Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC1-083

Smith Mountain-Bearskin 138 kV

February 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 #AC1-083, a 100.0 MW (38.0 MW Capacity) solar generating facility in Pittsylvania County, Virginia (see Figure 2). The primary point of interconnection is to AEP's Smith Mountain – Bearskin 138 kV section of the East Danville – Smith Mountain 138 kV circuit (see Figure 1). The secondary point of interconnection is at the Bearskin 138 kV Hard Tap (see Figure 4.) Note that the existing Bearskin station facilities are owned by Dominion Virginia Power.

The requested Backfeed date is September 1, 2019.

The requested in service date is October 1, 2019.

Attachment Facilities

Primary Point of Interconnection (Smith Mountain – Bearskin 138 kV Line)

To accommodate the interconnection on the Smith Mountain – Bearskin 138 kV section of the East Danville – Smith Mountain 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.

<u>New Switching Station Work:</u>

- 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: $5,000,000**

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
Smith Mountain-Bearskin 138 kV T-Line Cut In	**$1,000,000**
Total	**$1,000,000**

Table 1

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	**$300,000**
Upgrade line protection and controls at the Smith Mountain 138 kV substation to coordinate with the new 138 kV switching station.	**$250,000**
Upgrade line protection and controls at the Bearskin 138 kV substation to coordinate with the new 138 kV switching station. **Bearskin substation is owned by DVP**	**$250,000***
Upgrade line protection and controls at the Banister 138 kV substation to coordinate with the new 138 kV switching station. **Bearskin substation is owned by DVP**	**$250,000***
Upgrade line protection and controls at the East Danville 138 kV substation to coordinate with the new 138 kV switching station.	**$250,000**
Total	**$1,300,000**

***Estimates need to be confirmed by DVP**

Table 2

Secondary Point of Interconnection (Bearskin 138 kV Substation)

Option 1:

To accommodate the interconnection at the Bearskin 138 kV hard tap, the hard tap will have to be reconfigured into a new four (4) circuit breaker 138 kV switching station operated as a ring-bus, but constructed and physically configured in a breaker and half bus arrangement (see Figure 3). The new switching station will provide a connection to Dominion Virginia Power Company. 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.

Option 2:

Contact Dominion Virginia Power to accommodate the interconnection at the Bearskin 138 kV substation.

It is understood that The IC Solar is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of The IC Solar's generating plant and the costs for the line connecting the generating plant to The IC Solar's switching station are not included in this report; these are assumed to be The IC Solar'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 AC1-083 was evaluated as a 100.0 MW (Capacity 38.0 MW) injection tapping the Smith Mountain-Bearskin 138 kV line in the AEP area. Project AC1-083 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-083 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**
374	CONTINGENCY '374_C2' OPEN BRANCH FROM BUS 242701 TO BUS 247499 CKT 1 / 242701 05LEESVI 138 247499 05SMITHM 138 1 OPEN BRANCH FROM BUS 247499 TO BUS 242802 CKT Z1 / 247499 05SMITHM 138 242802 05SMITHMTN1 138 1 OPEN BRANCH FROM BUS 242701 TO BUS 314667 CKT 1 / 242701 05LEESVI 138 314667 4ALTVSTA 138 1 END
374_C2	CONTINGENCY '374_C2' OPEN BRANCH FROM BUS 242701 TO BUS 247499 CKT 1 / 242701 05LEESVI 138 247499 05SMITHM 138 1 OPEN BRANCH FROM BUS 247499 TO BUS 242802 CKT Z1 / 247499 05SMITHM 138 242802 05SMITHMTN1 138 1 OPEN BRANCH FROM BUS 242701 TO BUS 314667 CKT 1 / 242701 05LEESVI 138 314667 4ALTVSTA 138 1 END
6215_B2_TOR13860B_MOAB	CONTINGENCY '6215_B2_TOR13860B_MOAB' OPEN BRANCH FROM BUS 242748 TO BUS 242802 CKT 1 / 242748 05PENHOK 138 242802 05SMITHMTN1 138 1 END

