Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD1-152

Clover-Halifax 230kV 48 MW Capacity / 80 MW Energy

February 2018

Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the Feasibility Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Virginia Electric and Power Company (VEPCO).

Preface

The intent of the Feasibility Study is to determine a plan, with high level estimated cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the IC. The IC may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the IC 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 IC is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by ITO, the costs may be included in the study.

General

The IC has proposed a solar generating facility located in Halifax County, Virginia. The installed AD1-152 facilities will have a total capability of 80 MW with 48 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 31, 2020. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AD1-152 will interconnect with the ITO transmission system via one of the following Points of Interconnections:

Option 1: AD1-152 will interconnect via a new three breaker ring bus switching station that connects the Clover-Halifax 230kV line.

Option 2: AD1-152 will interconnect via a new three breaker ring bus switching station that connects the Mt. Laurel-Halifax 115kV line.

Cost Summary

The AD1-152 project will be responsible for the following costs:

Description	Total Estimated Cost
Attachment Facilities	$ 1,800,000
Direct Connection Network Upgrades	$ 6,300,000
Non Direct Connection Network Upgrades	$ 1,000,000
Total Costs	**$ 9,100,000**

In addition, the AD1-152 project may be responsible for a contribution to the following costs:

Description	Total Estimated Cost
New System Upgrades	$ 43,620,000
Previously Identified Upgrades	$ 41,165,000
Total Costs	**$ 84,785,000**

PJM Open Access Transmission Tariff (OATT) section 217.3A outlines cost allocation rules. The rules are further clarified in PJM Manual 14A Attachment B. For New System Upgrades, the cost allocation rule differ depending on whether the minimum amount of upgrades to resolve a single reliability criteria violation will cost less than $5,000,000. For upgrades estimated to cost less than $5,000,000 the allocation of costs will not occur outside of the Queue in which the need for the Network Upgrade was identified. Cost allocation within the Queue will be contingent each Queue projects Distribution Factor on the overloaded facility. For upgrades estimated to cost $5,000,000 or greater the allocation of costs will start with the first Queue project to cause the need for the upgrade. Later queue projects will receive cost allocation contingent on their contribution to the violation and are allocated to the queues that have not closed less than 5 years following the execution of the first Interconnection Service Agreement which identifies the need for this upgrade.

The Feasibility Study is used to make a preliminary determination of the type and scope of Attachment Facilities, Local Upgrades, and Network Upgrades that will be necessary to accommodate the Interconnection Request and to provide the Interconnection Customer a preliminary estimate of the time that will be required to construct any necessary facilities and upgrades and the Interconnection Customer's cost responsibility. The System Impact Study provides refined and comprehensive estimates of cost responsibility and construction lead times for new facilities and system upgrades. Facilities Studies will include, commensurate with the degree of engineering specificity as provided in the Facilities Study Agreement, good faith estimates of the cost, determined in accordance with Section 217 of the Tariff,

(a) to be charged to each affected New Service Customer for the Facilities and System Upgrades that are necessary to accommodate this queue project;

(b) the time required to complete detailed design and construction of the facilities and upgrades; and

(c) a description of any site-specific environmental issues or requirements that could reasonably be anticipated to affect the cost or time required to complete construction of such facilities and upgrades.

System Reinforcements

Violation #	Upgrade Description	Upgrade Cost
	***NEW SYSTEM REINFORCEMENTS**	
1	Wreck and rebuild the line of 15 miles to increase its line rating to 4453 MVA (normal), 4453 MVA (emergency), and 5121 MVA (load dump).. It is estimated to cost $43,620,000 to 44-48 months to engineer, permit and construct. A VA CPCN is required.	$43,620,000
2-4	Briery – Prince Edw – Farmville: Wreck and rebuild the line of 13 miles to increase its line rating to 722 MVA (normal), 722 MVA (emergency), and 830 MVA (load dump). It is estimated to cost $32,275,000 and 30-36 months to engineer, permit, and construct. A VA CPCN is required.	Upgrade Costs are captured in reinforcements for violation #5-9
	CONTRIBUTIONS TO PREVIOUS SYSTEM REINFORCEMENTS	
5-9 (2-4)	Briery – Prince Edw – Farmville: Wreck and rebuild the line of 13 miles to increase its line rating to 722 MVA (normal), 722 MVA (emergency), and 830 MVA (load dump). It is estimated to cost $32,275,000 and 30-36 months to engineer, permit, and construct. A VA CPCN is required.	$32,275,000
10	05EDAN 1-05DANVL2 138 kV line: The total costs for AEP upgrades items 1 – 10 in is $8,890,000. The estimated schedule is 24 to 36 months after signing the Interconnection Service Agreement. See mitigation for violation #10 later in this report for itemized list.	$8,890,000
	Total Network Upgrades	**$84,785,000**

*Note:
For New System Reinforcements, only violations in which the AD1-152 overloads the facility are included in the table above. Costs for New System Reinforcement for which AD1-152 is not the first project to overload the facility are included for reference in the later part of this report. Cost allocation will be provided in the Impact Study.

Attachment Facilities

Generation Substation: Install metering and associated protection equipment. Estimated Cost $600,000.

Transmission: Construct approximately one span of 230 kV Attachment line between the generation substation and a new AD1-152 Switching Station. The estimated cost for this work is $1,200,000.

The estimated total cost of the Attachment Facilities is $1,800,000. It is estimated to take 18-24 months to complete this work upon execution of an Interconnection Construction Service Agreement (ICSA). These preliminary cost estimates are based on typical engineering costs. A more detailed engineering cost estimates are normally done when the IC provides an exact site plan location for the generation substation during the Facility Study phase.

Cost Estimate

Substation: Establish the new 230 kV AD1-152 Switching Substation (interconnection substation). The estimated cost of this work scope is $6,300,000. It is estimated to take 24-36 months to complete this work upon execution of an Interconnection Construction Service Agreement.

Non-Direct Network Upgrades:

Transmission: Install transmission structure in-line with transmission line to allow the proposed interconnection switching station to be interconnected with the transmission system. Estimated cost is $1,000,000 dollars and is estimated to take 24-30 months to complete.

Remote Terminal Work: During the Facilities Study, ITO's System Protection Engineering Department will review transmission line protection as well as anti-islanding required to accommodate the new generation and interconnection substation. System Protection Engineering will determine the minimal acceptable protection requirements to reliably interconnect the proposed generating facility with the transmission system. The review is based on maintaining system reliability by reviewing ITO's protection requirements with the known transmission system configuration which includes generating facilities in the area. This review may determine that transmission line protection and communication upgrades are required at remote substations.

Interconnection Customer Requirements

ITO's Facility Connection Requirements as posted on PJM's website
http://www.pjm.com/~/media/planning/plan-standards/private-dominion/facility-connection-requirements1.ashx

Voltage Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for voltages and times as specified for the Eastern Interconnection in Attachment 1 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low voltage conditions, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Frequency Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for frequencies and times as specified in Attachment 2 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low frequency condition, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Reactive Power - The Generation Interconnection Customer shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading to 0.95 lagging measured at the generator's terminals.

Revenue Metering and SCADA Requirements

PJM Requirements

The IC 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.

Meteorological Data Reporting Requirement

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

OPTION 1:

Network Impacts

PJM assessed the impact of the proposed Queue Project as an injection into the ITO's transmission system, for compliance with NERC Reliability Criteria. The system was assessed using the summer 2021 RTEP case. When performing analysis, ITO Criteria considers a transmission facility overloaded if it exceeds 94% of its emergency rating under single contingency (normal and stressed system conditions). A full listing of the ITO's Planning Criteria and interconnection requirements can be found in the ITO's Facility Connection Requirements which are publicly available at: http://www.dom.com.

The results of these studies evaluate the system under a limited set of operating conditions and do not guarantee the full delivery of the capacity and associated energy of this proposed generation facility under all operating conditions. NERC Planning and Operating Reliability Criteria allow for the re-dispatch of generating units to resolve projected and actual deficiencies in real time and planning studies. Specifically NERC Category C Contingency Conditions (Bus Fault, Tower Line, N-1-1, and Stuck Breaker scenarios) allow for re-dispatch of generating units to resolve potential reliability deficiencies. For ITO Planning Criteria the re-dispatch of generating units for these contingency conditions is allowed as long as the projected loading does not exceed 100% of a facility Load Dump Rating. The results of these studies are discussed in more detail below.

The Queue Project AD1-152 was evaluated as an 80.0 MW (Capacity 48.0 MW) injection tapping Clover to Halifax 230kV line in the ITO area. Project AD1-152 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-152 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
AEP_P1-2_#1377	CONTINGENCY 'AEP_P1-2_#1377' OPEN BRANCH FROM BUS 242514 TO BUS 242520 CKT 1 / 242514 05J.FERR 765 242520 05J.FERR 500 1 OPEN BRANCH FROM BUS 242520 TO BUS 306719 CKT 1 / 242520 05J.FERR 500 306719 8ANTIOCH 500 1 END

Contingency Name	Description
AEP_P4_#7589_05J.FERR 765	CONTINGENCY 'AEP_P4_#7589_05J.FERR 765' OPEN BRANCH FROM BUS 242514 TO BUS 242520 CKT 1 / 242514 05J.FERR 765 242520 05J.FERR 500 1 OPEN BRANCH FROM BUS 242514 TO BUS 242684 CKT 2 / 242514 05J.FERR 765 242684 05J.FERR 138 2 OPEN BRANCH FROM BUS 242520 TO BUS 306719 CKT 1 / 242520 05J.FERR 500 306719 8ANTIOCH 500 1 END
DVP_P1-2: LN 2027-A	CONTINGENCY 'DVP_P1-2: LN 2027-A' OPEN BRANCH FROM BUS 314310 TO BUS 314322 CKT 1 /* 6JUDES F 230.00 - 6MDLTHAN 230.00 OPEN BRANCH FROM BUS 314310 TO BUS 314333 CKT 1 /* 6JUDES F 230.00 - 6POWHATN 230.00 OPEN BRANCH FROM BUS 314333 TO BUS 933500 CKT 1 /* 6POWHATN 230.00 - AC2-165 TAP 230.00 OPEN BUS 314310 /* ISLAND OPEN BUS 314333 /* ISLAND END
DVP_P1-2: LN 556	CONTINGENCY 'DVP_P1-2: LN 556' OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 1 /* 6CLOVER 230.00 - 8CLOVER 500.00 OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 2 /* 6CLOVER 230.00 - 8CLOVER 500.00 OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 3 /* 6CLOVER 230.00 - 8CLOVER 500.00 OPEN BRANCH FROM BUS 314906 TO BUS 314936 CKT 1 /* 8CLOVER 500.00 - 8RAWLINGS 500.00 OPEN BUS 314906 /* ISLAND END
DVP_P1-2: LN 573	CONTINGENCY 'DVP_P1-2: LN 573' OPEN BRANCH FROM BUS 314918 TO BUS 314934 CKT 1 /* 8NO ANNA 500.00 - 8SPOTSYL 500.00 END

