

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position AC1-098***

***Dawson Crossroads – South Justice Branch
115kV***

37.6 MW Capacity / 60 MW Energy

Revised May / 2017

Introduction

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

Preface

The intent of the Feasibility Study is to determine a plan, with high level estimated cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the IC. The IC may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the IC may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation will be deferred until the Impact Study is performed.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The IC is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by ITO, the costs may be included in the study.

General

The IC has proposed a solar generating facility located in Halifax County, NC. The installed facilities will have a total capability of 60 MW with 37.6 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is 6/01/2019. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AC1-098 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects at the future Dawson Crossroads – South Justice Branch 115kV line.

Cost Summary

The AC1-098 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$1,100,000
Direct Connection Network Upgrades	\$5,600,000
Non Direct Connection Network Upgrades	\$ 600,000
Total Costs	\$7,300,000

In addition, the AC1-098 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	\$41,000,000
Previously Identified Upgrades	\$13,665,000
Total Costs	\$54,665,000

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 cost allocation rule differ depending on whether the minimum amount of upgrades to resolve a single reliability criteria violation will cost less than \$5,000,000. For upgrades estimated to cost less than \$5,000,000 the allocation of costs will not occur outside of the Queue in which the need for the Network Upgrade was identified. Cost allocation within the Queue will be contingent each Queue projects Distribution Factor on the overloaded facility. For upgrades estimated to cost \$5,000,000 or greater the allocation of costs will start with the first Queue project to cause the need for the upgrade. Later queue projects will receive cost allocation contingent on their contribution to the violation and are allocated to the queues that have not closed less than 5 years following the execution of the first Interconnection Service Agreement which identifies the need for this upgrade.

Attachment Facilities

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

Transmission: Build a half mile of 115 kV attachment line to the POI. Estimated cost \$500,000.

The estimated total cost of the Attachment Facilities is \$1,100,000. It is estimated to take 12-14 months to complete this work. These costs do not include CIAC Tax Gross-up. The single line is shown below in Attachment 1.

Direct Connection Cost Estimate

Substation: Build a three breaker and install associated equipment at the 115 kV Switching Station located between Scotland Neck and South Justice Substations. Estimated cost \$5,600,000 and it is estimated to take 24-30 months to permit and construct.

Non-Direct Connection Cost Estimate

Transmission: Install necessary transmission structures to split Line # 31 into the proposed new AC1-098 Switching Station. Estimated cost \$600,000.

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.

New System Reinforcements

Reinforcement: AB2-100 Tap – Lakeview 230 kV line #254: Rebuild the AB2-100 TAP-Lakeview 230kV line to increase its emergency line rating to a minimum of 460 MVA and its load dump rating to a minimum of 530 MVA. It is estimated to take 44-48 months to permit and construct a Virginia CPCN and potentially a certificate from the NC PUC will most likely be required for this rebuild, the estimated cost is \$41,000,000 to resolve this deficiency.

Contribution to Previously Identified System Reinforcements

Reinforcement: Battleboro – Rocky Mt 115kV: Replace Battleboro substation terminal equipment. Estimated cost is \$15,000.

Note: Duke/Progress Energy portion of this line will need to be studied under Duke's FERC tariff process.

Reinforcement: Clubhouse – Sapony 230kV line: Replace wave trap at Clubhouse Substation. This will increase emergency rating 722 MVA. Estimated cost \$150,000 and it is estimated to take 12-16 months.

Reinforcement: Rebuild the AB2-100 TAP-Clubhouse 230kV line: Estimated cost \$13,500,000 and it is estimated to take 24-28 months to engineer, permit and construct.

Interconnection Customer Requirements

ITO's Facility Connection Requirements as posted on PJM's website

<http://www.pjm.com/~media/planning/plan-standards/private-dominion/facility-connection-requirements1.ashx>

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

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

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

Revenue Metering and SCADA Requirements

PJM Requirements

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

Network Impacts

The Queue Project AC1-098 was evaluated as a 60.0 MW (Capacity 37.6 MW) injection tapping the Scotland Neck-South Justice 115kV in the ITO area. Project AC1-099 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-098 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
201262	CONTINGENCY '201262' /* EARLEYS OPEN BRANCH FROM BUS 314569 TO BUS 314266 CKT 1 /* 2012 OPEN BRANCH FROM BUS 314266 TO BUS 314599 CKT 1 /* 2012 OPEN BRANCH FROM BUS 314569 TO BUS 314568 CKT 1 /* TX. #3 END
246T2034_A	CONTINGENCY '246T2034_A' /* EARLEYS OPEN BRANCH FROM BUS 314569 TO BUS 314575 CKT 1 /* 246 OPEN BRANCH FROM BUS 314575 TO BUS 921571 CKT 1 /* 246 AA1-138 TAP OPEN BRANCH FROM BUS 314575 TO BUS 314590 CKT 1 /* 246 - NUCOR OPEN BRANCH FROM BUS 314569 TO BUS 314620 CKT 1 /* 2034 OPEN BRANCH FROM BUS 314620 TO BUS 314616 CKT 1 /* 2034 OPEN BRANCH FROM BUS 314616 TO BUS 314613 CKT 1 /* TROWBRIDGE TX #1&2 END
562T563	CONTINGENCY '562T563' /*CARSON OPEN BRANCH FROM BUS 314902 TO BUS 314923 CKT 1 /*CARSON TO MIDLOTHIAN OPEN BRANCH FROM BUS 314914 TO BUS 314902 CKT 1 /*CARSON 500.00 - 8SEPTA 500.00 END
DVP_P1-2:2056_A	CONTINGENCY 'DVP_P1-2:2056_A' OPEN BRANCH FROM BUS 313845 TO BUS 927140 CKT 1 /* 6HATHAWAY 230.00 - AC1-208 TAP 230.00 END
LN 2012	CONTINGENCY 'LN 2012' OPEN BRANCH FROM BUS 314266 TO BUS 314569 CKT 1 /* 6NORTHAMPTON230.00 - 6EARLEYS 230.00 OPEN BRANCH FROM BUS 314266 TO BUS 314599 CKT 1 /* 6NORTHAMPTON230.00 - 6ROA VAL 230.00 OPEN BUS 314266 /* ISLAND END

