

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position AB2-188***

***Creswell 34.5kV
13.8MW Capacity / 20MW Energy***

September / 2016

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 Washington County, NC. The installed facilities will have a total capability of 20 MW with 13.8 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is 6/30/2017. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AB2-188 will interconnect with the ITO distribution system at one of the following points of interconnection:

Option 1 will connect on Creswell 34.5kV circuit.

Option 2 will connect via a tap on Creswell – Riders Creek 115kV line.

Cost Summary

The AB2-188 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$300,000
Direct Connection Network Upgrades	\$0
Non Direct Connection Network Upgrades	\$300,000
Total Costs	\$600,000

In addition, the AB2-188 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	\$58,155,000
Previously Identified Upgrades	\$0
Total Costs	\$58,155,000

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

Transmission Owner Scope of Work

There is an existing distribution line of three-phase 34.5 kV adjacent to the IC's site and the requested POI. The existing 34.5 kV distribution line is served from a 22.4 MVA 115/34.5 kV transformer in Creswell Substation.

Attachment Facilities

To provide the interconnection the ITO will install approximately 800 feet of overhead three phase primary voltage conductors to provide an interconnection to the existing primary voltage conductors. A pole mounted electronic recloser, pole mounted primary bi-directional metering equipment, a power quality monitoring relay and a set of disconnects to provide an isolation point will also be provided. The estimated cost of these attachment facilities is \$300,000. These costs do not include CIAC Tax Gross-up. The single line is shown below in Attachment 1.

Non-Direct Connection Local Upgrades Cost Estimate

To accept the requested 20 MW Creswell Substation will require a complete rebuild/expansion with a larger transformer and control house installation. This work is required on an existing NC State Queued Request NC14050. If NC14050 was to move forward the only upgrades required for AB2-188 would be a bulk feeder underground getaway and necessary transfer trip equipment.

- As indicated above the distribution upgrades for the bulk feeder underground getaway has an anticipated cost of \$200,000
- As indicated above the substation upgrades to accommodate transfer trip has an anticipated cost of \$100,000.

The estimated cost of these required System Upgrades to accommodate the 20 MW request if NC14050 was to move forward is \$300,000. The estimated time to interconnect the IC with the required System Upgrades is 12 months.

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.

Reinforcement: Rebuild of the Elizabeth City-Shawboro 230kV line. It is estimated to take 44-48 months to complete and it is estimated to cost \$15,405,000 to resolve this deficiency.

Reinforcement: Rebuild of the Sunbury-Suffolk 230kV line. It is estimated to take 44-48 months to complete and it is estimated to cost \$28,065,000 to resolve this deficiency.

Reinforcement: Rebuild of the W1-029-Sunbury 230kV line. It is estimated to take 44-48 months to complete and it is estimated to cost \$14,685,000 to resolve this deficiency.

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>

The ITO's preferred transformer configuration is wye grounded (primary)/delta (secondary) with provisions for external resistance grounding of the primary with the level of resistance to be determined by the IC and approved by the ITO. If a wye (primary)/wye (secondary) transformer configuration is utilized the IC will apply a ground bank configured transformer [zig-zag or wye (interconnection side) – delta (floated)] at (near) the point where the generation is connected. Additionally, the ITO will require the IC to provide specific inverter information including the model and parameter data required for a short-circuit analysis including Positive, Negative and Zero Sequence Resistance and Reactance for the initial 4 to 6 cycles.

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.

Option One

Network Impacts

The Queue Project AB2-188 was evaluated as a 20.0 MW (Capacity 13.8 MW) injection at the Creswell 115kV substation in the ITO area. Project AB2-188 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB2-188 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
246T247_A	CONTINGENCY '246T247_A' /* 246T247 @ SUFFOLK OPEN BRANCH FROM BUS 314537 TO BUS 921571 CKT 1 /* SUFFOLK - AA1-138 TAP OPEN BRANCH FROM BUS 314537 TO BUS 314648 CKT 1 /* SUFFOLK - SUNBURY OPEN BRANCH FROM BUS 314648 TO BUS 901080 CKT 1 /* SUNBURY - WINFALL END
LN 269-2087_A	CONTINGENCY 'LN 269-2087_A' OPEN BRANCH FROM BUS 314466 TO BUS 314645 CKT 1 /* 6FENTRES 230.00 - 6SLIGO 230.00 OPEN BRANCH FROM BUS 314645 TO BUS 314647 CKT 1 /* 6SLIGO 230.00 - 6SHAWBRO 230.00 OPEN BUS 314645 /* ISLAND OPEN BRANCH FROM BUS 314466 TO BUS 314550 CKT 1 /* 6FENTRES 230.00 - 6HICKORY 230.00 OPEN BRANCH FROM BUS 314550 TO BUS 921541 CKT 1 /* 6HICKORY 230.00 - AA1-133 TAP 230.00 OPEN BUS 314468 /* ISLAND OPEN BUS 314476 /* ISLAND OPEN BUS 314550 /* ISLAND END

