

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position AC2-049
Hillsboro – Millbrook Park 138 kV***

September 2017

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. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

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

General

The Interconnection Customer (IC) proposes to install PJM Project #AC2-049, a 49.0 MW (29.4 MW Capacity) solar generating facility in Hillsboro, OH (see Figure 2). The point of interconnection is to tap AEP's Millbrook Park – Sinking Springs 138 kV section of the Hillsboro – Millbrook Park 138 kV circuit (see Figure 1).

The requested in service date is June 1, 2019.

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 maintaining the reliability of the AEP transmission system. Stability analysis is not included as part of this study.

Attachment Facilities

Point of Interconnection (Millbrook Park – Sinking Springs 138 kV)

To accommodate the interconnection on the Millbrook Park – Sinking Springs 138 kV section of the Hillsboro – Millbrook 138 kV circuit, 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 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.

New Switching Station Work:

- 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. Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required (see Figure 1).
- **Estimated Station Cost: \$6,300,000**

Direct Connection Cost Estimate

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

For AEP building Direct Connection cost estimates:

Description	Total Cost
Millbrook Park-Hillsboro 138 kV T-Line Cut In	\$1,500,000

Total	\$1,500,000
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Table 1

Non-Direct Connection Cost Estimate

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

For AEP building Non-Direct Connection cost estimates:

Description	Estimated Cost
138 kV Revenue Metering	\$250,000
Upgrade line protection and controls at the Hillsboro 138 kV substation.	\$250,000
Upgrade line protection and controls at the Millbrook Park 138 kV substation.	\$250,000
Total	\$750,000

Table 2

Interconnection Customer Requirements

It is understood that IC is responsible for all costs associated with this interconnection. The cost of the IC's generating plant and the costs for the line connecting the generating plant to the new switching station 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.

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.

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 AC2-049 was evaluated as a 49.0 MW (Capacity 29.4 MW) injection tapping the Millbrook – Sinking Spring 138 kV line in the AEP area. Project AC2-049 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-049 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2020 Case

Contingency Descriptions

The following contingencies resulted in overloads:

Option 1	
Contingency Name	Description
462_B3_05MILLBR 138-5_WOMOAB	CONTINGENCY '462_B3_05MILLBR 138-5_WOMOAB'
	OPEN BRANCH FROM BUS 242988 TO BUS 243042 CKT 1 / 242988 05DOGWOO 138 243042 05MILLBR 138 1
	OPEN BRANCH FROM BUS 243069 TO BUS 243042 CKT 1 / 243069 05FIREBR 138 243042 05MILLBR 138 1
	OPEN BRANCH FROM BUS 243042 TO BUS 243047 CKT 1 / 243042 05MILLBR 138 243047 05N PORT 138 1
	OPEN BRANCH FROM BUS 243042 TO BUS 243173 CKT 1 / 243042 05MILLBR 138 243173 05MILLBRK 69.0 1
	END
5891_B2_TOR607	CONTINGENCY '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
7342_B2_TOR7202268	CONTINGENCY '7342_B2_TOR7202268'
	OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1
	END

Option 1	
Contingency Name	Description
7351_C2_05HILLSB 138-_A	CONTINGENCY '7351_C2_05HILLSB 138-_A' OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 926100 CKT 1 / 243019 05HILLSB 138 926100 AC1-089 TAP 138 1 END
7353_B2_TOR12737	CONTINGENCY '7353_B2_TOR12737' OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 243019 05HILLSB 138 249995 08CLINCO 138 1 OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995 08CLINCO 138 250122 08WARRN1 138 1 END
7954_C1_05MILLBR 138-2_A	CONTINGENCY '7954_C1_05MILLBR 138-2_A' OPEN BRANCH FROM BUS 243042 TO BUS 243088 CKT 1 / 243042 05MILLBR 138 243088 05S POIN 138 1 OPEN BRANCH FROM BUS 243042 TO BUS 931350 CKT 1 / 243042 05MILLBR 138 931350 AC2-049 TAP 138 1 END
7965_C2_05MILLBR 138-N	CONTINGENCY '7965_C2_05MILLBR 138-N' OPEN BRANCH FROM BUS 242988 TO BUS 243042 CKT 1 / 242988 05DOGWOO 138 243042 05MILLBR 138 1 OPEN BRANCH FROM BUS 243069 TO BUS 243042 CKT 1 / 243069 05FIREBR 138 243042 05MILLBR 138 1 OPEN BRANCH FROM BUS 243042 TO BUS 243047 CKT 1 / 243042 05MILLBR 138 243047 05N PORT 138 1 OPEN BRANCH FROM BUS 243042 TO BUS 243173 CKT 1 / 243042 05MILLBR 138 243173 05MILLBRK 69.0 1 OPEN BRANCH FROM BUS 243047 TO BUS 243819 CKT 1 / 243047 05N PORT 138 243819 05N PORTSM 69.0 1 OPEN BRANCH FROM BUS 243819 TO BUS 243826 CKT 1 / 243819 05N PORTSM 69.0 243826 05ORTELCRN 69.0 1 OPEN BRANCH FROM BUS 243819 TO BUS 243822 CKT 1 / 243819 05N PORTSM 69.0 243822 05ROSEMOUN 69.0 1 END
7970_C2_05MILLBR 138-G	CONTINGENCY '7970_C2_05MILLBR 138-G' OPEN BRANCH FROM BUS 242988 TO BUS 243042 CKT 1 / 242988 05DOGWOO 138 243042 05MILLBR 138 1 OPEN BRANCH FROM BUS 243069 TO BUS 243042 CKT 1 / 243069 05FIREBR 138 243042 05MILLBR 138 1 OPEN BRANCH FROM BUS 243688 TO BUS 243042 CKT 1 / 243688 05FULLER 138 243042 05MILLBR 138 1 OPEN BRANCH FROM BUS 243688 TO BUS 342538 CKT 1 / 243688 05FULLER 138 342538 4ARGENTUM 138 1 OPEN BRANCH FROM BUS 243042 TO BUS 243047 CKT 1 / 243042 05MILLBR 138 243047 05N PORT 138 1 OPEN BRANCH FROM BUS 243042 TO BUS 243173 CKT 1 / 243042 05MILLBR 138 243173 MILLBRK 69.0 1 OPEN BRANCH FROM BUS 243688 TO BUS 244686 CKT 1 / 243688 05FULLER 138 244686 VANCEBRG 12.0 1 END

Option 1	
Contingency Name	Description
7981_A	CONTINGENCY '7981_A' OPEN BRANCH FROM BUS 243019 TO BUS 931430 CKT 1 / 243019 05HILLSB 138 931430 AC2-061 TAP 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995 08CLINCO 138 250122 08WARRN1 138 1 OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111 09MIDDLE 138 253057 09OHH 138 1 END
7981_B	CONTINGENCY '7981_B' OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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 OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995 08CLINCO 138 250122 08WARRN1 138 1 OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111 09MIDDLE 138 253057 09OHH 138 1 END
8107_C2_05HILLSB 138-C_A	CONTINGENCY '8107_C2_05HILLSB 138-C_A' 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
8107_C2_05HILLSB 138-C_B	CONTINGENCY '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
8108_C2_05HILLSB 138-D_A	CONTINGENCY '8108_C2_05HILLSB 138-D_A' OPEN BRANCH FROM BUS 243019 TO BUS 931430 CKT 1 / 243019 05HILLSB 138 931430 AC2-061 TAP 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995 08CLINCO 138 250122 08WARRN1 138 1 OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111 09MIDDLE 138 253057 09OHH 138 1 END
8111_C2_05HILLSB 138-_A	CONTINGENCY '8111_C2_05HILLSB 138-_A' OPEN BRANCH FROM BUS 243019 TO BUS 926100 CKT 1 / 243019 05HILLSB 138 926100 AC1-089 TAP 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 931430 CKT 1 / 243019 05HILLSB 138 931430 AC2-060 TAP 138 1 END
P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381	CONTINGENCY 'P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381' OPEN BUS 249995 END

Option 1	
Contingency Name	Description
P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	CONTINGENCY 'P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381' OPEN BRANCH FROM BUS 249995 TO BUS 931430 CKT 1 END