Contingency Name	Description
LN 2058-2181	CONTINGENCY 'LN 2058-2181' OPEN BUS 304226 /* ISLAND: 6PA-RMOUNT#4115.00 OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 6PA- RMOUNT#4230.00 - 6NASH 230.00 OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 6HATHAWAY 230.00 - 6NASH 230.00 OPEN BUS 314591 /* ISLAND: 6NASH 230.00 OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /* 6ROCKYMT230T230.00 - 6HATHAWAY 230.00 END
LN 2131A	CONTINGENCY 'LN 2131A' OPEN BRANCH FROM BUS 314662 TO BUS 916040 CKT 1 /* 6S HERTFORD 230.00 - Z1-036 TAP 230.00 OPEN BRANCH FROM BUS 314651 TO BUS 314662 CKT 1 /* 6WINFALL 230.00 - 6S HERTFORD 230.00 OPEN BUS 314662 /* ISLAND END
LN 54-2012_B	CONTINGENCY 'LN 54-2012_B' OPEN BRANCH FROM BUS 921751 TO BUS 314581 CKT 1 /* AA2-053 TAP 115.00 - 3JACKSON 115.00 OPEN BRANCH FROM BUS 314568 TO BUS 314625 CKT 1 /* 3EARLEYS 115.00 - 3AULANDR 115.00 OPEN BRANCH FROM BUS 314581 TO BUS 314626 CKT 1 /* 3JACKSON 115.00 - 3WOODLND 115.00 OPEN BRANCH FROM BUS 314625 TO BUS 314626 CKT 1 /* 3AULANDR 115.00 - 3WOODLND 115.00 OPEN BUS 314581 /* ISLAND OPEN BUS 314625 /* ISLAND OPEN BUS 314626 /* ISLAND OPEN BRANCH FROM BUS 314266 TO BUS 314569 CKT 1 /* 6NORTHAMPTON230.00 - 6EARLEYS 230.00 OPEN BRANCH FROM BUS 314266 TO BUS 314599 CKT 1 /* 6NORTHAMPTON230.00 - 6ROA VAL 230.00 OPEN BUS 314266 /* ISLAND END

Contingency Name	Description
LN 56-2012_A	<p>CONTINGENCY 'LN 56-2012_A'</p> <p>OPEN BRANCH FROM BUS 314259 TO BUS 314559 CKT Z1 /* 3CAR56_1 115.00 - 3CAROLNA 115.00</p> <p>OPEN BRANCH FROM BUS 314259 TO BUS 921161 CKT 1 /* 3CAR56_1 115.00 - AA1-063A TAP 115.00</p> <p>OPEN BRANCH FROM BUS 314558 TO BUS 314587 CKT 1 /* 3BOYKINS 115.00 - 3MARGTSV 115.00</p> <p>OPEN BRANCH FROM BUS 314587 TO BUS 314604 CKT 1 /* 3MARGTSV 115.00 - 3SEABORD 115.00</p> <p>OPEN BUS 314259 /* ISLAND</p> <p>OPEN BUS 314587 /* ISLAND</p> <p>OPEN BUS 314604 /* ISLAND</p> <p>OPEN BRANCH FROM BUS 314266 TO BUS 314569 CKT 1 /* 6NORTHAMPTON230.00 - 6EARLEYS 230.00</p> <p>OPEN BRANCH FROM BUS 314266 TO BUS 314599 CKT 1 /* 6NORTHAMPTON230.00 - 6ROA VAL 230.00</p> <p>OPEN BUS 314266 /* ISLAND</p> <p>END</p>

Summer Peak Analysis - 2020

System Reinforcement responsible by ITO

Contingency			Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
#	Type	Name			From	To	Cir.		Initial	Final	Type	MVA		
1	LFFB	562T563	DVP - DVP	6CHARCTY-6LAKESD 230 kV line	314225	314227	1	DC	99.91	100.22	ER	459	3.13	

Generator Deliverability

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

Contingency			Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
#	Type	Name			From	To	Cir.		Initial	Final	Type	MVA		
2	N-1	LN 2012	DVP - DVP	6LAKEVIEW-AB2-100 TAP 230 kV line	314583	924510	1	DC	94.92	96.26	ER	375	5.06	1

Multiple Facility Contingency

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

Contingency			Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
#	Type	Name			From	To	Cir.		Initial	Final	Type	MVA		
3	LFFB	562T563	DVP - DVP	6CHARCTY-6LAKESD 230 kV line	314225	314227	1	DC	99.91	100.22	ER	459	3.13	2

