Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC2-040, AC2-041, AC2-042

Hillsboro 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 proposes to install PJM Projects #AC2-040, #AC2-041, and #AC2-042, a combined 349.0 MW (209.4 MW Capacity) solar generating facility in Hillsboro, 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
AC2-040	49.0	29.4
AC2-041	100.0	60.0
AC2-042	200.0	120.0

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: $3,000,000**

Non-Direct Connection Cost Estimate

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

For AEP building Direct Connection cost estimates:

Description	Estimated Cost
138 kV Revenue Metering	**$250,000**
Upgrade line protection and controls at the expanded Hillsboro 138 kV substation.	**$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.	**DP&L to provide scope and cost**
Total	**$600,000**

Table 1

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

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

Interconnection Customer Requirements

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 AC2-042 (AC2-040, AC2-041 & AC2-042 studied as 1 project, AC2-042) was evaluated as a 349.0 MW (Capacity 209.4 MW) injection at the Hillsboro 138 kV substation in the AEP area. Project AC2-042 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-042 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**
349_B2_TOR21	CONTINGENCY '349_B2_TOR21' OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1 END
363_B2_TOR1682	CONTINGENCY '363_B2_TOR1682' OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1 END

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
6190_B3_05SPORN 345-4_WOMOAB	CONTINGENCY '6190_B3_05SPORN 345-4_WOMOAB' 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
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
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

Option 1	
Contingency Name	**Description**
	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
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

Option 1 Contingency Name	Description
	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
8109_C2_05HILLSB 138-A_A	CONTINGENCY '8109_C2_05HILLSB 138-A_A' 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 931350 TO BUS 243102 CKT 1 / 931350 AC2-049 TAP 138 243102 05SINKG8 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
8468_B2	CONTINGENCY '8468_B2' OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 2 / 242528 05SPORN 345 248005 06KYGER 345 2 END
P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381	CONTINGENCY 'P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381' OPEN BUS 249995 END
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
AC2-042 (AC2-040, AC2-041 & AC2-042 studied as 1 project, AC2-042)

was evaluated as a 349.0 MW (Capacity 209.4 MW) injection at the Hillsboro 138 kV substation in the AEP area. Project AC2-042 Generator Deliverability

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.

Option 1 AC2-042 (AC2-040, AC2-041 & AC2-042 studied as 1 project, AC2-042) was evaluated as a 349.0 MW (Capacity 209.4 MW) injection at the Hillsboro 138 kV substation in the AEP area. Project AC2-042 Generator Deliverability															
	Contingency		Affected		Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	67.28	89.4	ER	185	40.92	
2	N-1	7353_B2_TOR12737	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	67.17	89.29	ER	185	40.92	
3	N-1	5891_B2_TOR607	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	67.49	97.78	ER	184	55.73	
4	N-1	7342_B2_TOR7202268	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	68.21	101.31	ER	184	60.9	
5	Non	Non	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	58.73	88.34	NR	159	47.07	
6	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	82.78	103.13	ER	122	24.83	
7	N-1	P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	82.7	103.05	ER	122	24.83	
8	N-1	7342_B2_TOR7202268	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	49	79.75	ER	198	60.9	
9	N-1	5891_B2_TOR607	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	48.37	76.52	ER	198	55.73	
10	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	65.01	87.13	ER	185	40.92	
11	N-1	7353_B2_TOR12737	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	64.9	87.02	ER	185	40.92	
12	N-1	7353_B2_TOR12737	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	39.17	72.2	ER	179	59.13	
13	N-1	P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	39.11	72.14	ER	179	59.13	
14	N-1	7342_B2_TOR7202268	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	68.21	101.31	ER	184	60.9	
15	N-1	5891_B2_TOR607	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	67.49	97.78	ER	184	55.73	
16	Non	Non	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	58.67	88.27	NR	159	47.07	

Table 3

Multiple Facility Contingency

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

AC2-042 (AC2-040, AC2-041 & AC2-042 studied as 1 project, AC2-042) was evaluated as a 349.0 MW (Capacity 209.4 MW) injection at the Hillsboro 138 kV substation in the AEP area. Project AC2-042 Multiple Facility Contingency														
	Contingency		Affected		Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	DCTL	7981_B	AEP - AEP	05HILLSB-05HIGHLA 138 kV line	243019	246911	1	DC	86.93	118	ER	413	128.34	1
2	LFFB	8108_C2_05HILLSB 138-D_A	AEP - AEP	05HILLSB-05HIGHLA 138 kV line	243019	246911	1	DC	86.93	118	ER	413	128.34	

AC2-042 (AC2-040, AC2-041 & AC2-042 studied as 1 project, AC2-042)

was evaluated as a 349.0 MW (Capacity 209.4 MW) injection at the Hillsboro 138 kV substation in the AEP area. Project AC2-042 Multiple Facility Contingency

