

***Generation Interconnection
System Impact Study Report***

For

***PJM Generation Interconnection Request
Queue Position AC2-012***

***Grassfield – Great Bridge 115kV
57 MW Capacity / 150 MW Energy***

Revised December 2020

May / 2018

Introduction

This System Impact Study (SIS) has been prepared in accordance with the PJM Open Access Transmission Tariff, Section 205, as well as the System Impact Study Agreement between NextEra Energy Resources LLC, 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 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 Chesapeake, Virginia (City of Chesapeake). The installed facilities will have a total capability of 150 MW with 57 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is 12/13/2022. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AC2-012 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects on to the Grassfield – Great Bridge 115kV line # 74.

Cost Summary

The AC2-012 interconnection request will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$ 1,550,000
Direct Connection Network Upgrades	\$ 5,500,000
Non Direct Connection Network Upgrades	\$ 800,000
Allocation for New System Upgrades	\$ 0
Contribution for Previously Identified Upgrades	\$ 0
Total Costs	\$ 7,850,000

Attachment Facilities

Generation Substation: Install metering and associated protection equipment. Estimated Cost \$550,000.

Transmission: Construct approximately one span of 115 kV Attachment line between the generation substation and a new AC2-012 Switching Station. The estimated cost for this work is \$1,000,000.

The estimated total cost of the Attachment Facilities is \$1,550,000. It is estimated to take 18-24 months to complete this work. 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. These costs do not include CIAC Tax Gross-up. The single line is shown below in Attachment 1.

Direct Connection Cost Estimate

Substation: Establish the new 115 kV AC2-012 Switching Substation (interconnection substation). The estimated cost of this work scope is \$5,500,000. It is estimated to take 24-36 months to complete this work.

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 \$800,000 dollars and 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.

New System Reinforcements

PJM OATT 217.3 outlines cost responsibility for Network Upgrades and as the minimum amount of Network Upgrades required to resolve a single reliability criteria violation will not meet or exceed \$5,000,000 such costs shall be allocated to those Interconnection Requests in the New Services Queue that contribute to the need for such upgrades. Such allocations shall be made in proportion to each Interconnection Request's megawatt contribution to the need for these upgrades subject to the rules for minimum cost allocation thresholds in the PJM Manuals. For the purpose of applying the \$5,000,000 threshold, each reliability criteria violation shall be considered separately.

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>

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

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

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

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

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.dominionenergy.com.

Network Impacts

The Queue Project AC2-012 was evaluated as a 150.0 MW (Capacity 57.0 MW) injection tapping the Grassfield – Great Bridge 115kV line in the ITO area. Project AC2-012 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-012 was studied with a commercial probability of 100%. Potential network impacts were as follows:

PJM assessed the impact of the proposed Queue Project as an injection into the ITO, for compliance with NERC Reliability Criteria. The system was assessed using the summer 2021 RTEP case. When performing analysis, ITO Criteria considers a transmission facility overloaded if it exceeds 94% of its emergency rating under single contingency (normal and stressed system conditions). A full listing of the ITO's Planning Criteria and interconnection requirements can be found in the ITO's Facility Connection Requirements which are publicly available at: <http://www.dominionenergy.com>.

The results of these studies evaluate the system under a limited set of operating conditions and do not guarantee the full delivery of the capacity and associated energy of this proposed generation facility under all operating conditions. NERC Planning and Operating Reliability Criteria allow for the re-dispatch of generating units to resolve projected and actual deficiencies in real time and planning studies. Specifically NERC Category C Contingency Conditions (Bus Fault, Tower Line, N-1-1, and Stuck Breaker scenarios) allow for re-dispatch of generating units to resolve potential reliability deficiencies. For ITO Planning Criteria the re-dispatch of generating units for these contingency conditions is allowed as long as the projected loading does not exceed 100% of a facility Load Dump Rating. The results of these studies are discussed in more detail below.

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
57602	CONTINGENCY '57602' /*NORTH ANNA
	OPEN BRANCH FROM BUS 314914 TO BUS 314918 CKT 1 /*MIDLOTHIAN TO NORTH ANNA (LINE 576)
	OPEN BRANCH FROM BUS 314914 TO BUS 314322 CKT 1 /*MIDLOTHIAN 500-230 (TX#2)
	OPEN BRANCH FROM BUS 314918 TO BUS 314232 CKT 1 /*NORTH ANNA 500-230 (TX#5)
	END
557T574	CONTINGENCY '557T574' /* 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 314911 TO BUS 314908 CKT 1 /*ELMONT TO LADYSMITH (LINE 574) 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
563T576	CONTINGENCY '563T576' /*MIDLOTHIAN OPEN BRANCH FROM BUS 314914 TO BUS 314918 CKT 1 /*MIDLOTHIAN TO NORTH ANNA (LINE 576) OPEN BRANCH FROM BUS 314914 TO BUS 314322 CKT 1 /*MIDLOTHIAN 500-230 (TX#2) OPEN BRANCH FROM BUS 314914 TO BUS 314902 CKT 1 /*MIDLOTHIAN TO CARSON (LINE 563) END
LN 208-259	CONTINGENCY 'LN 208-259' OPEN BRANCH FROM BUS 314286 TO BUS 314309 CKT 1 /* 6CHSTF A 230.00 - 6IRON208 230.00 OPEN BRANCH FROM BUS 314309 TO BUS 314338 CKT 1 /* 6IRON208 230.00 - 6SOUWEST 230.00 OPEN BUS 314309 /* ISLAND OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1 /* 6BASIN 230.00 - 6CHSTF B 230.00 END
LN 557	CONTINGENCY '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
LN 563	CONTINGENCY 'LN 563' OPEN BRANCH FROM BUS 314902 TO BUS 314914 CKT 1 /* 8CARSON 500.00 - 8MDLTHAN 500.00 END
LN 568	CONTINGENCY 'LN 568' OPEN BRANCH FROM BUS 314911 TO BUS 314922 CKT 1 /* 8LDYSMTH 500.00 - 8POSSUM 500.00 END

LN 573	CONTINGENCY 'LN 573' OPEN BRANCH FROM BUS 314918 TO BUS 314934 CKT 1 /* 8NO ANNA 500.00 - 8SPOTSYL 500.00 END
LN 574	CONTINGENCY 'LN 574' OPEN BRANCH FROM BUS 314908 TO BUS 314911 CKT 1 /* 8ELMONT 500.00 - 8LDYSMTH 500.00 END
LN 576	CONTINGENCY 'LN 576' OPEN BRANCH FROM BUS 314322 TO BUS 314914 CKT 1 /* 6MDLTHAN 230.00 - 8MDLTHAN 500.00 OPEN BRANCH FROM BUS 314914 TO BUS 314918 CKT 1 /* 8MDLTHAN 500.00 - 8NO ANNA 500.00 END
LN 594	CONTINGENCY 'LN 594' OPEN BRANCH FROM BUS 314916 TO BUS 314934 CKT 1 /* 8MORRSVL 500.00 - 8SPOTSYL 500.00 END
LN 74_B	CONTINGENCY 'LN 74_B' OPEN BRANCH FROM BUS 314471 TO BUS 932040 CKT 1 /* AC2-012 TAP - 3GREAT B 115.00 OPEN BUS 314471 /* ISLAND END
WT576	CONTINGENCY 'WT576' /*NORTH ANNA OPEN BRANCH FROM BUS 314914 TO BUS 314918 CKT 1 /*MIDLOTHIAN TO NORTH ANNA (LINE 576) OPEN BRANCH FROM BUS 314914 TO BUS 314322 CKT 1 /*MIDLOTHIAN 500-230 (TX#2) OPEN BRANCH FROM BUS 314918 TO BUS 314232 CKT 2 /*NORTH ANNA 500-230 (TX#6) END