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		
4	DCTL	LN 2058-2181	DVP - CPLE	3BTLEBRO-3ROCKYMT115T 115 kV line	314554	304223	1	DC	154.3	162.08	ER	164	12.76	3
5	LFFB	246T2034_A	DVP - DVP	6CLUBHSE-6SAPONY 230 kV line	314563	314435	1	DC	103.28	105.55	LD	637	14.47	4
6	DCTL	LN 54-2012_B	DVP - DVP	6CLUBHSE-6SAPONY 230 kV line	314563	314435	1	DC	102.92	104.56	LD	637	10.48	
7	DCTL	LN 56-2012_A	DVP - DVP	6CLUBHSE-6SAPONY 230 kV line	314563	314435	1	DC	102.01	103.77	LD	637	11.2	
8	LFFB	246T2034_A	DVP - DVP	AB2-100 TAP-6CLUBHSE 230 kV line	924510	314563	1	DC	116.21	118.75	LD	459	11.64	5
9	DCTL	LN 54-2012_B	DVP - DVP	AB2-100 TAP-6CLUBHSE 230 kV line	924510	314563	1	DC	115.74	117.48	LD	459	7.98	
10	LFFB	201262	DVP - DVP	AB2-100 TAP-6CLUBHSE 230 kV line	924510	314563	1	DC	113.45	115.28	LD	459	8.41	
11	N-1	LN 2012	DVP - DVP	AB2-100 TAP-6CLUBHSE 230 kV line	924510	314563	1	DC	113.37	114.72	ER	375	5.06	

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Cir.		Initial	Final	Type	MVA		
12	DCTL	LN 56-2012_A	DVP - DVP	AB2-100 TAP-6CLUBHSE 230 kV line	924510	314563	1	DC	112.88	114.71	LD	459	8.4	
13	N-1	DVP_P1-2:2056_A	DVP - DVP	AB2-100 TAP-6CLUBHSE 230 kV line	924510	314563	1	DC	104.76	106.04	ER	375	4.79	

Steady-State Voltage Requirements

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

To be determined during Impact Study.

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

To be determined during Impact Study.

New System Reinforcements

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

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
# 1, 3	6CHARCTY-6LAKESD 230 kV line	Rebuild 21.32 miles of the Chesterfield - Lakeside 230kV transmission line by 6/1/2020	b2745	
# 2	6LAKEVEW-AB2-100 TAP 230 kV line	Rebuild the AB2-100 TAP-Lakeview 230kV line. Estimated time: 44-48 months.	Pending	\$41,000,000
Total New Network Upgrades				\$41,000,000

Contribution to Previously Identified System Reinforcements

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

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
# 4	3BTLEBRO-3ROCKYMT115T 115 kV line	Upgrade Battleboro terminal equipment	Pending	\$15,000
# 5 – 7	6CLUBHSE-6SAPONY 230 kV line	Replace wave trap at Clubhouse Substation. This will increase emergency rating 722 MVA. Estimated time: 12-16 months.	Pending	\$150,000
# 8 - 13	AB2-100 TAP-6CLUBHSE 230 kV line	Rebuild the AB2-100 TAP-Clubhouse 230kV line. Estimated time: 44-48 months.	Pending	\$13,500,000
Total New Network Upgrades				\$13,165,000

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The IC can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA	
14	N-1	LN 2012	DVP - DVP	6CLUBHSE-6SAPONY 230 kV line	314563	314435	1	DC	104.82	106.6	ER	599	10.65

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA	
15	N-1	LN 2131A	DVP - DVP	6EARLEYS-6NUCO TP 230 kV line	314569	314575	1	DC	105.07	107.28	ER	572	12.65
16	N-1	LN 2131A	DVP - DVP	6NUCO TP-AA1-138 TAP 230 kV line	314575	921571	1	DC	98.27	100.48	ER	572	12.65
17	N-1	LN 2012	DVP - DVP	6LAKEVEW-AB2-100 TAP 230 kV line	314583	924510	1	DC	111.24	113.39	ER	375	8.07
18	N-1	LN 2131A	DVP - DVP	AA1-138 TAP-6SUFFOLK 230 kV line	921571	314537	1	DC	107.77	109.98	ER	572	12.65
19	N-1	LN 2012	DVP - DVP	AB2-100 TAP-6CLUBHSE 230 kV line	924510	314563	1	DC	137.49	139.64	ER	375	8.07

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 #AC1-098 interconnection of a 60 MW Energy (37.6 MW Capacity) injection into the ITO's Transmission System at a new interconnection switching station located between Scotland Neck and South Justice Substation at 115 kV section of Line, 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

The import and export conditions into and out of the ITO System are evaluated with any new interconnection greater than 20 MW, any new facility that is interconnected with the ITO System should not significantly decrement FCITC between utilities. These studies will be performed during the System Impact Study.