Contingency Name	Description
DVP_P4-2: 511T556	CONTINGENCY 'DVP_P4-2: 511T556' /*RAWLINGS OPEN BRANCH FROM BUS 314936 TO BUS 314906 CKT 1 /*RAWLINGS TO CLOVER (LINE 556) OPEN BRANCH FROM BUS 314906 TO BUS 314686 CKT 1 /*CLOVER 500-230 (TX#9) OPEN BRANCH FROM BUS 314906 TO BUS 314686 CKT 2 /*CLOVER 500-230 (TX#8) OPEN BRANCH FROM BUS 314906 TO BUS 314686 CKT 3 /*CLOVER 500-230 (TX#7) OPEN BRANCH FROM BUS 314936 TO BUS 314902 CKT 1 /*RAWLINGS TO CARSON (LINE 511) END
DVP_P4-2: 511T591	CONTINGENCY 'DVP_P4-2: 511T591' /*RAWLINGS OPEN BRANCH FROM BUS 314936 TO BUS 314902 CKT 1 /*RAWLINGS TO CARSON (LINE 511) OPEN BRANCH FROM BUS 314936 TO BUS 314935 CKT 1 /*RAWLINGS TO BRUNSWICK (LINE 591) END
DVP_P4-2: 556T591	CONTINGENCY 'DVP_P4-2: 556T591' /*RAWLINGS OPEN BRANCH FROM BUS 314936 TO BUS 314906 CKT 1 /*RAWLINGS TO CLOVER (LINE 556) OPEN BRANCH FROM BUS 314906 TO BUS 314686 CKT 1 /*CLOVER 500-230 (TX#9) OPEN BRANCH FROM BUS 314906 TO BUS 314686 CKT 2 /*CLOVER 500-230 (TX#8) OPEN BRANCH FROM BUS 314906 TO BUS 314686 CKT 3 /*CLOVER 500-230 (TX#7) OPEN BRANCH FROM BUS 314936 TO BUS 314935 CKT 1 /*RAWLINGS TO BRUNSWICK (LINE 591) END

Summer Peak Analysis – 2021

Generator Deliverability

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

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
1	N-1	DVP_P1-2: LN 573	DVP - DVP	8NO ANNA-8LADYSMITH 500 kV line	314918	314911	1	DC	99.92	100.16	ER	3219	7.37	1

Multiple Facility Contingency

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

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
2	LFFB	DVP_P4-2: 511T556	DVP - DVP	6PRINCE EDW-6FARMVIL 230 kV line	313802	314692	1	DC	99.91	102.84	LD	699	20.44	
3	LFFB	DVP_P4-2: 556T591	DVP - DVP	6PRINCE EDW-6FARMVIL 230 kV line	313802	314692	1	DC	99.91	102.84	LD	699	20.44	
4	LFFB	DVP_P4-2: 511T591	DVP - DVP	6PRINCE EDW-6FARMVIL 230 kV line	313802	314692	1	DC	99.74	102.67	LD	699	20.44	

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Contributions to previously identified circuit breakers found to be over-duty:

None

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)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
5	N-1	DVP_P1-2: LN 556	DVP - DVP	6PRINCE EDW-6FARMVIL 230 kV line	313802	314692	1	DC	105.44	107.59	ER	572	12.24	2
6	N-1	DVP_P1-2: LN 556	DVP - DVP	6BRIERY-6PRINCE EDW 230 kV line	314268	313802	1	DC	106.46	108.61	ER	572	12.24	3
7	LFFB	DVP_P4-2: 556T591	DVP - DVP	6BRIERY-6PRINCE EDW 230 kV line	314268	313802	1	DC	100.75	103.68	LD	699	20.44	
8	LFFB	DVP_P4-2: 511T556	DVP - DVP	6BRIERY-6PRINCE EDW 230 kV line	314268	313802	1	DC	100.74	103.67	LD	699	20.44	
9	LFFB	DVP_P4-2: 511T591	DVP - DVP	6BRIERY-6PRINCE EDW 230 kV line	314268	313802	1	DC	100.58	103.51	LD	699	20.44	
10	LFFB	AEP_P4_#7589_05J.FERR 765	AEP - AEP	05EDAN 1-05DANVL2 138 kV line	242631	242620	1	DC	119.66	120.27	ER	415	5.6	4

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

To be determined during Impact Study

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined during Impact Study

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	Network Upgrade Number	Upgrade Cost
1	8NO ANNA-8LADYSMITH 500 kV line	Wreck and rebuild the line of 15 miles to increase its line rating to 4453 MVA (normal), 4453 MVA (emergency), and 5121 MVA (load dump).. It is estimated to cost $43,620,000 to 44-48 months to engineer, permit and construct. A VA CPCN is required.	Pending	$43,620,000
2-4 (5-9)	The 6PRINCE EDW-6FARMVIL 230 kV line ; 6BRIERY-6PRINCE EDW 230 kV	Briery – Prince Edw – Farmville: Wreck and rebuild the line of 13 miles to increase its line rating to 722 MVA (normal), 722 MVA (emergency), and 830 MVA (load dump). It is estimated to cost $32,275,000 and 30-36 months to engineer, permit, and construct. A VA CPCN is required.	Pending	$32,275,000
			Total New Network Upgrades	**$75,895,000**

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 %

#	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
5-9 (2-4)	The 6PRINCE EDW-6FARMVIL 230 kV line ; 6BRIERY-6PRINCE EDW 230 kV	Briery – Prince Edw – Farmville: Wreck and rebuild the line of 13 miles to increase its line rating to 722 MVA (normal), 722 MVA (emergency), and 830 MVA (load dump). It is estimated to cost $32,275,000 and 30-36 months to engineer, permit, and construct. A VA CPCN is required.	Pending	$32,275,000

#	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
10	05EDAN 1-05DANVL2 138 kV line	Limiting Element: AEP Records show ratings S/N: 275 MVA S/E: 361 MVA 1) Switch (1200A) - Danville Sw. CB M - Danville Circuit Breaker M needs to be replaced. Estimated cost: $1,000,000. 2) Sub Cond 1590 AAC 61 Str - Danville Risers - Replace Danville risers, Estimated cost: $100,000. 3) ACSR ~ 336/556 six wire - conductor section 2 - 2.87 miles of conductor will need to be reconductored / rebuilt. Estimated cost: $4.3 million. 4) Relay Thermal limit 1795 Amps - E Danville 1 - An Engineering study needs to be conducted to determine if the relay thermal limit can be adjusted to mitigate the overload. Estimated Cost: $25,000. In addition, new relay packages will be required if the settings cannot be adjusted. Estimated cost: $600,000. 5) Relay Thermal limit 1795 Amps- Danville2 - An engineering study needs to be conducted to determine if the relay thermal limit can be adjusted to mitigate the overload. Estimated Cost: $25,000. In addition, new relay packages will be required if the settings cannot be adjusted. Estimated cost: $600,000. 6) Relay compliance trip limit 1916 Amps- E Danville (RCTL) - An engineering study needs to be conducted to determine if the relay compliance trip limits settings can be adjusted to mitigate the overload. Estimated Cost: $25,000. In addition, new relay packages will be required if the settings cannot be adjusted. Estimated cost: $600,000. 7) Relay compliance trip limit 1916 Amps- Danville2 (RCTL) - An engineering study needs to be conducted to determine if the relay compliance trip limits settings can be adjusted to mitigate the overload. Estimated Cost: $25,000. In addition, new relay packages will be required if the settings cannot be adjusted. Estimated cost: $600,000. 8) ACSR ~ 1351.5 ~ 45/7 ~ DIPPER - Conductor Section 3 - 0.03 miles of conductor will need to re-conductored/rebuilt. Estimated cost: $0.045 Million. 9) ACSR ~ 1351.5 ~ 45/7 ~ DIPPER - Conductor Section 1 - 0.03 miles of conductor will need to re-conductored/rebuilt. Estimated cost: $0.045 Million 10) Breaker (2000A) Non Oil- E. Danville CB L - East Danville Circuit Breaker L needs to be replaced. Estimated cost: $1,000,000. New Rating: S/N: 351 MVA S/E: 474 MVA. The total costs for AEP upgrades items 1 – 10 outlined above is $8,890,000. The estimated schedule is 24 to 36 months after signing the Interconnection Service Agreement.	Pending	$8,890,000

#	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
			Total New Network Upgrades	**$41,165,000**

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The IC 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					Bus				Loading %		Rating		
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	Power Flow	Initial	Final	Type	MVA	MW Contribution
11	N-1	DVP_P1-2: LN 556	DVP - DVP	6PRINCE EDW-6FARMVIL 230 kV line	313802	314692	1	DC	119.92	123.5	ER	572	20.39
12	N-1	DVP_P1-2: LN 2027-A	DVP - DVP	6BREMODIST-6MTEAGLE 230 kV line	313867	314765	1	DC	103.72	104.15	ER	662	7.01
13	N-1	DVP_P1-2: LN 556	DVP - DVP	6BRIERY-6PRINCE EDW 230 kV line	314268	313802	1	DC	120.93	124.51	ER	572	20.39
14	N-1	DVP_P1-2: LN 556	DVP - DVP	6HALIFAX-AC1-221 TAP 230 kV line	314697	927250	1	DC	107.44	114.04	ER	675	44.52
15	N-1	DVP_P1-2: LN 2027-A	DVP - DVP	6BREMO-6BREMODIST 230 kV line	314747	313867	1	DC	105.83	106.26	ER	662	7.01

Contingency					Bus				Loading %		Rating		
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	Power Flow	Initial	Final	Type	MVA	MW Contribution
16	N-1	DVP_P1-2: LN 556	DVP - CPLE	AC1-221 TAP-6PERSON230 T 230 kV line	927250	304070	1	DC	115.47	121.21	ER	718	44.52
17	N-1	AEP_P1-2_#1377	AEP - AEP	05EDAN 1-05DANVL2 138 kV line	242631	242620	1	DC	119.64	120.25	ER	415	5.6

Light Load Analysis

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

Affected System Analysis & Mitigation

Duke, Progress & TVA Impacts:

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

OPTION 2

Network Impacts

PJM assessed the impact of the proposed Queue Project as an injection into the ITO's transmission system, for compliance with NERC Reliability Criteria. The system was assessed using the summer 2021 RTEP case. When performing analysis, ITO Criteria considers a transmission facility overloaded if it exceeds 94% of its emergency rating under single contingency (normal and stressed system conditions). A full listing of the ITO's Planning Criteria and interconnection requirements can be found in the ITO's Facility Connection Requirements which are publicly available at: http://www.dom.com.