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
3	DCTL	7981_A	AEP - AEP	05HILLSB-05HIGHLA 138 kV line	243019	246911	1	DC	86.93	118	ER	413	128.34	
4	BUS	7954_C1_05MILLBR 138-2_A	AEP - AEP	05HILLSB-05HIGHLA 138 kV line	243019	246911	1	DC	66.44	91.48	ER	413	103.41	
5	DCTL	7981_B	AEP - AEP	05HILLSB-AC1-089 TAP 138 kV line	243019	926100	1	DC	66.81	120.27	ER	185	98.91	2
6	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05HILLSB-AC1-089 TAP 138 kV line	243019	926100	1	DC	63.48	116.68	ER	185	98.42	
7	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05HILLSB-AC1-089 TAP 138 kV line	243019	926100	1	DC	63.48	116.68	ER	185	98.42	
8	DCTL	7981_A	AEP - AEP	05HILLSB-AC1-089 TAP 138 kV line	243019	926100	1	DC	66.81	120.27	ER	185	98.91	
9	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05MILLBR-05N PORT 138 kV line	243042	243047	1	DC	73.61	96.7	ER	185	42.72	3
10	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05MILLBR-05N PORT 138 kV line	243042	243047	1	DC	73.61	96.7	ER	185	42.72	
11	DCTL	7981_B	AEP - AEP	05MILLBR-05N PORT 138 kV line	243042	243047	1	DC	62.63	83.28	ER	185	38.19	
12	DCTL	7981_A	AEP - AEP	05MILLBR-05N PORT 138 kV line	243042	243047	1	DC	62.63	83.28	ER	185	38.19	
13	LFFB	7970_C2_05MILLBR 138-G	AEP - AEP	05MILLBR-05S POIN 138 kV line	243042	243088	1	DC	65.51	94.78	ER	167	48.87	4
14	LFFB	7965_C2_05MILLBR 138-N	AEP - AEP	05MILLBR-05S POIN 138 kV line	243042	243088	1	DC	53.76	77.66	ER	167	39.92	
15	BUS	7954_C1_05MILLBR 138-2_A	AEP - AEP	05ADAMS-05WARERD 138 kV line	243464	246942	1	DC	88.9	121.62	ER	150	49.08	
16	LFFB	8109_C2_05HILLSB 138-A_A	AEP - AEP	05SEAMAN-05ADAMS 138 kV line	243571	243464	1	DC	97.83	136.95	ER	150	58.67	
17	BUS	7954_C1_05MILLBR 138-2_A	AEP - AEP	05SEAMAN-05ADAMS 138 kV line	243571	243464	1	DC	76.63	108.57	ER	150	47.9	
18	DCTL	7981_B	AEP - AEP	05HIGHLA-05NMARSS 138 kV line	246911	247035	1	DC	61.46	86.04	ER	310	76.19	5
19	BUS	7954_C1_05MILLBR 138-2_A	AEP - AEP	05WARERD-05WAVERL 138 kV line	246942	243585	1	DC	78.7	111.42	ER	150	49.08	
20	DCTL	7981_B	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	94.43	147.89	ER	185	98.91	6
21	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	91.01	144.21	ER	185	98.42	
22	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	91.01	144.21	ER	185	98.42	
23	DCTL	7981_A	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	94.43	147.89	ER	185	98.91	
24	DCTL	7981_B	AEP - AEP	05EMERSS-AC2-062 TAP 138 kV line	247034	931440	1	DC	92.43	145.89	ER	185	98.91	7
25	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05EMERSS-AC2-062 TAP 138 kV line	247034	931440	1	DC	88.96	142.16	ER	185	98.42	
26	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05EMERSS-AC2-062 TAP 138 kV line	247034	931440	1	DC	88.96	142.16	ER	185	98.42	
27	DCTL	7981_A	AEP - AEP	05EMERSS-AC2-062 TAP 138 kV line	247034	931440	1	DC	92.43	145.89	ER	185	98.91	
28	DCTL	7981_B	AEP - AEP	05NMARSS-05SEAMAN 138 kV line	247035	243571	1	DC	58.07	82.65	ER	310	76.19	8
29	DCTL	7981_B	AEP - AEP	AC1-089 TAP-05WLDCAT 138 kV line	926100	246946	1	DC	95.51	148.97	ER	185	98.91	9
30	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	AC1-089 TAP-05WLDCAT 138 kV line	926100	246946	1	DC	92.1	145.3	ER	185	98.42	
31	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	AC1-089 TAP-05WLDCAT 138 kV line	926100	246946	1	DC	92.1	145.3	ER	185	98.42	
32	DCTL	7981_A	AEP - AEP	AC1-089 TAP-05WLDCAT 138 kV line	926100	246946	1	DC	95.51	148.97	ER	185	98.91	

AC2-042 (AC2-040, AC2-041 & AC2-042 studied as 1 project, AC2-042) was evaluated as a 349.0 MW (Capacity 209.4 MW) injection at the Hillsboro 138 kV substation in the AEP area. Project AC2-042 Multiple Facility Contingency															
	Contingency		Affected		Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
33	DCTL	7981_B	AEP - LGEE	AC2-062 TAP-4KENTON 138 kV line	931440	324267	1	DC	91.73	145.19	ER	185	98.91	10
34	LFFB	8107_C2_05HILLSB 138-C_B	AEP - LGEE	AC2-062 TAP-4KENTON 138 kV line	931440	324267	1	DC	88.31	141.51	ER	185	98.42	
35	LFFB	8107_C2_05HILLSB 138-C_A	AEP - LGEE	AC2-062 TAP-4KENTON 138 kV line	931440	324267	1	DC	88.31	141.51	ER	185	98.42	
36	DCTL	7981_A	AEP - LGEE	AC2-062 TAP-4KENTON 138 kV line	931440	324267	1	DC	91.73	145.19	ER	185	98.91	

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)

