

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

***For***

***PJM Generation Interconnection Request  
Queue Position AD1-022***

***Cashie – Trowbridge 230kV  
51.8 MW Capacity / 80.0 MW Energy***

**Revised July 2022**

**Revised May 2022**

**Revised March 2022**

**Revised December 2021**

**December 2019**

## 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 Sumac Solar 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.

## Summary Revision 4 – July 2022

The revision is being issued to update Duke Energy/Progress (DEP) affected system study results and split n6618 into n6618 and n6618.1 to reflect scope of work in the facility study report.

## Summary Revision 3 – May 2022

This revision is being issued as a result of retool driven by AD1-023 withdrawing from the queue.

## Summary Revision 2 – March 2022

This revision is being issued due to a re-tool and clarification by ITO on previously identified network upgrades that are no longer needed. Executive Summary from the stability study report also added.

## Summary Revision 1 – December 2021

This revision is being issued due to a re-tool performed.

## General

The IC has proposed two solar generating facilities located in Bertie County, North Carolina. Queue project AD1-022 will have a total installed capability of 80 MW (51.8 MW Capacity).

The installed AD1-022 facility will have a total capability of 80 MW, with 51.8 MW of this output being recognized by PJM as capacity. The proposed in-service date for the project is June 1, 2019. This study does not imply an ITO commitment to this in-service date.

## Point of Interconnection

Queue project AD1-022 will interconnect with the ITO transmission system via a new three breaker ring bus that connects the Cashie – Trowbridge 230kV line.

## Cost Summary

The AD1-022 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$ 1,800,000
Direct Connection Network Upgrades	\$ 6,300,000
Non Direct Connection Network Upgrades	\$ 1,000,000
<b>Total Costs</b>	<b>\$ 9,100,000</b>

These costs are for PJM network upgrades:

Description	Total Cost
Allocation for New System Upgrades	\$14,073,759
Contribution for Previously Identified Upgrades	\$ 0
<b>Total Costs</b>	<b>\$14,073,759</b>

These costs are for Duke Energy Progress upgrades to be confirmed as part of the affected systems study and constructed via a separate agreement between the customer and Duke:

Description	Total Cost
Allocation for New System Upgrades	\$ 350,000
Contribution for Previously Identified Upgrades	\$ 0
<b>Total Costs</b>	<b>\$ 350,000</b>

## **Attachment Facilities**

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

Transmission: Construct approximately one span of 230 kV Attachment line between the generation substation and a new AD1-022 Switching Station. The estimated cost for this work is \$1,200,000.

The estimated total cost of the Attachment Facilities is \$1,800,000. It is estimated to take 18-24 months to complete this work upon execution of an Interconnection Construction Service Agreement (ICSA). These preliminary cost estimates are based on typical engineering costs. A more detailed engineering cost estimates are normally done when the IC provides an exact site plan location for the generation substation during the Facility Study phase. See Attachment 1.

## **Direct Connection Cost Estimate**

Substation: Establish the new 230 kV AD1-022 Switching Substation (interconnection substation). The arrangement in the substation will be as shown below on Dominion Attachment 1: One-Line Diagram. The estimated cost of this work scope is \$6,300,000. It is estimated to take 24-36 months to complete this work upon execution of an Interconnection Construction Service Agreement.

## **Non-Direct Connection Cost Estimate**

Transmission: Install transmission structure in-line with transmission line to allow the proposed interconnection switching station to be interconnected with the transmission system. Estimated cost is \$1,000,000 and is estimated to take 24-30 months to complete. See Attachment 1.

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.

Violation #	Ruling Violation #	Loading	Upgrade Description	Upgrade Cost	Allocated Cost
# 2	2	From 115.92% To 117.62%	Description: Rebuild 4.3 miles of Dominion 230 kV Line #2058 Rocky Mt. – Hathaway	\$13,000,000	\$0
# 3	3	From 221.56% To 224.02%	Replace Battleboro substation terminal equipment. Upgrading the breaker leads at Battleboro will bring the rating to 398 MVA for the DVP terminal. The Duke terminal equipment is still limiting.	\$100,000	\$0
			Rebuild Line #55 (Tarboro – Anaconda 115 kV) and associated 230 kV work on towers shared with 230 kV line 229.	\$14,053,010	\$14,053,010
			Split the 155 kV Bus at Hathaway into two separate buses with a 115 kV Line on each bus and close the tie switch between Line 55 & 80. Line #1001 is opened at Battleboro thus making Line #1001 radial from Chestnut Substation	\$20,749	\$20,749
<b>Total Estimate Allocated Cost of Network Upgrades</b>					<b>\$ 14,073,759</b>

