Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Positions AD2-010, AD2-011, AD2-012

Hillsboro 138 kV

August 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.

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

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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.

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General

The interconnection customer (IC) proposes to install PJM Projects #AD2-010, #AD2-011, and #AD2-012, a combined 349.0 MW (209.4 MW Capacity) solar generating facility in Highland county, Ohio (see Figure 2). The point of interconnection will be a direct connection to AEP's Hillsboro 138 kV substation (see Figure 1). The following table lists the requested generation for the various queue requests:

Queue Position	MFO	MWC
AD2-010	200.0	120.0
AD2-011	100.0	60.0
AD2-012	49.0	29.4

Table 1

The requested in service date is June 1, 2019.

Attachment Facilities

Point of Interconnection (Hillsboro 138 kV Substation)

To accommodate the interconnection at the Hillsboro 138 kV substation, the substation will have to be expanded requiring the installation of two (2) 138 kV circuit breakers, extending the two 138 kV buses, and starting a new string (see Figure 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required.

Note: Two 138 kV circuit breakers are recommended for this interconnection to allow for breaker maintenance and inspections.

Station Work:

- Expand the Hillsboro 138 kV substation, start a new string, extend the two 138 kV buses and install two (2) 138 kV circuit breakers (see Figure 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required.
    - **Estimated Station Cost: $3,250,000**

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for Non-Direct Connection work is given in the following tables below:

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For AEP building Non Direct Connection cost estimates:

Description	Estimated Cost
138 kV Revenue Metering	**$250,000**
Upgrade line protection and control settings at the Millbrook Park 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	**$25,000**
Upgrade line protection and control settings at the Highland 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	**$25,000**
Upgrade line protection and control settings at the Clinton County 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	**$25,000**
Upgrade line protection and control settings at the Wildcat 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	**$25,000**
Upgrade line protection and control settings at the O.H. Hutchings (DP&L) 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation. (this estimate will be confirmed by DP&L in the System Impact Study)	**$25,0000**
Total	**$375,000**

Table 2

Interconnection Customer Requirements

It is understood that the IC is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of the IC's generating plant and the costs for the line connecting the generating plant to the Hillsboro 138 kV substation are not included in this report; these are assumed to be the IC'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.

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Revenue Metering and SCADA Requirements

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 Sections 24.1 and 24.2.

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

Network Impacts

The Queue Project AD2-012 (AD2-010, AD2-011 & AD2-012 studied as 1 project, AD2-012) was evaluated as a 349.0 MW (Capacity 209.4 MW) injection at the Hillsboro 138 kV substation in the AEP area. Project AD2-012 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-012 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2021 Case

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
AEP_P1-2_#349	CONTINGENCY 'AEP_P1-2_#349' OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1 END
AEP_P1-2_#363	CONTINGENCY 'AEP_P1-2_#363' OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1 END
AEP_P1-2_#5891	CONTINGENCY 'AEP_P1-2_#5891' OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 END

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Contingency Name	Description
AEP_P1-2_#7353-B	CONTINGENCY 'AEP_P1-2_#7353-B' OPEN BRANCH FROM BUS 932430 TO BUS 249995 CKT 1 / 932430 AC2-061 TAP 138 249995 08CLINCO 138 1 END
AEP_P1-2_#8468	CONTINGENCY 'AEP_P1-2_#8468' OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 2 / 242528 05SPORN 345 248005 06KYGER 345 2 END
AEP_P1-3_#6190	CONTINGENCY 'AEP_P1-3_#6190' OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1 OPEN BRANCH FROM BUS 242528 TO BUS 242808 CKT 4 / 242528 05SPORN 345 242808 05SPORNS 138 4 END
AEP_P4_#7351_05HILLSB 138	CONTINGENCY 'AEP_P4_#7351_05HILLSB 138' OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 246946 CKT 1 / 243019 05HILLSB 138 246946 05WLDCAT 138 1 END
AEP_P4_#8107_05HILLSB 138	CONTINGENCY 'AEP_P4_#8107_05HILLSB 138' OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 END
AEP_P4_#8108_05HILLSB 138	CONTINGENCY 'AEP_P4_#8108_05HILLSB 138' OPEN BRANCH FROM BUS 243019 TO BUS 932430 CKT 1 / 243019 05HILLSB 138 932430 AC2-061 TAP 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 END
AEP_P4_#8109_05HILLSB 138	CONTINGENCY 'AEP_P4_#8109_05HILLSB 138' OPEN BRANCH FROM BUS 243019 TO BUS 243102 CKT 1 / 243019 05HILLSB 138 243102 05SINKG8 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 OPEN BRANCH FROM BUS 932450 TO BUS 243102 CKT 1 / 932450 AC2-064 TAP 138 243102 05SINKG8 138 1 END
AEP_P7-1_#7981_A	CONTINGENCY 'AEP_P7-1_#7981_A' OPEN BRANCH FROM BUS 243019 TO BUS 932430 CKT 1 / 243019 05HILLSB 138 932430 AC2-061 TAP 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 END

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Contingency Name	Description
AEP_P7-1_#7981_B	CONTINGENCY 'AEP_P7-1_#7981_B' OPEN BRANCH FROM BUS 932430 TO BUS 249995 CKT 1 / 932430 AC2-061 TAP 138 249995 08CLINCO 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 END
AEP_P7-1_#8123	CONTINGENCY 'AEP_P7-1_#8123' OPEN BRANCH FROM BUS 243453 TO BUS 253110 CKT 1 / 243453 05BEATTY 345 253110 09ADKINS 345 1 OPEN BRANCH FROM BUS 243453 TO BUS 253248 CKT 1 / 243453 05BEATTY 345 253248 09SCHARL 345 1 OPEN BRANCH FROM BUS 243453 TO BUS 243469 CKT 3 / 243453 05BEATTY 345 243469 05BEATTY 138 3 END
DAY_P1_5891_B2_TOR607	CONTINGENCY 'DAY_P1_5891_B2_TOR607' OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111 09MIDDLE 138 253057 09OHH 138 1 END
DAY_P4_8107_C2_05HILLSB 138-C_B	CONTINGENCY 'DAY_P4_8107_C2_05HILLSB 138-C_B' OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111 09MIDDLE 138 253057 09OHH 138 1 END
DEO&K P1-* P2-1 WARREN-CLINTONCO-HILLSBORO 2381	CONTINGENCY 'DEO&K P1-* P2-1 WARREN-CLINTONCO-HILLSBORO 2381' OPEN BUS 249995 END

Table 3

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)