Table 3

Generator Deliverability

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

None

Multiple Facility Contingency

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

AC1-083 Multiple Facility Contingency														
	Contingency		Affected		Bus			Loading		Rating		MW	FG
#	Type	Name	Area	Facility Description	From	To	PF	Initial	Final	Type	MVA	Con.	App.
1	LFFB	374_C2	AEP - AEP	05BANSTR-05EDAN 2 138 kV line	242549	242632	DC	86.52	110.23	ER	286	67.82	1
2	DCTL	374	AEP - AEP	05BANSTR-05EDAN 2 138 kV line	242549	242632	DC	86.52	110.23	ER	286	67.82	1
3	LFFB	374_C2	AEP - AEP	AC1-083 TAP-05BEARSK 138 kV line	926050	242550	DC	89.24	112.96	ER	286	67.82	2
4	DCTL	374	AEP - AEP	AC1-083 TAP-05BEARSK 138 kV line	926050	242550	DC	89.24	112.96	ER	286	67.82	2

Table 4

Note: Please see Appendices providing impacts to flowgate violations. The values in the "FG" column correspond to the proper table in the Appendix.

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)

None

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.

AC1-083 Delivery of Energy Portion of Interconnection Request														
	Contingency		Affected		Bus			Loading		Rating		MW	FG	
#	Type	Name	Area	Facility Description	From	To	PF	Initial	Final	Type	MVA	Con.	App.	
1	N-1	6215_B2_TOR13860 B_MOAB	AEP - AEP	05SMITHMTN2-05ROCKCA 138 kV line	247499	242775	DC	81.68	90.4	ER	286	24.94		
2	Non	Non	DVP - AEP	4ALTVSTA-05OTTER 138 kV line	314667	242741	DC	88.2	90.32	NR	151	7.11		
3	Non	Non	DVP - AEP	4ALTVSTA-05OTTER 138 kV line	314667	242741	DC	88.2	90.32	NR	151	7.11		

Table 5

New System Reinforcements

Violation #	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	Banister – East Danville 138 kV line	A sag check will be required for the ACSR ~ 1033.5 ~ 45/7 ~ Conductor Section 2 to determine if the line section can be operated above its emergency rating of 296 MVA. The result could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 0.1 mile entry span would need to be rebuilt.	Sag Study: 6 to 12 months. Reconductor/Rebuild: The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	**$15,000**
#2	Same as 1 above	Same as 1 above	Same as 1 above	Same as 1 above
#3	AC1-083 Tap – Bearskin 138 kV line	A sag check will be required for the ACSR ~ 1033.5 ~ 45/7 ~ Conductor Section 1 to determine if the line section can be operated above its emergency rating of 296 MVA. The result could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 0.25 mile entry span would need to be rebuilt.	Sag Study: 6 to 12 months. Reconductor/Rebuild: The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	**$15,000**
#4	Same as 3 above	Same as 3 above	Same as 3 above	Same as 3 above
			Total New Network Upgrades	**$30,000**

Table 6

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would be between 24 to 36 months after signing an interconnection agreement.

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

Conclusion

Based upon the results of this Feasibility Study, the construction of the 100.0 MW (38.0 MW Capacity) solar generating facility for PJM Project #AC1-083 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 solar generating facility.

Cost Breakdown for Primary Point of Interconnection (Smith Mountain-Bearskin 138 kV)		
Attachment Cost	New 138 kV Switching Station	**$5,000,000**
Direct Connection Cost Estimate	Smith Mountain-Bearskin 138 kV T-Line Cut In	**$1,000,000**
Non-Direct Connection Cost Estimate	138 kV Revenue Metering	**$300,000**
	Upgrade line protection and controls at the Smith Mountain 138 kV substation to coordinate with the new 138 kV switching station.	**$250,000**
	Upgrade line protection and controls at the Bearskin 138 kV substation to coordinate with the new 138 kV switching station.	**$250,000**
	Upgrade line protection and controls at the Banister 138 kV substation to coordinate with the new 138 kV switching station.	**$250,000**
	Upgrade line protection and controls at the East Danville 138 kV substation to coordinate with the new 138 kV switching station.	**$250,000**
	A sag check will be required for the Banister – East Danville 138 kV line	**$15,000**
	A sag check will be required for the AC1-083 Tap – Bearskin 138 kV line	**$15,000**
	Total Estimated Cost for Project AC1-083	**$7,330,000**

Table 7

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.

