Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD2-008

Hopewell – Surry 230kV 16.4 MW Capacity / 52.1 MW Energy

August / 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 Spring Grove, VA (Surry County). The installed facilities will have a total capability of 150 MW with 71.2 MW of this output being recognized by PJM as capacity. This queue request is for an additional 16.4 MW and 54.8 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is 11/01/2019. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AD2-008 will interconnect with the ITO transmission system Hopewell – Surry 230kV line #212.

Note: As Queue AC1-216 is no longer owned by the same Interconnection Customer, PJM requires evidence of ownership for site control for this AD2-008 queue is still with this IC. FERC Order 807 allows multiple projects to interconnect behind a Point of Interconnection. A shared facilities agreement is required if jointly owned common Attachment Facilities are proposed. PJM will require at the time of submittal of the System Impact Study Agreement Queue AD2-007 (the IC) to acknowledge this requirement along with the owner of such common Attachment Facilities/all parties sharing such common Attachment Facilities.

Cost Summary

The AD2-008 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
Total Costs	**$0**

In addition, the AD2-008 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$0
Previously Identified Upgrades	$77,850,000
Total Costs	**$77,850,000**

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.

Attachment Facilities

The existing AC1-216 scope of work is sufficient to accommodate this queue request from an Attachment Facilities and substation expansion perspective. The single line is shown below in Attachment 1. These costs do not include CIAC Tax Gross-up.

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.

System Reinforcement

Violation #	Upgrade Description	Upgrade Cost
# 1	Replace the Elmont 500/230 kV transformer #1 increase its line rating to 1134 MVA (normal), 1203 MVA (emergency), and 1365 MVA (load dump). It is estimated to take 24-30 months to engineer and construct.	$17,500,000
# 2	Add a second Prince George 230/115 kV transformer to increase its rating to 276.8 MVA (normal), 292.4 MVA (emergency), and 328.7 MVA (load dump). Estimated to take 24-30 months to engineer and construct.	$5,500,000
# 3, 4	Wreck and rebuild the Hopewell – Bermuda – Chesterfield 230 kV line #228 of 11 miles increase its line rating to 722 MVA (normal), 722 MVA (emergency), and 830 MVA (load dump). It is estimated to take 44-48 months to engineer, permit, and construct. A VA CPCN is required.	$27,425,000
# 5, 6	Wreck and rebuild the Hopewell – Chesterfield 230 kV line #211 of 11 miles to increase its line rating to 722 MVA (normal), 722 MVA (emergency), and 830 MVA (load dump). It is estimated to take 44-48 months to engineer, permit, and construct. A VA CPCN is required.	$27,500,000
	Total Network Upgrades	**$77,850,000**

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

An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

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

Network Impacts

The Queue Project AD2-008 was evaluated as a 52.1 MW (Capacity 16.4 MW) uprate to AC1-216 which is modeled as an injection tapping the Hopewell to Surry 230kV line #212 in the ITO area. Project AD2-008 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-008 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
DVP_P1-2: LN 211	CONTINGENCY 'DVP_P1-2: LN 211' OPEN BRANCH FROM BUS 314287 TO BUS 314303 CKT 1 /* 6CHSTF B 230.00 - 6HOPEWLL 230.00 END
DVP_P1-2: LN 228	CONTINGENCY 'DVP_P1-2: LN 228' OPEN BRANCH FROM BUS 314278 TO BUS 314286 CKT 1 /* 6BERMUDA 230.00 - 6CHSTF A 230.00 OPEN BRANCH FROM BUS 314278 TO BUS 314303 CKT 1 /* 6BERMUDA 230.00 - 6HOPEWLL 230.00 OPEN BUS 314278 /* ISLAND END
DVP_P1-2: LN 563	CONTINGENCY 'DVP_P1-2: LN 563' OPEN BRANCH FROM BUS 314902 TO BUS 314914 CKT 1 /* 8CARSON 500.00 - 8MDLTHAN 500.00 END