Summer Peak Analysis – 2020

Generator Deliverability

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

#	Contingency		Affected Area	Facility Description	Bus		Circuit	Power Flow	Loading %		Rating		MW Contribution
	Type	Name			From	To			Initial	Final	Type	MVA	
1	N-1	LN 557	DVP - DVP	6PENNIMAN-6WALR209 230 kV line	314296	314415	1	AC	99.94	100.74	ER	442	4.21
2	N-1	LN 573	DVP - DVP	8LDYSMTH-8POSSUM 500 kV line	314911	314922	1	AC	99.8	100.12	ER	2442	9.32

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		Circuit	Power Flow	Loading %		Rating		MW Contribution
	Type	Name			From	To			Initial	Final	Type	MVA	
3	LFFB	557T574	DVP - DVP	8CARSON-8MDLTHAN 500 kV line	314902	314914	1	AC	94.83	96.1		3144	45.75

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 208-259	DVP - DVP	6CHARCTY-6LAKESD 230 kV line	314225	314227	1	AC	105.47	106.9		459	7.73	4
5	DCTL	LN 208-259	DVP - DVP	6MESSER-6CHARCTY 230 kV line	314228	314225	1	AC	116.58	118.01		459	7.73	5
6	DCTL	LN 208-259	DVP - DVP	6CHSTF B-6MESSER 230 kV line	314287	314228	1	AC	116.61	118.05		459	7.73	6
7	LFFB	562T563	DVP - DVP	6CHSTF B-6BASIN 230 kV line	314287	314276	1	AC	104.15	105.52		549	8.78	7
8	LFFB	57602	DVP - DVP	8ELMONT-8LDYSMTH 500 kV line	314908	314911	1	AC	107.71	108.91		3351	47.09	8
9	LFFB	WT576	DVP - DVP	8ELMONT-8LDYSMTH 500 kV line	314908	314911	1	AC	107.71	108.9		3351	47.09	
10	LFFB	563T576	DVP - DVP	8ELMONT-8LDYSMTH 500 kV line	314908	314911	1	AC	107.62	108.82		3351	47.11	
11	LFFB	557T574	DVP - DVP	8MDLTHAN-8NO ANNA 500 kV line	314914	314918	1	AC	100.02	101.31		3144	46.87	9

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)

No mitigations were found to be required.

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	AC2-012 Allocation
# 1	6PENNIMAN-6WALR209 230 kV line	<u>Skiffes Creek-Kings Mill-Waller-Penniman 230kV</u> Rebuild 6.1 miles of Waller-Skiffes Creek 230 kV Line (#2154) between Waller and Kings Mill to current standards with a minimum summer emergency rating of 1047 MVA utilizing single circuit steel structures. Remove this 6.1 mile section of Line #58 between Waller and Kings Mill. Rebuild the 1.6 miles of Line #2154 and #19 between Kings Mill and Skiffes Creek to current standards with a minimum summer emergency rating of 1047 MVA at 230 kV for Line #2154 and 261 MVA at 115 kV for Line #19, utilizing double circuit steel structures. The baseline project has a projected in-service date of 12/30/2024.	b3057	\$10,000,000	\$0
2	8LDYSMTH-8POSSUM 500 kV line	<u>Ladysmith-Possum Point 500kV</u> Replace wave traps at both Ladysmith and Possum Point Substations for the Ladysmith – Possum Pt 500kV line #552. Estimated to take 14-16 months to engineer and construct. Ratings after the upgrade: 2598/2598/3637 Queue Project AC2-012 presently does not receive cost allocation for the Network Upgrade. Although Queue Project AC2-012 may not have cost responsibility for this upgrade, Queue Project AC2-012 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AC2-012 comes into service prior to completion of the upgrade, an interim study will be required.	n6063	\$500,000	\$0

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AC2-012 Allocation
3	8CARSON-8MDLTHAN 500 kV line	The line's rating was uprated to a new emergency rating 3424 MVA and 3938 load dump rating. This is not a criteria violation for AC2-012.			\$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)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AC2-012 Allocation
5	6MESSER-6CHARCTY 230 kV line	Baseline #b2745 rebuilt 21.32 miles of existing line between Chesterfield - Lakeside 230 kV. b2745 went into service on 05/26/2020	b2745	\$31,700,000	\$0
4	6CHARCTY-6LAKESD 230 kV line				
6	6CHSTF B-6MESSER 230 kV				
7	6CHSTF B-6BASIN 230 kV line	PJM Baseline #b2990 - Chesterfield to Basin 230 kV line - Replace 0.14 miles of 1109 ACAR with a conductor which will increase the line rating to approximately 706 MVA. In service 4/27/18.	b2990	\$350,000	\$0

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AC2-012 Allocation
8, 9, 10	8ELMONT-8LDYSMTH 500 kV line	Elmont-Lady Smith 500kV wave trap replacement will increase the line's rating up to 2913 MVA (normal), 2913 MVA (emergency), and 3351 MVA (load dump). Queue Project AC2-012 presently does not receive cost allocation for the Network Upgrade. Although Queue Project AC2-012 may not have cost responsibility for this upgrade, Queue Project AC2-012 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AC2-012 comes into service prior to completion of the upgrade, an interim study will be required.	n5483	\$700,000	\$0
11	8MDLTHAN-8NO ANNA 500 kV line	Replace wave trap at North Anna Substation for Midlothian – North Anna 500 kV line #576. This will increase emergency rating by 31% to 3424 MVA. The network project had a required in-service date of 10/01/2019. Queue Project AC2-012 presently does not receive cost allocation for the Network Upgrade. Although Queue Project AC2-012 may not have cost responsibility for this upgrade, Queue Project AC2-012 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AC2-012 comes into service prior to completion of the upgrade, an interim study will be required.	n6055	\$250,000	\$0
Total New Network Upgrades					\$0

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		Affected Area	Facility Description	Bus		Circuit	Power Flow	Loading %		Rating		MW Contribution
	Type	Name			From	To			Initial	Final	Type	MVA	
12	N-1	LN 557	DVP - DVP	6SKIFF CREEK-6KINGS M 230 kV line	314209	314386	1	AC	109.06	111.19	ER	442	11.09
13	N-1	LN 557	DVP - DVP	6CHARCTY-6LAKESD 230 kV line	314225	314227	1	AC	98.66	100.51	ER	375	8.14
14	N-1	LN 563	DVP - DVP	6CHSTF B-6BASIN 230 kV line	314287	314276	1	AC	115.25	117.1	ER	449	9.6
15	N-1	LN 557	DVP - DVP	6PENNIMAN-6WALR209 230 kV line	314296	314415	1	AC	97.25	99.38	ER	442	11.09
16	N-1	LN 557	DVP - DVP	6KINGS M-6PENNIMAN 230 kV line	314386	314296	1	AC	101.06	103.19	ER	442	11.09
17	N-1	LN 74_B	DVP - DVP	3GRASFLD-3CMN GAS 115 kV line	314470	314456	1	AC	15.89	134.57	ER	111	150
18	N-1	LN 557	DVP - DVP	8CARSON-8MDLTHAN 500 kV line	314902	314914	1	AC	109.95	111.48	ER	2442	43.17
19	N-1	LN 576	DVP - DVP	8CHCKAHM-8ELMONT 500 kV line	314903	314908	1	AC	117.67	119.4	ER	2442	49.13
20	N-1	LN 594	DVP - DVP	8CHANCE-8BRISTER 500 kV line	314905	314900	1	AC	118.9	119.87	ER	2442	28.08
21	N-1	LN 576	DVP - DVP	8ELMONT-8LDYSMTH 500 kV line	314908	314911	1	AC	147.68	149.32	ER	2442	47.11
22	Non	Non	DVP - DVP	8ELMONT-8LDYSMTH 500 kV line	314908	314911	1	AC	104.63	105.69	NR	2442	30.54

