Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC2-023

"Hebron 23 kV"

March 2018
Revised January 2022

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 Interconnection Customer. As a requirement for interconnection, the Interconnection Customer 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 Interconnection Customer 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 Interconnection Customer 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

Porter Mill LLC, the Interconnection Customer (IC), has proposed a 45.8 MW (26.5 MWC) solar generating facility to be located in Hebron, Wicomico County, Maryland. PJM studied AC2-023 as a 45.8 MW injection into the Delmarva Power & Light Company (DPL) system at the Hebron 69 kV Substation and evaluated it for compliance with reliability criteria for summer peak conditions in 2020. The planned in-service date, as requested by the IC during the project kick-off call, is September 30, 2019. This date may not be attainable due to additional PJM studies (System Impact and Facilities) and the Transmission Owner's construction schedule.

Revision History

This report was revised in January 2022 to reflect the results of PJM's retool analysis.

Point of Interconnection

The Interconnection Customer requested a transmission level Point of Interconnection (POI). As a result, the AC2-023 project will require a Point of Interconnection (POI) off the DPL 69 kV substation bus at the Hebron Substation adjacent to the North Salisbury to Hebron 69 kV circuit. AC2-023 will connect into the 69 kV substation via a new 69 kV

line terminal that will be created by converting Hebron to a 4 position ring bus. One position will be utilized to serve the existing load out of Hebron (see Attachment 1).

Transmission Owner Scope of Work

Substation Interconnection Estimate
Scope: Convert existing Hebron tap to a four (4) position ring bus.
Estimate: $5,226,000
Construction Time: 24-36 months

Major Equipment Included in Estimate:

- Control Enclosure, 20' x 15' Qty. 1
- Power Circuit Breaker, 69 kV, 2000A, 40kA, 3 cycle Qty. 4
- Disconnect Switch, 69 kV, 2000A, Manual Wormgear, Arcing Horns Qty. 12
- CT/VT Combination Units, 69 kV Qty. 4
- CVT, 69 kV Qty. 8
- Disconnect Switch Stand, High, 69 kV, Steel Qty. 5
- Disconnect Switch Stand, Low, 69 kV, Steel Qty. 4
- CT/VT Stand, Single Phase, Low, 69 kV, Steel Qty. 3
- CVT Stand, Single Phase, Low, 69 kV, Steel Qty. 8
- SSVT, 69 kV/240-120 V Qty. 1
- Relay Panel, Transmission Line, FL/BU (20") Qty. 4
- Control Panel, 69 kV Circuit Breaker (10") Qty. 4
- Take-off structure, 69 kV Qty. 2
- Bus Support Structure, 3 phase, 69 kV, Steel Qty. 8

Conceptual Estimate Assumptions:

- The existing Hebron substation property will not need to be expanded. The cost of purchasing any new property is not included in the conceptual estimate.
- No new storm water management is required.
- Clearing and grading of the existing site is minimal.
- Permitting will be performed by DPL.

Transmission Engineering Interconnection Estimate
Scope: Reconfigure Circuit 6708 to accommodate new line terminal positions at Hebron Substation.
Estimate: Approximately $600,000
Construction Time: 24 months

Required Relaying and Communications
New protection relays are required for the new line terminals. An SEL-421 will be required for primary protection and an SEL-311C will be required for back-up protection. A 20" relay panel will be required for each transmission line (2 total).

New protection relays are required for the new generator terminal. An SEL-487 will be required for primary protection and an SEL-387 will be required for back-up protection. A 20" relay panel is required.

A SEL-451 relay on a 10" breaker control panel will be required for the control and operation of the new 69 kV circuit breakers (4 total).

The cost of the required relay and communications is included in the Substation Interconnection Estimate.

Metering

Three phase 69 kV revenue metering points will need to be established. DPL will purchase and install all metering instrument transformers as well as construct a metering structure. The secondary wiring connections at the instrument transformers will be completed by DPL's metering technicians. The metering control cable and meter cabinets will be supplied and installed by DPL. DPL will install conduit for the control cable between the instrument transformers and the metering enclosure. The location of the metering enclosure will be determined in the construction phase. DPL will provide both the Primary and the Backup meters. DPL's meter technicians will program and install the Primary & Backup solid state multi-function meters for each new metering position. Each meter will be equipped with load profile, telemetry, and DNP outputs. The IC will be provided with one meter DNP output for each meter. DPL will own the metering equipment for the interconnection point, unless the IC asserts its right to install, own, and operate the metering system.

The Interconnection Customer will be required to make provisions for a voice quality phone line within approximately 3 feet of each Company metering position to facilitate remote interrogation and data collection.

It is the IC's responsibility to send the data that PJM and DPL requires directly to PJM. The IC will grant permission for PJM to send DPL the following telemetry that the IC sends to PJM: real time MW, MVAR, volts, amperes, generator status, and interval MWH and MVARH.

The estimate for DPL to design, purchase, and install metering as specified in the aforementioned scope for metering is included in the Substation Interconnection Estimate.

Interconnection Customer Scope of Direct Connection Work

The Interconnection Customer is responsible for all design and construction related to activities on their side of the Point of Interconnection. Site preparation, including grading and an access road, as necessary, is assumed to be by the IC. Route selection, line design, and right-of-way acquisition of the direct connect facilities is not included in this report, and is the responsibility of the IC. Protective relaying and metering design and installation must comply with DPL's applicable standards. The IC is also required to

provide revenue metering and real-time telemetering data to PJM in conformance with the requirements contained in PJM Manuals M-01 and M-14 and the PJM Tariff.

DPL Interconnection Customer Scope of Direct Connection Work Requirements:

- DPL requires that an IC circuit breaker is located within 500 feet of the DPL substation to facilitate the relay protection scheme between DPL and the IC at the Point of Interconnection (POI).

Special Operating Requirements

1. DPL will require the capability to remotely disconnect the generator from the grid by communication from its System Operations facility. Such disconnection may be facilitated by a generator breaker, or other method depending upon the specific circumstances and the evaluation by DPL.

2. DPL reserves the right to charge the Interconnection Customer operation and maintenance expenses to maintain the Interconnection Customer attachment facilities, including metering and telecommunications facilities, owned by DPL.

Summer Peak Analysis - 2020

Transmission Network Impacts

Potential transmission network impacts are as follows:

Generator Deliverability

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

1. (DP&L - DP&L) The ROCKAWLKN-NSALSBRY 69 kV line (from bus 232291 to bus 232271 ckt 1) loads from 88.83% to 112.23% (AC power flow) of its emergency rating (58 MVA) for the single line contingency outage of 'CKT 6728'. This project contributes approximately 13.84 MW to the thermal violation.

CONTINGENCY 'CKT 6728'
OPEN LINE FROM BUS 232272 TO BUS 232274 CIRCUIT 1 /MOUNT HERMON - PINEY GROVE 69
DISCONNECT BUS 230912 / PINEY GROVE 69 CAP
END

Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

2. (DP&L - DP&L) The ROCKAWLKN-NSALSBRY 69 kV line (from bus 232291 to bus 232271 ckt 1) loads from 88.85% to 112.03% (AC power flow) of its emergency rating (58 MVA) for the single line contingency outage of 'LORETO AT1&2'. This project contributes approximately 14.13 MW to the thermal violation.

CONTINGENCY 'LORETO AT1&2'
 OPEN LINE FROM BUS 232127 TO BUS 232275 CIRCUIT 1 /LORETTO AT1 138/69
 OPEN LINE FROM BUS 232127 TO BUS 232275 CIRCUIT 2 /LORETTO AT2 138/69
 END

Multiple Facility Contingency

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

1. (DP&L - DP&L) The SHARPTWN-W1-070TAP1 69 kV line (from bus 232239 to bus 901490 ckt 1) loads from 99.92% to 106.02% (AC power flow) of its emergency rating (43 MVA) for the line fault with failed breaker contingency outage of 'DP36'. This project contributes approximately 3.08 MW to the thermal violation.