Contingency Name	Description
DVP_P4-2: 211T2124	CONTINGENCY 'DVP_P4-2: 211T2124' /*_ HOPEWELL OPEN BRANCH FROM BUS 314303 TO BUS 314287 CKT 1 /*L211 HOPEWELL CHESTERFIELD OPEN BRANCH FROM BUS 314303 TO BUS 314269 CKT 1 /*L2124 END
DVP_P4-2: G5T228	CONTINGENCY 'DVP_P4-2: G5T228' /*_ CHESTERFIELD OPEN BRANCH FROM BUS 314286 TO BUS 314278 CKT 1 /*L228 CHESTERFIELD BERMUDA OPEN BRANCH FROM BUS 314278 TO BUS 314303 CKT 1 /*L228 BERMUDA HOPEWELL REMOVE MACHINE 5 FROM BUS 315060 /*CHESTERFIELD GEN G5 END
DVP_P4-2: H2T557	CONTINGENCY 'DVP_P4-2: H2T557' /* ELMONT OPEN BRANCH FROM BUS 314908 TO BUS 314903 CKT 1 /*ELMONT TO CHICKAHOMINY (LINE 557) OPEN BRANCH FROM BUS 314903 TO BUS 314214 CKT 1 /*CHICKAHOMINY 500-230 (TX#1) OPEN BRANCH FROM BUS 314908 TO BUS 314218 CKT 2 /*ELMONT 500-230 (TX#2) END
DVP_P7-1: LN 211-228	CONTINGENCY 'DVP_P7-1: LN 211-228' OPEN BRANCH FROM BUS 314287 TO BUS 314303 CKT 1 /* 6CHSTF B 230.00 - 6HOPEWLL 230.00 OPEN BRANCH FROM BUS 314278 TO BUS 314286 CKT 1 /* 6BERMUDA 230.00 - 6CHSTF A 230.00 OPEN BRANCH FROM BUS 314278 TO BUS 314303 CKT 1 /* 6BERMUDA 230.00 - 6HOPEWLL 230.00 OPEN BUS 314278 /* ISLAND END

Summer Peak Analysis - 2021

Generator Deliverability

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

None

Multiple Facility Contingency

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

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		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Cir.	Flow	Initial	Final	Type	MVA	Contribution	Ref
1	LFFB	DVP_P4-2: H2T557	DVP – DVP	8ELMONT 500/230 kV transformer	314218	314908	1	DC	146.16	146.57	LDR	1051	11.51	1

#	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	DCTL	DVP_P7-1: LN 211-228	DVP – DVP	6PRGEORG 230/115 kV transformer	314269	314291	1	DC	140.03	144.73	LDR	220	10.32	2
3	LFFB	DVP_P4-2: 211T2124	DVP – DVP	6BERMUDA-6CHESTF A 230 kV line	314278	314286	1	DC	119.95	124.01	LDR	549	22.22	3
4	LFFB	DVP_P4-2: 211T2124	DVP – DVP	6HOPEWLL-6BERMUDA 230 kV line	314303	314278	1	DC	119.95	124.01	LDR	549	22.22	4
5	LFFB	DVP_P4-2: G5T228	DVP – DVP	6HOPEWLL-6CHESTF B 230 kV line	314303	314287	1	DC	115.46	119.01	LDR	541	20.08	5

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)

None

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
# 1	8ELMONT 500/230 kV transformer	Replace the Elmont 500/230 kV transformer #1 increase its line rating to 1134 MVA (normal), 1203 MVA (emergency), and 1365 MVA (load dump). It is estimated to take 24-30 months to engineer and construct.	Pending	**$17,500,000**
# 2	6PRGEORG 230/115 kV transformer	Add a second Prince George 230/115 kV transformer to increase its rating to 276.8 MVA (normal), 292.4 MVA (emergency), and 328.7 MVA (load dump). Estimated to take 24-30 months to engineer and construct.	Pending	**$5,500,000**
# 3	6BERMUDA-6CHESTF A 230 kV line	Wreck and rebuild the Hopewell – Bermuda – Chesterfield 230 kV line #228 of 11 miles increase its line rating to 722 MVA (normal), 722 MVA (emergency), and 830 MVA (load dump). It is estimated to take 44-48 months to engineer, permit, and construct. A VA CPCN is required.	Pending	**$27,425,000**
# 4	6HOPEWLL-6BERMUDA 230 kV line			
# 5	6HOPEWLL-6CHESTF B 230 kV line	Wreck and rebuild the Hopewell – Chesterfield 230 kV line #211 of 11 miles to increase its line rating to 722 MVA (normal), 722 MVA (emergency), and 830 MVA (load dump). It is estimated to take 44-48 months to engineer, permit, and construct. A VA CPCN is required	Pending	**$27,425,000**
# 6	6HOPEWLL-6CHESTF B 230 kV line			
			Total New Network Upgrades	**$77,850,000**