Table 2

Generator Deliverability

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

Option 1														
AC2-049 Generator Deliverability														
#	Type	Contingency Name	Affected Area	Facility Description	Bus		Cir.	PF	Loading		Rating		MW Con.	FG App.
					From	To			Initial	Final	Type	MVA		
1	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	89.4	90.95	ER	185	2.86	
2	N-1	7353_B2_TOR12737	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	89.29	90.84	ER	185	2.86	
3	N-1	5891_B2_TOR607	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	97.78	99.89	ER	184	3.89	
4	Non	Non	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	88.34	90.4	NR	159	3.28	
5	N-1	7342_B2_TOR7202268	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	79.75	81.87	ER	198	4.18	
6	N-1	5891_B2_TOR607	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	76.52	78.48	ER	198	3.89	
7	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	87.13	88.68	ER	185	2.86	
8	N-1	7353_B2_TOR12737	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	87.02	88.57	ER	185	2.86	
9	N-1	7353_B2_TOR12737	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	72.2	82.91	ER	179	19.18	
10	N-1	P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	72.14	82.85	ER	179	19.18	
11	N-1	5891_B2_TOR607	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	97.78	99.89	ER	184	3.89	
12	Non	Non	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	88.27	90.34	NR	159	3.28	

Table 3

Multiple Facility Contingency

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

AC2-049 Multiple Facility Contingency														
#	Type	Contingency Name	Affected Area	Facility Description	Bus		Cir.	PF	Loading		Rating		MW Con.	FG App.
					From	To			Initial	Final	Type	MVA		
1	BUS	7954_C1_05MILLBR 138-2_A	AEP - AEP	05HILLSB-05HIGHLA 138 kV	243019	246911	1	DC	91.48	94.99	ER	413	14.52	

AC2-049 Multiple Facility Contingency														
#	Type	Contingency Name	Affected Area	Facility Description	Bus				Loading		Rating		MW Con.	FG App.
				line	From	To	Cir.	PF	Initial	Final	Type	MVA		
2	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05MILLBR-05N PORT 138 kV line	243042	243047	1	DC	96.7	103.11	ER	185	11.86	1
3	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05MILLBR-05N PORT 138 kV line	243042	243047	1	DC	96.7	103.11	ER	185	11.86	
4	DCTL	7981_B	AEP - AEP	05MILLBR-05N PORT 138 kV line	243042	243047	1	DC	83.28	89.55	ER	185	11.61	
5	DCTL	7981_A	AEP - AEP	05MILLBR-05N PORT 138 kV line	243042	243047	1	DC	83.28	89.55	ER	185	11.61	
6	LFFB	7970_C2_05MILLBR 138-G	AEP - AEP	05MILLBR-05S POIN 138 kV line	243042	243088	1	DC	94.78	106.18	ER	167	19.05	2
7	LFFB	7965_C2_05MILLBR 138-N	AEP - AEP	05MILLBR-05S POIN 138 kV line	243042	243088	1	DC	77.66	86.9	ER	167	15.43	
8	DCTL	7981_B	AEP - AEP	05HIGHLA-05NMARSS 138 kV line	246911	247035	1	DC	86.04	87.63	ER	310	4.93	3
9	DCTL	7981_B	AEP - AEP	05NMARSS-05SEAMAN 138 kV line	247035	243571	1	DC	82.65	84.24	ER	310	4.93	4
10	LFFB	7965_C2_05MILLBR 138-N	EKPC - AEP	2ARGENTUM-05GRAYSB 69 kV line	341020	243725	1	DC	64.24	75.96	ER	44	5.15	5

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)

AC2-049 Contribution to Previously Identified Overloads														
#	Type	Contingency Name	Affected Area	Facility Description	Bus				Loading		Rating		MW Con.	FG App.
					From	To	Cir.	PF	Initial	Final	Type	MVA		
1	DCTL	7981_B	AEP - AEP	05HILLSB-05HIGHLA 138 kV line	243019	246911	1	DC	118	120.08	ER	413	8.57	6
2	LFFB	8108_C2_05HILLSB 138-D_A	AEP - AEP	05HILLSB-05HIGHLA 138 kV line	243019	246911	1	DC	118	120.08	ER	413	8.57	
3	DCTL	7981_A	AEP - AEP	05HILLSB-05HIGHLA 138 kV line	243019	246911	1	DC	118	120.08	ER	413	8.57	
4	LFFB	7351_C2_05HILLSB 138-A	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	153.08	156.34	ER	185	6.04	7
5	LFFB	8111_C2_05HILLSB 138-A	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	156.23	159.57	ER	185	6.17	
6	BUS	7954_C1_05MILLBR 138-2_A	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	142.23	147.3	ER	185	9.38	
7	DCTL	7981_B	AEP - AEP	05HILLSB-AC1-089 TAP 138 kV line	243019	926100	1	DC	120.27	123.97	ER	185	6.84	8
8	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05HILLSB-AC1-089 TAP 138 kV line	243019	926100	1	DC	116.68	120.3	ER	185	6.7	
9	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05HILLSB-AC1-089 TAP 138 kV line	243019	926100	1	DC	116.68	120.3	ER	185	6.7	
10	DCTL	7981_A	AEP - AEP	05HILLSB-AC1-089 TAP 138 kV line	243019	926100	1	DC	120.27	123.97	ER	185	6.84	
11	LFFB	8107_C2_05HILLSB 138-C_A	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	243.39	248.13	ER	184	8.72	9
12	LFFB	8107_C2_05HILLSB 138-C_B	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	243.34	248.07	ER	184	8.72	

AC2-049 Contribution to Previously Identified Overloads														
#	Type	Contingency Name	Affected Area	Facility Description	Bus				Loading		Rating		MW Con.	FG App.
					From	To	Cir.	PF	Initial	Final	Type	MVA		
13	BUS	7954_C1_05MILLBR 138-2_A	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	181.67	189.32	ER	184	14.08	
14	N-1	7342_B2_TOR7202268	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	101.31	103.58	ER	184	4.18	
15	DCTL	7981_B	AEP - AEP	05ADAMS-05WARERD 138 kV line	243464	246942	1	DC	152.45	153.54	ER	150	3.63	10
16	LFFB	8108_C2_05HILLSB 138-D_A	AEP - AEP	05ADAMS-05WARERD 138 kV line	243464	246942	1	DC	152.45	153.54	ER	150	3.63	
17	DCTL	7981_A	AEP - AEP	05ADAMS-05WARERD 138 kV line	243464	246942	1	DC	152.45	153.54	ER	150	3.63	
18	BUS	7954_C1_05MILLBR 138-2_A	AEP - AEP	05ADAMS-05WARERD 138 kV line	243464	246942	1	DC	121.62	126.21	ER	150	6.89	
19	DCTL	7981_B	AEP - AEP	05SEAMAN-05ADAMS 138 kV line	243571	243464	1	DC	139	140.09	ER	150	3.62	11
20	LFFB	8108_C2_05HILLSB 138-D_A	AEP - AEP	05SEAMAN-05ADAMS 138 kV line	243571	243464	1	DC	139	140.09	ER	150	3.62	
21	DCTL	7981_A	AEP - AEP	05SEAMAN-05ADAMS 138 kV line	243571	243464	1	DC	139	140.09	ER	150	3.62	
22	BUS	7954_C1_05MILLBR 138-2_A	AEP - AEP	05SEAMAN-05ADAMS 138 kV line	243571	243464	1	DC	108.57	113.05	ER	150	6.72	
23	DCTL	7981_B	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	198.14	199.49	ER	122	3.64	12
24	LFFB	8108_C2_05HILLSB 138-D_A	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	198.14	199.49	ER	122	3.64	
25	DCTL	7981_A	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	198.14	199.49	ER	122	3.64	
26	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	103.13	104.55	ER	122	1.73	
27	N-1	P1-#.B2 WARREN-CLINTONCO-HILLSBORO 2381	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	103.05	104.47	ER	122	1.73	
28	DCTL	7981_B	AEP - AEP	05WARERD-05WAVERL 138 kV line	246942	243585	1	DC	142.25	143.34	ER	150	3.63	13
29	LFFB	8108_C2_05HILLSB 138-D_A	AEP - AEP	05WARERD-05WAVERL 138 kV line	246942	243585	1	DC	142.25	143.34	ER	150	3.63	
30	DCTL	7981_A	AEP - AEP	05WARERD-05WAVERL 138 kV line	246942	243585	1	DC	142.25	143.34	ER	150	3.63	
31	BUS	7954_C1_05MILLBR 138-2_A	AEP - AEP	05WARERD-05WAVERL 138 kV line	246942	243585	1	DC	111.42	116.01	ER	150	6.89	
32	DCTL	7981_B	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	147.89	151.59	ER	185	6.84	14
33	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	144.21	147.83	ER	185	6.7	
34	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	144.21	147.83	ER	185	6.7	
35	DCTL	7981_A	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	147.89	151.59	ER	185	6.84	
36	DCTL	7981_B	AEP - AEP	05EMERSS-AC2-062 TAP 138 kV line	247034	931440	1	DC	145.89	149.59	ER	185	6.84	15