Option 2

Network Impacts

The Queue Project AC1-083 was evaluated as a 100.0 MW (Capacity 38.0 MW) injection at the Bearskin 138kV substation in the AEP area. Project AC1-083 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-083 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**
374_A	CONTINGENCY '374_A' OPEN BRANCH FROM BUS 242701 TO BUS 247499 CKT 1 / 242701 05LEESVI 138 247499 05SMITHM 138 1 OPEN BRANCH FROM BUS 247499 TO BUS 242802 CKT Z1 / 247499 05SMITHM 138 242802 05SMITHMTN1 138 1 OPEN BRANCH FROM BUS 242701 TO BUS 926510 CKT 1 / 242701 05LEESVI 138 926510 AC1-122 TAP 138 1 END
374_B	CONTINGENCY '374_B' OPEN BRANCH FROM BUS 242701 TO BUS 247499 CKT 1 / 242701 05LEESVI 138 247499 05SMITHM 138 1 OPEN BRANCH FROM BUS 247499 TO BUS 242802 CKT Z1 / 247499 05SMITHM 138 242802 05SMITHMTN1 138 1 OPEN BRANCH FROM BUS 926510 TO BUS 314667 CKT 1 / 926510 AC1-122 TAP 138 314667 4ALTVSTA 138 1 END
374_C2_A	CONTINGENCY '374_C2_A' OPEN BRANCH FROM BUS 242701 TO BUS 247499 CKT 1 / 242701 05LEESVI 138 247499 05SMITHM 138 1 OPEN BRANCH FROM BUS 247499 TO BUS 242802 CKT Z1 / 247499 05SMITHM 138 242802 05SMITHMTN1 138 1 OPEN BRANCH FROM BUS 242701 TO BUS 926510 CKT 1 / 242701 05LEESVI 138 926510 AC1-122 TAP 138 1 END

Table 8

Generator Deliverability

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

AC1-083 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	Non	Non	DVP - AEP	4ALTVSTA-05OTTER 138 kV line	314667	242741	1	DC	85.79	87.21	NR	151	2.14	3
2	Non	Non	DVP - AEP	4ALTVSTA-05OTTER 138 kV line	314667	242741	1	DC	85.79	87.21	NR	151	2.14	3

Table 9

Note: Please see Appendices providing impacts to flowgate violations. The values in the "FG" column correspond to the proper table in the Appendix.

Multiple Facility Contingency

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

AC1-083 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	LFFB	374_C2_A	AEP - AEP	05BANSTR-05EDAN 2 138 kV line	242549	242632	1	DC	86.56	112.84	ER	286	75.16	4
2	DCTL	374_A	AEP - AEP	05BANSTR-05EDAN 2 138 kV line	242549	242632	1	DC	86.56	112.84	ER	286	75.16	4
3	DCTL	374_B	AEP - AEP	05BANSTR-05EDAN 2 138 kV line	242549	242632	1	DC	86.56	112.84	ER	286	75.16	4

Table 10

Note: Please see Appendices providing impacts to flowgate violations. The values in the "FG" column correspond to the proper table in the Appendix.

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)

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.

	Contingency		Affected		Bus				Loading		Rating		MW
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.
6	Non	Non	AEP - AEP	05OTTER-05JOHNMT 138 kV line	242741	242687	1	DC	76.74	78.27	NR	167	5.64
7	Non	Non	DVP - AEP	4ALTVSTA-05OTTER 138 kV line	314667	242741	1	DC	87.86	89.54	NR	151	5.64
8	Non	Non	DVP - AEP	4ALTVSTA-05OTTER 138 kV line	314667	242741	1	DC	87.86	89.54	NR	151	5.64
9	Non	Non	AEP - DVP	AC1-122 TAP-4ALTVSTA 138 kV line	926510	314667	1	DC	79.13	85.09	NR	205	12.21
10	Non	Non	AEP - DVP	AC1-122 TAP-4ALTVSTA 138 kV line	926510	314667	1	DC	79.13	85.09	NR	205	12.21