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 Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution
7	N-1	DVP_P1-2: LN 211	DVP – DVP	6BERMUDA-6CHESTF A 230 kV line	314278	314286	1	DC	129.54	133.85	ER	449	19.33
8	N-1	DVP_P1-2: LN 563	DVP – DVP	6CHESTF B-6BASIN 230 kV line	314287	314276	1	DC	165.29	165.81	ER	449	5.09
9	N-1	DVP_P1-2: LN 211	DVP – DVP	6HOPEWLL-6BERMUDA 230 kV line	314303	314278	1	DC	129.54	133.85	ER	449	19.33
10	N-1	DVP_P1-2: LN 228	DVP – DVP	6HOPEWLL-6CHESTF B 230 kV line	314303	314287	1	DC	140.51	144.85	ER	442	20.08

Light Load Analysis

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

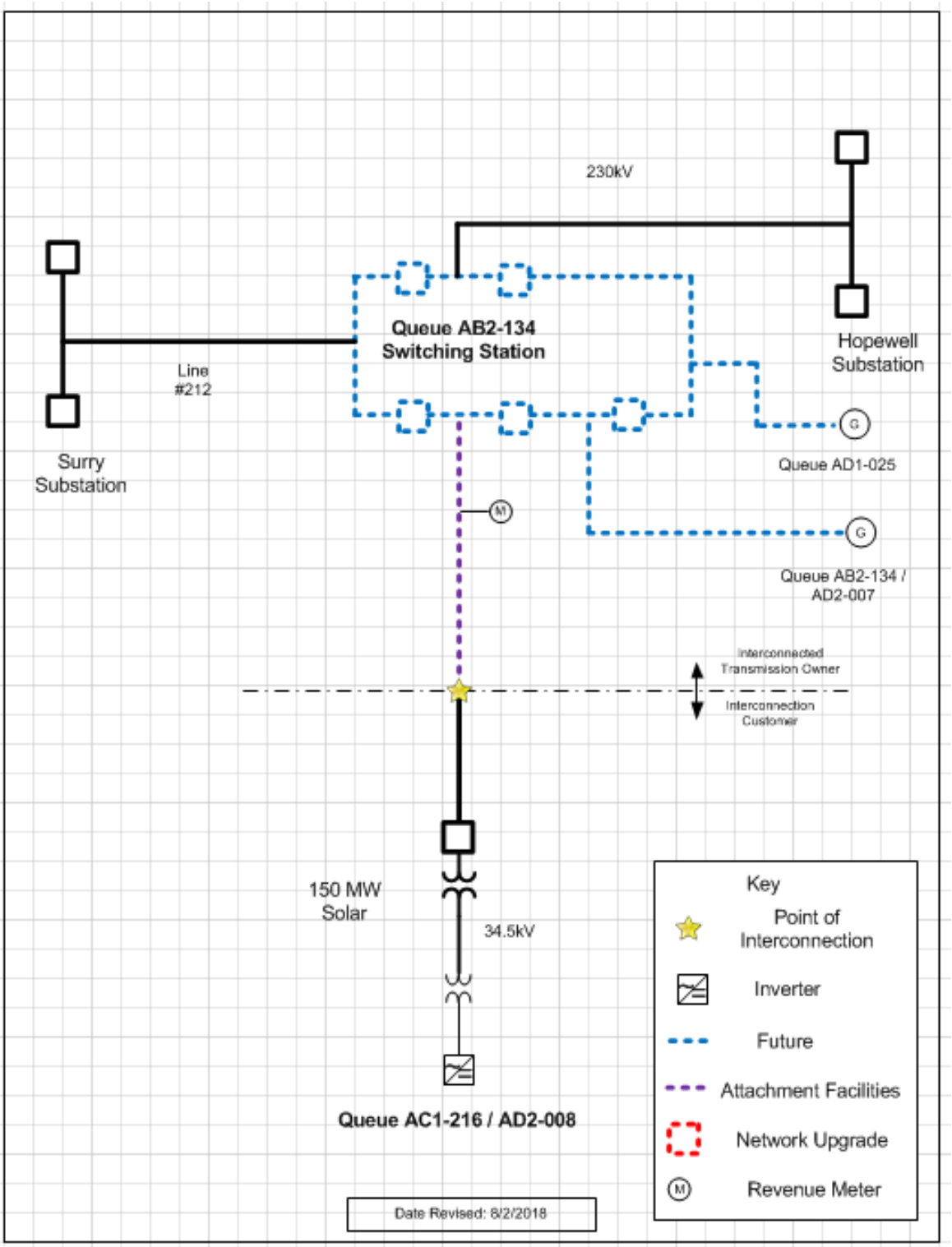
Affected System Analysis & Mitigation

Duke, Progress & TVA Impacts:

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

Attachment 1.