Contingency Name	Description
LN 247	CONTINGENCY 'LN 247' OPEN BRANCH FROM BUS 314537 TO BUS 314648 CKT 1 /* 6SUFFOLK 230.00 - 6SUNBURY 230.00 OPEN BRANCH FROM BUS 314648 TO BUS 901080 CKT 1 /* 6SUNBURY 230.00 - W1-029 230.00 OPEN BUS 314648 /* ISLAND END
LN 2020	CONTINGENCY 'LN 2020' OPEN BRANCH FROM BUS 313851 TO BUS 314638 CKT 1 /* 6ECITYDP2 230.00 - 6ELIZ CT 230.00 OPEN BRANCH FROM BUS 313851 TO BUS 314639 CKT 1 /* 6ECITYDP2 230.00 - 6TANGLEW 230.00 OPEN BRANCH FROM BUS 314639 TO BUS 314651 CKT 1 /* 6TANGLEW 230.00 - 6WINFALL 230.00 OPEN BUS 313851 /* ISLAND OPEN BUS 314639 /* ISLAND OPEN BUS 913391 /* ISLAND OPEN BUS 913392 /* ISLAND END

Summer Peak Analysis - 2020

Generator Deliverability

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

None

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

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 Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
#	Type	Name			From	To	Cir.		Initial	Final	Type	MVA		
1	LFFB	246T247_A	DVP - DVP	6ELIZ CT-6SHAWBRO 230 kV line	314638	314647	1	DC	126.7	128.21	ER	608	9.19	1

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Cir.		Initial	Final	Type	MVA		
2	DCTL	LN 269-2087_A	DVP - DVP	6SUNBURY-6SUFFOLK 230 kV line	314648	314537	1	DC	141.69	143.33	ER	478	7.87	2
3	DCTL	LN 269-2087_A	DVP - DVP	W1-029-6SUNBURY 230 kV line	901080	314648	1	DC	146.23	147.87	ER	478	7.87	3

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
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Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
# 1	6ELIZ CT-6SHAWBRO 230 kV line	Rebuild of the Elizabeth City-Shawboro 230kV line	Pending	\$15,405,000
# 2	6SUNBURY-6SUFFOLK 230 kV line	Rebuild of the Sunbury-Suffolk 230kV line	Pending	\$28,065,000
# 3	W1-029-6SUNBURY 230 kV line	Rebuild of the W1-029-Sunbury 230kV line	Pending	\$14,685,000
Total New Network Upgrades				\$58,155,000

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		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA	
4	Non	Non	DVP – DVP	3CRESWEL-3MACKEYS 115 kV line	314566	314586	1	DC	85.04	100.31	NR	131	20.0
5	N-1	LN 247	DVP – DVP	6ELIZ CT-6SHAWBRO 230 kV line	314638	314647	1	DC	112.76	114.14	ER	608	8.35

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA	
6	N-1	LN 2020	DVP – DVP	6SUNBURY-6SUFFOLK 230 kV line	314648	314537	1	DC	133.03	134.67	ER	478	7.87
7	N-1	LN 2020	DVP – DVP	W1-029-6SUNBURY 230 kV line	901080	314648	1	DC	137.55	139.19	ER	478	7.87

Light Load Analysis

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

ITO Analysis

ITO assessed the impact of the proposed Queue Project #AB2-188 interconnection of a 20.0 MW Energy (13.8 MW Capacity) injection into the ITO's Transmission System, for compliance with NERC Reliability Criteria on ITO's Transmission System. The system was assessed using the summer 2020 RTEP case provided to ITO by PJM. When performing a generation analysis, ITO's main analysis will be load flow study results under single contingency (both normal and stressed system conditions). ITO Criteria considers a transmission facility overloaded if it exceeds 94% of its emergency rating under normal and stressed system conditions. A full listing of 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's 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.

