

***Generation Interconnection  
Feasibility Study Report***

***For***

***PJM Generation Interconnection Request  
Queue Position AD2-043***

***Crystal Hill 115kV  
30 MW Capacity / 65.5 MW Energy***

**September / 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, VA. The installed facilities will have a total capability of 65.5 MW with 30 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is 1/31/2019. **This study does not imply an ITO commitment to this in-service date.**

## Point of Interconnection

AD2-043 will interconnect with the ITO transmission system via the ITO Crystal Hill 115kV tap which feeds Mecklenburg Electrical Co-operative's system.

## Cost Summary

The AD2-043 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$0
Direct Connection Network Upgrades	\$0
Non Direct Connection Network Upgrades	\$0
<b>Total Costs</b>	<b>\$0</b>

In addition, the AD2-043 project may be responsible for a contribution to the following costs:

<b>Description</b>	<b>Total Cost</b>
New System Upgrades	\$0
Previously Identified Upgrades	\$60,985,000
<b>Total Costs</b>	<b>\$60,985,000</b>

Cost allocations for these upgrades will be provided in the System Impact Study Report.

Note: PJM Open Access Transmission Tariff (OATT) section 217.3A outline cost allocation rules. The rules are further clarified in PJM Manual 14A Attachment B. For New System Upgrades, the allocation of costs for a network upgrade 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.

## Transmission Owner Scope of Work

Attachment facilities and local upgrades (if required) along with terms and conditions to interconnect AD2-043 will be specified in a separate two party Interconnection Agreement (IA) between Mecklenburg Electrical Co-operative and the IC as this project is considered FERC non-jurisdictional per the PJM Open Access Transmission Tariff (OATT). The single line is shown below in Attachment 1.

## Non-Direct Connection Cost Estimate

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. **Note: The ITO identified at the Feasibility kickoff that during the Facilities Study there will likely be required metering and protection requirements which might include a new 3 breaker ringbus at Crystal Hill 115kV.**

## System Reinforcement

### VEPCO:

- Wreck and rebuild the Briery – Prince Edward – Farmville 230 kV line #235 of 13 miles to increase its line rating to 722 MVA (normal), 722 MVA (emergency), and 830 MVA (load dump). It is estimated to take 30-36 months to engineer, permit, and construct. A VA CPCN is required. Estimated cost is \$32,275,000.
- Replace line relay device at Altavista Substation to increase its line rating. It is estimated to cost \$500,000 and take 24 months.

### AEP:

- **Rebuild Altavista – Otter – Johnson Mt – New London 138kV line**
  1. Replace Otter risers , (Limiting Element: Sub Cond 477 AAC 19 Str-Otter Riser (both side of the SW); estimated cost \$100,000
  2. Reconductor / rebuild Altavista – Otter – Johnson Mt – New London 138kV line (6.8 miles), (Limiting Element: ACSR ~ 397.5 ~ 30/7 ~ LARK - Conductor section 1); expected cost of \$10.2 million.

An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

- **AEP: Current ratings S/N : 275 MVA S/E : 361 MVA, New rating: S/N : 439 MVA S/E :510 MVA**
  1. Replace Switch (1200 A), estimated cost \$400,000.

2. Replace line risers (Limiting Element: Sub Cond 1590 AAC 61 Str.), estimated cost \$100,000.
3. Rebuild / Reconductor 3.16 miles of conductor (Limiting Element: 336/556 Six Wire ACSR), estimated cost \$4.72 million.
4. Conduct an engineering study to determine if Relay - CT Thermal limit settings can be adjusted to mitigate the overload (Estimated Cost \$25,000), if not, a new relay package will be required (Estimated Cost: \$600,000). (Limiting Element: Relay Thermal Limit 1795 Amps - East Danville)
5. Conduct an engineering study to determine if Relay - CT Thermal limit settings can be adjusted to mitigate the overload (Estimated Cost \$25,000), if not, a new relay package will be required (Estimated Cost: \$600,000). (Limiting Element: Relay Thermal Limit 1795 Amps - Danville)
6. Conduct an engineering study to determine if Relay - CT Compliance Trip limit settings can be adjusted to mitigate the overload (Estimated Cost \$25,000), if not, a new relay package will be required (Estimated Cost: \$600,000). (Limiting Element: Relay Compliance Trip Limit 1916 Amps - East Danville)
7. Conduct an engineering study to determine if Relay - CT Compliance Trip limit settings can be adjusted to mitigate the overload (Estimated Cost \$25,000), if not, a new relay package will be required (Estimated Cost: \$600,000). (Limiting Element: Relay Compliance Trip Limit 1916 Amps - Danville)
8. Rebuild / Reconductor 0.03 miles of conductor (Limiting Element: 1351.5 ACSR 45/7 DIPPER) Near East Danville, estimated cost \$0.045 million.
9. Rebuild / Reconductor 0.03 miles of conductor (Limiting Element: 1351.5 ACSR 45/7 DIPPER) Near Danville, estimated cost \$0.045 million.

An approximate construction time would be 24 to 36 months after signing an interconnection agreement

- **Johnson Mountain – New London 138 kV line**

1. Reconductor / Rebuild 6.8 miles of conductor (Limiting Element: ACSR ~ 397.5 ~ 30/7 ~LARK ~ Fe Clamps - Conductor section); Estimated cost of \$10.2 million.

An approximate construction time would be 24 to 36 months after signing an interconnection agreement

## **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>

## **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

## Network Impacts

The Queue Project AD2-043 was evaluated as a 65.5 MW (Capacity 30.0 MW) injection at Crystal Hill 115kV substation in the ITO area. Project AD2-043 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-043 was studied with a commercial probability of 53%. Potential network impacts were as follows:

PJM assessed the impact of the proposed Queue Project as an injection into the ITO, 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.