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AD2-012 (AD2-010, AD2-011 & AD2-012 studied as 1 project, AD2-012) Multiple Facility Contingency															
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	DCTL	AEP_P7-1_#7981_B	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	56.18	122.21	ER	185	122.2	1
2	LFFB	DAY_P4_8107_C2_05HILLSB 138-C_B	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	50.91	117.97	ER	185	124.1	
3	LFFB	AEP_P4_#8107_05HILLSB 138	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	50.85	117.92	ER	185	124.1	
4	DCTL	AEP_P7-1_#7981_A	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	34.05	100.07	ER	185	122.2	
5	LFFB	AEP_P4_#7351_05HILLSB 138	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	63.37	110.93	ER	185	87.98	2
6	LFFB	AEP_P4_#8107_05HILLSB 138	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	932430	1	DC	89.37	158.81	ER	184	127.8	3
7	LFFB	DAY_P4_8107_C2_05HILLSB 138-C_B	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	932430	1	DC	89.32	158.76	ER	184	127.8	
8	LFFB	AEP_P4_#8109_05HILLSB 138	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	932430	1	DC	67.33	135.33	ER	184	125.1	
9	DCTL	AEP_P7-1_#7981_B	AEP - AEP	05SINKG8-AC2-064 TAP 138 kV line	243102	932450	1	DC	57.82	128.43	ER	173	122.2	4
10	LFFB	DAY_P4_8107_C2_05HILLSB 138-C_B	AEP - AEP	05SINKG8-AC2-064 TAP 138 kV line	243102	932450	1	DC	52.18	123.9	ER	173	124.1	
11	LFFB	AEP_P4_#8107_05HILLSB 138	AEP - AEP	05SINKG8-AC2-064 TAP 138 kV line	243102	932450	1	DC	52.13	123.85	ER	173	124.1	
12	DCTL	AEP_P7-1_#7981_A	AEP - AEP	05SINKG8-AC2-064 TAP 138 kV line	243102	932450	1	DC	34.15	104.76	ER	173	122.2	
13	DCTL	AEP_P7-1_#7981_B	AEP - DAY	05HIGHLA-09MRTNSV 69 kV line	243606	253043	1	DC	83.62	103.14	ER	68	29.46	5
14	LFFB	AEP_P4_#8108_05HILLSB 138	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	89.45	132.6	ER	122	52.65	
15	DCTL	AEP_P7-1_#7981_A	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	89.45	132.6	ER	122	52.65	
16	DCTL	AEP_P7-1_#7981_B	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	74.65	127.44	ER	185	97.66	6
17	LFFB	DAY_P4_8107_C2_05HILLSB 138-C_B	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	62.95	115.46	ER	185	97.15	
18	LFFB	AEP_P4_#8107_05HILLSB 138	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	62.95	115.46	ER	185	97.15	
19	DCTL	AEP_P7-1_#7981_A	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	56.95	109.74	ER	185	97.66	
20	DCTL	AEP_P7-1_#7981_B	AEP - LGEE	05EMERSS-4KENTON 138 kV line	247034	324267	1	DC	73.35	126.14	ER	185	97.66	7
21	LFFB	DAY_P4_8107_C2_05HILLSB 138-C_B	AEP - LGEE	05EMERSS-4KENTON 138 kV line	247034	324267	1	DC	61.7	114.22	ER	185	97.15	
22	LFFB	AEP_P4_#8107_05HILLSB 138	AEP - LGEE	05EMERSS-4KENTON 138 kV line	247034	324267	1	DC	61.7	114.22	ER	185	97.15	

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AD2-012 (AD2-010, AD2-011 & AD2-012 studied as 1 project, AD2-012) Multiple Facility Contingency														
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
23	DCTL	AEP_P7-1_#7981_A	AEP - LGEE	05EMERSS-4KENTON 138 kV line	247034	324267	1	DC	55.65	108.44	ER	185	97.66	
24	LFFB	AEP_P4_#8107_05HILLSB 138	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	95.19	159.72	ER	198	127.8	8
25	LFFB	DAY_P4_8107_C2_05HILLS B 138-C_B	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	95.14	159.67	ER	198	127.8	
26	LFFB	AEP_P4_#8109_05HILLSB 138	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	74.29	137.48	ER	198	125.1	
27	DCTL	AEP_P7-1_#8123	DAY - AEP	09KILLEN-05MARQUI 345 kV line	253038	242938	1	DC	99.72	100.44	ER	1372	22.02	9
28	LFFB	AEP_P4_#7351_05HILLSB 138	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	61.1	108.66	ER	185	87.98	10
29	LFFB	AEP_P4_#8109_05HILLSB 138	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	932430	249995	1	DC	93.72	161.72	ER	184	125.1	
30	LFFB	DAY_P4_8107_C2_05HILLS B 138-C_B	AEP - AEP	AC2-064 TAP-05MILLBR 138 kV line	932450	243042	1	DC	97.28	169	ER	173	124.1	
31	LFFB	AEP_P4_#8107_05HILLSB 138	AEP - AEP	AC2-064 TAP-05MILLBR 138 kV line	932450	243042	1	DC	97.28	169	ER	173	124.1	
32	DCTL	AEP_P7-1_#7981_A	AEP - AEP	AC2-064 TAP-05MILLBR 138 kV line	932450	243042	1	DC	79.31	149.91	ER	173	122.2	

Table 4

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)

AD2-012 (AD2-010, AD2-011 & AD2-012 studied as 1 project, AD2-012) Contribution to Previously Identified Overloads														
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	DCTL	AEP_P7-1_#7981_B	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	103.92	147.07	ER	122	52.65	11
2	N-1	AEP_P1-2_#349	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	113.45	114.21	NR	971	18.19	12
3	N-1	AEP_P1-3_#6190	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	112.73	113.49	NR	971	18.34	
4	LFFB	AEP_P4_#8107_05HILLSB 138	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	932430	249995	1	DC	116.18	185.62	ER	184	127.8	13

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AD2-012 (AD2-010, AD2-011 & AD2-012 studied as 1 project, AD2-012) Contribution to Previously Identified Overloads															
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
5	LFFB	DAY_P4_8107_C2_05HILLS B 138-C_B	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	932430	249995	1	DC	116.18	185.62	ER	184	127.8	
6	DCTL	AEP_P7-1_#7981_B	AEP - AEP	AC2-064 TAP-05MILLBR 138 kV line	932450	243042	1	DC	102.98	173.59	ER	173	122.2	14

Table 5

Steady-State Voltage Requirements

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Affected System Analysis & Mitigation

LGEE Impacts:

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

MISO Impacts:

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

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

OVEC 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.

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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.

AD2-012 (AD2-010, AD2-011 & AD2-012 studied as 1 project, AD2-012) Delivery of Energy Portion of Interconnection Request													
	Contingency		Affected	Facility	Bus				Loading		Rating		MW
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.
1	N-1	AEP_P1-2_#7353-B	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	71.92	108.95	ER	185	68.5
2	N-1	AEP_P1-2_#5891	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	932430	1	DC	76.08	126.81	ER	184	93.33
3	Non	Non	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	932430	1	DC	69.71	119.25	NR	159	78.77
4	N-1	AEP_P1-2_#7353-B	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	84.14	118.34	ER	122	41.73
5	N-1	AEP_P1-2_#363	OVEC - AEP	06CLIFTY-05JEFRSO 345 kV line	248000	242865	Z1	DC	105.17	105.79	NR	1756	25.97
6	N-1	AEP_P1-2_#8468	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	1	DC	99.29	100.15	NR	1294	30.31
7	N-1	AEP_P1-2_#349	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	132.31	133.46	NR	971	30.31
8	N-1	DAY_P1_5891_B2_TOR607	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	76.97	124.11	ER	198	93.33
9	N-1	AEP_P1-2_#7353-B	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	69.65	106.68	ER	185	68.5
10	N-1	AEP_P1-2_#5891	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	932430	249995	1	DC	97.24	147.96	ER	184	93.33
11	Non	Non	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	932430	249995	1	DC	91.41	140.95	NR	159	78.77
12	N-1	DEO&K P1-* P2-1 WARREN-CLINTONCO-HILLSBORO 2381	AEP - AEP	AC2-064 TAP-05MILLBR 138 kV line	932450	243042	1	DC	75.77	132.87	ER	173	98.77
13	Non	Non	AEP - AEP	AC2-064 TAP-05MILLBR 138 kV line	932450	243042	1	DC	56.83	101.53	NR	173	77.32

Table 6

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New System Reinforcements

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

AD2-012 (AD2-010, AD2-011 & AD2-012 studied as 1 project, AD2-012) Multiple Facility Contingency						
#	Contingency Type	Contingency Name	Affected Area	Facility Description	Mitigation	Est. Cost
1	DCTL	AEP_P7-1_#7981_B	AEP - AEP	05HILLSB-05SINKG8 138 kV line	A Sag Study will be required on the 4.36 mile section of line to mitigate the overload. Depending on the sag study results, cost for this upgrade is expected to be between $17,440 (no remediation required just sag study) and $6.54 million (complete line reconductor/rebuild required)" Sag Study: 6 to 12 months. 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.	$17,440
2	LFFB	DAY_P4_8107_C2_05HILLSB 138-C_B	AEP - AEP	05HILLSB-05SINKG8 138 kV line	Same as #1	
3	LFFB	AEP_P4_#8107_05HILLSB 138	AEP - AEP	05HILLSB-05SINKG8 138 kV line	Same as #1	
4	DCTL	AEP_P7-1_#7981_A	AEP - AEP	05HILLSB-05SINKG8 138 kV line	Same as #1	
5	LFFB	AEP_P4_#7351_05HILLSB 138	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	AEP: A Sag Study will be required on the 22.3 mile section of line to mitigate the overload . Depending on the sag study results, cost for this upgrade is expected to be between $89,200 (no remediation required just sag study) and $33.45 million (complete line reconductor/rebuild required) Sag Study: 6 to 12 months. 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. DAYTON: AEP owns the transmission line conductor that is associated with the overloads on the Middleboro-Hillsboro 138kV section of the line. This is not an overload on DAYTON's side.	$89,200
6	LFFB	AEP_P4_#8107_05HILLSB 138	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	AEP: A Sag Study will be required on the 5 mile section of line to mitigate the overload . Depending on the sag study results, cost for this upgrade is expected to be between $20,000 (no remediation required just sag study) and $7.5 million (complete line reconductor/rebuild required) Sag Study: 6 to 12 months. 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. DEOK: DEOK does not own this section of the line.	$20,000
7	LFFB	DAY_P4_8107_C2_05HILLSB 138-C_B	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	Same as #6	
8	LFFB	AEP_P4_#8109_05HILLSB 138	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	Same as #6	
9	DCTL	AEP_P7-1_#7981_B	AEP - AEP	05SINKG8-AC2-064 TAP 138 kV line	AEP: An engineering study will need to be conducted to determine if the CT Thermal limits settings can be adjusted to mitigate the overload,	$65,000