#	Contingency		Affected Area	Facility Description	Bus		Circuit	Power Flow	Loading %		Rating		MW Contribution
	Type	Name			From	To			Initial	Final	Type	MVA	
23	N-1	LN 573	DVP - DVP	8LDYSMTH-8CHANCE 500 kV line	314911	314905	1	AC	107.47	108.36	ER	2738	28.5
24	N-1	LN 594	DVP - DVP	8LDYSMTH-8POSSUM 500 kV line	314911	314922	1	AC	111.26	112.12	ER	2442	24.47
25	N-1	LN 574	DVP - DVP	8MDLTHAN-8NO ANNA 500 kV line	314914	314918	1	AC	110.01	111.5	ER	2442	42.23
26	N-1	LN 568	DVP - DVP	8SPOTSYL-8MORRSVL 500 kV line	314934	314916	1	AC	99.42	100.18	ER	3219	28.52
27	N-1	LN 74_B	DVP - DVP	AC2-012 TAP-3GRASFLD 115 kV line	932040	314470	1	AC	0.16	143.29	ER	111	150

Light Load Analysis in 2020

Not required

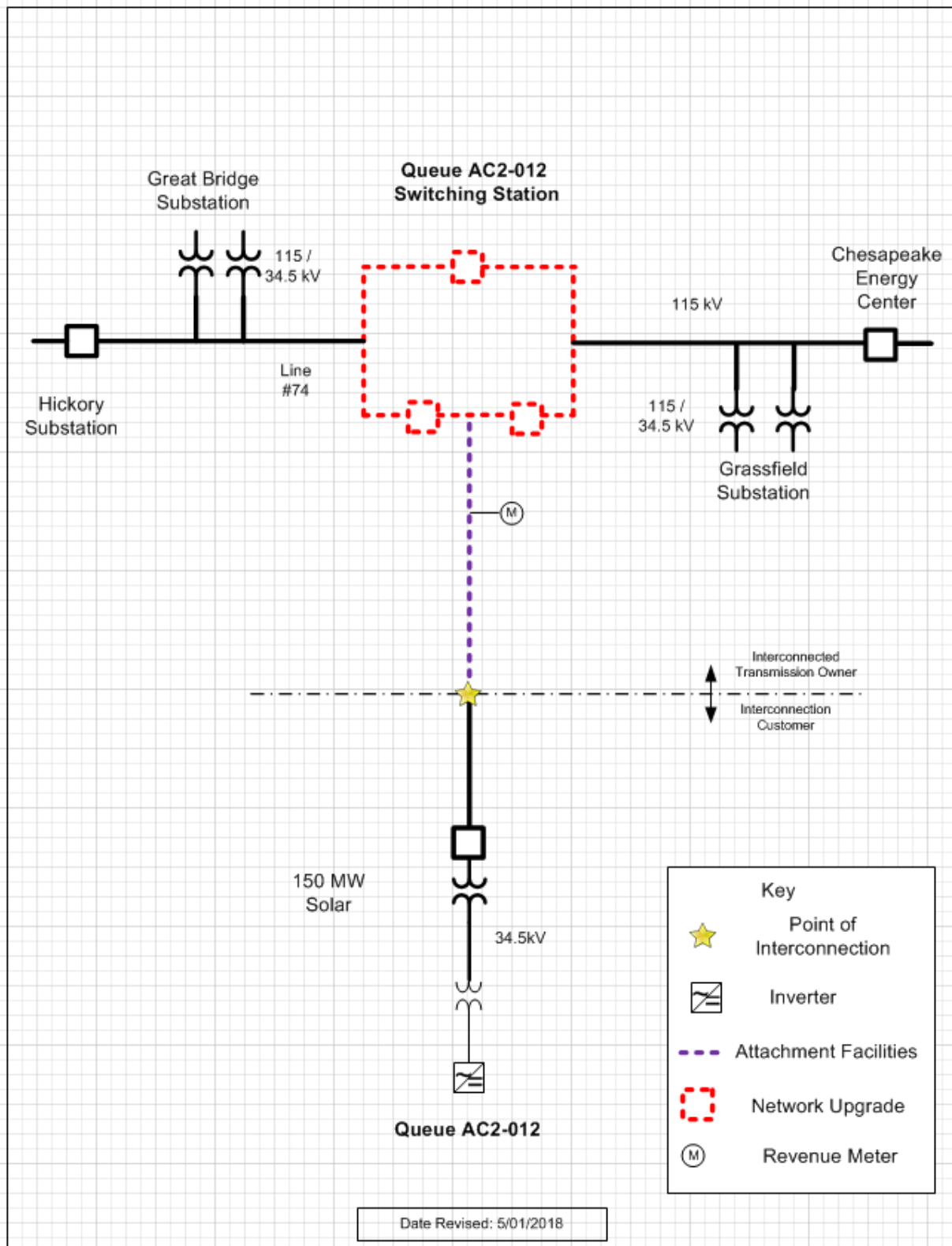
Affected System Analysis & Mitigation

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. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

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 6PENNIMAN-6WALR209 230 kV line (from bus 314296 to bus 314415 ckt 1) loads from 99.94% to 100.74% (AC power flow) of its emergency rating (442 MVA) for the single line contingency outage of 'LN 557'. This project contributes approximately 4.21 MW to the thermal violation.

CONTINGENCY '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

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315099	1CHESPKB	0.49
315108	1ELIZAR1	1.44
315109	1ELIZAR2	1.41
315110	1ELIZAR3	1.46
315233	1SURRY 2	14.86
315092	1YORKTN3	20.44
314421	6WINCHST	0.11
932041	AC2-012 C O1	4.21
932591	AC2-079 C O1	1.73
933291	AC2-141 C O1	14.1
933731	AC2-196 C	0.74
916191	Z1-068 C	0.02
921982	AA2-088 C	1.9
922532	AA2-178 C	3.34
923801	AB2-015 C OP	2.77
923831	AB2-022 C	0.92
924241	AB2-068 OP	103.47

<i>926261</i>	<i>AC1-027 C</i>	<i>0.83</i>
<i>927061</i>	<i>AC1-107 OP</i>	<i>156.18</i>
<i>927561</i>	<i>AC1-147 C</i>	<i>0.93</i>
<i>927711</i>	<i>AC1-161 C OP</i>	<i>14.1</i>

Appendix 2

(DVP - DVP) The 8LDYSMTH-8POSSUM 500 kV line (from bus 314911 to bus 314922 ckt 1) loads from 99.8% to 100.12% (AC power flow) of its emergency rating (2442 MVA) for the single line contingency outage of 'LN 573'. This project contributes approximately 9.32 MW to the thermal violation.

CONTINGENCY 'LN 573'

OPEN BRANCH FROM BUS 314918 TO BUS 314934 CKT 1

/* 8NO ANNA

500.00 - 8SPOTSYL 500.00

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315053	1BELMED1	2.84
315054	1BELMED2	2.84
315055	1BELMED3	2.35
315060	1CHESTF5	10.04
315061	1CHESTG7	3.93
315063	1CHESTG8	3.9
315062	1CHESTS7	1.79
315064	1CHESTS8	2.
315067	1DARBY 1	2.57
315068	1DARBY 2	2.58
315069	1DARBY 3	2.61
315070	1DARBY 4	2.61
315225	1N ANNA1	39.09
315226	1N ANNA2	38.49
315083	1SPRUNCA	1.74
315084	1SPRUNCB	1.74
315085	1SPRUNCC	1.29
315086	1SPRUNCD	1.29