Table 11

Figure 1: Primary Point of Interconnection (Smith Mountain - Bearskin 138 kV)

Single-Line Diagram

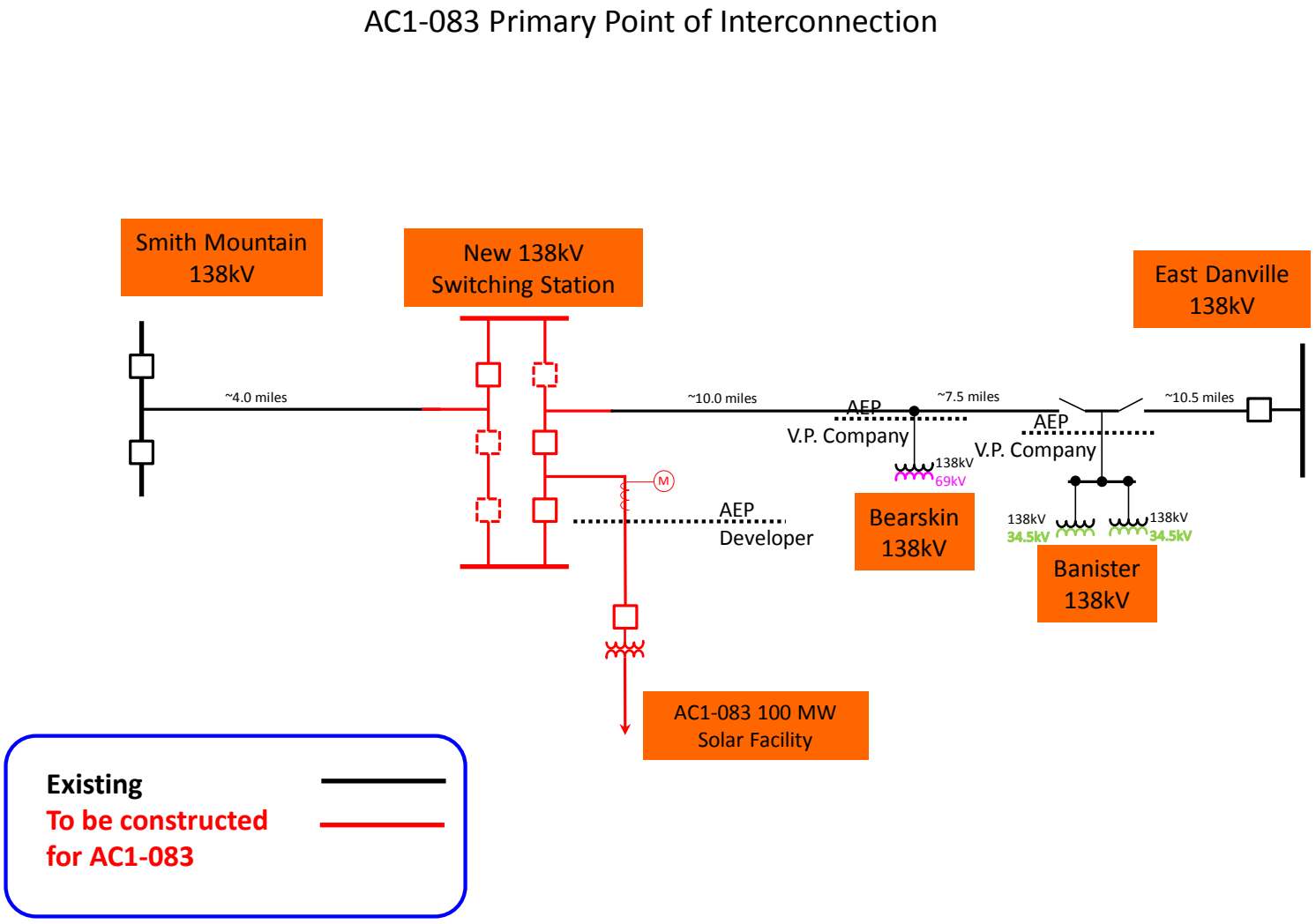


Figure 2: Primary Point of Interconnection (Smith Mountain – Bearskin 138 kV)