As part of its generation impact analysis, the ITO routinely evaluates the impact that a proposed new generation resource will have under maximum generation conditions, stress system conditions and import/export system conditions (greater than 20 MW). The results of these studies are discussed in more detail below.

Category B Analysis (Single Contingency):

1. System Normal – No deficiencies identified
2. Critical System Condition (No Surry 230 kV Unit) – No deficiencies identified.

Category C Analysis: (Multiple Facility Analysis)

1. Bus Fault - No deficiencies identified
2. Line Stuck Breaker - No deficiencies identified
3. Tower Line – No deficiencies identified

Affected System Analysis & Mitigation

Duke, Progress & TVA Impacts:

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

Option Two

Network Impacts

The Queue Project AB2-188 was evaluated as a 20.0 MW (Capacity 13.8 MW) injection at the Creswell 115kV substation in the ITO area. Project AB2-188 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB2-188 was studied with a commercial probability of 53%. Potential network impacts were as follows:

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Summer Peak Analysis - 2020

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(Summary of impacted circuit breakers)

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

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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)

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Contingency			Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
#	Type	Name			From	To	Cir.		Initial	Final	Type	MVA		
2	DCTL	LN 269-2087_A	DVP - DVP	6SUNBURY-6SUFFOLK 230 kV line	314648	314537	1	DC	141.69	143.33	ER	478	7.87	5
3	DCTL	LN 269-2087_A	DVP - DVP	W1-029-6SUNBURY 230 kV line	901080	314648	1	DC	146.23	147.87	ER	478	7.87	6

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.

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Contingency			Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution
#	Type	Name			From	To	Circuit		Initial	Final	Type	MVA	
4	Non	Non	DVP – DVP	3CRESWEL-3MACKEYS 115 kV line	314566	314586	1	DC	85.04	100.31	NR	131	20.0

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA	
5	N-1	LN 247	DVP – DVP	6ELIZ CT-6SHAWBRO 230 kV line	314638	314647	1	DC	112.76	113.97	ER	608	8.35
6	N-1	LN 2020	DVP – DVP	6SUNBURY-6SUFFOLK 230 kV line	314648	314537	1	DC	133.03	134.66	ER	478	7.87
7	N-1	LN 2020	DVP – DVP	W1-029-6SUNBURY 230 kV line	901080	314648	1	DC	137.53	139.18	ER	478	7.87
8	Non	Non	DVP – DVP	AB2-188 TAP-3CRESWEL 115 kV line	925290	314566	1	DC	92.6	107.86	NR	131	20.0

Light Load Analysis

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

ITO Analysis

ITO assessed the impact of the proposed Queue Project #AB2-188 interconnection of a 20.0 MW Energy (13.8 MW Capacity) injection into the ITO's Transmission System, for compliance with NERC Reliability Criteria on ITO's Transmission System. The system was assessed using the summer 2020 RTEP case provided to ITO by PJM. When performing a generation analysis, ITO's main analysis will be load flow study results under single contingency (both normal and stressed system conditions). ITO Criteria considers a transmission facility overloaded if it exceeds 94% of its emergency rating under normal and stressed system conditions. A full listing of 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's 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.

As part of its generation impact analysis, the ITO routinely evaluates the impact that a proposed new generation resource will have under maximum generation conditions, stress system conditions and import/export system conditions (greater than 20 MW). The results of these studies are discussed in more detail below.

Category B Analysis (Single Contingency):

1. System Normal – No deficiencies identified
2. Critical System Condition (No Surry 230 kV Unit) – No deficiencies identified.

Category C Analysis: (Multiple Facility Analysis)

1. Bus Fault - No deficiencies identified
2. Line Stuck Breaker - No deficiencies identified
3. Tower Line – No deficiencies identified

Affected System Analysis & Mitigation

Duke, Progress & TVA Impacts:

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

Attachment 1.

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 - DVP) The 6ELIZ CT-6SHAWBRO 230 kV line (from bus 314638 to bus 314647 ckt 1) loads from 126.7% to 128.21% (**DC power flow**) of its emergency rating (608 MVA) for the line fault with failed breaker contingency outage of '246T247_A'. This project contributes approximately 9.19 MW to the thermal violation.

