# *Generation Interconnection*
# *Feasibility Study Report*

# *For*

# *PJM Generation Interconnection Request*
# *Queue Position AC2-158*

# *Cashie – Earleys 230kV*
# *32.5MW Capacity / 65MW Energy*

**October / 2017**

# Introduction

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

# Preface

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

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

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

# General

The IC has proposed a solar generating facility located in Windsor, North Carolina (Bertie Country). The installed facilities will have a total capability of 65 MW with 32.5 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is 5/01/2019. **This study does not imply an ITO commitment to this in-service date.**

## Point of Interconnection

AC2-158 will interconnect with the ITO transmission system at one of the following points of interconnection:

Option 1 will connect a new three breaker ring bus switching station that connects on the Cashie – Earleys 230kV line # 2034.

Option 2 will connect via a new three breaker ring bus switching station that connects on the Everetts – Earleys 230kV line.

## Cost Summary

The AC2-158 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 |
| **Total Costs** | **$9,100,000** |

In addition, the AC2-158 project may be responsible for a contribution to the following costs:

| Description | Total Cost |
|---|---|
| New System Upgrades | $46,000,000 |
| Previously Identified Upgrades | $24,000,000 |
| **Total Costs** | **$70,000,000** |

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

## 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 AC2-158 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. 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 230 kV AC2-158 Switching Substation (interconnection substation). The estimated cost of this work scope is $6,300,000. 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 $1,000,000 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.

## System Reinforcement

| Violation # | Upgrade Description | Upgrade Cost |
|---|---|---|
| # 2, 5 | Rebuild the Hathaway - Hornertown 230kV line to increase its line rating to 706 MVA (normal), 706 MVA (emergency), and 812 MVA (load dump). Rebuild/Uprate approximately 28.9 miles of Line #2056. It is estimated to take 44-48 months to permit (NC PUC may be required), engineer and construct. Final engineering may require structure replacements. | $24,000,000 |
| # 3, 4, 22 | Wreck and rebuild the 18 mile Lakeview - AB2-100 Tap - Clubhouse 230kV to an emergency rating of 706 MVA and a load dump rating of 812 MVA. It is estimated to take 30-36 months to permit (combination of NC PUC and VA SCC may be required), engineer and construct. | $46,000,000 |
| | Total Network Upgrades | **$70,000,000** |

# Interconnection Customer Requirements

ITO's Facility Connection Requirements as posted on PJM's website
http://www.pjm.com/~/media/planning/plan-standards/private-dominion/facility-connection-requirements1.ashx

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

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

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

# Revenue Metering and SCADA Requirements

## PJM Requirements

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

### Meteorological Data Reporting Requirement

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

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

# Network Impacts

The Queue Project AC2-158 was evaluated as a 65.0 MW (Capacity 32.5 MW) injection tapping the Earleys – Cashie 230 kV line in the ITO area. Project AC2-158 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-158 was studied with a commercial probability of 53%. Potential network impacts were as follows:

## Contingency Descriptions

The following contingencies resulted in overloads:

| Contingency Name | Description |
|---|---|
| DVP_P1-2: LN 2181 | CONTINGENCY 'DVP_P1-2: LN 2181'<br>OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 6PA-RMOUNT#4230.00 - 6NASH 230.00<br>OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 6HATHAWAY 230.00 - 6NASH 230.00<br>OPEN BRANCH FROM BUS 304226 TO BUS 304222 CKT 1 /* 6PA-RMOUNT#4230.00 - 6ROCKYMT230T<br>OPEN BUS 304226 /* ISLAND<br>OPEN BUS 314591 /* ISLAND: 6NASH 230.00<br>END |
| DVP_P1-2:2056_A | CONTINGENCY 'DVP_P1-2:2056_A'<br>OPEN BRANCH FROM BUS 313845 TO BUS 927140 CKT 1 /* 6HATHAWAY 230.00 - AC1-208 TAP 230.00<br>END |
| DVP_P1-2:2056_B | CONTINGENCY 'DVP_P1-2:2056_B'<br>OPEN BRANCH FROM BUS 927140 TO BUS 314579 CKT 1 /* AC1-208 TAP 230.00 - 6HORNRTN 230.00<br>END |
| LN 2020 | CONTINGENCY 'LN 2020'<br>OPEN BRANCH FROM BUS 313851 TO BUS 314638 CKT 1 /* 6ECITYDP2 230.00 - 6ELIZ CT 230.00<br>OPEN BRANCH FROM BUS 313851 TO BUS 314639 CKT 1 /* 6ECITYDP2 230.00 - 6TANGLEW 230.00<br>OPEN BRANCH FROM BUS 314639 TO BUS 314651 CKT 1 /* 6TANGLEW 230.00 - 6WINFALL 230.00<br>OPEN BUS 313851 /* ISLAND<br>OPEN BUS 314639 /* ISLAND<br>OPEN BUS 913391 /* ISLAND<br>OPEN BUS 913392 /* ISLAND<br>END |

| Contingency Name | Description |
|---|---|
| LN 2058 | CONTINGENCY 'LN 2058-2181'<br>OPEN BUS 304226 /* ISLAND: 6PA-RMOUNT#4115.00<br>OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 6PA-RMOUNT#4230.00 - 6NASH 230.00<br>OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 6HATHAWAY 230.00 - 6NASH 230.00<br>OPEN BUS 314591 /* ISLAND: 6NASH 230.00<br>OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /* 6ROCKYMT230T230.00 - 6HATHAWAY 230.00<br>END |
| LN 2058-2181 | CONTINGENCY 'LN 2058-2181'<br>OPEN BUS 304226 /* ISLAND: 6PA-RMOUNT#4115.00<br>OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 6PA-RMOUNT#4230.00 - 6NASH 230.00<br>OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 6HATHAWAY 230.00 - 6NASH 230.00<br>OPEN BUS 314591 /* ISLAND: 6NASH 230.00<br>OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /* 6ROCKYMT230T230.00 - 6HATHAWAY 230.00<br>END |
| LN 2131A | CONTINGENCY 'LN 2131A'<br>OPEN BRANCH FROM BUS 314662 TO BUS 916040 CKT 1 /* 6S HERTFORD 230.00 - Z1-036 TAP 230.00<br>OPEN BRANCH FROM BUS 314651 TO BUS 314662 CKT 1 /* 6WINFALL 230.00 - 6S HERTFORD 230.00<br>OPEN BUS 314662 /* ISLAND<br>END |
| LN 238 | CONTINGENCY 'LN 238-249'<br>OPEN BRANCH FROM BUS 314282 TO BUS 314435 CKT 1 /* 6CARSON 230.00 - 6SAPONY 230.00<br>OPEN BRANCH FROM BUS 314435 TO BUS 314563 CKT 1 /* 6SAPONY 230.00 - 6CLUBHSE 230.00<br>OPEN BRANCH FROM BUS 314562 TO BUS 314563 CKT 1 /* 3CLUBHSE 115.00 - 6CLUBHSE 230.00<br>OPEN BUS 314435 /* ISLAND<br>OPEN BRANCH FROM BUS 314282 TO BUS 314285 CKT 1 /* 6CARSON 230.00 - 6CHRL249 230.00<br>OPEN BRANCH FROM BUS 314285 TO BUS 314316 CKT 1 /* 6CHRL249 230.00 - 6LOCKS 230.00<br>OPEN BRANCH FROM BUS 314314 TO BUS 314316 CKT 1 /* 3LOCKS 115.00 - 6LOCKS 230.00<br>OPEN BUS 314285 /* ISLAND<br>END |

| Contingency Name | Description |
|---|---|
| LN 238-249 | CONTINGENCY 'LN 238-249'<br>OPEN BRANCH FROM BUS 314282 TO BUS 314435 CKT 1 /* 6CARSON 230.00 - 6SAPONY 230.00<br>OPEN BRANCH FROM BUS 314435 TO BUS 314563 CKT 1 /* 6SAPONY 230.00 - 6CLUBHSE 230.00<br>OPEN BRANCH FROM BUS 314562 TO BUS 314563 CKT 1 /* 3CLUBHSE 115.00 - 6CLUBHSE 230.00<br>OPEN BUS 314435 /* ISLAND<br>OPEN BRANCH FROM BUS 314282 TO BUS 314285 CKT 1 /* 6CARSON 230.00 - 6CHRL249 230.00<br>OPEN BRANCH FROM BUS 314285 TO BUS 314316 CKT 1 /* 6CHRL249 230.00 - 6LOCKS 230.00<br>OPEN BRANCH FROM BUS 314314 TO BUS 314316 CKT 1 /* 3LOCKS 115.00 - 6LOCKS 230.00<br>OPEN BUS 314285 /* ISLAND<br>END |
| LN 246_A | CONTINGENCY 'LN 246_A'<br>OPEN BRANCH FROM BUS 921571 TO BUS 314575 CKT 1 /* AA1-138 TAP - 6NUCO TP 230.00<br>OPEN BRANCH FROM BUS 314569 TO BUS 314575 CKT 1 /* 6EARLEYS 230.00 - 6NUCO TP 230.00<br>OPEN BRANCH FROM BUS 314575 TO BUS 314590 CKT 1 /* 6NUCO TP 230.00 - 6NUCOR 230.00<br>OPEN BUS 314575 /* ISLAND<br>OPEN BUS 314590 /* ISLAND<br>END |
| LN 246_B | CONTINGENCY 'LN 246_B'<br>OPEN BRANCH FROM BUS 314537 TO BUS 921571 CKT 1 /* 6SUFFOLK 230.00 - AA1-138 TAP<br>END |
| LN 254_A | CONTINGENCY 'LN 254_A'<br>OPEN BRANCH FROM BUS 314563 TO BUS 924510 CKT 1 /* 6CLUBHSE 230.00 - AB2-100 TAP 230.00<br>END |

# Summer Peak Analysis - 2020

## Generator Deliverability

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

None

## Multiple Facility Contingency

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

None

## Short Circuit

*(Summary of impacted circuit breakers)*

New circuit breakers found to be over-duty:

None

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

None

## Contribution to Previously Identified Overloads

*(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)*

| | Contingency | | Affected | | Bus | | | Power | Loading % | | Rating | | MW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | Type | Name | Area | Facility Description | From | To | Cir. | Flow | Initial | Final | Type | MVA | Contribution | Ref |
| 1 | DCTL | LN 2058-2181 | DVP - CPLE | 3BTLEBRO-3ROCKYMT115T 115 kV line | 314554 | 304223 | 1 | DC | 200.95 | 202.22 | ER | 164 | 4.62 | 1 |

| # | Contingency Type | Contingency Name | Affected Area | Facility Description | Bus From | Bus To | Cir. | Power Flow | Loading % Initial | Loading % Final | Rating Type | Rating MVA | MW Contribution | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | DCTL | LN 238-249 | DVP - DVP | 6HORNRTN-AC1-208 TAP 230 kV line | 314579 | 927140 | 1 | DC | 101.18 | 101.68 | LD | 541 | 6.09 | 2 |
| 3 | N-1 | DVP_P1-2:2056_A | DVP - DVP | AB2-100 TAP-6CLUBHSE 230 kV line | 924510 | 314563 | 1 | DC | 113.91 | 115.12 | ER | 375 | 4.55 | 3 |
| 4 | N-1 | DVP_P1-2:2056_B | DVP - DVP | AB2-100 TAP-6CLUBHSE 230 kV line | 924510 | 314563 | 1 | DC | 108.5 | 109.71 | ER | 375 | 4.55 | |
| 5 | DCTL | LN 238-249 | DVP - DVP | AC1-208 TAP-6HATHAWAY 230 kV line | 927140 | 313845 | 1 | DC | 110.35 | 110.86 | LD | 541 | 6.09 | 4 |

## Steady-State Voltage Requirements

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

To be determined during Impact Study

## Stability and Reactive Power Requirement for Low Voltage Ride Through

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

To be determined during Impact Study

## New System Reinforcements

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

None

## Contribution to Previously Identified System Reinforcements

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

| Violation # | Overloaded Facility | Upgrade Description | Network Upgrade Number | Upgrade Cost |
|---|---|---|---|---|
| # 1 | 3BTLEBRO-3ROCKYMT115T 115 kV line | CPLE (Duke) owns the limiting element on the Battleboro - Rocky Mountain line. This violation will be further analyzed in the System Impact Study. | | |
| # 2 | 6HORNRTN-AC1-208 TAP 230 kV line | Rebuild the line to increase its line rating to 706 MVA (normal), 706 MVA (emergency), and 812 MVA (load dump). Rebuild/Uprate approximately 28.9 miles of Line #2056. It is estimated to take 44-48 months to permit (NC PUC may be required), engineer and construct. Final engineering may require structure replacements. | Pending | **$24,000,000** |
| # 5 | AC1-208 TAP-6HATHAWAY 230 kV line | | | |
| # 3, 4 | AB2-100 TAP-6CLUBHSE 230 kV line | Wreck and rebuild the line of 18 miles to an emergency rating of 706 MVA and a load dump rating of 812 MVA. It is estimated to take 30-36 months to permit (combination of NC PUC and VA SCC may be required), engineer and construct. | Pending | **$46,000,000** |
| | | | **Total New Network Upgrades** | **$70,000,000** |

## Potential Congestion due to Local Energy Deliverability

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

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

| | Contingency | | Affected | | Bus | | | Power | Loading % | | Rating | | MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | Type | Name | Area | Facility Description | From | To | Circuit | Flow | Initial | Final | Type | MVA | Contribution |

| # | Contingency Type | Contingency Name | Affected Area | Facility Description | Bus From | Bus To | Circuit | Power Flow | Loading % Initial | Loading % Final | Rating Type | Rating MVA | MW Contribution |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | N-1 | DVP_P1-2: LN 2181 | DVP - CPLE | 6HATHAWAY-6ROCKYMT230T 230 kV line | 313845 | 304222 | 1 | DC | 113.16 | 114.97 | ER | 386 | 6.98 |
| 7 | N-1 | LN 2058 | DVP - DVP | 6HATHAWAY-6NASH 230 kV line | 313845 | 314591 | 1 | DC | 112.22 | 113.94 | ER | 449 | 7.74 |
| 8 | N-1 | LN 246_B | DVP - DVP | 6SAPONY-6CARSON 230 kV line | 314435 | 314282 | 1 | DC | 108.58 | 110.4 | ER | 679 | 12.38 |
| 9 | N-1 | LN 254_A | DVP - DVP | 6CAROLNA 230/115 kV transformer | 314561 | 314559 | 1 | DC | 105.73 | 106.51 | ER | 240 | 4.13 |
| 10 | N-1 | LN 246_B | DVP - DVP | 6CLUBHSE-6SAPONY 230 kV line | 314563 | 314435 | 1 | DC | 124 | 126.07 | ER | 599 | 12.38 |
| 11 | N-1 | LN 2131A | DVP - DVP | 6EARLEYS-6NUCO TP 230 kV line | 314569 | 314575 | 1 | DC | 116.63 | 120.9 | ER | 572 | 24.44 |
| 12 | N-1 | LN 2131A | DVP - DVP | 6NUCO TP-AA1-138 TAP 230 kV line | 314575 | 921571 | 1 | DC | 109.84 | 114.11 | ER | 572 | 24.44 |
| 13 | N-1 | LN 238 | DVP - DVP | 6HORNRTN-AC1-208 TAP 230 kV line | 314579 | 927140 | 1 | DC | 123.86 | 124.48 | ER | 442 | 6.09 |
| 14 | N-1 | LN 238 | DVP - DVP | 6LAKEVEW-6HORNRTN 230 kV line | 314583 | 314579 | 1 | DC | 97.61 | 98.24 | ER | 442 | 6.15 |
| 15 | N-1 | LN 246_B | DVP - DVP | 6LAKEVEW-AB2-100 TAP 230 kV line | 314583 | 924510 | 1 | DC | 120.88 | 124.03 | ER | 375 | 11.83 |
| 16 | N-1 | LN 2058 | DVP - CPLE | 6NASH-6PA-RMOUNT#4 230 kV line | 314591 | 304226 | 1 | DC | 102.79 | 104.44 | ER | 470 | 7.74 |
| 17 | N-1 | LN 2020 | DVP - DVP | 6SUNBURY-6SUFFOLK 230 kV line | 314648 | 314537 | 1 | DC | 99.71 | 101.85 | ER | 449 | 9.61 |

| # | Contingency Type | Contingency Name | Affected Area | Facility Description | Bus From | Bus To | Circuit | Power Flow | Loading % Initial | Loading % Final | Rating Type | Rating MVA | MW Contribution |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | N-1 | LN 2020 | DVP - DVP | W1-029-6SUNBURY 230 kV line | 901080 | 314648 | 1 | DC | 104.53 | 106.67 | ER | 449 | 9.61 |
| 19 | N-1 | LN 2131A | DVP - DVP | AA1-138 TAP-6SUFFOLK 230 kV line | 921571 | 314537 | 1 | DC | 118.12 | 122.39 | ER | 572 | 24.44 |
| 20 | N-1 | LN 246_A | DVP - DVP | AB2-100 TAP-6CLUBHSE 230 kV line | 924510 | 314563 | 1 | DC | 143.26 | 146.42 | ER | 375 | 11.83 |
| 21 | N-1 | LN 238 | DVP - DVP | AC1-208 TAP-6HATHAWAY 230 kV line | 927140 | 313845 | 1 | DC | 135.12 | 135.74 | ER | 442 | 6.09 |

## Light Load Analysis

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

## ITO Analysis

ITO assessed the impact of the proposed Queue Project #AC2-158 interconnection of a 65 MW Energy (32.5 MW Capacity) injection into the ITO's Transmission System at a new interconnection switching station located between the Cashie – Earleys 230kV section of Line #2034, for compliance with NERC Reliability Criteria on ITO's Transmission System. The system was assessed using the summer 2020 RTEP case provided to ITO by PJM. When performing a generation analysis, ITO's main analysis will be load flow study results under single contingency (both normal and stressed system conditions). ITO Criteria considers a transmission facility overloaded if it exceeds 94% of its emergency rating under normal and stressed system conditions. A full listing of ITO's Planning Criteria and interconnection requirements can be found in the ITO's Facility Connection Requirements which are publicly available at: http://www.dom.com.

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

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

Category B Analysis (Single Contingency):

1. System Normal – No deficiencies identified
2. Critical System Condition (No Surry 230 kV or Possum Point 6 Unit) –

**Critical Condition - No Possum Point 6**

| | Contingency | | Affected | | Bus | | | Power | Loading % | | Rating | | MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | Type | Name | Area | Facility Description | From | To | Circuit | Flow | Initial | Final | Type | MVA | Contribution |
| 22 | N-1 | DVP_P1-2: LN 2181 | DVP - DVP | 6LAKEVEW-AB2-100 TAP 230 kV line | 314583 | 924510 | 1 | DC | 96.65 | 97.74 | ER | 375 | 4.55 |

**Violation # 22 will be resolved with the upgrade identified for violation # 3 and 4.**

Category C Analysis: (Multiple Facility Analysis)

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

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

## Affected System Analysis & Mitigation

### Duke, Progress & TVA Impacts:

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

Note: Violation # 1 on the Battleboro – Rocky Mount 115kV line has been identified to be on the Duke owned portion of this line.