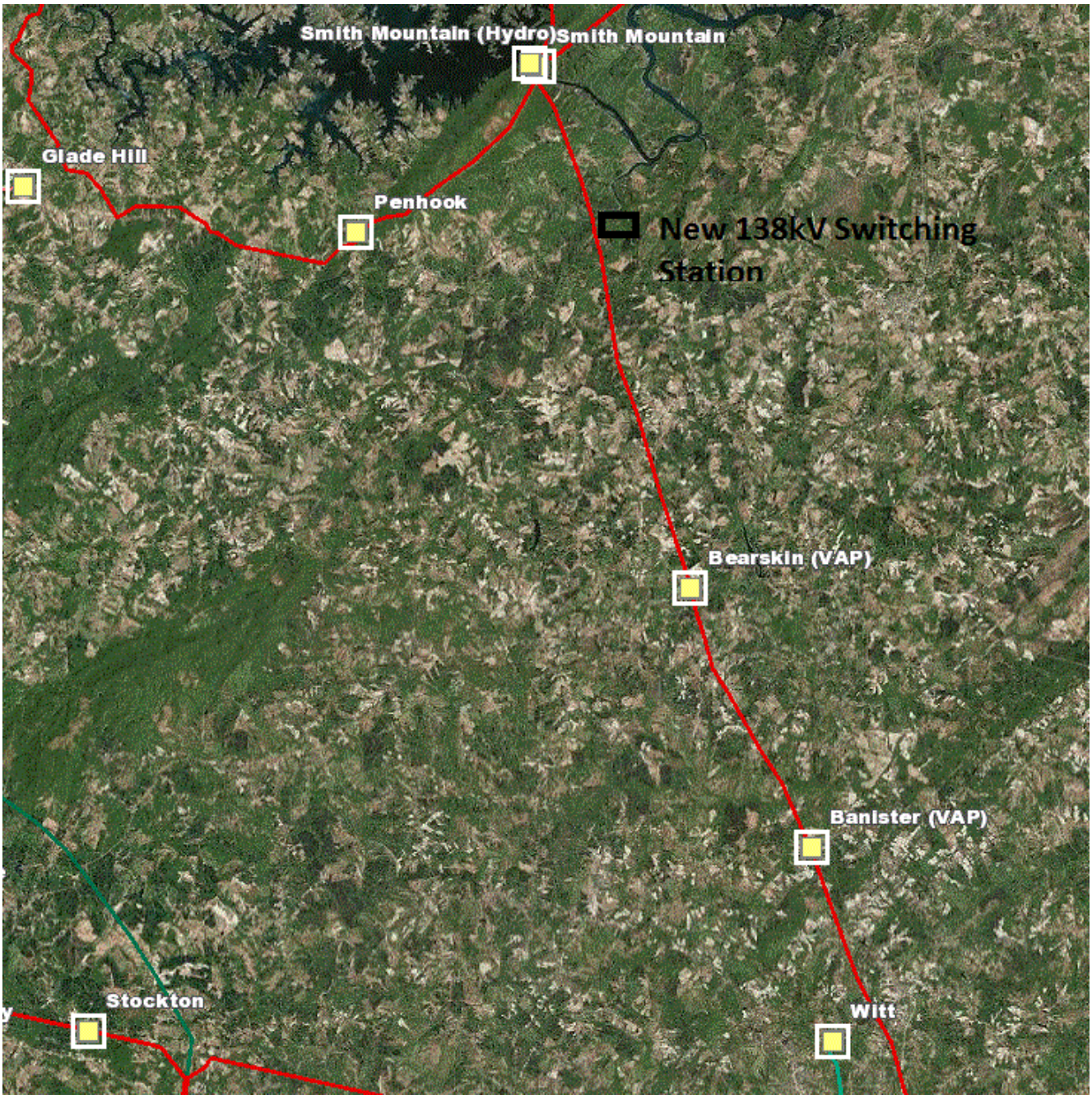


Figure 3: Secondary Point of Interconnection (Bearskin 138 kV Hard Tap)

