Generation Interconnection
System Impact Study Report

For

PJM Generation Interconnection Request
Queue Position AD1-033

Fentress-Landstown 230kV
42 MW Capacity / 70 MW Energy

March 2019

Introduction

This System Impact 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), Bedford Solar Center, LLC, 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 The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the IC. As a requirement for interconnection, the IC may be responsible for the cost of constructing Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an IC may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, 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 System Impact Study is performed.

The System Impact 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 Transmission Owners, the costs may be included in the study.

General

The IC has proposed a solar generating facility located in City of Chesapeake County, Virginia. The installed facilities will have a total capability of 70 MW with 42 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

AD1-033 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects the Fentress – Landstown 230kV line.

Cost Summary

The AD1-033 interconnection request will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 1,800,000
Direct Connection Network Upgrades	$ 6,300,000
Non Direct Connection Network Upgrades	$ 1,000,000
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 817,760
Total Costs	**$ 9,917,760**

System Reinforcements

Network Upgrade Number	Violation #	Ruling Violation #	Loading	Upgrade Description	$817, 760	Allocated Cost
Pending	# 1, #2	# 1	From 99.91% to 100.54%	Replace the wave trap in the Chickahominy substation to increase the Chickahominy – Elmont 500kV line #557 rating to 3424 MVA (normal), 3424 MVA (emergency), and 3937 MVA (load dump). It is estimated to take 12-16 months to engineer and construct.	$500,000	$0
Pending	# 3	# 3	From 105.75% to 106.25 %	Replace the 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 cost $17,500,000 and 24-30 months to engineer and construct.	$17,500,000	$817, 760
				Total Estimated Allocated Cost of Network Upgrades		**$817,760**

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 the new AD1-033 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.

Direct Connection Cost Estimate

Substation: Establish the new 230 kV AD1-033 Switching Substation (interconnection substation). The arrangement in the substation will be as shown in Attachment 1. The estimated cost of this work scope is $6,300,000.

Non-Direct Connection Cost Estimate

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 and it 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.

Incremental Capacity Transfer Rights

The network upgrades outlined in this report do not increase the CETL in the 2021/22 BRA case.

Interconnection Customer Requirements

ITO's Facility Interconnection 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.

Meteorological Data Reporting Requirement - The solar generation facility shall, at a minimum, be required to provide the Transmission Provider with site-specific meteorological data including:

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

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

Interconnected Transmission Owner Requirements

Metering and SCADA/Communication equipment must meet the requirements outlined in section 3.1.6 Metering and Telecommunications of ITO's Facility Connection Requirement NERC Standard FAC-001 which is publically available at www.dom.com.

Network Impacts

The Queue Project AD1-033 was evaluated as a 70.0 MW (Capacity 42.0 MW) injection tapping into Fentress-Landstown 230kV in the ITO area. Project AD1-033 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-033 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
DVP_P1-2: LN 557	CONTINGENCY 'DVP_P1-2: LN 557' OPEN BRANCH FROM BUS 314214 TO BUS 314903 CKT 1 /* 6CHCKAHM 230.00 - 8CHCKAHM 500.00 OPEN BRANCH FROM BUS 314903 TO BUS 314908 CKT 1 /* 8CHCKAHM 500.00 - 8ELMONT 500.00 END
DVP_P4-2: 57602	CONTINGENCY 'DVP_P4-2: 57602' /* NORTH ANNA 500 KV OPEN BRANCH FROM BUS 314914 TO BUS 314918 CKT 1 /* 8MDLTHAN 500.00 - 8NO ANNA 500.00 OPEN BRANCH FROM BUS 314232 TO BUS 314918 CKT 1 /* 6NO ANNA 230.00 - 8NO ANNA 500.00 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_P4-2: WT576	CONTINGENCY 'DVP_P4-2: WT576' /* NORTH ANNA 500 KV OPEN BRANCH FROM BUS 314914 TO BUS 314918 CKT 1 /* 8MDLTHAN 500.00 - 8NO ANNA 500.00 OPEN BRANCH FROM BUS 314232 TO BUS 314918 CKT 2 /* 6NO ANNA 230.00 - 8NO ANNA 500.00 END

Summer Peak Analysis – 2021

The Queue Project AD1-033 was evaluated as a 70.0 MW (Capacity 42.0 MW) injection tapping into Fentress-Landstown 230kV in the ITO area. Project AD1-033 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-033 was studied with a commercial probability of 100%. Potential network impacts were as follows:

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).