The results of these studies evaluate the system under a limited set of operating conditions and do not guarantee the full delivery of the capacity and associated energy of this proposed generation facility under all operating conditions. NERC Planning and Operating Reliability Criteria allow for the re-dispatch of generating units to resolve projected and actual deficiencies in real time and planning studies. Specifically NERC Category C Contingency Conditions (Bus Fault, Tower Line, N-1-1, and Stuck Breaker scenarios) allow for re-dispatch of generating units to resolve potential reliability deficiencies. For ITO Planning Criteria the re-dispatch of generating units for these contingency conditions is allowed as long as the projected loading does not exceed 100% of a facility Load Dump Rating. The results of these studies are discussed in more detail below.

The Queue Project AD1-152 was evaluated as an 80.0 MW (Capacity 48.0 MW) injection tapping the Mt. Laurel to Halifax 115kV line in the ITO area. Project AD1-152 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-152 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
AEP_P1-2_#1377	CONTINGENCY 'AEP_P1-2_#1377' OPEN BRANCH FROM BUS 242514 TO BUS 242520 CKT 1 / 242514 05J.FERR 765 242520 05J.FERR 500 1 OPEN BRANCH FROM BUS 242520 TO BUS 306719 CKT 1 / 242520 05J.FERR 500 306719 8ANTIOCH 500 1 END

Contingency Name	Description
AEP_P1-2_#5473-A	CONTINGENCY 'AEP_P1-2_#5473-A' OPEN BRANCH FROM BUS 242575 TO BUS 926520 CKT 1 / 242575 05CAMDLM 138 926520 AC1-123 TAP 138 1 END
AEP_P4_#7589_05J.FERR 765	CONTINGENCY 'AEP_P4_#7589_05J.FERR 765' OPEN BRANCH FROM BUS 242514 TO BUS 242520 CKT 1 / 242514 05J.FERR 765 242520 05J.FERR 500 1 OPEN BRANCH FROM BUS 242514 TO BUS 242684 CKT 2 / 242514 05J.FERR 765 242684 05J.FERR 138 2 OPEN BRANCH FROM BUS 242520 TO BUS 306719 CKT 1 / 242520 05J.FERR 500 306719 8ANTIOCH 500 1 END
DVP_P1-2: LN 2027-A	CONTINGENCY 'DVP_P1-2: LN 2027-A' OPEN BRANCH FROM BUS 314310 TO BUS 314322 CKT 1 /* 6JUDES F 230.00 - 6MDLTHAN 230.00 OPEN BRANCH FROM BUS 314310 TO BUS 314333 CKT 1 /* 6JUDES F 230.00 - 6POWHATN 230.00 OPEN BRANCH FROM BUS 314333 TO BUS 933500 CKT 1 /* 6POWHATN 230.00 - AC2-165 TAP 230.00 OPEN BUS 314310 /* ISLAND OPEN BUS 314333 /* ISLAND END
DVP_P1-2: LN 33-C	CONTINGENCY 'DVP_P1-2: LN 33-C' OPEN BRANCH FROM BUS 926270 TO BUS 314696 CKT 1 /* AC1-105 TAP 115.00 - 3HALIFAX 115.00 END
DVP_P1-2: LN 556	CONTINGENCY 'DVP_P1-2: LN 556' OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 1 /* 6CLOVER 230.00 - 8CLOVER 500.00 OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 2 /* 6CLOVER 230.00 - 8CLOVER 500.00 OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 3 /* 6CLOVER 230.00 - 8CLOVER 500.00

Contingency Name	Description
	OPEN BRANCH FROM BUS 314906 TO BUS 314936 CKT 1 /* 8CLOVER 500.00 - 8RAWLINGS 500.00 OPEN BUS 314906 /* ISLAND END
DVP_P1-2: LN 585A	CONTINGENCY 'DVP_P1-2: LN 585A' OPEN BRANCH FROM BUS 314902 TO BUS 314940 CKT 1 /* 8CARSON 500.00 - 8ROGERS RD 500.00 END
DVP_P1-3: 3ALTVSTA-4ALTVSTA	CONTINGENCY 'DVP_P1-3: 3ALTVSTA-4ALTVSTA' OPEN BRANCH FROM BUS 314666 TO BUS 314667 CKT 1 END
DVP_P1-3: 3ALTVSTA-4ALTVSTAA	CONTINGENCY 'DVP_P1-3: 3ALTVSTA-4ALTVSTAA' OPEN BRANCH FROM BUS 314666 TO BUS 314667 CKT 2 END
DVP_P1-3: 3HALIFAX-6HALIFAXA	CONTINGENCY 'DVP_P1-3: 3HALIFAX-6HALIFAXA' OPEN BRANCH FROM BUS 314696 TO BUS 314697 CKT 2 END
DVP_P4-2: 2202	CONTINGENCY 'DVP_P4-2: 2202' /* CAROLINA OPEN BRANCH FROM BUS 314559 TO BUS 314571 CKT 1 /* LINE 22 OPEN BRANCH FROM BUS 314571 TO BUS 925780 CKT 1 /* LINE 22 OPEN BRANCH FROM BUS 314559 TO BUS 314259 CKT Z1 /* LINE 56 OPEN BRANCH FROM BUS 314559 TO BUS 919690 CKT 1 /* LINE 54 OPEN BRANCH FROM BUS 314559 TO BUS 314600 CKT 1 /* LINE 130 OPEN BRANCH FROM BUS 314559 TO BUS 314561 CKT 1 /* TX. #4 DECREASE BUS 314559 LOAD BY 100 PERCENT /* REMOVE ALL LOAD AT CAROLINA

Contingency Name	Description
	END
DVP_P4-5: T122C	CONTINGENCY 'DVP_P4-5: T122C' /* CAROLINA OPEN BUS 314559 /* CAROLINA 115KV BUS OPEN BUS 315126 /* ROANOKE RAPIDS GEN 1 AND 2 OPEN BUS 315128 /* ROANOKE RAPIDS GEN 3 AND 4 OPEN BRANCH FROM BUS 314559 TO BUS 314561 CKT 1 /* TX. #4 END
DVP_P7-1: LN 22-90_B	CONTINGENCY 'DVP_P7-1: LN 22-90_B' OPEN BRANCH FROM BUS 314559 TO BUS 314571 CKT 1 /* 3CAROLNA 115.00 - 3EATON F 115.00 OPEN BRANCH FROM BUS 314571 TO BUS 925780 CKT 1 /* 3EATON F 115.00 - AC1-054 TAP 115.00 OPEN BUS 314571 /* ISLAND OPEN BRANCH FROM BUS 314265 TO BUS 314584 CKT 1 /* 3FIVEFORKSDP115.00 - 3LITTLTN 115.00 OPEN BRANCH FROM BUS 314265 TO BUS 314673 CKT 1 /* 3FIVEFORKSDP115.00 - 3BCHWD90 115.00 OPEN BRANCH FROM BUS 314559 TO BUS 314585 CKT 1 /* 3CAROLNA 115.00 - 3L GASTN 115.00 OPEN BRANCH FROM BUS 314584 TO BUS 314585 CKT 1 /* 3LITTLTN 115.00 - 3L GASTN 115.00 OPEN BRANCH FROM BUS 314672 TO BUS 314673 CKT 1 /* 3BEECHWD 115.00 - 3BCHWD90 115.00 OPEN BRANCH FROM BUS 314673 TO BUS 314702 CKT 1 /* 3BCHWD90 115.00 - 3KERR 115.00 OPEN BUS 314265 /* ISLAND OPEN BUS 314584 /* ISLAND OPEN BUS 314585 /* ISLAND OPEN BUS 314672 /* ISLAND

Contingency Name	Description
	OPEN BUS 314673 /* ISLAND END

Summer Peak Analysis – 2021

Generator Deliverability

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

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
1	N-1	DVP_P1-3: 3ALTVSTA - 4ALTVSTA	DVP - DVP	4ALTVSTA 138/115 kV transformer	314666	314667	2	DC	98.48	102.21	ER	130	4.87	1
2	N-1	DVP_P1-2: LN 585A	DVP - DVP	8RAWLINGS-8CARSON 500 kV line	314936	314902	1	DC	99.88	100.2	ER	4042	12.89	2
3	Non	Non	AEP - AEP	05JOHNMT-05NEWLDN 138 kV line	242687	242734	1	DC	98.51	100.08	NR	167	2.63	3

Multiple Facility Contingency

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

None.

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Contributions to previously identified circuit breakers found to be over-duty:

None

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)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
4	Non	Non	DVP - AEP	4ALTVSTA-05OTTER 138 kV line	314667	242741	1	DC	106.29	107.87	NR	167	2.63	4
5	LFFB	DVP_P4-5: T122C	DVP - CPLE	3KERR-3GW KING TAP 115 kV line	314702	304102	1	DC	113.98	115.53	ER	199	6.87	5
6	DCTL	DVP_P7-1: LN 22-90_B	DVP - CPLE	3KERR-3GW KING TAP 115 kV line	314702	304102	1	DC	106.05	107.59	ER	199	6.8	
7	LFFB	DVP_P4-2: 2202	DVP - CPLE	3KERR-3GW KING TAP 115 kV line	314702	304102	1	DC	105.36	106.71	ER	199	5.94	
8	LFFB	AEP_P4_#7589_05J.FERR 765	AEP - AEP	05EDAN 1-05DANVL2 138 kV line	242631	242620	1	DC	120.04	120.65	ER	415	5.62	6
9	Non	Non	AEP - AEP	05OTTER-05JOHNMT 138 kV line	242741	242687	1	DC	103.6	105.17	NR	167	2.63	7

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

To be determined during the System Impact Study

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined during the System Impact Study

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The IC 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			Power	Loading %		Rating		MW
#	Type	Name	Area	Facility Description	From	To	Cir.	Flow	Initial	Final	Type	MVA	Contribution
10	N-1	DVP_P1-2: LN 556	DVP - DVP	6PRINCE EDW-6FARMVIL 230 kV line	313802	314692	1	DC	106.17	107.79	ER	572	9.13
11	N-1	DVP_P1-2: LN 33-C	DVP - DVP	3PLYWOOD-3HALIFAX 115 kV line	313825	314696	1	DC	91.46	100.89	ER	141	13.29
12	N-1	DVP_P1-2: LN 2027-A	DVP - DVP	6BREMODIST-6MTEAGLE 230 kV line	313867	314765	1	DC	103.26	103.71	ER	662	7.44
13	N-1	DVP_P1-2: LN 556	DVP - DVP	6BRIERY-6PRINCE EDW 230 kV line	314268	313802	1	DC	107.19	108.8	ER	572	9.13
14	N-1	DVP_P1-2: LN 556	DVP - DVP	6CLUBHSE 230/115 kV transformer	314562	314563	1	DC	121.56	122.81	ER	183	5.47
15	N-1	DVP_P1-3: 3ALTVSTA - 4ALTVSTA A	DVP - DVP	4ALTVSTA 138/115 kV transformer	314666	314667	1	DC	103.64	106.36	ER	127	7.64