System Configuration



Attachment 2.

Flowgate Appendices

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact. 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 - DVP) The 8ELMONT 500/230 kV transformer (from bus 314218 to bus 314908 ckt 1) loads from 146.16% to 146.57% (**DC power flow**) of its load dump rating (1051 MVA) for the line fault with failed breaker contingency outage of 'DVP_P4-2: H2T557'. This project contributes approximately 11.51 MW to the thermal violation.

CONTINGENCY 'DVP_P4-2: H2T557' /* ELMONT
OPEN BRANCH FROM BUS 314908 TO BUS 314903 CKT 1 /*ELMONT TO CHICKAHOMINY (LINE 557)
OPEN BRANCH FROM BUS 314903 TO BUS 314214 CKT 1 /*CHICKAHOMINY 500-230 (TX#1)
OPEN BRANCH FROM BUS 314908 TO BUS 314218 CKT 2 /*ELMONT 500-230 (TX#2)
END

Bus Number	Bus Name	Full Contribution
315067	1DARBY 1	5.
315068	1DARBY 2	5.01
315069	1DARBY 3	5.02
315070	1DARBY 4	5.03
315043	1FOUR RIVERA	6.65
315044	1FOUR RIVERB	5.14
315045	1FOUR RIVERC	6.65
315046	1FOUR RIVERD	5.14
315047	1FOUR RIVERE	5.14
315048	1FOUR RIVERF	6.65
315074	1HOPCGN1	11.28
315075	1HOPCGN2	11.14
315083	1SPRUNCA	14.95
315084	1SPRUNCB	14.95
315085	1SPRUNCC	11.08
315086	1SPRUNCD	11.08
315073	1STONECA	9.36
315090	1YORKTN1	30.92
315091	1YORKTN2	32.09
314566	3CRESWEL	2.11
314572	3EMPORIA	0.36
314315	3LOCKS E	1.65
314617	3TUNIS	0.71
314539	3UNCAMP	2.19
314541	3WATKINS	0.61
314620	6CASHIE	0.72
314229	6MT RD221	1.41

314236	6NRTHEST	0.37
314189	6PAPERMILL	8.82
314594	6PLYMOTH	0.73
314250	6ROCKVILLE	0.4
314256	6ROCKVILLE E	1.15
314648	6SUNBURY	0.81
314651	6WINFALL	1.59
932041	AC2-012 C	9.62
932042	AC2-012 E	15.69
932501	AC2-070 C	2.9
932502	AC2-070 E	1.2
932531	AC2-073 C	3.1
932532	AC2-073 E	1.56
932581	AC2-078 C	4.75
932582	AC2-078 E	7.75
932591	AC2-079 C	5.79
932592	AC2-079 E	9.45
932831	AC2-110 C	1.74
932832	AC2-110 E	2.84
933061	AC2-130	3.48
933071	AC2-131 1	2.36
933081	AC2-131 2	1.07
933111	AC2-132 1	1.24
933121	AC2-132 2	0.63
933261	AC2-137 C	3.16
933262	AC2-137 E	2.02
933271	AC2-138 C	0.87
933272	AC2-138 E	1.09
933291	AC2-141 C	27.15
933292	AC2-141 E	11.59
933471	AC2-161 C	2.47
933472	AC2-161 E	1.27
933481	AC2-162 C	4.17
933482	AC2-162 E	2.15
933731	AC2-196 C	1.66
933732	AC2-196 E	1.1
933991	AD1-023 C	11.28
933992	AD1-023 E	6.14
934011	AD1-025 C O1	20.82
934012	AD1-025 E O1	12.33
934061	AD1-033 C O1	6.96
934062	AD1-033 E O1	4.64
934141	AD1-041 C O1	6.74
934142	AD1-041 E O1	4.49
934191	AD1-046 C	4.71