CONTINGENCY '246T247_A' /* 246T247 @ SUFFOLK
 OPEN BRANCH FROM BUS 314537 TO BUS 921571 CKT 1 /* SUFFOLK -
 AA1-138 TAP
 OPEN BRANCH FROM BUS 314569 TO BUS 314575 CKT 1 /* NUCOR TAP -
 EARLEYS
 OPEN BRANCH FROM BUS 314537 TO BUS 314648 CKT 1 /* SUFFOLK -
 SUNBURY
 OPEN BRANCH FROM BUS 314648 TO BUS 901080 CKT 1 /* SUNBURY -
 WINFALL
 END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315292	1DOMTR78	3.16
315134	1ROAVALA	3.67
315135	1ROAVALB	0.98
314784	1WEYRHSB	4.03
901081	W1-029C	5.13
901082	W1-029E	175.15
902241	W2-022 C OP1	2.72
902242	W2-022 E OP1	18.2
913391	Y1-086 C	1.1
913392	Y1-086 E	9.14
916041	Z1-036 C	4.57
916042	Z1-036 E	156.13
917121	Z2-027 C	2.02
917122	Z2-027 E	4.42
917331	Z2-043 C	0.41
917332	Z2-043 E	0.9
917511	Z2-088 C OP1	0.81
917512	Z2-088 E OP1	6.78
918411	AA1-050	0.69
LTF	AA1-058	0.38
918511	AA1-065 C OP	2.13
918512	AA1-065 E OP	5.35
921182	AA1-067 C	1.67
921183	AA1-067 E	0.71
918561	AA1-072 C	0.06

918562	AA1-072 E	0.15
921552	AA1-134 C	37.58
921553	AA1-134 E	16.11
921562	AA1-135 C	10.12
921563	AA1-135 E	4.34
921752	AA2-053 C	5.63
921753	AA2-053 E	2.42
921772	AA2-059 C	7.57
921773	AA2-059 E	3.48
921862	AA2-068 C	1.42
921863	AA2-068 E	0.65
922512	AA2-174 C	0.26
922513	AA2-174 E	0.28
922532	AA2-178 C	25.74
922533	AA2-178 E	11.03
922602	AB1-013 C	7.77
922603	AB1-013 E	51.99
922882	AB1-077 C	13.09
922883	AB1-077 E	87.57
923831	AB2-022 C	10.04
923832	AB2-022 E	5.41
923941	AB2-035 C	0.24
923942	AB2-035 E	0.1
924381	AB2-087 C	0.58
924382	AB2-087 E	0.27
924391	AB2-088 C	0.31
924392	AB2-088 E	0.15
924491	AB2-098 C	0.56
924492	AB2-098 E	0.24
924501	AB2-099 C	0.54
924502	AB2-099 E	0.23
925121	AB2-169 C OP	11.08
925122	AB2-169 E OP	9.95
925281	AB2-186 C	1.93
925282	AB2-186 E	0.83
925291	AB2-188 C OP	6.34
925292	AB2-188 E OP	2.85

Appendix 2

(DVP - DVP) The 6SUNBURY-6SUFFOLK 230 kV line (from bus 314648 to bus 314537 ckt 1) loads from 141.69% to 143.33% (**DC power flow**) of its emergency rating (478 MVA) for the tower line contingency outage of 'LN 269-2087_A'. This project contributes approximately 7.87 MW to the thermal violation.

CONTINGENCY 'LN 269-2087_A'

OPEN BRANCH FROM BUS 314466 TO BUS 314645 CKT 1 /* 6FENTRES
230.00 - 6SLIGO 230.00

OPEN BRANCH FROM BUS 314645 TO BUS 314647 CKT 1 /* 6SLIGO 230.00 -
6SHAWBRO 230.00

OPEN BUS 314645 /* ISLAND

OPEN BRANCH FROM BUS 314466 TO BUS 314550 CKT 1 /* 6FENTRES
230.00 - 6HICKORY 230.00

OPEN BRANCH FROM BUS 314550 TO BUS 921541 CKT 1 /* 6HICKORY
230.00 - AA1-133 TAP 230.00

OPEN BUS 314468 /* ISLAND

OPEN BUS 314476 /* ISLAND

OPEN BUS 314550 /* ISLAND

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315292	1DOMTR78	2.47
314784	1WEYRHSB	3.16
314643	3O INLET	1.82
901081	W1-029C	5.25
901082	W1-029E	179.33
902241	W2-022 C OP1	2.07
902242	W2-022 E OP1	13.85
903520	W3-066 C1OP1	12.11
903531	W3-066 C2OP1	12.11
903522	W3-066 E1OP1	81.02
903532	W3-066 E2OP1	81.02
913391	Y1-086 C	0.92
913392	Y1-086 E	7.7
916041	Z1-036 C	4.14
916042	Z1-036 E	141.53
917121	Z2-027 C	1.7
917122	Z2-027 E	3.72
921542	AA1-133 C	34.77