## 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
AEP_P1-2_#5479	CONTINGENCY 'AEP_P1-2_#5479' OPEN BRANCH FROM BUS 242569 TO BUS 242734 CKT 1 / 242569 05BRUSHT 138 242734 05NEWLDN 138 1 OPEN BRANCH FROM BUS 242687 TO BUS 242734 CKT 1 / 242687 05JOHNMT 138 242734 05NEWLDN 138 1 OPEN BRANCH FROM BUS 242687 TO BUS 242741 CKT 1 / 242687 05JOHNMT 138 242741 05OTTER 138 1 OPEN BRANCH FROM BUS 242741 TO BUS 314667 CKT 1 / 242741 05OTTER 138 314667 4ALTVSTA 138 1 END

Contingency Name	Description
AEP_P1-2_#6215	CONTINGENCY 'AEP_P1-2_#6215' OPEN BRANCH FROM BUS 242748 TO BUS 242802 CKT 1 / 242748 05PENHOK 138 242802 05SMITHMTN1 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 31-A	CONTINGENCY 'DVP_P1-2: LN 31-A' OPEN BRANCH FROM BUS 314520 TO BUS 314696 CKT 1 /* 3HALIF_1 115.00 - 3HALIFAX 115.00 OPEN BRANCH FROM BUS 927260 TO BUS 314696 CKT 1 /* AC1- 222 TAP 115.00 - 3HALIFAX 115.00 OPEN BUS 314520 /* 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_P1-3: 3ALTVSTA- 4ALTVSTAA	CONTINGENCY 'DVP_P1-3: 3ALTVSTA-4ALTVSTAA' OPEN BRANCH FROM BUS 314666 TO BUS 314667 CKT 2 END
DVP_P4-2: 3312	CONTINGENCY 'DVP_P4-2: 3312' /* CHASE CITY OPEN BUS 314267 /*CHASE CITY 115KV BUS 3 OPEN BUS 314669 /*LINE 33 BARNS J OPEN BUS 314684 /*LINE 33 MT LAUREL OPEN BUS 314696 /*LINE 33 HALIFAX OPEN BUS 314518 /*SC312 END
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

Contingency Name	Description
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		Affected Area	Facility Description	Bus		Cir.	Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To			Initial	Final	Type	MVA		
1	N-1	DVP_P1-2: LN 556	DVP - CPLE	AC1-221 TAP- 6PERSON230 T 230 kV line	927250	304070	1	DC	98.39	100.09	ER	718	13.04	1

### 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	Affected	Facility Description	Bus	Cir.	Power	Loading %	Rating	MW	Ref
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Type	Name	Area	From	To	Flow	Initial	Final	Type	MVA	Contribution				
2	LFFB	DVP_P4-2: 511T556	DVP - DVP	6PRINCE EDW- 6FARMVIL 230 kV line	313802	314692	1	DC	101.99	103.24	LD	699	8.67	2
3	LFFB	DVP_P4-2: 556T591	DVP - DVP	6PRINCE EDW- 6FARMVIL 230 kV line	313802	314692	1	DC	101.99	103.24	LD	699	8.67	
4	LFFB	DVP_P4-2: 511T591	DVP - DVP	6PRINCE EDW- 6FARMVIL 230 kV line	313802	314692	1	DC	101.82	103.06	LD	699	8.67	
5	LFFB	DVP_P4-2: 511T556	DVP - DVP	6BRIERY-6PRINCE EDW 230 kV line	314268	313802	1	DC	102.83	104.08	LD	699	8.67	3
6	LFFB	DVP_P4-2: 556T591	DVP - DVP	6BRIERY-6PRINCE EDW 230 kV line	314268	313802	1	DC	102.83	104.08	LD	699	8.67	
7	LFFB	DVP_P4-2: 511T591	DVP - DVP	6BRIERY-6PRINCE EDW 230 kV line	314268	313802	1	DC	102.66	103.91	LD	699	8.67	
8	LFFB	DVP_P4-2: 3312	DVP - AEP	4ALTVSTA-05OTTER 138 kV line	314667	242741	1	DC	111.98	122.92	ER	245	26.79	4
9	Non	Non	DVP - AEP	4ALTVSTA-05OTTER 138 kV line	314667	242741	1	DC	104.22	105.84	NR	167	2.72	
10	LFFB	DVP_P4-2: 556T591	DVP - DVP	AC1-162 TAP-6BRIERY 230 kV line	926760	314268	1	DC	103.93	105.18	LD	699	8.67	5
11	LFFB	DVP_P4-2: 511T556	DVP - DVP	AC1-162 TAP-6BRIERY 230 kV line	926760	314268	1	DC	103.92	105.17	LD	699	8.67	
12	LFFB	DVP_P4-2: 511T591	DVP - DVP	AC1-162 TAP-6BRIERY 230 kV line	926760	314268	1	DC	103.76	105.01	LD	699	8.67	
13	LFFB	AEP_P4_#7 589_05J.FE RR 765	AEP - AEP	05EDAN 1-05DANVL2 138 kV line	242631	242620	1	DC	132.68	133.15	ER	415	4.37	6
14	LFFB	DVP_P4-2: 3312	AEP - AEP	05JOHNMT-05NEWLDN 138 kV line	242687	242734	1	DC	108.9	120.06	ER	240	26.79	7

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Cir.		Initial	Final	Type	MVA		
15	LFFB	DVP_P4-2: 3312	AEP - AEP	05OTTER-05JOHNMT 138 kV line	242741	242687	1	DC	110.15	121.08	ER	245	26.79	8
16	Non	Non	AEP - AEP	05OTTER-05JOHNMT 138 kV line	242741	242687	1	DC	101.52	103.15	NR	167	2.72	

### **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)*

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
# 1	AC1-221 TAP-6PERSON230 T 230 kV line	The line rating at PJM ITO portion of this tie line is 904MVA (normal), 904MVA (Emergency) and 1105 MVA (normal). Therefore, the line limit element is not overloaded on the VEPCO portion of this line. An affected systems study will need to be completed with Duke/Progress to determine upgrades required on the Duke/Progress system.		\$0
<b>Total New Network Upgrades</b>				<b>\$0</b>