AC2-042 (AC2-040, AC2-041 & AC2-042 studied as 1 project, AC2-042) was evaluated as a 349.0 MW (Capacity 209.4 MW) injection at the Hillsboro 138 kV substation in the AEP area. Project AC2-042 Contribution to Previously Identified Overloads															
	Contingency		Affected		Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	DCTL	7981_B	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	145.09	210.9	ER	185	121.75	11
2	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	144.68	211.52	ER	185	123.66	
3	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	144.62	211.46	ER	185	123.66	
4	DCTL	7981_A	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	145.14	210.95	ER	185	121.75	
5	LFFB	7351_C2_05HILLSB 138-_A	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	105.52	153.08	ER	185	87.99	12
6	LFFB	8111_C2_05HILLSB 138-_A	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	108.39	156.23	ER	185	88.52	
7	BUS	7954_C1_05MILLBR 138-2_A	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	106.1	142.23	ER	185	66.84	
8	LFFB	8107_C2_05HILLSB 138-C_A	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	174.41	243.39	ER	184	126.92	13
9	LFFB	8107_C2_05HILLSB 138-C_B	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	174.36	243.34	ER	184	126.92	
10	LFFB	8109_C2_05HILLSB 138-A_A	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	166.67	234.3	ER	184	124.46	
11	BUS	7954_C1_05MILLBR 138-2_A	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	127.18	181.67	ER	184	100.27	
12	DCTL	7981_B	AEP - AEP	05SINKG8-AC2-049 TAP 138 kV line	243102	931350	1	DC	148	216.01	ER	179	121.75	14
13	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05SINKG8-AC2-049 TAP 138 kV line	243102	931350	1	DC	147.51	216.6	ER	179	123.66	
14	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05SINKG8-AC2-049 TAP 138 kV line	243102	931350	1	DC	147.51	216.6	ER	179	123.66	
15	DCTL	7981_A	AEP - AEP	05SINKG8-AC2-049 TAP 138 kV line	243102	931350	1	DC	148	216.01	ER	179	121.75	
16	DCTL	7981_B	AEP - AEP	05ADAMS-05WARERD 138 kV line	243464	246942	1	DC	113.57	152.45	ER	150	58.31	15
17	LFFB	8109_C2_05HILLSB 138-A_A	AEP - AEP	05ADAMS-05WARERD 138 kV line	243464	246942	1	DC	111.22	151.25	ER	150	60.05	
18	LFFB	8108_C2_05HILLSB 138-D_A	AEP - AEP	05ADAMS-05WARERD 138 kV line	243464	246942	1	DC	113.57	152.45	ER	150	58.31	

AC2-042 (AC2-040, AC2-041 & AC2-042 studied as 1 project, AC2-042)

was evaluated as a 349.0 MW (Capacity 209.4 MW) injection at the Hillsboro 138 kV substation in the AEP area. Project AC2-042 Contribution to Previously Identified Overloads

	Contingency		Affected		Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
19	DCTL	7981_A	AEP - AEP	05ADAMS-05WARERD 138 kV line	243464	246942	1	DC	113.57	152.45	ER	150	58.31	
20	DCTL	7981_B	AEP - AEP	05SEAMAN-05ADAMS 138 kV line	243571	243464	1	DC	100.73	139	ER	150	57.4	16
21	LFFB	8108_C2_05HILLSB 138-D_A	AEP - AEP	05SEAMAN-05ADAMS 138 kV line	243571	243464	1	DC	100.73	139	ER	150	57.4	
22	DCTL	7981_A	AEP - AEP	05SEAMAN-05ADAMS 138 kV line	243571	243464	1	DC	100.73	139	ER	150	57.4	
23	DCTL	7981_B	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	155.4	198.14	ER	122	52.15	17
24	LFFB	8108_C2_05HILLSB 138-D_A	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	155.4	198.14	ER	122	52.15	
25	DCTL	7981_A	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	155.4	198.14	ER	122	52.15	
26	DCTL	7981_B	AEP - AEP	05WARERD-05WAVERL 138 kV line	246942	243585	1	DC	103.37	142.25	ER	150	58.31	18
27	LFFB	8109_C2_05HILLSB 138-A_A	AEP - AEP	05WARERD-05WAVERL 138 kV line	246942	243585	1	DC	101.02	141.05	ER	150	60.05	
28	LFFB	8108_C2_05HILLSB 138-D_A	AEP - AEP	05WARERD-05WAVERL 138 kV line	246942	243585	1	DC	103.37	142.25	ER	150	58.31	
29	DCTL	7981_A	AEP - AEP	05WARERD-05WAVERL 138 kV line	246942	243585	1	DC	103.37	142.25	ER	150	58.31	
30	N-1	8468_B2	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	1	DC	105.13	105.91	NR	1017	17.64	19
31	N-1	6190_B3_05SPORN 345-4_WOMOAB	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	110.1	110.92	NR	971	17.81	20
32	N-1	349_B2_TOR21	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	110.11	110.93	NR	971	17.64	
33	LFFB	8107_C2_05HILLSB 138-C_A	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	148.52	212.63	ER	198	126.92	21
34	LFFB	8107_C2_05HILLSB 138-C_B	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	148.47	212.58	ER	198	126.92	
35	LFFB	8109_C2_05HILLSB 138-A_A	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	141.36	204.22	ER	198	124.46	
36	LFFB	7351_C2_05HILLSB 138-_A	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	101.72	168.36	ER	198	131.94	
37	BUS	7954_C1_05MILLBR 138-2_A	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	104.38	155.02	ER	198	100.27	
38	LFFB	7351_C2_05HILLSB 138-_A	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	103.25	150.81	ER	185	87.99	22
39	LFFB	8111_C2_05HILLSB 138-_A	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	106.12	153.96	ER	185	88.52	
40	BUS	7954_C1_05MILLBR 138-2_A	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	103.83	139.96	ER	185	66.84	
41	DCTL	7981_B	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	147.89	215.9	ER	179	121.75	23
42	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	147.4	216.48	ER	179	123.66	
43	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	147.4	216.48	ER	179	123.66	
44	DCTL	7981_A	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	147.89	215.9	ER	179	121.75	
45	LFFB	8107_C2_05HILLSB 138-C_B	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	174.36	243.34	ER	184	126.92	24
46	LFFB	8107_C2_05HILLSB 138-C_A	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	174.36	243.34	ER	184	126.92	
47	LFFB	8109_C2_05HILLSB 138-A_A	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	166.67	234.3	ER	184	124.46	