	Contingency		Affected		Bus			Power	Loading %		Rating		MW
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution
1	LFFB	DVP_P4-2: 57602	DVP - DVP	8CHCKAHM-8ELMONT 500 kV line	314903	314908	1	AC	99.91	100.54	LDR	3144	21.78
2	LFFB	DVP_P4-2: WT576	DVP - DVP	8CHCKAHM-8ELMONT 500 kV line	314903	314908	1	AC	99.91	100.54	LDR	3144	21.78

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	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution
3	LFFB	DVP_P4-2: H2T557	DVP - DVP	8ELMONT 500/230 kV transformer	314218	314908	1	AC	105.75	106.25	LDR	1051	11.61

Steady-State Voltage Requirements

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

None.

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

The queue project, AD1-033, does not meet the 0.95 lagging power factor requirement. An additional 5.88 Mvar would be required for the plant to meet the 0.95 lagging power factor requirement. The plant did meet the 0.95 leading power factor requirements.

Power Factor Assessment for the AD1-033 Queue Project

Generator	MFO (MW)	Required Power Factor Range		Maximum Lagging (Mvar)	Minimum Leading (Mvar)
		Lagging	Leading		
AD1-033	70.00*	0.95	0.95		
Total Reactive Power Required				23.01	-23.01
Reactive Power from Generator				**Qmax**	**Qmin**

	28.56	-28.56
Customer Planned Compensation	0	0
Reactive Power Losses	-11.43	-11.43
Total Available Reactive Power at High Side of Main Transformer	17.13	-39.99
Deficiency in Reactive Power	-5.88	Meet

*Note: Please note that PGEN will need to equal 70.7 MW to produce an MFO of 70 MW at the POI

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this interconnection request)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AD1-033 Allocation
#1, 2	8CHCKAHM-8ELMONT 500 kV line	Replace the wave trap in the Chickahominy substation to increase the Chickahominy – Elmont 500kV line #557 rating to 3424 MVA (normal), 3424 MVA (emergency), and 3937 MVA (load dump). It is estimated to take 12-16 months to engineer and construct. The above upgrade is identified in the prior queues. AD1-033 will not get any cost allocation towards the upgrade due to the cost allocation rules. However AD1-033 needs this upgrade for it to be operational. Note that if the prior projects withdraw, AD1-033 will be re-tooled and could get cost allocation in the future.	Pending	$500,000	**$0**
				Total New Network Upgrades	**$0**

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 is calculated and reported for in the Impact Study)

<table>
<tr><th>Violation #</th><th>Overloaded Facility</th><th>Upgrade Description</th><th>Network Upgrade Number</th><th>Upgrade Cost</th><th>AD1-033 Allocation</th></tr>
<tr><td>#3</td><td><u>Elmont 500 – 230 kV Tx#1</u>:</td><td><u>Elmont 500 – 230 kV Tx#1</u>: replace the 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 cost $17,500,000 and 24-30 months to engineer and construct.
<table>
<tr><th>Queue</th><th>Impact (MW)</th><th>Cost</th></tr>
<tr><td>AC1-164</td><td>48.87</td><td>$3,442,970.82</td></tr>
<tr><td>AC1-191</td><td>26.35</td><td>$1,856,400.27</td></tr>
<tr><td>AC1-216</td><td>21.14</td><td>$1,489,347.31</td></tr>
<tr><td>AC2-012</td><td>24.79</td><td>$1,746,495.74</td></tr>
<tr><td>AC2-078</td><td>12.13</td><td>$854,578.19</td></tr>
<tr><td>AC2-079</td><td>14.89</td><td>$1,049,024.67</td></tr>
<tr><td>AC2-141</td><td>38.06</td><td>$2,681,388.77</td></tr>
<tr><td>AD1-023</td><td>17.40</td><td>$1,225,858.24</td></tr>
<tr><td>AD1-025</td><td>33.16</td><td>$2,336,175.82</td></tr>
<tr><td>AD1-033</td><td>11.61</td><td>$817,760.17</td></tr>
</table></td><td>Pending</td><td>$17,500,000</td><td>$817, 760</td></tr>
<tr><td colspan="5">Total New Network Upgrades</td><td>$817, 760</td></tr>
</table>