934192	AD1-046 E	3.14
934201	AD1-047 C	6.75
934202	AD1-047 E	4.5
934211	AD1-048 C	3.82
934212	AD1-048 E	1.93
934391	AD1-063 C	2.1
934392	AD1-063 E	1.4
934521	AD1-076 C O1	46.87
934522	AD1-076 E O1	23.87
934571	AD1-082 C O1	8.27
934572	AD1-082 E O1	4.72
934781	AD1-105 C	8.08
934782	AD1-105 E	5.62
LTF	AD1-120	5.92
LTF	AD1-121	5.88
935111	AD1-144 C	1.68
935112	AD1-144 E	0.92
935161	AD1-151 C O1	19.89
935162	AD1-151 E O1	13.26
935211	AD1-156 C	2.56
935212	AD1-156 E	1.71
936041	AD2-007	2.21
936051	AD2-008 C	3.62
936052	AD2-008 E	7.89
936151	AD2-021	0.36
936241	AD2-030 C	2.88
936242	AD2-030 E	1.47
936301	AD2-039 C	1.74
936302	AD2-039 E	2.84
936341	AD2-044 C	0.27
936342	AD2-044 E	0.31
936391	AD2-049 C	1.88
936392	AD2-049 E	1.88
936401	AD2-051 C O1	7.33
936402	AD2-051 E O1	3.15
936581	AD2-073 C	2.24
936582	AD2-073 E	1.11
936591	AD2-074 C	6.53
936592	AD2-074 E	10.65
936661	AD2-085 C	3.5
936662	AD2-085 E	5.71
936711	AD2-090 C O1	6.37
936712	AD2-090 E O1	4.25
LTF	AD2-099	4.53
937221	AD2-160 C O1	5.41

937222	AD2-160 E O1	2.83
937251	AD2-164	5.14
937441	AD2-195 C	7.75
937442	AD2-195 E	3.34
937541	AD2-215 C	1.7
937542	AD2-215 E	0.9
LTF	CARR	0.67
LTF	CBM-S1	3.85
LTF	CBM-S2	13.83
LTF	CBM-W1	0.23
LTF	CBM-W2	18.
LTF	CIN	0.12
LTF	CLIFTY	1.63
LTF	CPLE	4.75
LTF	DEARBORN	0.47
LTF	G-007	2.31
LTF	IPL	0.06
LTF	LGEE	0.04
LTF	MEC	1.98
LTF	O-066	7.74
LTF	RENSSELAER	0.53
LTF	ROSETON	3.83
292791	U1-032 E	4.87
297087	V2-040	0.28
900672	V4-068 E	0.26
901082	W1-029E	41.81
LTF	WEC	0.06
907092	X1-038 E	5.47
913392	Y1-086 E	1.99
916042	Z1-036 E	40.84
916192	Z1-068 E	1.76
917122	Z2-027 E	0.96
918492	AA1-063AE OP	3.35
918512	AA1-065 E OP	3.74
918691	AA1-083	1.17
919152	AA1-139 E	5.92
919211	AA1-145	19.85
919692	AA2-053 E	3.06
LTF	AA2-074	3.23
920042	AA2-088 E	9.15
920672	AA2-174 E	0.35
920691	AA2-178 C	8.42
920692	AA2-178 E	3.61
930051	AB1-013 C	2.54
930052	AB1-013 E	17.01

930121	AB1-027 C	0.87
930122	AB1-027 E	1.89
930861	AB1-132 C	11.77
930862	AB1-132 E	5.05
931231	AB1-173 C	1.9
931232	AB1-173 E	0.89
931241	AB1-173AC	1.9
931242	AB1-173AE	0.89
923801	AB2-015 C O1	7.73
923802	AB2-015 E O1	6.34
923831	AB2-022 C	2.1
923832	AB2-022 E	1.13
923842	AB2-024 E	1.49
923852	AB2-025 E	1.09
923862	AB2-026 E	0.88
923911	AB2-031 C O1	1.88
923912	AB2-031 E O1	0.93
923991	AB2-040 C O1	6.18
923992	AB2-040 E O1	5.06
924061	AB2-050	1.17
924071	AB2-051	128.84
924241	AB2-068 O1	177.92
924501	AB2-099 C	0.49
924502	AB2-099 E	0.21
924511	AB2-100 C	10.48
924512	AB2-100 E	5.16
924811	AB2-134 C O1	15.87
924812	AB2-134 E O1	15.07
925051	AB2-160 C O1	7.18
925052	AB2-160 E O1	11.71
925061	AB2-161 C O1	3.63
925062	AB2-161 E O1	5.92
925171	AB2-174 C O1	5.96
925172	AB2-174 E O1	5.39
925281	AB2-186 C	0.55
925282	AB2-186 E	0.24
925291	AB2-188 C O1	2.08
925292	AB2-188 E O1	0.93
925331	AB2-190 C	24.75
925332	AB2-190 E	10.61
925522	AC1-027 E	1.07
925692	AC1-045 E	0.92
925861	AC1-065 C	4.36
925862	AC1-065 E	7.11
926071	AC1-086 C	17.34