## Contribution to Previously Identified System Reinforcements

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

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
# 2 - 4	6PRINCE EDW-6FARMVIL 230 kV line	Wreck and rebuild the Briery – Prince Edward – Farmville 230 kV line #235 of 13 miles to increase its line rating to 722 MVA (normal), 722 MVA (emergency), and 830 MVA (load dump). It is estimated to take 30-36 months to engineer, permit, and construct. A VA CPCN is required.	Pending	<b>\$32,275,000</b>
# 5 - 7	6BRIERY-6PRINCE EDW 230 kV line			
# 10 - 12	AC1-162 TAP-6BRIERY 230 kV line			
# 8, 9	4ALTVSTA-05OTTER 138 kV line	<p><b>AEP:</b></p> <ol style="list-style-type: none"> <li>1. Replace Otter risers , (Limiting Element: Sub Cond 477 AAC 19 Str-Otter Riser (both side of the SW); estimated cost \$100,000</li> <li>2. Reconductor / rebuild Altavista – Otter – Johnson Mt – New London 138kV line (6.8 miles), (Limiting Element: ACSR ~ 397.5 ~ 30/7 ~ LARK - Conductor section 1); expected cost of \$10.2 million.</li> </ol> <p>An approximate construction time would be 24 to 36 months after signing an interconnection agreement.</p> <p><b>VEPCO:</b> Replace line relay device at Altavista Substation to increase its line rating. It is estimated to cost \$500,000 and take 24 months.</p>	Pending	<b>\$10,800,000</b>
# 15, 16	05OTTER-05JOHNMT 138 kV line			

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
# 13	05EDAN 1-05DANVL2 138 kV line	<p><b>AEP: Current ratings S/N : 275 MVA S/E : 361 MVA, New rating: S/N : 439 MVA S/E :510 MVA</b></p> <ol style="list-style-type: none"> <li>1. Replace Switch (1200 A), estimated cost \$400,000.</li> <li>2. Replace line risers (Limiting Element: Sub Cond 1590 AAC 61 Str.), estimated cost \$100,000.</li> <li>3. Rebuild / Reconductor 3.16 miles of conductor (Limiting Element: 336/556 Six Wire ACSR), estimated cost \$4.72 million.</li> <li>4. Conduct an engineering study to determine if Relay - CT Thermal limit settings can be adjusted to mitigate the overload (Estimated Cost \$25,000), if not, a new relay package will be required (Estimated Cost: \$600,000). (Limiting Element: Relay Thermal Limit 1795 Amps - East Danville)</li> <li>5. Conduct an engineering study to determine if Relay - CT Thermal limit settings can be adjusted to mitigate the overload (Estimated Cost \$25,000), if not, a new relay package will be required (Estimated Cost: \$600,000). (Limiting Element: Relay Thermal Limit 1795 Amps - Danville)</li> <li>6. Conduct an engineering study to determine if Relay - CT Compliance Trip limit settings can be adjusted to mitigate the overload (Estimated Cost \$25,000), if not, a new relay package will be required (Estimated Cost: \$600,000). (Limiting Element: Relay Compliance Trip Limit 1916 Amps - East Danville)</li> <li>7. Conduct an engineering study to determine if Relay - CT Compliance Trip limit settings can be adjusted to mitigate the overload (Estimated Cost \$25,000), if not, a new relay package will be required (Estimated Cost: \$600,000). (Limiting Element: Relay Compliance Trip Limit 1916 Amps - Danville)</li> <li>8. Rebuild / Reconductor 0.03 miles of conductor (Limiting Element: 1351.5 ACSR 45/7 DIPPER) Near East Danville, estimated cost \$0.045 million.</li> <li>9. Rebuild / Reconductor 0.03 miles of conductor (Limiting Element: 1351.5 ACSR 45/7 DIPPER) Near Danville, estimated cost \$0.045 million.</li> </ol> <p>An approximate construction time would be 24 to 36 months after signing an interconnection agreement</p>	Pending	\$7,710,0000

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
# 14	05JOHNMT-05NEWLDN 138 kV line	<b>AEP:</b> Reconductor / Rebuild Johnson Mountain to New London 138kV line 6.8 miles of conductor (Limiting Element: ACSR ~ 397.5 ~ 30/7 ~LARK ~ Fe Clamps - Conductor section); Estimated cost of \$10.2 million. An approximate construction time would be 24 to 36 months after signing an interconnection agreement	Pending	\$10,200,000
<b>Total New Network Upgrades</b>				<b>\$60,985,000</b>

### 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 Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA	
17	N-1	DVP_P1-2: LN 556	DVP - DVP	6PRINCE EDW-6FARMVIL 230 kV line	313802	314692	1	DC	122.39	123.91	ER	572	8.64
18	N-1	DVP_P1-2: LN 556	DVP - DVP	6BRIERY-6PRINCE EDW 230 kV line	314268	313802	1	DC	123.43	124.94	ER	572	8.64

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA	
19	N-1	DVP_P1-3: 3ALTVST A- 4ALTVST AA	DVP - DVP	4ALTVSTA 138/115 kV transformer	314666	314667	1	DC	99.09	107.6 2	ER	127	10.79
20	N-1	DVP_P1-2: LN 31-A	DVP - DVP	4ALTVSTA 138/115 kV transformer	314666	314667	2	DC	109.9 9	136.9 3	ER	130	35.14
21	N-1	DVP_P1-2: LN 31-A	DVP - AEP	4ALTVSTA-05OTTER 138 kV line	314667	242741	1	DC	111.7 3	122.6 7	ER	245	26.79
22	Non	Non	DVP - AEP	4ALTVSTA-05OTTER 138 kV line	314667	242741	1	DC	118.1 9	119.7 9	NR	167	5.93
23	N-1	DVP_P1-2: LN 556	DVP - DVP	6BUCKING-6BREMO 230 kV line	314677	314747	1	DC	104.9 7	105.8 8	ER	572	11.46
24	N-1	DVP_P1-2: LN 556	DVP - DVP	6FARMVIL-6BUCKING 230 kV line	314692	314677	1	DC	105.1	106.0 3	ER	559	11.47
25	N-1	DVP_P1-2: LN 556	DVP - DVP	6HALIFAX-AC1-221 TAP 230 kV line	314697	927250	1	DC	113.7 1	117.5 4	ER	675	28.48
26	N-1	DVP_P1-2: LN 31-A	DVP - DVP	3OTTER R-3ALTVSTA 115 kV line	314712	314666	1	DC	86.62	115.7 7	ER	225	65.5
27	N-1	DVP_P1-2: LN 556	DVP - DVP	AC1-162 TAP-6BRIERY 230 kV line	926760	314268	1	DC	124.7 7	126.2 9	ER	572	8.64
28	N-1	DVP_P1-2: LN 556	DVP - CPLE	AC1-221 TAP-6PERSON230 T 230 kV line	927250	304070	1	DC	121.0 7	124.7 2	ER	718	28.48
29	N-1	AEP_P1- 2_#5479	DVP - DVP	AC1-222 TAP-3HALIFAX 115 kV line	927260	314696	1	DC	82.87	101.4 7	ER	286	53.16