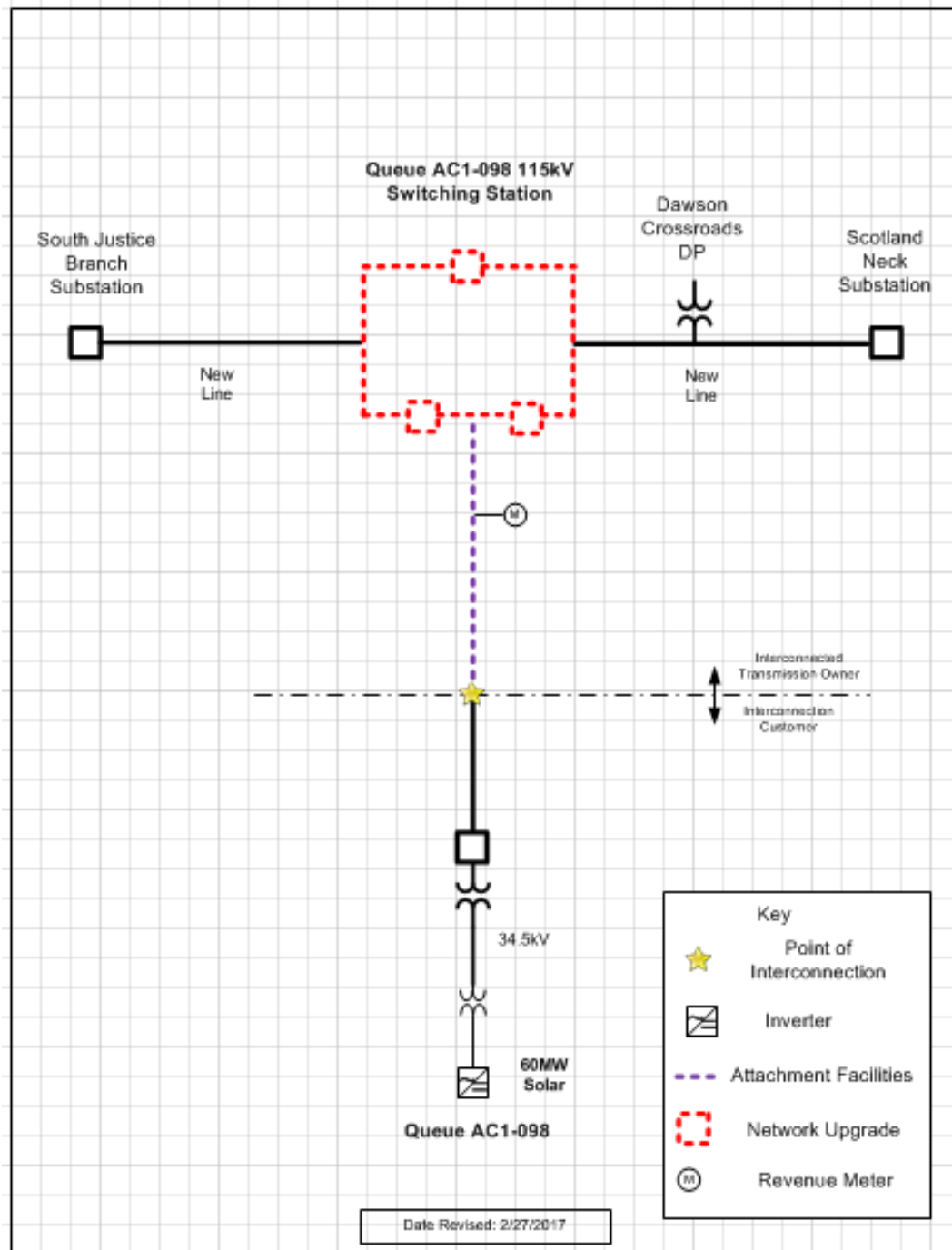
Affected System Analysis & Mitigation

Duke, Progress & TVA Impacts:

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

Attachment 1.

System Configuration



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 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 6LAKEVEW-AB2-100 TAP 230 kV line (from bus 314583 to bus 924510 ckt 1) loads from 94.92% to 96.26% (**DC power flow**) of its emergency rating (375 MVA) for the single line contingency outage of 'LN 2012'. This project contributes approximately 5.06 MW to the thermal violation.

CONTINGENCY 'LN 2012'

OPEN BRANCH FROM BUS 314266 TO BUS 314569 CKT 1 /*

6NORTHAMPTON230.00 - 6EARLEYS 230.00

OPEN BRANCH FROM BUS 314266 TO BUS 314599 CKT 1 /*

6NORTHAMPTON230.00 - 6ROA VAL 230.00

OPEN BUS 314266 /* ISLAND

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315131	1EDGECEMA	1.83
315132	1EDGECEMB	1.83
315139	1GASTONA	8.68
315141	1GASTONB	8.68
315159	1KERR 2	0.58
315161	1KERR 4	0.57
315162	1KERR 5	0.57
315163	1KERR 6	0.57
315164	1KERR 7	0.57
315126	1ROARAP2	1.66
315128	1ROARAP4	1.59
315134	1ROAVALA	12.68
315135	1ROAVALB	3.38
315136	1ROSEMG1	5.76
315138	1ROSEMG2	2.7
315137	1ROSEMS1	3.57
315115	1SHAMPT1	0.85
900671	V4-068 C	0.06
917331	Z2-043 C	0.27
917341	Z2-044 C	0.24
917511	Z2-088 C OP1	0.65
917591	Z2-099 C	0.11
918411	AA1-050	0.54
LTF	AA1-058	0.36