AC2-049 Contribution to Previously Identified Overloads														
#	Type	Contingency	Affected Area	Facility Description	Bus		Cir.	PF	Loading		Rating Type	MVA	MW Con.	FG App.
		Name			From	To			Initial	Final				
37	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05EMERSS-AC2-062 TAP 138 kV line	247034	931440	1	DC	142.16	145.78	ER	185	6.7	
38	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05EMERSS-AC2-062 TAP 138 kV line	247034	931440	1	DC	142.16	145.78	ER	185	6.7	
39	DCTL	7981_A	AEP - AEP	05EMERSS-AC2-062 TAP 138 kV line	247034	931440	1	DC	145.89	149.59	ER	185	6.84	
40	LFFB	8107_C2_05HILLSB 138-C_A	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	212.63	217.03	ER	198	8.72	16
41	LFFB	8107_C2_05HILLSB 138-C_B	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	212.58	216.98	ER	198	8.72	
42	LFFB	7351_C2_05HILLSB 138-A	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	168.36	172.92	ER	198	9.03	
43	BUS	7954_C1_05MILLBR 138-2_A	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	155.02	162.13	ER	198	14.08	
44	LFFB	7351_C2_05HILLSB 138-A	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	150.81	154.07	ER	185	6.04	17
45	LFFB	8111_C2_05HILLSB 138-A	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	153.96	157.3	ER	185	6.17	
46	BUS	7954_C1_05MILLBR 138-2_A	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	139.96	145.03	ER	185	9.38	
47	DCTL	7981_B	AEP - AEP	AC1-089 TAP-05WLDCAT 138 kV line	926100	246946	1	DC	148.97	152.67	ER	185	6.84	18
48	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	AC1-089 TAP-05WLDCAT 138 kV line	926100	246946	1	DC	145.3	148.92	ER	185	6.7	
49	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	AC1-089 TAP-05WLDCAT 138 kV line	926100	246946	1	DC	145.3	148.92	ER	185	6.7	
50	DCTL	7981_A	AEP - AEP	AC1-089 TAP-05WLDCAT 138 kV line	926100	246946	1	DC	148.97	152.67	ER	185	6.84	
51	DCTL	7981_B	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	215.9	234.67	ER	179	33.58	19
52	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	216.48	235.24	ER	179	33.58	
53	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	216.48	235.24	ER	179	33.58	
54	DCTL	7981_A	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	215.9	234.67	ER	179	33.58	
55	LFFB	8107_C2_05HILLSB 138-C_B	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	243.34	248.07	ER	184	8.72	20
56	LFFB	8107_C2_05HILLSB 138-C_A	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	243.34	248.07	ER	184	8.72	
57	LFFB	7351_C2_05HILLSB 138-A	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	195.64	200.55	ER	184	9.03	
58	BUS	7954_C1_05MILLBR 138-2_A	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	181.67	189.32	ER	184	14.08	
59	N-1	7342_B2_TOR7202268	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	101.31	103.58	ER	184	4.18	
60	DCTL	7981_B	AEP - LGEE	AC2-062 TAP-4KENTON 138 kV line	931440	324267	1	DC	145.19	148.89	ER	185	6.84	21

AC2-049 Contribution to Previously Identified Overloads														
Contingency		Affected Area	Facility Description	Bus		Loading		Rating		MW Con.	FG App.			
#	Type			Name	From	To	Cir.	PF	Initial			Final	Type	MVA
61	LFFB	8107_C2_05HILLSB 138-C_B	AEP - LGEE	AC2-062 TAP-4KENTON 138 kV line	931440	324267	1	DC	141.51	145.13	ER	185	6.7	
62	LFFB	8107_C2_05HILLSB 138-C_A	AEP - LGEE	AC2-062 TAP-4KENTON 138 kV line	931440	324267	1	DC	141.51	145.13	ER	185	6.7	
63	DCTL	7981_A	AEP - LGEE	AC2-062 TAP-4KENTON 138 kV line	931440	324267	1	DC	145.19	148.89	ER	185	6.84	

Table 5

Steady-State Voltage Requirements

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed, which will study all overload conditions associated with the overloaded element(s) identified.

AC2-049 Delivery of Energy Portion of Interconnection Request														
Contingency			Affected Area	Facility Description	Bus		Cir.	PF	Loading		Rating		MW Con.	FG App.
#	Type	Name			From	To			Initial	Final	Type	MVA		
1	Non	Non	AEP - AEP	05HILLSB-05HIGHLA 138 kV line	243019	246911	1	DC	106.64	108.39	NR	296	5.18	
2	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - AEP	05HILLSB-05HIGHLA 138 kV line	243019	246911	1	DC	94.23	95.88	ER	413	6.79	
3	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	149.86	151.02	ER	185	4.77	
4	N-1	7353_B2_TOR12737	AEP - AEP	05HILLSB-AC1-089 TAP 138 kV line	243019	926100	1	DC	80.94	83.9	ER	185	5.48	
5	N-1	7342_B2_TOR7202268	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	187.92	191.7	ER	184	6.97	
6	Non	Non	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	171.27	174.71	NR	159	5.47	

AC2-049 Delivery of Energy Portion of Interconnection Request														
#	Type	Contingency Name	Affected Area	Facility Description	Bus		Cir.	PF	Loading		Type	Rating MVA	MW Con.	FG App.
					From	To			Initial	Final				
7	N-1	462_B3_05MILLBR 138-5_WOMOAB	AEP - AEP	05MILLBR-05S POIN 138 kV line	243042	243088	1	DC	77.65	86.87	ER	167	15.4	
8	N-1	P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381	AEP - AEP	05ADAMS-05WARERD 138 kV line	243464	246942	1	DC	121.85	122.71	ER	150	2.85	
9	N-1	7353_B2_TOR12737	AEP - AEP	05SEAMAN-05ADAMS 138 kV line	243571	243464	1	DC	109.54	110.4	ER	150	2.86	
10	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	161.4	162.47	ER	122	2.88	
11	N-1	P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381	AEP - AEP	05WARERD-05WAVERL 138 kV line	246942	243585	1	DC	111.65	112.51	ER	150	2.85	
12	N-1	7353_B2_TOR12737	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	104.94	107.9	ER	185	5.48	
13	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - AEP	05EMERSS-AC2-062 TAP 138 kV line	247034	931440	1	DC	102.94	105.9	ER	185	5.48	
14	N-1	7342_B2_TOR7202268	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	160.83	164.35	ER	198	6.97	
15	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	147.58	148.75	ER	185	4.77	
16	N-1	462_B3_05MILLBR 138-5_WOMOAB	EKPC - AEP	2ARGENTUM-05GRAYSB 69 kV line	341020	243725	1	DC	62.64	74.56	ER	44	5.25	
17	N-1	P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381	AEP - AEP	AC1-089 TAP-05WLDCAT 138 kV line	926100	246946	1	DC	106.26	109.22	ER	185	5.48	
18	N-1	7353_B2_TOR12737	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	163.08	180.93	ER	179	31.96	
19	N-1	7342_B2_TOR7202268	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	187.92	191.7	ER	184	6.97	
20	Non	Non	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	171.2	174.64	NR	159	5.47	
21	N-1	7353_B2_TOR12737	AEP - LGEE	AC2-062 TAP-4KENTON 138 kV line	931440	324267	1	DC	101.86	104.82	ER	185	5.48	

Table 6

New System Reinforcements

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

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	05MILLBR-N PORT 138 kV line	A Sag Study will be required on the 3.44 mile ACSR 477 26/7 conductor section 1 to mitigate the overload.	An approximate time for the sag study is 6 to 12 months after signing an interconnection agreement.	\$15,000
#2	05MILLBR-05S POIN 138 kV line	A Sag Study will be required on the 8.5 mile ACSR 397.5 30/7 conductor section 1 to mitigate the overload. Replace the South Point risers Replace the Millbrook Park risers	An approximate time for the sag study is 6 to 12 months after signing an interconnection agreement. An approximate construction time would be	\$463,000

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
		An engineering study will need to be conducted to determine if the Relay Thermal limits settings can be adjusted at South Point to mitigate the overload. Replace the Millbrook Park Wavetrap (800A) Replace the Millbrook Park line risers	12 to 24 months after signing an interconnection agreement	
#3	05HIGHLA-05NMARSS 138 kV line	1.0 mile of ACSR 636 26/7 conductor section 2 will need to be rebuilt/reconductored. This facility is not overloaded by the AC2-049 project as is shown in table 4 above but the AC2 Queue overloads this facility and the AC2-049 project contributes to the overload.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	\$1,500,000
#4	05NMARSS-05SEAMAN 138 kV line	13.2 mile of ACSR 636 26/7 conductor section 2 will need to be rebuilt/reconductored. This facility is not overloaded by the AC2-049 project as is shown in table 4 above but the AC2 Queue overloads this facility and the AC2-049 project contributes to the overload.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	\$19,800,000
Total Network Upgrades				\$21,778,000

Table 8

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 AC2-049.