AC2-042 (AC2-040, AC2-041 & AC2-042 studied as 1 project, AC2-042) was evaluated as a 349.0 MW (Capacity 209.4 MW) injection at the Hillsboro 138 kV substation in the AEP area. Project AC2-042 Contribution to Previously Identified Overloads															
	Contingency		Affected		Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
48	LFFB	7351_C2_05HILLSB 138-_A	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	123.94	195.64	ER	184	131.94	
49	BUS	7954_C1_05MILLBR 138-2_A	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	127.18	181.67	ER	184	100.27	

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.

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.

AC2-042 (AC2-040, AC2-041 & AC2-042 studied as 1 project, AC2-042)

was evaluated as a 349.0 MW (Capacity 209.4 MW) injection at the Hillsboro 138 kV substation in the AEP area. Project AC2-042 Delivery of Energy Portion of Interconnection Request

#	Contingency Type	Contingency Name	Affected Area	Bus Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
1	N-1	7353_B2_TOR12737	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	106.52	159.79	ER	185	98.54	
2	Non	Non	AEP - AEP	05HILLSB-05HIGHLA 138 kV line	243019	246911	1	DC	79.7	106.64	NR	296	79.75	
3	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - AEP	05HILLSB-05HIGHLA 138 kV line	243019	246911	1	DC	69.33	94.23	ER	413	102.84	
4	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	112.99	149.86	ER	185	68.21	
5	N-1	7353_B2_TOR12737	AEP - AEP	05HILLSB-AC1-089 TAP 138 kV line	243019	926100	1	DC	38.02	80.94	ER	185	79.41	
6	N-1	7342_B2_TOR7202268	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	132.75	187.92	ER	184	101.5	
7	Non	Non	AEP - DEO&K	05HILLSB-AC2-061 TAP 138 kV line	243019	931430	1	DC	121.92	171.27	NR	159	78.46	
8	N-1	462_B3_05MILLBR 138-5_WOMOAB	AEP - AEP	05MILLBR-05S POIN 138 kV line	243042	243088	1	DC	53.78	77.65	ER	167	39.86	
9	N-1	P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381	AEP - AEP	05SINKG8-AC2-049 TAP 138 kV line	243102	931350	1	DC	108.08	163.13	ER	179	98.54	
10	N-1	P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381	AEP - AEP	05ADAMS-05WARERD 138 kV line	243464	246942	1	DC	90.36	121.85	ER	150	47.23	
11	N-1	7353_B2_TOR12737	AEP - AEP	05SEAMAN-05ADAMS 138 kV line	243571	243464	1	DC	78.59	109.54	ER	150	46.43	
12	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	127.49	161.4	ER	122	41.38	
13	N-1	P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381	AEP - AEP	05WARERD-05WAVERL 138 kV line	246942	243585	1	DC	80.16	111.65	ER	150	47.23	
14	N-1	7353_B2_TOR12737	AEP - AEP	05WLDCAT-05EMERSS 138 kV line	246946	247034	1	DC	62.02	104.94	ER	185	79.41	
15	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - AEP	05EMERSS-AC2-062 TAP 138 kV line	247034	931440	1	DC	60.02	102.94	ER	185	79.41	
16	N-1	363_B2_TOR1682	OVEC - AEP	06CLIFTY-05JEFRSO 345 kV line	248000	242865	Z1	DC	98.15	98.82	NR	1756	25.93	
17	N-1	8468_B2	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	1	DC	117.95	119.25	NR	1017	29.41	
18	N-1	6190_B3_05SPORN 345-4_WOMOAB	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	123.94	125.31	NR	971	29.68	

AC2-042 (AC2-040, AC2-041 & AC2-042 studied as 1 project, AC2-042) was evaluated as a 349.0 MW (Capacity 209.4 MW) injection at the Hillsboro 138 kV substation in the AEP area. Project AC2-042 Delivery of Energy Portion of Interconnection Request															
	Contingency		Affected		Bus				Loading		Rating		MW	FG	
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.	
19	N-1	7342_B2_TOR7202268	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	109.57	160.83	ER	198	101.5		
20	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	110.72	147.58	ER	185	68.21		
21	N-1	P1-#..B2 WARREN-CLINTONCO-HILLSBORO 2381	AEP - AEP	AC1-089 TAP-05WLDCAT 138 kV line	926100	246946	1	DC	63.34	106.26	ER	185	79.41		
22	N-1	7353_B2_TOR12737	AEP - AEP	AC2-049 TAP-05MILLBR 138 kV line	931350	243042	1	DC	108.02	163.08	ER	179	98.54		
23	N-1	7342_B2_TOR7202268	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	132.75	187.92	ER	184	101.5		
24	Non	Non	DEO&K - DEO&K	AC2-061 TAP-08CLINCO 138 kV line	931430	249995	1	DC	121.86	171.2	NR	159	78.46		
25	N-1	7353_B2_TOR12737	AEP - LGEE	AC2-062 TAP-4KENTON 138 kV line	931440	324267	1	DC	58.93	101.86	ER	185	79.41		