921162	AA1-063AC	7.41
921182	AA1-067 C	0.9
918561	AA1-072 C	0.04
921562	AA1-135 C	4.
921752	AA2-053 C	8.07
921762	AA2-057 C	6.56
921862	AA2-068 C	2.02
920021	AA2-086 C	0.06
921982	AA2-088 C	3.58
922442	AA2-165 C	0.89
922472	AA2-169 C	1.45
922512	AA2-174 C	0.37
922722	AB1-053 C	2.47
922732	AB1-054 C	3.89
922922	AB1-081 C OP	8.71
923262	AB1-132 C OP	35.07
923801	AB2-015 C OP	3.18
923941	AB2-035 C	0.29
924151	AB2-059 C OP	10.27
924381	AB2-087 C	0.27
924391	AB2-088 C	0.38
924401	AB2-089 C	1.01
924491	AB2-098 C	0.3
924501	AB2-099 C	0.29
925121	AB2-169 C OP	2.39
925141	AB2-171 C OP	2.13
925591	AC1-034 C OP	5.94
925781	AC1-054 C OP	3.91
926071	AC1-086 C	51.64
926201	AC1-098 C	5.06
926211	AC1-099 C	1.69
926771	AC1-163 C	1.04
927021	AC1-189 C	5.31
927051	AC1-193 C	1.56
927141	AC1-208 C	15.32

Appendix 2

(DVP - DVP) The 6CHARCTY-6LAKESD 230 kV line (from bus 314225 to bus 314227 ckt 1) loads from 99.91% to 100.22% (**DC power flow**) of its emergency rating (459 MVA) for the line fault with failed breaker contingency outage of '562T563'. This project contributes approximately 3.13 MW to the thermal violation.

CONTINGENCY '562T563'

/*CARSON

OPEN BRANCH FROM BUS 314902 TO BUS 314923 CKT 1

/*CARSON TO

MIDLOTHIAN

OPEN BRANCH FROM BUS 314914 TO BUS 314902 CKT 1

/*CARSON 500.00

- 8SEPTA 500.00

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315065	1CHESTF6	25.21
315073	1STONECA	3.83
314314	3LOCKS	0.8
314539	3UNCAMP	0.75
314541	3WATKINS	0.22
314229	6MT R221	-0.28
292791	U1-032 E	1.99
900672	V4-068 E	0.1
907092	X1-038 E	1.87
916302	Z1-086 E	2.94
917332	Z2-043 E	0.31
917592	Z2-099 E	0.14
921162	AA1-063AC	2.88
921163	AA1-063AE	1.36
918512	AA1-065 E OP	1.35
918562	AA1-072 E	0.05
921752	AA2-053 C	2.96
921753	AA2-053 E	1.27
921762	AA2-057 C	2.23
921763	AA2-057 E	1.12
921862	AA2-068 C	0.71
921863	AA2-068 E	0.33
920022	AA2-086 E	0.08
921982	AA2-088 C	2.07
921983	AA2-088 E	3.38

922442	AA2-165 C	0.3
922443	AA2-165 E	0.15
922472	AA2-169 C	0.69
922473	AA2-169 E	0.32
922512	AA2-174 C	0.14
922513	AA2-174 E	0.15
922522	AA2-177 C	4.46
922523	AA2-177 E	1.91
922722	AB1-053 C	0.39
922723	AB1-053 E	0.22
922732	AB1-054 C	2.19
922733	AB1-054 E	1.08
923262	AB1-132 C OP	5.31
923263	AB1-132 E OP	2.28
923572	AB1-173 C OP	0.88
923573	AB1-173 E OP	0.41
923582	AB1-173AC OP	0.88
923583	AB1-173AE OP	0.41
923801	AB2-015 C OP	2.68
923802	AB2-015 E OP	2.2
923851	AB2-025 C	1.35
923852	AB2-025 E	0.61
923911	AB2-031 C OP	0.87
923912	AB2-031 E OP	0.43
923981	AB2-039 C OP	3.83
923982	AB2-039 E OP	3.1
923991	AB2-040 C OP	2.86
923992	AB2-040 E OP	2.34
924381	AB2-087 C	0.18
924382	AB2-087 E	0.08
924501	AB2-099 C	0.18
924502	AB2-099 E	0.08
924511	AB2-100 C	4.84
924512	AB2-100 E	2.39
924761	AB2-128 C	4.15
924762	AB2-128 E	1.63
924811	AB2-134 C OP	5.72
924812	AB2-134 E OP	7.65
924931	AB2-147 C	1.06

924932	AB2-147 E	1.73
924941	AB2-149 C OP	1.27
924942	AB2-149 E OP	2.08
924951	AB2-150 C OP	1.06
924952	AB2-150 E OP	1.73
924961	AB2-152	1.5
925051	AB2-160 C OP	3.21
925052	AB2-160 E OP	5.24
925061	AB2-161 C OP	1.55
925062	AB2-161 E OP	2.53
925141	AB2-171 C OP	1.54
925142	AB2-171 E OP	2.51
925171	AB2-174 C OP	2.81
925172	AB2-174 E OP	2.54
925331	AB2-190 C	10.19
925332	AB2-190 E	2.55
925361	AC1-007 C OP	0.19
925362	AC1-007 E OP	0.31
925821	AC1-061	0.02
926071	AC1-086 C	7.83
926072	AC1-086 E	3.56
926201	AC1-098 C	1.96
926202	AC1-098 E	1.17
926211	AC1-099 C	0.66
926212	AC1-099 E	0.39
926771	AC1-163 C	0.66
926772	AC1-163 E	0.31
927051	AC1-193 C	1.13
927052	AC1-193 E	1.84
927111	AC1-206 C OP	5.52
927112	AC1-206 E OP	2.61
927141	AC1-208 C	3.04
927142	AC1-208 E	1.35
927221	AC1-216 C OP	4.36
927222	AC1-216 E OP	3.43