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AD2-012 (AD2-010, AD2-011 & AD2-012 studied as 1 project, AD2-012) Multiple Facility Contingency						
#	Contingency Type	Contingency Name	Affected Area	Facility Description	Mitigation	Est. Cost
					Estimated Cost: $25,000. New relay packages will be required if the settings cannot be adjusted, Estimated Cost: $600,000 A Sag Study will be required on the 8 mile section of line to mitigate the overload . Depending on the sag study results, cost for this upgrade is expected to be between $40,000 (no remediation required just sag study) and $12.0 million (complete line reconductor/rebuild required)" Sag Study: 6 to 12 months. 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.	
10	LFFB	DAY_P4_8107_C2_ 05HILLSB 138-C_B	AEP - AEP	05SINKG8-AC2-064 TAP 138 kV line	Same as #9	
11	LFFB	AEP_P4_#8107_05H ILLSB 138	AEP - AEP	05SINKG8-AC2-064 TAP 138 kV line	Same as #9	
12	DCTL	AEP_P7-1_#7981_A	AEP - AEP	05SINKG8-AC2-064 TAP 138 kV line	Same as #9	
13	DCTL	AEP_P7-1_#7981_B	AEP - DAY	05HIGHLA-09MRTNSV 69 kV line	AEP: No mitigation is required on AEP's end. DAYTON: The overload on the Highland-Martinsville line is the result of a limit on the AEP end. Dayton end is sufficient.	
14	LFFB	AEP_P4_#8108_05H ILLSB 138	AEP - AEP	05HIGHLA 138/69 kV transformer	AEP: Replace 138kV-69kV transformer, estimated cost $1.5 million. An approximate construction time would be 12 months after signing an interconnection agreement	$1,500,000
15	DCTL	AEP_P7-1_#7981_A	AEP - AEP	05HIGHLA 138/69 kV transformer	Same as #14	
16	DCTL	AEP_P7-1_#7981_B	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	AEP: A Sag Study will be required on the 1.3 mile section of line to mitigate the overload. Depending on the sag study results, cost for this upgrade is expected to be between $5,200 (no remediation required just sag study) and $1.95 million (complete line reconductor/rebuild required). Sag Study: 6 to 12 months. 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.	$5,200
17	LFFB	DAY_P4_8107_C2_ 05HILLSB 138-C_B	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	Same as #16	
18	LFFB	AEP_P4_#8107_05H ILLSB 138	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	Same as #16	
19	DCTL	AEP_P7-1_#7981_A	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	Same as #16	
20	DCTL	AEP_P7-1_#7981_B	AEP - LGEE	05EMERSS-4KENTON 138 kV line	AEP: 18 miles of conductor will need rebuilt/reconductored, estimated cost $27 million An approximate construction time would be 24 to 36 months after signing an interconnection agreement. LG&E: The external (i.e. Non-PJM) Transmission Owner, LG&E, will not evaluate this violation until the impact study phase.	$27,000,000

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AD2-012 (AD2-010, AD2-011 & AD2-012 studied as 1 project, AD2-012) Multiple Facility Contingency						
#	Contingency Type	Contingency Name	Affected Area	Facility Description	Mitigation	Est. Cost
21	LFFB	DAY_P4_8107_C2_05HILLSB 138-C_B	AEP - LGEE	05EMERSS-4KENTON 138 kV line	Same as #20	
22	LFFB	AEP_P4_#8107_05HILLSB 138	AEP - LGEE	05EMERSS-4KENTON 138 kV line	Same as #20	
23	DCTL	AEP_P7-1_#7981_A	AEP - LGEE	05EMERSS-4KENTON 138 kV line	Same as #20	
24	LFFB	AEP_P4_#8107_05HILLSB 138	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	DEOK: DEOK will rebuild the 17 mile long line between Clinton County and Warren substations with 954ACSR and light duty steel poles. Cost estimate is $34MM. The project can be completed two years from the signing of the ISA. The new expected ratings are A/B/C = 301/301/301MVA.	$34,000,000
25	LFFB	DAY_P4_8107_C2_05HILLSB 138-C_B	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	Same as #24	
26	LFFB	AEP_P4_#8109_05HILLSB 138	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	Same as #24	
27	DCTL	AEP_P7-1_#8123	DAY - AEP	09KILLEN-05MARQUI 345 kV line	AEP: No mitigation required. DAYTON: Dayton will upgrade to a 3000A wavetrap at Killen Substation on the Killen-Marquis line. Cost: $100k. Estimated time required to construct the upgrade: 6 months.	$100,000
28	LFFB	AEP_P4_#7351_05HILLSB 138	DAY - DAY	09MIDDLE-09OHH 138 kV line	DAYTON: No mitigation required from DAYTON's side. AEP owns the transmission line conductor that is associated with the overloads on the Middleboro-Hillsboro 138kV section of the line. This will be addressed during the System Impact Study.	
29	LFFB	AEP_P4_#8109_05HILLSB 138	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	AEP: A Sag Study will be required on the 12 mile section of line to mitigate the overload. Depending on the sag study results, cost for this upgrade is expected to be between $48,000 (no remediation required just sag study) and $18 million (complete line reconductor/rebuild required) Sag Study: 6 to 12 months. 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. DEOK: DEOK owns the first 2.8 miles of the line outside Clinton County substation with the remainder being owned by AEP. The limit is on the AEP side. No mitigations required on DEOK's side.	$48,000
30	LFFB	DAY_P4_8107_C2_05HILLSB 138-C_B	AEP - AEP	AC2-064 TAP-05MILLBR 138 kV line	AEP: An engineering study will need to be conducted to determine if the CT Thermal limits settings can be adjusted to mitigate the overload, Estimated Cost: $25,000. New relay packages will be required if the settings cannot be adjusted, Estimated Cost: $600,000. A Sag Study will be required on the 8 mile section of line to mitigate the overload. Depending on the sag study results, cost for this upgrade is expected to be between $40,000 (no remediation required just sag study) and $12.0 million (complete line reconductor/rebuild required) Replace Millbrook Line riser, estimated cost: $100,000.	$165,000

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AD2-012 (AD2-010, AD2-011 & AD2-012 studied as 1 project, AD2-012) Multiple Facility Contingency						
#	Contingency Type	Name	Affected Area	Facility Description	Mitigation	Est. Cost
					Sag Study: 6 to 12 months. 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.	
31	LFFB	AEP_P4_#8107_05H ILLSB 138	AEP - AEP	AC2-064 TAP-05MILLBR 138 kV line	Same as #30	
32	DCTL	AEP_P7-1_#7981_A	AEP - AEP	AC2-064 TAP-05MILLBR 138 kV line	Same as #30	
					Total Estimated Cost	**$63,009,840**

Table 7

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)

See Multiple Contingency #30

The System Reinforcements listed below are not part of the Bulk Electric System (BES), but was identified by AEP and will be required for the interconnection of AD2-010, AD2-011, and AD2-012

See Multiple Contingency #14

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 be between 24 to 36 months after signing an interconnection agreement.

Note: The time provided between anticipated normal completion of System Impact, Facilities Studies, subsequent execution of ISA and ICSA documents, and the proposed Backfeed Date is shorter than usual and may be difficult to achieve.