926072	AC1-086 E	7.89
926291	AC1-107	268.56
926411	AC1-112 C	0.68
926412	AC1-112 E	1.93
926472	AC1-118 E	1.07
926551	AC1-134	14.83
926662	AC1-147 E	1.25
926741	AC1-159	62.12
926751	AC1-161 C	27.15
926752	AC1-161 E	11.59
926771	AC1-163 C	1.63
926772	AC1-163 E	0.76
926781	AC1-164 C	58.41
926782	AC1-164 E	26.24
927041	AC1-191 C	17.46
927042	AC1-191 E	8.7
927221	AC1-216 C O1	12.11
927222	AC1-216 E O1	9.53

Appendix 2

(DVP - DVP) The 6PRGEORG 230/115 kV transformer (from bus 314269 to bus 314291 ckt 1) loads from 140.03% to 144.73% (**DC power flow**) of its load dump rating (220 MVA) for the tower line contingency outage of 'DVP_P7-1: LN 211-228'. This project contributes approximately 10.32 MW to the thermal violation.

CONTINGENCY 'DVP_P7-1: LN 211-228'
OPEN BRANCH FROM BUS 314287 TO BUS 314303 CKT 1 /* 6CHSTF B 230.00 - 6HOPEWLL 230.00
OPEN BRANCH FROM BUS 314278 TO BUS 314286 CKT 1 /* 6BERMUDA 230.00 - 6CHSTF A 230.00
OPEN BRANCH FROM BUS 314278 TO BUS 314303 CKT 1 /* 6BERMUDA 230.00 - 6HOPEWLL 230.00
OPEN BUS 314278 /* ISLAND
END

Bus Number	Bus Name	Full Contribution
315120	1GRAVEL4	1.97
315121	1GRAVEL5	1.94
315122	1GRAVEL6	1.97
315074	1HOPCGN1	13.02
315075	1HOPCGN2	12.85
315077	1HOPHCF1	4.13
315078	1HOPHCF2	4.13
315079	1HOPHCF3	4.13
315080	1HOPHCF4	6.26
315076	1HOPPOLC	2.94
315073	1STONECA	10.8
315116	1SURRY 1	19.48
933471	AC2-161 C	1.13
933472	AC2-161 E	0.58
934011	AD1-025 C O1	18.66
934012	AD1-025 E O1	11.06
935161	AD1-151 C O1	17.83
935162	AD1-151 E O1	11.89
936041	AD2-007	1.98
936051	AD2-008 C	3.25
936052	AD2-008 E	7.07
LTF	AMIL	0.03
LTF	BAYOU	0.08
LTF	BIG_CAJUN1	0.11

LTF	BIG_CAJUN2	0.23
LTF	BLUEG	0.19
LTF	CALDERWOOD	0.03
LTF	CANNELTON	0.03
LTF	CARR	0.06
LTF	CATAWBA	< 0.01
LTF	CBM-S2	0.02
LTF	CELEVELAND	0.01
LTF	CHEOAH	0.03
LTF	CHILHOWEE	0.01
LTF	CHOCTAW	0.07
LTF	CLIFTY	0.83
LTF	COTTONWOOD	0.3
LTF	CPLE	0.04
LTF	DEARBORN	0.11
LTF	EDWARDS	0.06
LTF	ELMERSMITH	0.09
LTF	FARMERCITY	0.03
LTF	G-007	0.19
LTF	GIBSON	0.06
LTF	MORGAN	0.12
LTF	NEWTON	0.14
LTF	O-066	0.62
LTF	PRAIRIE	0.25
LTF	RENSSELAER	0.05
LTF	ROSETON	0.34
LTF	ROWAN	< 0.01
LTF	SANTEETLA	< 0.01
LTF	SMITHLAND	0.02
LTF	TATANKA	0.06
LTF	TILTON	0.07
LTF	TRIMBLE	0.04
LTF	TVA	0.06
292791	U1-032 E	5.62
LTF	UNIONPOWER	0.03
914231	Y2-077	1.66
924811	AB2-134 C O1	14.23
924812	AB2-134 E O1	13.51
925331	AB2-190 C	22.19
925332	AB2-190 E	9.51
927221	AC1-216 C O1	10.86
927222	AC1-216 E O1	8.54

Appendix 3

(DVP - DVP) The 6BERMUDA-6CHESTF A 230 kV line (from bus 314278 to bus 314286 ckt 1) loads from 119.95% to 124.01% (**DC power flow**) of its load dump rating (549 MVA) for the line fault with failed breaker contingency outage of 'DVP_P4-2: 211T2124'. This project contributes approximately 22.22 MW to the thermal violation.