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 interconnection request by addressing 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
4	N-1	DVP_P1-2: LN 557	DVP - DVP	6SKIFF CREEK-6KINGS M 230 kV line	314209	314386	1	AC	129.41	130.55	ER	442	5.17
5	N-1	DVP_P1-2: LN 557	DVP - DVP	6PENNIMAN-6WALR209 230 kV line	314296	314415	1	AC	118.59	119.73	ER	442	5.17
6	N-1	DVP_P1-2: LN 557	DVP - DVP	6KINGS M-6PENNIMAN 230 kV line	314386	314296	1	AC	122.01	123.15	ER	442	5.17
7	N-1	DVP_P1-2: LN 557	DVP - DVP	6WALR209-6LIGH209 230 kV line	314415	314391	1	AC	104.86	106	ER	442	5.17
8	N-1	DVP_P1-2: LN 557	DVP - DVP	8CARSON-8MDLTHAN 500 kV line	314902	314914	1	AC	99.55	100.21	ER	3219	20.27
4	N-1	DVP_P1-2: LN 557	DVP - DVP	6SKIFF CREEK-6KINGS M 230 kV line	314209	314386	1	AC	129.41	130.55	ER	442	5.17

Light Load Analysis in 2021

None.

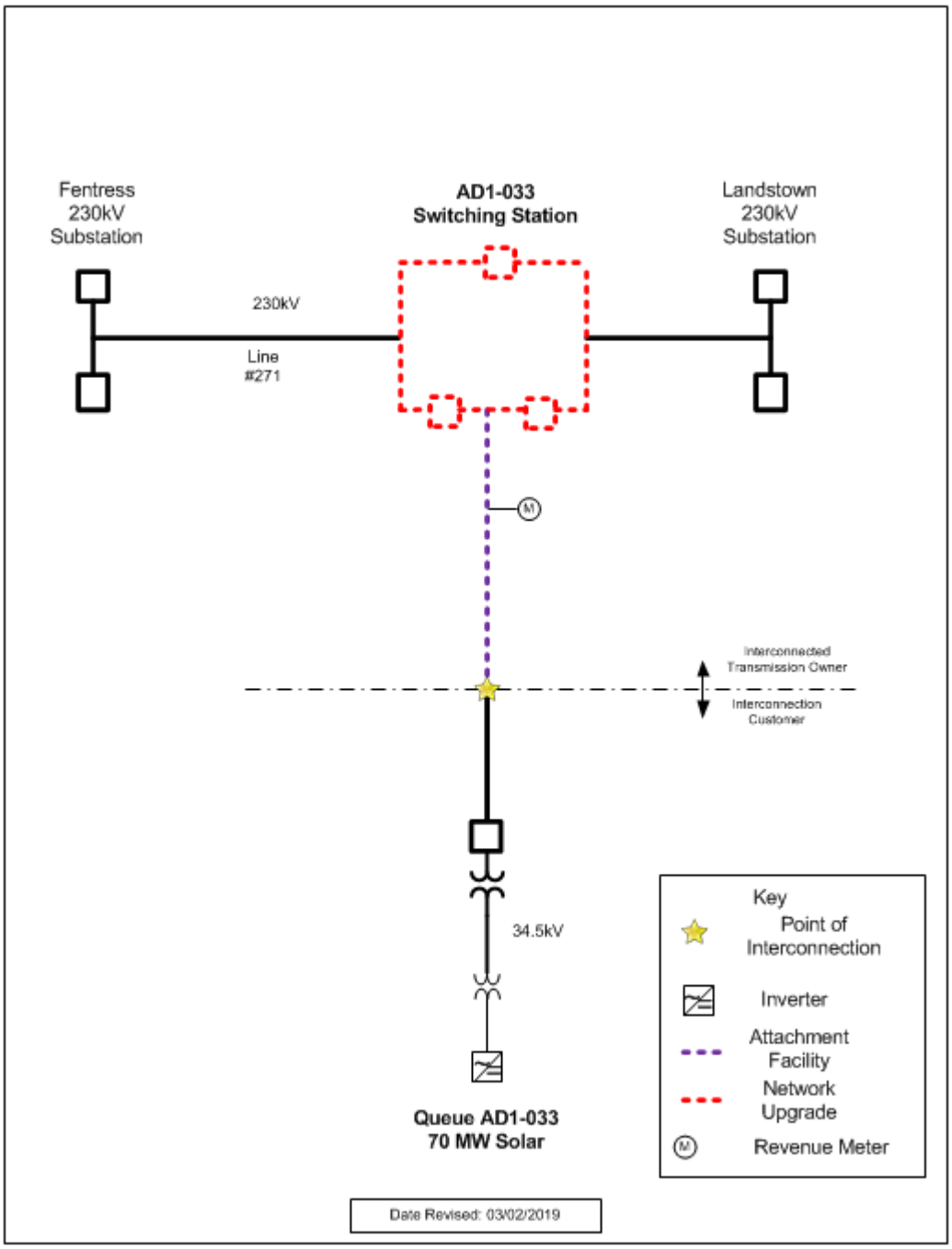
Affected System Analysis & Mitigation

Duke Energy:

None.

Attachment 1.

System Configuration



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, take into consideration the commercial probability of each project as well as the ramping impact of "Adder" contributions.

Appendix 1