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA	
30	N-1	DVP_P1-2: LN 556	DVP - DVP	AD1-088 TAP-AC1-162 TAP 230 kV line	934620	926760	1	DC	100.8 7	102.4	ER	572	8.64
31	N-1	AEP_P1- 2_#1377	AEP - AEP	05EDAN 1-05DANVL2 138 kV line	242631	242620	1	DC	132.6 5	133.1 3	ER	415	4.37
32	Non	Non	AEP - AEP	05EDAN 1-05DANVL2 138 kV line	242631	242620	1	DC	107.9 2	108.5 3	NR	275	3.73
33	N-1	DVP_P1-2: LN 31-A	AEP - AEP	05JOHNMT-05NEWLDN 138 kV line	242687	242734	1	DC	108.6	119.7 7	ER	240	26.79
34	Non	Non	AEP - AEP	05JOHNMT-05NEWLDN 138 kV line	242687	242734	1	DC	110.4	112.0 1	NR	167	5.93
35	N-1	DVP_P1-2: LN 31-A	AEP - AEP	05OTTER-05JOHNMT 138 kV line	242741	242687	1	DC	109.8 6	120.7 9	ER	245	26.79
36	Non	Non	AEP - AEP	05OTTER-05JOHNMT 138 kV line	242741	242687	1	DC	115.4 9	117.1	NR	167	5.93
37	N-1	AEP_P1- 2_#6215	AEP - AEP	05SMITHMTN2- 05ROCKCA 138 kV line	247499	242775	1	DC	111.7 7	112.3 3	ER	277	3.41

### **Light Load Analysis**

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

### **Affected System Analysis & Mitigation**

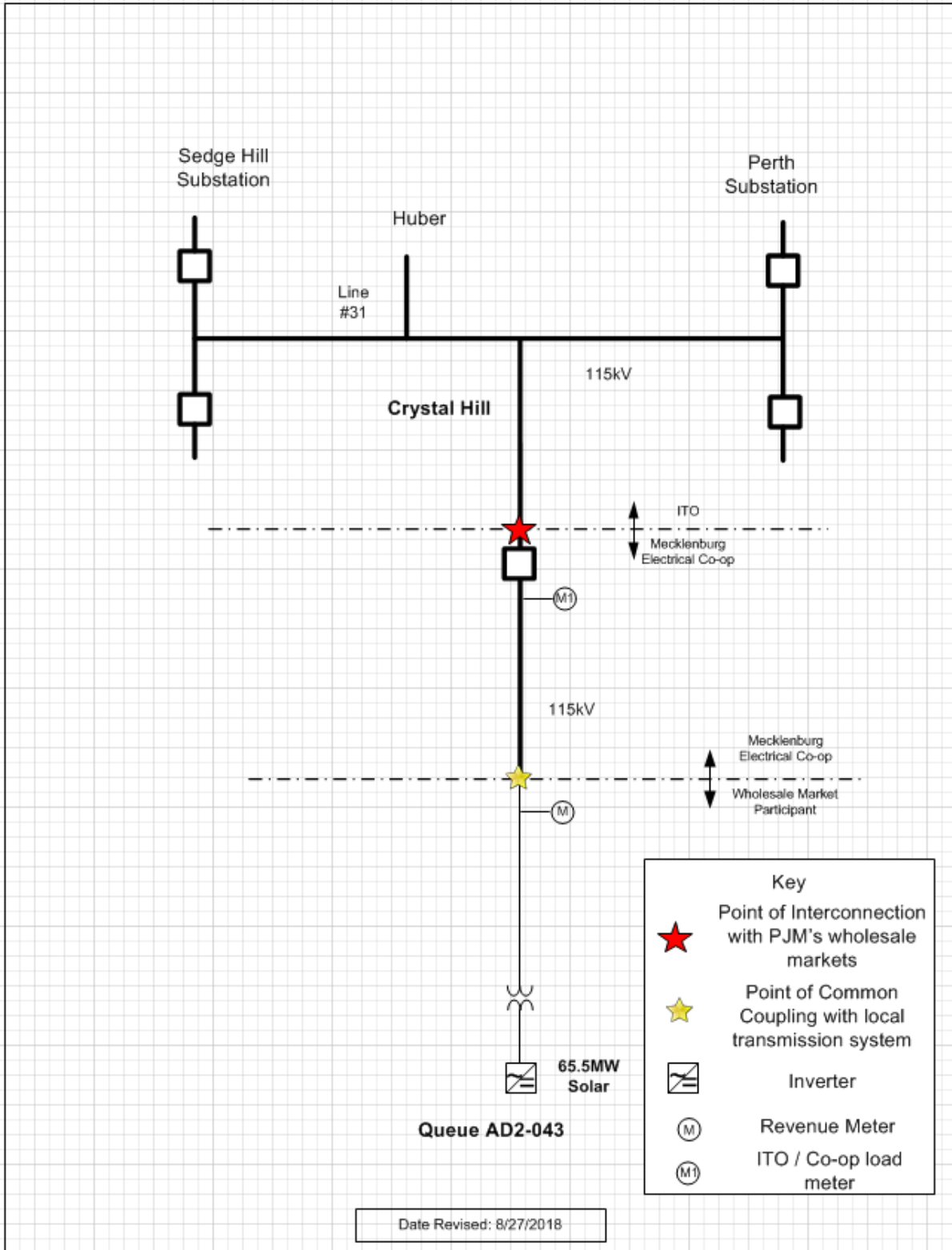
#### **Duke, Progress & TVA Impacts:**

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

- AC1-221 TAP-6PERSON230 T 230 kV line overload.

# Attachment 1.

## System Configuration



## Attachment 2.

### *Flowgate Appendices – Option 1*

## **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 gauge other generators impact. When a flowgate is identified in multiple analysis the appendix is presented for only the analysis with the greatest overload.