CONTINGENCY 'DP36' /*COOL SPRINGS BUS BREAKER TO IR 2
 DISCONNECT BRANCH FROM BUS 232001 TO BUS 232006 CKT 1 /*COOL SPRINGS INDRIV 4 230 230
 DISCONNECT BRANCH FROM BUS 232001 TO BUS 232004 CKT 1 /*COOL SPRINGS MILFORD 230 230
 END

2. (DP&L - DP&L) The SHARPTWN-W1-070TAP1 69 kV line (from bus 232239 to bus 901490 ckt 1) loads from 99.92% to 106.02% (AC power flow) of its emergency rating (43 MVA) for the line fault with failed breaker contingency outage of 'DP34'. This project contributes approximately 3.08 MW to the thermal violation.

CONTINGENCY 'DP34' /*COOL SPRINGS BUS BREAKER TO MILFORD
 DISCONNECT BRANCH FROM BUS 232001 TO BUS 232004 CKT 1 /*COOL SPRINGS INDRIV 4 230 230
 DISCONNECT BRANCH FROM BUS 232001 TO BUS 232269 CKT 1 /*COOL SPRINGS 230 138
 END

3. (DP&L - DP&L) The SHARPTWN-W1-070TAP1 69 kV line (from bus 232239 to bus 901490 ckt 1) loads from 99.91% to 106.0% (AC power flow) of its emergency rating (43 MVA) for the line fault with failed breaker contingency outage of 'DP35'. This project contributes approximately 3.08 MW to the thermal violation.

```
CONTINGENCY 'DP35'                              /*COOL SPRINGS BUS
BREAKER TO IR
  DISCONNECT BRANCH FROM BUS 232001 TO BUS 232006 CKT 1
/*COOL SPRINGS INDRIV 4 230 230
  DISCONNECT BRANCH FROM BUS 232001 TO BUS 232269 CKT 1
/*COOL SPRINGS 230 138
  END
```

4. (DP&L - DP&L) The W1-070TAP1-LAUREL 69 kV line (from bus 901490 to bus 232249 ckt 1) loads from 99.85% to 105.94% (AC power flow) of its emergency rating (43 MVA) for the line fault with failed breaker contingency outage of 'DP36'. This project contributes approximately 3.08 MW to the thermal violation.

```
CONTINGENCY 'DP36'                              /*COOL SPRINGS BUS
BREAKER TO IR 2
  DISCONNECT BRANCH FROM BUS 232001 TO BUS 232006 CKT 1
/*COOL SPRINGS INDRIV 4 230 230
  DISCONNECT BRANCH FROM BUS 232001 TO BUS 232004 CKT 1
/*COOL SPRINGS MILFORD 230 230
  END
```

5. (DP&L - DP&L) The W1-070TAP1-LAUREL 69 kV line (from bus 901490 to bus 232249 ckt 1) loads from 99.85% to 105.94% (AC power flow) of its emergency rating (43 MVA) for the line fault with failed breaker contingency outage of 'DP34'. This project contributes approximately 3.08 MW to the thermal violation.

```
CONTINGENCY 'DP34'                              /*COOL SPRINGS BUS
BREAKER TO MILFORD
  DISCONNECT BRANCH FROM BUS 232001 TO BUS 232004 CKT 1
/*COOL SPRINGS INDRIV 4 230 230
  DISCONNECT BRANCH FROM BUS 232001 TO BUS 232269 CKT 1
/*COOL SPRINGS 230 138
  END
```

6. (DP&L - DP&L) The W1-070TAP1-LAUREL 69 kV line (from bus 901490 to bus 232249 ckt 1) loads from 99.83% to 105.92% (AC power flow) of its emergency rating (43 MVA) for the line fault with failed breaker contingency outage of 'DP35'. This project contributes approximately 3.08 MW to the thermal violation.

```
CONTINGENCY 'DP35'                              /*COOL SPRINGS BUS
BREAKER TO IR
  DISCONNECT BRANCH FROM BUS 232001 TO BUS 232006 CKT 1
/*COOL SPRINGS INDRIV 4 230 230
```


DISCONNECT BRANCH FROM BUS 232001 TO BUS 232269 CKT 1
/*COOL SPRINGS 230 138
END

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)

1. (DP&L - DP&L) The SHARPTWN-W1-070TAP1 69 kV line (from bus 232239 to bus 901490 ckt 1) loads from 104.95% to 110.49% (AC power flow) of its emergency rating (43 MVA) for the line fault with failed breaker contingency outage of 'DP6'. This project contributes approximately 2.8 MW to the thermal violation.

CONTINGENCY 'DP6' /*MILFORD BUS BREAKER TO STEELE
DISCONNECT BRANCH FROM BUS 232000 TO BUS 232004 CKT 1
/*MILFORD STEELE 230 230
DISCONNECT BRANCH FROM BUS 232009 TO BUS 232004 CKT 1
/*MAGNOLIA MILFORD 230 230
END

Please refer to Appendix 2 for a table containing the generators having contribution to this flowgate.

2. (DP&L - DP&L) The W1-070TAP1-LAUREL 69 kV line (from bus 901490 to bus 232249 ckt 1) loads from 104.87% to 110.41% (AC power flow) of its emergency rating (43 MVA) for the line fault with failed breaker contingency outage of 'DP6'. This project contributes approximately 2.8 MW to the thermal violation.

CONTINGENCY 'DP6' /*MILFORD BUS BREAKER TO STEELE
DISCONNECT BRANCH FROM BUS 232000 TO BUS 232004 CKT 1
/*MILFORD STEELE 230 230
DISCONNECT BRANCH FROM BUS 232009 TO BUS 232004 CKT 1
/*MAGNOLIA MILFORD 230 230
END

Please refer to Appendix 3 for a table containing the generators having contribution to this flowgate.

Summer Peak Load Flow Analysis Reinforcements

Facility	Upgrade Description	Cost	Cost Allocation to AC2-023
ROCKAWLKN-NSALSBRY 69 kV Ckt. 1	**No Violation** **New rating is 136/174 MVA**	$0	$0
SHARPTWN-W1-070TAP1 69 kV Ckt. 1 **W1-070TAP1-LAUREL 69 kV Ckt. 1**	**Project ID**: S2072 **Description**: Rebuild 69 kV line from Sharptown – Laurel substations. All structures, conductor, and static wire will be replaced with new steel poles, conductor, and OPGW. **Type**: FAC **Projected in-service date**: 05/31/24 **Note:** Although Queue Project AC2-023 may not have cost responsibility for this upgrade, Queue Project AC2-023 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AC2-023 comes into service prior to completion of the upgrade, Queue Project AC2-023 will need an interim study.	$11,000,000	$0
	Total Cost	$11,000,000	$0

Steady-State Voltage Requirements

No issues identified.

Short Circuit

No issues identified.

Stability and Reactive Power Requirement

No issues identified. See Attachment 2 for full report.

Light Load Analysis - 2020

Light Load Analysis not required for AC2-023

Delivery of Energy Portion of Interconnection Request

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 developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request. Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

1. (DP&L - DP&L) The SHARPTWN-W1-070TAP1 69 kV line (from bus 232239 to bus 901490 ckt 1) loads from 97.76% to 103.99% (AC power flow) of its emergency rating (43 MVA) for the single line contingency outage of 'COOLSPG AT20'. This project contributes approximately 3.15 MW to the thermal violation.