(DVP - DVP) The 8CHCKAHM-8ELMONT 500 kV line (from bus 314903 to bus 314908 ckt 1) loads from 99.91% to 100.54% (AC power flow) of its load dump rating (3144 MVA) for the line fault with failed breaker contingency outage of 'DVP_P4-2: 57602'. This project contributes approximately 21.78 MW to the thermal violation.

CONTINGENCY 'DVP_P4-2: 57602' /* NORTH ANNA 500 KV
OPEN BRANCH FROM BUS 314914 TO BUS 314918 CKT 1 /* 8MDLTHAN 500.00 - 8NO ANNA 500.00
OPEN BRANCH FROM BUS 314232 TO BUS 314918 CKT 1 /* 6NO ANNA 230.00 - 8NO ANNA 500.00
END

Bus Number	*Bus Name*	*Full Contribution*
315131	*1EDGECMA*	*11.05*
315132	*1EDGECMB*	*11.05*
315074	*1HOPCGN1*	*10.59*
315075	*1HOPCGN2*	*10.45*
315073	*1STONECA*	*8.78*
315233	*1SURRY 2*	*64.91*
315090	*1YORKTN1*	*52.2*
315091	*1YORKTN2*	*54.17*
315092	*1YORKTN3*	*54.4*
314557	*3BETHELC*	*0.99*
314554	*3BTLEBRO*	*0.95*
314566	*3CRESWEL*	*3.77*
314572	*3EMPORIA*	*0.52*
314578	*3HORNRTN*	*4.25*
314582	*3KELFORD*	*1.14*
314315	*3LOCKS E*	*1.42*
314603	*3SCOT NK*	*4.36*
314617	*3TUNIS*	*1.2*
314539	*3UNCAMP*	*3.71*
314541	*3WATKINS*	*1.03*
314620	*6CASHIE*	*1.26*
314574	*6EVERETS*	*3.18*
314189	*6PAPERMILL*	*10.99*
314594	*6PLYMOTH*	*1.3*
314648	*6SUNBURY*	*1.48*
314651	*6WINFALL*	*2.9*
932041	*AC2-012 C*	*17.73*
932042	*AC2-012 E*	*28.93*
932501	*AC2-070 C*	*1.68*
932502	*AC2-070 E*	*0.69*
932531	*AC2-073 C*	*3.9*