# Option 2

# Network Impacts

The Queue Project AC2-158 was evaluated as a 65.0 MW (Capacity 32.5 MW) injection tapping the Earleys – Everetts 230 kV line in the ITO area. Project AC2-158 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-158 was studied with a commercial probability of 53%. Potential network impacts were as follows:

## Contingency Descriptions

The following contingencies resulted in overloads:

| Contingency Name | Description |
|---|---|
| 246T2034_A | CONTINGENCY '246T2034_A' /* EARLEYS<br>OPEN BRANCH FROM BUS 314569 TO BUS 314575 CKT 1 /* 246<br>OPEN BRANCH FROM BUS 314575 TO BUS 921571 CKT 1 /* 246 AA1-138 TAP<br>OPEN BRANCH FROM BUS 314575 TO BUS 314590 CKT 1 /* 246 - NUCOR<br>OPEN BRANCH FROM BUS 314569 TO BUS 314620 CKT 1 /* 2034<br>OPEN BRANCH FROM BUS 314620 TO BUS 314616 CKT 1 /* 2034<br>OPEN BRANCH FROM BUS 314616 TO BUS 314613 CKT 1 /* TROWBRIDGE TX #1&2<br>END |
| DVP_P1-2: LN 2181 | CONTINGENCY 'DVP_P1-2: LN 2181'<br>OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 6PA-RMOUNT#4230.00 - 6NASH 230.00<br>OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 6HATHAWAY 230.00 - 6NASH 230.00<br>OPEN BRANCH FROM BUS 304226 TO BUS 304222 CKT 1 /* 6PA-RMOUNT#4230.00 - 6ROCKYMT230T<br>OPEN BUS 304226 /* ISLAND<br>OPEN BUS 314591 /* ISLAND: 6NASH 230.00<br>END |
| DVP_P1-2:2056_A | CONTINGENCY 'DVP_P1-2:2056_A'<br>OPEN BRANCH FROM BUS 313845 TO BUS 927140 CKT 1 /* 6HATHAWAY 230.00 - AC1-208 TAP 230.00<br>END |
| DVP_P1-2:2056_B | CONTINGENCY 'DVP_P1-2:2056_B'<br>OPEN BRANCH FROM BUS 927140 TO BUS 314579 CKT 1 /* AC1-208 TAP 230.00 - 6HORNRTN 230.00<br>END |

| Contingency Name | Description |
|---|---|
| LN 2020 | CONTINGENCY 'LN 2020'<br>OPEN BRANCH FROM BUS 313851 TO BUS 314638 CKT 1 /* 6ECITYDP2 230.00 - 6ELIZ CT 230.00<br>OPEN BRANCH FROM BUS 313851 TO BUS 314639 CKT 1 /* 6ECITYDP2 230.00 - 6TANGLEW 230.00<br>OPEN BRANCH FROM BUS 314639 TO BUS 314651 CKT 1 /* 6TANGLEW 230.00 - 6WINFALL 230.00<br>OPEN BUS 313851 /* ISLAND<br>OPEN BUS 314639 /* ISLAND<br>OPEN BUS 913391 /* ISLAND<br>OPEN BUS 913392 /* ISLAND<br>END |
| LN 2058 | CONTINGENCY 'LN 2058-2181'<br>OPEN BUS 304226 /* ISLAND: 6PA-RMOUNT#4115.00<br>OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 6PA-RMOUNT#4230.00 - 6NASH 230.00<br>OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 6HATHAWAY 230.00 - 6NASH 230.00<br>OPEN BUS 314591 /* ISLAND: 6NASH 230.00<br>OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /* 6ROCKYMT230T230.00 - 6HATHAWAY 230.00<br>END |
| LN 2058-2181 | CONTINGENCY 'LN 2058-2181'<br>OPEN BUS 304226 /* ISLAND: 6PA-RMOUNT#4115.00<br>OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 6PA-RMOUNT#4230.00 - 6NASH 230.00<br>OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 6HATHAWAY 230.00 - 6NASH 230.00<br>OPEN BUS 314591 /* ISLAND: 6NASH 230.00<br>OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /* 6ROCKYMT230T230.00 - 6HATHAWAY 230.00<br>END |
| LN 2131A | CONTINGENCY 'LN 2131A'<br>OPEN BRANCH FROM BUS 314662 TO BUS 916040 CKT 1 /* 6S HERTFORD 230.00 - Z1-036 TAP 230.00<br>OPEN BRANCH FROM BUS 314651 TO BUS 314662 CKT 1 /* 6WINFALL 230.00 - 6S HERTFORD 230.00<br>OPEN BUS 314662 /* ISLAND<br>END |
| LN 246_A | CONTINGENCY 'LN 246_A'<br>OPEN BRANCH FROM BUS 921571 TO BUS 314575 CKT 1 /* AA1-138 TAP - 6NUCO TP 230.00<br>OPEN BRANCH FROM BUS 314569 TO BUS 314575 CKT 1 /* 6EARLEYS 230.00 - 6NUCO TP 230.00<br>OPEN BRANCH FROM BUS 314575 TO BUS 314590 CKT 1 /* 6NUCO TP 230.00 - 6NUCOR 230.00<br>OPEN BUS 314575 /* ISLAND<br>OPEN BUS 314590 /* ISLAND<br>END |
| LN 246_B | CONTINGENCY 'LN 246_B'<br>OPEN BRANCH FROM BUS 314537 TO BUS 921571 CKT 1 /* 6SUFFOLK 230.00 - AA1-138 TAP<br>END |

| Contingency Name | Description |
|---|---|
| LN 254_A | CONTINGENCY 'LN 254_A'<br>OPEN BRANCH FROM BUS 314563 TO BUS 924510 CKT 1 /* 6CLUBHSE 230.00 - AB2-100 TAP 230.00<br>END |

# Summer Peak Analysis - 2020

## Generator Deliverability

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

None

## Multiple Facility Contingency

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

| # | Contingency Type | Contingency Name | Affected Area | Facility Description | Bus From | Bus To | Cir. | Power Flow | Loading % Initial | Loading % Final | Rating Type | Rating MVA | MW Contribution | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | LFFB | 246T2034_A | DVP - DVP | 6SAPONY-6CARSON 230 kV line | 314435 | 314282 | 1 | DC | 96.12 | 97.84 | LD | 830 | 14.31 | 5 |
| 2 | DCTL | LN 2058-2181 | DVP - CPLE | 6EVERETS-6GREENVILE T 230 kV line | 314574 | 304451 | 1 | DC | 95.13 | 98.85 | ER | 478 | 17.79 | 6 |

## 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 Type | Contingency Name | Affected Area | Facility Description | Bus From | Bus To | Cir. | Power Flow | Loading % Initial | Loading % Final | Rating Type | Rating MVA | MW Contribution | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | DCTL | LN 2058-2181 | DVP - CPLE | 3BTLEBRO-3ROCKYMT115T 115 kV line | 314554 | 304223 | 1 | DC | 200.83 | 202.12 | ER | 164 | 4.69 | 7 |
| 4 | LFFB | 246T2034_A | DVP - DVP | 6CLUBHSE-6SAPONY 230 kV line | 314563 | 314435 | 1 | DC | 126.04 | 128.28 | LD | 637 | 14.31 | 8 |
| 5 | LFFB | 246T2034_A | DVP - DVP | 6LAKEVEW-AB2-100 TAP 230 kV line | 314583 | 924510 | 1 | DC | 108.03 | 110.99 | LD | 459 | 13.61 | 9 |
| 6 | LFFB | 246T2034_A | DVP - DVP | AB2-100 TAP-6CLUBHSE 230 kV line | 924510 | 314563 | 1 | DC | 128.82 | 131.78 | LD | 459 | 13.61 | 10 |
| 7 | N-1 | DVP_P1-2:2056_A | DVP - DVP | AB2-100 TAP-6CLUBHSE 230 kV line | 924510 | 314563 | 1 | DC | 113.95 | 115.01 | ER | 375 | 3.99 | |
| 8 | N-1 | DVP_P1-2:2056_B | DVP - DVP | AB2-100 TAP-6CLUBHSE 230 kV line | 924510 | 314563 | 1 | DC | 108.53 | 109.6 | ER | 375 | 3.99 | |

## Steady-State Voltage Requirements

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

To be determined during Impact Study

## Stability and Reactive Power Requirement for Low Voltage Ride Through

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

To be determined during Impact Study

## Potential Congestion due to Local Energy Deliverability

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

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

| | Contingency | | Affected | | Bus | | | Power | Loading % | | Rating | | MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | Type | Name | Area | Facility Description | From | To | Circuit | Flow | Initial | Final | Type | MVA | Contribution |
| 9 | N-1 | DVP_P1-2: LN 2181 | DVP - CPLE | 6HATHAWAY-6ROCKYMT230T 230 kV line | 313845 | 304222 | 1 | DC | 113.09 | 115.05 | ER | 386 | 7.56 |
| 10 | N-1 | LN 2058 | DVP - DVP | 6HATHAWAY-6NASH 230 kV line | 313845 | 314591 | 1 | DC | 112.13 | 114 | ER | 449 | 8.38 |
| 11 | N-1 | LN 246_B | DVP - DVP | 6SAPONY-6CARSON 230 kV line | 314435 | 314282 | 1 | DC | 108.64 | 110.41 | ER | 679 | 11.99 |
| 12 | N-1 | LN 254_A | DVP - DVP | 6CAROLNA 230/115 kV transformer | 314561 | 314559 | 1 | DC | 105.74 | 106.52 | ER | 240 | 4.19 |
| 13 | N-1 | LN 246_B | DVP - DVP | 6CLUBHSE-6SAPONY 230 kV line | 314563 | 314435 | 1 | DC | 124.08 | 126.08 | ER | 599 | 11.99 |
| 14 | N-1 | LN 2131A | DVP - DVP | 6EARLEYS-6NUCO TP 230 kV line | 314569 | 314575 | 1 | DC | 116.7 | 120.31 | ER | 572 | 20.64 |
| 15 | N-1 | LN 2131A | DVP - DVP | 6NUCO TP-AA1-138 TAP 230 kV line | 314575 | 921571 | 1 | DC | 109.91 | 113.52 | ER | 572 | 20.64 |
| 16 | N-1 | LN 246_B | DVP - DVP | 6LAKEVEW-AB2-100 TAP 230 kV line | 314583 | 924510 | 1 | DC | 120.96 | 124.01 | ER | 375 | 11.44 |
| 17 | N-1 | LN 2058 | DVP - CPLE | 6NASH-6PA-RMOUNT#4 230 kV line | 314591 | 304226 | 1 | DC | 102.71 | 104.49 | ER | 470 | 8.38 |

| # | Contingency Type | Contingency Name | Affected Area | Facility Description | Bus From | Bus To | Circuit | Power Flow | Loading % Initial | Loading % Final | Rating Type | Rating MVA | MW Contribution |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | N-1 | LN 2020 | DVP - DVP | 6SUNBURY-6SUFFOLK 230 kV line | 314648 | 314537 | 1 | DC | 100.51 | 102 | ER | 449 | 6.7 |
| 19 | N-1 | LN 2020 | DVP - DVP | W1-029-6SUNBURY 230 kV line | 901080 | 314648 | 1 | DC | 105.36 | 106.86 | ER | 449 | 6.7 |
| 20 | N-1 | LN 2131A | DVP - DVP | AA1-138 TAP-6SUFFOLK 230 kV line | 921571 | 314537 | 1 | DC | 118.19 | 121.8 | ER | 572 | 20.64 |
| 21 | N-1 | LN 246_A | DVP - DVP | AB2-100 TAP-6CLUBHSE 230 kV line | 924510 | 314563 | 1 | DC | 143.37 | 146.42 | ER | 375 | 11.44 |

## Light Load Analysis

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

## ITO Analysis

ITO assessed the impact of the proposed Queue Project #AC2-158 interconnection of a 65 MW Energy (32.5 MW Capacity) injection into the ITO's Transmission System at a new interconnection switching station located between on the Everetts – Earleys 230kV line, for compliance with NERC Reliability Criteria on ITO's Transmission System. The system was assessed using the summer 2020 RTEP case provided to ITO by PJM. When performing a generation analysis, ITO's main analysis will be load flow study results under single contingency (both normal and stressed system conditions). ITO Criteria considers a transmission facility overloaded if it exceeds 94% of its emergency rating under normal and stressed system conditions. A full listing of ITO's Planning Criteria and interconnection requirements can be found in the ITO's Facility Connection Requirements which are publicly available at: http://www.dom.com.

