP_P7-1_#11019	CONTINGENCY 'AEP_P7-1_#11019' OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2 OPEN BRANCH FROM BUS 243225 TO BUS 243232 CKT 1 / 243225 05KEYSTN 345 243232 05SORENS 345 1 END

Short Circuit

21 Short Circuit

The following Breakers are overduty

None