932532	*AC2-073 E*	*1.96*
932581	*AC2-078 C*	*5.33*
932582	*AC2-078 E*	*8.69*
932591	*AC2-079 C*	*8.9*
932592	*AC2-079 E*	*14.52*
932631	*AC2-084 C*	*11.39*
932632	*AC2-084 E*	*5.61*
932831	*AC2-110 C*	*2.15*
932832	*AC2-110 E*	*3.51*
933061	*AC2-130*	*3.19*
933071	*AC2-131 1*	*2.16*
933081	*AC2-131 2*	*0.98*
933111	*AC2-132 1*	*1.14*
933121	*AC2-132 2*	*0.58*
933262	*AC2-137 E*	*1.91*
933272	*AC2-138 E*	*1.19*
933291	*AC2-141 C*	*56.77*
933292	*AC2-141 E*	*24.23*
933732	*AC2-196 E*	*2.07*
933991	*AD1-023 C*	*19.83*
933992	*AD1-023 E*	*10.8*
934011	*AD1-025 C O1*	*24.26*
934012	*AD1-025 E O1*	*14.37*
934061	*AD1-033 C O1*	*13.07*
934062	*AD1-033 E O1*	*8.71*
934141	*AD1-041 C O1*	*8.48*
934142	*AD1-041 E O1*	*5.65*
934201	*AD1-047 C*	*10.12*
934202	*AD1-047 E*	*6.74*
934211	*AD1-048 C*	*2.84*
934212	*AD1-048 E*	*1.43*
934231	*AD1-050 C*	*5.24*
934232	*AD1-050 E*	*2.86*
934331	*AD1-057 C O1*	*12.33*
934332	*AD1-057 E O1*	*6.58*
934391	*AD1-063 C*	*2.64*
934392	*AD1-063 E*	*1.76*
934521	*AD1-076 C O1*	*82.87*
934522	*AD1-076 E O1*	*42.2*
934571	*AD1-082 C O1*	*11.21*
934572	*AD1-082 E O1*	*6.39*
934611	*AD1-087 C O1*	*9.49*
934612	*AD1-087 E O1*	*4.44*
LTF	*AD1-120*	*11.88*
LTF	*AD1-121*	*11.81*

935111	*AD1-144 C*	*2.93*
935112	*AD1-144 E*	*1.6*
935161	*AD1-151 C O1*	*23.18*
935162	*AD1-151 E O1*	*15.46*
935171	*AD1-152 C O1*	*8.8*
935172	*AD1-152 E O1*	*5.86*
935211	*AD1-156 C*	*2.48*
935212	*AD1-156 E*	*1.65*
LTF	*CARR*	*0.95*
LTF	*CBM-S1*	*11.74*
LTF	*CBM-S2*	*27.87*
LTF	*CBM-W1*	*18.37*
LTF	*CBM-W2*	*60.7*
LTF	*CIN*	*4.25*
LTF	*CPLE*	*9.04*
LTF	*G-007*	*3.98*
LTF	*IPL*	*2.69*
LTF	*LGEE*	*0.94*
LTF	*MEC*	*10.99*
LTF	*MECS*	*2.57*
LTF	*O-066*	*13.3*
LTF	*RENSSELAER*	*0.75*
292791	*U1-032 E*	*4.57*
900672	*V4-068 E*	*0.43*
901082	*W1-029E*	*76.29*
LTF	*WEC*	*1.18*
907092	*X1-038 E*	*9.27*
913392	*Y1-086 E*	*3.66*
916042	*Z1-036 E*	*74.1*
916192	*Z1-068 E*	*3.26*
916302	*Z1-086 E*	*12.31*
917122	*Z2-027 E*	*1.77*
917332	*Z2-043 E*	*1.37*
917342	*Z2-044 E*	*0.7*
917512	*Z2-088 E OP1*	*4.82*
918492	*AA1-063AE OP*	*5.42*
918512	*AA1-065 E OP*	*6.41*
918532	*AA1-067 E*	*0.95*
918562	*AA1-072 E*	*0.23*
919152	*AA1-139 E*	*11.05*
919692	*AA2-053 E*	*4.92*
919702	*AA2-057 E*	*4.4*
LTF	*AA2-074*	*6.15*
920042	*AA2-088 E*	*15.23*
920592	*AA2-165 E*	*0.58*