***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

(DVP - CPLE) The AC1-221 TAP-6PERSON230 T 230 kV line (from bus 927250 to bus 304070 ckt 1) loads from 98.39% to 100.09% (**DC power flow**) of its emergency rating (718 MVA) for the single line contingency outage of 'DVP\_P1-2: LN 556'. This project contributes approximately 13.04 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
315150	1BUGGS 1	17.67
315151	1BUGGS 2	17.67
315153	1CLOVER1	42.46
315154	1CLOVER2	41.91
315159	1KERR 2	1.41
315164	1KERR 7	1.39
315266	1PLYWOOD A	3.72
314429	3JTRSVLE	0.61
932511	AC2-071 C	2.43
932761	AC2-100 C	26.97
932821	AC2-107 C	21.11
934311	AD1-055 C	6.99
934341	AD1-058 C	29.38
934611	AD1-087 C O1	26.89
934621	AD1-088 C	31.8
934911	AD1-123 C	3.15
934991	AD1-131 C	9.63
935171	AD1-152 C O1	26.72
935221	AD1-157 C	2.12
935231	AD1-160 C	1.56
936261	AD2-033 C	17.89
936331	AD2-043 C	13.04
936361	AD2-046 C O1	8.56
936481	AD2-063 C O1	20.59

936651	AD2-082 C	2.38
937461	AD2-200 C	4.02
937481	AD2-202 C O1	7.4
LTF	AMIL	0.46
LTF	BAYOU	2.62
LTF	BIG_CAJUN1	4.14
LTF	BIG_CAJUN2	8.34
LTF	BLUEG	2.31
LTF	CALDERWOOD	1.58
LTF	CANNELTON	0.45
LTF	CARR	0.04
LTF	CATAWBA	1.7
LTF	CELEVELAND	4.82
LTF	CHEOAH	1.48
LTF	CHILHOWEE	0.51
LTF	CHOCTAW	2.83
LTF	CLIFTY	8.11
LTF	COTTONWOOD	10.23
LTF	DEARBORN	0.83
LTF	EDWARDS	0.73
LTF	ELMERSMITH	1.33
LTF	FARMERCITY	0.6
LTF	G-007A	0.4
LTF	GIBSON	0.82
LTF	HAMLET	6.39
LTF	MORGAN	4.56
LTF	NEWTON	2.03
LTF	PRAIRIE	4.5
LTF	RENSSELAER	0.03
LTF	ROSETON	0.22
LTF	ROWAN	3.76
LTF	SANTEETLA	0.44
LTF	SMITHLAND	0.41
LTF	TATANKA	1.
LTF	TILTON	0.86
LTF	TRIMBLE	0.44
LTF	TVA	1.9
LTF	UNIONPOWER	2.99
LTF	VFT	1.05
924021	AB2-043 C O1	4.29
924031	AB2-045 C	0.46
924161	AB2-060 C O1	12.36
924301	AB2-077 C O1	2.76
924311	AB2-078 C O1	2.76
924321	AB2-079 C O1	2.76

924411	AB2-090 C	5.4
925221	AB2-176 C	2.22
925611	AC1-036 C	1.32
925831	AC1-062	0.08
925991	AC1-075 C	11.87
926021	AC1-080 C	3.97
926271	AC1-105 C	14.48
926761	AC1-162 C	56.7
927251	AC1-221 C	11.72
927261	AC1-222 C	10.07

## Appendix 2

(DVP - DVP) The 6PRINCE EDW-6FARMVIL 230 kV line (from bus 313802 to bus 314692 ckt 1) loads from 101.99% to 103.24% (**DC power flow**) of its load dump rating (699 MVA) for the line fault with failed breaker contingency outage of 'DVP\_P4-2: 511T556'. This project contributes approximately 8.67 MW to the thermal violation.

```
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
```

Bus Number	Bus Name	Full Contribution
315153	1CLOVER1	26.08
315154	1CLOVER2	25.73
315266	1PLYWOOD A	1.06
932511	AC2-071 C	-2.76
932761	AC2-100 C	3.41
932762	AC2-100 E	1.66
932821	AC2-107 C	6.68
932822	AC2-107 E	3.13
934311	AD1-055 C	2.13
934312	AD1-055 E	0.55
934341	AD1-058 C	3.71
934342	AD1-058 E	0.94
934611	AD1-087 C O1	12.33
934612	AD1-087 E O1	5.8
934621	AD1-088 C	34.27
934622	AD1-088 E	16.09
LTF	AD1-120	3.6
LTF	AD1-121	3.64
934911	AD1-123 C	0.95
934912	AD1-123 E	0.49
934991	AD1-131 C	1.22

934992	AD1-131 E	0.81
935171	AD1-152 C O1	12.26
935172	AD1-152 E O1	8.17
936331	AD2-043 C	3.97
936332	AD2-043 E	4.7
LTF	AD2-099	2.39
937461	AD2-200 C	4.33
937462	AD2-200 E	2.05
937481	AD2-202 C O1	3.4
937482	AD2-202 E O1	1.71
LTF	CARR	0.12
LTF	CBM-S1	4.03
LTF	CBM-S2	8.41
LTF	CBM-W1	8.31
LTF	CBM-W2	21.53
LTF	CIN	1.88
LTF	CPLE	2.68
LTF	G-007	0.64
LTF	IPL	1.2
LTF	LGEE	0.41
LTF	MEC	4.33
LTF	MECS	1.76
LTF	O-066	4.09
LTF	RENSSELAER	0.1
LTF	ROSETON	0.71
LTF	WEC	0.52
LTF	AA2-074	1.83
925611	AC1-036 C	-0.37
925991	AC1-075 C	3.76
925992	AC1-075 E	2.13
926021	AC1-080 C	1.26
926022	AC1-080 E	0.71
926271	AC1-105 C	3.9
926272	AC1-105 E	1.94
926761	AC1-162 C	99.01
926762	AC1-162 E	41.68
927251	AC1-221 C	1.48
927252	AC1-221 E	1.48
927261	AC1-222 C	3.06
927262	AC1-222 E	2.92

### Appendix 3

(DVP - DVP) The 6BRIERY-6PRINCE EDW 230 kV line (from bus 314268 to bus 313802 ckt 1) loads from 102.83% to 104.08% (**DC power flow**) of its load dump rating (699 MVA) for the line fault with failed breaker contingency outage of 'DVP\_P4-2: 511T556'. This project contributes approximately 8.67 MW to the thermal violation.

```

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
  