Appendix 3

(DVP - CPLE) The 3BTLEBRO-3ROCKYMT115T 115 kV line (from bus 314554 to bus 304223 ckt 1) loads from 154.3% to 162.08% (**DC power flow**) of its emergency rating (164 MVA) for the tower line contingency outage of 'LN 2058-2181'. This project contributes approximately 12.76 MW to the thermal violation.

CONTINGENCY 'LN 2058-2181'

OPEN BUS 304226 /* ISLAND: 6PA-RMOUNT#4115.00

OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 6PA-
RMOUNT#4230.00 - 6NASH 230.00

OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 6HATHAWAY
230.00 - 6NASH 230.00

OPEN BUS 314591 /* ISLAND: 6NASH 230.00

OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /*
6ROCKYMT230T230.00 - 6HATHAWAY 230.00

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315131	1EDGECEMA	2.54
315132	1EDGECEMB	2.54
315139	1GASTONA	2.41
315141	1GASTONB	2.41
315126	1ROARAP2	1.
315128	1ROARAP4	0.96
315134	1ROAVALA	3.42
315135	1ROAVALB	0.91
315136	1ROSEMG1	1.96
315138	1ROSEMG2	0.92
315137	1ROSEMS1	1.21
900672	V4-068 E	0.15
917331	Z2-043 C	0.36
917332	Z2-043 E	0.83
917341	Z2-044 C	0.55
917342	Z2-044 E	1.25
917511	Z2-088 C OP1	0.71
917512	Z2-088 E OP1	6.1
917592	Z2-099 E	0.2
918411	AA1-050	0.59
LTF	AA1-055	9.47

921162	AA1-063AC	4.88
921163	AA1-063AE	2.3
918512	AA1-065 E OP	1.96
921182	AA1-067 C	0.73
921183	AA1-067 E	0.31
918561	AA1-072 C	0.05
918562	AA1-072 E	0.14
921562	AA1-135 C	4.03
921563	AA1-135 E	1.73
921752	AA2-053 C	5.42
921753	AA2-053 E	2.33
921762	AA2-057 C	12.88
921763	AA2-057 E	6.44
921862	AA2-068 C	3.3
921863	AA2-068 E	1.52
920022	AA2-086 E	0.11
921982	AA2-088 C	2.94
921983	AA2-088 E	4.8
922442	AA2-165 C	1.76
922443	AA2-165 E	0.85
922512	AA2-174 C	0.25
922513	AA2-174 E	0.27
922722	AB1-053 C	0.84
922723	AB1-053 E	0.47
922732	AB1-054 C	3.16
922733	AB1-054 E	1.55
922922	AB1-081 C OP	20.07
922923	AB1-081 E OP	8.6
923262	AB1-132 C OP	9.76
923263	AB1-132 E OP	4.18
923572	AB1-173 C OP	1.21
923573	AB1-173 E OP	0.57
923582	AB1-173AC OP	1.21
923583	AB1-173AE OP	0.57
923911	AB2-031 C OP	1.2
923912	AB2-031 E OP	0.59
923941	AB2-035 C	0.37
923942	AB2-035 E	0.16
923991	AB2-040 C OP	3.95

923992	AB2-040 E OP	3.23
924151	AB2-059 C OP	23.66
924152	AB2-059 E OP	12.19
924381	AB2-087 C	0.31
924382	AB2-087 E	0.15
924391	AB2-088 C	0.47
924392	AB2-088 E	0.23
924491	AB2-098 C	0.24
924492	AB2-098 E	0.1
924501	AB2-099 C	0.32
924502	AB2-099 E	0.14
924511	AB2-100 C	6.41
924512	AB2-100 E	3.16
924761	AB2-128 C	5.49
924762	AB2-128 E	2.16
924931	AB2-147 C	1.14
924932	AB2-147 E	1.86
924951	AB2-150 C OP	1.14
924952	AB2-150 E OP	1.86
925141	AB2-171 C OP	1.93
925142	AB2-171 E OP	3.14
925171	AB2-174 C OP	3.57
925172	AB2-174 E OP	3.23
925591	AC1-034 C OP	7.52
925592	AC1-034 E OP	5.67
926071	AC1-086 C	14.37
926072	AC1-086 E	6.54
926201	AC1-098 C	8.
926202	AC1-098 E	4.76
926211	AC1-099 C	2.68
926212	AC1-099 E	1.57
926771	AC1-163 C	1.14
926772	AC1-163 E	0.53
927021	AC1-189 C	5.15
927022	AC1-189 E	2.56
927051	AC1-193 C	1.41
927052	AC1-193 E	2.31
927111	AC1-206 C OP	5.11
927112	AC1-206 E OP	2.42

<i>927141</i>	<i>ACI-208 C</i>	<i>10.06</i>
<i>927142</i>	<i>ACI-208 E</i>	<i>4.47</i>

Appendix 4

(DVP - DVP) The 6CLUBHSE-6SAPONY 230 kV line (from bus 314563 to bus 314435 ckt 1) loads from 103.28% to 105.55% (**DC power flow**) of its load dump rating (637 MVA) for the line fault with failed breaker contingency outage of '246T2034_A'. This project contributes approximately 14.47 MW to the thermal violation.