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

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

Category B Analysis (Single Contingency):

1. System Normal – No deficiencies identified
2. Critical System Condition (No Surry 230 kV or Possum Point 6 Unit) –

**Critical Condition - No Surry Unit 1**

| # | Contingency Type | Contingency Name | Affected Area | Facility Description | Bus From | Bus To | Circuit | Power Flow | Loading % Initial | Loading % Final | Rating Type | Rating MVA | MW Contribution |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22 | N-1 | LN 246_B | DVP - DVP | 6LAKEVEW-AB2-100 TAP 230 kV line | 314583 | 924510 | 1 | DC | 95.88 | 97.41 | ER | 375 | 5.71 |
| 23 | N-1 | DVP_P1-2: LN 2181 | DVP - DVP | 6LAKEVEW-AB2-100 TAP 230 kV line | 314583 | 924510 | 1 | DC | 95.75 | 96.81 | ER | 375 | 3.99 |

**Critical Condition - No Possum Point 6**

| # | Contingency Type | Contingency Name | Affected Area | Facility Description | Bus From | Bus To | Circuit | Power Flow | Loading % Initial | Loading % Final | Rating Type | Rating MVA | MW Contribution |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 | N-1 | DVP_P1-2: LN 2181 | DVP - DVP | 6LAKEVEW-AB2-100 TAP 230 kV line | 314583 | 924510 | 1 | DC | 96.56 | 97.62 | ER | 375 | 3.99 |

Category C Analysis: (Multiple Facility Analysis)

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

3. Tower Line – No deficiencies identified

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

## Affected System Analysis & Mitigation

### Duke, Progress & TVA Impacts:

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

# Attachment 1.

***System Configuration***

## Attachment 2.

***Flowgate Appendices***

# Appendices

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

***It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.***

# Appendix 1

(DVP - CPLE) The 3BTLEBRO-3ROCKYMT115T 115 kV line (from bus 314554 to bus 304223 ckt 1) loads from 200.95% to 202.22% (**DC power flow**) of its emergency rating (164 MVA) for the tower line contingency outage of 'LN 2058-2181'. This project contributes approximately 4.62 MW to the thermal violation.

CONTINGENCY 'LN 2058-2181'
OPEN BUS 304226 /* ISLAND: 6PA-RMOUNT#4115.00
OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 6PA-RMOUNT#4230.00 - 6NASH 230.00
OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 6HATHAWAY 230.00 - 6NASH 230.00
OPEN BUS 314591 /* ISLAND: 6NASH 230.00
OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /* 6ROCKYMT230T230.00 - 6HATHAWAY 230.00
END

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *315131* | *1EDGECMA* | *13.46* |
| *315132* | *1EDGECMB* | *13.46* |
| *315139* | *1GASTONA* | *2.09* |
| *315141* | *1GASTONB* | *2.09* |
| *315126* | *1ROARAP2* | *0.87* |
| *315128* | *1ROARAP4* | *0.84* |
| *315134* | *1ROAVALA* | *18.11* |
| *315135* | *1ROAVALB* | *4.83* |
| *315136* | *1ROSEMG1* | *1.69* |
| *315138* | *1ROSEMG2* | *0.79* |
| *315137* | *1ROSEMS1* | *1.05* |
| *314541* | *3WATKINS* | *0.26* |
| *931631* | *AC2-084 C* | *11.41* |
| *931632* | *AC2-084 E* | *5.62* |
| *932451* | *AC2-158 C OP* | *2.31* |
| *932452* | *AC2-158 E OP* | *2.31* |
| *932461* | *AC2-159 C OP* | *3.98* |
| *932462* | *AC2-159 E OP* | *3.98* |
| *932521* | *AC2-167 C* | *1.51* |
| *932522* | *AC2-167 E* | *2.46* |
| *900672* | *V4-068 E* | *0.15* |

| | | |
|---|---|---|
| *917331* | *Z2-043 C* | *0.32* |
| *917332* | *Z2-043 E* | *0.83* |
| *917341* | *Z2-044 C* | *0.48* |
| *917342* | *Z2-044 E* | *1.25* |
| *917511* | *Z2-088 C OP1* | *0.61* |
| *917512* | *Z2-088 E OP1* | *6.1* |
| *917592* | *Z2-099 E* | *0.2* |
| *918411* | *AA1-050* | *0.51* |
| *LTF* | *AA1-055* | *9.27* |
| *921162* | *AA1-063AC* | *4.89* |
| *921163* | *AA1-063AE* | *2.3* |
| *918512* | *AA1-065 E OP* | *1.96* |
| *921182* | *AA1-067 C* | *0.74* |
| *921183* | *AA1-067 E* | *0.32* |
| *918561* | *AA1-072 C* | *0.05* |
| *918562* | *AA1-072 E* | *0.14* |
| *921562* | *AA1-135 C* | *4.04* |
| *921563* | *AA1-135 E* | *1.73* |
| *921752* | *AA2-053 C* | *5.43* |
| *921753* | *AA2-053 E* | *2.33* |
| *921762* | *AA2-057 C* | *12.89* |
| *921763* | *AA2-057 E* | *6.45* |
| *921862* | *AA2-068 C* | *3.3* |
| *921863* | *AA2-068 E* | *1.52* |
| *920022* | *AA2-086 E* | *0.11* |
| *921982* | *AA2-088 C* | *2.95* |
| *921983* | *AA2-088 E* | *4.81* |
| *922442* | *AA2-165 C* | *1.76* |
| *922443* | *AA2-165 E* | *0.85* |
| *922512* | *AA2-174 C* | *0.25* |
| *922513* | *AA2-174 E* | *0.27* |
| *922922* | *AB1-081 C OP* | *20.09* |
| *922923* | *AB1-081 E OP* | *8.61* |
| *923262* | *AB1-132 C OP* | *9.77* |
| *923263* | *AB1-132 E OP* | *4.19* |
| *923572* | *AB1-173 C OP* | *1.21* |
| *923573* | *AB1-173 E OP* | *0.57* |
| *923582* | *AB1-173AC OP* | *1.21* |
| *923583* | *AB1-173AE OP* | *0.57* |

| | | |
|---|---|---|
| *923911* | *AB2-031 C OP* | *1.21* |
| *923912* | *AB2-031 E OP* | *0.59* |
| *923941* | *AB2-035 C* | *0.37* |
| *923942* | *AB2-035 E* | *0.16* |
| *923991* | *AB2-040 C OP* | *3.96* |
| *923992* | *AB2-040 E OP* | *3.24* |
| *924151* | *AB2-059 C OP* | *23.67* |
| *924152* | *AB2-059 E OP* | *12.19* |
| *924381* | *AB2-087 C* | *0.32* |
| *924382* | *AB2-087 E* | *0.15* |
| *924391* | *AB2-088 C* | *0.48* |
| *924392* | *AB2-088 E* | *0.23* |
| *924491* | *AB2-098 C* | *0.25* |
| *924492* | *AB2-098 E* | *0.11* |
| *924501* | *AB2-099 C* | *0.32* |
| *924502* | *AB2-099 E* | *0.14* |
| *924511* | *AB2-100 C* | *6.42* |
| *924512* | *AB2-100 E* | *3.16* |
| *924761* | *AB2-128 C* | *5.5* |
| *924762* | *AB2-128 E* | *2.17* |
| *924931* | *AB2-147 C* | *1.15* |
| *924932* | *AB2-147 E* | *1.87* |
| *924951* | *AB2-150 C OP* | *1.15* |
| *924952* | *AB2-150 E OP* | *1.87* |
| *925121* | *AB2-169 C OP* | *2.49* |
| *925122* | *AB2-169 E OP* | *2.23* |
| *925141* | *AB2-171 C OP* | *1.93* |
| *925142* | *AB2-171 E OP* | *3.15* |
| *925171* | *AB2-174 C OP* | *3.58* |
| *925172* | *AB2-174 E OP* | *3.24* |
| *925591* | *AC1-034 C OP* | *7.52* |
| *925592* | *AC1-034 E OP* | *5.68* |
| *926071* | *AC1-086 C* | *14.39* |
| *926072* | *AC1-086 E* | *6.55* |
| *926201* | *AC1-098 C* | *8.* |
| *926202* | *AC1-098 E* | *4.77* |
| *926211* | *AC1-099 C* | *2.68* |
| *926212* | *AC1-099 E* | *1.58* |
| *LTF* | *AC1-133* | *9.11* |

| | | |
|---|---|---|
| *926771* | *AC1-163 C* | *1.14* |
| *926772* | *AC1-163 E* | *0.53* |
| *927021* | *AC1-189 C* | *5.16* |
| *927022* | *AC1-189 E* | *2.57* |
| *927051* | *AC1-193 C* | *1.42* |
| *927052* | *AC1-193 E* | *2.31* |
| *927111* | *AC1-206 C OP* | *5.12* |
| *927112* | *AC1-206 E OP* | *2.42* |
| *927141* | *AC1-208 C* | *10.07* |
| *927142* | *AC1-208 E* | *4.47* |