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	02ARGENTUM-05GRAYSB 69 kV line	1.0 miles of ACSR 167.8 6/1 conductor section 1 will need to be rebuilt/reconductored. This facility is not overloaded by the AC2-049 project as is shown in table 4 above but the AC2 Queue overloads this facility and the AC2-049 project contributes to the overload.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	\$1,200,000
Total Network Upgrades				\$1,200,000

Table 9

Contribution to Previously Identified System Reinforcements

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

(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	05HILLSB-05HIGHLA 138 kV line	4.24 miles of the ACSR 1033.5 54/7 conductor section 2 will need to be rebuilt/reconductored. 3.15 miles of ACSR 1033.5 54/7 conductor section 1 will need to be rebuilt/reconductored. Replace the Highland Wavetrap (2000A) Replace the Hillsboro Wavetrap (2000A)	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	\$11,190,000
#2	05HILLSB-09MIDDLE 138 kV line	22.3 miles of the ACSR 477 26/7 conductor section 1 will need to be rebuilt/reconductored. An engineering study will need to be conducted to determine if the Relay Compliance Trip limits settings at Hillsboro can be adjusted to mitigate the overload.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	\$33,450,000
#3	05HILLSB-AC1-089 Tap 138 kV line	A Sag Study will be required on the 8.5 mile ACSR 477 26/7 conductor section 1 to mitigate the overload.	An approximate time for the sag study is 6 to 12 months after signing an interconnection agreement.	\$34,000
#4	05ADAMS-05WARERD 138 kV line	20.52 miles of ACSR 336.4 30/7 conductor section 1 will need to be rebuilt/reconductored.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	\$30,780,000
#5	05SEAMAN-05ADAMS 138 kV line	8.0 miles of ACSR 336.4 30/7 conductor section 1 will need to be rebuilt/reconductored.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	\$12,000,000
#6	05WARERD- 05WAVERL 138 kV line	3.12 miles of ACSR 336.4 30/7 conductor section 1 will need to be rebuilt/reconductored. 4.37 miles of ACSR 336.4 30/7 conductor section 2 will need to be rebuilt/reconductored.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	\$11,240,000
	05WLDCAT-05EMERSS 138 kV line	1.3 miles of the ACSR 477 26/7 conductor section 1 will need to be rebuilt/reconductored. Replace the Emerald jumpers	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	\$2,025,000

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#7		An engineering study will need to be conducted to determine if the Relay Compliance Trip limits settings at Wildcat can be adjusted to mitigate the overload.		
#8	05EMERSS-AC2-062 Tap 138 kV line	6.4 miles of the ACSR 477 26/7 conductor section 1 will need to be rebuilt/reconductored.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	\$9,600,000
#9	05WLDCAT-AC1-089 Tap 138 kV line	1.7 mile of ACSR 477 26/7 conductor section 2 will need to be rebuilt/reconductored.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	\$2,500,000
#10	AC2-062 Tap-4KENTON 138 kV line	18.0 miles of the ACSR 477 26/7 conductor section 1 will need to be rebuilt/reconductored. Replace the Emerald Jumpers This is an AEP-LGEE tie line therefore; PJM is going to have to coordinate this upgrade with LGEE as well to make sure that their equipment will not set a limit lower than what is required	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	\$27,050,000
#11	AC2-049 Tap- 05MILLBR 138 kV line	An engineering study will need to be conducted to determine if the Relay Compliance Trip limit settings can be adjusted at Millbrook Park to mitigate the overload. 8.50 miles of ACSR 477 26/7 conductor section 3 will need to be rebuilt/reconductored. Replace the Millbrook Park line risers Replace the Millbrook Park bus and risers Replace the Millbrook Park trap riser Replace the Sinking Spring switch (1200A) 20.4 miles of ACSR 477 26/7 conductor section 2 will need to be rebuilt/reconductored. 9.8 miles of ACSR 477 26/7 conductor section 1 will need to be rebuilt/reconductored. An engineering study will need to be conducted to determine if the Relay Thermal limits settings can be adjusted at Millbrook Park to mitigate the overload.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	\$59,100,000

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
		Replace the Hillsboro Wavetrap (2000A)		
			Total Network Upgrades	\$198,969,000

Table 10

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 AC2-049.

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	05HIGHLA 138/69 kV transformer	Replace the 138/69 kV Transformer #3 at Highland	An approximate construction time will be 12 months after signing of an interconnection agreement.	\$1,500,000
			Total Network Upgrades	\$1,500,000

Table 11

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 In-Service Date is shorter than usual and may be difficult to achieve.

Conclusion

Based upon the results of this Feasibility Study, the construction of the 49.0 MW (29.4 MW Capacity) IC's solar generating facility (PJM Project #AC2-049) 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's generating facility.

Cost Breakdown for Point of Interconnection (Hillsboro – Millbrook Park 138 kV)		
Attachment Cost	New 138 kV Switching Station	\$6,300,000
Direct Connection Cost Estimate	Millbrook Park-Hillsboro 138 kV T-Line Cut In	\$1,500,000
Non-Direct Connection Cost Estimate	138 kV Revenue Metering	\$250,000
	Upgrade line protection and controls at the Millbrook Park 138 kV substation.	\$250,000
	Upgrade line protection and controls at the Hillsboro 138 kV substation.	\$250,000

	New System Reinforcements-Not part of the BES	\$1,200,000
	New System Reinforcements	\$21,778,000
	Contribution to Previously Identified System Reinforcements-Not part of the BES	\$1,500,000
	Contribution to Previously Identified System Reinforcements	\$198,969,000
	Total Estimated Cost for Project AC2-049	\$231,997,000

Table 12

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.

Figure 1: Point of Interconnection (Hillsboro – Sinking Springs 138 kV)
Single-Line Diagram