CONTINGENCY 'COOLSPG AT20'
OPEN LINE FROM BUS 232001 TO BUS 232269 CIRCUIT 1 /COOL SPRINGS AT20 230/69
END

2. (DP&L - DP&L) The HEBRON-ROCKAWLKN 69 kV line (from bus 232270 to bus 232291 ckt 1) loads from 74.62% to 111.3% (AC power flow) of its emergency rating (64 MVA) for the single line contingency outage of 'CKT 6728'. This project contributes approximately 23.93 MW to the thermal violation.

CONTINGENCY 'CKT 6728'
OPEN LINE FROM BUS 232272 TO BUS 232274 CIRCUIT 1 /MOUNT HERMON - PINEY GROVE 69
DISCONNECT BUS 230912 / PINEY GROVE 69 CAP
END

3. (DP&L - DP&L) The ROCKAWLKN-NSALSBRY 69 kV line (from bus 232291 to bus 232271 ckt 1) loads from 121.94% to 162.44% (AC power flow) of its emergency rating (58 MVA) for the single line contingency outage of 'LORETO AT1&2'. This project contributes approximately 24.42 MW to the thermal violation.

CONTINGENCY 'LORETO AT1&2'
OPEN LINE FROM BUS 232127 TO BUS 232275 CIRCUIT 1 /LORETTO AT1 138/69
OPEN LINE FROM BUS 232127 TO BUS 232275 CIRCUIT 2 /LORETTO AT2 138/69
END

4. (DP&L - DP&L) The W1-070TAP1-LAUREL 69 kV line (from bus 901490 to bus 232249 ckt 1) loads from 97.69% to 103.91% (AC power flow) of its emergency rating (43 MVA) for the single line contingency outage of 'COOLSPG AT20'. This project contributes approximately 3.15 MW to the thermal violation.

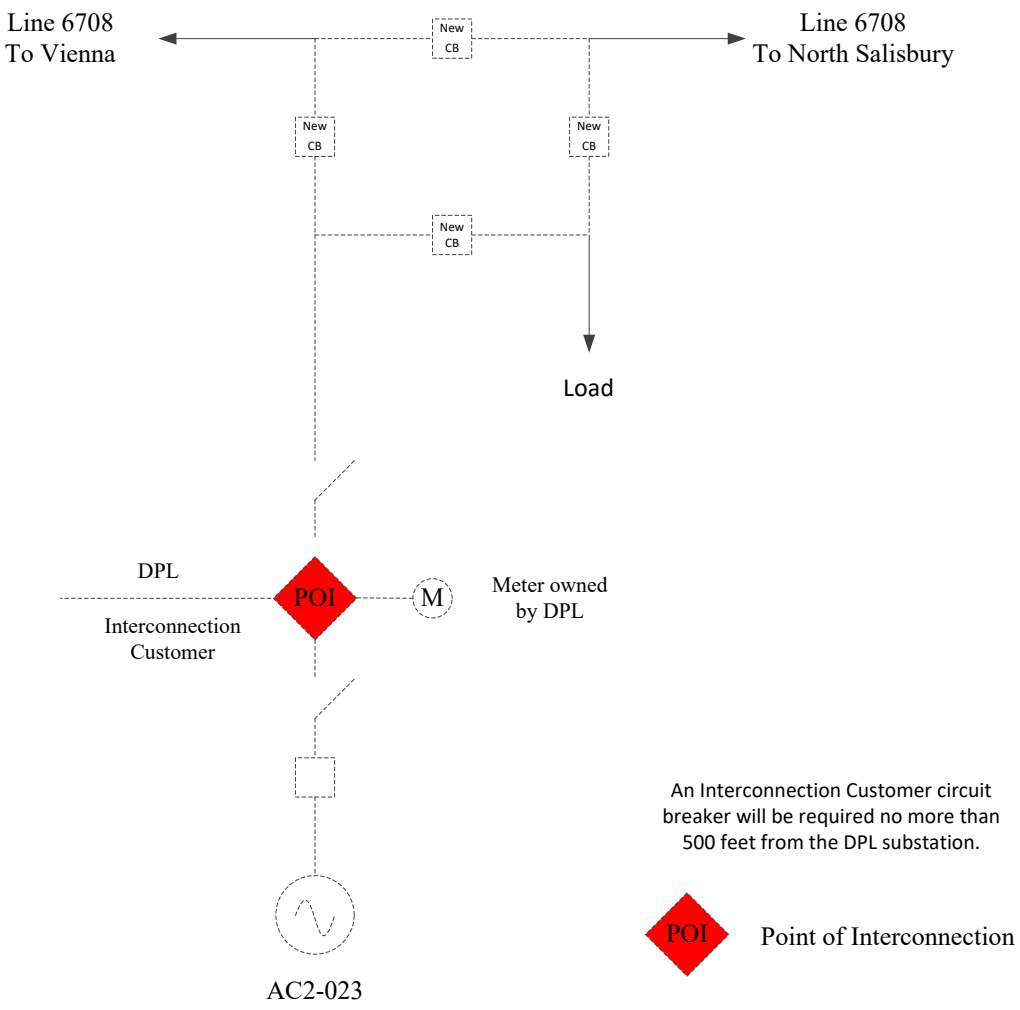
CONTINGENCY 'COOLSPG AT20'
OPEN LINE FROM BUS 232001 TO BUS 232269 CIRCUIT 1 /COOL SPRINGS AT20 230/69
END

Delmarva Power and Light Costs

Cost estimates will further be refined as a part of the Facilities Study for this project. The Interconnection Customer will be responsible for all costs incurred by DPL in connection with the AC2-023 project. Such costs may include, but are not limited to, any transmission system assets currently in DPL's rate base that are prematurely retired due to the AC2-023 project. PJM shall work with DPL to identify these retirement costs and any additional expenses. DPL reserves the right to reassess issues presented in this document and, upon appropriate justification, submit additional costs related to the AC2-023 project.

Attachment 1

AC2-023
Hebron 69 kV
New 69 kV Ring Bus at Hebron 69 kV Substation



Attachment 2

AC2-023

System Impact Study

Dynamic Simulation Analysis

Version 0

October 19th, 2016

TABLE OF CONTENTS

Executive Summary

Generator Interconnection Request AC2-023 is for a 45.8 MW Maximum Facility Output (MFO) solar powered generating facility with a Point of Interconnection (POI) as Hebron 69kV substation in the DPL system, Wicomico County, Maryland. AC2-023 consists of 18 TMEIC PVH-L2700GR 2.6MW solar inverters.

This report describes a dynamic simulation analysis of AC2-023 as part of the overall system impact study.

The load flow scenario for the analysis was based on the RTEP 2020 summer peak case, modified to include applicable queue projects. AC2-023 has been dispatched online at maximum power output. The AC2-023 regulats POI voltage of (1.014 p.u.), consistent with the default generator reference voltage specified in PJM Manual 03 Transmission Operations Section 3.3.3 for generator connections to the PJM 69 kV system.

The AC2-023 queue project was tested for compliance with NERC, PJM and other applicable criteria. The range of contingencies evaluated was limited to that necessary to assess compliance and each was limited to a 20-second simulation time period.

Simulated NERC Standard TPL-001faults include:

1. Three-phase (3ph) fault with normal clearing (Category P1)
2. Operating of a line section w/o a fault, Single-line-to-ground (slg) on Bus Section and Breaker. (Category P2)
3. Single-line-to-ground (slg) with delayed clearing as a result of breaker failure (Category P4)
4. Single-line-to-ground (slg) with delayed clearing as a result of protection failure (Category P5)
5. Single-line-to-ground (slg) with normal clearing for common structure (Category P7)

Note: For generator interconnection studies, Category P3 and P6 faults will be studied on an as needed basis. In this study, P2 contingencies are not applicable.