# Appendix 2

(DVP - DVP) The 6HORNRTN-AC1-208 TAP 230 kV line (from bus 314579 to bus 927140 ckt 1) loads from 101.18% to 101.68% (**DC power flow**) of its load dump rating (541 MVA) for the tower line contingency outage of 'LN 238-249'. This project contributes approximately 6.09 MW to the thermal violation.

```
CONTINGENCY 'LN 238-249'
  OPEN BRANCH FROM BUS 314282 TO BUS 314435 CKT 1          /* 6CARSON
230.00 - 6SAPONY 230.00
  OPEN BRANCH FROM BUS 314435 TO BUS 314563 CKT 1          /* 6SAPONY
230.00 - 6CLUBHSE 230.00
  OPEN BRANCH FROM BUS 314562 TO BUS 314563 CKT 1          /* 3CLUBHSE
115.00 - 6CLUBHSE 230.00
  OPEN BUS 314435                                  /* ISLAND
  OPEN BRANCH FROM BUS 314282 TO BUS 314285 CKT 1          /* 6CARSON
230.00 - 6CHRL249 230.00
  OPEN BRANCH FROM BUS 314285 TO BUS 314316 CKT 1          /* 6CHRL249
230.00 - 6LOCKS 230.00
  OPEN BRANCH FROM BUS 314314 TO BUS 314316 CKT 1          /* 3LOCKS 115.00 -
6LOCKS 230.00
  OPEN BUS 314285                                  /* ISLAND
  END
```

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *315139* | *1GASTONA* | *6.95* |
| *315141* | *1GASTONB* | *6.95* |
| *315126* | *1ROARAP2* | *1.57* |
| *315128* | *1ROARAP4* | *1.51* |
| *315134* | *1ROAVALA* | *55.69* |
| *315135* | *1ROAVALB* | *14.85* |
| *315136* | *1ROSEMG1* | *5.7* |
| *315138* | *1ROSEMG2* | *2.67* |
| *315137* | *1ROSEMS1* | *3.54* |
| *314704* | *3LAWRENC* | *0.23* |
| *314539* | *3UNCAMP* | *1.19* |
| *314541* | *3WATKINS* | *0.39* |
| *932451* | *AC2-158 C OP* | *3.05* |
| *932452* | *AC2-158 E OP* | *3.05* |
| *932461* | *AC2-159 C OP* | *5.92* |

| | | |
|---|---|---|
| *932462* | *AC2-159 E OP* | *5.92* |
| *932521* | *AC2-167 C* | *2.3* |
| *932522* | *AC2-167 E* | *3.75* |
| *900671* | *V4-068 C* | *0.06* |
| *900672* | *V4-068 E* | *0.21* |
| *907092* | *X1-038 E* | *2.97* |
| *917332* | *Z2-043 E* | *0.48* |
| *917591* | *Z2-099 C* | *0.12* |
| *917592* | *Z2-099 E* | *0.32* |
| *921162* | *AA1-063AC* | *8.45* |
| *921163* | *AA1-063AE* | *3.98* |
| *918511* | *AA1-065 C OP* | *0.89* |
| *918512* | *AA1-065 E OP* | *2.7* |
| *918562* | *AA1-072 E* | *0.08* |
| *921752* | *AA2-053 C* | *9.08* |
| *921753* | *AA2-053 E* | *3.9* |
| *920021* | *AA2-086 C* | *0.06* |
| *920022* | *AA2-086 E* | *0.17* |
| *921982* | *AA2-088 C* | *4.54* |
| *921983* | *AA2-088 E* | *7.42* |
| *922472* | *AA2-169 C* | *1.65* |
| *922473* | *AA2-169 E* | *0.76* |
| *922512* | *AA2-174 C* | *0.42* |
| *922513* | *AA2-174 E* | *0.45* |
| *923262* | *AB1-132 C OP* | *32.5* |
| *923263* | *AB1-132 E OP* | *13.93* |
| *923572* | *AB1-173 C OP* | *2.26* |
| *923573* | *AB1-173 E OP* | *1.05* |
| *923582* | *AB1-173AC OP* | *2.26* |
| *923583* | *AB1-173AE OP* | *1.05* |
| *923801* | *AB2-015 C OP* | *4.6* |
| *923802* | *AB2-015 E OP* | *3.77* |
| *923911* | *AB2-031 C OP* | *2.24* |
| *923912* | *AB2-031 E OP* | *1.1* |
| *923991* | *AB2-040 C OP* | *7.36* |
| *923992* | *AB2-040 E OP* | *6.02* |
| *924381* | *AB2-087 C* | *0.36* |
| *924382* | *AB2-087 E* | *0.17* |
| *924401* | *AB2-089 C* | *1.2* |

| | | |
|---|---|---|
| *924402* | *AB2-089 E* | *0.62* |
| *924501* | *AB2-099 C* | *0.38* |
| *924502* | *AB2-099 E* | *0.16* |
| *924511* | *AB2-100 C* | *25.92* |
| *924512* | *AB2-100 E* | *12.77* |
| *924761* | *AB2-128 C* | *22.21* |
| *924762* | *AB2-128 E* | *8.74* |
| *924931* | *AB2-147 C* | *2.19* |
| *924932* | *AB2-147 E* | *3.57* |
| *924951* | *AB2-150 C OP* | *2.19* |
| *924952* | *AB2-150 E OP* | *3.57* |
| *925141* | *AB2-171 C OP* | *2.91* |
| *925142* | *AB2-171 E OP* | *4.75* |
| *925171* | *AB2-174 C OP* | *6.71* |
| *925172* | *AB2-174 E OP* | *6.07* |
| *925781* | *AC1-054 C OP* | *4.54* |
| *925782* | *AC1-054 E OP* | *2.09* |
| *926071* | *AC1-086 C* | *47.86* |
| *926072* | *AC1-086 E* | *21.78* |
| *926771* | *AC1-163 C* | *1.36* |
| *926772* | *AC1-163 E* | *0.64* |
| *927051* | *AC1-193 C* | *2.13* |
| *927052* | *AC1-193 E* | *3.48* |
| *927111* | *AC1-206 C OP* | *26.27* |
| *927112* | *AC1-206 E OP* | *12.42* |

# Appendix 3

(DVP - DVP) The AB2-100 TAP-6CLUBHSE 230 kV line (from bus 924510 to bus 314563 ckt 1) loads from 113.91% to 115.12% (**DC power flow**) of its emergency rating (375 MVA) for the single line contingency outage of 'DVP_P1-2:2056_A'. This project contributes approximately 4.55 MW to the thermal violation.

CONTINGENCY 'DVP_P1-2:2056_A'
 OPEN BRANCH FROM BUS 313845 TO BUS 927140 CKT 1 /* 6HATHAWAY 230.00 - AC1-208 TAP 230.00
 END

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *315292* | *1DOMTR78* | *0.82* |
| *315131* | *1EDGECMA* | *3.61* |
| *315132* | *1EDGECMB* | *3.61* |
| *315139* | *1GASTONA* | *7.73* |
| *315141* | *1GASTONB* | *7.73* |
| *315159* | *1KERR 2* | *0.48* |
| *315162* | *1KERR 5* | *0.47* |
| *315163* | *1KERR 6* | *0.47* |
| *315164* | *1KERR 7* | *0.47* |
| *315126* | *1ROARAP2* | *1.49* |
| *315128* | *1ROARAP4* | *1.43* |
| *315134* | *1ROAVALA* | *62.63* |
| *315135* | *1ROAVALB* | *16.7* |
| *315136* | *1ROSEMG1* | *5.55* |
| *315138* | *1ROSEMG2* | *2.6* |
| *315137* | *1ROSEMS1* | *3.44* |
| *315115* | *1SHAMPT1* | *1.* |
| *931631* | *AC2-084 C* | *6.85* |
| *932451* | *AC2-158 C OP* | *4.55* |
| *932461* | *AC2-159 C OP* | *6.6* |
| *932521* | *AC2-167 C* | *2.36* |
| *900671* | *V4-068 C* | *0.07* |
| *916041* | *Z1-036 C* | *0.37* |
| *917331* | *Z2-043 C* | *0.32* |
| *917341* | *Z2-044 C* | *0.12* |
| *917511* | *Z2-088 C OP1* | *0.42* |
| *917591* | *Z2-099 C* | *0.12* |

| | | |
|---|---|---|
| *918411* | *AA1-050* | *0.35* |
| *921162* | *AA1-063AC* | *8.14* |
| *918511* | *AA1-065 C OP* | *1.31* |
| *921182* | *AA1-067 C* | *1.* |
| *918561* | *AA1-072 C* | *0.05* |
| *921562* | *AA1-135 C* | *6.87* |
| *921572* | *AA1-138 C* | *3.69* |
| *921752* | *AA2-053 C* | *9.17* |
| *921762* | *AA2-057 C* | *4.63* |
| *921772* | *AA2-059 C* | *0.45* |
| *921862* | *AA2-068 C* | *1.69* |
| *920021* | *AA2-086 C* | *0.06* |
| *921982* | *AA2-088 C* | *4.58* |
| *922442* | *AA2-165 C* | *0.63* |
| *922472* | *AA2-169 C* | *1.46* |
| *922512* | *AA2-174 C* | *0.42* |
| *922532* | *AA2-178 C* | *4.75* |
| *922602* | *AB1-013 C* | *1.43* |
| *922922* | *AB1-081 C OP* | *3.89* |
| *923262* | *AB1-132 C OP* | *36.16* |
| *923801* | *AB2-015 C OP* | *4.44* |
| *923941* | *AB2-035 C* | *0.16* |
| *924151* | *AB2-059 C OP* | *4.58* |
| *924381* | *AB2-087 C* | *0.5* |
| *924391* | *AB2-088 C* | *0.2* |
| *924401* | *AB2-089 C* | *1.* |
| *924491* | *AB2-098 C* | *0.33* |
| *924501* | *AB2-099 C* | *0.5* |
| *924511* | *AB2-100 C* | *38.17* |
| *924761* | *AB2-128 C* | *32.7* |
| *925121* | *AB2-169 C OP* | *3.87* |
| *925141* | *AB2-171 C OP* | *2.86* |
| *925291* | *AB2-188 C OP* | *1.17* |
| *925591* | *AC1-034 C OP* | *3.16* |
| *925781* | *AC1-054 C OP* | *3.89* |
| *926071* | *AC1-086 C* | *53.24* |
| *926201* | *AC1-098 C* | *4.81* |
| *926211* | *AC1-099 C* | *1.61* |
| *926771* | *AC1-163 C* | *1.81* |

| | | |
|---|---|---|
| *927021* | *AC1-189 C* | *4.81* |
| *927051* | *AC1-193 C* | *2.1* |
| *927141* | *AC1-208 C* | *23.85* |

# Appendix 4

(DVP - DVP) The AC1-208 TAP-6HATHAWAY 230 kV line (from bus 927140 to bus 313845 ckt 1) loads from 110.35% to 110.86% (**DC power flow**) of its load dump rating (541 MVA) for the tower line contingency outage of 'LN 238-249'. This project contributes approximately 6.09 MW to the thermal violation.