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Conclusion

Based upon the results of this Feasibility Study, the construction of the 349.0 MW (209.4 MW Capacity) solar generating facility of the IC (PJM Project #AD2-010, AD2-011, AD2-012) will require the following additional interconnection charges. This plan of service will interconnect the proposed solar generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the IC generating facility.

Cost Breakdown for Point of Interconnection (Hillsboro 138 kV Substation)		
Attachment Cost	Expand the Hillsboro 138 kV Substation	$3,250,000
Non-Direct Connection Cost Estimate	138 kV Revenue Metering	$250,000
	Upgrade line protection and control settings at the Millbrook Park 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	$250,000
	Upgrade line protection and control settings at the Highland 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	$25,000
	Upgrade line protection and control settings at the Clinton County 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	$25,000
	Upgrade line protection and control settings at the Wildcat 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	$25,000
	Upgrade line protection and control settings at the O.H. Hutchings (DP&L) 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation. (This estimate will be confirmed during the System Impact Study)	$25,000
	New System Reinforcements	$63,009,840
	(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation	
Total Estimated Cost for Project AD2-010, AD2-011, and AD2-012		**$66,859,840**

Table 8

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It is important to note that there is a potential additional cost of $91,440,000 in transmission line reconductoring/rebuild projects as noted in Table 7, should any of the sag studies indicate that there is no other way to mitigate the contingency violations. See Table 9 below for the potential costs and Multiple Facility Contingency number.

Contingency #	Cost
MFC #1	$6,540,000
MFC #5	$33,450,000
MFC #6	$7,500,000
MFC #9	$12,000,000
MFC #16	$1,950,000
MFC #29	$18,000,000
MFC #30	$12,000,000
Total	**$91,440,000**

Table 9

The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. The cost of remediation for sag limited conductors is not included in this estimate. Final estimates will require an on-site review and coordination to determine final construction requirements.

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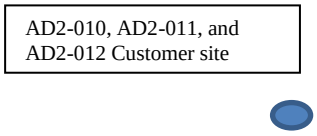
Figure 1: Point of Interconnection (Hillsboro 138 kV Substation)

Single-Line Diagram

Figure 2: Point of Interconnection (Hillsboro 138 kV Substation)



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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.

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Appendix 1

(AEP - AEP) The 05HILLSB-05SINKG8 138 kV line (from bus 243019 to bus 243102 ckt 1) loads from 56.18% to 122.21% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of 'AEP_P7-1_#7981_B'. This project contributes approximately 122.15 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7981_B'
OPEN BRANCH FROM BUS 932430 TO BUS 249995 CKT 1 / 932430 AC2-061 TAP 138 249995 08CLINCO 138 1
OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932131	*AC2-020 C*	*0.6*
932132	*AC2-020 E*	*0.98*
932381	*AC2-055 C*	*1.48*
932382	*AC2-055 E*	*2.42*
932421	*AC2-060 C*	*5.26*
932422	*AC2-060 E*	*2.96*
932431	*AC2-061 C*	*20.34*
932432	*AC2-061 E*	*20.62*
932651	*AC2-087 C*	*3.9*
932652	*AC2-087 E*	*3.09*
934491	*AD1-073 C*	*1.09*
934492	*AD1-073 E*	*0.56*
936091	*AD2-012 C*	*73.29*
936092	*AD2-012 E*	*48.86*
936251	*AD2-031 C O1*	*1.72*
936252	*AD2-031 E O1*	*2.8*
LTF	*CARR*	*0.03*

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LTF	*CATAWBA*	*0.02*
LTF	*CBM-S1*	*0.87*
LTF	*CBM-W1*	*2.8*
LTF	*CBM-W2*	*4.74*
LTF	*CELEVELAND*	*0.05*
LTF	*CIN*	*1.07*
LTF	*G-007*	*0.1*
LTF	*HAMLET*	*0.08*
LTF	*IPL*	*0.69*
LTF	*LGEE*	*0.36*
LTF	*MEC*	*1.23*
LTF	*MECS*	*0.74*
LTF	*O-066*	*0.34*
LTF	*RENSSELAER*	*0.02*
LTF	*ROSETON*	*0.16*
LTF	*ROWAN*	*0.06*
LTF	*WEC*	*0.18*
924371	*AB2-085 C O1*	*8.26*
924372	*AB2-085 E O1*	*3.89*
926101	*AC1-089 C*	*15.99*
926102	*AC1-089 E*	*26.08*
926631	*AC1-144 C*	*20.02*
926632	*AC1-144 E*	*9.73*

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Appendix 2

(AEP - DAY) The 05HILLSB-09MIDDLE 138 kV line (from bus 243019 to bus 253111 ckt 1) loads from 63.37% to 110.93% (**DC power flow**) of its emergency rating (185 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7351_05HILLSB 138'. This project contributes approximately 87.98 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#7351_05HILLSB 138'
OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1
OPEN BRANCH FROM BUS 243019 TO BUS 246946 CKT 1 / 243019 05HILLSB 138 246946 05WLDCAT 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932431	*AC2-061 C*	*13.3*
932432	*AC2-061 E*	*13.48*
932451	*AC2-064 C*	*8.52*
932452	*AC2-064 E*	*5.68*
936091	*AD2-012 C*	*52.79*
936092	*AD2-012 E*	*35.19*
LTF	*AMIL*	*0.03*
LTF	*BLUEG*	*0.14*
LTF	*CANNELTON*	*0.02*
LTF	*CBM-N*	*< 0.01*
LTF	*CBM-S1*	*< 0.01*
LTF	*CBM-S2*	*0.26*
LTF	*COTTONWOOD*	*< 0.01*
LTF	*CPLE*	*0.07*
LTF	*DEARBORN*	*0.15*
LTF	*EDWARDS*	*0.06*
LTF	*ELMERSMITH*	*0.06*

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LTF	*FARMERCITY*	*0.03*
LTF	*G-007A*	*0.12*
LTF	*GIBSON*	*0.07*
LTF	*NEWTON*	*0.12*
LTF	*NYISO*	*0.08*
LTF	*O-066A*	*0.06*
LTF	*PRAIRIE*	*0.18*
LTF	*SMITHLAND*	*< 0.01*
LTF	*TATANKA*	*0.06*
LTF	*TILTON*	*0.08*
LTF	*TRIMBLE*	*0.03*
LTF	*VFT*	*0.32*
916272	*Z1-080 E*	*0.84*
918802	*AA1-099 E*	*0.56*
926631	*AC1-144 C*	*14.42*
926632	*AC1-144 E*	*7.01*

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Appendix 3

(AEP - DEO&K) The 05HILLSB-AC2-061 TAP 138 kV line (from bus 243019 to bus 932430 ckt 1) loads from 89.37% to 158.81% (**DC power flow**) of its emergency rating (184 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#8107_05HILLSB 138'. This project contributes approximately 127.77 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#8107_05HILLSB 138'
OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1
OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932451	*AC2-064 C*	*12.38*
932452	*AC2-064 E*	*8.26*
936091	*AD2-012 C*	*76.66*
936092	*AD2-012 E*	*51.11*
LTF	*AMIL*	*0.07*
LTF	*BAYOU*	*0.06*
LTF	*BIG_CAJUN1*	*0.07*
LTF	*BIG_CAJUN2*	*0.15*
LTF	*BLUEG*	*0.67*
LTF	*CANNELTON*	*0.08*
LTF	*CBM-N*	*0.02*
LTF	*CBM-S2*	*0.35*
LTF	*CHOCTAW*	*0.03*
LTF	*CLIFTY*	*1.5*
LTF	*COTTONWOOD*	*0.26*
LTF	*CPLE*	*0.09*
LTF	*DEARBORN*	*0.18*

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LTF	*EDWARDS*	*0.14*
LTF	*ELMERSMITH*	*0.21*
LTF	*FARMERCITY*	*0.07*
LTF	*G-007A*	*0.24*
LTF	*GIBSON*	*0.22*
LTF	*MORGAN*	*0.02*
LTF	*NEWTON*	*0.38*
LTF	*NYISO*	*0.25*
LTF	*O-066A*	*0.11*
LTF	*PRAIRIE*	*0.55*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.15*
LTF	*TILTON*	*0.21*
LTF	*TRIMBLE*	*0.13*
LTF	*TVA*	*0.01*
LTF	*VFT*	*0.66*
916272	*Z1-080 E*	*2.16*
918802	*AA1-099 E*	*1.44*
926101	*AC1-089 C*	*16.59*
926102	*AC1-089 E*	*27.07*
926631	*AC1-144 C*	*20.94*
926632	*AC1-144 E*	*10.18*