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution
16	N-1	DVP_P1-3: 3ALTVSTA - 4ALTVSTA	DVP - DVP	4ALTVSTA 138/115 kV transformer	314666	314667	2	DC	107.99	114.21	ER	130	8.11
17	Non	Non	DVP - AEP	4ALTVSTA-05OTTER 138 kV line	314667	242741	1	DC	119.76	120.94	NR	167	4.38
18	N-1	AEP_P1-2_#5473-A	DVP - AEP	4ALTVSTA-05OTTER 138 kV line	314667	242741	1	DC	106.37	107.22	ER	245	4.59
19	N-1	DVP_P1-3: 3HALIFAX - 6HALIFAXA	DVP - DVP	6HALIFAX 230/115 kV transformer	314696	314697	1	DC	84.8	103.02	ER	219	39.86
20	N-1	DVP_P1-2: LN 556	DVP - DVP	6HALIFAX-AC1-221 TAP 230 kV line	314697	927250	1	DC	99.01	104.06	ER	675	34
21	N-1	DVP_P1-2: LN 2027-A	DVP - DVP	6BREMO-6BREMODIST 230 kV line	314747	313867	1	DC	105.36	105.82	ER	662	7.44
22	N-1	DVP_P1-2: LN 2027-A	DVP - DVP	6MTEAGLE-6CHARLVL 230 kV line	314765	314749	1	DC	100.52	101.04	ER	662	7.44
23	N-1	DVP_P1-2: LN 556	DVP - CPLE	AC1-221 TAP-6PERSON230 T 230 kV line	927250	304070	1	DC	107.65	111.88	ER	718	34
24	N-1	AEP_P1-2_#1377	AEP - AEP	05EDAN 1-05DANVL2 138 kV line	242631	242620	1	DC	120.02	120.63	ER	415	5.62
25	Non	Non	AEP - AEP	05EDAN 1-05DANVL2 138 kV line	242631	242620	1	DC	99.48	100.26	NR	275	4.74

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution
26	Non	Non	AEP - AEP	05JOHNMT-05NEWLDN 138 kV line	242687	242734	1	DC	111.97	113.16	NR	167	4.38
27	N-1	AEP_P1-2_#5473-A	AEP - AEP	05JOHNMT-05NEWLDN 138 kV line	242687	242734	1	DC	103.13	104	ER	240	4.59
28	Non	Non	AEP - AEP	05OTTER-05JOHNMT 138 kV line	242741	242687	1	DC	117.06	118.25	NR	167	4.38
29	N-1	AEP_P1-2_#5473-A	AEP - AEP	05OTTER-05JOHNMT 138 kV line	242741	242687	1	DC	104.54	105.39	ER	245	4.59

Light Load Analysis

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

Affected System Analysis & Mitigation

Duke, Progress & TVA Impacts:

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

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the Appendices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the Appendices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators.

It should be noted the project/generator MW contributions presented in the body of the report and appendices sections are full contributions, whereas the loading percentages reported in the body of the report, those contributions take into consideration the commercial probability of each project as well as the ramping impact of "Adder" contributions.

OPTION 1

Appendix 1

(DVP - DVP) The 8NO ANNA-8LADYSMITH 500 kV line (from bus 314918 to bus 314911 ckt 1) loads from 99.92% to 100.16% (**DC power flow**) of its emergency rating (3219 MVA) for the single line contingency outage of 'DVP_P1-2: LN 573'. This project contributes approximately 7.37 MW to the thermal violation.

CONTINGENCY 'DVP_P1-2: LN 573'
 OPEN BRANCH FROM BUS 314918 TO BUS 314934 CKT 1 /* 8NO ANNA 500.00 - 8SPOTSYL 500.00
 END

Bus Number	*Bus Name*	*Full Contribution*
315102	*1BRUNSWICKG1*	*10.18*
315103	*1BRUNSWICKG2*	*10.18*
315104	*1BRUNSWICKG3*	*10.18*
315105	*1BRUNSWICKS1*	*21.15*
315153	*1CLOVER1*	*14.43*
315154	*1CLOVER2*	*14.24*
315131	*1EDGECMA*	*7.41*
315132	*1EDGECMB*	*7.41*
315108	*1ELIZAR1*	*3.04*
315109	*1ELIZAR2*	*2.99*
315110	*1ELIZAR3*	*3.08*
315172	*1LOISA A*	*3.52*
315173	*1LOISA B*	*3.54*
315174	*1LOISA C*	*3.54*
315175	*1LOISA D*	*3.54*
315176	*1LOISA E*	*7.21*
315225	*1N ANNA1*	*128.45*
315226	*1N ANNA2*	*128.38*

315177	*1S ANNAG1*	*2.26*
315179	*1S ANNAG2*	*2.26*
315178	*1S ANNAS1*	*1.16*
315180	*1S ANNAS2*	*1.16*
315083	*1SPRUNCA*	*7.26*
315084	*1SPRUNCB*	*7.26*
315085	*1SPRUNCC*	*5.38*
315086	*1SPRUNCD*	*5.38*
314643	*3O INLET*	*0.42*
932041	*AC2-012 C*	*8.06*
932511	*AC2-071 C*	*1.84*
932581	*AC2-078 C*	*2.99*
932591	*AC2-079 C*	*5.23*
932631	*AC2-084 C*	*7.12*
932701	*AC2-093 C*	*76.01*
932711	*AC2-094 C*	*31.11*
933291	*AC2-141 C*	*24.2*
933451	*AC2-158 C*	*4.42*
933461	*AC2-159 C*	*5.44*
933471	*AC2-161 C*	*1.72*
933501	*AC2-165 C*	*11.01*
933711	*AC2-194 C*	*0.87*
933731	*AC2-196 C*	*1.43*
933991	*AD1-023 C*	*10.61*
934041	*AD1-029 C*	*8.8*
934061	*AD1-033 C O1*	*5.99*

934201	*AD1-047 C*	*6.67*
934231	*AD1-050 C*	*3.86*
934311	*AD1-055 C*	*2.01*
934331	*AD1-057 C O1*	*8.09*
934521	*AD1-076 C O1*	*43.88*
934531	*AD1-077 C*	*2.48*
934571	*AD1-082 C O1*	*5.84*
934611	*AD1-087 C O1*	*7.96*
934621	*AD1-088 C O1*	*13.91*
LTF	*AD1-120*	*9.67*
LTF	*AD1-121*	*9.64*
934911	*AD1-123 C*	*0.88*
935111	*AD1-144 C*	*1.32*
935171	*AD1-152 C O1*	*7.37*
935211	*AD1-156 C*	*1.61*
935221	*AD1-157 C*	*1.25*
935231	*AD1-160 C*	*0.92*
LTF	*CARR*	*1.08*
LTF	*CBM-S1*	*10.95*
LTF	*CBM-S2*	*22.65*
LTF	*CBM-W1*	*19.53*
LTF	*CBM-W2*	*57.11*
LTF	*CIN*	*4.63*
LTF	*CPLE*	*7.06*
LTF	*IPL*	*2.94*
LTF	*LGEE*	*1.03*

LTF	*MEC*	*11.*
LTF	*MECS*	*3.27*
LTF	*RENSSELAER*	*0.86*
LTF	*ROSETON*	*6.24*
LTF	*WEC*	*1.25*
916191	*Z1-068 C*	*0.04*
916301	*Z1-086 C*	*62.*
919151	*AA1-139 C*	*2.34*
LTF	*AA2-074*	*4.8*
920631	*AA2-169 C*	*1.83*
920691	*AA2-178 C*	*7.73*
930051	*AB1-013 C*	*2.33*
930401	*AB1-081 C*	*7.15*
930861	*AB1-132 C*	*11.54*
931231	*AB1-173 C*	*1.88*
931241	*AB1-173AC*	*1.88*
923801	*AB2-015 C O1*	*6.91*
923831	*AB2-022 C*	*1.84*
923851	*AB2-025 C*	*0.41*
923861	*AB2-026 C*	*0.48*
923911	*AB2-031 C O1*	*1.86*
923941	*AB2-035 C*	*0.27*
923991	*AB2-040 C O1*	*6.12*
924021	*AB2-043 C O1*	*2.55*
924071	*AB2-051*	*108.49*
924151	*AB2-059 C O1*	*8.43*

924161	*AB2-060 C O1*	*7.35*
924301	*AB2-077 C O1*	*1.62*
924311	*AB2-078 C O1*	*1.62*
924321	*AB2-079 C O1*	*1.62*
924381	*AB2-087 C*	*0.46*
924391	*AB2-088 C*	*0.35*
924401	*AB2-089 C*	*1.75*
924411	*AB2-090 C*	*3.21*
924491	*AB2-098 C*	*0.45*
924501	*AB2-099 C*	*0.48*
924511	*AB2-100 C*	*9.63*
925021	*AB2-158 C*	*25.05*
925061	*AB2-161 C O1*	*2.56*
925121	*AB2-169 C*	*5.21*
925171	*AB2-174 C O1*	*5.87*
925221	*AB2-176 C*	*1.32*
925281	*AB2-186 C*	*0.49*
925291	*AB2-188 C O1*	*1.9*
925521	*AC1-027 C*	*0.31*
925591	*AC1-034 C*	*5.49*
925611	*AC1-036 C*	*0.78*
925781	*AC1-054 C*	*5.91*
926071	*AC1-086 C*	*17.*
926201	*AC1-098 C*	*4.99*
926211	*AC1-099 C*	*1.67*
926271	*AC1-105 C*	*4.54*

926741	*AC1-159*	*52.31*
926751	*AC1-161 C*	*24.2*
926761	*AC1-162 C*	*25.06*
926771	*AC1-163 C*	*1.57*
927021	*AC1-189 C*	*6.89*
927111	*AC1-206 C*	*8.34*
927141	*AC1-208 C*	*7.38*
927261	*AC1-222 C*	*2.89*

Appendix 2

(DVP - DVP) The 6PRINCE EDW-6FARMVIL 230 kV line (from bus 313802 to bus 314692 ckt 1) loads from 105.44% to 107.59% (**DC power flow**) of its emergency rating (572 MVA) for the single line contingency outage of 'DVP_P1-2: LN 556'. This project contributes approximately 12.24 MW to the thermal violation.