921543	AA1-133 E	14.9
921552	AA1-134 C	38.48
921553	AA1-134 E	16.49
921582	AA1-139 C	52.15
921583	AA1-139 E	22.35
921772	AA2-059 C	6.75
921773	AA2-059 E	3.11
922532	AA2-178 C	22.02
922533	AA2-178 E	9.44
922602	AB1-013 C	6.65
922603	AB1-013 E	44.48
922882	AB1-077 C	13.4
922883	AB1-077 E	89.66
923831	AB2-022 C	8.07
923832	AB2-022 E	4.35
925121	AB2-169 C OP	8.43
925122	AB2-169 E OP	7.57
925281	AB2-186 C	1.73
925282	AB2-186 E	0.74
925291	AB2-188 C OP	5.43
925292	AB2-188 E OP	2.44

Appendix 3

(DVP - DVP) The W1-029-6SUNBURY 230 kV line (from bus 901080 to bus 314648 ckt 1) loads from 146.23% to 147.87% (**DC power flow**) of its emergency rating (478 MVA) for the tower line contingency outage of 'LN 269-2087_A'. This project contributes approximately 7.87 MW to the thermal violation.

CONTINGENCY 'LN 269-2087_A'

OPEN BRANCH FROM BUS 314466 TO BUS 314645 CKT 1 /* 6FENTRES
230.00 - 6SLIGO 230.00

OPEN BRANCH FROM BUS 314645 TO BUS 314647 CKT 1 /* 6SLIGO 230.00 -
6SHAWBRO 230.00

OPEN BUS 314645 /* ISLAND

OPEN BRANCH FROM BUS 314466 TO BUS 314550 CKT 1 /* 6FENTRES
230.00 - 6HICKORY 230.00

OPEN BRANCH FROM BUS 314550 TO BUS 921541 CKT 1 /* 6HICKORY
230.00 - AA1-133 TAP 230.00

OPEN BUS 314468 /* ISLAND

OPEN BUS 314476 /* ISLAND

OPEN BUS 314550 /* ISLAND

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315292	1DOMTR78	2.47
314784	1WEYRHSB	3.16
314643	3O INLET	1.82
901081	W1-029C	5.25
901082	W1-029E	179.33
902241	W2-022 C OP1	2.07
902242	W2-022 E OP1	13.85
903520	W3-066 C1OP1	12.11
903531	W3-066 C2OP1	12.11
903522	W3-066 E1OP1	81.02
903532	W3-066 E2OP1	81.02
913391	Y1-086 C	0.92
913392	Y1-086 E	7.7
916041	Z1-036 C	4.14
916042	Z1-036 E	141.53
917121	Z2-027 C	1.7
917122	Z2-027 E	3.72
921542	AA1-133 C	34.77

921543	AA1-133 E	14.9
921552	AA1-134 C	38.48
921553	AA1-134 E	16.49
921582	AA1-139 C	52.15
921583	AA1-139 E	22.35
921772	AA2-059 C	6.75
921773	AA2-059 E	3.11
922532	AA2-178 C	22.02
922533	AA2-178 E	9.44
922602	AB1-013 C	6.65
922603	AB1-013 E	44.48
922882	AB1-077 C	13.4
922883	AB1-077 E	89.66
923831	AB2-022 C	8.07
923832	AB2-022 E	4.35
925121	AB2-169 C OP	8.43
925122	AB2-169 E OP	7.57
925281	AB2-186 C	1.73
925282	AB2-186 E	0.74
925291	AB2-188 C OP	5.43
925292	AB2-188 E OP	2.44

Appendix 4

(DVP - DVP) The 6ELIZ CT-6SHAWBRO 230 kV line (from bus 314638 to bus 314647 ckt 1) loads from 126.53% to 128.05% (**DC power flow**) of its emergency rating (608 MVA) for the line fault with failed breaker contingency outage of '246T247_A'. This project contributes approximately 9.19 MW to the thermal violation.