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	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 1will need to be rebuilt/reconductored. Replace the Highland Wavetrap (2000A) Replace the Hiillsboro Wavetrap (2000A)	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	$11,190,000
#2	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
#3	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. This facility is not overloaded by the AC2-040, AC2-041, or AC2-042 projects as is shown in table 4 above but the AC2 Queue overloads this facility and the AC2-040, AC2-041, and AC2-042 projects contribute to the overload.	An approximate time for the sag study is 6 to 12 months after signing an interconnection agreement.	$15,000
	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.	An approximate time for the sag study is 6 to 12 months after signing an	$463,000

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#5		Replace the South Point risers Replace the Millbrook Park risers 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 This facility is not overloaded by the AC2-040, AC2-041, or AC2-042 projects as is shown in table 4 above but the AC2 Queue overloads this facility and the AC2-040, AC2-041, and AC2-042 projects contribute to the overload.	interconnection agreement. An approximate construction time would be 12 to 24 months after signing an interconnection agreement	
#6	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 AC2-040, AC2-041, or AC2-042 projects as is shown in table 4 above but the AC2 Queue overloads this facility and the AC2-040, AC2-041, and AC2-042 projects contribute to the overload.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	$1,500,000
#7	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 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.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	$2,025,000
#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	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 AC2-040, AC2-041, or AC2-042 projects as is shown in table 4 above but the AC2 Queue overloads this facility and the AC2-040, AC2-041, and AC2-042 projects contribute to the overload.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	$19,800,000
	05WLDCAT-AC1-089	1.7 mile of ACSR 477 26/7 conductor	An approximate	$2,500,000

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#10	Tap 138 kV line	section 2 will need to be rebuilt/reconductored.	construction time would be 24 to 36 months after signing an interconnection agreement	
#11	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
			Total Network Upgrades	**$74,177,000**

Table 7

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 AC2-040, AC2-041, and AC2-042.

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	05HIGHLA-09MRTNSV 69 kV line	An engineering study will need to be conducted to determine if the CT Thermal limit settings can be adjusted at Highland to mitigate the overload. An engineering study will need to be conducted to determine if the Relay Thermal limits settings can be adjusted at Highland to mitigate the overload.	An approximate engineering study time would be 6 to 12 months after signing an interconnection agreement	$50,000
#2	05PETERSB8-AC2-055 Tap 69 kV line	6.4 miles of ACSR 211.6.4 6/1 conductor section 1will need to be rebuilt/reconductored.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	$7,680,000
			Total Network Upgrades	**$7,730,000**

Table 8

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-05SINKG8 138 kV line	Rebuild/Reconductor 4.36 miles of ACSR 477 26/7 conductor section 1. An engineering study will need to be conducted to determine if the Relay Compliance Trip limits settings can be adjusted to mitigate the overload. Replace the Sinking Springs jumpers. Replace the Sinking Spring Switch (1200A) Rebuild/Reconductor 8.93 miles of ACSR 477 26/7 conductor section 2.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	$20,500,000
#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-AC2-061 Tap 138 kV line	5.0 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 . This is an AEP-Dayton Power & Light tie line therefore; PJM is going to have to coordinate this upgrade with Dayton Power & Light 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	$7,500,000
	05SINKG8-05AC2-049 Tap 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. Replace the Millbrook Park line risers Replace the Millbrook Park bus and risers Replace the Millbrook Park trap riser	An approximate time for the sag study is 6 to 12 months after signing an interconnection agreement. An approximate construction time would be 12 to 24 months after signing an interconnection agreement	$1,170,500

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#4		Replace the Sinking Spring switch (1200A) A Sag Study will be required on the 20.37 mile ACSR 477 26/7 conductor section 2 to mitigate the overload. A Sag Study will be required on the 9.76 mile ACSR 477 26/7 conductor section 2 to mitigate the overload. 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.		
#5	05ADAMS-05WARERD 138 kV line	20.52 miles of ACSR 336.4 30/7 conductor section 1will need to be rebuilt/reconductored.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	$30,780,000
#6	05SEAMAN-05ADAMS 138 kV line	8.0 miles of ACSR 336.4 30/7 conductor section 1will need to be rebuilt/reconductored.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	$12,000,000
#7	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
#8	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 approximate construction time would be 24 to 36 months after signing an interconnection agreement	$59,100,000

#	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 Millbrook Park to mitigate the overload. Replace the Hillsboro Wavetrap (2000A)		
#5	06KYGER-05SPORN 345 kV line	Baseline project B2832 will mitigate this overload.	In-Service Date: 6/1/2019	N/A
			Total Network Upgrades	**$175,740,500**

Table 9

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 AC2-040, AC2-041, and AC2-042.