Other applicable criteria tested include:

1. Transmission Owner (TO) specific criteria
2. Other criteria

The system was tested for a system intact condition and the fault types listed above. Specific fault descriptions and breaker clearing times used for this study are provided in the result table.

Relevent High Speed Reclosing (HSR) contingencies were identified in the P1 contingency list table.

For all simulations, the queue project under study along with the rest of the PJM system were required to maintain synchronism and with all states returning to an acceptable new condition following the disturbance.

For the fault contingencies tested on the 2020 summer peak case:

a) Post-contingency oscillations were positively damped with a damping margin of at least 3%.

b) The AC2-023 generator was able to ride through all faults (except for faults where protective action trips a generator(s)).

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of that fault.

No mitigations were found to be required.

1. Introduction

Generator Interconnection Request AC2-023 is for a 45.8 MW Maximum Facility Output (MFO) solar powered generating facility with a Point of Interconnection (POI) as Hebron 69kV substation in the DPL system, Wicomico County, Maryland. AC2-023 consists of 18 TMEIC PVH-L2700GR 2.6MW solar inverters.

This analysis is effectively a screening study to determine whether the addition of AC2-023 will meet the dynamic requirements of the NERC, PJM and Transmission Owner reliability standards.

In this report the AC2-023 project and how it is proposed to be connected to the grid are first described, followed by a description of how the project is modeled in this study. The fault cases are then described and analyzed, and lastly a discussion of the results is provided.

2. Description of Project

Generator Interconnection Request AC2-023 is for a 45.8 MW Maximum Facility Output (MFO) solar powered generating facility with a Point of Interconnection (POI) as Hebron 69kV substation in the DPL system, Wicomico County, Maryland. AC2-023 consists of 18 TMEIC PVH-L2700GR 2.6MW solar inverters.

Figure 1 shows the simplified one-line diagram of the AC2-023 loadflow model. Table 1 lists the parameters given in the impact study data and the corresponding parameters of the AC2-023 loadflow model.

The dynamic models for AC2-023 plant are based on the PSS\E standard REGCAU1, REECBU1, and REPCAU1 model with parameters supplied by the developer.

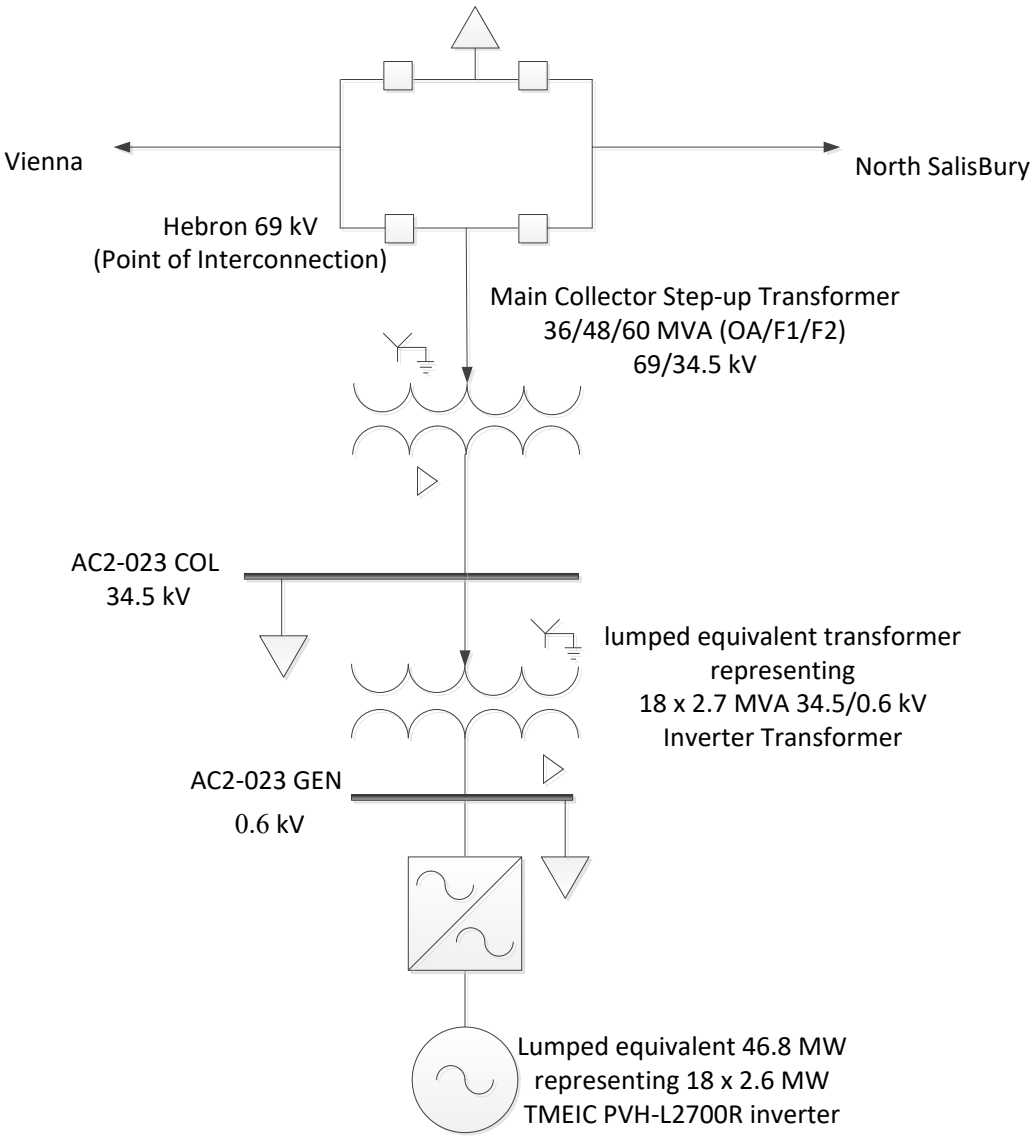


Figure 1: AC2-023 Plant Model

Table 1: AC2-023 Plant Model

	Impact Study Data	Model
Inverter Type	18 × 2.6 MW TMEIC PVH-L2700GR MVA base = 2.7 MVA Vt = 0.6 kV Unsaturated sub-transient reactance = j9999.0 pu @ MVA base	Lumped equivalent representing 18 x 2.6 MW SMA units Pgen 46.8 MW Pmax 46.8 MW Pmin 0 MW Qmax 15.1 MVAr Qmin -15.1 MVAr Mbase 48.6 MVA Zsorce j9999.0 pu @ Mbase
GSU transformer(s)	18 x 34.5/0.6 kV two winding transformers Rating = 2.7 MVA Transformer base = 2.7 MVA Impedance = 0.00713 + j0.05704pu @ MVA base Number of taps = 5 Tap step size = 2.5%	Lumped equivalent representing 18 x 34.5/0.6 kV two winding transformers Rating = 48.6 MVA Transformer base = 48.6 MVA Impedance = 0.00713 + j0.05704pu @ MVA base Number of taps = 5 Tap step size = 2.5%
Main collector step-up transformer	1 x 69/34.5 KV Two winding transformer Rating = 36/48/60 MVA Transformer base = 36 MVA Impedances High-Low = 0.003330 + j0.0999 pu All impedances pu @ MVA Base Number of taps = 5 Tap step size = 2.5%	1 x 69/34.5 KV Two winding transformer Rating = 36/48/60 MVA Transformer base = 36 MVA Impedances High-Low = 0.003330 + j0.0999 pu All impedances pu @ MVA Base Number of taps = 5 Tap step size = 2.5%
Auxiliary load	0.8 MW, 3.7 MVAr	0.8 MW, 3.7 MVAr
Station load	0.2 MW, 7.3 MVAr	0.2 MW, 7.3 MVAr
Collector System Equivalent	Impedance @ 100 MVA R=0.012070 X=0.00887 B=0.00436	R=0.012070 X=0.00887 B=0.00436