CONTINGENCY '246T247_A' /* 246T247 @ SUFFOLK
 OPEN BRANCH FROM BUS 314537 TO BUS 921571 CKT 1 /* SUFFOLK -
 AA1-138 TAP
 OPEN BRANCH FROM BUS 314569 TO BUS 314575 CKT 1 /* NUCOR TAP -
 EARLEYS
 OPEN BRANCH FROM BUS 314537 TO BUS 314648 CKT 1 /* SUFFOLK -
 SUNBURY
 OPEN BRANCH FROM BUS 314648 TO BUS 901080 CKT 1 /* SUNBURY -
 WINFALL
 END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315292	1DOMTR78	3.16
315134	1ROAVALA	3.67
315135	1ROAVALB	0.98
314784	1WEYRHSB	4.03
901081	W1-029C	5.13
901082	W1-029E	175.15
902241	W2-022 C OP1	2.72
902242	W2-022 E OP1	18.2
913391	Y1-086 C	1.1
913392	Y1-086 E	9.14
916041	Z1-036 C	4.57
916042	Z1-036 E	156.13
917121	Z2-027 C	2.02
917122	Z2-027 E	4.42
917331	Z2-043 C	0.41
917332	Z2-043 E	0.9
917511	Z2-088 C OP1	0.81
917512	Z2-088 E OP1	6.78
918411	AA1-050	0.69
LTF	AA1-058	0.38
918511	AA1-065 C OP	2.13
918512	AA1-065 E OP	5.35
921182	AA1-067 C	1.67
921183	AA1-067 E	0.71
918561	AA1-072 C	0.06

918562	AA1-072 E	0.15
921552	AA1-134 C	37.58
921553	AA1-134 E	16.11
921562	AA1-135 C	10.12
921563	AA1-135 E	4.34
921752	AA2-053 C	5.63
921753	AA2-053 E	2.42
921772	AA2-059 C	7.57
921773	AA2-059 E	3.48
921862	AA2-068 C	1.42
921863	AA2-068 E	0.65
922512	AA2-174 C	0.26
922513	AA2-174 E	0.28
922532	AA2-178 C	25.74
922533	AA2-178 E	11.03
922602	AB1-013 C	7.77
922603	AB1-013 E	51.99
922882	AB1-077 C	13.09
922883	AB1-077 E	87.57
923831	AB2-022 C	10.04
923832	AB2-022 E	5.41
923941	AB2-035 C	0.24
923942	AB2-035 E	0.1
924381	AB2-087 C	0.58
924382	AB2-087 E	0.27
924391	AB2-088 C	0.31
924392	AB2-088 E	0.15
924491	AB2-098 C	0.56
924492	AB2-098 E	0.24
924501	AB2-099 C	0.54
924502	AB2-099 E	0.23
925121	AB2-169 C OP	10.54
925122	AB2-169 E OP	9.46
925281	AB2-186 C	1.93
925282	AB2-186 E	0.83
925291	AB2-188 C OP	6.34
925292	AB2-188 E OP	2.85

Appendix 5

(DVP - DVP) The 6SUNBURY-6SUFFOLK 230 kV line (from bus 314648 to bus 314537 ckt 1) loads from 141.6% to 143.24% (**DC power flow**) of its emergency rating (478 MVA) for the tower line contingency outage of 'LN 269-2087_A'. This project contributes approximately 7.87 MW to the thermal violation.

CONTINGENCY 'LN 269-2087_A'