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	05HIGHLA-05PETERSB8 69 kV line	10.0 miles of ACSR 336.4 30/7 conductor section 1will need to be rebuilt/reconductored.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	$12,000,000
#2	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
#3	AC2-055 Tap-05BCKSKI 69 kV line	2.75 miles of ACSR 211.6.4 6/1 conductor section 1will need to be rebuilt/reconductored. Replace the Petersburg Switch (600A)	An approximate construction time would be 24 to 36 months after signing an interconnection agreement	$4,500,000
			Total Network Upgrades	**$18,000,000**

Table 10

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 349.0 MW (209.4 MW Capacity) solar generating facility of the Interconnection Customer (PJM Project #AC2-040,

AC2-041, AC2-042) 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 the Interconnection Customer generating facility.

Cost Breakdown for Point of Interconnection (Hillsboro 138 kV Substation)		
Attachment Cost	Expand Hillsboro 138 kV Substation	$3,000,000
Non-Direct Connection Cost Estimate	138 kV Revenue Metering	$250,000
	Upgrade line protection and controls at the expanded Hillsboro 138 kV substation.	$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.	DP&L to provide scope and cost
	New System Reinforcements-Not part of the BES	$7,730,000
	New System Reinforcements	$74,177,000
	Contribution to Previously Identified System Reinforcements-Not part of the BES	$18,000,000
	Contribution to Previously Identified System Reinforcements	$175,740,500
	Total Estimated Cost for Project AC2-040, AC2-041, and AC2-042	**$279,247,500**

Table 11

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 138 kV Substation)

Single-Line Diagram

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

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 05HILLSB-05HIGHLA 138 kV line (from bus 243019 to bus 246911 ckt 1) loads from 86.93% to 118.0% (**DC power flow**) of its emergency rating (413 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 128.34 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

Bus Number	*Bus Name*	*Full Contribution*
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 2

(AEP - AEP) The 05HILLSB-AC1-089 TAP 138 kV line (from bus 243019 to bus 926100 ckt 1) loads from 66.81% to 120.27% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 98.91 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

Bus Number	*Bus Name*	*Full Contribution*
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*
926631	*AC1-144 C*	*19.07*
926632	*AC1-144 E*	*9.27*

Appendix 3

(AEP - AEP) The 05MILLBR-05N PORT 138 kV line (from bus 243042 to bus 243047 ckt 1) loads from 73.61% to 96.7% (**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 42.72 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

Bus Number	*Bus Name*	*Full Contribution*
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 4

(AEP - AEP) The 05MILLBR-05S POIN 138 kV line (from bus 243042 to bus 243088 ckt 1) loads from 65.51% to 94.78% (**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 48.87 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

Bus Number	*Bus Name*	*Full Contribution*
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	*AB2-103 E OP*	*1.*
926061	*AC1-085 C*	*21.28*
926062	*AC1-085 E*	*34.73*
926101	*AC1-089 C*	*7.2*
926102	*AC1-089 E*	*11.74*
926631	*AC1-144 C*	*9.42*
926632	*AC1-144 E*	*4.58*

Appendix 5

(AEP - AEP) The 05HIGHLA-05NMARSS 138 kV line (from bus 246911 to bus 247035 ckt 1) loads from 61.46% to 86.04% (**DC power flow**) of its emergency rating (310 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 76.19 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

Bus Number	*Bus Name*	*Full Contribution*
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*

926101	*AC1-089 C*	*11.16*
926102	*AC1-089 E*	*18.22*
926631	*AC1-144 C*	*14.69*
926632	*AC1-144 E*	*7.14*

Appendix 6

(AEP - AEP) The 05WLDCAT-05EMERSS 138 kV line (from bus 246946 to bus 247034 ckt 1) loads from 94.43% to 147.89% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 98.91 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

Bus Number	*Bus Name*	*Full Contribution*
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 7

(AEP - AEP) The 05EMERSS-AC2-062 TAP 138 kV line (from bus 247034 to bus 931440 ckt 1) loads from 92.43% to 145.89% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 98.91 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

Bus Number	*Bus Name*	*Full Contribution*
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 8

(AEP - AEP) The 05NMARSS-05SEAMAN 138 kV line (from bus 247035 to bus 243571 ckt 1) loads from 58.07% to 82.65% (**DC power flow**) of its emergency rating (310 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 76.19 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

Bus Number	*Bus Name*	*Full Contribution*
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*

926101	*AC1-089 C*	*11.16*
926102	*AC1-089 E*	*18.22*
926631	*AC1-144 C*	*14.69*
926632	*AC1-144 E*	*7.14*

Appendix 9

(AEP - AEP) The AC1-089 TAP-05WLDCAT 138 kV line (from bus 926100 to bus 246946 ckt 1) loads from 95.51% to 148.97% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 98.91 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

Bus Number	*Bus Name*	*Full Contribution*
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 10

(AEP - LGEE) The AC2-062 TAP-4KENTON 138 kV line (from bus 931440 to bus 324267 ckt 1) loads from 91.73% to 145.19% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 98.91 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

Bus Number	*Bus Name*	*Full Contribution*
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	*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 11

(AEP - AEP) The 05HILLSB-05SINKG8 138 kV line (from bus 243019 to bus 243102 ckt 1) loads from 145.09% to 210.9% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 121.75 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

Bus Number	*Bus Name*	*Full Contribution*
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*
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*
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	*AB2-103 C OP*	*5.1*
924542	*AB2-103 E OP*	*2.4*
926061	*AC1-085 C*	*53.03*
926062	*AC1-085 E*	*86.52*