## **Interconnection Customer Requirements**

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

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

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

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

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

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

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

## **Revenue Metering and SCADA Requirements**

### **PJM Requirements**

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

### **Interconnected Transmission Owner Requirements**

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

## Network Impacts

The Queue Project AD1-022 was evaluated as an 80.0 MW (Capacity 51.8 MW) injection into a new substation on the Cashie-Trowbridge 230kV transmission line in the Dominion zone. Project AD1-022 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-022 was studied with a commercial probability of 100%. Potential network impacts were as follows:

### Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
DVP_P1-2: LN 2058	CONTINGENCY 'DVP_P1-2: LN 2058' OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /* 6ROCKYMT230T230.00 - 6MORNSTR 230.00 END
DVP_P1-2: LN 2131A	CONTINGENCY 'DVP_P1-2: 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
DVP_P1-2: LN 2181	CONTINGENCY 'DVP_P1-2: LN 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 END
DVP_P1-2: LN 246	CONTINGENCY 'DVP_P1-2: LN 246' OPEN BRANCH FROM BUS 314537 TO BUS 314575 CKT 1 /* 6SUFFOLK 230.00 - 6NUCO TP 230.00 OPEN BRANCH FROM BUS 314569 TO BUS 314575 CKT 1 /* 6EARLEYS 230.00 - 6NUCO TP 230.00 OPEN BRANCH FROM BUS 314575 TO BUS 314590 CKT 1 /* 6NUCO TP 230.00 - 6NUCOR 230.00 OPEN BUS 314575 /* ISLAND OPEN BUS 314590 /* ISLAND

	END
DVP_P1-2: LN 563	CONTINGENCY 'DVP_P1-2: LN 563' OPEN BRANCH FROM BUS 314902 TO BUS 314914 CKT 1 /* 8CARSON 500.00 - 8MDLTHAN 500.00 END
DVP_P7-1: LN 2058-2181	CONTINGENCY 'DVP_P7-1: LN 2058-2181' OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /* 6ROCKYMT230T230.00 - 6HATHAWAY 230.00 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 END
DVP_P7-1: LN 81-2056	CONTINGENCY 'DVP_P7-1: LN 81-2056' OPEN BRANCH FROM BUS 314559 TO BUS 314578 CKT 1 /* 3CAROLNA 115.00 - 3HORNRTN 115.00 OPEN BRANCH FROM BUS 314578 TO BUS 314598 CKT 1 /* 3HORNRTN 115.00 - 3ROAN DP 115.00 OPEN BRANCH FROM BUS 314598 TO BUS 314628 CKT 1 /* 3ROAN DP 115.00 - 3DARLINGT DP115.00 OPEN BUS 314578 /* ISLAND: 3HORNRTN 115.00 OPEN BUS 314598 /* ISLAND: 3ROAN DP 115.00 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 /* 6MORNSTR 230.00 - 6NASH 230.00 OPEN BRANCH FROM BUS 304226 TO BUS 304222 CKT 1 /* 6PA-RMOUNT#4230.00 - 6ROCKYMT230T OPEN BUS 304226 /* ISLAND OPEN BUS 314591 /* ISLAND: 6NASH 230.00 END



## Summer Peak Analysis – 2021

### Generator Deliverability

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

None

### Multiple Facility Contingency

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

#	Contingency			Bus				Power Flow	Loading %		Rating		MW Contr	Flowgate Appendix
	Type	Name	Affected Area	Facility Description	From	To	Ckt		Initial	Final	Type	MVA		
1	DCTL	DVP_P7-1: LN 2058-2181	DVP - CPLE	6EVERETS-6GREENVILLE T 230 kV line	314574	304451	1	AC	96.75	99.52	ER	478	13.8	

### 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			Bus				Power Flow	Loading %		Rating		MW Contr	Flowgate Appendix
	Type	Name	Affected Area	Facility Description	From	To	Ckt		Initial	Final	Type	MVA		
2	DCTL	DVP_P7-1: LN 81-2056	DVP - CPLE	6MORNSTR-6ROCKYMT230T 230 kV line	313845	304222	1	AC	115.92	117.62	ER	374	7.47	1