```

Bus Number	Bus Name	Full Contribution
315153	1CLOVER1	26.08
315154	1CLOVER2	25.73
315266	1PLYWOOD A	1.06
932511	AC2-071 C	-2.76
932761	AC2-100 C	3.41
932762	AC2-100 E	1.66
932821	AC2-107 C	6.68
932822	AC2-107 E	3.13
934311	AD1-055 C	2.13
934312	AD1-055 E	0.55
934341	AD1-058 C	3.71
934342	AD1-058 E	0.94
934611	AD1-087 C O1	12.33
934612	AD1-087 E O1	5.8
934621	AD1-088 C	34.27
934622	AD1-088 E	16.09
LTF	AD1-120	3.6
LTF	AD1-121	3.64
934911	AD1-123 C	0.95
934912	AD1-123 E	0.49
934991	AD1-131 C	1.22

934992	AD1-131 E	0.81
935171	AD1-152 C O1	12.26
935172	AD1-152 E O1	8.17
936331	AD2-043 C	3.97
936332	AD2-043 E	4.7
LTF	AD2-099	2.39
937461	AD2-200 C	4.33
937462	AD2-200 E	2.05
937481	AD2-202 C O1	3.4
937482	AD2-202 E O1	1.71
LTF	CARR	0.12
LTF	CBM-S1	4.03
LTF	CBM-S2	8.41
LTF	CBM-W1	8.31
LTF	CBM-W2	21.53
LTF	CIN	1.88
LTF	CPLE	2.68
LTF	G-007	0.64
LTF	IPL	1.2
LTF	LGEE	0.41
LTF	MEC	4.33
LTF	MECS	1.76
LTF	O-066	4.09
LTF	RENSSELAER	0.1
LTF	ROSETON	0.71
LTF	WEC	0.52
LTF	AA2-074	1.83
925611	AC1-036 C	-0.37
925991	AC1-075 C	3.76
925992	AC1-075 E	2.13
926021	AC1-080 C	1.26
926022	AC1-080 E	0.71
926271	AC1-105 C	3.9
926272	AC1-105 E	1.94
926761	AC1-162 C	99.01
926762	AC1-162 E	41.68
927251	AC1-221 C	1.48
927252	AC1-221 E	1.48
927261	AC1-222 C	3.06
927262	AC1-222 E	2.92

## Appendix 4

(DVP - AEP) The 4ALTVSTA-05OTTER 138 kV line (from bus 314667 to bus 242741 ckt 1) loads from 111.98% to 122.92% (**DC power flow**) of its emergency rating (245 MVA) for the line fault with failed breaker contingency outage of 'DVP\_P4-2: 3312'. This project contributes approximately 26.79 MW to the thermal violation.

CONTINGENCY 'DVP\_P4-2: 3312'

OPEN BUS 314267

OPEN BUS 314669

OPEN BUS 314684

OPEN BUS 314696

OPEN BUS 314518

END

/\* CHASE CITY

/\*CHASE CITY 115KV BUS 3

/\*LINE 33 BARNS J

/\*LINE 33 MT LAUREL

/\*LINE 33 HALIFAX

/\*SC312

Bus Number	Bus Name	Full Contribution
247284	05LEESVG	2.54
246843	05SMG1	1.64
246844	05SMG2	4.31
246845	05SMG3	2.53
246846	05SMG4	4.46
246847	05SMG5	1.69
315156	1HALLBR1	4.56
315165	1HURT 1	3.16
315166	1HURT 2	3.16
932821	AC2-107 C	27.86
932822	AC2-107 E	13.05
933941	AD1-017 C	0.73
933942	AD1-017 E	1.19
934311	AD1-055 C	6.5
934312	AD1-055 E	1.68
936331	AD2-043 C	12.27
936332	AD2-043 E	14.52
LTF	AMIL	0.02
LTF	BLUEG	0.16
LTF	CANNELTON	0.02
LTF	CARR	0.04
LTF	CBM-S1	< 0.01
LTF	CBM-S2	1.05
LTF	CLIFTY	0.81
LTF	CPL	0.4
LTF	DEARBORN	0.09

LTF	EDWARDS	0.04
LTF	ELMERSMITH	0.06
LTF	FARMERCITY	0.02
LTF	G-007	0.09
LTF	GIBSON	0.05
LTF	NEWTON	0.09
LTF	O-066	0.59
LTF	PRAIRIE	0.11
LTF	RENSSELAER	0.03
LTF	ROSETON	0.21
LTF	SMITHLAND	< 0.01
LTF	TATANKA	0.04
LTF	TILTON	0.05
LTF	TRIMBLE	0.03
919841	AA2-070	4.41
924572	AB2-109 E	-0.65
925661	AC1-042 C	6.79
925662	AC1-042 E	11.08
925991	AC1-075 C	15.67
925992	AC1-075 E	8.88
926021	AC1-080 C	5.24
926022	AC1-080 E	2.95
926051	AC1-083 C	3.64
926052	AC1-083 E	5.95
926641	AC1-145 C	8.09
926642	AC1-145 E	13.19
927261	AC1-222 C	9.37
927262	AC1-222 E	8.92

## Appendix 5

(DVP - DVP) The AC1-162 TAP-6BRIERY 230 kV line (from bus 926760 to bus 314268 ckt 1) loads from 103.93% to 105.18% (**DC power flow**) of its load dump rating (699 MVA) for the line fault with failed breaker contingency outage of 'DVP\_P4-2: 556T591'. This project contributes approximately 8.67 MW to the thermal violation.

```
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
```

Bus Number	Bus Name	Full Contribution
315153	1CLOVER1	26.08
315154	1CLOVER2	25.73
315266	1PLYWOOD A	1.06
932511	AC2-071 C	-2.76
932761	AC2-100 C	3.41
932762	AC2-100 E	1.66
932821	AC2-107 C	6.68
932822	AC2-107 E	3.13
934311	AD1-055 C	2.13
934312	AD1-055 E	0.55
934341	AD1-058 C	3.71
934342	AD1-058 E	0.94
934611	AD1-087 C O1	12.33
934612	AD1-087 E O1	5.8
934621	AD1-088 C	34.27
934622	AD1-088 E	16.09
LTF	AD1-120	3.6
LTF	AD1-121	3.64
934911	AD1-123 C	0.95
934912	AD1-123 E	0.49
934991	AD1-131 C	1.22