CONTINGENCY 'LN 238-249'
OPEN BRANCH FROM BUS 314282 TO BUS 314435 CKT 1 /* 6CARSON 230.00 - 6SAPONY 230.00
OPEN BRANCH FROM BUS 314435 TO BUS 314563 CKT 1 /* 6SAPONY 230.00 - 6CLUBHSE 230.00
OPEN BRANCH FROM BUS 314562 TO BUS 314563 CKT 1 /* 3CLUBHSE 115.00 - 6CLUBHSE 230.00
OPEN BUS 314435 /* ISLAND
OPEN BRANCH FROM BUS 314282 TO BUS 314285 CKT 1 /* 6CARSON 230.00 - 6CHRL249 230.00
OPEN BRANCH FROM BUS 314285 TO BUS 314316 CKT 1 /* 6CHRL249 230.00 - 6LOCKS 230.00
OPEN BRANCH FROM BUS 314314 TO BUS 314316 CKT 1 /* 3LOCKS 115.00 - 6LOCKS 230.00
OPEN BUS 314285 /* ISLAND
END

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *315139* | *1GASTONA* | *6.95* |
| *315141* | *1GASTONB* | *6.95* |
| *315126* | *1ROARAP2* | *1.57* |
| *315128* | *1ROARAP4* | *1.51* |
| *315134* | *1ROAVALA* | *55.69* |
| *315135* | *1ROAVALB* | *14.85* |
| *315136* | *1ROSEMG1* | *5.7* |
| *315138* | *1ROSEMG2* | *2.67* |
| *315137* | *1ROSEMS1* | *3.54* |
| *314704* | *3LAWRENC* | *0.23* |
| *314539* | *3UNCAMP* | *1.19* |
| *314541* | *3WATKINS* | *0.39* |
| *932451* | *AC2-158 C OP* | *3.05* |
| *932452* | *AC2-158 E OP* | *3.05* |
| *932461* | *AC2-159 C OP* | *5.92* |

| | | |
|---|---|---|
| *932462* | *AC2-159 E OP* | *5.92* |
| *932521* | *AC2-167 C* | *2.3* |
| *932522* | *AC2-167 E* | *3.75* |
| *900671* | *V4-068 C* | *0.06* |
| *900672* | *V4-068 E* | *0.21* |
| *907092* | *X1-038 E* | *2.97* |
| *917591* | *Z2-099 C* | *0.12* |
| *917592* | *Z2-099 E* | *0.32* |
| *921162* | *AA1-063AC* | *8.45* |
| *921163* | *AA1-063AE* | *3.98* |
| *918511* | *AA1-065 C OP* | *0.89* |
| *918512* | *AA1-065 E OP* | *2.7* |
| *921752* | *AA2-053 C* | *9.08* |
| *921753* | *AA2-053 E* | *3.9* |
| *920021* | *AA2-086 C* | *0.06* |
| *920022* | *AA2-086 E* | *0.17* |
| *921982* | *AA2-088 C* | *4.54* |
| *921983* | *AA2-088 E* | *7.42* |
| *922472* | *AA2-169 C* | *1.65* |
| *922473* | *AA2-169 E* | *0.76* |
| *922512* | *AA2-174 C* | *0.42* |
| *922513* | *AA2-174 E* | *0.45* |
| *923262* | *AB1-132 C OP* | *32.5* |
| *923263* | *AB1-132 E OP* | *13.93* |
| *923572* | *AB1-173 C OP* | *2.26* |
| *923573* | *AB1-173 E OP* | *1.05* |
| *923582* | *AB1-173AC OP* | *2.26* |
| *923583* | *AB1-173AE OP* | *1.05* |
| *923801* | *AB2-015 C OP* | *4.6* |
| *923802* | *AB2-015 E OP* | *3.77* |
| *923911* | *AB2-031 C OP* | *2.24* |
| *923912* | *AB2-031 E OP* | *1.1* |
| *923991* | *AB2-040 C OP* | *7.36* |
| *923992* | *AB2-040 E OP* | *6.02* |
| *924381* | *AB2-087 C* | *0.36* |
| *924382* | *AB2-087 E* | *0.17* |
| *924401* | *AB2-089 C* | *1.2* |
| *924402* | *AB2-089 E* | *0.62* |
| *924501* | *AB2-099 C* | *0.38* |

| | | |
|---|---|---|
| *924502* | *AB2-099 E* | *0.16* |
| *924511* | *AB2-100 C* | *25.92* |
| *924512* | *AB2-100 E* | *12.77* |
| *924761* | *AB2-128 C* | *22.21* |
| *924762* | *AB2-128 E* | *8.74* |
| *924931* | *AB2-147 C* | *2.19* |
| *924932* | *AB2-147 E* | *3.57* |
| *924951* | *AB2-150 C OP* | *2.19* |
| *924952* | *AB2-150 E OP* | *3.57* |
| *925141* | *AB2-171 C OP* | *2.91* |
| *925142* | *AB2-171 E OP* | *4.75* |
| *925171* | *AB2-174 C OP* | *6.71* |
| *925172* | *AB2-174 E OP* | *6.07* |
| *925781* | *AC1-054 C OP* | *4.54* |
| *925782* | *AC1-054 E OP* | *2.09* |
| *926071* | *AC1-086 C* | *47.86* |
| *926072* | *AC1-086 E* | *21.78* |
| *926771* | *AC1-163 C* | *1.36* |
| *926772* | *AC1-163 E* | *0.64* |
| *927051* | *AC1-193 C* | *2.13* |
| *927052* | *AC1-193 E* | *3.48* |
| *927111* | *AC1-206 C OP* | *26.27* |
| *927112* | *AC1-206 E OP* | *12.42* |
| *927141* | *AC1-208 C* | *34.91* |
| *927142* | *AC1-208 E* | *15.5* |

# Appendix 5

(DVP - DVP) The 6SAPONY-6CARSON 230 kV line (from bus 314435 to bus 314282 ckt 1) loads from 96.12% to 97.84% (**DC power flow**) of its load dump rating (830 MVA) for the line fault with failed breaker contingency outage of '246T2034_A'. This project contributes approximately 14.31 MW to the thermal violation.

```
CONTINGENCY '246T2034_A'                                    /* EARLEYS
  OPEN BRANCH FROM BUS 314569 TO BUS 314575 CKT 1           /* 246
  OPEN BRANCH FROM BUS 314575 TO BUS 921571 CKT 1           /* 246 AA1-138
TAP
  OPEN BRANCH FROM BUS 314575 TO BUS 314590 CKT 1           /* 246 - NUCOR
  OPEN BRANCH FROM BUS 314569 TO BUS 314620 CKT 1           /* 2034
  OPEN BRANCH FROM BUS 314620 TO BUS 314616 CKT 1           /* 2034
  OPEN BRANCH FROM BUS 314616 TO BUS 314613 CKT 1           /* TROWBRIDGE
TX #1&2
  END
```

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *315131* | *1EDGECMA* | *11.38* |
| *315132* | *1EDGECMB* | *11.38* |
| *315139* | *1GASTONA* | *6.65* |
| *315141* | *1GASTONB* | *6.65* |
| *315126* | *1ROARAP2* | *2.41* |
| *315128* | *1ROARAP4* | *2.31* |
| *315134* | *1ROAVALA* | *57.8* |
| *315135* | *1ROAVALB* | *15.41* |
| *315136* | *1ROSEMG1* | *4.49* |
| *315138* | *1ROSEMG2* | *2.1* |
| *315137* | *1ROSEMS1* | *2.78* |
| *314704* | *3LAWRENC* | *0.7* |
| *314541* | *3WATKINS* | *0.52* |
| *931631* | *AC2-084 C* | *12.95* |
| *931632* | *AC2-084 E* | *6.38* |
| *932451* | *AC2-158 C OP* | *7.16* |
| *932452* | *AC2-158 E OP* | *7.16* |
| *932461* | *AC2-159 C OP* | *11.98* |
| *932462* | *AC2-159 E OP* | *11.98* |
| *932521* | *AC2-167 C* | *3.6* |
| *932522* | *AC2-167 E* | *5.87* |