3	DCTL	DVP_P7-1: LN 2058-2181	DVP - CPLE	3BTLEBRO-3ROCKYMT115T 115 kV line	314554	304223	1	AC	221.56	224.02	ER	164	4.85	2
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**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	AD1-022/023 Allocation
#1	6EVERETS-6GREENVILE T 230 kV line	<p><b>Duke Energy/Progress Portion:</b> Rebuild 1.87 miles of aging double circuit 230kV towers. Project Type: FAC.</p> <p>Time Estimate: 36 months</p> <p>Note 1: Duke Energy/Progress facilities of concern are those that have a post contingency loading greater than 95% of their thermal rating.</p> <p>Note 2: The Duke/Progress Energy portion of this line is studied under Duke’s FERC tariff process. Reference the applicable affected system study for the AD1 cluster.</p>	-	\$19,000,000	\$0

		<p><b>Duke Energy/Progress Portion:</b> Rebuild 1.87 miles of aging double circuit 230kV towers. Project Type: FAC.</p> <p>Time Estimate: 36 months</p> <p>Note 1: Duke Energy/Progress facilities of concern are those that have a post contingency loading greater than 95% of their thermal rating.</p> <p>Note 2: The Duke/Progress Energy portion of this line is studied under Duke’s FERC tariff process. Reference the applicable affected system study for the AD1 cluster.</p>	-	\$350,000	<b>\$350,000</b>
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**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	AD1-022 Allocation
#2	6MORNSTR-6ROCKYMT30T 230 kV line	<p>Description: Rebuild 4.3 miles of Dominion 230 kV Line #2058 Rocky Mt. – Hathaway</p> <p>New Rating: 1047/1047/1204</p> <p>Schedule: 12/31/2024 in-service date</p> <p>Note: Although Queue Project AD1-022 may not have cost responsibility for this upgrade, it may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AD1-022 comes into service prior to completion of the upgrade, it will need an interim study.</p>	b3122	\$13,000,000	<b>\$0</b>

#3	3BTLEBRO-3ROCKYMT11 5T 115 kV line	<p><b>Dominion Portion:</b> Replace Battleboro substation terminal equipment. Upgrading the breaker leads at Battleboro will bring the rating to 398 MVA for the DVP terminal. The Duke terminal equipment is still limiting.</p> <p>New Ratings: 239/239/239 MVA (until Duke terminal is upgraded)</p> <p>Note: Although Queue Project AD1-022 may not have cost responsibility for this upgrade, it may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AD1-022 comes into service prior to completion of the upgrade, it will need an interim study.</p>	n6118	\$100,000	\$0
		<p><b>Dominion Portion:</b> Rebuild Line #55 (Tarboro – Anaconda 115 kV) and associated 230 kV work on towers shared with 230 kV line 229. Time Estimate: 20 months</p> <p><b>AD1-022 is the driver for this overload.</b></p>	n6618	\$14,053,010	\$14,053,010
		<p><b>Dominion Portion:</b> Split the 155 kV Bus at Hathaway into two separate buses with a 115 kV Line on each bus and close the tie switch between Line 55 &amp; 80. Line #1001 is opened at Battleboro thus making Line #1001 radial from Chestnut Substation Time Estimate: 20 months</p> <p><b>AD1-022 is the driver for this overload.</b></p>	n6618.1	\$20,749	\$20,749
		<p><b>Duke Energy/Progress Portion:</b> Reconductor 8.5 miles with single 795 ACSS-TW per phase, upgrade disconnect switches and CT ratios.</p>	dep0001	\$31,300,000	\$0