	Impact Study Data	Model
Attachment line	Length = 0.1 miles Impedance @ 100 MVA R = 0.000360 X = 0.001380 B = 0.000030	R = 0.000360 X = 0.001380 B = 0.000030

3. Loadflow and Dynamics Case Setup

The dynamics simulation analysis was carried out using PSS/E Version 33.7.
The load flow scenario and fault cases for this study are based on PJM's Regional Transmission Planning Process[1].
The selected load flow scenario is the RTEP 2020 summer peak case with the following modifications:

a) Addition of all applicable queue projects prior to AC2-023.

b) Addition of AC2-023 queue project.

c) Removal of withdrawn and subsequent queue projects in the vicinity of AC2-023.

d) Dispatch of units in the PJM system to maintain slack generators within limits.

The AC2-023 initial conditions are listed in Table 2, indicating maximum power output, with AC2-023 regulating POI voltage of (1.014 p.u.), consistent with the default generator reference voltage specified in PJM Manual 03 Transmission Operations Section 3.3.3 for generator connections to the PJM 69 kV system.

Table 2: AC2-023 machine initial conditions

Bus	Name	Unit	PGEN	QGEN	ETERM	POI Voltage
932164	AC2-023 GEN 0.6000	1	46.8	-13.1	1.016	1.014

The vicinity of AC2-023 has been dispatched online at maximum output (PMAX). The dispatch of generation in the vicinity of AC2-023 is given in Attachment 3.

[1] Manual 14B: PJM Region Transmission Planning Process, Rev 33, May 5 2016, Attachment G : PJM Stability, Short Circuit, and Special RTEP Practices and Procedures.

4. Fault Cases

Tables 3 listed the contingencies and results that were studied, with representative worst case total clearing times provided by PJM. Each contingency was studied over a 20 second simulation time interval.
Simulated NERC Standard TPL-001faults include:

1. Three-phase (3ph) fault with normal clearing (Category P1)
2. Operating of a line section w/o a fault, Single-line-to-ground (slg) on Bus Section and Breaker. (Category P2)
3. Single-line-to-ground (slg) with delayed clearing as a result of breaker failure (Category P4)
4. Single-line-to-ground (slg) with delayed clearing as a result of protection failure (Category P5)
5. Single-line-to-ground (slg) with normal clearing for common structure (Category P7)

Note: For generator interconnection studies, Category P3 and P6 faults will be studied on an as needed basis. In this study, P2 contingencies are not applicable.

Other applicable criteria tested include:

1. Transmission Owner (TO) specific criteria
2. Other criteria

The system was tested for a system intact condition and the fault types listed above. High Speed Reclosing (HSR) contingencies in the vinicity area were studied and the HSR time is also included in the P1 fault list if applicable.

5. Evaluation Criteria

This study is focused on AC2-023, along with the rest of the PJM system, maintaining synchronism and having all states return to an acceptable new condition following the disturbance. The recovery criteria applicable to this study are as per PJM's Regional Transmission Planning Process and Transmission Owner criteria:

a) The system with AC2-023 included is transiently stable and post-contingency oscillations should be positively damped with a damping margin of at least 3%

b) The AC2-023 is able to ride through faults (except for faults where protective action trips AC2-023).

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of that fault.

6. Summary of Results

Plots from the dynamic simulations are provided in Attachment 4, with results summarized in Table 3.
Frequency protection in the model is disabled due to the deficiency of PSSE frequency calculation for inverter based generation facilities.

For the studied fault contingencies tested on the 2020 summer peak case:

a) Post-contingency oscillations were positively damped with a damping margin of at least 3%.

b) The AC2-023 generator was able to ride through all faults (except for faults where protective action trips a generator(s)).

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of that fault.

7. System Reinforcement Requirements

None.

Table 3: Contingency List and Stability Study Results

P0: Stead State

Fault ID	Duration
SS.01	Steady State 20 sec run

P1: Three Phase Faults with normal clearing

Fault ID	Fault description	Clearing Time Normal & HSR (Cycles)	Results
P1.00	Fault at Hebron 69 kV resulting in the loss of AC2-023	9	Stable
P1.01	Fault at Hebron 69 kV on Rockawalkin – North Salisbury circuit 6708 resulting in the loss of Rockawalkin 69 kV, AB2-180, Y3-058	9	Stable
P1.02	Fault at Hebron 69 kV on Mardela - Vienna circuit 6708 resulting in the loss of Mardela 69 kV, AC1-050	9	Stable
P1.03	Fault at Hebron 69 kV resulting in the loss of Hebron load	9	Stable
P1.04	Fault at Vienna 69 kV on Rockawalkin – Hebron circuit 6708 resulting in the loss of AB2-180 and Y3-058	9	Stable
P1.05	Fault at Vienna 69 kV on Sharptown - Laurel circuit resulting in loss of all equipment at Sharptown 69 kV	9	Stable
P1.06	Fault at Vienna 69 kV on Vienna 69/138 kV Transformer AT1	9	Stable
P1.07	Fault at Vienna 69 kV on Vienna 69/138 kV Transformer AT2	9	Stable
P1.08	Fault at Vienna 69 kV on Vienna 69/13.2 kV Transformer 10 resulting in the loss of generator V10	9	Stable
P1.09	Fault at Vienna 69 kV on Vienna 69/4.16 kV Transformer T8A resulting in the loss of generator	9	Stable
P1.10	Fault at Vienna 69 kV on Vienna Local - Airey - X3-015 POI Circuit resulting in the loss of all equipment at Vienna Local and Airey 69 kV	9	Stable
P1.11	Fault at Vienna 69 kV on Todd circuit	9	Stable
P1.12	Fault at North Salisbury 69 kV on Hebron circuit resulting in the loss of AC1-050	9	Stable
P1.13	Fault at North Salisbury 69 kV on North Salisbury 69/25 kV Transformer T1	9	Stable
P1.14	Fault at North Salisbury 69 kV on North Salisbury 69/25 kV Transformer T2	9	Stable

Fault ID	Fault description	Clearing Time Normal & HSR (Cycles)	Results
P1.15	Fault at North Salisbury 69 kV on MT. Hermon circuit 6726	9	Stable
P1.16	Fault at North Salisbury 69 kV on Walston Switch - New Hope - Ocean Pines - Worcester circuit 6741 resulting in the loss of all equipment at Walston Switch, New Hope, Ocean Pines 69 kV,1x19.8 Mvar North Salisbury Capacitor Bank and 1x19.8 Mvar Worcester Capacitor Bank.	9	Stable
P1.17	Fault at North Salisbury 69 kV on Edgewood - Nelson circuit 6743 resulting in the loss of all equipment at Edgewood 69 kV and AB2-166	9	Stable
P1.18	Fault at North Salisbury 69 kV on Pemberton - Fruitland circuit 6701 resulting in the loss of all equipment at Pemberton 69 kV	9	Stable