CONTINGENCY '246T2034_A'

/* EARLEYS

OPEN BRANCH FROM BUS 314569 TO BUS 314575 CKT 1

/* 246

OPEN BRANCH FROM BUS 314575 TO BUS 921571 CKT 1

/* 246 AA1-138

TAP

OPEN BRANCH FROM BUS 314575 TO BUS 314590 CKT 1

/* 246 - NUCOR

OPEN BRANCH FROM BUS 314569 TO BUS 314620 CKT 1

/* 2034

OPEN BRANCH FROM BUS 314620 TO BUS 314616 CKT 1

/* 2034

OPEN BRANCH FROM BUS 314616 TO BUS 314613 CKT 1

/* TROWBRIDGE

TX #1&2

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315132	1EDGE CMB	2.14
315139	1GASTONA	7.67
315141	1GASTONB	7.67
315126	1ROARAP2	2.78
315128	1ROARAP4	2.67
315134	1ROAVALA	10.91
315135	1ROAVALB	2.91
315136	1ROSEMG1	5.18
315138	1ROSEMG2	2.43
315137	1ROSEMS1	3.21
314704	3LAWRENC	0.81
314541	3WATKINS	0.52
900671	V4-068 C	0.13
900672	V4-068 E	0.36
917331	Z2-043 C	0.66
917332	Z2-043 E	1.49
917341	Z2-044 C	0.33
917342	Z2-044 E	0.74
917512	Z2-088 E OP1	9.27
917592	Z2-099 E	0.48
LTF	AA1-058	0.57

921162	AA1-063AC	12.86
921163	AA1-063AE	6.07
918511	AA1-065 C OP	2.6
918512	AA1-065 E OP	6.78
921182	AA1-067 C	1.92
921183	AA1-067 E	0.82
918561	AA1-072 C	0.1
918562	AA1-072 E	0.25
921562	AA1-135 C	12.3
921563	AA1-135 E	5.27
921752	AA2-053 C	14.96
921753	AA2-053 E	6.42
921762	AA2-057 C	9.81
921763	AA2-057 E	4.91
921862	AA2-068 C	3.27
921863	AA2-068 E	1.5
LTF	AA2-074	2.64
920022	AA2-086 E	0.26
921982	AA2-088 C	6.85
921983	AA2-088 E	11.18
922442	AA2-165 C	1.34
922443	AA2-165 E	0.65
922472	AA2-169 C	2.96
922473	AA2-169 E	1.36
922512	AA2-174 C	0.69
922513	AA2-174 E	0.74
922722	AB1-053 C	2.22
922723	AB1-053 E	1.25
922732	AB1-054 C	7.44
922733	AB1-054 E	3.66
922922	AB1-081 C OP	10.86
922923	AB1-081 E OP	4.65
923262	AB1-132 C OP	31.01
923263	AB1-132 E OP	13.29
923572	AB1-173 C OP	5.12
923573	AB1-173 E OP	2.39
923582	AB1-173AC OP	5.12
923583	AB1-173AE OP	2.39
923911	AB2-031 C OP	5.09

923912	AB2-031 E OP	2.51
923941	AB2-035 C	0.4
923942	AB2-035 E	0.17
923991	AB2-040 C OP	16.7
923992	AB2-040 E OP	13.67
924021	AB2-043 C OP	2.78
924022	AB2-043 E OP	4.57
924151	AB2-059 C OP	12.8
924152	AB2-059 E OP	6.59
924301	AB2-077 C OP	1.74
924302	AB2-077 E OP	1.16
924311	AB2-078 C OP	1.74
924312	AB2-078 E OP	1.16
924321	AB2-079 C OP	1.74
924322	AB2-079 E OP	1.16
924381	AB2-087 C	0.86
924382	AB2-087 E	0.4
924391	AB2-088 C	0.52
924392	AB2-088 E	0.25
924401	AB2-089 C	2.43
924402	AB2-089 E	1.25
924411	AB2-090 C	3.51
924412	AB2-090 E	1.8
924491	AB2-098 C	0.64
924492	AB2-098 E	0.27
924501	AB2-099 C	0.84
924502	AB2-099 E	0.36
924511	AB2-100 C	31.41
924512	AB2-100 E	15.47
924761	AB2-128 C	26.91
924762	AB2-128 E	10.59
924931	AB2-147 C	6.65
924932	AB2-147 E	10.85
924951	AB2-150 C OP	6.65
924952	AB2-150 E OP	10.85
925141	AB2-171 C OP	4.01
925142	AB2-171 E OP	6.54
925171	AB2-174 C OP	16.93
925172	AB2-174 E OP	15.32