		<p>New Ratings: 313/313/313 MVA</p> <p>Time Estimate: 48 months</p> <p>Note 1: Although Queue Project AD1-022 may not have cost responsibility for this upgrade, it may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AD1-022 comes into service prior to completion of the upgrade, it will need an interim study.</p> <p>Note 2: The Duke/Progress Energy portion of this line is studied under Duke's FERC tariff process. Reference the applicable affected system study for the AD1 cluster.</p>			
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**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			Bus					Loading %		Rating		MW Contribution
	Type	Name	Affected Area	Facility Description	From	To	Ckt	Power Flow	Initial	Final	Type	MVA	
1	N-1	DVP_P1-2: LN 2181	DVP - CPLE	6MORNSTR-6ROCKYMT230T 230 kV line	313845	304222	1	AC	115.3	117	ER	374	7.45
2	N-1	DVP_P1-2: LN 2058	DVP - DVP	6MORNSTR-6NASH 230 kV line	313845	314591	1	AC	102.76	104.19	ER	449	7.6
3	N-1	DVP_P1-2: LN 563	DVP - DVP	6CHESTF B-6BASIN 230 kV line	314287	314276	1	AC	115.15	116.09	ER	449	4.96
4	N-1	DVP_P1-2: LN 2131A	DVP - DVP	6EARLEYS-6NUCO TP 230 kV line	314569	314575	1	AC	95.17	100.07	ER	572	28.65

5	N-1	DVP_P1-2: LN 246	DVP - DVP	AB2-100 TAP-6CLUBHSE 230 kV line	924510	314563	1	AC	111.03	113.96	ER	375	11.1
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### **Light Load Analysis in 2021**

Not required

### **Affected System Analysis & Mitigation**

#### **Duke Energy/Progress:**

Potential constraints were identified by PJM on the following Dominion – Duke Energy/Progress (DEP) tie lines. Duke/Progress Energy portion of this line will need to be studied under Duke’s FERC tariff process. The following facilities were identified in this report:

- Battleboro – Rocky Mt. 115 kV line
- Everetts - Greenville 230 kV line

## Stability Study Report Executive Summary

**Note:** While the executive summary references the withdrawn AD1-023, the report's findings do not change as a result of the withdrawn project.

Generator Interconnection Request AD1-022 is for an 80 MW Maximum Facility Output (MFO) solar generating facility. AD1-022 consists of 40 x 2.025 MW SMA Sunny Central MVB 2500-US solar inverters with a Point of Interconnection (POI) at a tap off of the Cashie to Trowbridge 230 kV line in Bertie County, North Carolina, in the Dominion Energy (DVP) transmission system.

Generation Interconnection Request AD1-023 is for a 40 MW Maximum Facility Output (MFO) solar generating facility. AD1-023 consists of 19 x 2.136 MW SMA Sunny Central MVB 2500-US solar inverters with a Point of Interconnection (POI) at a tap off of the Cashie to Trowbridge 230 kV line in Bertie County, North Carolina, in the Dominion Energy transmission system.

The power flow scenario for the analysis was based on the RTEP 2021 summer peak case, modified to include applicable queue projects. AD1-022 and AD1-023 has been dispatched online at maximum facility output, with approximately unity power factor at the high-side of the station transformer.

AD1-022 and AD1-023 were tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. For this study, 89 contingencies were simulated, each with a 20 second simulation time period. Studied faults included:

- Steady-state operation (30 second simulation)
- Three-phase faults with normal clearing time
- Single-phase faults with a stuck breaker
- Single-phase faults placed at 80% of the line with delayed (Zone 2) clearing at remote line end because of primary communications/relaying failure
- Single-phase faults with loss of multiple-circuit tower lines

The 89 fault contingencies tested on the 2021 summer peak case met the recovery criteria:

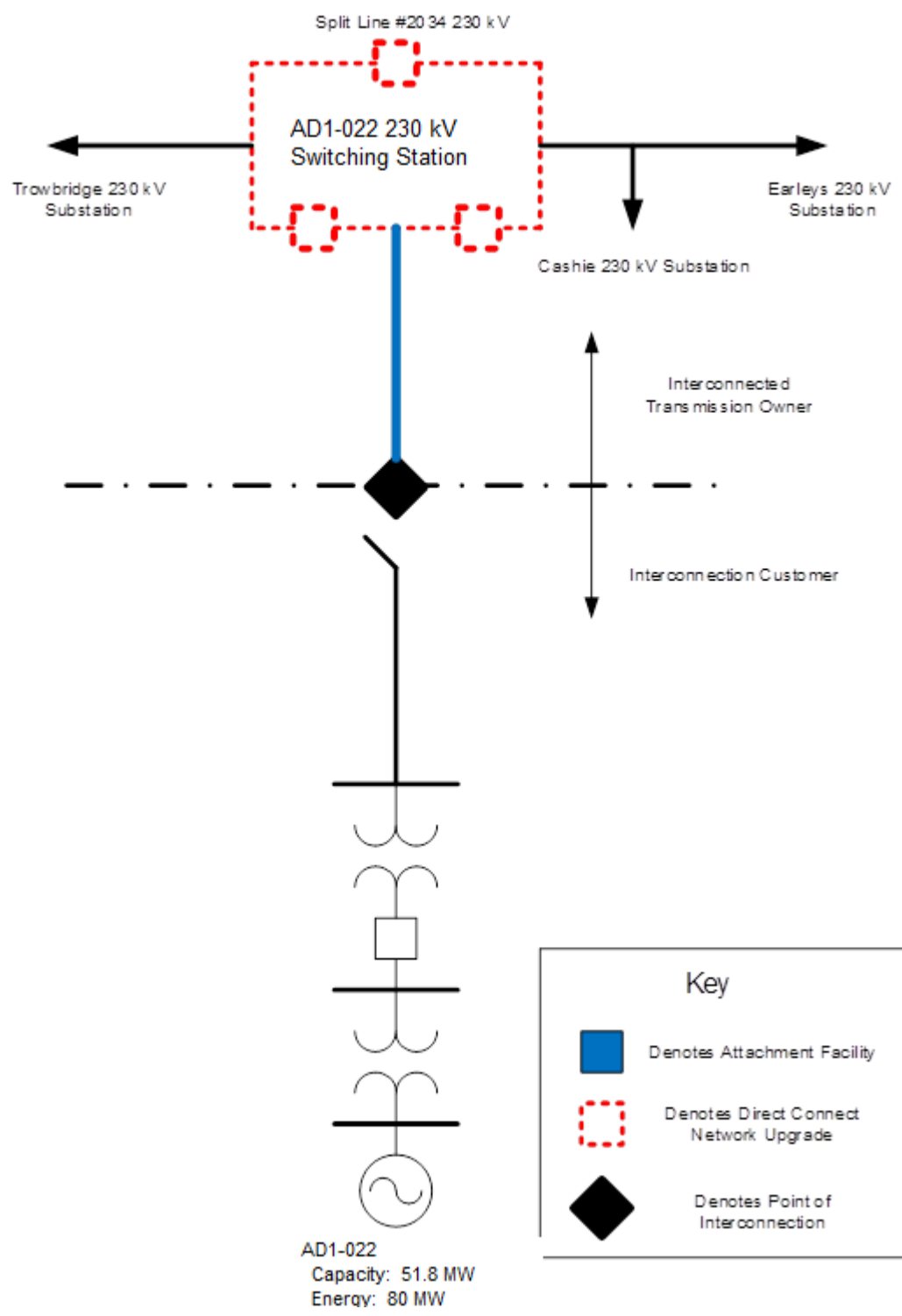
- The AD1-022 and AD1-023 generators were able to ride through the faults except for faults where protective actions trip one or more generator(s).
- All generators maintained synchronism and any post-contingency oscillations are positively damped with a damping margin of at least 3%.
- All bus voltages recover to 0.7 p.u. within 2.5 seconds and the final voltage is within the range of 0.92 p.u. to 1.05 p.u. for buses other than 500 kV buses. The final voltages for 500 kV buses should be within 1.02 p.u. to 1.08 p.u.
- No transmission element trips, other than those either directly connected or designated to trip as a consequence of the fault.

Based on the Impact Data submitted, the queue projects, AD1-022 and AD1-023, met both the 0.95 leading and 0.95 lagging power factor requirement.



# Attachment 1

## System Configuration



## **Appendices**

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the Appendices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the Appendices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators.

It should be noted the project/generator MW contributions presented in the body of the report and appendices sections are full contributions, whereas the loading percentages reported in the body of the report, take into consideration the commercial probability of each project as well as the ramping impact of "Adder" contributions.

## Appendix 1

(DVP - CPLE) The 6MORNSTR-6ROCKYMT230T 230 kV line (from bus 313845 to bus 304222 ckt 1) loads from 115.92% to 117.62% (AC power flow) of its emergency rating (374 MVA) for the tower line contingency outage of 'DVP\_P7-1: LN 81-2056'. This project contributes approximately 7.47 MW to the thermal violation.