OPEN BRANCH FROM BUS 314466 TO BUS 314645 CKT 1 /* 6FENTRES
230.00 - 6SLIGO 230.00

OPEN BRANCH FROM BUS 314645 TO BUS 314647 CKT 1 /* 6SLIGO 230.00 -
6SHAWBRO 230.00

OPEN BUS 314645 /* ISLAND

OPEN BRANCH FROM BUS 314466 TO BUS 314550 CKT 1 /* 6FENTRES
230.00 - 6HICKORY 230.00

OPEN BRANCH FROM BUS 314550 TO BUS 921541 CKT 1 /* 6HICKORY
230.00 - AA1-133 TAP 230.00

OPEN BUS 314468 /* ISLAND

OPEN BUS 314476 /* ISLAND

OPEN BUS 314550 /* ISLAND

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315292	1DOMTR78	2.47
314784	1WEYRHSB	3.16
314643	3O INLET	1.82
901081	W1-029C	5.25
901082	W1-029E	179.33
902241	W2-022 C OPI	2.07
902242	W2-022 E OPI	13.85
903520	W3-066 C1OPI	12.11
903531	W3-066 C2OPI	12.11
903522	W3-066 E1OPI	81.02
903532	W3-066 E2OPI	81.02
913391	Y1-086 C	0.92
913392	Y1-086 E	7.7
916041	Z1-036 C	4.14
916042	Z1-036 E	141.53
917121	Z2-027 C	1.7
917122	Z2-027 E	3.72
921542	AA1-133 C	34.77

921543	AA1-133 E	14.9
921552	AA1-134 C	38.48
921553	AA1-134 E	16.49
921582	AA1-139 C	52.15
921583	AA1-139 E	22.35
921772	AA2-059 C	6.75
921773	AA2-059 E	3.11
922532	AA2-178 C	22.02
922533	AA2-178 E	9.44
922602	AB1-013 C	6.65
922603	AB1-013 E	44.48
922882	AB1-077 C	13.4
922883	AB1-077 E	89.66
923831	AB2-022 C	8.07
923832	AB2-022 E	4.35
925121	AB2-169 C OP	7.92
925122	AB2-169 E OP	7.11
925281	AB2-186 C	1.73
925282	AB2-186 E	0.74
925291	AB2-188 C OP	5.43
925292	AB2-188 E OP	2.44

Appendix 6

(DVP - DVP) The W1-029-6SUNBURY 230 kV line (from bus 901080 to bus 314648 ckt 1) loads from 146.14% to 147.78% (**DC power flow**) of its emergency rating (478 MVA) for the tower line contingency outage of 'LN 269-2087_A'. This project contributes approximately 7.87 MW to the thermal violation.

CONTINGENCY 'LN 269-2087_A'

OPEN BRANCH FROM BUS 314466 TO BUS 314645 CKT 1 /* 6FENTRES
230.00 - 6SLIGO 230.00

OPEN BRANCH FROM BUS 314645 TO BUS 314647 CKT 1 /* 6SLIGO 230.00 -
6SHAWBRO 230.00

OPEN BUS 314645 /* ISLAND

OPEN BRANCH FROM BUS 314466 TO BUS 314550 CKT 1 /* 6FENTRES
230.00 - 6HICKORY 230.00

OPEN BRANCH FROM BUS 314550 TO BUS 921541 CKT 1 /* 6HICKORY
230.00 - AA1-133 TAP 230.00

OPEN BUS 314468 /* ISLAND

OPEN BUS 314476 /* ISLAND

OPEN BUS 314550 /* ISLAND

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315292	1DOMTR78	2.47
314784	1WEYRHSB	3.16
314643	3O INLET	1.82
901081	W1-029C	5.25
901082	W1-029E	179.33
902241	W2-022 C OP1	2.07
902242	W2-022 E OP1	13.85
903520	W3-066 C1OP1	12.11
903531	W3-066 C2OP1	12.11
903522	W3-066 E1OP1	81.02
903532	W3-066 E2OP1	81.02
913391	Y1-086 C	0.92
913392	Y1-086 E	7.7
916041	Z1-036 C	4.14
916042	Z1-036 E	141.53
917121	Z2-027 C	1.7
917122	Z2-027 E	3.72
921542	AA1-133 C	34.77

921543	AA1-133 E	14.9
921552	AA1-134 C	38.48
921553	AA1-134 E	16.49
921582	AA1-139 C	52.15
921583	AA1-139 E	22.35
921772	AA2-059 C	6.75
921773	AA2-059 E	3.11
922532	AA2-178 C	22.02
922533	AA2-178 E	9.44
922602	AB1-013 C	6.65
922603	AB1-013 E	44.48
922882	AB1-077 C	13.4
922883	AB1-077 E	89.66
923831	AB2-022 C	8.07
923832	AB2-022 E	4.35
925121	AB2-169 C OP	7.92
925122	AB2-169 E OP	7.11
925281	AB2-186 C	1.73
925282	AB2-186 E	0.74
925291	AB2-188 C OP	5.43
925292	AB2-188 E OP	2.44