926101	*AC1-089 C*	*17.87*
926102	*AC1-089 E*	*29.16*
926631	*AC1-144 C*	*23.48*
926632	*AC1-144 E*	*11.41*

Appendix 12

(AEP - DAY) The 05HILLSB-09MIDDLE 138 kV line (from bus 243019 to bus 253111 ckt 1) loads from 105.52% to 153.08% (**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 87.99 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

Bus Number	*Bus Name*	*Full Contribution*
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 13

(AEP - DEO&K) The 05HILLSB-AC2-061 TAP 138 kV line (from bus 243019 to bus 931430 ckt 1) loads from 174.41% to 243.39% (**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 126.92 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

Bus Number	*Bus Name*	*Full Contribution*
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 14

(AEP - AEP) The 05SINKG8-AC2-049 TAP 138 kV line (from bus 243102 to bus 931350 ckt 1) loads from 148.0% to 216.01% (**DC power flow**) of its emergency rating (179 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 121.75 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

Bus Number	*Bus Name*	*Full Contribution*
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*
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*
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	*AB2-103 C OP*	*5.1*
924542	*AB2-103 E OP*	*2.4*
926061	*AC1-085 C*	*53.03*
926062	*AC1-085 E*	*86.52*

926101	*AC1-089 C*	*17.87*
926102	*AC1-089 E*	*29.16*
926631	*AC1-144 C*	*23.48*
926632	*AC1-144 E*	*11.41*

Appendix 15

(AEP - AEP) The 05ADAMS-05WARERD 138 kV line (from bus 243464 to bus 246942 ckt 1) loads from 113.57% to 152.45% (**DC power flow**) of its emergency rating (150 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 58.31 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

Bus Number	*Bus Name*	*Full Contribution*
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	*AB2-103 C OP*	*10.95*
924542	*AB2-103 E OP*	*5.15*
926061	*AC1-085 C*	*25.4*
926062	*AC1-085 E*	*41.44*
926101	*AC1-089 C*	*8.57*
926102	*AC1-089 E*	*13.99*
926631	*AC1-144 C*	*11.25*
926632	*AC1-144 E*	*5.46*

Appendix 16

(AEP - AEP) The 05SEAMAN-05ADAMS 138 kV line (from bus 243571 to bus 243464 ckt 1) loads from 100.73% to 139.0% (**DC power flow**) of its emergency rating (150 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 57.4 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

Bus Number	*Bus Name*	*Full Contribution*
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 17

(AEP - AEP) The 05HIGHLA 138/69 kV transformer (from bus 246911 to bus 243606 ckt 3) loads from 155.4% to 198.14% (**DC power flow**) of its emergency rating (122 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 52.15 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

Bus Number	*Bus Name*	*Full Contribution*
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 18

(AEP - AEP) The 05WARERD-05WAVERL 138 kV line (from bus 246942 to bus 243585 ckt 1) loads from 103.37% to 142.25% (**DC power flow**) of its emergency rating (150 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 58.31 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

Bus Number	*Bus Name*	*Full Contribution*
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	*AB2-103 C OP*	*10.95*
924542	*AB2-103 E OP*	*5.15*
926061	*AC1-085 C*	*25.4*
926062	*AC1-085 E*	*41.44*
926101	*AC1-089 C*	*8.57*
926102	*AC1-089 E*	*13.99*
926631	*AC1-144 C*	*11.25*
926632	*AC1-144 E*	*5.46*

Appendix 19

(OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 1) loads from 105.13% to 105.91% (**DC power flow**) of its normal rating (1017 MVA) for the single line contingency outage of '8468_B2'. This project contributes approximately 17.64 MW to the thermal violation.

CONTINGENCY '8468_B2'
OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 2 / 242528 05SPORN 345 248005 06KYGER 345 2
END

Bus Number	*Bus Name*	*Full Contribution*
251936	*08BCKJD4*	*20.15*
251937	*08BCKJD5*	*31.07*
251964	*08WSDLE3*	*1.6*
251965	*08WSDLE4*	*1.6*
251966	*08WSDLE5*	*1.6*
251967	*08WSDLE6*	*1.6*
253038	*09KILLEN*	*14.15*
253058	*09OHH C.*	*5.21*
931121	*AC2-019 C*	*0.33*
931131	*AC2-020 C OP*	*0.61*
931181	*AC2-026 C OP*	*2.87*
931211	*AC2-030 C OP*	*0.91*
931221	*AC2-031 C*	*5.65*
931281	*AC2-042 C*	*17.64*
931321	*AC2-046 C OP*	*1.85*
931381	*AC2-055 C OP*	*1.48*
931411	*AC2-059 C*	*4.5*
931421	*AC2-060 C*	*5.18*
931431	*AC2-061 C*	*5.27*
931441	*AC2-062 C OP*	*3.4*
931461	*AC2-066 C*	*3.17*
931481	*AC2-068 C*	*2.15*
931551	*AC2-075 C*	*5.09*
931641	*AC2-085 C OP*	*1.2*
931651	*AC2-087 C OP*	*3.84*
931661	*AC2-088 C OP*	*4.22*
931681	*AC2-090 C*	*2.77*
931811	*AC2-106 C OP*	*5.97*
931841	*AC2-111 C OP*	*2.69*
247536	*S-071 C*	*1.63*
247543	*V3-007 C*	*1.9*
916261	*Z1-079*	*10.13*
922002	*AA2-100*	*0.53*