P4: SLG Stuck Breaker (SB) Faults at Backup Clearing

Fault ID	Fault description	Clearing Time Near & Remote (Cycles)	Results
P4.01	SLG @ Vienna 69kV, normal clear loss of Vienna – Sharptown – Laurel 69kV line, SB @ Vienna 69kV, delayed clear loss of Vienna 69kV red bus, V2-028	9/22	Stable
P4.02	SLG @ Vienna 69kV, normal clear loss of V2-028, SB @ Vienna 69kV, delayed clear loss of Vienna 69kV red bus, Vienna – Sharptown – Laurel 69kV line	9/22	Stable
P4.03	SLG @ Vienna 69kV, normal clear loss of Vienna 69kV red bus, V2-028, Vienna – Sharptown – Laurel 69kV line, SB @ Vienna 69kV, delayed clear loss of Vienna – Todd 69kV line	9/22	Stable
P4.04	SLG @ Vienna 69kV, normal clear loss of Vienna 69kV red bus, V2-028, Vienna – Sharptown – Laurel 69kV line, SB @ Vienna 69kV, delayed clear loss of Vienna 69kV White Bus, Vienna unit 10, Vienna capbank, Viena 138/69kV TF 2, Vienna – Mardela – Hebron 69kV line	9/22	Stable
P4.05	SLG @ Vienna 69kV, normal clear loss of Vienna unit 10, SB @ Vienna 69kV, delayed clear loss of Vienna 69kV white bus, Vienna capbank, Viena 138/69kV TF 2, Vienna – Mardela – Hebron 69kV line	9/22	Stable
P4.06	SLG @ Vienna 69kV, normal clear loss of Vienna capbank, SB @ Vienna 69kV, delayed clear loss of Vienna 69kV white bus, Vienna unit 10, Viena 138/69kV TF 2, Vienna – Mardela – Hebron 69kV line	9/22	Stable
P4.07	SLG @ Vienna 69kV, normal clear loss of Viena 138/69kV TF 2, SB @ Vienna 69kV, delayed clear loss of Vienna 69kV white bus, Vienna unit 10, Vienna capbank, Vienna – Mardela – Hebron 69kV line	9/22	Stable
P4.08	SLG @ Vienna 69kV, normal clear loss of Vienna – Mardela – Hebron 69kV line, SB @ Vienna 69kV, delayed clear loss of Vienna 69kV white bus, Vienna unit 10, Vienna capbank, Viena 138/69kV TF 2	9/22	Stable

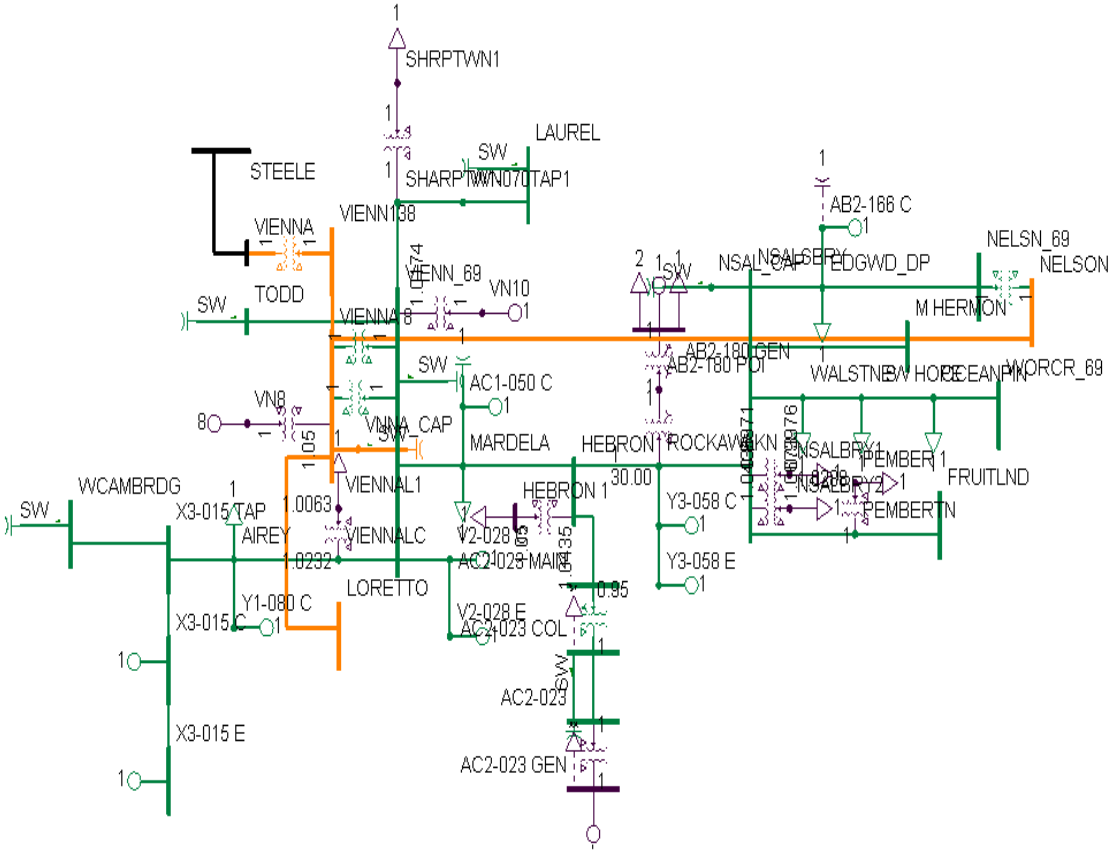
Fault ID	Fault description	Clearing Time Near & Remote (Cycles)	Results
P4.09	SLG @ Vienna 69kV, normal clear loss of Vienna – Todd 69kV line, SB @ Vienna 69kV, delayed clear loss of Vienna 69kV yellow bus, Vienna – Vienna Local – Airey – X3-015 69kV line, Viena 138/69kV TF 1	9/22	Stable
P4.10	SLG @ Vienna 69kV, normal clear loss of Vienna – Vienna Local – Airey – X3-015 69kV line, SB @ Vienna 69kV, delayed clear loss of Vienna 69kV yellow bus, Viena 138/69kV TF 1	9/22	Stable
P4.11	SLG @ Vienna 69kV, normal clear loss of Viena 138/69kV TF 1, SB @ Vienna 69kV, delayed clear loss of Vienna 69kV yellow bus, Vienna – Vienna Local – Airey – X3-015 69kV line	9/22	Stable
P4.12	SLG @ Vienna 69kV, normal clear loss of Vienna 69kV yellow bus, Viena 138/69kV TF 1, Vienna – Vienna Local – Airey – X3-015 69kV line, SB @ Vienna 69kV, delayed clear loss of Vienna 69kV white bus, Vienna unit 10, Vienna capbank, Viena 138/69kV TF 2, Vienna – Mardela – Hebron 69kV line	9/22	Stable
P4.13	SLG @ North Salisbury 69kV, normal clear loss of North Salisbury – Mt. Hermon 69kV line, SB @ North Salisbury 69kV, delayed clear loss of North Salisbury 69kV north bus, North Salisbury – Edgewood – Nelson 69kV line, North Salisbury – Walston Switch – New Hope – Ocean Pines – Worcester 69kV line, North Salisbury 69kV capbank, North Salisbury 69/25kV T1	9/22	Stable
P4.14	SLG @ North Salisbury 69kV, normal clear loss of North Salisbury – Edgewood – Nelson 69kV line, SB @ North Salisbury 69kV, delayed clear loss of North Salisbury 69kV north bus, North Salisbury – Mt. Hermon 69kV line, North Salisbury – Walston Switch – New Hope – Ocean Pines – Worcester 69kV line, North Salisbury 69kV capbank, North Salisbury 69/25kV T1	9/22	Stable
P4.15	SLG @ North Salisbury 69kV, normal clear loss of North Salisbury – Walston Switch – New Hope – Ocean Pines – Worcester 69kV line, North Salisbury 69kV capbank, SB @ North Salisbury 69kV, delayed clear loss of North Salisbury 69kV north bus, North Salisbury – Mt. Hermon 69kV line, North Salisbury – Edgewood – Nelson 69kV line, North Salisbury 69/25kV T1	9/22	Stable
P4.16	SLG @ North Salisbury 69kV, normal clear loss of North Salisbury 69/25kV T1, SB @ North Salisbury 69kV, delayed clear loss of North Salisbury 69kV north bus, North Salisbury – Mt. Hermon 69kV line, North Salisbury – Walston Switch – New Hope – Ocean Pines – Worcester 69kV line, North Salisbury 69kV capbank, North Salisbury – Edgewood – Nelson 69kV line	9/22	Stable
P4.17	SLG @ North Salisbury 69kV, normal clear loss of North Salisbury 69kV north bus, North Salisbury 69/25kV T1, North Salisbury – Mt. Hermon 69kV line, North Salisbury – Walston Switch – New Hope – Ocean Pines – Worcester 69kV line, North Salisbury 69kV capbank, North Salisbury – Edgewood – Nelson 69kV line, SB @ North Salisbury, delayed clear loss of North Salisbury 69kV station	9/22	Stable