920672	*AA2-174 E*	*0.57*
920692	*AA2-178 E*	*6.46*
930122	*AB1-027 E*	*1.1*
930402	*AB1-081 E*	*4.57*
930861	*AB1-132 C*	*18.07*
930862	*AB1-132 E*	*7.74*
931231	*AB1-173 C*	*2.85*
931232	*AB1-173 E*	*1.33*
931241	*AB1-173AC*	*2.85*
931242	*AB1-173AE*	*1.33*
923801	*AB2-015 C O1*	*13.04*
923802	*AB2-015 E O1*	*10.69*
923831	*AB2-022 C*	*3.88*
923832	*AB2-022 E*	*2.09*
923842	*AB2-024 E*	*1.85*
923852	*AB2-025 E*	*1.36*
923911	*AB2-031 C O1*	*2.82*
923912	*AB2-031 E O1*	*1.39*
923941	*AB2-035 C*	*0.42*
923942	*AB2-035 E*	*0.18*
923991	*AB2-040 C O1*	*9.27*
923992	*AB2-040 E O1*	*7.59*
924151	*AB2-059 C O1*	*12.58*
924152	*AB2-059 E O1*	*6.48*
924241	*AB2-068 O1*	*618.87*
924391	*AB2-088 C*	*0.53*
924392	*AB2-088 E*	*0.26*
924401	*AB2-089 C*	*2.37*
924402	*AB2-089 E*	*1.22*
924491	*AB2-098 C*	*0.74*
924492	*AB2-098 E*	*0.32*
924501	*AB2-099 C*	*0.83*
924502	*AB2-099 E*	*0.36*
924511	*AB2-100 C*	*14.45*
924512	*AB2-100 E*	*7.12*
924811	*AB2-134 C O1*	*18.49*
924812	*AB2-134 E O1*	*18.19*
925051	*AB2-160 C O1*	*6.16*
925052	*AB2-160 E O1*	*10.06*
925061	*AB2-161 C O1*	*4.92*
925062	*AB2-161 E O1*	*8.03*
925121	*AB2-169 C*	*9.25*
925122	*AB2-169 E*	*8.3*
925171	*AB2-174 C O1*	*8.83*
925172	*AB2-174 E O1*	*7.99*

925281	*AB2-186 C*	*1.*
925282	*AB2-186 E*	*0.43*
925291	*AB2-188 C O1*	*3.71*
925292	*AB2-188 E O1*	*1.67*
925331	*AB2-190 C*	*28.85*
925332	*AB2-190 E*	*12.36*
925522	*AC1-027 E*	*1.99*
925591	*AC1-034 C*	*8.15*
925592	*AC1-034 E*	*6.15*
925781	*AC1-054 C*	*8.17*
925782	*AC1-054 E*	*3.76*
925861	*AC1-065 C*	*5.37*
925862	*AC1-065 E*	*8.76*
926071	*AC1-086 C*	*26.61*
926072	*AC1-086 E*	*12.11*
926201	*AC1-098 C*	*7.99*
926202	*AC1-098 E*	*4.76*
926211	*AC1-099 C*	*2.68*
926212	*AC1-099 E*	*1.57*
926291	*AC1-107*	*934.14*
926412	*AC1-112 E*	*1.11*
926662	*AC1-147 E*	*2.3*
926751	*AC1-161 C*	*56.77*
926752	*AC1-161 E*	*24.23*
926781	*AC1-164 C*	*68.81*
926782	*AC1-164 E*	*30.91*
927021	*AC1-189 C*	*10.92*
927022	*AC1-189 E*	*5.44*
927141	*AC1-208 C*	*11.56*
927142	*AC1-208 E*	*5.13*
927221	*AC1-216 C O1*	*14.12*
927222	*AC1-216 E O1*	*11.1*

Appendix 2

(DVP - DVP) The 8ELMONT 500/230 kV transformer (from bus 314218 to bus 314908 ckt 1) loads from 105.75% to 106.25% (AC 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 11.61 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*	*5.32*
315068	*1DARBY 2*	*5.32*
315069	*1DARBY 3*	*5.34*
315070	*1DARBY 4*	*5.35*
315043	*1FOUR RIVERA*	*7.07*
315044	*1FOUR RIVERB*	*5.47*
315045	*1FOUR RIVERC*	*7.07*
315046	*1FOUR RIVERD*	*5.47*
315047	*1FOUR RIVERE*	*5.47*
315048	*1FOUR RIVERF*	*7.07*
315074	*1HOPCGN1*	*11.29*
315075	*1HOPCGN2*	*11.14*
315083	*1SPRUNCA*	*14.96*
315084	*1SPRUNCB*	*14.96*
315085	*1SPRUNCC*	*11.09*
315086	*1SPRUNCD*	*11.09*
315073	*1STONECA*	*9.36*
315090	*1YORKTN1*	*30.94*
315091	*1YORKTN2*	*32.11*
314566	*3CRESWEL*	*2.11*
314315	*3LOCKS E*	*1.65*
314539	*3UNCAMP*	*2.19*
314541	*3WATKINS*	*0.61*
314229	*6MT RD221*	*1.41*
314236	*6NRTHEST*	*0.39*
314189	*6PAPERMILL*	*8.82*
314594	*6PLYMOTH*	*0.73*
314250	*6ROCKVILLE*	*0.42*
314256	*6ROCKVILLE E*	*1.15*