925221	AB2-176 C	1.44
925222	AB2-176 E	0.62
925591	AC1-034 C OP	8.17
925592	AC1-034 E OP	6.16
925781	AC1-054 C OP	8.73
925782	AC1-054 E OP	4.02
926071	AC1-086 C	45.67
926072	AC1-086 E	20.79
926201	AC1-098 C	9.07
926202	AC1-098 E	5.4
926211	AC1-099 C	3.04
926212	AC1-099 E	1.78
926281	AC1-106	2.31
926771	AC1-163 C	3.04
926772	AC1-163 E	1.42
927021	AC1-189 C	9.87
927022	AC1-189 E	4.91
927051	AC1-193 C	2.94
927052	AC1-193 E	4.79
927111	AC1-206 C OP	38.59
927112	AC1-206 E OP	18.24
927141	AC1-208 C	15.04
927142	AC1-208 E	6.68
927211	AC1-215 C	9.17
927212	AC1-215 E	4.16

Appendix 5

(DVP - DVP) The AB2-100 TAP-6CLUBHSE 230 kV line (from bus 924510 to bus 314563 ckt 1) loads from 116.21% to 118.75% (**DC power flow**) of its load dump rating (459 MVA) for the line fault with failed breaker contingency outage of '246T2034_A'. This project contributes approximately 11.64 MW to the thermal violation.

CONTINGENCY '246T2034_A'

/* EARLEYS

OPEN BRANCH FROM BUS 314569 TO BUS 314575 CKT 1

/* 246

OPEN BRANCH FROM BUS 314575 TO BUS 921571 CKT 1

/* 246 AA1-138

TAP

OPEN BRANCH FROM BUS 314575 TO BUS 314590 CKT 1

/* 246 - NUCOR

OPEN BRANCH FROM BUS 314569 TO BUS 314620 CKT 1

/* 2034

OPEN BRANCH FROM BUS 314620 TO BUS 314616 CKT 1

/* 2034

OPEN BRANCH FROM BUS 314616 TO BUS 314613 CKT 1

/* TROWBRIDGE

TX #1&2

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315131	1EDGECEMA	2.07
315132	1EDGECEMB	2.07
315139	1GASTONA	7.99
315141	1GASTONB	7.99
315126	1ROARAP2	1.71
315128	1ROARAP4	1.64
315134	1ROAVALA	11.09
315135	1ROAVALB	2.96
315136	1ROSEMG1	5.36
315138	1ROSEMG2	2.51
315137	1ROSEMS1	3.33
900671	V4-068 C	0.1
900672	V4-068 E	0.28
917331	Z2-043 C	0.56
917332	Z2-043 E	1.27
917341	Z2-044 C	0.29
917342	Z2-044 E	0.65
917511	Z2-088 C OP1	1.03
917512	Z2-088 E OP1	8.87
917591	Z2-099 C	0.14
917592	Z2-099 E	0.33

918411	AA1-050	0.87
LTF	AA1-058	0.53
921162	AA1-063AC	8.21
921163	AA1-063AE	3.87
918511	AA1-065 C OP	2.47
918512	AA1-065 E OP	6.44
921182	AA1-067 C	1.83
921183	AA1-067 E	0.78
918561	AA1-072 C	0.08
918562	AA1-072 E	0.21
921562	AA1-135 C	11.7
921563	AA1-135 E	5.01
921752	AA2-053 C	10.03
921753	AA2-053 E	4.31
921762	AA2-057 C	8.1
921763	AA2-057 E	4.05
921862	AA2-068 C	2.57
921863	AA2-068 E	1.18
LTF	AA2-074	2.29
920021	AA2-086 C	0.08
920022	AA2-086 E	0.18
921982	AA2-088 C	4.76
921983	AA2-088 E	7.76
922442	AA2-165 C	1.1
922443	AA2-165 E	0.53
922472	AA2-169 C	1.51
922473	AA2-169 E	0.69
922512	AA2-174 C	0.46
922513	AA2-174 E	0.5
922722	AB1-053 C	2.3
922723	AB1-053 E	1.29
922732	AB1-054 C	5.17
922733	AB1-054 E	2.54
922922	AB1-081 C OP	10.09
922923	AB1-081 E OP	4.32
923262	AB1-132 C OP	32.27
923263	AB1-132 E OP	13.83
923941	AB2-035 C	0.39
923942	AB2-035 E	0.17

924151	AB2-059 C OP	11.89
924152	AB2-059 E OP	6.12
924381	AB2-087 C	0.76
924382	AB2-087 E	0.36
924391	AB2-088 C	0.5
924392	AB2-088 E	0.24
924491	AB2-098 C	0.61
924492	AB2-098 E	0.26
924501	AB2-099 C	0.72
924502	AB2-099 E	0.31
924511	AB2-100 C	35.63
924512	AB2-100 E	17.55
924761	AB2-128 C	30.53
924762	AB2-128 E	12.02
925121	AB2-169 C OP	4.42
925122	AB2-169 E OP	3.96
925141	AB2-171 C OP	2.77
925142	AB2-171 E OP	4.52
925591	AC1-034 C OP	7.86
925592	AC1-034 E OP	5.93
926071	AC1-086 C	47.52
926072	AC1-086 E	21.63
926201	AC1-098 C	7.29
926202	AC1-098 E	4.35
926211	AC1-099 C	2.44
926212	AC1-099 E	1.44
926771	AC1-163 C	2.6
926772	AC1-163 E	1.22
927021	AC1-189 C	9.42
927022	AC1-189 E	4.69
927051	AC1-193 C	2.03
927052	AC1-193 E	3.32
927141	AC1-208 C	15.19
927142	AC1-208 E	6.75