Single-Line Diagram

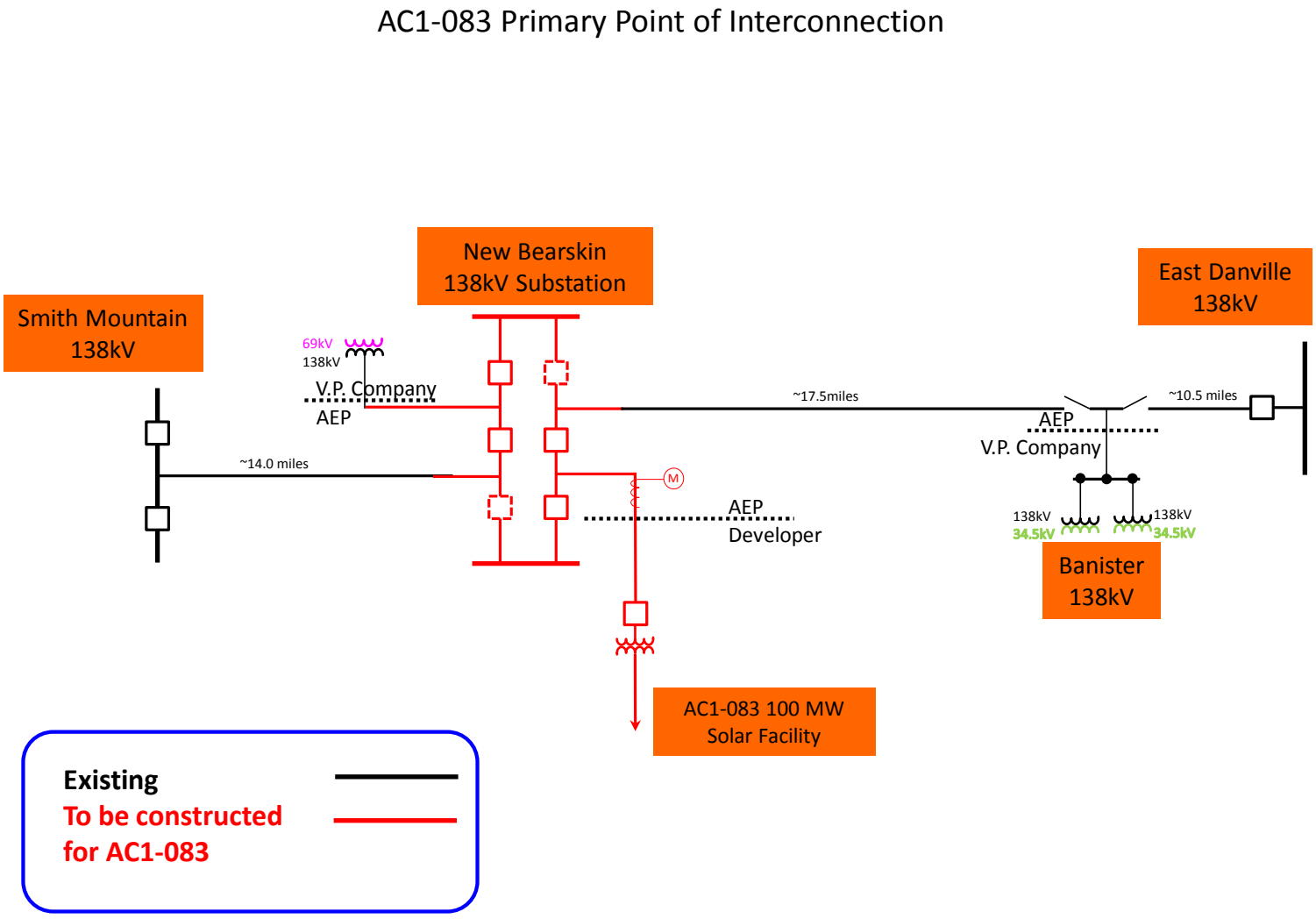