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Appendix 4

(AEP - AEP) The 05SINKG8-AC2-064 TAP 138 kV line (from bus 243102 to bus 932450 ckt 1) loads from 57.82% to 128.43% (**DC power flow**) of its emergency rating (173 MVA) for the tower line contingency outage of 'AEP_P7-1_#7981_B'. This project contributes approximately 122.15 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7981_B'
OPEN BRANCH FROM BUS 932430 TO BUS 249995 CKT 1 / 932430 AC2-061 TAP 138 249995 08CLINCO 138 1
OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932131	*AC2-020 C*	*0.6*
932132	*AC2-020 E*	*0.98*
932381	*AC2-055 C*	*1.48*
932382	*AC2-055 E*	*2.42*
932421	*AC2-060 C*	*5.26*
932422	*AC2-060 E*	*2.96*
932431	*AC2-061 C*	*20.34*
932432	*AC2-061 E*	*20.62*
932651	*AC2-087 C*	*3.9*
932652	*AC2-087 E*	*3.09*
934491	*AD1-073 C*	*1.09*
934492	*AD1-073 E*	*0.56*
936091	*AD2-012 C*	*73.29*
936092	*AD2-012 E*	*48.86*
936251	*AD2-031 C O1*	*1.72*
936252	*AD2-031 E O1*	*2.8*
LTF	*CARR*	*0.03*

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LTF	*CATAWBA*	*0.02*
LTF	*CBM-S1*	*0.87*
LTF	*CBM-W1*	*2.8*
LTF	*CBM-W2*	*4.74*
LTF	*CELEVELAND*	*0.05*
LTF	*CIN*	*1.07*
LTF	*G-007*	*0.1*
LTF	*HAMLET*	*0.08*
LTF	*IPL*	*0.69*
LTF	*LGEE*	*0.36*
LTF	*MEC*	*1.23*
LTF	*MECS*	*0.74*
LTF	*O-066*	*0.34*
LTF	*RENSSELAER*	*0.02*
LTF	*ROSETON*	*0.16*
LTF	*ROWAN*	*0.06*
LTF	*WEC*	*0.18*
924371	*AB2-085 C O1*	*8.26*
924372	*AB2-085 E O1*	*3.89*
926101	*AC1-089 C*	*15.99*
926102	*AC1-089 E*	*26.08*
926631	*AC1-144 C*	*20.02*
926632	*AC1-144 E*	*9.73*

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Appendix 5

(AEP - DAY) The 05HIGHLA-09MRTNSV 69 kV line (from bus 243606 to bus 253043 ckt 1) loads from 83.62% to 103.14% (**DC power flow**) of its emergency rating (68 MVA) for the tower line contingency outage of 'AEP_P7-1_#7981_B'. This project contributes approximately 29.46 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7981_B'
OPEN BRANCH FROM BUS 932430 TO BUS 249995 CKT 1 / 932430 AC2-061 TAP 138 249995 08CLINCO 138 1
OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932131	*AC2-020 C*	*0.61*
932132	*AC2-020 E*	*1.*
932381	*AC2-055 C*	*1.55*
932382	*AC2-055 E*	*2.53*
932421	*AC2-060 C*	*5.5*
932422	*AC2-060 E*	*3.09*
932431	*AC2-061 C*	*4.9*
932432	*AC2-061 E*	*4.97*
932651	*AC2-087 C*	*4.07*
932652	*AC2-087 E*	*3.23*
934491	*AD1-073 C*	*1.13*
934492	*AD1-073 E*	*0.58*
936091	*AD2-012 C*	*17.68*
936092	*AD2-012 E*	*11.79*
LTF	*AMIL*	*0.02*
LTF	*BAYOU*	*0.01*
LTF	*BIG_CAJUN1*	*0.01*

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LTF	*BIG_CAJUN2*	*0.03*
LTF	*BLUEG*	*0.16*
LTF	*CANNELTON*	*0.02*
LTF	*CBM-N*	*< 0.01*
LTF	*CBM-S2*	*0.12*
LTF	*CHOCTAW*	*< 0.01*
LTF	*CLIFTY*	*0.09*
LTF	*COTTONWOOD*	*0.06*
LTF	*CPLE*	*0.03*
LTF	*DEARBORN*	*0.08*
LTF	*EDWARDS*	*0.04*
LTF	*ELMERSMITH*	*0.05*
LTF	*FARMERCITY*	*0.02*
LTF	*G-007A*	*0.07*
LTF	*GIBSON*	*0.05*
LTF	*NEWTON*	*0.09*
LTF	*NYISO*	*0.07*
LTF	*O-066A*	*0.03*
LTF	*PRAIRIE*	*0.14*
LTF	*SMITHLAND*	*< 0.01*
LTF	*TATANKA*	*0.04*
LTF	*TILTON*	*0.05*
LTF	*TRIMBLE*	*0.03*
LTF	*TVA*	*< 0.01*
LTF	*VFT*	*0.2*

924371	*AB2-085 C O1*	*3.36*
924372	*AB2-085 E O1*	*1.58*
926101	*AC1-089 C*	*3.81*
926102	*AC1-089 E*	*6.22*
926631	*AC1-144 C*	*4.83*
926632	*AC1-144 E*	*2.35*

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Appendix 6

(AEP - AEP) The 05WLDCAT-05EMERSS 138 kV line (from bus 246946 to bus 247034 ckt 1) loads from 74.65% to 127.44% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of 'AEP_P7-1_#7981_B'. This project contributes approximately 97.66 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7981_B'
OPEN BRANCH FROM BUS 932430 TO BUS 249995 CKT 1 / 932430 AC2-061 TAP 138 249995 08CLINCO 138 1
OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932131	*AC2-020 C*	*0.47*
932132	*AC2-020 E*	*0.76*
932381	*AC2-055 C*	*1.16*
932382	*AC2-055 E*	*1.9*
932421	*AC2-060 C*	*4.12*
932422	*AC2-060 E*	*2.32*
932431	*AC2-061 C*	*16.26*
932432	*AC2-061 E*	*16.48*
932451	*AC2-064 C*	*9.53*
932452	*AC2-064 E*	*6.35*
932651	*AC2-087 C*	*3.05*
932652	*AC2-087 E*	*2.42*
934491	*AD1-073 C*	*0.85*
934492	*AD1-073 E*	*0.44*
936091	*AD2-012 C*	*58.59*
936092	*AD2-012 E*	*39.06*
936251	*AD2-031 C O1*	*1.23*

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936252	*AD2-031 E O1*	*2.*
LTF	*AMIL*	*0.1*
LTF	*BAYOU*	*0.32*
LTF	*BIG_CAJUN1*	*0.49*
LTF	*BIG_CAJUN2*	*0.98*
LTF	*BLUEG*	*1.25*
LTF	*CALDERWOOD*	*0.15*
LTF	*CANNELTON*	*0.17*
LTF	*CATAWBA*	*0.02*
LTF	*CBM-N*	*0.02*
LTF	*CELEVELAND*	*0.07*
LTF	*CHEOAH*	*0.13*
LTF	*CHILHOWEE*	*0.05*
LTF	*CHOCTAW*	*0.33*
LTF	*CLIFTY*	*1.3*
LTF	*COTTONWOOD*	*1.29*
LTF	*DEARBORN*	*0.06*
LTF	*EDWARDS*	*0.15*
LTF	*ELMERSMITH*	*0.49*
LTF	*FARMERCITY*	*0.11*
LTF	*G-007A*	*0.27*
LTF	*GIBSON*	*0.29*
LTF	*HAMLET*	*0.05*
LTF	*MORGAN*	*0.55*
LTF	*NEWTON*	*0.51*