CONTINGENCY 'DVP\_P7-1: LN 81-2056'

OPEN BRANCH FROM BUS 314559 TO BUS 314578 CKT 1 /\* 3CAROLNA  
115.00 - 3HORNRTN 115.00  
OPEN BRANCH FROM BUS 314578 TO BUS 314598 CKT 1 /\* 3HORNRTN  
115.00 - 3ROAN DP 115.00  
OPEN BRANCH FROM BUS 314598 TO BUS 314628 CKT 1 /\* 3ROAN DP  
115.00 - 3DARLINGT DP115.00  
OPEN BUS 314578 /\* ISLAND: 3HORNRTN 115.00  
OPEN BUS 314598 /\* ISLAND: 3ROAN DP 115.00  
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 /\* 6MORNSTR  
230.00 - 6NASH 230.00  
OPEN BRANCH FROM BUS 304226 TO BUS 304222 CKT 1 /\* 6PA-  
RMOUNT#4230.00 - 6ROCKYMT230T  
OPEN BUS 304226 /\* ISLAND  
OPEN BUS 314591 /\* ISLAND: 6NASH 230.00  
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315131	1EDGECEMA	21.38
315132	1EDGECEMB	21.38
315139	1GASTONA	3.75
315141	1GASTONB	3.75
315126	1ROARAP2	1.14
315128	1ROARAP4	1.1
315136	1ROSEMG1	3.14
315138	1ROSEMG2	1.47
315137	1ROSEMS1	1.95
314557	3BETHEL C	1.61

314554	3BTLEBRO	1.08
314566	3CRESWEL	1.09
314572	3EMPORIA	0.27
314603	3SCOT NK	3.23
314541	3WATKINS	0.33
314620	6CASHIE	0.49
314574	6EVERETS	1.81
314594	6PLYMOTH	0.44
932631	AC2-084 C	7.04
932632	AC2-084 E	3.47
933991	AD1-022 C	4.84
933992	AD1-022 E	2.63
934331	AD1-057 C O1	19.79
934332	AD1-057 E O1	10.56
934521	AD1-076 C O1	28.52
934522	AD1-076 E O1	14.52
LTF	AMIL	0.38
LTF	BLUEG	1.99
LTF	CALDERWOOD	1.17
LTF	CANNELTON	0.38
LTF	CARR	< 0.01
LTF	CATAWBA	1.14
LTF	CELEVELAND /* 35% REVERSE 4479079 4642907	< 0.01
LTF	CHEOAH	1.09
LTF	CLIFTY	7.31
LTF	COTTONWOOD	3.91

<i>LTF</i>	<i>EDWARDS</i>	<i>0.61</i>
<i>LTF</i>	<i>ELMERSMITH</i>	<i>1.11</i>
<i>LTF</i>	<i>FARMERCITY</i>	<i>0.48</i>
<i>LTF</i>	<i>G-007A</i>	<i>0.76</i>
<i>LTF</i>	<i>GIBSON</i>	<i>0.69</i>
<i>LTF</i>	<i>HAMLET</i>	<i>2.25</i>
<i>LTF</i>	<i>MORGAN</i>	<i>3.43</i>
<i>LTF</i>	<i>NEWTON</i>	<i>1.68</i>
<i>LTF</i>	<i>O-066A</i>	<i>0.35</i>
<i>LTF</i>	<i>PRAIRIE</i>	<i>3.62</i>
<i>LTF</i>	<i>SMITHLAND</i>	<i>0.32</i>
<i>LTF</i>	<i>TATANKA</i>	<i>0.82</i>
<i>LTF</i>	<i>TILTON</i>	<i>0.72</i>
<i>LTF</i>	<i>TRIMBLE</i>	<i>0.38</i>
<i>LTF</i>	<i>TVA</i>	<i>1.45</i>
<i>LTF</i>	<i>UNIONPOWER</i>	<i>1.94</i>
<i>900671</i>	<i>V4-068 C</i>	<i>0.06</i>
<i>900672</i>	<i>V4-068 E</i>	<i>0.18</i>
<i>LTF</i>	<i>VFT</i>	<i>2.03</i>
<i>907092</i>	<i>X1-038 E</i>	<i>2.6</i>
<i>LTF</i>	<i>Y3-032</i>	<i>&lt; 0.01</i>
<i>917331</i>	<i>Z2-043 C</i>	<i>0.36</i>
<i>917332</i>	<i>Z2-043 E</i>	<i>0.84</i>
<i>917341</i>	<i>Z2-044 C</i>	<i>0.32</i>
<i>917342</i>	<i>Z2-044 E</i>	<i>0.75</i>
<i>917511</i>	<i>Z2-088 C OPI</i>	<i>1.56</i>