934992	AD1-131 E	0.81
935171	AD1-152 C O1	12.26
935172	AD1-152 E O1	8.17
936331	AD2-043 C	3.97
936332	AD2-043 E	4.7
LTF	AD2-099	2.39
937461	AD2-200 C	4.33
937462	AD2-200 E	2.05
937481	AD2-202 C O1	3.4
937482	AD2-202 E O1	1.71
LTF	CARR	0.12
LTF	CBM-S1	4.03
LTF	CBM-S2	8.41
LTF	CBM-W1	8.31
LTF	CBM-W2	21.53
LTF	CIN	1.88
LTF	CPLE	2.68
LTF	G-007	0.64
LTF	IPL	1.2
LTF	LGEE	0.41
LTF	MEC	4.33
LTF	MECS	1.76
LTF	O-066	4.09
LTF	RENSSELAER	0.1
LTF	ROSETON	0.71
LTF	WEC	0.52
LTF	AA2-074	1.83
925611	AC1-036 C	-0.37
925991	AC1-075 C	3.76
925992	AC1-075 E	2.13
926021	AC1-080 C	1.26
926022	AC1-080 E	0.71
926271	AC1-105 C	3.9
926272	AC1-105 E	1.94
926761	AC1-162 C	99.01
926762	AC1-162 E	41.68
927251	AC1-221 C	1.48
927252	AC1-221 E	1.48
927261	AC1-222 C	3.06
927262	AC1-222 E	2.92

## Appendix 6

(AEP - AEP) The 05EDAN 1-05DANVL2 138 kV line (from bus 242631 to bus 242620 ckt 1) loads from 132.68% to 133.15% (**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 4.37 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
315150	1BUGGS 1	4.75
315151	1BUGGS 2	4.75
315131	1EDGECSMA	4.26
315132	1EDGECSMB	4.26
314557	3BETHEL C	0.35
314554	3BTLEBRO	0.37
314572	3EMPORIA	0.14
314578	3HORNRTN	1.22
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	3.43
932632	AC2-084 E	1.69
932701	AC2-093 C	24.45
932702	AC2-093 E	13.99
932761	AC2-100 C	3.67
932762	AC2-100 E	1.79
932821	AC2-107 C	3.49
932822	AC2-107 E	1.63
933941	AD1-017 C	0.84
933942	AD1-017 E	1.37

933991	AD1-023 C	4.11
933992	AD1-023 E	2.24
934201	AD1-047 C	2.75
934202	AD1-047 E	1.83
934231	AD1-050 C	2.02
934232	AD1-050 E	1.1
934311	AD1-055 C	1.07
934312	AD1-055 E	0.28
934331	AD1-057 C O1	4.11
934332	AD1-057 E O1	2.19
934341	AD1-058 C	3.99
934342	AD1-058 E	1.01
934521	AD1-076 C O1	16.75
934522	AD1-076 E O1	8.53
934611	AD1-087 C O1	3.38
934612	AD1-087 E O1	1.59
934621	AD1-088 C	4.01
934622	AD1-088 E	1.88
LTF	AD1-120	7.56
LTF	AD1-121	7.62
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
936161	AD2-022 C O1	10.78
936162	AD2-022 E O1	6.47
936171	AD2-023 C O1	6.2
936172	AD2-023 E O1	3.37
936261	AD2-033 C	4.76
936262	AD2-033 E	3.17
936331	AD2-043 C	2.
936332	AD2-043 E	2.37
936361	AD2-046 C O1	3.84
936362	AD2-046 E O1	1.76
936401	AD2-051 C O1	2.97
936402	AD2-051 E O1	1.27
936481	AD2-063 C O1	5.55
936482	AD2-063 E O1	3.7
936531	AD2-068 C	2.28

936532	AD2-068 E	1.17
936641	AD2-081 C	2.56
936642	AD2-081 E	1.15
936651	AD2-082 C	0.52
936652	AD2-082 E	0.25
936701	AD2-089 C	3.17
936702	AD2-089 E	2.12
936711	AD2-090 C O1	2.13
936712	AD2-090 E O1	1.42
LTF	AD2-099	4.99
937441	AD2-195 C	3.15
937442	AD2-195 E	1.36
937461	AD2-200 C	0.51
937462	AD2-200 E	0.24
937481	AD2-202 C O1	0.93
937482	AD2-202 E O1	0.47
LTF	AMIL	0.17
LTF	BLUEG	2.05
LTF	CANNELTON	0.27
LTF	CARR	0.07
LTF	CBM-S1	1.16
LTF	CBM-S2	16.95
LTF	CBM-W2	3.27
LTF	CLIFTY	10.69
LTF	CPLE	5.58
LTF	DEARBORN	0.97
LTF	EDWARDS	0.44
LTF	ELMERSMITH	0.7
LTF	FARMERCITY	0.12
LTF	G-007A	0.82
LTF	GIBSON	0.58
LTF	NEWTON	0.95
LTF	PRAIRIE	0.83
LTF	RENSSELAER	0.05
LTF	ROSETON	0.36
LTF	TATANKA	0.33
LTF	TILTON	0.6
LTF	TRIMBLE	0.4
900672	V4-068 E	0.1
LTF	VFT	2.17
917332	Z2-043 E	0.36
917342	Z2-044 E	0.26
917512	Z2-088 E OP1	1.67
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
LTF	AA2-074	3.79
920042	AA2-088 E	3.28
920592	AA2-165 E	0.2
920672	AA2-174 E	0.15
930401	AB1-081 C	4.1
930402	AB1-081 E	1.76
930861	AB1-132 C	4.94
930862	AB1-132 E	2.12
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	1.22
924022	AB2-043 E O1	2.
924151	AB2-059 C O1	4.83
924152	AB2-059 E O1	2.49
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
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	0.79
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	3.51