Fault ID	Fault description	Clearing Time Near & Remote (Cycles)	Results
P4.18	SLG @ North Salisbury 69kV, normal clear loss of North Salisbury – Pemberton – Fruitland 69kV line, SB @ North Salisbury 69kV, delayed clear loss of North Salisbury 69kV south bus, North Salisbury 69/25kV T2, North Salisbury – Rockawalkin 69kV line	9/22	Stable
P4.19	SLG @ North Salisbury 69kV, normal clear loss of North Salisbury – Rockawalkin – Hebron 69kV line, SB @ North Salisbury 69kV, delayed clear loss of North Salisbury 69kV south bus, North Salisbury 69/25kV T2, North Salisbury – Pemberton – Fruitland 69kV line	9/22	Stable
P4.20	SLG @ North Salisbury 69kV, normal clear loss of North Salisbury 69/25kV T2, SB @ North Salisbury 69kV, delayed clear loss of North Salisbury 69kV south bus, North Salisbury – Rockawalkin 69kV line, North Salisbury – Pemberton – Fruitland 69kV line	9/22	Stable
P4.21	SGL @ Hebron 69kV, normal clear loss of Hebron 69/12.5kV TF, SB @ Hebron 69kV, delayed clear loss of Hebron – Mardela – Vienna 69kV line, AC1-050	9/22	Stable
P4.22	SGL @ Hebron 69kV, normal clear loss of Hebron 69/12.5kV TF, SB @ Hebron 69kV, delayed clear loss of Hebron – Rockawalkin – North Salisbury 69kV line, Y3-058, AB2-180	9/22	Stable
P4.23	SGL @ Hebron 69kV, normal clear loss of AC2-023, SB @ Hebron 69kV, delayed clear loss of Hebron – Mardela – Vienna 69kV line, AC1-050	9/22	Stable
P4.24	SGL @ Hebron 69kV, normal clear loss of AC2-023, SB @ Hebron 69kV, delayed clear loss of Hebron – Rockawalkin – North Salisbury 69kV line, Y3-058, AB2-180	9/22	Stable

P5: SLG Fault with Delayed Clearing

Fault ID	Fault description	Clearing Time Near & Remote (Cycles)	Results
P5.01	Fault at 80 % of 69 kV circuit 6705 from Vienna to Sharptown - Laurel. Delayed clearing at Vienna 69 kV. Fault cleared with loss of all equipment at Sharptown 69 kV.	9/42	Stable
P5.02	Fault at 80 % of 69 kV circuit 6702 from Vienna to Todd. Delayed clearing at Vienna 69 kV	9/42	Stable
P5.03	Fault at 80 % of 69 kV circuit 6709 from Vienna to Vienna Local - Airey - X3-015 POI. Delayed clearing at Vienna 69 kV. Fault cleared with loss of all equipment at Vienna Local and Airey 69 kV.	9/42	Stable
P5.04	Fault at 80 % of 69 kV circuit 6701 from North Salisbury to Pemberton - Fruitland resulting in the loss of all equipment at Pemberton 69 kV. Delayed Clearing at North Salisbury 69 kV.	9/42	Stable
P5.05	Fault at 80 % of 69 kV circuit 6743 from North Salisbury to Edgewood - Nelson resulting in the loss of all equipment at Edgewood 69 kV and AB2-166. Delayed Clearing at North Salisbury 69 kV.	9/42	Stable
P5.06	Fault at 80 % of 69 kV circuit 6741 from North Salisbury to Walston Switch - New Hope - Ocean Pines - Worcester resulting in the loss of all equipment at Ocean Pines 69 kV, 1x19.8 Mvar North Salisbury Capacitor Bank and 1x19.8 Mvar Worcester Capacitor Bank. Delayed Clearing at North Salisbury 69 kV. Fault cleared with loss of all equipment at Walston Switch and New Hope.	9/42	Stable
P5.07	Fault at 80 % of 69 kV circuit 6726 from North Salisbury to MT. Hermon. Delayed Clearing at North Salisbury 69 kV.	9/42	Stable
P5.08	SLG @ 80% of Hebron – Mardela – Vienna 69kV line, relay failure @ Hebron, delayed clear loss of AC1-050	9/42	Stable
P5.09	SLG @ 80% of Vienna – Mardela – Hebron 69kV line, relay failure @ Vienna, delayed clear loss of AC1-050	9/42	Stable
P5.10	SLG @ 80% of Hebron – Rockawalkin – North Salisbury 69kV line, relay failure @ Hebron, delayed clear loss of AB2-180, Y3-058	9/42	Stable
P5.11	SLG @ 80% of North Salisbury – Rockawalkin – Hebron 69kV line, relay failure @ North Salisbury, delayed clear loss of AB2-180, Y3-058	9/42	Stable

Attachment 1. PSS/E Model One Line Diagram



Attachment 2. PSS/E Dynamic Model

/*************************
/*AC2-023 TMEIC
/*************************
932164,'USRMDL', 1, 'REGCAU1', 101, 1, 1, 14, 3, 4, 1, 0.2, 10.0, 0.75,-10.0, 0.23, 2.0, 0.1, 0.0, -0.377, 0.02, 0.0, 10.0, -10.0, 0.0/
932164,'USRMDL', 1, 'REECBU1', 102, 0, 5, 25, 6, 4, 0, 0, 0, 0, 0, 0.0, 2.0, 0.0, -0.1, 0.1, 0.0, 0.377, -0.377, 0.0, 0.05, 0.377, -0.377, 1.1, 0.9, 0.0, 0.0, 0.0, 0.0, 0.02, 2.0, -2.0, 0.963, 0.0, 1.00, 0.02/
932164,'USRMDL', 1, 'REPCAU1', 107, 0, 7, 27, 7, 9, 232270, 0, 0, 0, 0, 1, 0, 0.02, 18, 5, 0, 0.15, -1, 0, 0, 0, 999, -999,-0.02, 0.02, 0.377, -0.377, 10, 1, 0.02, -99.0, 99.0, 999, -999, 0.963, 0, 20, 20, 20/
93216401, 'VTGTPAT', 232270, 932164, 1, -1, 1.200, 0, 0.0/
93216402, 'VTGTPAT', 232270, 932164, 1, -1, 1.175, 0.2, 0.0/
93216403, 'VTGTPAT', 232270, 932164, 1, -1, 1.15, 0.5, 0.0/
93216404, 'VTGTPAT', 232270, 932164, 1, -1, 1.10, 1.0, 0.0/
93216405, 'VTGTPAT', 232270, 932164, 1, 0.45, 5, 0.20, 0.0/
93216406, 'VTGTPAT', 232270, 932164, 1, 0.65, 5, 0.80, 0.0/
93216407, 'VTGTPAT', 232270, 932164, 1, 0.75, 5, 2, 0.0/
93216408, 'VTGTPAT', 232270, 932164, 1, 0.90, 5, 3, 0.0/
93216409, 'FRQTPAT', 232270, 932164, 1, -100, 61.8, 0, 0.0/
93216410, 'FRQTPAT', 232270, 932164, 1, -100, 60.5, 600.66, 0.0/
93216412, 'FRQTPAT', 232270, 932164, 1, 57.8, 100, 0, 0.0/
93216413, 'FRQTPAT', 232270, 932164, 1, 59.5, 100, 1792.049, 0.0/