314309	6IRON208	0.39
314236	6NRTHEST	0.19
314251	6S PUMP	0.9
932041	AC2-012 C O1	9.32
932501	AC2-070 C	1.57
932581	AC2-078 C O1	3.73
932591	AC2-079 C O1	5.21
932631	AC2-084 C	7.35
932831	AC2-110 C	1.21
933011	AC2-125	2.28
933021	AC2-126	2.29
933061	AC2-130	2.22
933261	AC2-137 C	1.93
933291	AC2-141 C O1	27.81
933501	AC2-165 C	8.16
933731	AC2-196 C	1.63
315074	CIR_AB2-152	9.
297087	V2-040	0.12
921162	AA1-063AC	7.31
921622	AA1-145	10.1
921752	AA2-053 C	7.42
921982	AA2-088 C	5.64
922512	AA2-174 C	0.34
922532	AA2-178 C	8.47
922682	AB1-027 C	2.39
923262	AB1-132 C OP	11.96

923572	AB1-173 C OP	1.93
923582	AB1-173AC OP	1.93
923801	AB2-015 C OP	7.62
923831	AB2-022 C	2.08
923841	AB2-024 C	2.25
923851	AB2-025 C	2.16
923861	AB2-026 C	2.09
923911	AB2-031 C OP	1.92
923991	AB2-040 C OP	6.29
924061	AB2-050	3.36
924241	AB2-068 OP	186.61
924501	AB2-099 C	0.51
924511	AB2-100 C	9.98
924811	AB2-134 C OP	11.89
925021	AB2-158 C	8.79
925051	AB2-160 C OP	5.02
925061	AB2-161 C OP	3.08
925171	AB2-174 C O1	6.03
925331	AB2-190 C	18.53
926261	AC1-027 C	1.83
926591	AC1-060	0.07
926601	AC1-061	0.03
926621	AC1-063	0.35
926641	AC1-065 C	3.03
926851	AC1-086 C	17.61
926981	AC1-099 C	6.89

<i>927061</i>	<i>AC1-107 OP</i>	<i>281.68</i>
<i>927181</i>	<i>AC1-112 C</i>	<i>1.86</i>
<i>927411</i>	<i>AC1-134</i>	<i>8.4</i>
<i>927561</i>	<i>AC1-147 C</i>	<i>2.06</i>
<i>927711</i>	<i>AC1-161 C OP</i>	<i>27.81</i>
<i>927741</i>	<i>AC1-164 C OP</i>	<i>37.25</i>
<i>928011</i>	<i>AC1-191 C OP</i>	<i>8.62</i>
<i>928271</i>	<i>AC1-216 C OP</i>	<i>9.08</i>

Appendix 3

(DVP - DVP) The 8CARSON-8MDLTHAN 500 kV line (from bus 314902 to bus 314914 ckt 1) loads from 94.83% to 96.1% (AC power flow) of its load dump rating (3144 MVA) for the line fault with failed breaker contingency outage of '557T574'. This project contributes approximately 45.75 MW to the thermal violation.

CONTINGENCY '557T574' /* 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 314911 TO BUS 314908 CKT 1 /*ELMONT TO
 LADYSMITH (LINE 574)
 END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315102	1BRUNSWICKG1	17.2
315103	1BRUNSWICKG2	17.2
315104	1BRUNSWICKG3	17.2
315105	1BRUNSWICKS1	35.73
315108	1ELIZAR1	5.93
315109	1ELIZAR2	5.83
315110	1ELIZAR3	6.01
315233	1SURRY 2	47.63
314784	1WEYRHSB	3.36
314539	3UNCAMP	3.88
314541	3WATKINS	1.09
932041	AC2-012 C O1	17.39
932042	AC2-012 E O1	28.37
932581	AC2-078 C O1	5.2
932582	AC2-078 E O1	8.48

932591	AC2-079 C O1	8.84
932592	AC2-079 E O1	14.43
932631	AC2-084 C	13.37
932632	AC2-084 E	6.58
932761	AC2-100 C	7.17
932762	AC2-100 E	3.5
933291	AC2-141 C O1	55.23
933292	AC2-141 E O1	23.58
933731	AC2-196 C	3.08
933732	AC2-196 E	2.05
900672	V4-068 E	0.47
901082	W1-029E	77.38
907092	X1-038 E	9.7
913392	Y1-086 E	3.71
916042	Z1-036 E	75.89
916191	Z1-068 C	0.08
916192	Z1-068 E	3.22
916301	Z1-086 C	104.91
916302	Z1-086 E	18.53
917122	Z2-027 E	1.79
917332	Z2-043 E	1.55
917342	Z2-044 E	0.86
917512	Z2-088 E OP1	12.15
921162	AA1-063AC	13.03
921163	AA1-063AE	6.15
918512	AA1-065 E OP	7.05

921183	AA1-067 E	1.12
918562	AA1-072 E	0.26
921582	AA1-139 C	4.54
921583	AA1-139 E	11.01
921752	AA2-053 C	13.24
921753	AA2-053 E	5.69
921762	AA2-057 C	10.69
921763	AA2-057 E	5.34
921982	AA2-088 C	10.15
921983	AA2-088 E	16.56
922442	AA2-165 C	1.46
922443	AA2-165 E	0.7
922512	AA2-174 C	0.61
922513	AA2-174 E	0.66
922532	AA2-178 C	15.74
922533	AA2-178 E	6.75
922922	AB1-081 C OP	13.27
922923	AB1-081 E OP	5.69
923262	AB1-132 C OP	21.29
923263	AB1-132 E OP	9.12
923572	AB1-173 C OP	3.37
923573	AB1-173 E OP	1.57
923582	AB1-173AC OP	3.37
923583	AB1-173AE OP	1.57
923801	AB2-015 C OP	13.75
923802	AB2-015 E OP	11.27

923831	AB2-022 C	3.91
923832	AB2-022 E	2.1
923851	AB2-025 C	3.65
923852	AB2-025 E	1.64
923911	AB2-031 C OP	3.34
923912	AB2-031 E OP	1.65
923991	AB2-040 C OP	10.97
923992	AB2-040 E OP	8.98
924021	AB2-043 C OP	3.91
924022	AB2-043 E OP	6.41
924151	AB2-059 C	15.64
924152	AB2-059 E	8.06
924161	AB2-060 C	11.18
924162	AB2-060 E	5.26
924241	AB2-068 OP	331.55
924321	AB2-079 C OP	7.48
924322	AB2-079 E OP	4.99
924501	AB2-099 C	0.92
924502	AB2-099 E	0.4
924511	AB2-100 C	17.26
924512	AB2-100 E	8.5
924811	AB2-134 C OP	14.77
924812	AB2-134 E OP	14.52
925051	AB2-160 C OP	5.43
925052	AB2-160 E OP	8.85
925061	AB2-161 C OP	4.85

925062	AB2-161 E OP	7.92
925122	AB2-169 E	9.19
925171	AB2-174 C O1	10.47
925172	AB2-174 E O1	9.47
925331	AB2-190 C	23.74
925332	AB2-190 E	10.18
926261	AC1-027 C	3.43
926262	AC1-027 E	1.96
926331	AC1-034 C	10.13
926332	AC1-034 E	7.64
926351	AC1-036 C	1.06
926352	AC1-036 E	1.73
926531	AC1-054 C OP	10.05
926532	AC1-054 E OP	4.63
926601	AC1-061	0.04
926851	AC1-086 C	31.35
926852	AC1-086 E	14.27
926981	AC1-099 C	12.52
926982	AC1-099 E	7.43
927041	AC1-105 C OP	7.47
927042	AC1-105 E OP	3.72
927061	AC1-107 OP	500.45
927561	AC1-147 C	3.84
927562	AC1-147 E	2.26
927711	AC1-161 C OP	55.23
927712	AC1-161 E OP	23.58

927991	AC1-189 C	13.18
927992	AC1-189 E	6.57
928191	AC1-208 C O1	13.65
928192	AC1-208 E O1	6.06
928271	AC1-216 C OP	11.27
928272	AC1-216 E OP	8.86
928321	AC1-221 C	3.11
928322	AC1-221 E	3.11
928331	AC1-222 C	4.84
928332	AC1-222 E	4.6

Appendix 4

(DVP - DVP) The 6CHARCTY-6LAKESD 230 kV line (from bus 314225 to bus 314227 ckt 1) loads from 105.47% to 106.9% (AC power flow) of its load dump rating (459 MVA) for the tower line contingency outage of 'LN 208-259'. This project contributes approximately 7.73 MW to the thermal violation.