| | | |
|---|---|---|
| *900671* | *V4-068 C* | *0.11* |
| *900672* | *V4-068 E* | *0.36* |
| *917331* | *Z2-043 C* | *0.57* |
| *917332* | *Z2-043 E* | *1.49* |
| *917341* | *Z2-044 C* | *0.28* |
| *917342* | *Z2-044 E* | *0.75* |
| *917511* | *Z2-088 C OP1* | *0.93* |
| *917512* | *Z2-088 E OP1* | *9.3* |
| *917591* | *Z2-099 C* | *0.18* |
| *917592* | *Z2-099 E* | *0.48* |
| *918411* | *AA1-050* | *0.78* |
| *LTF* | *AA1-058* | *0.57* |
| *921162* | *AA1-063AC* | *12.89* |
| *921163* | *AA1-063AE* | *6.08* |
| *918511* | *AA1-065 C OP* | *2.25* |
| *918512* | *AA1-065 E OP* | *6.79* |
| *921182* | *AA1-067 C* | *1.92* |
| *921183* | *AA1-067 E* | *0.82* |
| *918561* | *AA1-072 C* | *0.09* |
| *918562* | *AA1-072 E* | *0.25* |
| *921562* | *AA1-135 C* | *12.33* |
| *921563* | *AA1-135 E* | *5.29* |
| *921752* | *AA2-053 C* | *14.98* |
| *921753* | *AA2-053 E* | *6.43* |
| *921762* | *AA2-057 C* | *9.84* |
| *921763* | *AA2-057 E* | *4.92* |
| *921862* | *AA2-068 C* | *3.28* |
| *921863* | *AA2-068 E* | *1.51* |
| *LTF* | *AA2-074* | *2.67* |
| *920021* | *AA2-086 C* | *0.09* |
| *920022* | *AA2-086 E* | *0.26* |
| *921982* | *AA2-088 C* | *6.87* |
| *921983* | *AA2-088 E* | *11.21* |
| *922442* | *AA2-165 C* | *1.34* |
| *922443* | *AA2-165 E* | *0.65* |
| *922472* | *AA2-169 C* | *2.97* |
| *922473* | *AA2-169 E* | *1.36* |
| *922512* | *AA2-174 C* | *0.69* |
| *922513* | *AA2-174 E* | *0.74* |

| | | |
|---|---|---|
| *922922* | *AB1-081 C OP* | *10.89* |
| *922923* | *AB1-081 E OP* | *4.67* |
| *923262* | *AB1-132 C OP* | *31.06* |
| *923263* | *AB1-132 E OP* | *13.31* |
| *923572* | *AB1-173 C OP* | *5.13* |
| *923573* | *AB1-173 E OP* | *2.39* |
| *923582* | *AB1-173AC OP* | *5.13* |
| *923583* | *AB1-173AE OP* | *2.39* |
| *923851* | *AB2-025 C* | *10.36* |
| *923852* | *AB2-025 E* | *4.65* |
| *923911* | *AB2-031 C OP* | *5.09* |
| *923912* | *AB2-031 E OP* | *2.51* |
| *923941* | *AB2-035 C* | *0.4* |
| *923942* | *AB2-035 E* | *0.17* |
| *923991* | *AB2-040 C OP* | *16.73* |
| *923992* | *AB2-040 E OP* | *13.69* |
| *924021* | *AB2-043 C OP* | *2.79* |
| *924022* | *AB2-043 E OP* | *4.58* |
| *924151* | *AB2-059 C OP* | *12.83* |
| *924152* | *AB2-059 E OP* | *6.61* |
| *924301* | *AB2-077 C OP* | *1.75* |
| *924302* | *AB2-077 E OP* | *1.17* |
| *924311* | *AB2-078 C OP* | *1.75* |
| *924312* | *AB2-078 E OP* | *1.17* |
| *924321* | *AB2-079 C OP* | *1.75* |
| *924322* | *AB2-079 E OP* | *1.17* |
| *924381* | *AB2-087 C* | *0.86* |
| *924382* | *AB2-087 E* | *0.4* |
| *924391* | *AB2-088 C* | *0.52* |
| *924392* | *AB2-088 E* | *0.25* |
| *924401* | *AB2-089 C* | *2.43* |
| *924402* | *AB2-089 E* | *1.25* |
| *924411* | *AB2-090 C* | *3.52* |
| *924412* | *AB2-090 E* | *1.8* |
| *924491* | *AB2-098 C* | *0.64* |
| *924492* | *AB2-098 E* | *0.27* |
| *924501* | *AB2-099 C* | *0.84* |
| *924502* | *AB2-099 E* | *0.36* |
| *924511* | *AB2-100 C* | *31.44* |

| | | |
|---|---|---|
| *924512* | *AB2-100 E* | *15.49* |
| *924761* | *AB2-128 C* | *26.94* |
| *924762* | *AB2-128 E* | *10.61* |
| *924931* | *AB2-147 C* | *6.66* |
| *924932* | *AB2-147 E* | *10.87* |
| *924951* | *AB2-150 C OP* | *6.66* |
| *924952* | *AB2-150 E OP* | *10.87* |
| *925141* | *AB2-171 C OP* | *4.02* |
| *925142* | *AB2-171 E OP* | *6.56* |
| *925171* | *AB2-174 C OP* | *16.96* |
| *925172* | *AB2-174 E OP* | *15.34* |
| *925221* | *AB2-176 C* | *1.45* |
| *925222* | *AB2-176 E* | *0.62* |
| *925591* | *AC1-034 C OP* | *8.19* |
| *925592* | *AC1-034 E OP* | *6.18* |
| *925781* | *AC1-054 C OP* | *8.75* |
| *925782* | *AC1-054 E OP* | *4.03* |
| *926071* | *AC1-086 C* | *45.74* |
| *926072* | *AC1-086 E* | *20.82* |
| *926201* | *AC1-098 C* | *9.09* |
| *926202* | *AC1-098 E* | *5.41* |
| *926211* | *AC1-099 C* | *3.05* |
| *926212* | *AC1-099 E* | *1.79* |
| *926771* | *AC1-163 C* | *3.04* |
| *926772* | *AC1-163 E* | *1.42* |
| *927021* | *AC1-189 C* | *9.89* |
| *927022* | *AC1-189 E* | *4.93* |
| *927051* | *AC1-193 C* | *2.95* |
| *927052* | *AC1-193 E* | *4.81* |
| *927111* | *AC1-206 C OP* | *38.63* |
| *927112* | *AC1-206 E OP* | *18.26* |
| *927141* | *AC1-208 C* | *15.07* |
| *927142* | *AC1-208 E* | *6.69* |
| *927211* | *AC1-215 C* | *9.21* |
| *927212* | *AC1-215 E* | *4.17* |

# Appendix 6

(DVP - CPLE) The 6EVERETS-6GREENVILE T 230 kV line (from bus 314574 to bus 304451 ckt 1) loads from 95.13% to 98.85% (**DC power flow**) of its emergency rating (478 MVA) for the tower line contingency outage of 'LN 2058-2181'. This project contributes approximately 17.79 MW to the thermal violation.

```
CONTINGENCY 'LN 2058-2181'
  OPEN BUS 304226                                   /* ISLAND: 6PA-RMOUNT#4115.00
  OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1          /* 6PA-
RMOUNT#4230.00 - 6NASH 230.00
  OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1          /* 6HATHAWAY
230.00 - 6NASH 230.00
  OPEN BUS 314591                                   /* ISLAND: 6NASH 230.00
  OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1          /*
6ROCKYMT230T230.00 - 6HATHAWAY 230.00
  END
```

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *315292* | *1DOMTR78* | *1.8* |
| *315131* | *1EDGECMA* | *9.38* |
| *315132* | *1EDGECMB* | *9.38* |
| *315134* | *1ROAVALA* | *21.95* |
| *315135* | *1ROAVALB* | *5.85* |
| *314784* | *1WEYRHSB* | *2.76* |
| *314539* | *3UNCAMP* | *1.2* |
| *314541* | *3WATKINS* | *0.37* |
| *931631* | *AC2-084 C* | *6.26* |
| *931632* | *AC2-084 E* | *3.09* |
| *932451* | *AC2-158 C OP* | *8.9* |
| *932452* | *AC2-158 E OP* | *8.9* |
| *932461* | *AC2-159 C OP* | *6.48* |
| *932462* | *AC2-159 E OP* | *6.48* |
| *932521* | *AC2-167 C* | *2.02* |
| *932522* | *AC2-167 E* | *3.29* |
| *932711* | *AC2-194 C* | *0.59* |
| *932712* | *AC2-194 E* | *0.95* |
| *900672* | *V4-068 E* | *0.21* |
| *901082* | *W1-029 E* | *22.99* |
| *907092* | *X1-038 E* | *2.99* |

| | | |
|---|---|---|
| *913392* | *Y1-086 E* | *1.04* |
| *916042* | *Z1-036 E* | *30.03* |
| *917122* | *Z2-027 E* | *0.5* |
| *917331* | *Z2-043 C* | *0.33* |
| *917332* | *Z2-043 E* | *0.87* |
| *917342* | *Z2-044 E* | *0.33* |
| *917511* | *Z2-088 C OP1* | *1.47* |
| *917512* | *Z2-088 E OP1* | *14.69* |
| *917592* | *Z2-099 E* | *0.27* |
| *918411* | *AA1-050* | *1.24* |
| *921162* | *AA1-063AC* | *5.22* |
| *921163* | *AA1-063AE* | *2.46* |
| *918511* | *AA1-065 C OP* | *1.63* |
| *918512* | *AA1-065 E OP* | *4.91* |
| *921182* | *AA1-067 C* | *3.8* |
| *921183* | *AA1-067 E* | *1.63* |
| *918561* | *AA1-072 C* | *0.05* |
| *918562* | *AA1-072 E* | *0.15* |
| *921562* | *AA1-135 C* | *15.33* |
| *921563* | *AA1-135 E* | *6.57* |
| *921572* | *AA1-138 C* | *5.83* |
| *921573* | *AA1-138 E* | *2.5* |
| *921752* | *AA2-053 C* | *6.11* |
| *921753* | *AA2-053 E* | *2.62* |
| *921762* | *AA2-057 C* | *4.37* |
| *921763* | *AA2-057 E* | *2.19* |
| *921772* | *AA2-059 C* | *0.87* |
| *921773* | *AA2-059 E* | *0.41* |
| *921862* | *AA2-068 C* | *1.45* |
| *921863* | *AA2-068 E* | *0.67* |
| *920022* | *AA2-086 E* | *0.14* |
| *921982* | *AA2-088 C* | *3.87* |
| *921983* | *AA2-088 E* | *6.32* |
| *922442* | *AA2-165 C* | *0.6* |
| *922443* | *AA2-165 E* | *0.29* |
| *922512* | *AA2-174 C* | *0.28* |
| *922513* | *AA2-174 E* | *0.3* |
| *922532* | *AA2-178 C* | *8.57* |
| *922533* | *AA2-178 E* | *3.67* |