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LTF	*NYISO*	*0.37*
LTF	*O-066A*	*0.13*
LTF	*PRAIRIE*	*0.91*
LTF	*ROWAN*	*0.03*
LTF	*SANTEETLA*	*0.04*
LTF	*SMITHLAND*	*0.08*
LTF	*TATANKA*	*0.19*
LTF	*TILTON*	*0.23*
LTF	*TRIMBLE*	*0.24*
LTF	*TVA*	*0.26*
LTF	*UNIONPOWER*	*0.13*
LTF	*VFT*	*0.72*
924371	*AB2-085 C O1*	*6.94*
924372	*AB2-085 E O1*	*3.27*
926101	*AC1-089 C*	*24.2*
926102	*AC1-089 E*	*39.48*
926631	*AC1-144 C*	*16.01*
926632	*AC1-144 E*	*7.78*

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Appendix 7

(AEP - LGEE) The 05EMERSS-4KENTON 138 kV line (from bus 247034 to bus 324267 ckt 1) loads from 73.35% to 126.14% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of 'AEP_P7-1_#7981_B'. This project contributes approximately 97.66 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7981_B'
OPEN BRANCH FROM BUS 932430 TO BUS 249995 CKT 1 / 932430 AC2-061 TAP 138 249995 08CLINCO 138 1
OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932131	*AC2-020 C*	*0.47*
932132	*AC2-020 E*	*0.76*
932381	*AC2-055 C*	*1.16*
932382	*AC2-055 E*	*1.9*
932421	*AC2-060 C*	*4.12*
932422	*AC2-060 E*	*2.32*
932431	*AC2-061 C*	*16.26*
932432	*AC2-061 E*	*16.48*
932451	*AC2-064 C*	*9.53*
932452	*AC2-064 E*	*6.35*
932651	*AC2-087 C*	*3.05*
932652	*AC2-087 E*	*2.42*
934491	*AD1-073 C*	*0.85*
934492	*AD1-073 E*	*0.44*
936091	*AD2-012 C*	*58.59*
936092	*AD2-012 E*	*39.06*
936251	*AD2-031 C O1*	*1.23*

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936252	*AD2-031 E O1*	*2.*
LTF	*AMIL*	*0.1*
LTF	*BAYOU*	*0.32*
LTF	*BIG_CAJUN1*	*0.49*
LTF	*BIG_CAJUN2*	*0.98*
LTF	*BLUEG*	*1.25*
LTF	*CALDERWOOD*	*0.15*
LTF	*CANNELTON*	*0.17*
LTF	*CATAWBA*	*0.02*
LTF	*CBM-N*	*0.02*
LTF	*CELEVELAND*	*0.07*
LTF	*CHEOAH*	*0.13*
LTF	*CHILHOWEE*	*0.05*
LTF	*CHOCTAW*	*0.33*
LTF	*CLIFTY*	*1.3*
LTF	*COTTONWOOD*	*1.29*
LTF	*DEARBORN*	*0.06*
LTF	*EDWARDS*	*0.15*
LTF	*ELMERSMITH*	*0.49*
LTF	*FARMERCITY*	*0.11*
LTF	*G-007A*	*0.27*
LTF	*GIBSON*	*0.29*
LTF	*HAMLET*	*0.05*
LTF	*MORGAN*	*0.55*
LTF	*NEWTON*	*0.51*

LTF	*NYISO*	*0.37*
LTF	*O-066A*	*0.13*
LTF	*PRAIRIE*	*0.91*
LTF	*ROWAN*	*0.03*
LTF	*SANTEETLA*	*0.04*
LTF	*SMITHLAND*	*0.08*
LTF	*TATANKA*	*0.19*
LTF	*TILTON*	*0.23*
LTF	*TRIMBLE*	*0.24*
LTF	*TVA*	*0.26*
LTF	*UNIONPOWER*	*0.13*
LTF	*VFT*	*0.72*
924371	*AB2-085 C O1*	*6.94*
924372	*AB2-085 E O1*	*3.27*
926101	*AC1-089 C*	*24.2*
926102	*AC1-089 E*	*39.48*
926631	*AC1-144 C*	*16.01*
926632	*AC1-144 E*	*7.78*

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Appendix 8

(DEO&K - DEO&K) The 08CLINCO-08WARRN1 138 kV line (from bus 249995 to bus 250122 ckt 1) loads from 95.19% to 159.72% (**DC power flow**) of its emergency rating (198 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#8107_05HILLSB 138'. This project contributes approximately 127.77 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#8107_05HILLSB 138'
OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1
OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932431	*AC2-061 C*	*24.55*
932432	*AC2-061 E*	*24.88*
932451	*AC2-064 C*	*12.38*
932452	*AC2-064 E*	*8.26*
936091	*AD2-012 C*	*76.66*
936092	*AD2-012 E*	*51.11*
LTF	*AMIL*	*0.07*
LTF	*BAYOU*	*0.06*
LTF	*BIG_CAJUN1*	*0.07*
LTF	*BIG_CAJUN2*	*0.15*
LTF	*BLUEG*	*0.67*
LTF	*CANNELTON*	*0.08*
LTF	*CBM-N*	*0.02*
LTF	*CBM-S2*	*0.35*
LTF	*CHOCTAW*	*0.03*
LTF	*CLIFTY*	*1.5*
LTF	*COTTONWOOD*	*0.26*

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LTF	*CPLE*	*0.09*
LTF	*DEARBORN*	*0.18*
LTF	*EDWARDS*	*0.14*
LTF	*ELMERSMITH*	*0.21*
LTF	*FARMERCITY*	*0.07*
LTF	*G-007A*	*0.24*
LTF	*GIBSON*	*0.22*
LTF	*MORGAN*	*0.02*
LTF	*NEWTON*	*0.38*
LTF	*NYISO*	*0.25*
LTF	*O-066A*	*0.11*
LTF	*PRAIRIE*	*0.55*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.15*
LTF	*TILTON*	*0.21*
LTF	*TRIMBLE*	*0.13*
LTF	*TVA*	*0.01*
LTF	*VFT*	*0.66*
916272	*Z1-080 E*	*3.84*
918802	*AA1-099 E*	*2.56*
926101	*AC1-089 C*	*16.59*
926102	*AC1-089 E*	*27.07*
926631	*AC1-144 C*	*20.94*
926632	*AC1-144 E*	*10.18*

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Appendix 9

(DAY - AEP) The 09KILLEN-05MARQUI 345 kV line (from bus 253038 to bus 242938 ckt 1) loads from 99.72% to 100.44% (**DC power flow**) of its emergency rating (1372 MVA) for the tower line contingency outage of 'AEP_P7-1_#8123'. This project contributes approximately 22.02 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#8123'
OPEN BRANCH FROM BUS 243453 TO BUS 253110 CKT 1 / 243453 05BEATTY 345 253110 09ADKINS 345 1
OPEN BRANCH FROM BUS 243453 TO BUS 253248 CKT 1 / 243453 05BEATTY 345 253248 09SCHARL 345 1
OPEN BRANCH FROM BUS 243453 TO BUS 243469 CKT 3 / 243453 05BEATTY 345 243469 05BEATTY 138 3
END

Bus Number	*Bus Name*	*Full Contribution*
253038	*09KILLEN*	*297.78*
253077	*09STUART*	*633.56*
932131	*AC2-020 C*	*0.51*
932132	*AC2-020 E*	*0.83*
932381	*AC2-055 C*	*1.11*
932382	*AC2-055 E*	*1.81*
932421	*AC2-060 C*	*3.93*
932422	*AC2-060 E*	*2.21*
932431	*AC2-061 C*	*3.87*
932432	*AC2-061 E*	*3.92*
932461	*AC2-066 C*	*5.01*
932462	*AC2-066 E*	*8.17*
932481	*AC2-068 C*	*2.39*
932482	*AC2-068 E*	*3.91*
932551	*AC2-075 C*	*1.7*
932552	*AC2-075 E*	*0.84*