CONTINGENCY 'LN 208-259'

OPEN BRANCH FROM BUS 314286 TO BUS 314309 CKT 1 /* 6CHSTF A

230.00 - 6IRON208 230.00

OPEN BRANCH FROM BUS 314309 TO BUS 314338 CKT 1 /* 6IRON208

230.00 - 6SOUWEST 230.00

OPEN BUS 314309 /* ISLAND

OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1 /* 6BASIN 230.00 -
6CHSTF B 230.00

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315065	1CHESTF6	33.65
315077	1HOPHCF1	1.95
315078	1HOPHCF2	1.95
315079	1HOPHCF3	1.95
315080	1HOPHCF4	2.96
315076	1HOPPOLC	1.67
315073	1STONECA	5.67
314784	1WEYRHSB	0.66
314539	3UNCAMP	0.86
314541	3WATKINS	0.25
314229	6MT R221	-0.33
932041	AC2-012 C O1	2.94
932042	AC2-012 E O1	4.79
932581	AC2-078 C O1	3.15
932582	AC2-078 E O1	5.13

932591	AC2-079 C O1	2.65
932592	AC2-079 E O1	4.33
932631	AC2-084 C	2.99
932632	AC2-084 E	1.47
933061	AC2-130	0.81
315074	CIR_AB2-152	7.97
315075	CIR_AB2-152	0.67
292791	U1-032 E	2.95
900672	V4-068 E	0.11
901082	W1-029E	13.49
907092	X1-038 E	2.15
913392	Y1-086 E	0.63
914231	Y2-077	0.78
916042	Z1-036 E	13.59
916192	Z1-068 E	0.53
917122	Z2-027 E	0.31
917332	Z2-043 E	0.34
917342	Z2-044 E	0.18
921162	AA1-063AC	3.19
921163	AA1-063AE	1.51
918512	AA1-065 E OP	1.48
918562	AA1-072 E	0.06
921752	AA2-053 C	3.26
921753	AA2-053 E	1.4
921762	AA2-057 C	2.35
921763	AA2-057 E	1.17

921982	AA2-088 C	2.33
921983	AA2-088 E	3.81
922442	AA2-165 C	0.32
922443	AA2-165 E	0.15
922512	AA2-174 C	0.15
922513	AA2-174 E	0.16
922532	AA2-178 C	2.96
922533	AA2-178 E	1.27
923262	AB1-132 C OP	5.97
923263	AB1-132 E OP	2.56
923572	AB1-173 C OP	0.98
923573	AB1-173 E OP	0.46
923582	AB1-173AC OP	0.98
923583	AB1-173AE OP	0.46
923801	AB2-015 C OP	3.07
923802	AB2-015 E OP	2.51
923831	AB2-022 C	0.66
923832	AB2-022 E	0.35
923851	AB2-025 C	1.62
923852	AB2-025 E	0.73
923911	AB2-031 C OP	0.98
923912	AB2-031 E OP	0.48
923991	AB2-040 C OP	3.21
923992	AB2-040 E OP	2.62
924501	AB2-099 C	0.2
924502	AB2-099 E	0.09

924511	AB2-100 C	6.21
924512	AB2-100 E	3.06
924811	AB2-134 C OP	8.19
924812	AB2-134 E OP	8.05
925051	AB2-160 C OP	4.19
925052	AB2-160 E OP	6.83
925061	AB2-161 C OP	1.99
925062	AB2-161 E OP	3.24
925122	AB2-169 E	1.8
925171	AB2-174 C O1	3.15
925172	AB2-174 E O1	2.85
925331	AB2-190 C	12.21
925332	AB2-190 E	5.23
926261	AC1-027 C	0.57
926262	AC1-027 E	0.32
926601	AC1-061	0.03
926851	AC1-086 C	8.79
926852	AC1-086 E	4.
926981	AC1-099 C	2.8
926982	AC1-099 E	1.66
927561	AC1-147 C	0.65
927562	AC1-147 E	0.38
928191	AC1-208 C O1	3.12
928192	AC1-208 E O1	1.39
928271	AC1-216 C OP	6.25
928272	AC1-216 E OP	4.92

Appendix 5

(DVP - DVP) The 6MESSER-6CHARCTY 230 kV line (from bus 314228 to bus 314225 ckt 1) loads from 116.58% to 118.01% (AC power flow) of its load dump rating (459 MVA) for the tower line contingency outage of 'LN 208-259'. This project contributes approximately 7.73 MW to the thermal violation.

CONTINGENCY 'LN 208-259'

OPEN BRANCH FROM BUS 314286 TO BUS 314309 CKT 1 /* 6CHSTF A

230.00 - 6IRON208 230.00

OPEN BRANCH FROM BUS 314309 TO BUS 314338 CKT 1 /* 6IRON208

230.00 - 6SOUWEST 230.00

OPEN BUS 314309 /* ISLAND

OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1 /* 6BASIN 230.00 -
6CHSTF B 230.00

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315065	1CHESTF6	33.65
315077	1HOPHCF1	1.95
315078	1HOPHCF2	1.95
315079	1HOPHCF3	1.95
315080	1HOPHCF4	2.96
315076	1HOPPOLC	1.67
315073	1STONECA	5.67
314784	1WEYRHSB	0.66
314539	3UNCAMP	0.86
314541	3WATKINS	0.25
314229	6MT R221	-0.33
932041	AC2-012 C O1	2.94
932042	AC2-012 E O1	4.79
932581	AC2-078 C O1	3.15
932582	AC2-078 E O1	5.13

932591	AC2-079 C O1	2.65
932592	AC2-079 E O1	4.33
932631	AC2-084 C	2.99
932632	AC2-084 E	1.47
933061	AC2-130	0.81
315074	CIR_AB2-152	7.97
315075	CIR_AB2-152	0.67
292791	U1-032 E	2.95
900672	V4-068 E	0.11
901082	W1-029E	13.49
907092	X1-038 E	2.15
913392	Y1-086 E	0.63
914231	Y2-077	0.78
916042	Z1-036 E	13.59
916192	Z1-068 E	0.53
917122	Z2-027 E	0.31
917332	Z2-043 E	0.34
917342	Z2-044 E	0.18
921162	AA1-063AC	3.19
921163	AA1-063AE	1.51
918512	AA1-065 E OP	1.48
918562	AA1-072 E	0.06
921752	AA2-053 C	3.26
921753	AA2-053 E	1.4
921762	AA2-057 C	2.35
921763	AA2-057 E	1.17

921982	AA2-088 C	2.33
921983	AA2-088 E	3.81
922442	AA2-165 C	0.32
922443	AA2-165 E	0.15
922512	AA2-174 C	0.15
922513	AA2-174 E	0.16
922532	AA2-178 C	2.96
922533	AA2-178 E	1.27
923262	AB1-132 C OP	5.97
923263	AB1-132 E OP	2.56
923572	AB1-173 C OP	0.98
923573	AB1-173 E OP	0.46
923582	AB1-173AC OP	0.98
923583	AB1-173AE OP	0.46
923801	AB2-015 C OP	3.07
923802	AB2-015 E OP	2.51
923831	AB2-022 C	0.66
923832	AB2-022 E	0.35
923851	AB2-025 C	1.62
923852	AB2-025 E	0.73
923911	AB2-031 C OP	0.98
923912	AB2-031 E OP	0.48
923991	AB2-040 C OP	3.21
923992	AB2-040 E OP	2.62
924501	AB2-099 C	0.2
924502	AB2-099 E	0.09