**AC2-049 Point of Interconnection
Line Tap/New 138kV Switching Station**

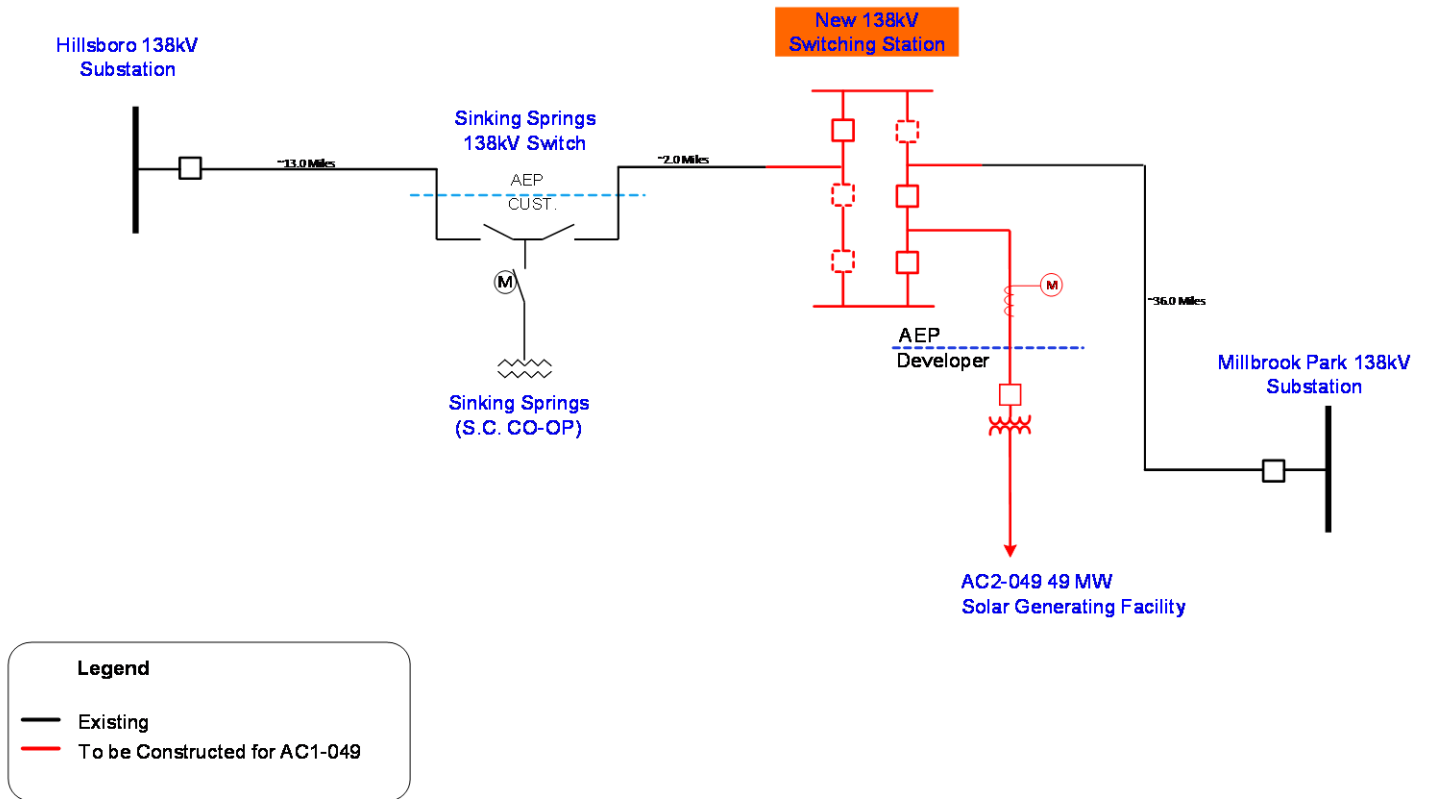


Figure 2: Point of Interconnection (Hillsboro – Sinking Springs 138 kV)

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(AEP - AEP) The 05MILLBR-05N PORT 138 kV line (from bus 243042 to bus 243047 ckt 1) loads from 96.7% to 103.11% (**DC power flow**) of its emergency rating (185 MVA) for the line fault with failed breaker contingency outage of '8107_C2_05HILLSB 138-C_A'. This project contributes approximately 11.86 MW to the thermal violation.

CONTINGENCY '8107_C2_05HILLSB 138-C_A'

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

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
342948	1LOVE HYDRO	2.67
931022	AC2-008 E	0.97
931221	AC2-031 C	8.2
931222	AC2-031 E	4.04
931281	AC2-042 C	25.63
931282	AC2-042 E	17.09
931351	AC2-049 C	7.12
931352	AC2-049 E	4.74
931431	AC2-061 C	5.52
931432	AC2-061 E	5.6
931441	AC2-062 C OP	2.25
931442	AC2-062 E OP	1.01
931451	AC2-064 C	16.7
931452	AC2-064 E	11.14
247613	X4-025	4.37
916272	Z1-080 E	0.41
926061	AC1-085 C	18.6
926062	AC1-085 E	30.36
926101	AC1-089 C	6.25
926102	AC1-089 E	10.2
926631	AC1-144 C	8.24
926632	AC1-144 E	4.

Appendix 2

(AEP - AEP) The 05MILLBR-05S POIN 138 kV line (from bus 243042 to bus 243088 ckt 1) loads from 94.78% to 106.18% (**DC power flow**) of its emergency rating (167 MVA) for the line fault with failed breaker contingency outage of '7970_C2_05MILLBR 138-G'. This project contributes approximately 19.05 MW to the thermal violation.

CONTINGENCY '7970_C2_05MILLBR 138-G'

OPEN BRANCH FROM BUS 242988 TO BUS 243042 CKT 1 / 242988
 05DOGWOO 138 243042 05MILLBR 138 1
 OPEN BRANCH FROM BUS 243069 TO BUS 243042 CKT 1 / 243069 05FIREBR
 138 243042 05MILLBR 138 1
 OPEN BRANCH FROM BUS 243688 TO BUS 243042 CKT 1 / 243688
 05FULLER 138 243042 05MILLBR 138 1
 OPEN BRANCH FROM BUS 243688 TO BUS 342538 CKT 1 / 243688
 05FULLER 138 342538 4ARGENTUM 138 1
 OPEN BRANCH FROM BUS 243042 TO BUS 243047 CKT 1 / 243042
 05MILLBR 138 243047 05N PORT 138 1
 OPEN BRANCH FROM BUS 243042 TO BUS 243173 CKT 1 / 243042
 05MILLBR 138 243173 MILLBRK 69.0 1
 OPEN BRANCH FROM BUS 243688 TO BUS 244686 CKT 1 / 243688
 05FULLER 138 244686 VANCEBRG 12.0 1
 END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	1.13
931121	AC2-019 C	0.32
931122	AC2-019 E	0.52
931192	AC2-027 E	0.83
931221	AC2-031 C	9.38
931222	AC2-031 E	4.62
931281	AC2-042 C	29.32
931282	AC2-042 E	19.55
931351	AC2-049 C	11.43
931352	AC2-049 E	7.62
931431	AC2-061 C	6.47
931432	AC2-061 E	6.56
931441	AC2-062 C OP	2.73
931442	AC2-062 E OP	1.22
931451	AC2-064 C	26.82
931452	AC2-064 E	17.88
247613	X4-025	7.47
916272	Z1-080 E	0.5
924371	AB2-085 C OP	3.48
924372	AB2-085 E OP	1.64
924541	AB2-103 C OP	2.12

924542	<i>AB2-103 E OP</i>	<i>1.</i>
926061	<i>AC1-085 C</i>	<i>21.28</i>
926062	<i>AC1-085 E</i>	<i>34.73</i>
926101	<i>AC1-089 C</i>	<i>7.2</i>
926102	<i>AC1-089 E</i>	<i>11.74</i>
926631	<i>AC1-144 C</i>	<i>9.42</i>
926632	<i>AC1-144 E</i>	<i>4.58</i>

Appendix 3

(AEP - AEP) The 05HIGHLA-05NMARSS 138 kV line (from bus 246911 to bus 247035 ckt 1) loads from 86.04% to 87.63% (**DC power flow**) of its emergency rating (310 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 4.93 MW to the thermal violation.

CONTINGENCY '7981_B'

OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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
OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1
OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	1.73
931121	AC2-019 C	0.77
931122	AC2-019 E	1.25
931131	AC2-020 C OP	0.54
931132	AC2-020 E OP	1.42
931192	AC2-027 E	2.02
931221	AC2-031 C	14.63
931222	AC2-031 E	7.2
931281	AC2-042 C	45.72
931282	AC2-042 E	30.48
931351	AC2-049 C	2.96
931352	AC2-049 E	1.97
931381	AC2-055 C OP	1.77
931382	AC2-055 E OP	2.88
931421	AC2-060 C	4.94
931422	AC2-060 E	2.78
931431	AC2-061 C	12.68
931432	AC2-061 E	12.86
931441	AC2-062 C OP	4.07
931442	AC2-062 E OP	1.82
931451	AC2-064 C	6.95
931452	AC2-064 E	4.63
931651	AC2-087 C OP	3.66
931652	AC2-087 E OP	2.9
247592	W4-036	0.93
926061	AC1-085 C	33.18
926062	AC1-085 E	54.14

<i>926101</i>	<i>AC1-089 C</i>	<i>11.16</i>
<i>926102</i>	<i>AC1-089 E</i>	<i>18.22</i>
<i>926631</i>	<i>AC1-144 C</i>	<i>14.69</i>
<i>926632</i>	<i>AC1-144 E</i>	<i>7.14</i>

Appendix 4

(AEP - AEP) The 05NMARSS-05SEAMAN 138 kV line (from bus 247035 to bus 243571 ckt 1) loads from 82.65% to 84.24% (**DC power flow**) of its emergency rating (310 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 4.93 MW to the thermal violation.

CONTINGENCY '7981_B'

OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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
OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1
OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	1.73
931121	AC2-019 C	0.77
931122	AC2-019 E	1.25
931131	AC2-020 C OP	0.54
931132	AC2-020 E OP	1.42
931192	AC2-027 E	2.02
931221	AC2-031 C	14.63
931222	AC2-031 E	7.2
931281	AC2-042 C	45.72
931282	AC2-042 E	30.48
931351	AC2-049 C	2.96
931352	AC2-049 E	1.97
931381	AC2-055 C OP	1.77
931382	AC2-055 E OP	2.88
931421	AC2-060 C	4.94
931422	AC2-060 E	2.78
931431	AC2-061 C	12.68
931432	AC2-061 E	12.86
931441	AC2-062 C OP	4.07
931442	AC2-062 E OP	1.82
931451	AC2-064 C	6.95
931452	AC2-064 E	4.63
931651	AC2-087 C OP	3.66
931652	AC2-087 E OP	2.9
247592	W4-036	0.93
926061	AC1-085 C	33.18
926062	AC1-085 E	54.14

<i>926101</i>	<i>AC1-089 C</i>	<i>11.16</i>
<i>926102</i>	<i>AC1-089 E</i>	<i>18.22</i>
<i>926631</i>	<i>AC1-144 C</i>	<i>14.69</i>
<i>926632</i>	<i>AC1-144 E</i>	<i>7.14</i>

Appendix 5

(EKPC - AEP) The 2ARGENTUM-05GRAYSB 69 kV line (from bus 341020 to bus 243725 ckt 1) loads from 64.24% to 75.96% (**DC power flow**) of its emergency rating (44 MVA) for the line fault with failed breaker contingency outage of '7965_C2_05MILLBR 138-N'. This project contributes approximately 5.15 MW to the thermal violation.