314648	*6SUNBURY*	*0.81*
314651	*6WINFALL*	*1.59*
932041	*AC2-012 C*	*9.63*
932042	*AC2-012 E*	*15.7*
932501	*AC2-070 C*	*2.91*
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*	*7.76*
932591	*AC2-079 C*	*5.8*
932592	*AC2-079 E*	*9.46*
932831	*AC2-110 C*	*1.74*
932832	*AC2-110 E*	*2.85*
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*	*0.66*
933262	*AC2-137 E*	*2.05*
933272	*AC2-138 E*	*1.09*
933291	*AC2-141 C*	*27.17*
933292	*AC2-141 E*	*11.6*
933732	*AC2-196 E*	*1.1*
933991	*AD1-023 C*	*11.29*
933992	*AD1-023 E*	*6.15*
934011	*AD1-025 C O1*	*20.83*
934012	*AD1-025 E O1*	*12.34*
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*
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*	*46.91*
934522	*AD1-076 E O1*	*23.89*
934571	*AD1-082 C O1*	*8.27*
934572	*AD1-082 E O1*	*4.72*
934781	*AD1-105 C*	*8.09*
934782	*AD1-105 E*	*5.62*
LTF	*AD1-120*	*5.94*
LTF	*AD1-121*	*5.9*

935111	*AD1-144 C*	*1.68*
935112	*AD1-144 E*	*0.92*
935161	*AD1-151 C O1*	*19.9*
935162	*AD1-151 E O1*	*13.27*
935211	*AD1-156 C*	*2.56*
935212	*AD1-156 E*	*1.71*
LTF	*CARR*	*0.67*
LTF	*CBM-S1*	*3.89*
LTF	*CBM-S2*	*13.86*
LTF	*CBM-W1*	*0.41*
LTF	*CBM-W2*	*18.21*
LTF	*CIN*	*0.16*
LTF	*CLIFTY*	*1.55*
LTF	*CPLE*	*4.76*
LTF	*DEARBORN*	*0.46*
LTF	*G-007*	*2.3*
LTF	*IPL*	*0.08*
LTF	*LGEE*	*0.05*
LTF	*MEC*	*2.05*
LTF	*O-066*	*7.7*
LTF	*RENSSELAER*	*0.53*
292791	*U1-032 E*	*4.88*
297087	*V2-040*	*0.29*
901082	*W1-029E*	*41.84*
LTF	*WEC*	*0.07*
907092	*X1-038 E*	*5.48*
913392	*Y1-086 E*	*1.99*
916042	*Z1-036 E*	*40.86*
916192	*Z1-068 E*	*1.76*
917122	*Z2-027 E*	*0.96*
918691	*AA1-083*	*1.24*
919152	*AA1-139 E*	*5.92*
919211	*AA1-145*	*21.11*
LTF	*AA2-074*	*3.24*
920042	*AA2-088 E*	*9.16*
920692	*AA2-178 E*	*3.61*
930121	*AB1-027 C*	*0.93*
930122	*AB1-027 E*	*1.89*
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*
924061	*AB2-050*	*1.24*

924241	*AB2-068 O1*	*178.04*
924511	*AB2-100 C*	*10.49*
924512	*AB2-100 E*	*5.17*
924811	*AB2-134 C O1*	*15.88*
924812	*AB2-134 E O1*	*15.61*
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*
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*	*24.76*
925332	*AB2-190 E*	*10.61*
925522	*AC1-027 E*	*1.07*
925861	*AC1-065 C*	*4.36*
925862	*AC1-065 E*	*7.11*
926291	*AC1-107*	*268.74*
926411	*AC1-112 C*	*0.72*
926412	*AC1-112 E*	*1.93*
926472	*AC1-118 E*	*1.07*
926551	*AC1-134*	*14.83*
926662	*AC1-147 E*	*1.25*
926751	*AC1-161 C*	*27.17*
926752	*AC1-161 E*	*11.6*
926781	*AC1-164 C*	*58.43*
926782	*AC1-164 E*	*26.25*
927041	*AC1-191 C*	*17.46*
927042	*AC1-191 E*	*8.7*
927221	*AC1-216 C O1*	*12.12*
927222	*AC1-216 E O1*	*9.53*