917512	Z2-088 E OPI	6.74
918411	AA1-050	1.32
918491	AA1-063AC OP	1.07
918492	AA1-063AE OP	2.74
918511	AA1-065 C OP	1.09
918512	AA1-065 E OP	2.92
918531	AA1-067 C	0.23
918532	AA1-067 E	0.54
918561	AA1-072 C	0.05
918562	AA1-072 E	0.14
919691	AA2-053 C	1.19
919692	AA2-053 E	2.79
919701	AA2-057 C	8.78
919702	AA2-057 E	4.39
920042	AA2-088 E	5.93
920591	AA2-165 C	0.22
920592	AA2-165 E	0.58
920671	AA2-174 C	0.05
920672	AA2-174 E	0.32
920692	AA2-178 E	1.86
930401	ABI-081 C	2.67
930402	ABI-081 E	6.24
930861	ABI-132 C	15.62
930862	ABI-132 E	6.7
931231	ABI-173 C	1.56
931232	ABI-173 E	0.73

931241	ABI-173AC	1.56
931242	ABI-173AE	0.73
923852	AB2-025 E	0.45
923911	AB2-031 C OI	1.55
923912	AB2-031 E OI	0.76
923991	AB2-040 C OI	5.07
923992	AB2-040 E OI	4.15
924151	AB2-059 C OI	17.15
924152	AB2-059 E OI	8.84
924501	AB2-099 C	0.4
924502	AB2-099 E	0.17
924511	AB2-100 C	8.3
924512	AB2-100 E	4.09
925121	AB2-169 C	4.03
925122	AB2-169 E	3.62
925171	AB2-174 C OI	4.75
925172	AB2-174 E OI	4.3
925591	ACI-034 C	11.11
925592	ACI-034 E	8.38
926071	ACI-086 C	23.01
926072	ACI-086 E	10.47
926201	ACI-098 C	6.58
926202	ACI-098 E	3.92
926211	ACI-099 C	2.21
926212	ACI-099 E	1.3
927021	ACI-189 C	12.21

927022	<i>ACI-189 E</i>	6.08
927141	<i>ACI-208 C</i>	10.44
927142	<i>ACI-208 E</i>	4.64



## Appendix 2

(DVP - CPLE) The 3BTLEBRO-3ROCKYMT115T 115 kV line (from bus 314554 to bus 304223 ckt 1) loads from 221.56% to 224.02% (AC power flow) of its emergency rating (164 MVA) for the tower line contingency outage of 'DVP\_P7-1: LN 2058-2181'. This project contributes approximately 4.85 MW to the thermal violation.

CONTINGENCY 'DVP\_P7-1: LN 2058-2181'

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

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315131	1EDGECEMA	11.56
315132	1EDGECEMB	11.56
315139	1GASTONA	2.33
315141	1GASTONB	2.33
315126	1ROARAP2	0.97
315128	1ROARAP4	0.93
315136	1ROSEMG1	1.89
315138	1ROSEMG2	0.88
315137	1ROSEMS1	1.17
314557	3BETHEL C	0.88
314554	3BTLEBRO	1.95
314572	3EMPORIA	0.2
314578	3HORNRTN	2.51
314603	3SCOT NK	3.67
314541	3WATKINS	0.26

314620	6CASHIE	0.32
314574	6EVERETS	1.04
932631	AC2-084 C	8.5
932632	AC2-084 E	4.19
933991	AD1-022 C	3.14
933992	AD1-022 E	1.71
934331	AD1-057 C O1	11.1
934332	AD1-057 E O1	5.92
LTF	AMIL	0.26
LTF	BLUEG	1.35
LTF	CALDERWOOD	0.8
LTF	CANNELTON	0.26
LTF	CARR	< 0.01
LTF	CATAWBA	0.78
LTF	CHEOAH	0.74
LTF	CLIFTY	4.95
LTF	COTTONWOOD	2.67
LTF	EDWARDS	0.42
LTF	ELMERSMITH	0.75
LTF	FARMERCITY	0.33
LTF	G-007A	0.49
LTF	GIBSON	0.47
LTF	HAMLET	1.56
LTF	MORGAN	2.34
LTF	NEWTON	1.14
LTF	O-066A	0.23