CONTINGENCY '7965_C2_05MILLBR 138-N'

OPEN BRANCH FROM BUS 242988 TO BUS 243042 CKT 1 / 242988
 05DOGWOO 138 243042 05MILLBR 138 1
 OPEN BRANCH FROM BUS 243069 TO BUS 243042 CKT 1 / 243069 05FIREBR
 138 243042 05MILLBR 138 1
 OPEN BRANCH FROM BUS 243042 TO BUS 243047 CKT 1 / 243042
 05MILLBR 138 243047 05N PORT 138 1
 OPEN BRANCH FROM BUS 243042 TO BUS 243173 CKT 1 / 243042
 05MILLBR 138 243173 05MILLBRK 69.0 1
 OPEN BRANCH FROM BUS 243047 TO BUS 243819 CKT 1 / 243047 05N PORT
 138 243819 05N PORTSM 69.0 1
 OPEN BRANCH FROM BUS 243819 TO BUS 243826 CKT 1 / 243819 05N
 PORTSM 69.0 243826 05ORTELCRN 69.0 1
 OPEN BRANCH FROM BUS 243819 TO BUS 243822 CKT 1 / 243819 05N
 PORTSM 69.0 243822 05ROSEMOUN 69.0 1
 END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
342948	1LOVE HYDRO	3.14
931351	AC2-049 C	3.09
931352	AC2-049 E	2.06
931451	AC2-064 C	7.26
931452	AC2-064 E	4.84
247613	X4-025	2.03

Appendix 6

(AEP - AEP) The 05HILLSB-05HIGHLA 138 kV line (from bus 243019 to bus 246911 ckt 1) loads from 118.0% to 120.08% (**DC power flow**) of its emergency rating (413 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 8.57 MW to the thermal violation.

CONTINGENCY '7981_B'

OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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
OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1
OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	2.92
931132	AC2-020 E OP	2.77
931221	AC2-031 C	24.64
931222	AC2-031 E	12.14
931281	AC2-042 C	77.01
931282	AC2-042 E	51.34
931351	AC2-049 C	5.14
931352	AC2-049 E	3.43
931431	AC2-061 C	21.37
931432	AC2-061 E	21.66
931441	AC2-062 C OP	6.83
931442	AC2-062 E OP	3.05
931451	AC2-064 C	12.07
931452	AC2-064 E	8.05
926061	AC1-085 C	55.9
926062	AC1-085 E	91.2
926101	AC1-089 C	18.8
926102	AC1-089 E	30.67
926631	AC1-144 C	24.75
926632	AC1-144 E	12.03

Appendix 7

(AEP - DAY) The 05HILLSB-09MIDDLE 138 kV line (from bus 243019 to bus 253111 ckt 1) loads from 153.08% to 156.34% (**DC power flow**) of its emergency rating (185 MVA) for the line fault with failed breaker contingency outage of '7351_C2_05HILLSB 138-_A'. This project contributes approximately 6.04 MW to the thermal violation.

CONTINGENCY '7351_C2_05HILLSB 138-_A'

OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911

05HIGHLA 138 243019 05HILLSB 138 1

OPEN BRANCH FROM BUS 243019 TO BUS 926100 CKT 1 / 243019 05HILLSB

138 926100 AC1-089 TAP 138 1

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931221	AC2-031 C	16.89
931222	AC2-031 E	8.32
931281	AC2-042 C	52.79
931282	AC2-042 E	35.2
931351	AC2-049 C	3.62
931352	AC2-049 E	2.42
931431	AC2-061 C	11.38
931432	AC2-061 E	11.53
931451	AC2-064 C	8.5
931452	AC2-064 E	5.67
916272	Z1-080 E	0.84
926061	AC1-085 C	38.32
926062	AC1-085 E	62.53
926631	AC1-144 C	16.97
926632	AC1-144 E	8.24

Appendix 8

(AEP - AEP) The 05HILLSB-AC1-089 TAP 138 kV line (from bus 243019 to bus 926100 ckt 1) loads from 120.27% to 123.97% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 6.84 MW to the thermal violation.

CONTINGENCY '7981_B'

OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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
OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1
OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931121	AC2-019 C	0.61
931122	AC2-019 E	1.
931131	AC2-020 C OP	0.46
931132	AC2-020 E OP	1.22
931192	AC2-027 E	1.62
931221	AC2-031 C	18.99
931222	AC2-031 E	9.35
931281	AC2-042 C	59.34
931282	AC2-042 E	39.56
931351	AC2-049 C	4.11
931352	AC2-049 E	2.74
931381	AC2-055 C OP	1.49
931382	AC2-055 E OP	2.42
931421	AC2-060 C	4.27
931422	AC2-060 E	2.4
931431	AC2-061 C	16.47
931432	AC2-061 E	16.69
931451	AC2-064 C	9.64
931452	AC2-064 E	6.43
931651	AC2-087 C OP	3.16
931652	AC2-087 E OP	2.51
247592	W4-036	0.8
924371	AB2-085 C OP	7.03
924372	AB2-085 E OP	3.31
924541	AB2-103 C OP	4.25
924542	AB2-103 E OP	2.
926061	AC1-085 C	43.08

<i>926062</i>	<i>AC1-085 E</i>	<i>70.28</i>
<i>926631</i>	<i>AC1-144 C</i>	<i>19.07</i>
<i>926632</i>	<i>AC1-144 E</i>	<i>9.27</i>

Appendix 9

(AEP - DEO&K) The 05HILLSB-AC2-061 TAP 138 kV line (from bus 243019 to bus 931430 ckt 1) loads from 243.39% to 248.13% (**DC power flow**) of its emergency rating (184 MVA) for the line fault with failed breaker contingency outage of '8107_C2_05HILLSB 138-C_A'. This project contributes approximately 8.72 MW to the thermal violation.

CONTINGENCY '8107_C2_05HILLSB 138-C_A'

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

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	2.88
931221	AC2-031 C	24.37
931222	AC2-031 E	12.
931281	AC2-042 C	76.15
931282	AC2-042 E	50.77
931351	AC2-049 C	5.23
931352	AC2-049 E	3.49
931441	AC2-062 C OP	6.68
931442	AC2-062 E OP	2.99
931451	AC2-064 C	12.27
931452	AC2-064 E	8.18
916272	Z1-080 E	2.17
926061	AC1-085 C	55.28
926062	AC1-085 E	90.19
926101	AC1-089 C	18.57
926102	AC1-089 E	30.29
926631	AC1-144 C	24.48
926632	AC1-144 E	11.89

Appendix 10

(AEP - AEP) The 05ADAMS-05WARERD 138 kV line (from bus 243464 to bus 246942 ckt 1) loads from 152.45% to 153.54% (**DC power flow**) of its emergency rating (150 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 3.63 MW to the thermal violation.

CONTINGENCY '7981_B'

OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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
OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1
OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	1.34
931121	AC2-019 C	0.59
931122	AC2-019 E	0.96
931131	AC2-020 C OP	0.41
931132	AC2-020 E OP	1.07
931192	AC2-027 E	1.55
931221	AC2-031 C	11.2
931222	AC2-031 E	5.51
931281	AC2-042 C	34.99
931282	AC2-042 E	23.33
931351	AC2-049 C	2.18
931352	AC2-049 E	1.45
931381	AC2-055 C OP	1.33
931382	AC2-055 E OP	2.18
931421	AC2-060 C	3.7
931422	AC2-060 E	2.08
931431	AC2-061 C	9.71
931432	AC2-061 E	9.84
931441	AC2-062 C OP	3.21
931442	AC2-062 E OP	1.44
931451	AC2-064 C	5.11
931452	AC2-064 E	3.41
931651	AC2-087 C OP	2.74
931652	AC2-087 E OP	2.18
247592	W4-036	0.69
924371	AB2-085 C OP	27.11
924372	AB2-085 E OP	12.76

924541	<i>AB2-103 C OP</i>	<i>10.95</i>
924542	<i>AB2-103 E OP</i>	<i>5.15</i>
926061	<i>AC1-085 C</i>	<i>25.4</i>
926062	<i>AC1-085 E</i>	<i>41.44</i>
926101	<i>AC1-089 C</i>	<i>8.57</i>
926102	<i>AC1-089 E</i>	<i>13.99</i>
926631	<i>AC1-144 C</i>	<i>11.25</i>
926632	<i>AC1-144 E</i>	<i>5.46</i>

Appendix 11

(AEP - AEP) The 05SEAMAN-05ADAMS 138 kV line (from bus 243571 to bus 243464 ckt 1) loads from 139.0% to 140.09% (**DC power flow**) of its emergency rating (150 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 3.62 MW to the thermal violation.