924511	AB2-100 C	6.21
924512	AB2-100 E	3.06
924811	AB2-134 C OP	8.19
924812	AB2-134 E OP	8.05
925051	AB2-160 C OP	4.19
925052	AB2-160 E OP	6.83
925061	AB2-161 C OP	1.99
925062	AB2-161 E OP	3.24
925122	AB2-169 E	1.8
925171	AB2-174 C O1	3.15
925172	AB2-174 E O1	2.85
925331	AB2-190 C	12.21
925332	AB2-190 E	5.23
926261	AC1-027 C	0.57
926262	AC1-027 E	0.32
926601	AC1-061	0.03
926851	AC1-086 C	8.79
926852	AC1-086 E	4.
926981	AC1-099 C	2.8
926982	AC1-099 E	1.66
927561	AC1-147 C	0.65
927562	AC1-147 E	0.38
928191	AC1-208 C O1	3.12
928192	AC1-208 E O1	1.39
928271	AC1-216 C OP	6.25
928272	AC1-216 E OP	4.92

Appendix 6

(DVP - DVP) The 6CHSTF B-6MESSER 230 kV line (from bus 314287 to bus 314228 ckt 1) loads from 116.61% to 118.05% (AC power flow) of its load dump rating (459 MVA) for the tower line contingency outage of 'LN 208-259'. This project contributes approximately 7.73 MW to the thermal violation.

CONTINGENCY 'LN 208-259'

OPEN BRANCH FROM BUS 314286 TO BUS 314309 CKT 1 /* 6CHSTF A

230.00 - 6IRON208 230.00

OPEN BRANCH FROM BUS 314309 TO BUS 314338 CKT 1 /* 6IRON208

230.00 - 6SOUWEST 230.00

OPEN BUS 314309 /* ISLAND

OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1 /* 6BASIN 230.00 -
6CHSTF B 230.00

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315065	1CHESTF6	33.65
315077	1HOPHCF1	1.95
315078	1HOPHCF2	1.95
315079	1HOPHCF3	1.95
315080	1HOPHCF4	2.96
315076	1HOPPOLC	1.67
315073	1STONECA	5.67
314784	1WEYRHSB	0.66
314539	3UNCAMP	0.86
314541	3WATKINS	0.25
314229	6MT R221	-0.33
932041	AC2-012 C O1	2.94
932042	AC2-012 E O1	4.79
932581	AC2-078 C O1	3.15
932582	AC2-078 E O1	5.13

932591	AC2-079 C O1	2.65
932592	AC2-079 E O1	4.33
932631	AC2-084 C	2.99
932632	AC2-084 E	1.47
933061	AC2-130	0.81
315074	CIR_AB2-152	7.97
315075	CIR_AB2-152	0.67
292791	U1-032 E	2.95
900672	V4-068 E	0.11
901082	W1-029E	13.49
907092	X1-038 E	2.15
913392	Y1-086 E	0.63
914231	Y2-077	0.78
916042	Z1-036 E	13.59
916192	Z1-068 E	0.53
917122	Z2-027 E	0.31
917332	Z2-043 E	0.34
917342	Z2-044 E	0.18
921162	AA1-063AC	3.19
921163	AA1-063AE	1.51
918512	AA1-065 E OP	1.48
918562	AA1-072 E	0.06
921752	AA2-053 C	3.26
921753	AA2-053 E	1.4
921762	AA2-057 C	2.35
921763	AA2-057 E	1.17

921982	AA2-088 C	2.33
921983	AA2-088 E	3.81
922442	AA2-165 C	0.32
922443	AA2-165 E	0.15
922512	AA2-174 C	0.15
922513	AA2-174 E	0.16
922532	AA2-178 C	2.96
922533	AA2-178 E	1.27
923262	AB1-132 C OP	5.97
923263	AB1-132 E OP	2.56
923572	AB1-173 C OP	0.98
923573	AB1-173 E OP	0.46
923582	AB1-173AC OP	0.98
923583	AB1-173AE OP	0.46
923801	AB2-015 C OP	3.07
923802	AB2-015 E OP	2.51
923831	AB2-022 C	0.66
923832	AB2-022 E	0.35
923851	AB2-025 C	1.62
923852	AB2-025 E	0.73
923911	AB2-031 C OP	0.98
923912	AB2-031 E OP	0.48
923991	AB2-040 C OP	3.21
923992	AB2-040 E OP	2.62
924501	AB2-099 C	0.2
924502	AB2-099 E	0.09

924511	AB2-100 C	6.21
924512	AB2-100 E	3.06
924811	AB2-134 C OP	8.19
924812	AB2-134 E OP	8.05
925051	AB2-160 C OP	4.19
925052	AB2-160 E OP	6.83
925061	AB2-161 C OP	1.99
925062	AB2-161 E OP	3.24
925122	AB2-169 E	1.8
925171	AB2-174 C O1	3.15
925172	AB2-174 E O1	2.85
925331	AB2-190 C	12.21
925332	AB2-190 E	5.23
926261	AC1-027 C	0.57
926262	AC1-027 E	0.32
926601	AC1-061	0.03
926851	AC1-086 C	8.79
926852	AC1-086 E	4.
926981	AC1-099 C	2.8
926982	AC1-099 E	1.66
927561	AC1-147 C	0.65
927562	AC1-147 E	0.38
928191	AC1-208 C O1	3.12
928192	AC1-208 E O1	1.39
928271	AC1-216 C OP	6.25
928272	AC1-216 E OP	4.92

Appendix 7

(DVP - DVP) The 6CHSTF B-6BASIN 230 kV line (from bus 314287 to bus 314276 ckt 1) loads from 104.15% to 105.52% (AC power flow) of its load dump rating (549 MVA) for the line fault with failed breaker contingency outage of '562T563'. This project contributes approximately 8.78 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	33.94
315077	1HOPHCF1	1.8
315078	1HOPHCF2	1.8
315079	1HOPHCF3	1.8
315080	1HOPHCF4	2.73
315076	1HOPPOLC	1.54
315073	1STONECA	5.23
314784	1WEYRHSB	0.81
314539	3UNCAMP	1.01
314541	3WATKINS	0.29
932041	AC2-012 C O1	3.34
932042	AC2-012 E O1	5.44
932581	AC2-078 C O1	3.25
932582	AC2-078 E O1	5.31
932591	AC2-079 C O1	2.9
932592	AC2-079 E O1	4.73
932631	AC2-084 C	3.76

932632	AC2-084 E	1.85
933731	AC2-196 C	0.57
933732	AC2-196 E	0.38
315074	CIR_AB2-152	7.36
315075	CIR_AB2-152	0.62
292791	U1-032 E	2.73
900672	V4-068 E	0.13
901082	W1-029E	15.89
907092	X1-038 E	2.52
913392	Y1-086 E	0.74
914231	Y2-077	0.72
916042	Z1-036 E	16.17
916192	Z1-068 E	0.61
916302	Z1-086 E	3.97
917122	Z2-027 E	0.36
917332	Z2-043 E	0.42
917342	Z2-044 E	0.24
917512	Z2-088 E OP1	3.18
921162	AA1-063AC	3.88
921163	AA1-063AE	1.83
918512	AA1-065 E OP	1.81
921183	AA1-067 E	0.29
918562	AA1-072 E	0.07
921583	AA1-139 E	2.09
921752	AA2-053 C	3.99
921753	AA2-053 E	1.71

921762	AA2-057 C	3.01
921763	AA2-057 E	1.51
921982	AA2-088 C	2.79
921983	AA2-088 E	4.55
922442	AA2-165 C	0.41
922443	AA2-165 E	0.2
922512	AA2-174 C	0.18
922513	AA2-174 E	0.2
922532	AA2-178 C	3.57
922533	AA2-178 E	1.53
922922	AB1-081 C OP	3.64
922923	AB1-081 E OP	1.56
923262	AB1-132 C OP	7.23
923263	AB1-132 E OP	3.1
923572	AB1-173 C OP	1.18
923573	AB1-173 E OP	0.55
923582	AB1-173AC OP	1.18
923583	AB1-173AE OP	0.55
923801	AB2-015 C OP	3.61
923802	AB2-015 E OP	2.96
923831	AB2-022 C	0.77
923832	AB2-022 E	0.42
923851	AB2-025 C	1.86
923852	AB2-025 E	0.84
923911	AB2-031 C OP	1.18
923912	AB2-031 E OP	0.58