Attachment 3. PSS/E Case Dispatch

Bus Number	Bus Name	Id	In Service	PGen (MW)	PMax (MW)	PMin (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)
232907	VN8 18.000	8	1	153	153	0	6.626	28	-15
232919	VN10 13.200	1	1	14.3	14.3	0	0	14.3	0
232925	NELSVC 16.000	1	1	0	0	0	1.065	150	-150
293670	O-025 C 25.000	1	1	6	6	0	0	0	0
297076	V2-028 C 69.000	1	1	2.28	2.28	0	0	0	0
297077	V2-028 E 69.000	1	1	3.72	3.72	0	0	0	0
910571	X3-008 2 24.900	1	1	10	10	0	0	0	0
910572	X3-008 1 24.900	1	1	10	10	0	0	0	0
910591	X3-015 C 69.000	1	1	7.41	7.41	0	0	0	0
913411	Y1-080 C 69.000	1	1	1.28	1.28	0	0	0	0
913412	Y1-080 E 69.000	1	1	2.1	2.1	0	0	0	0
915541	Y3-058 C 69.000	1	1	5.7	5.7	0	0	0	0
915542	Y3-058 E 69.000	1	1	9.3	9.3	0	0	0	0
925091	AB2-166 C 69.000	1	1	2	2	0	0	0	0
925092	AB2-166 E 69.000	1	1	3.5	3.5	0	0	0	0
925153	AB2-172 GEN 0.5500	1	1	50.4	50.4	0	-0.327	17	-17
925261	AB2-180 GEN 0.3850	1	1	20	20	0	-1.215	6.56	-6.56
925651	AC1-041 C 69.000	1	1	1.9	1.9	0	0.627	0.627	-0.627
925741	AC1-050 C 69.000	1	1	1.9	1.9	0	0.627	0.627	-0.627
925742	AC1-050 E 69.000	1	1	3.1	3.1	0	0.627	0.627	-0.627
927191	AC1-213 C 24.900	1	1	3.2	3.2	0	1.155	1.155	-1.155
927192	AC1-213 E 24.900	1	1	2.1	2.1	0	1.155	1.155	-1.155
927311	AC1-228 C 12.500	1	1	1.1	1.1	0	0.363	0.363	-0.363

927312	AC1-228 E 12.500	1	1	1.9	1.9	0	0.363	0.363	-0.363
932164	AC2-023 GEN 0.6000	1	1	46.8	46.8	0	-13.06	15.1	-15.1

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to 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

(DP&L - DP&L) The ROCKAWLKN-NSALSBRY 69 kV line (from bus 232291 to bus 232271 ckt 1) loads from 88.83% to 112.23% (AC power flow) of its emergency rating (58 MVA) for the single line contingency outage of 'CKT 6728'. This project contributes approximately 13.84 MW to the thermal violation.

CONTINGENCY 'CKT 6728'
OPEN LINE FROM BUS 232272 TO BUS 232274 CIRCUIT 1 /MOUNT HERMON - PINEY GROVE 69
DISCONNECT BUS 230912 / PINEY GROVE 69 CAP
END

Bus Number	*Bus Name*	*Full Contribution*
932161	*AC2-023 C*	*13.84*
232919	*VN10*	*0.42*
910571	*X3-008 C*	*0.17*
913411	*Y1-080 C*	*0.03*
915541	*Y3-058 C*	*0.64*
920762	*Z2-076 C*	*0.65*
924831	*AB2-136 C*	*0.65*
925151	*AB2-172 C OP*	*2.42*
925261	*AB2-180 C*	*8.74*
928001	*AC1-190 C*	*4.57*

Appendix 2

(DP&L - DP&L) The SHARPTWN-W1-070TAP1 69 kV line (from bus 232239 to bus 901490 ckt 1) loads from 104.95% to 110.49% (AC power flow) of its emergency rating (43 MVA) for the line fault with failed breaker contingency outage of 'DP6'. This project contributes approximately 2.8 MW to the thermal violation.

CONTINGENCY 'DP6' /*MILFORD BUS BREAKER TO STEELE
DISCONNECT BRANCH FROM BUS 232000 TO BUS 232004 CKT 1 /*MILFORD STEELE 230 230
DISCONNECT BRANCH FROM BUS 232009 TO BUS 232004 CKT 1 /*MAGNOLIA MILFORD 230 230
END

Bus Number	*Bus Name*	*Full Contribution*
932161	*AC2-023 C*	*1.62*
932162	*AC2-023 E*	*1.18*
232919	*VN10*	*0.4*
910571	*X3-008 C*	*0.17*
910572	*X3-008 E*	*1.54*
913411	*Y1-080 C*	*0.03*
913412	*Y1-080 E*	*0.31*
923961	*AB2-037 C*	*0.99*
923962	*AB2-037 E*	*1.61*
924831	*AB2-136 C*	*0.63*
924832	*AB2-136 E*	*3.69*
925151	*AB2-172 C OP*	*2.36*
925152	*AB2-172 E OP*	*3.85*
928001	*AC1-190 C*	*4.45*
928002	*AC1-190 E*	*1.91*

Appendix 3

(DP&L - DP&L) The W1-070TAP1-LAUREL 69 kV line (from bus 901490 to bus 232249 ckt 1) loads from 104.87% to 110.41% (AC power flow) of its emergency rating (43 MVA) for the line fault with failed breaker contingency outage of 'DP6'. This project contributes approximately 2.8 MW to the thermal violation.

CONTINGENCY 'DP6' /*MILFORD BUS BREAKER TO STEELE
DISCONNECT BRANCH FROM BUS 232000 TO BUS 232004 CKT 1 /*MILFORD STEELE 230 230
DISCONNECT BRANCH FROM BUS 232009 TO BUS 232004 CKT 1 /*MAGNOLIA MILFORD 230 230
END

Bus Number	*Bus Name*	*Full Contribution*
932161	*AC2-023 C*	*1.62*
932162	*AC2-023 E*	*1.18*
232919	*VN10*	*0.4*
910571	*X3-008 C*	*0.17*
910572	*X3-008 E*	*1.54*
913411	*Y1-080 C*	*0.03*
913412	*Y1-080 E*	*0.31*
923961	*AB2-037 C*	*0.99*
923962	*AB2-037 E*	*1.61*
924831	*AB2-136 C*	*0.63*
924832	*AB2-136 E*	*3.69*
925151	*AB2-172 C OP*	*2.36*
925152	*AB2-172 E OP*	*3.85*
928001	*AC1-190 C*	*4.45*
928002	*AC1-190 E*	*1.91*