CONTINGENCY 'DVP_P1-2: LN 556'
OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 1 /* 6CLOVER 230.00 - 8CLOVER 500.00
OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 2 /* 6CLOVER 230.00 - 8CLOVER 500.00
OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 3 /* 6CLOVER 230.00 - 8CLOVER 500.00
OPEN BRANCH FROM BUS 314906 TO BUS 314936 CKT 1 /* 8CLOVER 500.00 - 8RAWLINGS 500.00
OPEN BUS 314906 /* ISLAND
END

Bus Number	*Bus Name*	*Full Contribution*
315153	*1CLOVER1*	*27.5*
315154	*1CLOVER2*	*27.14*
315266	*1PLYWOOD A*	*1.11*
932761	*AC2-100 C*	*3.38*
932821	*AC2-107 C*	*6.66*
934311	*AD1-055 C*	*2.12*
934341	*AD1-058 C*	*3.68*
934611	*AD1-087 C O1*	*13.2*
934621	*AD1-088 C O1*	*41.81*
LTF	*AD1-120*	*3.52*
LTF	*AD1-121*	*3.56*
934911	*AD1-123 C*	*0.95*
934991	*AD1-131 C*	*1.21*
935171	*AD1-152 C O1*	*12.24*

LTF	*CARR*	*0.12*
LTF	*CBM-S1*	*3.96*
LTF	*CBM-S2*	*8.23*
LTF	*CBM-W1*	*8.21*
LTF	*CBM-W2*	*21.12*
LTF	*CIN*	*1.86*
LTF	*CPLE*	*2.63*
LTF	*IPL*	*1.19*
LTF	*LGEE*	*0.4*
LTF	*MEC*	*4.27*
LTF	*MECS*	*1.75*
LTF	*RENSSELAER*	*0.09*
LTF	*ROSETON*	*0.67*
LTF	*WEC*	*0.51*
LTF	*AA2-074*	*1.79*
925991	*AC1-075 C*	*3.75*
926021	*AC1-080 C*	*1.25*
926271	*AC1-105 C*	*3.89*
926761	*AC1-162 C*	*106.14*
927251	*AC1-221 C*	*1.47*
927261	*AC1-222 C*	*3.05*

Appendix 3

(DVP - DVP) The 6BRIERY-6PRINCE EDW 230 kV line (from bus 314268 to bus 313802 ckt 1) loads from 106.46% to 108.61% (**DC power flow**) of its emergency rating (572 MVA) for the single line contingency outage of 'DVP_P1-2: LN 556'. This project contributes approximately 12.24 MW to the thermal violation.

CONTINGENCY 'DVP_P1-2: LN 556'
OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 1 /* 6CLOVER 230.00 - 8CLOVER 500.00
OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 2 /* 6CLOVER 230.00 - 8CLOVER 500.00
OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 3 /* 6CLOVER 230.00 - 8CLOVER 500.00
OPEN BRANCH FROM BUS 314906 TO BUS 314936 CKT 1 /* 8CLOVER 500.00 - 8RAWLINGS 500.00
OPEN BUS 314906 /* ISLAND
END

Bus Number	*Bus Name*	*Full Contribution*
315153	*1CLOVER1*	*27.5*
315154	*1CLOVER2*	*27.14*
315266	*1PLYWOOD A*	*1.11*
932761	*AC2-100 C*	*3.38*
932821	*AC2-107 C*	*6.66*
934311	*AD1-055 C*	*2.12*
934341	*AD1-058 C*	*3.68*
934611	*AD1-087 C O1*	*13.2*
934621	*AD1-088 C O1*	*41.81*
LTF	*AD1-120*	*3.52*
LTF	*AD1-121*	*3.56*
934911	*AD1-123 C*	*0.95*
934991	*AD1-131 C*	*1.21*
935171	*AD1-152 C O1*	*12.24*

LTF	*CARR*	*0.12*
LTF	*CBM-S1*	*3.96*
LTF	*CBM-S2*	*8.23*
LTF	*CBM-W1*	*8.21*
LTF	*CBM-W2*	*21.12*
LTF	*CIN*	*1.86*
LTF	*CPLE*	*2.63*
LTF	*IPL*	*1.19*
LTF	*LGEE*	*0.4*
LTF	*MEC*	*4.27*
LTF	*MECS*	*1.75*
LTF	*RENSSELAER*	*0.09*
LTF	*ROSETON*	*0.67*
LTF	*WEC*	*0.51*
LTF	*AA2-074*	*1.79*
925991	*AC1-075 C*	*3.75*
926021	*AC1-080 C*	*1.25*
926271	*AC1-105 C*	*3.89*
926761	*AC1-162 C*	*106.14*
927251	*AC1-221 C*	*1.47*
927261	*AC1-222 C*	*3.05*

Appendix 4

(AEP - AEP) The 05EDAN 1-05DANVL2 138 kV line (from bus 242631 to bus 242620 ckt 1) loads from 119.66% to 120.27% (**DC power flow**) of its emergency rating (415 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7589_05J.FERR 765'. This project contributes approximately 5.6 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#7589_05J.FERR 765'
OPEN BRANCH FROM BUS 242514 TO BUS 242520 CKT 1 / 242514 05J.FERR 765 242520 05J.FERR 500 1
OPEN BRANCH FROM BUS 242514 TO BUS 242684 CKT 2 / 242514 05J.FERR 765 242684 05J.FERR 138 2
OPEN BRANCH FROM BUS 242520 TO BUS 306719 CKT 1 / 242520 05J.FERR 500 306719 8ANTIOCH 500 1
END

Bus Number	*Bus Name*	*Full Contribution*
244012	*05PINNACLE*	*-2.08*
315131	*1EDGECMA*	*4.25*
315132	*1EDGECMB*	*4.25*
314557	*3BETHELC*	*0.35*
314554	*3BTLEBRO*	*0.37*
314572	*3EMPORIA*	*0.14*
314578	*3HORNRTN*	*1.21*
314582	*3KELFORD*	*0.3*
314603	*3SCOT NK*	*1.24*
314617	*3TUNIS*	*0.28*
314620	*6CASHIE*	*0.27*
314574	*6EVERETS*	*0.98*
314594	*6PLYMOTH*	*0.26*
932631	*AC2-084 C*	*3.42*
932632	*AC2-084 E*	*1.68*

932701	*AC2-093 C*	*24.4*
932702	*AC2-093 E*	*13.96*
932761	*AC2-100 C*	*3.66*
932762	*AC2-100 E*	*1.79*
932821	*AC2-107 C*	*3.48*
932822	*AC2-107 E*	*1.63*
933451	*AC2-158 C*	*1.78*
933452	*AC2-158 E*	*1.78*
933461	*AC2-159 C*	*2.33*
933462	*AC2-159 E*	*2.33*
933941	*AD1-017 C*	*0.84*
933942	*AD1-017 E*	*1.36*
933991	*AD1-023 C*	*4.1*
933992	*AD1-023 E*	*2.23*
934041	*AD1-029 C*	*4.23*
934042	*AD1-029 E*	*2.79*
934201	*AD1-047 C*	*2.75*
934202	*AD1-047 E*	*1.83*
934231	*AD1-050 C*	*2.01*
934232	*AD1-050 E*	*1.1*
934311	*AD1-055 C*	*1.07*
934312	*AD1-055 E*	*0.28*
934331	*AD1-057 C O1*	*4.1*
934332	*AD1-057 E O1*	*2.19*
934341	*AD1-058 C*	*3.99*
934342	*AD1-058 E*	*1.01*

934521	*AD1-076 C O1*	*16.71*
934522	*AD1-076 E O1*	*8.51*
934611	*AD1-087 C O1*	*3.62*
934612	*AD1-087 E O1*	*1.69*
934621	*AD1-088 C O1*	*4.63*
934622	*AD1-088 E O1*	*2.17*
LTF	*AD1-120*	*7.55*
LTF	*AD1-121*	*7.6*
934911	*AD1-123 C*	*0.47*
934912	*AD1-123 E*	*0.24*
934991	*AD1-131 C*	*1.31*
934992	*AD1-131 E*	*0.87*
935171	*AD1-152 C O1*	*3.36*
935172	*AD1-152 E O1*	*2.24*
935221	*AD1-157 C*	*0.46*
935222	*AD1-157 E*	*0.31*
935231	*AD1-160 C*	*0.34*
935232	*AD1-160 E*	*0.47*
LTF	*AMIL*	*0.17*
LTF	*BLUEG*	*2.07*
LTF	*CANNELTON*	*0.27*
LTF	*CARR*	*0.06*
LTF	*CBM-S1*	*1.13*
LTF	*CBM-S2*	*16.92*
LTF	*CBM-W2*	*2.91*
LTF	*CLIFTY*	*10.78*

LTF	*CPLE*	*5.57*
LTF	*DEARBORN*	*0.98*
LTF	*EDWARDS*	*0.45*
LTF	*ELMERSMITH*	*0.71*
LTF	*FARMERCITY*	*0.12*
LTF	*G-007A*	*0.79*
LTF	*GIBSON*	*0.59*
LTF	*NEWTON*	*0.97*
LTF	*O-066A*	*0.36*
LTF	*PRAIRIE*	*0.86*
LTF	*RENSSELAER*	*0.05*
LTF	*ROSETON*	*0.35*
LTF	*SMITHLAND*	*< 0.01*
LTF	*TATANKA*	*0.34*
LTF	*TILTON*	*0.61*
LTF	*TRIMBLE*	*0.41*
900672	*V4-068 E*	*0.1*
LTF	*VFT*	*2.09*
LTF	*X1-078*	*0.61*
917332	*Z2-043 E*	*0.36*
917342	*Z2-044 E*	*0.25*
917512	*Z2-088 E OP1*	*1.66*
917592	*Z2-099 E*	*0.14*
918492	*AA1-063AE OP*	*1.37*
918512	*AA1-065 E OP*	*1.46*
918532	*AA1-067 E*	*0.29*

918562	*AA1-072 E*	*0.06*
919692	*AA2-053 E*	*1.33*
919702	*AA2-057 E*	*1.51*
919822	*AA2-068 E*	*0.41*
LTF	*AA2-074*	*3.79*
920022	*AA2-086 E*	*0.07*
920042	*AA2-088 E*	*3.27*
920592	*AA2-165 E*	*0.2*
920631	*AA2-169 C*	*0.91*
920632	*AA2-169 E*	*0.42*
920672	*AA2-174 E*	*0.15*
930401	*AB1-081 C*	*4.09*
930402	*AB1-081 E*	*1.75*
930861	*AB1-132 C*	*4.93*
930862	*AB1-132 E*	*2.11*
931231	*AB1-173 C*	*0.77*
931232	*AB1-173 E*	*0.36*
931241	*AB1-173AC*	*0.77*
931242	*AB1-173AE*	*0.36*
923911	*AB2-031 C O1*	*0.77*
923912	*AB2-031 E O1*	*0.38*
923941	*AB2-035 C*	*0.15*
923942	*AB2-035 E*	*0.06*
923991	*AB2-040 C O1*	*2.52*
923992	*AB2-040 E O1*	*2.06*
924021	*AB2-043 C O1*	*1.21*