<i>LTF</i>	<i>PRAIRIE</i>	<i>2.46</i>
<i>LTF</i>	<i>RENSSELAER</i>	<i>&lt; 0.01</i>
<i>LTF</i>	<i>SMITHLAND</i>	<i>0.22</i>
<i>LTF</i>	<i>TATANKA</i>	<i>0.55</i>
<i>LTF</i>	<i>TILTON</i>	<i>0.49</i>
<i>LTF</i>	<i>TRIMBLE</i>	<i>0.26</i>
<i>LTF</i>	<i>TVA</i>	<i>0.99</i>
<i>LTF</i>	<i>UNIONPOWER</i>	<i>1.32</i>
<i>900672</i>	<i>V4-068 E</i>	<i>0.15</i>
<i>LTF</i>	<i>VFT</i>	<i>1.3</i>
<i>917331</i>	<i>Z2-043 C</i>	<i>0.35</i>
<i>917332</i>	<i>Z2-043 E</i>	<i>0.82</i>
<i>917341</i>	<i>Z2-044 C</i>	<i>0.53</i>
<i>917342</i>	<i>Z2-044 E</i>	<i>1.25</i>
<i>917511</i>	<i>Z2-088 C OP1</i>	<i>0.86</i>
<i>917512</i>	<i>Z2-088 E OP1</i>	<i>3.69</i>
<i>918411</i>	<i>AA1-050</i>	<i>0.72</i>
<i>918492</i>	<i>AA1-063AE OP</i>	<i>2.28</i>
<i>918512</i>	<i>AA1-065 E OP</i>	<i>1.94</i>
<i>918532</i>	<i>AA1-067 E</i>	<i>0.31</i>
<i>918561</i>	<i>AA1-072 C</i>	<i>0.05</i>
<i>918562</i>	<i>AA1-072 E</i>	<i>0.14</i>
<i>919691</i>	<i>AA2-053 C</i>	<i>0.99</i>
<i>919692</i>	<i>AA2-053 E</i>	<i>2.32</i>
<i>919701</i>	<i>AA2-057 C</i>	<i>13.27</i>
<i>919702</i>	<i>AA2-057 E</i>	<i>6.64</i>

920042	AA2-088 E	4.77
920591	AA2-165 C	0.33
920592	AA2-165 E	0.87
920671	AA2-174 C	0.05
920672	AA2-174 E	0.27
930401	AB1-081 C	3.67
930402	AB1-081 E	8.59
930861	AB1-132 C	9.71
930862	AB1-132 E	4.16
931231	AB1-173 C	1.21
931232	AB1-173 E	0.56
931241	AB1-173AC	1.21
931242	AB1-173AE	0.56
923911	AB2-031 C O1	1.2
923912	AB2-031 E O1	0.59
923991	AB2-040 C O1	3.93
923992	AB2-040 E O1	3.22
924151	AB2-059 C O1	23.61
924152	AB2-059 E O1	12.16
924501	AB2-099 C	0.31
924502	AB2-099 E	0.13
924511	AB2-100 C	5.32
924512	AB2-100 E	2.62
925121	AB2-169 C	2.45
925122	AB2-169 E	2.2
925171	AB2-174 C O1	3.6

<i>925172</i>	<i>AB2-174 E O1</i>	<i>3.26</i>
<i>925591</i>	<i>AC1-034 C</i>	<i>15.3</i>
<i>925592</i>	<i>AC1-034 E</i>	<i>11.54</i>
<i>926071</i>	<i>AC1-086 C</i>	<i>14.3</i>
<i>926072</i>	<i>AC1-086 E</i>	<i>6.51</i>
<i>926201</i>	<i>AC1-098 C</i>	<i>7.95</i>
<i>926202</i>	<i>AC1-098 E</i>	<i>4.74</i>
<i>926211</i>	<i>AC1-099 C</i>	<i>2.66</i>
<i>926212</i>	<i>AC1-099 E</i>	<i>1.56</i>
<i>927021</i>	<i>AC1-189 C</i>	<i>6.74</i>
<i>927022</i>	<i>AC1-189 E</i>	<i>3.36</i>
<i>927141</i>	<i>AC1-208 C</i>	<i>11.27</i>
<i>927142</i>	<i>AC1-208 E</i>	<i>5.</i>