CONTINGENCY 'DVP_P4-2: 211T2124' /*_ HOPEWELL
OPEN BRANCH FROM BUS 314303 TO BUS 314287 CKT 1 /*L211 HOPEWELL CHESTERFIELD
OPEN BRANCH FROM BUS 314303 TO BUS 314269 CKT 1 /*L2124
END

Bus Number	Bus Name	Full Contribution
315120	1GRAVEL4	4.3
315121	1GRAVEL5	4.24
315122	1GRAVEL6	4.29
315074	1HOPCGN1	27.86
315075	1HOPCGN2	27.5
315077	1HOPHCF1	8.84
315078	1HOPHCF2	8.84
315079	1HOPHCF3	8.84
315080	1HOPHCF4	13.41
315076	1HOPPOLC	6.29
315073	1STONECA	23.11
315116	1SURRY 1	42.54
932041	AC2-012 C	5.33
932042	AC2-012 E	8.69
933471	AC2-161 C	2.52
933472	AC2-161 E	1.3
934011	AD1-025 C O1	40.18
934012	AD1-025 E O1	23.8
935111	AD1-144 C	0.97
935112	AD1-144 E	0.53
935161	AD1-151 C O1	38.39
935162	AD1-151 E O1	25.59
936041	AD2-007	4.27
936051	AD2-008 C	6.99
936052	AD2-008 E	15.23
936391	AD2-049 C	0.94
936392	AD2-049 E	0.94
937541	AD2-215 C	0.98

937542	AD2-215 E	0.52
LTF	CARR	0.16
LTF	CBM-S1	0.99
LTF	CBM-S2	3.05
LTF	CBM-W1	0.63
LTF	CBM-W2	4.82
LTF	CIN	0.16
LTF	CPLE	1.04
LTF	DEARBORN	0.06
LTF	G-007	0.61
LTF	IPL	0.1
LTF	LGEE	0.04
LTF	MEC	0.67
LTF	O-066	2.05
LTF	RENSSELAER	0.13
LTF	ROSETON	0.92
292791	U1-032 E	12.03
LTF	WEC	0.05
914231	Y2-077	3.55
924811	AB2-134 C O1	30.62
924812	AB2-134 E O1	29.09
925331	AB2-190 C	47.77
925332	AB2-190 E	20.47
925692	AC1-045 E	0.53
926662	AC1-147 E	0.69
927221	AC1-216 C O1	23.37
927222	AC1-216 E O1	18.38

Appendix 4

(DVP - DVP) The 6HOPEWLL-6BERMUDA 230 kV line (from bus 314303 to bus 314278 ckt 1) loads from 119.95% to 124.01% (**DC power flow**) of its load dump rating (549 MVA) for the line fault with failed breaker contingency outage of 'DVP_P4-2: 211T2124'. This project contributes approximately 22.22 MW to the thermal violation.

CONTINGENCY 'DVP_P4-2: 211T2124' /*_ HOPEWELL
OPEN BRANCH FROM BUS 314303 TO BUS 314287 CKT 1 /*L211 HOPEWELL CHESTERFIELD
OPEN BRANCH FROM BUS 314303 TO BUS 314269 CKT 1 /*L2124
END

Bus Number	Bus Name	Full Contribution
315120	1GRAVEL4	4.3
315121	1GRAVEL5	4.24
315122	1GRAVEL6	4.29
315074	1HOPCGN1	27.86
315075	1HOPCGN2	27.5
315077	1HOPHCF1	8.84
315078	1HOPHCF2	8.84
315079	1HOPHCF3	8.84
315080	1HOPHCF4	13.41
315076	1HOPPOLC	6.29
315073	1STONECA	23.11
315116	1SURRY 1	42.54
932041	AC2-012 C	5.33
932042	AC2-012 E	8.69
933471	AC2-161 C	2.52
933472	AC2-161 E	1.3
934011	AD1-025 C O1	40.18
934012	AD1-025 E O1	23.8
935111	AD1-144 C	0.97
935112	AD1-144 E	0.53
935161	AD1-151 C O1	38.39
935162	AD1-151 E O1	25.59
936041	AD2-007	4.27
936051	AD2-008 C	6.99
936052	AD2-008 E	15.23
936391	AD2-049 C	0.94
936392	AD2-049 E	0.94
937541	AD2-215 C	0.98