924512	AB2-100 E	1.73
925121	AB2-169 C	2.27
925122	AB2-169 E	2.03
925171	AB2-174 C O1	2.38
925172	AB2-174 E O1	2.16
925221	AB2-176 C	0.63
925222	AB2-176 E	0.27
925591	AC1-034 C	3.13
925592	AC1-034 E	2.36
925611	AC1-036 C	0.33
925612	AC1-036 E	0.54
925781	AC1-054 C	3.04
925782	AC1-054 E	1.4
925991	AC1-075 C	1.96
925992	AC1-075 E	1.11
926021	AC1-080 C	0.66
926022	AC1-080 E	0.37
926051	AC1-083 C	4.18
926052	AC1-083 E	6.83
926071	AC1-086 C	7.28
926072	AC1-086 E	3.31
926201	AC1-098 C	2.4
926202	AC1-098 E	1.43
926211	AC1-099 C	0.81
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
927141	AC1-208 C	3.55
927142	AC1-208 E	1.58
927251	AC1-221 C	1.59
927252	AC1-221 E	1.59
927261	AC1-222 C	1.54
927262	AC1-222 E	1.47

## Appendix 7

(AEP - AEP) The 05JOHNMT-05NEWLDN 138 kV line (from bus 242687 to bus 242734 ckt 1) loads from 108.9% to 120.06% (**DC power flow**) of its emergency rating (240 MVA) for the line fault with failed breaker contingency outage of 'DVP\_P4-2: 3312'. This project contributes approximately 26.79 MW to the thermal violation.

CONTINGENCY 'DVP\_P4-2: 3312'

OPEN BUS 314267

OPEN BUS 314669

OPEN BUS 314684

OPEN BUS 314696

OPEN BUS 314518

END

/\* CHASE CITY

/\*CHASE CITY 115KV BUS 3

/\*LINE 33 BARNES J

/\*LINE 33 MT LAUREL

/\*LINE 33 HALIFAX

/\*SC312

Bus Number	Bus Name	Full Contribution
247284	05LEESVG	2.54
246843	05SMG1	1.64
246844	05SMG2	4.31
246845	05SMG3	2.53
246846	05SMG4	4.46
246847	05SMG5	1.69
315156	1HALLBR1	4.56
315165	1HURT 1	3.16
315166	1HURT 2	3.16
932821	AC2-107 C	27.86
932822	AC2-107 E	13.05
933941	AD1-017 C	0.73
933942	AD1-017 E	1.19
934311	AD1-055 C	6.5
934312	AD1-055 E	1.68
936331	AD2-043 C	12.27
936332	AD2-043 E	14.52
LTF	AMIL	0.02
LTF	BLUEG	0.16
LTF	CANNELTON	0.02
LTF	CARR	0.04
LTF	CBM-S1	< 0.01
LTF	CBM-S2	1.05
LTF	CLIFTY	0.81
LTF	CPL	0.4
LTF	DEARBORN	0.09

LTF	EDWARDS	0.04
LTF	ELMERSMITH	0.06
LTF	FARMERCITY	0.02
LTF	G-007	0.09
LTF	GIBSON	0.05
LTF	NEWTON	0.09
LTF	O-066	0.59
LTF	PRAIRIE	0.11
LTF	RENSSELAER	0.03
LTF	ROSETON	0.21
LTF	SMITHLAND	< 0.01
LTF	TATANKA	0.04
LTF	TILTON	0.05
LTF	TRIMBLE	0.03
919841	AA2-070	4.41
924572	AB2-109 E	-0.65
925661	AC1-042 C	6.79
925662	AC1-042 E	11.08
925991	AC1-075 C	15.67
925992	AC1-075 E	8.88
926021	AC1-080 C	5.24
926022	AC1-080 E	2.95
926051	AC1-083 C	3.64
926052	AC1-083 E	5.95
926641	AC1-145 C	8.09
926642	AC1-145 E	13.19
927261	AC1-222 C	9.37
927262	AC1-222 E	8.92

## Appendix 8

(AEP - AEP) The 05OTTER-05JOHNMT 138 kV line (from bus 242741 to bus 242687 ckt 1) loads from 110.15% to 121.08% (**DC power flow**) of its emergency rating (245 MVA) for the line fault with failed breaker contingency outage of 'DVP\_P4-2: 3312'. This project contributes approximately 26.79 MW to the thermal violation.

CONTINGENCY 'DVP\_P4-2: 3312'

OPEN BUS 314267

OPEN BUS 314669

OPEN BUS 314684

OPEN BUS 314696

OPEN BUS 314518

END

/\* CHASE CITY

/\*CHASE CITY 115KV BUS 3

/\*LINE 33 BARNS J

/\*LINE 33 MT LAUREL

/\*LINE 33 HALIFAX

/\*SC312

Bus Number	Bus Name	Full Contribution
247284	05LEESVG	2.54
246843	05SMG1	1.64
246844	05SMG2	4.31
246845	05SMG3	2.53
246846	05SMG4	4.46
246847	05SMG5	1.69
315156	1HALLBR1	4.56
315165	1HURT 1	3.16
315166	1HURT 2	3.16
932821	AC2-107 C	27.86
932822	AC2-107 E	13.05
933941	AD1-017 C	0.73
933942	AD1-017 E	1.19
934311	AD1-055 C	6.5
934312	AD1-055 E	1.68
936331	AD2-043 C	12.27
936332	AD2-043 E	14.52
LTF	AMIL	0.02
LTF	BLUEG	0.16
LTF	CANNELTON	0.02
LTF	CARR	0.04
LTF	CBM-S1	< 0.01
LTF	CBM-S2	1.05
LTF	CLIFTY	0.81
LTF	CPL	0.4
LTF	DEARBORN	0.09

LTF	EDWARDS	0.04
LTF	ELMERSMITH	0.06
LTF	FARMERCITY	0.02
LTF	G-007	0.09
LTF	GIBSON	0.05
LTF	NEWTON	0.09
LTF	O-066	0.59
LTF	PRAIRIE	0.11
LTF	RENSSELAER	0.03
LTF	ROSETON	0.21
LTF	SMITHLAND	< 0.01
LTF	TATANKA	0.04
LTF	TILTON	0.05
LTF	TRIMBLE	0.03
919841	AA2-070	4.41
924572	AB2-109 E	-0.65
925661	AC1-042 C	6.79
925662	AC1-042 E	11.08
925991	AC1-075 C	15.67
925992	AC1-075 E	8.88
926021	AC1-080 C	5.24
926022	AC1-080 E	2.95
926051	AC1-083 C	3.64
926052	AC1-083 E	5.95
926641	AC1-145 C	8.09
926642	AC1-145 E	13.19
927261	AC1-222 C	9.37
927262	AC1-222 E	8.92