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932641	*AC2-085 C*	*1.85*
932642	*AC2-085 E*	*1.58*
932651	*AC2-087 C*	*2.91*
932652	*AC2-087 E*	*2.31*
932661	*AC2-088 C*	*7.55*
932662	*AC2-088 E*	*6.21*
932841	*AC2-111 C*	*2.07*
932842	*AC2-111 E*	*3.37*
934491	*AD1-073 C*	*0.81*
934492	*AD1-073 E*	*0.42*
935011	*AD1-134*	*7.99*
935031	*AD1-136 C*	*1.06*
935032	*AD1-136 E*	*0.9*
935041	*AD1-140 C1*	*7.49*
935043	*AD1-140 C2*	*0.48*
935042	*AD1-140 E1*	*6.19*
935044	*AD1-140 E2*	*1.47*
936091	*AD2-012 C*	*13.21*
936092	*AD2-012 E*	*8.81*
936251	*AD2-031 C O1*	*2.32*
936252	*AD2-031 E O1*	*3.78*
936281	*AD2-036 C*	*5.09*
936282	*AD2-036 E*	*2.54*
936381	*AD2-048 C*	*5.76*
936382	*AD2-048 E*	*2.87*

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936571	*AD2-072 C O1*	*5.23*
936572	*AD2-072 E O1*	*2.57*
937111	*AD2-147 C O1*	*4.68*
937112	*AD2-147 E O1*	*6.46*
937151	*AD2-151 C O1*	*7.53*
937152	*AD2-151 E O1*	*10.4*
LTF	*CARR*	*0.43*
LTF	*CATAWBA*	*0.06*
LTF	*CBM-S1*	*8.02*
LTF	*CBM-W1*	*20.75*
LTF	*CBM-W2*	*43.39*
LTF	*CELEVELAND*	*0.11*
LTF	*CIN*	*9.85*
LTF	*G-007*	*1.3*
LTF	*HAMLET*	*0.38*
LTF	*IPL*	*6.17*
LTF	*LGEE*	*2.97*
LTF	*MEC*	*10.29*
LTF	*MECS*	*4.21*
LTF	*O-066*	*4.38*
LTF	*RENSSELAER*	*0.34*
LTF	*ROSETON*	*2.49*
LTF	*ROWAN*	*0.25*
904722	*V4-073E*	*0.15*
902531	*W2-040C*	*0.7*

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902532	*W2-040E*	*1.15*
LTF	*WEC*	*1.43*
910512	*X3-002 E*	*0.17*
913222	*Y1-054 E*	*1.79*
914372	*Y2-111 E*	*1.14*
915582	*Y3-080 E*	*0.76*
915662	*Y3-099 E*	*0.16*
915672	*Y3-100 E*	*0.16*
916182	*Z1-065 E*	*0.55*
916272	*Z1-080 E*	*0.48*
918802	*AA1-099 E*	*0.32*
930062	*AB1-014 E*	*13.61*
931181	*AB1-169*	*299.46*
925242	*AB2-178 E*	*1.58*
925921	*AC1-068 C*	*7.88*
925922	*AC1-068 E*	*3.68*
925931	*AC1-069 C*	*7.88*
925932	*AC1-069 E*	*3.68*
925981	*AC1-074 C*	*7.12*
925982	*AC1-074 E*	*3.05*
926061	*AC1-085 C*	*34.42*
926062	*AC1-085 E*	*56.15*
926101	*AC1-089 C*	*4.66*
926102	*AC1-089 E*	*7.6*
926631	*AC1-144 C*	*3.61*

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926632	*AC1-144 E*	*1.75*
926691	*AC1-152*	*3.38*
926791	*AC1-165 C*	*7.79*
926792	*AC1-165 E*	*3.78*
926801	*AC1-166 C*	*7.79*
926802	*AC1-166 E*	*3.78*
926851	*AC1-172*	*3.38*
926951	*AC1-182*	*2.81*

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Appendix 10

(DAY - DAY) The 09MIDDLE-09OHH 138 kV line (from bus 253111 to bus 253057 ckt 1) loads from 61.1% to 108.66% (**DC power flow**) of its emergency rating (185 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7351_05HILLSB 138'. This project contributes approximately 87.98 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#7351_05HILLSB 138'
OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1
OPEN BRANCH FROM BUS 243019 TO BUS 246946 CKT 1 / 243019 05HILLSB 138 246946 05WLDCAT 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932431	*AC2-061 C*	*13.3*
932432	*AC2-061 E*	*13.48*
932451	*AC2-064 C*	*8.52*
932452	*AC2-064 E*	*5.68*
936091	*AD2-012 C*	*52.79*
936092	*AD2-012 E*	*35.19*
LTF	*AMIL*	*0.03*
LTF	*BLUEG*	*0.14*
LTF	*CANNELTON*	*0.02*
LTF	*CBM-N*	*< 0.01*
LTF	*CBM-S1*	*< 0.01*
LTF	*CBM-S2*	*0.26*
LTF	*COTTONWOOD*	*< 0.01*
LTF	*CPLE*	*0.07*
LTF	*DEARBORN*	*0.15*
LTF	*EDWARDS*	*0.06*
LTF	*ELMERSMITH*	*0.06*

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LTF	*FARMERCITY*	*0.03*
LTF	*G-007A*	*0.12*
LTF	*GIBSON*	*0.07*
LTF	*NEWTON*	*0.12*
LTF	*NYISO*	*0.08*
LTF	*O-066A*	*0.06*
LTF	*PRAIRIE*	*0.18*
LTF	*SMITHLAND*	*< 0.01*
LTF	*TATANKA*	*0.06*
LTF	*TILTON*	*0.08*
LTF	*TRIMBLE*	*0.03*
LTF	*VFT*	*0.32*
916272	*Z1-080 E*	*0.84*
918802	*AA1-099 E*	*0.56*
926631	*AC1-144 C*	*14.42*
926632	*AC1-144 E*	*7.01*

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Appendix 11

(AEP - AEP) The 05HIGHLA 138/69 kV transformer (from bus 246911 to bus 243606 ckt 3) loads from 103.92% to 147.07% (**DC power flow**) of its emergency rating (122 MVA) for the tower line contingency outage of 'AEP_P7-1_#7981_B'. This project contributes approximately 52.65 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7981_B'
OPEN BRANCH FROM BUS 932430 TO BUS 249995 CKT 1 / 932430 AC2-061 TAP 138 249995 08CLINCO 138 1
OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932431	*AC2-061 C*	*8.76*
932432	*AC2-061 E*	*8.89*
932451	*AC2-064 C*	*5.18*
932452	*AC2-064 E*	*3.45*
936091	*AD2-012 C*	*31.59*
936092	*AD2-012 E*	*21.06*
LTF	*AMIL*	*< 0.01*
LTF	*BLUEG*	*< 0.01*
LTF	*CARR*	*< 0.01*
LTF	*CBM-S1*	*0.17*
LTF	*CBM-S2*	*0.23*
LTF	*CBM-W2*	*0.13*
LTF	*CPLE*	*0.05*
LTF	*DEARBORN*	*0.1*
LTF	*EDWARDS*	*0.03*
LTF	*FARMERCITY*	*< 0.01*
LTF	*G-007A*	*0.04*

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LTF	*GIBSON*	*0.02*
LTF	*LGEE*	*0.03*
LTF	*NEWTON*	*0.03*
LTF	*O-066A*	*0.02*
LTF	*PRAIRIE*	*0.02*
LTF	*RENSSELAER*	*< 0.01*
LTF	*ROSETON*	*< 0.01*
LTF	*TATANKA*	*0.02*
LTF	*TILTON*	*0.03*
LTF	*TRIMBLE*	*< 0.01*
LTF	*VFT*	*0.1*
924371	*AB2-085 C O1*	*5.89*
924372	*AB2-085 E O1*	*2.77*
926101	*AC1-089 C*	*6.84*
926102	*AC1-089 E*	*11.16*
926631	*AC1-144 C*	*8.63*
926632	*AC1-144 E*	*4.19*

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Appendix 12

(OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 2) loads from 113.45% to 114.21% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of 'AEP_P1-2_#349'. This project contributes approximately 18.19 MW to the thermal violation.