937542	AD2-215 E	0.52
LTF	CARR	0.16
LTF	CBM-S1	0.99
LTF	CBM-S2	3.05
LTF	CBM-W1	0.63
LTF	CBM-W2	4.82
LTF	CIN	0.16
LTF	CPLE	1.04
LTF	DEARBORN	0.06
LTF	G-007	0.61
LTF	IPL	0.1
LTF	LGEE	0.04
LTF	MEC	0.67
LTF	O-066	2.05
LTF	RENSSELAER	0.13
LTF	ROSETON	0.92
292791	U1-032 E	12.03
LTF	WEC	0.05
914231	Y2-077	3.55
924811	AB2-134 C O1	30.62
924812	AB2-134 E O1	29.09
925331	AB2-190 C	47.77
925332	AB2-190 E	20.47
925692	AC1-045 E	0.53
926662	AC1-147 E	0.69
927221	AC1-216 C O1	23.37
927222	AC1-216 E O1	18.38

Appendix 5

(DVP - DVP) The 6HOPEWLL-6CHESTF B 230 kV line (from bus 314303 to bus 314287 ckt 1) loads from 115.46% to 119.01% (**DC power flow**) of its load dump rating (541 MVA) for the line fault with failed breaker contingency outage of 'DVP_P4-2: G5T228'. This project contributes approximately 20.08 MW to the thermal violation.

CONTINGENCY 'DVP_P4-2: G5T228' /*_ CHESTERFIELD
OPEN BRANCH FROM BUS 314286 TO BUS 314278 CKT 1 /*L228 CHESTERFIELD BERMUDA
OPEN BRANCH FROM BUS 314278 TO BUS 314303 CKT 1 /*L228 BERMUDA HOPEWELL
REMOVE MACHINE 5 FROM BUS 315060 /*CHESTERFIELD GEN G5
END

Bus Number	Bus Name	Full Contribution
315120	1GRAVEL4	3.96
315121	1GRAVEL5	3.91
315122	1GRAVEL6	3.95
315074	1HOPCGN1	24.99
315075	1HOPCGN2	24.67
315077	1HOPHCF1	7.93
315078	1HOPHCF2	7.93
315079	1HOPHCF3	7.93
315080	1HOPHCF4	12.03
315076	1HOPPOLC	5.64
315073	1STONECA	20.73
315116	1SURRY 1	39.13
932041	AC2-012 C	5.08
932042	AC2-012 E	8.29
933471	AC2-161 C	2.34
933472	AC2-161 E	1.2
934011	AD1-025 C O1	36.31
934012	AD1-025 E O1	21.51
935111	AD1-144 C	0.94
935112	AD1-144 E	0.51
935161	AD1-151 C O1	34.69
935162	AD1-151 E O1	23.13
936041	AD2-007	3.85
936051	AD2-008 C	6.32
936052	AD2-008 E	13.76

936391	AD2-049 C	0.96
936392	AD2-049 E	0.96
937541	AD2-215 C	0.95
937542	AD2-215 E	0.5
LTF	CARR	0.14
LTF	CBM-S1	0.61
LTF	CBM-S2	2.19
LTF	CBM-W2	2.79
LTF	CIN	< 0.01
LTF	CLIFTY	0.3
LTF	CPLE	0.76
LTF	DEARBORN	0.09
LTF	G-007	0.52
LTF	LGEE	< 0.01
LTF	MEC	0.29
LTF	O-066	1.73
LTF	RENSSELAER	0.11
LTF	ROSETON	0.8
LTF	TRIMBLE	< 0.01
292791	U1-032 E	10.79
LTF	WEC	< 0.01
914231	Y2-077	3.19
924071	AB2-051	66.52
924811	AB2-134 C O1	27.68
924812	AB2-134 E O1	26.29
925331	AB2-190 C	43.17
925332	AB2-190 E	18.5
925692	AC1-045 E	0.51
926662	AC1-147 E	0.66
926741	AC1-159	32.07
927221	AC1-216 C O1	21.12
927222	AC1-216 E O1	16.61