CONTINGENCY '7981_B'

OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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
OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1
OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	1.31
931121	AC2-019 C	0.58
931122	AC2-019 E	0.95
931131	AC2-020 C OP	0.4
931132	AC2-020 E OP	1.06
931192	AC2-027 E	1.53
931221	AC2-031 C	11.02
931222	AC2-031 E	5.43
931281	AC2-042 C	34.44
931282	AC2-042 E	22.96
931351	AC2-049 C	2.17
931352	AC2-049 E	1.45
931381	AC2-055 C OP	1.32
931382	AC2-055 E OP	2.15
931421	AC2-060 C	3.67
931422	AC2-060 E	2.07
931431	AC2-061 C	9.56
931432	AC2-061 E	9.69
931441	AC2-062 C OP	3.13
931442	AC2-062 E OP	1.4
931451	AC2-064 C	5.1
931452	AC2-064 E	3.4
931651	AC2-087 C OP	2.72
931652	AC2-087 E OP	2.16
247592	W4-036	0.69
924541	AB2-103 C OP	10.77
924542	AB2-103 E OP	5.07

926061	AC1-085 C	25.
926062	AC1-085 E	40.79
926101	AC1-089 C	8.43
926102	AC1-089 E	13.75
926631	AC1-144 C	11.07
926632	AC1-144 E	5.38

Appendix 12

(AEP - AEP) The 05HIGHLA 138/69 kV transformer (from bus 246911 to bus 243606 ckt 3) loads from 198.14% to 199.49% (**DC power flow**) of its emergency rating (122 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 3.64 MW to the thermal violation.

CONTINGENCY '7981_B'

OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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
OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1
OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	1.18
931132	AC2-020 E OP	4.19
931221	AC2-031 C	10.01
931222	AC2-031 E	4.93
931281	AC2-042 C	31.29
931282	AC2-042 E	20.86
931351	AC2-049 C	2.18
931352	AC2-049 E	1.45
931431	AC2-061 C	8.68
931432	AC2-061 E	8.8
931441	AC2-062 C OP	2.76
931442	AC2-062 E OP	1.23
931451	AC2-064 C	5.12
931452	AC2-064 E	3.41
924371	AB2-085 C OP	5.85
924372	AB2-085 E OP	2.75
924541	AB2-103 C OP	3.58
924542	AB2-103 E OP	1.68
926061	AC1-085 C	22.71
926062	AC1-085 E	37.06
926101	AC1-089 C	7.63
926102	AC1-089 E	12.45
926631	AC1-144 C	10.06
926632	AC1-144 E	4.89

Appendix 13

(AEP - AEP) The 05WARERD-05WAVERL 138 kV line (from bus 246942 to bus 243585 ckt 1) loads from 142.25% to 143.34% (**DC power flow**) of its emergency rating (150 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 3.63 MW to the thermal violation.

CONTINGENCY '7981_B'

OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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
OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1
OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	1.34
931121	AC2-019 C	0.59
931122	AC2-019 E	0.96
931131	AC2-020 C OP	0.41
931132	AC2-020 E OP	1.07
931192	AC2-027 E	1.55
931221	AC2-031 C	11.2
931222	AC2-031 E	5.51
931281	AC2-042 C	34.99
931282	AC2-042 E	23.33
931351	AC2-049 C	2.18
931352	AC2-049 E	1.45
931381	AC2-055 C OP	1.33
931382	AC2-055 E OP	2.18
931421	AC2-060 C	3.7
931422	AC2-060 E	2.08
931431	AC2-061 C	9.71
931432	AC2-061 E	9.84
931441	AC2-062 C OP	3.21
931442	AC2-062 E OP	1.44
931451	AC2-064 C	5.11
931452	AC2-064 E	3.41
931651	AC2-087 C OP	2.74
931652	AC2-087 E OP	2.18
247592	W4-036	0.69
924371	AB2-085 C OP	27.11
924372	AB2-085 E OP	12.76

924541	<i>AB2-103 C OP</i>	<i>10.95</i>
924542	<i>AB2-103 E OP</i>	<i>5.15</i>
926061	<i>AC1-085 C</i>	<i>25.4</i>
926062	<i>AC1-085 E</i>	<i>41.44</i>
926101	<i>AC1-089 C</i>	<i>8.57</i>
926102	<i>AC1-089 E</i>	<i>13.99</i>
926631	<i>AC1-144 C</i>	<i>11.25</i>
926632	<i>AC1-144 E</i>	<i>5.46</i>

Appendix 14

(AEP - AEP) The 05WLDCAT-05EMERSS 138 kV line (from bus 246946 to bus 247034 ckt 1) loads from 147.89% to 151.59% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 6.84 MW to the thermal violation.

CONTINGENCY '7981_B'

OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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
OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1
OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	4.3
931121	AC2-019 C	0.61
931122	AC2-019 E	1.
931131	AC2-020 C OP	0.46
931132	AC2-020 E OP	1.22
931192	AC2-027 E	1.62
931221	AC2-031 C	18.99
931222	AC2-031 E	9.35
931281	AC2-042 C	59.34
931282	AC2-042 E	39.56
931351	AC2-049 C	4.11
931352	AC2-049 E	2.74
931381	AC2-055 C OP	1.49
931382	AC2-055 E OP	2.42
931421	AC2-060 C	4.27
931422	AC2-060 E	2.4
931431	AC2-061 C	16.47
931432	AC2-061 E	16.69
931451	AC2-064 C	9.64
931452	AC2-064 E	6.43
931651	AC2-087 C OP	3.16
931652	AC2-087 E OP	2.51
247592	W4-036	0.8
924371	AB2-085 C OP	7.03
924372	AB2-085 E OP	3.31
924541	AB2-103 C OP	4.25
924542	AB2-103 E OP	2.

926061	AC1-085 C	43.08
926062	AC1-085 E	70.28
926101	AC1-089 C	20.33
926102	AC1-089 E	33.17
926631	AC1-144 C	19.07
926632	AC1-144 E	9.27

Appendix 15

(AEP - AEP) The 05EMERSS-AC2-062 TAP 138 kV line (from bus 247034 to bus 931440 ckt 1) loads from 145.89% to 149.59% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 6.84 MW to the thermal violation.

CONTINGENCY '7981_B'

OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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
OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1
OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	4.3
931121	AC2-019 C	0.61
931122	AC2-019 E	1.
931131	AC2-020 C OP	0.46
931132	AC2-020 E OP	1.22
931192	AC2-027 E	1.62
931221	AC2-031 C	18.99
931222	AC2-031 E	9.35
931281	AC2-042 C	59.34
931282	AC2-042 E	39.56
931351	AC2-049 C	4.11
931352	AC2-049 E	2.74
931381	AC2-055 C OP	1.49
931382	AC2-055 E OP	2.42
931421	AC2-060 C	4.27
931422	AC2-060 E	2.4
931431	AC2-061 C	16.47
931432	AC2-061 E	16.69
931451	AC2-064 C	9.64
931452	AC2-064 E	6.43
931651	AC2-087 C OP	3.16
931652	AC2-087 E OP	2.51
247592	W4-036	0.8
924371	AB2-085 C OP	7.03
924372	AB2-085 E OP	3.31
924541	AB2-103 C OP	4.25
924542	AB2-103 E OP	2.

926061	AC1-085 C	43.08
926062	AC1-085 E	70.28
926101	AC1-089 C	20.33
926102	AC1-089 E	33.17
926631	AC1-144 C	19.07
926632	AC1-144 E	9.27

Appendix 16

(DEO&K - DEO&K) The 08CLINCO-08WARRN1 138 kV line (from bus 249995 to bus 250122 ckt 1) loads from 212.63% to 217.03% (**DC power flow**) of its emergency rating (198 MVA) for the line fault with failed breaker contingency outage of '8107_C2_05HILLSB 138-C_A'. This project contributes approximately 8.72 MW to the thermal violation.