924022	*AB2-043 E O1*	*1.99*
924151	*AB2-059 C O1*	*4.82*
924152	*AB2-059 E O1*	*2.48*
924161	*AB2-060 C O1*	*3.48*
924162	*AB2-060 E O1*	*1.64*
924301	*AB2-077 C O1*	*0.78*
924302	*AB2-077 E O1*	*0.52*
924311	*AB2-078 C O1*	*0.78*
924312	*AB2-078 E O1*	*0.52*
924321	*AB2-079 C O1*	*0.78*
924322	*AB2-079 E O1*	*0.52*
924381	*AB2-087 C*	*0.19*
924382	*AB2-087 E*	*0.09*
924391	*AB2-088 C*	*0.19*
924392	*AB2-088 E*	*0.09*
924401	*AB2-089 C*	*0.91*
924402	*AB2-089 E*	*0.47*
924411	*AB2-090 C*	*1.53*
924412	*AB2-090 E*	*0.78*
924491	*AB2-098 C*	*0.23*
924492	*AB2-098 E*	*0.1*
924501	*AB2-099 C*	*0.2*
924502	*AB2-099 E*	*0.08*
924511	*AB2-100 C*	*3.5*
924512	*AB2-100 E*	*1.72*
925121	*AB2-169 C*	*2.26*

925122	*AB2-169 E*	*2.03*
925171	*AB2-174 C O1*	*2.38*
925172	*AB2-174 E O1*	*2.15*
925221	*AB2-176 C*	*0.63*
925222	*AB2-176 E*	*0.27*
925591	*AC1-034 C*	*3.01*
925592	*AC1-034 E*	*2.27*
925611	*AC1-036 C*	*0.33*
925612	*AC1-036 E*	*0.54*
925781	*AC1-054 C*	*3.03*
925782	*AC1-054 E*	*1.4*
925991	*AC1-075 C*	*1.96*
925992	*AC1-075 E*	*1.11*
926021	*AC1-080 C*	*0.65*
926022	*AC1-080 E*	*0.37*
926051	*AC1-083 C*	*4.18*
926052	*AC1-083 E*	*6.82*
926071	*AC1-086 C*	*7.26*
926072	*AC1-086 E*	*3.31*
926201	*AC1-098 C*	*2.4*
926202	*AC1-098 E*	*1.43*
926211	*AC1-099 C*	*0.8*
926212	*AC1-099 E*	*0.47*
926271	*AC1-105 C*	*2.39*
926272	*AC1-105 E*	*1.19*
926771	*AC1-163 C*	*0.65*

926772	*AC1-163 E*	*0.3*
927021	*AC1-189 C*	*3.63*
927022	*AC1-189 E*	*1.81*
927111	*AC1-206 C*	*2.97*
927112	*AC1-206 E*	*1.4*
927141	*AC1-208 C*	*3.54*
927142	*AC1-208 E*	*1.57*
927251	*AC1-221 C*	*1.59*
927252	*AC1-221 E*	*1.59*
927261	*AC1-222 C*	*1.54*
927262	*AC1-222 E*	*1.46*

OPTION 2

Appendix 1

(DVP - DVP) The 4ALTVSTA 138/115 kV transformer (from bus 314666 to bus 314667 ckt 2) loads from 98.48% to 102.21% (**DC power flow**) of its emergency rating (130 MVA) for the single line contingency outage of 'DVP_P1-3: 3ALTVSTA-4ALTVSTA'. This project contributes approximately 4.87 MW to the thermal violation.

CONTINGENCY 'DVP_P1-3: 3ALTVSTA-4ALTVSTA'
OPEN BRANCH FROM BUS 314666 TO BUS 314667 CKT 1
END

Bus Number	*Bus Name*	*Full Contribution*
315150	*1BUGGS 1*	*0.88*
315151	*1BUGGS 2*	*0.88*
315156	*1HALLBR1*	*7.38*
315165	*1HURT 1*	*5.1*
315166	*1HURT 2*	*5.1*
315266	*1PLYWOOD A*	*0.95*
932821	*AC2-107 C*	*24.25*
934311	*AD1-055 C*	*2.67*
934611	*AD1-087 C O2*	*4.17*
934621	*AD1-088 C O2*	*4.79*
934911	*AD1-123 C*	*0.75*
935171	*AD1-152 C O2*	*4.87*
LTF	*AMIL*	*0.1*
LTF	*BAYOU*	*0.19*
LTF	*BIG_CAJUN1*	*0.27*
LTF	*BIG_CAJUN2*	*0.55*
LTF	*BLUEG*	*0.76*
LTF	*CALDERWOOD*	*0.08*
LTF	*CANNELTON*	*0.12*
LTF	*CARR*	*0.02*
LTF	*CBM-S2*	*1.39*
LTF	*CHEOAH*	*0.06*
LTF	*CHILHOWEE*	*0.03*
LTF	*CHOCTAW*	*0.17*
LTF	*CLIFTY*	*3.41*
LTF	*COTTONWOOD*	*0.8*
LTF	*CPLE*	*0.67*
LTF	*DEARBORN*	*0.33*
LTF	*EDWARDS*	*0.2*
LTF	*ELMERSMITH*	*0.34*
LTF	*FARMERCITY*	*0.12*
LTF	*G-007A*	*0.22*

LTF	*GIBSON*	*0.24*
LTF	*MORGAN*	*0.31*
LTF	*NEWTON*	*0.5*
LTF	*O-066A*	*0.1*
LTF	*PRAIRIE*	*0.86*
LTF	*RENSSELAER*	*0.02*
LTF	*ROSETON*	*0.13*
LTF	*SANTEETLA*	*0.02*
LTF	*SMITHLAND*	*0.06*
LTF	*TATANKA*	*0.22*
LTF	*TILTON*	*0.25*
LTF	*TRIMBLE*	*0.15*
LTF	*TVA*	*0.17*
LTF	*VFT*	*0.57*
LTF	*X1-078*	*0.17*
924021	*AB2-043 C O1*	*1.03*
924161	*AB2-060 C O1*	*2.95*
924301	*AB2-077 C O1*	*0.67*
924311	*AB2-078 C O1*	*0.67*
924321	*AB2-079 C O1*	*0.67*
924411	*AB2-090 C*	*1.3*
925221	*AB2-176 C*	*0.54*
925991	*AC1-075 C*	*13.64*
926021	*AC1-080 C*	*4.56*
926271	*AC1-105 C*	*3.45*
927261	*AC1-222 C*	*3.84*

Appendix 2

(DVP - DVP) The 8RAWLINGS-8CARSON 500 kV line (from bus 314936 to bus 314902 ckt 1) loads from 99.88% to 100.2% (**DC power flow**) of its emergency rating (4042 MVA) for the single line contingency outage of 'DVP_P1-2: LN 585A'. This project contributes approximately 12.89 MW to the thermal violation.

CONTINGENCY 'DVP_P1-2: LN 585A'
 OPEN BRANCH FROM BUS 314902 TO BUS 314940 CKT 1 /* 8CARSON 500.00 - 8ROGERS RD 500.00
 END

Bus Number	*Bus Name*	*Full Contribution*
315102	*1BRUNSWICKG1*	*31.57*
315103	*1BRUNSWICKG2*	*31.57*
315104	*1BRUNSWICKG3*	*31.57*
315105	*1BRUNSWICKS1*	*65.58*
315150	*1BUGGS 1*	*2.64*
315151	*1BUGGS 2*	*2.64*
315153	*1CLOVER1*	*39.9*
315154	*1CLOVER2*	*39.38*
315159	*1KERR 2*	*1.6*
315266	*1PLYWOOD A*	*2.51*
314429	*3JTRSVLE*	*0.47*
932701	*AC2-093 C*	*227.12*
932761	*AC2-100 C*	*9.29*
932821	*AC2-107 C*	*15.02*
933941	*AD1-017 C*	*1.06*
934311	*AD1-055 C*	*4.41*
934341	*AD1-058 C*	*10.12*
934611	*AD1-087 C O2*	*11.65*
934621	*AD1-088 C O2*	*15.13*
LTF	*AD1-092*	*5.49*
LTF	*AD1-093*	*9.41*
LTF	*AD1-094*	*1.75*
LTF	*AD1-120*	*21.21*
LTF	*AD1-121*	*21.12*
934911	*AD1-123 C*	*1.94*
934991	*AD1-131 C*	*3.32*
935171	*AD1-152 C O2*	*12.89*
935221	*AD1-157 C*	*1.55*
935231	*AD1-160 C*	*1.14*
LTF	*CARR*	*0.76*
LTF	*CBM-S1*	*25.53*
LTF	*CBM-S2*	*48.91*
LTF	*CBM-W1*	*55.*

LTF	*CBM-W2*	*137.13*
LTF	*CIN*	*12.45*
LTF	*CPLE*	*14.75*
LTF	*IPL*	*7.94*
LTF	*LGEE*	*2.69*
LTF	*MEC*	*28.12*
LTF	*MECS*	*12.12*
LTF	*RENSSELAER*	*0.61*
LTF	*ROSETON*	*4.42*
LTF	*WEC*	*3.41*
LTF	*Y3-032*	*7.92*
LTF	*Z1-043*	*13.41*
916301	*Z1-086 C*	*189.86*
LTF	*AA2-074*	*10.04*
LTF	*AB2-013*	*7.84*
924021	*AB2-043 C O1*	*3.23*
924161	*AB2-060 C O1*	*9.3*
924301	*AB2-077 C O1*	*2.08*
924311	*AB2-078 C O1*	*2.08*
924321	*AB2-079 C O1*	*2.08*
924411	*AB2-090 C*	*4.07*
924911	*AB2-145 O1*	*77.05*
925221	*AB2-176 C*	*1.67*
925611	*AC1-036 C*	*0.98*
925831	*AC1-062*	*0.06*
925991	*AC1-075 C*	*8.45*
926021	*AC1-080 C*	*2.82*
926051	*AC1-083 C*	*5.3*
926271	*AC1-105 C*	*9.14*
926761	*AC1-162 C*	*40.59*
927251	*AC1-221 C*	*4.04*
927261	*AC1-222 C*	*6.36*

Appendix 3

(AEP - AEP) The 05JOHNMT-05NEWLDN 138 kV line (from bus 242687 to bus 242734 ckt 1) loads from 98.51% to 100.08% (**DC power flow**) of its normal rating (167 MVA) for non-contingency condition. This project contributes approximately 2.63 MW to the thermal violation.