922372	*AA2-148 C*	*1.79*
922612	*AB1-014 C*	*5.29*
923522	*AB1-169 C OP*	*118.07*
923881	*AB2-028 C*	*1.76*
924211	*AB2-065 C*	*1.26*
924351	*AB2-083 C OP*	*1.99*
924371	*AB2-085 C OP*	*5.57*
924541	*AB2-103 C OP*	*2.67*
925341	*AC1-001 C*	*3.98*
925801	*AC1-059 C*	*3.48*
925981	*AC1-074 C OP*	*5.09*
926061	*AC1-085 C*	*12.81*
926092	*AC1-088 C*	*1.29*
926101	*AC1-089 C*	*4.86*
926631	*AC1-144 C*	*5.67*
926691	*AC1-152 C*	*5.27*
926851	*AC1-172 C*	*5.27*
926871	*AC1-174 C*	*2.77*
926881	*AC1-175 C*	*2.77*

Appendix 20

(OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 2) loads from 110.1% to 110.92% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '6190_B3_05SPORN 345-4_WOMOAB'. This project contributes approximately 17.81 MW to the thermal violation.

CONTINGENCY '6190_B3_05SPORN 345-4_WOMOAB'
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

Bus Number	*Bus Name*	*Full Contribution*
251936	*08BCKJD4*	*20.16*
251937	*08BCKJD5*	*31.09*
251964	*08WSDLE3*	*1.6*
251965	*08WSDLE4*	*1.6*
251966	*08WSDLE5*	*1.6*
251967	*08WSDLE6*	*1.6*
253038	*09KILLEN*	*14.17*
253058	*09OHH C.*	*5.23*
931121	*AC2-019 C*	*0.33*
931131	*AC2-020 C OP*	*0.61*
931181	*AC2-026 C OP*	*2.9*
931211	*AC2-030 C OP*	*0.95*
931221	*AC2-031 C*	*5.7*
931281	*AC2-042 C*	*17.81*
931321	*AC2-046 C OP*	*1.92*
931381	*AC2-055 C OP*	*1.49*
931411	*AC2-059 C*	*4.54*
931421	*AC2-060 C*	*5.22*
931431	*AC2-061 C*	*5.31*
931441	*AC2-062 C OP*	*3.41*
931461	*AC2-066 C*	*3.18*
931481	*AC2-068 C*	*2.16*
931551	*AC2-075 C*	*5.09*
931641	*AC2-085 C OP*	*1.2*
931651	*AC2-087 C OP*	*3.87*
931661	*AC2-088 C OP*	*4.22*
931681	*AC2-090 C*	*2.77*
931811	*AC2-106 C OP*	*6.01*
931841	*AC2-111 C OP*	*2.7*
247536	*S-071 C*	*1.63*
247543	*V3-007 C*	*1.9*

916261	*Z1-079*	*10.14*
922002	*AA2-100*	*0.53*
922372	*AA2-148 C*	*1.79*
922612	*AB1-014 C*	*5.29*
923522	*AB1-169 C OP*	*118.26*
923881	*AB2-028 C*	*1.76*
924211	*AB2-065 C*	*1.26*
924351	*AB2-083 C OP*	*2.02*
924371	*AB2-085 C OP*	*5.61*
924541	*AB2-103 C OP*	*2.69*
925341	*AC1-001 C*	*4.04*
925801	*AC1-059 C*	*3.48*
925921	*AC1-068 C*	*2.18*
925931	*AC1-069 C*	*2.18*
925981	*AC1-074 C OP*	*5.09*
926061	*AC1-085 C*	*12.92*
926092	*AC1-088 C*	*1.29*
926101	*AC1-089 C*	*4.9*
926631	*AC1-144 C*	*5.72*
926691	*AC1-152 C*	*5.28*
926791	*AC1-165 C*	*2.15*
926801	*AC1-166 C*	*2.15*
926851	*AC1-172 C*	*5.28*
926871	*AC1-174 C*	*2.77*
926881	*AC1-175 C*	*2.77*

Appendix 21

(DEO&K - DEO&K) The 08CLINCO-08WARRN1 138 kV line (from bus 249995 to bus 250122 ckt 1) loads from 148.52% to 212.63% (**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 126.92 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

Bus Number	*Bus Name*	*Full Contribution*
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 22

(DAY - DAY) The 09MIDDLE-09OHH 138 kV line (from bus 253111 to bus 253057 ckt 1) loads from 103.25% to 150.81% (**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 87.99 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

Bus Number	*Bus Name*	*Full Contribution*
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 23

(AEP - AEP) The AC2-049 TAP-05MILLBR 138 kV line (from bus 931350 to bus 243042 ckt 1) loads from 147.89% to 215.9% (**DC power flow**) of its emergency rating (179 MVA) for the tower line contingency outage of '7981_B'. This project contributes approximately 121.75 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

Bus Number	*Bus Name*	*Full Contribution*
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	*AB2-103 C OP*	*5.1*
924542	*AB2-103 E OP*	*2.4*
926061	*AC1-085 C*	*53.03*
926062	*AC1-085 E*	*86.52*
926101	*AC1-089 C*	*17.87*
926102	*AC1-089 E*	*29.16*
926631	*AC1-144 C*	*23.48*
926632	*AC1-144 E*	*11.41*

Appendix 24

(DEO&K - DEO&K) The AC2-061 TAP-08CLINCO 138 kV line (from bus 931430 to bus 249995 ckt 1) loads from 174.36% to 243.34% (**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 126.92 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

Bus Number	*Bus Name*	*Full Contribution*
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*