923991	AB2-040 C OP	3.86
923992	AB2-040 E OP	3.16
924151	AB2-059 C	4.29
924152	AB2-059 E	2.21
924501	AB2-099 C	0.25
924502	AB2-099 E	0.11
924511	AB2-100 C	7.28
924512	AB2-100 E	3.59
924811	AB2-134 C OP	7.76
924812	AB2-134 E OP	7.63
925051	AB2-160 C OP	3.9
925052	AB2-160 E OP	6.36
925061	AB2-161 C OP	2.11
925062	AB2-161 E OP	3.44
925122	AB2-169 E	2.25
925171	AB2-174 C O1	3.77
925172	AB2-174 E O1	3.42
925331	AB2-190 C	11.62
925332	AB2-190 E	4.98
926261	AC1-027 C	0.65
926262	AC1-027 E	0.37
926331	AC1-034 C	2.78
926332	AC1-034 E	2.1
926531	AC1-054 C OP	2.8
926532	AC1-054 E OP	1.29
926601	AC1-061	0.03

926851	AC1-086 C	10.64
926852	AC1-086 E	4.84
926981	AC1-099 C	3.53
926982	AC1-099 E	2.09
927561	AC1-147 C	0.74
927562	AC1-147 E	0.43
927991	AC1-189 C	3.41
927992	AC1-189 E	1.7
928191	AC1-208 C O1	3.94
928192	AC1-208 E O1	1.75
928271	AC1-216 C OP	5.92
928272	AC1-216 E OP	4.66

Appendix 8

(DVP - DVP) The 8ELMONT-8LDYSMTH 500 kV line (from bus 314908 to bus 314911 ckt 1) loads from 107.71% to 108.91% (AC power flow) of its load dump rating (3351 MVA) for the line fault with failed breaker contingency outage of '57602'. This project contributes approximately 47.09 MW to the thermal violation.