Bus Number	*Bus Name*	*Full Contribution*
247284	*05LEESVG*	*2.11*
246843	*05SMG1*	*1.28*
246844	*05SMG2*	*3.37*
246845	*05SMG3*	*1.98*
246846	*05SMG4*	*3.48*
246847	*05SMG5*	*1.32*
315156	*1HALLBR1*	*3.63*
315165	*1HURT 1*	*2.51*
315166	*1HURT 2*	*2.51*
315266	*1PLYWOOD A*	*0.51*
932821	*AC2-107 C*	*12.11*
933941	*AD1-017 C*	*0.55*
934311	*AD1-055 C*	*1.38*
934911	*AD1-123 C*	*0.4*
935171	*AD1-152 C O2*	*2.63*
LTF	*AMIL*	*0.06*
LTF	*BAYOU*	*< 0.01*
LTF	*BLUEG*	*0.48*
LTF	*CANNELTON*	*0.07*
LTF	*CARR*	*0.04*
LTF	*CBM-S2*	*1.92*
LTF	*CLIFTY*	*2.27*
LTF	*COTTONWOOD*	*0.07*
LTF	*CPLE*	*0.79*
LTF	*DEARBORN*	*0.23*
LTF	*EDWARDS*	*0.12*
LTF	*ELMERSMITH*	*0.2*
LTF	*FARMERCITY*	*0.06*
LTF	*GIBSON*	*0.15*
LTF	*NEWTON*	*0.29*
LTF	*PRAIRIE*	*0.44*
LTF	*RENSSELAER*	*0.03*
LTF	*ROSETON*	*0.22*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.12*
LTF	*TILTON*	*0.16*
LTF	*TRIMBLE*	*0.09*

LTF	*TVA*	*0.03*
919841	*AA2-070*	*3.26*
925661	*AC1-042 C*	*5.45*
925991	*AC1-075 C*	*6.81*
926021	*AC1-080 C*	*2.28*
926051	*AC1-083 C*	*2.77*
926271	*AC1-105 C*	*1.86*
926641	*AC1-145 C*	*6.49*
927261	*AC1-222 C*	*1.99*

Appendix 4

(DVP - AEP) The 4ALTVSTA-05OTTER 138 kV line (from bus 314667 to bus 242741 ckt 1) loads from 106.29% to 107.87% (**DC power flow**) of its normal rating (167 MVA) for non-contingency condition. This project contributes approximately 2.63 MW to the thermal violation.

Bus Number	*Bus Name*	*Full Contribution*
247284	*05LEESVG*	*2.11*
246843	*05SMG1*	*1.28*
246844	*05SMG2*	*3.37*
246845	*05SMG3*	*1.98*
246846	*05SMG4*	*3.48*
246847	*05SMG5*	*1.32*
315156	*1HALLBR1*	*3.63*
315165	*1HURT 1*	*2.51*
315166	*1HURT 2*	*2.51*
315266	*1PLYWOOD A*	*0.51*
932821	*AC2-107 C*	*12.11*
933941	*AD1-017 C*	*0.55*
934311	*AD1-055 C*	*1.38*
934911	*AD1-123 C*	*0.4*
935171	*AD1-152 C O2*	*2.63*
LTF	*AMIL*	*0.06*
LTF	*BAYOU*	*< 0.01*
LTF	*BLUEG*	*0.48*
LTF	*CANNELTON*	*0.07*
LTF	*CARR*	*0.04*
LTF	*CBM-S2*	*1.92*
LTF	*CLIFTY*	*2.27*
LTF	*COTTONWOOD*	*0.07*
LTF	*CPLE*	*0.79*
LTF	*DEARBORN*	*0.23*
LTF	*EDWARDS*	*0.12*
LTF	*ELMERSMITH*	*0.2*
LTF	*FARMERCITY*	*0.06*
LTF	*GIBSON*	*0.15*
LTF	*NEWTON*	*0.29*
LTF	*PRAIRIE*	*0.44*
LTF	*RENSSELAER*	*0.03*
LTF	*ROSETON*	*0.22*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.12*
LTF	*TILTON*	*0.16*
LTF	*TRIMBLE*	*0.09*

LTF	*TVA*	*0.03*
919841	*AA2-070*	*3.26*
925661	*AC1-042 C*	*5.45*
925991	*AC1-075 C*	*6.81*
926021	*AC1-080 C*	*2.28*
926051	*AC1-083 C*	*2.77*
926271	*AC1-105 C*	*1.86*
926641	*AC1-145 C*	*6.49*
927261	*AC1-222 C*	*1.99*

Appendix 5

(DVP - CPLE) The 3KERR-3GW KING TAP 115 kV line (from bus 314702 to bus 304102 ckt 1) loads from 113.98% to 115.53% (**DC power flow**) of its emergency rating (199 MVA) for the line fault with failed breaker contingency outage of 'DVP_P4-5: T122C'. This project contributes approximately 6.87 MW to the thermal violation.

```
CONTINGENCY 'DVP_P4-5: T122C'                          /* CAROLINA
  OPEN BUS 314559                                      /* CAROLINA 115KV BUS
  OPEN BUS 315126                                      /* ROANOKE RAPIDS GEN 1 AND 2
  OPEN BUS 315128                                      /* ROANOKE RAPIDS GEN 3 AND 4
  OPEN BRANCH FROM BUS 314559 TO BUS 314561 CKT 1      /* TX. #4
  END
```

Bus Number	*Bus Name*	*Full Contribution*
315159	*1KERR 2*	*3.64*
315163	*1KERR 6*	*3.59*
315164	*1KERR 7*	*3.59*
934231	*AD1-050 C*	*10.19*
934232	*AD1-050 E*	*5.57*
934611	*AD1-087 C O2*	*6.99*
934612	*AD1-087 E O2*	*3.27*
934621	*AD1-088 C O2*	*17.09*
934622	*AD1-088 E O2*	*8.01*
935171	*AD1-152 C O2*	*4.12*
935172	*AD1-152 E O2*	*2.75*
935221	*AD1-157 C*	*1.02*
935222	*AD1-157 E*	*0.68*
935231	*AD1-160 C*	*0.75*
935232	*AD1-160 E*	*1.03*
LTF	*AMIL*	*0.13*
LTF	*BAYOU*	*0.72*
LTF	*BIG_CAJUN1*	*1.14*
LTF	*BIG_CAJUN2*	*2.28*
LTF	*BLUEG*	*0.7*
LTF	*CALDERWOOD*	*0.43*
LTF	*CANNELTON*	*0.13*
LTF	*CARR*	*0.02*
LTF	*CATAWBA*	*0.43*
LTF	*CELEVELAND*	*1.23*
LTF	*CHEOAH*	*0.4*
LTF	*CHILHOWEE*	*0.14*
LTF	*CHOCTAW*	*0.77*
LTF	*CLIFTY*	*2.54*
LTF	*COTTONWOOD*	*2.82*
LTF	*DEARBORN*	*0.26*

LTF	*EDWARDS*	*0.22*
LTF	*ELMERSMITH*	*0.39*
LTF	*FARMERCITY*	*0.17*
LTF	*G-007A*	*0.1*
LTF	*GIBSON*	*0.25*
LTF	*HAMLET*	*1.67*
LTF	*MORGAN*	*1.25*
LTF	*NEWTON*	*0.6*
LTF	*O-066A*	*0.04*
LTF	*PRAIRIE*	*1.3*
LTF	*RENSSELAER*	*0.01*
LTF	*ROSETON*	*0.1*
LTF	*ROWAN*	*0.93*
LTF	*SANTEETLA*	*0.12*
LTF	*SMITHLAND*	*0.12*
LTF	*TATANKA*	*0.29*
LTF	*TILTON*	*0.26*
LTF	*TRIMBLE*	*0.13*
LTF	*TVA*	*0.52*
LTF	*UNIONPOWER*	*0.78*
LTF	*VFT*	*0.26*
LTF	*X1-078*	*0.08*
920631	*AA2-169 C*	*4.8*
920632	*AA2-169 E*	*2.21*
924021	*AB2-043 C O1*	*3.7*
924022	*AB2-043 E O1*	*6.06*
924161	*AB2-060 C O1*	*10.51*
924162	*AB2-060 E O1*	*4.94*
924301	*AB2-077 C O1*	*2.38*
924302	*AB2-077 E O1*	*1.59*
924311	*AB2-078 C O1*	*2.38*
924312	*AB2-078 E O1*	*1.59*
924321	*AB2-079 C O1*	*2.38*
924322	*AB2-079 E O1*	*1.59*
924401	*AB2-089 C*	*4.62*
924402	*AB2-089 E*	*2.38*
924411	*AB2-090 C*	*4.65*
924412	*AB2-090 E*	*2.39*
925221	*AB2-176 C*	*1.92*
925222	*AB2-176 E*	*0.82*
925611	*AC1-036 C*	*0.9*
925612	*AC1-036 E*	*1.47*
925781	*AC1-054 C*	*15.59*
925782	*AC1-054 E*	*7.18*
926271	*AC1-105 C*	*2.92*

926272	*AC1-105 E*	*1.46*

Appendix 6

(AEP - AEP) The 05EDAN 1-05DANVL2 138 kV line (from bus 242631 to bus 242620 ckt 1) loads from 120.04% to 120.65% (**DC power flow**) of its emergency rating (415 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7589_05J.FERR 765'. This project contributes approximately 5.62 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#7589_05J.FERR 765'
OPEN BRANCH FROM BUS 242514 TO BUS 242520 CKT 1 / 242514 05J.FERR 765 242520 05J.FERR 500 1
OPEN BRANCH FROM BUS 242514 TO BUS 242684 CKT 2 / 242514 05J.FERR 765 242684 05J.FERR 138 2
OPEN BRANCH FROM BUS 242520 TO BUS 306719 CKT 1 / 242520 05J.FERR 500 306719 8ANTIOCH 500 1
END