CONTINGENCY 'AEP_P1-2_#349'
OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
249583	*08NTEGEN*	*11.58*
251962	*08WSDLE1*	*1.79*
251963	*08WSDLE2*	*1.83*
251964	*08WSDLE3*	*1.81*
251965	*08WSDLE4*	*1.77*
251966	*08WSDLE5*	*1.79*
251967	*08WSDLE6*	*1.83*
251973	*08YANKGE*	*1.13*
253038	*09KILLEN*	*82.7*
253077	*09STUART*	*255.27*
932131	*AC2-020 C*	*0.64*
932381	*AC2-055 C*	*1.53*
932411	*AC2-059 C*	*4.82*
932421	*AC2-060 C*	*5.42*
932431	*AC2-061 C*	*5.2*
932461	*AC2-066 C*	*3.24*
932481	*AC2-068 C*	*2.22*
932551	*AC2-075 C*	*1.25*

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932641	*AC2-085 C*	*1.23*
932651	*AC2-087 C*	*4.02*
932661	*AC2-088 C*	*4.31*
932681	*AC2-090 C*	*2.83*
932841	*AC2-111 C*	*2.76*
933591	*AC2-176 C*	*1.28*
933601	*AC2-177 C*	*1.94*
934161	*AD1-043 C O1*	*3.06*
934481	*AD1-072 C*	*1.06*
934491	*AD1-073 C*	*1.12*
LTF	*AD1-092*	*4.86*
LTF	*AD1-093*	*8.32*
LTF	*AD1-094*	*1.57*
934961	*AD1-128 C O1*	*4.45*
935011	*AD1-134*	*5.7*
935031	*AD1-136 C*	*0.61*
935041	*AD1-140 C1*	*6.89*
935043	*AD1-140 C2*	*0.45*
935051	*AD1-141 C O1*	*3.13*
936091	*AD2-012 C*	*18.19*
936111	*AD2-016 C*	*4.82*
936251	*AD2-031 C O1*	*1.73*
936281	*AD2-036 C*	*3.74*
936381	*AD2-048 C*	*4.24*
936571	*AD2-072 C O1*	*5.09*

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936681	*AD2-087 C O1*	*10.28*
937151	*AD2-151 C O1*	*4.78*
937231	*AD2-162 C*	*5.32*
LTF	*CARR*	*0.64*
LTF	*CBM-S1*	*12.71*
LTF	*CBM-S2*	*1.08*
LTF	*CBM-W1*	*53.71*
LTF	*CBM-W2*	*79.*
LTF	*CIN*	*16.69*
LTF	*IPL*	*10.85*
LTF	*LGEE*	*4.23*
LTF	*MEC*	*20.54*
LTF	*MECS*	*9.72*
LTF	*RENSSELAER*	*0.51*
LTF	*ROSETON*	*3.67*
247543	*V3-007 C*	*1.94*
902531	*W2-040C*	*0.65*
247588	*W4-004 C*	*0.94*
247589	*W4-008 C*	*0.94*
LTF	*WEC*	*2.99*
LTF	*Z1-043*	*12.01*
920501	*AA2-148 C*	*1.83*
931181	*AB1-169*	*120.66*
LTF	*AB2-013*	*6.93*
923881	*AB2-028 C*	*1.8*

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924351	*AB2-083 C O1*	*2.12*
924371	*AB2-085 C O1*	*5.72*
925341	*AC1-001 C*	*4.25*
925801	*AC1-059 C*	*3.33*
925921	*AC1-068 C*	*2.26*
925931	*AC1-069 C*	*2.26*
925981	*AC1-074 C*	*5.23*
926061	*AC1-085 C*	*15.69*
926091	*AC1-088*	*1.32*
926101	*AC1-089 C*	*5.05*
926631	*AC1-144 C*	*4.97*
926691	*AC1-152*	*5.37*
926791	*AC1-165 C*	*2.24*
926801	*AC1-166 C*	*2.24*
926851	*AC1-172*	*5.37*
926871	*AC1-174 C*	*2.83*
926881	*AC1-175 C*	*2.83*
926951	*AC1-182*	*2.27*

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Appendix 13

(DEO&K - DEO&K) The AC2-061 TAP-08CLINCO 138 kV line (from bus 932430 to bus 249995 ckt 1) loads from 116.18% to 185.62% (**DC power flow**) of its emergency rating (184 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#8107_05HILLSB 138'. This project contributes approximately 127.77 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#8107_05HILLSB 138'
OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1
OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932431	*AC2-061 C*	*24.55*
932432	*AC2-061 E*	*24.88*
932451	*AC2-064 C*	*12.38*
932452	*AC2-064 E*	*8.26*
936091	*AD2-012 C*	*76.66*
936092	*AD2-012 E*	*51.11*
LTF	*AMIL*	*0.07*
LTF	*BAYOU*	*0.06*
LTF	*BIG_CAJUN1*	*0.07*
LTF	*BIG_CAJUN2*	*0.15*
LTF	*BLUEG*	*0.67*
LTF	*CANNELTON*	*0.08*
LTF	*CBM-N*	*0.02*
LTF	*CBM-S2*	*0.35*
LTF	*CHOCTAW*	*0.03*
LTF	*CLIFTY*	*1.5*
LTF	*COTTONWOOD*	*0.26*

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LTF	*CPLE*	*0.09*
LTF	*DEARBORN*	*0.18*
LTF	*EDWARDS*	*0.14*
LTF	*ELMERSMITH*	*0.21*
LTF	*FARMERCITY*	*0.07*
LTF	*G-007A*	*0.24*
LTF	*GIBSON*	*0.22*
LTF	*MORGAN*	*0.02*
LTF	*NEWTON*	*0.38*
LTF	*NYISO*	*0.25*
LTF	*O-066A*	*0.11*
LTF	*PRAIRIE*	*0.55*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.15*
LTF	*TILTON*	*0.21*
LTF	*TRIMBLE*	*0.13*
LTF	*TVA*	*0.01*
LTF	*VFT*	*0.66*
916272	*Z1-080 E*	*2.16*
918802	*AA1-099 E*	*1.44*
926101	*AC1-089 C*	*16.59*
926102	*AC1-089 E*	*27.07*
926631	*AC1-144 C*	*20.94*
926632	*AC1-144 E*	*10.18*

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Appendix 14

(AEP - AEP) The AC2-064 TAP-05MILLBR 138 kV line (from bus 932450 to bus 243042 ckt 1) loads from 102.98% to 173.59% (**DC power flow**) of its emergency rating (173 MVA) for the tower line contingency outage of 'AEP_P7-1_#7981_B'. This project contributes approximately 122.15 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7981_B'
OPEN BRANCH FROM BUS 932430 TO BUS 249995 CKT 1 / 932430 AC2-061 TAP 138 249995 08CLINCO 138 1
OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932131	*AC2-020 C*	*0.6*
932132	*AC2-020 E*	*0.98*
932381	*AC2-055 C*	*1.48*
932382	*AC2-055 E*	*2.42*
932421	*AC2-060 C*	*5.26*
932422	*AC2-060 E*	*2.96*
932431	*AC2-061 C*	*20.34*
932432	*AC2-061 E*	*20.62*
932451	*AC2-064 C*	*47.29*
932452	*AC2-064 E*	*31.53*
932651	*AC2-087 C*	*3.9*
932652	*AC2-087 E*	*3.09*
934491	*AD1-073 C*	*1.09*
934492	*AD1-073 E*	*0.56*
936091	*AD2-012 C*	*73.29*
936092	*AD2-012 E*	*48.86*
936251	*AD2-031 C O1*	*1.72*

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936252	*AD2-031 E O1*	*2.8*
LTF	*CARR*	*0.03*
LTF	*CATAWBA*	*0.02*
LTF	*CBM-S1*	*0.87*
LTF	*CBM-W1*	*2.8*
LTF	*CBM-W2*	*4.74*
LTF	*CELEVELAND*	*0.05*
LTF	*CIN*	*1.07*
LTF	*G-007*	*0.1*
LTF	*HAMLET*	*0.08*
LTF	*IPL*	*0.69*
LTF	*LGEE*	*0.36*
LTF	*MEC*	*1.23*
LTF	*MECS*	*0.74*
LTF	*O-066*	*0.34*
LTF	*RENSSELAER*	*0.02*
LTF	*ROSETON*	*0.16*
LTF	*ROWAN*	*0.06*
LTF	*WEC*	*0.18*
924371	*AB2-085 C O1*	*8.26*
924372	*AB2-085 E O1*	*3.89*
926101	*AC1-089 C*	*15.99*
926102	*AC1-089 E*	*26.08*
926631	*AC1-144 C*	*20.02*
926632	*AC1-144 E*	*9.73*

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