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CONTINGENCY '57602'                                /*NORTH ANNA
  OPEN BRANCH FROM BUS 314914 TO BUS 314918 CKT 1    /*MIDLOTHIAN
TO NORTH ANNA (LINE 576)
  OPEN BRANCH FROM BUS 314914 TO BUS 314322 CKT 1    /*MIDLOTHIAN
500-230 (TX#2)
  OPEN BRANCH FROM BUS 314918 TO BUS 314232 CKT 1    /*NORTH ANNA
500-230 (TX#5)
  END

```

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
<i>315060</i>	<i>1CHESTF5</i>	<i>19.74</i>
<i>315061</i>	<i>1CHESTG7</i>	<i>7.74</i>
<i>315063</i>	<i>1CHESTG8</i>	<i>7.67</i>
<i>315062</i>	<i>1CHESTS7</i>	<i>3.52</i>
<i>315064</i>	<i>1CHESTS8</i>	<i>3.93</i>
<i>315067</i>	<i>1DARBY 1</i>	<i>5.04</i>
<i>315068</i>	<i>1DARBY 2</i>	<i>5.05</i>
<i>315069</i>	<i>1DARBY 3</i>	<i>5.11</i>
<i>315070</i>	<i>1DARBY 4</i>	<i>5.11</i>
<i>315073</i>	<i>1STONECA</i>	<i>12.38</i>
<i>315233</i>	<i>1SURRY 2</i>	<i>50.16</i>
<i>314784</i>	<i>1WEYRHSB</i>	<i>3.41</i>
<i>314539</i>	<i>3UNCAMP</i>	<i>4.06</i>
<i>314541</i>	<i>3WATKINS</i>	<i>1.14</i>
<i>314229</i>	<i>6MT R221</i>	<i>1.35</i>

314236	6NRTHEST	0.36
314189	6PAPERMILL	11.71
932041	AC2-012 C O1	17.9
932042	AC2-012 E O1	29.2
932501	AC2-070 C	3.14
932502	AC2-070 E	1.3
932581	AC2-078 C O1	7.07
932582	AC2-078 E O1	11.54
932591	AC2-079 C O1	9.94
932592	AC2-079 E O1	16.21
932631	AC2-084 C	13.61
932632	AC2-084 E	6.7
932831	AC2-110 C	2.32
932832	AC2-110 E	3.78
933061	AC2-130	4.37
933261	AC2-137 C	3.85
933262	AC2-137 E	2.5
933291	AC2-141 C O1	53.75
933292	AC2-141 E O1	22.95
933501	AC2-165 C	13.52
933502	AC2-165 E	10.17
933731	AC2-196 C	3.13
933732	AC2-196 E	2.08
315074	CIR_AB2-152	17.41
292791	U1-032 E	6.45
297087	V2-040	0.24

900672	V4-068 E	0.49
901082	W1-029E	78.99
907092	X1-038 E	10.16
913392	Y1-086 E	3.77
916042	Z1-036 E	77.32
916192	Z1-068 E	3.29
916302	Z1-086 E	14.15
917122	Z2-027 E	1.82
917332	Z2-043 E	1.58
917342	Z2-044 E	0.86
917512	Z2-088 E OP1	12.13
921162	AA1-063AC	13.58
921163	AA1-063AE	6.4
918512	AA1-065 E OP	7.2
921183	AA1-067 E	1.12
918562	AA1-072 E	0.26
921583	AA1-139 E	11.17
921752	AA2-053 C	13.74
921753	AA2-053 E	5.9
921762	AA2-057 C	10.78
921763	AA2-057 E	5.39
921982	AA2-088 C	10.58
921983	AA2-088 E	17.26
922442	AA2-165 C	1.47
922443	AA2-165 E	0.71
922512	AA2-174 C	0.63

922513	AA2-174 E	0.68
922532	AA2-178 C	16.02
922533	AA2-178 E	6.87
922682	AB1-027 C	4.77
922683	AB1-027 E	2.05
922922	AB1-081 C OP	13.19
922923	AB1-081 E OP	5.65
923262	AB1-132 C OP	22.13
923263	AB1-132 E OP	9.49
923572	AB1-173 C OP	3.56
923573	AB1-173 E OP	1.66
923582	AB1-173AC OP	3.56
923583	AB1-173AE OP	1.66
923801	AB2-015 C OP	14.39
923802	AB2-015 E OP	11.8
923831	AB2-022 C	3.97
923832	AB2-022 E	2.14
923841	AB2-024 C	4.39
923842	AB2-024 E	1.97
923851	AB2-025 C	4.01
923852	AB2-025 E	1.8
923861	AB2-026 C	3.54
923862	AB2-026 E	1.59
923911	AB2-031 C OP	3.53
923912	AB2-031 E OP	1.74
923991	AB2-040 C OP	11.59

923992	AB2-040 E OP	9.48
924061	AB2-050	4.8
924151	AB2-059 C	15.55
924152	AB2-059 E	8.01
924241	AB2-068 OP	415.05
924501	AB2-099 C	0.95
924502	AB2-099 E	0.41
924511	AB2-100 C	18.46
924512	AB2-100 E	9.09
924811	AB2-134 C OP	23.
924812	AB2-134 E OP	22.61
925051	AB2-160 C OP	9.55
925052	AB2-160 E OP	15.58
925061	AB2-161 C OP	5.86
925062	AB2-161 E OP	9.57
925122	AB2-169 E	9.28
925171	AB2-174 C O1	11.1
925172	AB2-174 E O1	10.04
925331	AB2-190 C	35.84
925332	AB2-190 E	15.36
926261	AC1-027 C	3.51
926262	AC1-027 E	2.
926331	AC1-034 C	10.07
926332	AC1-034 E	7.6
926531	AC1-054 C OP	10.55
926532	AC1-054 E OP	4.86

926591	AC1-060	0.13
926601	AC1-061	0.06
926621	AC1-063	0.67
926641	AC1-065 C	5.8
926642	AC1-065 E	9.46
926851	AC1-086 C	32.59
926852	AC1-086 E	14.83
926981	AC1-099 C	12.74
926982	AC1-099 E	7.56
927061	AC1-107 OP	626.5
927181	AC1-112 C	3.72
927182	AC1-112 E	2.08
927411	AC1-134	12.01
927561	AC1-147 C	3.96
927562	AC1-147 E	2.32
927711	AC1-161 C OP	53.75
927712	AC1-161 E OP	22.95
927741	AC1-164 C OP	75.19
927742	AC1-164 E OP	33.78
927991	AC1-189 C	13.18
927992	AC1-189 E	6.56
928011	AC1-191 C OP	16.37
928012	AC1-191 E OP	8.15
928191	AC1-208 C O1	13.91
928192	AC1-208 E O1	6.18
928271	AC1-216 C OP	17.55

928272	AC1-216 E OP	13.8
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Appendix 9

(DVP - DVP) The 8MDLTHAN-8NO ANNA 500 kV line (from bus 314914 to bus 314918 ckt 1) loads from 100.02% to 101.31% (AC power flow) of its load dump rating (3144 MVA) for the line fault with failed breaker contingency outage of '557T574'. This project contributes approximately 46.87 MW to the thermal violation.

CONTINGENCY '557T574' /* 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 314911 TO BUS 314908 CKT 1 /*ELMONT TO
 LADYSMITH (LINE 574)
 END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315102	1BRUNSWICKG1	15.61
315103	1BRUNSWICKG2	15.61
315104	1BRUNSWICKG3	15.61
315105	1BRUNSWICKS1	32.42
315108	1ELIZAR1	6.06
315109	1ELIZAR2	5.96
315110	1ELIZAR3	6.14
315073	1STONECA	10.3
315233	1SURRY 2	48.08
314784	1WEYRHSB	3.46
314539	3UNCAMP	4.07
314541	3WATKINS	1.15
314189	6PAPERMILL	8.86
932041	AC2-012 C O1	17.81
932042	AC2-012 E O1	29.06

932501	AC2-070 C	2.
932502	AC2-070 E	0.83
932581	AC2-078 C O1	6.58
932582	AC2-078 E O1	10.73
932591	AC2-079 C O1	9.69
932592	AC2-079 E O1	15.81
932631	AC2-084 C	13.93
932632	AC2-084 E	6.86
932761	AC2-100 C	7.21
932762	AC2-100 E	3.52
932831	AC2-110 C	1.8
932832	AC2-110 E	2.93
933061	AC2-130	3.31
933261	AC2-137 C	2.73
933262	AC2-137 E	1.77
933291	AC2-141 C O1	54.24
933292	AC2-141 E O1	23.15
933501	AC2-165 C	13.83
933502	AC2-165 E	10.41
933731	AC2-196 C	3.13
933732	AC2-196 E	2.08
315074	CIR_AB2-152	14.48
292791	U1-032 E	5.36
900672	V4-068 E	0.49
901082	W1-029E	79.16
907092	X1-038 E	10.17

913392	Y1-086 E	3.78
916042	Z1-036 E	77.71
916191	Z1-068 C	0.08
916192	Z1-068 E	3.28
916301	Z1-086 C	94.94
916302	Z1-086 E	16.77
917122	Z2-027 E	1.83
917332	Z2-043 E	1.61
917342	Z2-044 E	0.89
917512	Z2-088 E OP1	12.47
921162	AA1-063AC	13.8
921163	AA1-063AE	6.51
918512	AA1-065 E OP	7.3
921183	AA1-067 E	1.15
918562	AA1-072 E	0.27
921583	AA1-139 E	11.19
921752	AA2-053 C	14.01
921753	AA2-053 E	6.01
921762	AA2-057 C	11.09
921763	AA2-057 E	5.55
921982	AA2-088 C	10.67
921983	AA2-088 E	17.41
922442	AA2-165 C	1.51
922443	AA2-165 E	0.73
922512	AA2-174 C	0.64
922513	AA2-174 E	0.7

922532	AA2-178 C	16.16
922533	AA2-178 E	6.93
922682	AB1-027 C	3.05
922683	AB1-027 E	1.31
922922	AB1-081 C OP	13.64
922923	AB1-081 E OP	5.85
923262	AB1-132 C OP	22.59
923263	AB1-132 E OP	9.68
923572	AB1-173 C OP	3.63
923573	AB1-173 E OP	1.69
923582	AB1-173AC OP	3.63
923583	AB1-173AE OP	1.69
923801	AB2-015 C OP	14.43
923802	AB2-015 E OP	11.83
923831	AB2-022 C	3.98
923832	AB2-022 E	2.15
923841	AB2-024 C	3.31
923842	AB2-024 E	1.49
923851	AB2-025 C	4.06
923852	AB2-025 E	1.83
923861	AB2-026 C	3.72
923862	AB2-026 E	1.67
923911	AB2-031 C OP	3.6
923912	AB2-031 E OP	1.77
923991	AB2-040 C OP	11.83
923992	AB2-040 E OP	9.68

924021	AB2-043 C OP	4.46
924022	AB2-043 E OP	7.32
924151	AB2-059 C	16.08
924152	AB2-059 E	8.28
924161	AB2-060 C	12.82
924162	AB2-060 E	6.03
924241	AB2-068 OP	334.58
924321	AB2-079 C OP	8.49
924322	AB2-079 E OP	5.66
924501	AB2-099 C	0.96
924502	AB2-099 E	0.41
924511	AB2-100 C	18.79
924512	AB2-100 E	9.26
924811	AB2-134 C OP	20.14
924812	AB2-134 E OP	19.81
925051	AB2-160 C OP	8.33
925052	AB2-160 E OP	13.59
925061	AB2-161 C OP	5.61
925062	AB2-161 E OP	9.15
925122	AB2-169 E	9.44
925171	AB2-174 C O1	11.33
925172	AB2-174 E O1	10.25
925331	AB2-190 C	31.63
925332	AB2-190 E	13.56
926261	AC1-027 C	3.5
926262	AC1-027 E	2.

926331	AC1-034 C	10.41
926332	AC1-034 E	7.86
926351	AC1-036 C	1.31
926352	AC1-036 E	2.14
926531	AC1-054 C OP	10.9
926532	AC1-054 E OP	5.02
926591	AC1-060	0.1
926601	AC1-061	0.05
926611	AC1-062	0.43
926621	AC1-063	0.52
926641	AC1-065 C	4.5
926642	AC1-065 E	7.34
926851	AC1-086 C	33.27
926852	AC1-086 E	15.14
926981	AC1-099 C	13.04
926982	AC1-099 E	7.74
927041	AC1-105 C OP	7.9
927042	AC1-105 E OP	3.93
927061	AC1-107 OP	505.02
927181	AC1-112 C	2.37
927182	AC1-112 E	1.33
927561	AC1-147 C	3.94
927562	AC1-147 E	2.31
927711	AC1-161 C OP	54.24
927712	AC1-161 E OP	23.15
927741	AC1-164 C OP	53.47

927742	AC1-164 E OP	24.02
927991	AC1-189 C	13.53
927992	AC1-189 E	6.74
928191	AC1-208 C O1	14.26
928192	AC1-208 E O1	6.33
928271	AC1-216 C OP	15.38
928272	AC1-216 E OP	12.09
928321	AC1-221 C	3.13
928322	AC1-221 E	3.13
928331	AC1-222 C	5.06
928332	AC1-222 E	4.81