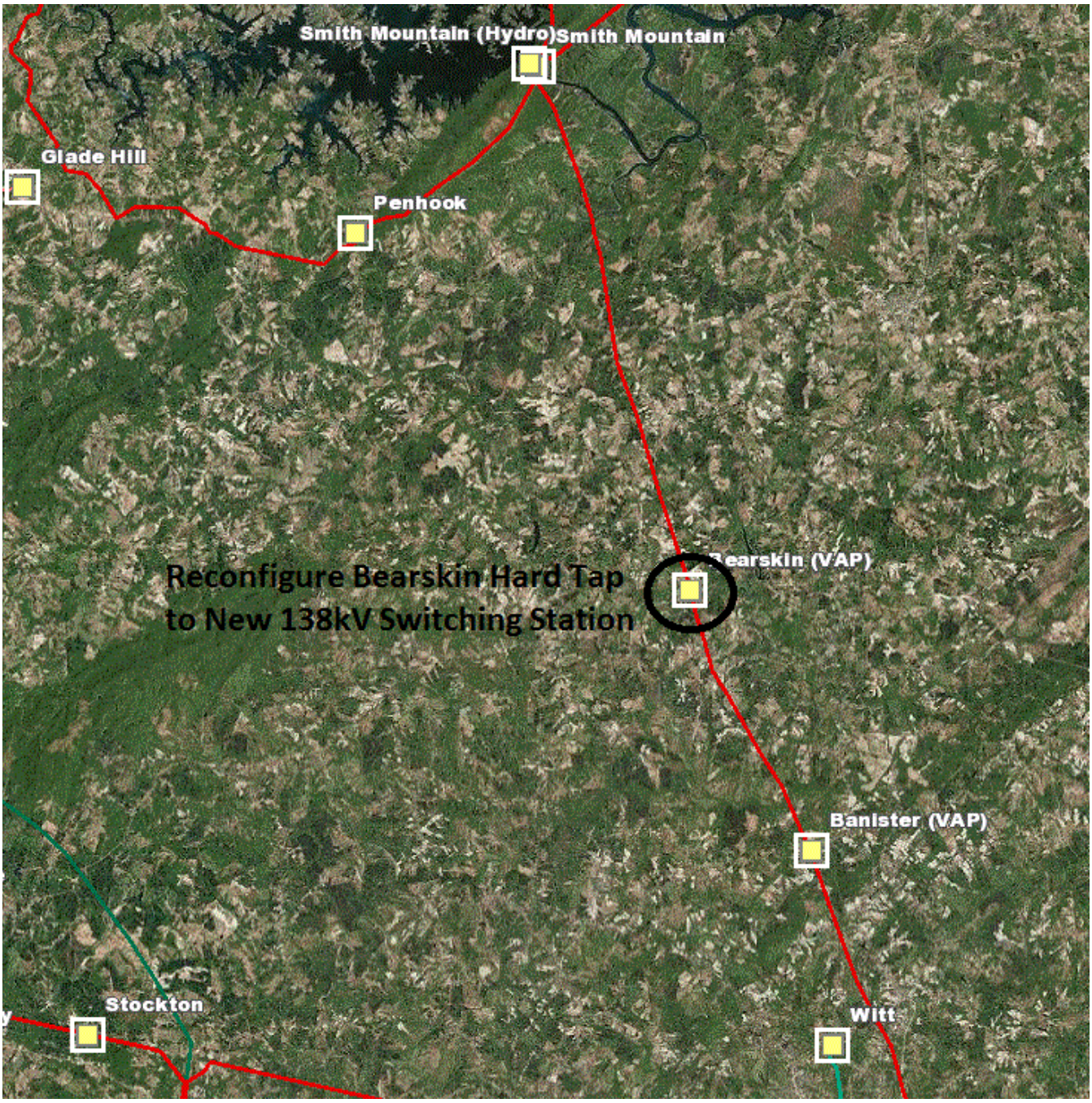