Bus Number	*Bus Name*	*Full Contribution*
244012	*05PINNACLE*	*-2.08*
315131	*1EDGECMA*	*4.25*
315132	*1EDGECMB*	*4.25*
314557	*3BETHELC*	*0.35*
314554	*3BTLEBRO*	*0.37*
314572	*3EMPORIA*	*0.14*
314578	*3HORNRTN*	*1.21*
314582	*3KELFORD*	*0.3*
314603	*3SCOT NK*	*1.24*
314617	*3TUNIS*	*0.28*
314620	*6CASHIE*	*0.27*
314574	*6EVERETS*	*0.98*
314594	*6PLYMOTH*	*0.26*
932631	*AC2-084 C*	*3.42*
932632	*AC2-084 E*	*1.68*
932701	*AC2-093 C*	*24.4*
932702	*AC2-093 E*	*13.96*
932761	*AC2-100 C*	*3.66*
932762	*AC2-100 E*	*1.79*
932821	*AC2-107 C*	*3.48*
932822	*AC2-107 E*	*1.63*
933451	*AC2-158 C*	*1.78*
933452	*AC2-158 E*	*1.78*
933461	*AC2-159 C*	*2.33*
933462	*AC2-159 E*	*2.33*
933941	*AD1-017 C*	*0.84*
933942	*AD1-017 E*	*1.36*
933991	*AD1-023 C*	*4.1*
933992	*AD1-023 E*	*2.23*

934041	*AD1-029 C*	*4.23*
934042	*AD1-029 E*	*2.79*
934201	*AD1-047 C*	*2.75*
934202	*AD1-047 E*	*1.83*
934231	*AD1-050 C*	*2.01*
934232	*AD1-050 E*	*1.1*
934311	*AD1-055 C*	*1.07*
934312	*AD1-055 E*	*0.28*
934331	*AD1-057 C O2*	*4.1*
934332	*AD1-057 E O2*	*2.18*
934341	*AD1-058 C*	*3.99*
934342	*AD1-058 E*	*1.01*
934521	*AD1-076 C O2*	*18.*
934522	*AD1-076 E O2*	*9.16*
934611	*AD1-087 C O2*	*3.5*
934612	*AD1-087 E O2*	*1.63*
934621	*AD1-088 C O2*	*5.65*
934622	*AD1-088 E O2*	*2.65*
LTF	*AD1-120*	*7.55*
LTF	*AD1-121*	*7.6*
934911	*AD1-123 C*	*0.47*
934912	*AD1-123 E*	*0.24*
934991	*AD1-131 C*	*1.31*
934992	*AD1-131 E*	*0.87*
935171	*AD1-152 C O2*	*3.37*
935172	*AD1-152 E O2*	*2.25*
935221	*AD1-157 C*	*0.46*
935222	*AD1-157 E*	*0.31*
935231	*AD1-160 C*	*0.34*
935232	*AD1-160 E*	*0.47*
LTF	*AMIL*	*0.17*
LTF	*BLUEG*	*2.07*
LTF	*CANNELTON*	*0.27*
LTF	*CARR*	*0.06*
LTF	*CBM-S1*	*1.13*
LTF	*CBM-S2*	*16.92*
LTF	*CBM-W2*	*2.91*
LTF	*CLIFTY*	*10.78*
LTF	*CPLE*	*5.57*
LTF	*DEARBORN*	*0.99*
LTF	*EDWARDS*	*0.45*
LTF	*ELMERSMITH*	*0.71*
LTF	*FARMERCITY*	*0.12*
LTF	*G-007A*	*0.79*
LTF	*GIBSON*	*0.59*

LTF	*NEWTON*	*0.97*
LTF	*O-066A*	*0.36*
LTF	*PRAIRIE*	*0.86*
LTF	*RENSSELAER*	*0.05*
LTF	*ROSETON*	*0.35*
LTF	*SMITHLAND*	*< 0.01*
LTF	*TATANKA*	*0.34*
LTF	*TILTON*	*0.61*
LTF	*TRIMBLE*	*0.41*
900672	*V4-068 E*	*0.1*
LTF	*VFT*	*2.09*
LTF	*X1-078*	*0.61*
917332	*Z2-043 E*	*0.36*
917342	*Z2-044 E*	*0.25*
917512	*Z2-088 E OP1*	*1.66*
917592	*Z2-099 E*	*0.14*
918492	*AA1-063AE OP*	*1.37*
918512	*AA1-065 E OP*	*1.46*
918532	*AA1-067 E*	*0.29*
918562	*AA1-072 E*	*0.06*
919692	*AA2-053 E*	*1.33*
919702	*AA2-057 E*	*1.51*
919822	*AA2-068 E*	*0.41*
LTF	*AA2-074*	*3.79*
920022	*AA2-086 E*	*0.07*
920042	*AA2-088 E*	*3.27*
920592	*AA2-165 E*	*0.2*
920631	*AA2-169 C*	*0.91*
920632	*AA2-169 E*	*0.42*
920672	*AA2-174 E*	*0.15*
930401	*AB1-081 C*	*4.09*
930402	*AB1-081 E*	*1.75*
930861	*AB1-132 C*	*4.93*
930862	*AB1-132 E*	*2.11*
931231	*AB1-173 C*	*0.77*
931232	*AB1-173 E*	*0.36*
931241	*AB1-173AC*	*0.77*
931242	*AB1-173AE*	*0.36*
923911	*AB2-031 C O1*	*0.77*
923912	*AB2-031 E O1*	*0.38*
923941	*AB2-035 C*	*0.15*
923942	*AB2-035 E*	*0.06*
923991	*AB2-040 C O1*	*2.52*
923992	*AB2-040 E O1*	*2.06*
924021	*AB2-043 C O1*	*1.21*

924022	*AB2-043 E O1*	*1.99*
924151	*AB2-059 C O1*	*4.82*
924152	*AB2-059 E O1*	*2.48*
924161	*AB2-060 C O1*	*3.48*
924162	*AB2-060 E O1*	*1.64*
924301	*AB2-077 C O1*	*0.78*
924302	*AB2-077 E O1*	*0.52*
924311	*AB2-078 C O1*	*0.78*
924312	*AB2-078 E O1*	*0.52*
924321	*AB2-079 C O1*	*0.78*
924322	*AB2-079 E O1*	*0.52*
924381	*AB2-087 C*	*0.19*
924382	*AB2-087 E*	*0.09*
924391	*AB2-088 C*	*0.19*
924392	*AB2-088 E*	*0.09*
924401	*AB2-089 C*	*0.91*
924402	*AB2-089 E*	*0.47*
924411	*AB2-090 C*	*1.53*
924412	*AB2-090 E*	*0.78*
924491	*AB2-098 C*	*0.23*
924492	*AB2-098 E*	*0.1*
924501	*AB2-099 C*	*0.2*
924502	*AB2-099 E*	*0.08*
924511	*AB2-100 C*	*3.5*
924512	*AB2-100 E*	*1.72*
925121	*AB2-169 C*	*2.26*
925122	*AB2-169 E*	*2.03*
925171	*AB2-174 C O1*	*2.38*
925172	*AB2-174 E O1*	*2.15*
925221	*AB2-176 C*	*0.63*
925222	*AB2-176 E*	*0.27*
925591	*AC1-034 C*	*3.01*
925592	*AC1-034 E*	*2.27*
925611	*AC1-036 C*	*0.33*
925612	*AC1-036 E*	*0.54*
925781	*AC1-054 C*	*3.03*
925782	*AC1-054 E*	*1.4*
925991	*AC1-075 C*	*1.96*
925992	*AC1-075 E*	*1.11*
926021	*AC1-080 C*	*0.65*
926022	*AC1-080 E*	*0.37*
926051	*AC1-083 C*	*4.18*
926052	*AC1-083 E*	*6.82*
926071	*AC1-086 C*	*7.26*
926072	*AC1-086 E*	*3.31*

926201	*AC1-098 C*	*2.4*
926202	*AC1-098 E*	*1.43*
926211	*AC1-099 C*	*0.8*
926212	*AC1-099 E*	*0.47*
926271	*AC1-105 C*	*2.39*
926272	*AC1-105 E*	*1.19*
926771	*AC1-163 C*	*0.65*
926772	*AC1-163 E*	*0.3*
927021	*AC1-189 C*	*3.63*
927022	*AC1-189 E*	*1.81*
927111	*AC1-206 C*	*2.97*
927112	*AC1-206 E*	*1.4*
927141	*AC1-208 C*	*3.54*
927142	*AC1-208 E*	*1.57*
927251	*AC1-221 C*	*1.59*
927252	*AC1-221 E*	*1.59*
927261	*AC1-222 C*	*1.54*
927262	*AC1-222 E*	*1.46*

Appendix 7

(AEP - AEP) The 05OTTER-05JOHNMT 138 kV line (from bus 242741 to bus 242687 ckt 1) loads from 103.6% to 105.17% (**DC power flow**) of its normal rating (167 MVA) for non-contingency condition. This project contributes approximately 2.63 MW to the thermal violation.

Bus Number	*Bus Name*	*Full Contribution*
247284	*05LEESVG*	*2.11*
246843	*05SMG1*	*1.28*
246844	*05SMG2*	*3.37*
246845	*05SMG3*	*1.98*
246846	*05SMG4*	*3.48*
246847	*05SMG5*	*1.32*
315156	*1HALLBR1*	*3.63*
315165	*1HURT 1*	*2.51*
315166	*1HURT 2*	*2.51*
315266	*1PLYWOOD A*	*0.51*
932821	*AC2-107 C*	*12.11*
933941	*AD1-017 C*	*0.55*
934311	*AD1-055 C*	*1.38*
934911	*AD1-123 C*	*0.4*
935171	*AD1-152 C O2*	*2.63*
LTF	*AMIL*	*0.06*
LTF	*BAYOU*	*< 0.01*
LTF	*BLUEG*	*0.48*
LTF	*CANNELTON*	*0.07*
LTF	*CARR*	*0.04*
LTF	*CBM-S2*	*1.92*
LTF	*CLIFTY*	*2.27*
LTF	*COTTONWOOD*	*0.07*
LTF	*CPLE*	*0.79*
LTF	*DEARBORN*	*0.23*
LTF	*EDWARDS*	*0.12*
LTF	*ELMERSMITH*	*0.2*
LTF	*FARMERCITY*	*0.06*
LTF	*GIBSON*	*0.15*
LTF	*NEWTON*	*0.29*
LTF	*PRAIRIE*	*0.44*
LTF	*RENSSELAER*	*0.03*
LTF	*ROSETON*	*0.22*
LTF	*SMITHLAND*	*0.03*
LTF	*TATANKA*	*0.12*
LTF	*TILTON*	*0.16*
LTF	*TRIMBLE*	*0.09*

LTF	*TVA*	*0.03*
919841	*AA2-070*	*3.26*
925661	*AC1-042 C*	*5.45*
925991	*AC1-075 C*	*6.81*
926021	*AC1-080 C*	*2.28*
926051	*AC1-083 C*	*2.77*
926271	*AC1-105 C*	*1.86*
926641	*AC1-145 C*	*6.49*
927261	*AC1-222 C*	*1.99*