CONTINGENCY '8107_C2_05HILLSB 138-C_A'

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

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	2.88
931221	AC2-031 C	24.37
931222	AC2-031 E	12.
931281	AC2-042 C	76.15
931282	AC2-042 E	50.77
931351	AC2-049 C	5.23
931352	AC2-049 E	3.49
931431	AC2-061 C	29.12
931432	AC2-061 E	29.52
931441	AC2-062 C OP	6.68
931442	AC2-062 E OP	2.99
931451	AC2-064 C	12.27
931452	AC2-064 E	8.18
916272	Z1-080 E	3.83
926061	AC1-085 C	55.28
926062	AC1-085 E	90.19
926101	AC1-089 C	18.57
926102	AC1-089 E	30.29
926631	AC1-144 C	24.48
926632	AC1-144 E	11.89

Appendix 17

(DAY - DAY) The 09MIDDLE-09OHH 138 kV line (from bus 253111 to bus 253057 ckt 1) loads from 150.81% to 154.07% (**DC power flow**) of its emergency rating (185 MVA) for the line fault with failed breaker contingency outage of '7351_C2_05HILLSB 138-_A'. This project contributes approximately 6.04 MW to the thermal violation.

CONTINGENCY '7351_C2_05HILLSB 138-_A'

OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911

05HIGHLA 138 243019 05HILLSB 138 1

OPEN BRANCH FROM BUS 243019 TO BUS 926100 CKT 1 / 243019 05HILLSB

138 926100 AC1-089 TAP 138 1

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931221	AC2-031 C	16.89
931222	AC2-031 E	8.32
931281	AC2-042 C	52.79
931282	AC2-042 E	35.2
931351	AC2-049 C	3.62
931352	AC2-049 E	2.42
931431	AC2-061 C	11.38
931432	AC2-061 E	11.53
931451	AC2-064 C	8.5
931452	AC2-064 E	5.67
916272	Z1-080 E	0.84
926061	AC1-085 C	38.32
926062	AC1-085 E	62.53
926631	AC1-144 C	16.97
926632	AC1-144 E	8.24

Appendix 18

(AEP - AEP) The AC1-089 TAP-05WLDCAT 138 kV line (from bus 926100 to bus 246946 ckt 1) loads from 148.97% to 152.67% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 6.84 MW to the thermal violation.

CONTINGENCY '7981_B'

OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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
OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1
OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931121	AC2-019 C	0.61
931122	AC2-019 E	1.
931131	AC2-020 C OP	0.46
931132	AC2-020 E OP	1.22
931192	AC2-027 E	1.62
931221	AC2-031 C	18.99
931222	AC2-031 E	9.35
931281	AC2-042 C	59.34
931282	AC2-042 E	39.56
931351	AC2-049 C	4.11
931352	AC2-049 E	2.74
931381	AC2-055 C OP	1.49
931382	AC2-055 E OP	2.42
931421	AC2-060 C	4.27
931422	AC2-060 E	2.4
931431	AC2-061 C	16.47
931432	AC2-061 E	16.69
931451	AC2-064 C	9.64
931452	AC2-064 E	6.43
931651	AC2-087 C OP	3.16
931652	AC2-087 E OP	2.51
247592	W4-036	0.8
924371	AB2-085 C OP	7.03
924372	AB2-085 E OP	3.31
924541	AB2-103 C OP	4.25
924542	AB2-103 E OP	2.
926061	AC1-085 C	43.08

926062	AC1-085 E	70.28
926101	AC1-089 C	20.33
926102	AC1-089 E	33.17
926631	AC1-144 C	19.07
926632	AC1-144 E	9.27

Appendix 19

(AEP - AEP) The AC2-049 TAP-05MILLBR 138 kV line (from bus 931350 to bus 243042 ckt 1) loads from 215.9% to 234.67% (**DC power flow**) of its emergency rating (179 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 33.58 MW to the thermal violation.

CONTINGENCY '7981_B'

OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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
OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1
OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	2.78
931121	AC2-019 C	0.76
931122	AC2-019 E	1.25
931131	AC2-020 C OP	0.59
931132	AC2-020 E OP	1.55
931192	AC2-027 E	2.01
931221	AC2-031 C	23.37
931222	AC2-031 E	11.51
931281	AC2-042 C	73.05
931282	AC2-042 E	48.7
931351	AC2-049 C	20.15
931352	AC2-049 E	13.43
931381	AC2-055 C OP	1.86
931382	AC2-055 E OP	3.04
931421	AC2-060 C	5.36
931422	AC2-060 E	3.02
931431	AC2-061 C	20.27
931432	AC2-061 E	20.55
931441	AC2-062 C OP	6.62
931442	AC2-062 E OP	2.96
931451	AC2-064 C	47.29
931452	AC2-064 E	31.53
931651	AC2-087 C OP	3.97
931652	AC2-087 E OP	3.15
247592	W4-036	1.01
924371	AB2-085 C OP	8.23
924372	AB2-085 E OP	3.87

924541	<i>AB2-103 C OP</i>	<i>5.1</i>
924542	<i>AB2-103 E OP</i>	<i>2.4</i>
926061	<i>AC1-085 C</i>	<i>53.03</i>
926062	<i>AC1-085 E</i>	<i>86.52</i>
926101	<i>AC1-089 C</i>	<i>17.87</i>
926102	<i>AC1-089 E</i>	<i>29.16</i>
926631	<i>AC1-144 C</i>	<i>23.48</i>
926632	<i>AC1-144 E</i>	<i>11.41</i>

Appendix 20

(DEO&K - DEO&K) The AC2-061 TAP-08CLINCO 138 kV line (from bus 931430 to bus 249995 ckt 1) loads from 243.34% to 248.07% (**DC power flow**) of its emergency rating (184 MVA) for the line fault with failed breaker contingency outage of '8107_C2_05HILLSB 138-C_B'. This project contributes approximately 8.72 MW to the thermal violation.

CONTINGENCY '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

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	2.88
931221	AC2-031 C	24.37
931222	AC2-031 E	12.
931281	AC2-042 C	76.15
931282	AC2-042 E	50.77
931351	AC2-049 C	5.23
931352	AC2-049 E	3.49
931431	AC2-061 C	29.12
931432	AC2-061 E	29.52
931441	AC2-062 C OP	6.68
931442	AC2-062 E OP	2.99
931451	AC2-064 C	12.27
931452	AC2-064 E	8.18
916272	Z1-080 E	2.17
926061	AC1-085 C	55.28
926062	AC1-085 E	90.19
926101	AC1-089 C	18.57
926102	AC1-089 E	30.29
926631	AC1-144 C	24.48
926632	AC1-144 E	11.89

Appendix 21

(AEP - LGEE) The AC2-062 TAP-4KENTON 138 kV line (from bus 931440 to bus 324267 ckt 1) loads from 145.19% to 148.89% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 6.84 MW to the thermal violation.

CONTINGENCY '7981_B'

OPEN BRANCH FROM BUS 931430 TO BUS 249995 CKT 1 / 931430 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
OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1
OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
931022	AC2-008 E	4.3
931121	AC2-019 C	0.61
931122	AC2-019 E	1.
931131	AC2-020 C OP	0.46
931132	AC2-020 E OP	1.22
931192	AC2-027 E	1.62
931221	AC2-031 C	18.99
931222	AC2-031 E	9.35
931281	AC2-042 C	59.34
931282	AC2-042 E	39.56
931351	AC2-049 C	4.11
931352	AC2-049 E	2.74
931381	AC2-055 C OP	1.49
931382	AC2-055 E OP	2.42
931421	AC2-060 C	4.27
931422	AC2-060 E	2.4
931431	AC2-061 C	16.47
931432	AC2-061 E	16.69
931441	AC2-062 C OP	24.55
931442	AC2-062 E OP	10.98
931451	AC2-064 C	9.64
931452	AC2-064 E	6.43
931651	AC2-087 C OP	3.16
931652	AC2-087 E OP	2.51
247592	W4-036	0.8
924371	AB2-085 C OP	7.03
924372	AB2-085 E OP	3.31

924541	<i>AB2-103 C OP</i>	4.25
924542	<i>AB2-103 E OP</i>	2.
926061	<i>AC1-085 C</i>	43.08
926062	<i>AC1-085 E</i>	70.28
926101	<i>AC1-089 C</i>	20.33
926102	<i>AC1-089 E</i>	33.17
926631	<i>AC1-144 C</i>	19.07
926632	<i>AC1-144 E</i>	9.27