Figure 4: Secondary Point of Interconnection (Bearskin 138 kV Hard Tap)



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 05BANSTR-05EDAN 2 138 kV line (from bus 242549 to bus 242632 ckt 1) loads from 86.52% to 110.23% (**DC power flow**) of its emergency rating (286 MVA) for the line fault with failed breaker contingency outage of '374_C2'. This project contributes approximately 67.82 MW to the thermal violation.

CONTINGENCY '374_C2'
OPEN BRANCH FROM BUS 242701 TO BUS 247499 CKT 1 / 242701 05LEESVI 138 247499 05SMITHM 138 1
OPEN BRANCH FROM BUS 247499 TO BUS 242802 CKT Z1 / 247499 05SMITHM 138 242802 05SMITHMTN1 138 1
OPEN BRANCH FROM BUS 242701 TO BUS 314667 CKT 1 / 242701 05LEESVI 138 314667 4ALTVSTA 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
246844	*05SMG2*	*20.52*
246845	*05SMG3*	*12.04*
246846	*05SMG4*	*21.21*
921882	*AA2-070*	*20.57*
926051	*AC1-083 C OP*	*25.77*
926052	*AC1-083 E OP*	*42.05*

Appendix 2

(AEP - AEP) The AC1-083 TAP-05BEARSK 138 kV line (from bus 926050 to bus 242550 ckt 1) loads from 89.24% to 112.96% (**DC power flow**) of its emergency rating (286 MVA) for the line fault with failed breaker contingency outage of '374_C2'. This project contributes approximately 67.82 MW to the thermal violation.

CONTINGENCY '374_C2'
OPEN BRANCH FROM BUS 242701 TO BUS 247499 CKT 1 / 242701 05LEESVI 138 247499 05SMITHM 138 1
OPEN BRANCH FROM BUS 247499 TO BUS 242802 CKT Z1 / 247499 05SMITHM 138 242802 05SMITHMTN1 138 1
OPEN BRANCH FROM BUS 242701 TO BUS 314667 CKT 1 / 242701 05LEESVI 138 314667 4ALTVSTA 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
246844	*05SMG2*	*20.52*
246845	*05SMG3*	*12.04*
246846	*05SMG4*	*21.21*
921882	*AA2-070*	*20.57*
926051	*AC1-083 C OP*	*25.77*
926052	*AC1-083 E OP*	*42.05*

Appendix 3

(DVP - AEP) The 4ALTVSTA-05OTTER 138 kV line (from bus 314667 to bus 242741 ckt 1) loads from 85.79% to 87.21% (**DC power flow**) of its normal rating (151 MVA) for non-contingency condition. This project contributes approximately 2.14 MW to the thermal violation.

Bus Number	*Bus Name*	*Full Contribution*
247284	*05LEESVG*	*1.76*
246843	*05SMG1*	*1.09*
246844	*05SMG2*	*2.87*
246845	*05SMG3*	*1.68*
246846	*05SMG4*	*2.96*
246847	*05SMG5*	*1.12*
315156	*1HALLBR1*	*3.01*
315165	*1HURT 1*	*2.08*
315166	*1HURT 2*	*2.08*
921882	*AA2-070*	*2.87*
925661	*AC1-042 C*	*5.57*
925991	*AC1-075 C*	*5.81*
926021	*AC1-080 C*	*2.12*
926051	*AC1-083 C OP*	*2.14*
926511	*AC1-122 C OP*	*9.74*
926521	*AC1-123 C OP*	*3.28*
926641	*AC1-145 C*	*5.57*
926651	*AC1-146 C*	*1.67*
927261	*AC1-222 C*	*2.3*

Appendix 4

(AEP - AEP) The 05BANSTR-05EDAN 2 138 kV line (from bus 242549 to bus 242632 ckt 1) loads from 86.56% to 112.84% (**DC power flow**) of its emergency rating (286 MVA) for the line fault with failed breaker contingency outage of '374_C2_A'. This project contributes approximately 75.16 MW to the thermal violation.

CONTINGENCY '374_C2_A'
OPEN BRANCH FROM BUS 242701 TO BUS 247499 CKT 1 / 242701 05LEESVI 138 247499 05SMITHM 138 1
OPEN BRANCH FROM BUS 247499 TO BUS 242802 CKT Z1 / 247499 05SMITHM 138 242802 05SMITHMTN1 138 1
OPEN BRANCH FROM BUS 242701 TO BUS 926510 CKT 1 / 242701 05LEESVI 138 926510 AC1-122 TAP 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
246844	*05SMG2*	*20.53*
246845	*05SMG3*	*12.04*
246846	*05SMG4*	*21.22*
921882	*AA2-070*	*20.57*
926051	*AC1-083 C OP*	*28.56*
926052	*AC1-083 E OP*	*46.6*