| | | |
|---|---|---|
| *922602* | *AB1-013 C* | *2.59* |
| *922603* | *AB1-013 E* | *17.3* |
| *922922* | *AB1-081 C OP* | *5.72* |
| *922923* | *AB1-081 E OP* | *2.45* |
| *923262* | *AB1-132 C OP* | *10.48* |
| *923263* | *AB1-132 E OP* | *4.49* |
| *923572* | *AB1-173 C OP* | *1.22* |
| *923573* | *AB1-173 E OP* | *0.57* |
| *923582* | *AB1-173AC OP* | *1.22* |
| *923583* | *AB1-173AE OP* | *0.57* |
| *923801* | *AB2-015 C OP* | *4.44* |
| *923802* | *AB2-015 E OP* | *3.64* |
| *923831* | *AB2-022 C* | *1.01* |
| *923832* | *AB2-022 E* | *0.54* |
| *923911* | *AB2-031 C OP* | *1.21* |
| *923912* | *AB2-031 E OP* | *0.6* |
| *923941* | *AB2-035 C* | *0.48* |
| *923942* | *AB2-035 E* | *0.21* |
| *923991* | *AB2-040 C OP* | *3.97* |
| *923992* | *AB2-040 E OP* | *3.25* |
| *924151* | *AB2-059 C OP* | *6.74* |
| *924152* | *AB2-059 E OP* | *3.47* |
| *924381* | *AB2-087 C* | *0.56* |
| *924382* | *AB2-087 E* | *0.26* |
| *924391* | *AB2-088 C* | *0.62* |
| *924392* | *AB2-088 E* | *0.3* |
| *924491* | *AB2-098 C* | *1.27* |
| *924492* | *AB2-098 E* | *0.54* |
| *924501* | *AB2-099 C* | *0.54* |
| *924502* | *AB2-099 E* | *0.23* |
| *924511* | *AB2-100 C* | *7.* |
| *924512* | *AB2-100 E* | *3.45* |
| *924761* | *AB2-128 C* | *5.99* |
| *924762* | *AB2-128 E* | *2.36* |
| *924931* | *AB2-147 C* | *1.2* |
| *924932* | *AB2-147 E* | *1.96* |
| *924951* | *AB2-150 C OP* | *1.2* |
| *924952* | *AB2-150 E OP* | *1.96* |
| *925121* | *AB2-169 C OP* | *9.9* |

| | | |
|---|---|---|
| *925122* | *AB2-169 E OP* | *8.88* |
| *925141* | *AB2-171 C OP* | *2.67* |
| *925142* | *AB2-171 E OP* | *4.35* |
| *925171* | *AB2-174 C OP* | *3.65* |
| *925172* | *AB2-174 E OP* | *3.3* |
| *925281* | *AB2-186 C* | *0.36* |
| *925282* | *AB2-186 E* | *0.15* |
| *925291* | *AB2-188 C OP* | *2.11* |
| *925292* | *AB2-188 E OP* | *0.95* |
| *925591* | *AC1-034 C OP* | *9.87* |
| *925592* | *AC1-034 E OP* | *7.44* |
| *926071* | *AC1-086 C* | *15.44* |
| *926072* | *AC1-086 E* | *7.03* |
| *926201* | *AC1-098 C* | *4.39* |
| *926202* | *AC1-098 E* | *2.62* |
| *926211* | *AC1-099 C* | *1.47* |
| *926212* | *AC1-099 E* | *0.86* |
| *LTF* | *AC1-133* | *21.95* |
| *926771* | *AC1-163 C* | *1.93* |
| *926772* | *AC1-163 E* | *0.9* |
| *927021* | *AC1-189 C* | *17.56* |
| *927022* | *AC1-189 E* | *8.75* |
| *927051* | *AC1-193 C* | *1.96* |
| *927052* | *AC1-193 E* | *3.19* |
| *927111* | *AC1-206 C OP* | *5.7* |
| *927112* | *AC1-206 E OP* | *2.7* |
| *927141* | *AC1-208 C* | *8.04* |
| *927142* | *AC1-208 E* | *3.57* |

# Appendix 7

(DVP - CPLE) The 3BTLEBRO-3ROCKYMT115T 115 kV line (from bus 314554 to bus 304223 ckt 1) loads from 200.83% to 202.12% (**DC power flow**) of its emergency rating (164 MVA) for the tower line contingency outage of 'LN 2058-2181'. This project contributes approximately 4.69 MW to the thermal violation.

CONTINGENCY 'LN 2058-2181'
OPEN BUS 304226 /* ISLAND: 6PA-RMOUNT#4115.00
OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 6PA-RMOUNT#4230.00 - 6NASH 230.00
OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 6HATHAWAY 230.00 - 6NASH 230.00
OPEN BUS 314591 /* ISLAND: 6NASH 230.00
OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /* 6ROCKYMT230T230.00 - 6HATHAWAY 230.00
END

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *315131* | *1EDGECMA* | *13.46* |
| *315132* | *1EDGECMB* | *13.46* |
| *315139* | *1GASTONA* | *2.09* |
| *315141* | *1GASTONB* | *2.09* |
| *315126* | *1ROARAP2* | *0.87* |
| *315128* | *1ROARAP4* | *0.84* |
| *315134* | *1ROAVALA* | *18.11* |
| *315135* | *1ROAVALB* | *4.83* |
| *315136* | *1ROSEMG1* | *1.69* |
| *315138* | *1ROSEMG2* | *0.79* |
| *315137* | *1ROSEMS1* | *1.05* |
| *314541* | *3WATKINS* | *0.26* |
| *931631* | *AC2-084 C* | *11.41* |
| *931632* | *AC2-084 E* | *5.62* |
| *932451* | *AC2-158 C OP* | *2.35* |
| *932452* | *AC2-158 E OP* | *2.35* |
| *932461* | *AC2-159 C OP* | *3.62* |
| *932462* | *AC2-159 E OP* | *3.62* |
| *932521* | *AC2-167 C* | *1.51* |
| *932522* | *AC2-167 E* | *2.46* |
| *900672* | *V4-068 E* | *0.15* |

| | | |
|---|---|---|
| *917331* | *Z2-043 C* | *0.32* |
| *917332* | *Z2-043 E* | *0.83* |
| *917341* | *Z2-044 C* | *0.48* |
| *917342* | *Z2-044 E* | *1.25* |
| *917511* | *Z2-088 C OP1* | *0.61* |
| *917512* | *Z2-088 E OP1* | *6.1* |
| *917592* | *Z2-099 E* | *0.2* |
| *918411* | *AA1-050* | *0.52* |
| *LTF* | *AA1-055* | *9.27* |
| *921162* | *AA1-063AC* | *4.89* |
| *921163* | *AA1-063AE* | *2.3* |
| *918512* | *AA1-065 E OP* | *1.96* |
| *921182* | *AA1-067 C* | *0.74* |
| *921183* | *AA1-067 E* | *0.32* |
| *918561* | *AA1-072 C* | *0.05* |
| *918562* | *AA1-072 E* | *0.14* |
| *921562* | *AA1-135 C* | *4.04* |
| *921563* | *AA1-135 E* | *1.73* |
| *921752* | *AA2-053 C* | *5.43* |
| *921753* | *AA2-053 E* | *2.33* |
| *921762* | *AA2-057 C* | *12.89* |
| *921763* | *AA2-057 E* | *6.45* |
| *921862* | *AA2-068 C* | *3.3* |
| *921863* | *AA2-068 E* | *1.52* |
| *920022* | *AA2-086 E* | *0.11* |
| *921982* | *AA2-088 C* | *2.95* |
| *921983* | *AA2-088 E* | *4.81* |
| *922442* | *AA2-165 C* | *1.76* |
| *922443* | *AA2-165 E* | *0.85* |
| *922512* | *AA2-174 C* | *0.25* |
| *922513* | *AA2-174 E* | *0.27* |
| *922922* | *AB1-081 C OP* | *20.09* |
| *922923* | *AB1-081 E OP* | *8.61* |
| *923262* | *AB1-132 C OP* | *9.77* |
| *923263* | *AB1-132 E OP* | *4.19* |
| *923572* | *AB1-173 C OP* | *1.21* |
| *923573* | *AB1-173 E OP* | *0.57* |
| *923582* | *AB1-173AC OP* | *1.21* |
| *923583* | *AB1-173AE OP* | *0.57* |

| | | |
|---|---|---|
| *923911* | *AB2-031 C OP* | *1.21* |
| *923912* | *AB2-031 E OP* | *0.59* |
| *923941* | *AB2-035 C* | *0.37* |
| *923942* | *AB2-035 E* | *0.16* |
| *923991* | *AB2-040 C OP* | *3.96* |
| *923992* | *AB2-040 E OP* | *3.24* |
| *924151* | *AB2-059 C OP* | *23.67* |
| *924152* | *AB2-059 E OP* | *12.19* |
| *924381* | *AB2-087 C* | *0.32* |
| *924382* | *AB2-087 E* | *0.15* |
| *924391* | *AB2-088 C* | *0.48* |
| *924392* | *AB2-088 E* | *0.23* |
| *924491* | *AB2-098 C* | *0.25* |
| *924492* | *AB2-098 E* | *0.11* |
| *924501* | *AB2-099 C* | *0.32* |
| *924502* | *AB2-099 E* | *0.14* |
| *924511* | *AB2-100 C* | *6.42* |
| *924512* | *AB2-100 E* | *3.16* |
| *924761* | *AB2-128 C* | *5.5* |
| *924762* | *AB2-128 E* | *2.17* |
| *924931* | *AB2-147 C* | *1.15* |
| *924932* | *AB2-147 E* | *1.87* |
| *924951* | *AB2-150 C OP* | *1.15* |
| *924952* | *AB2-150 E OP* | *1.87* |
| *925121* | *AB2-169 C OP* | *2.49* |
| *925122* | *AB2-169 E OP* | *2.23* |
| *925141* | *AB2-171 C OP* | *1.93* |
| *925142* | *AB2-171 E OP* | *3.15* |
| *925171* | *AB2-174 C OP* | *3.58* |
| *925172* | *AB2-174 E OP* | *3.24* |
| *925591* | *AC1-034 C OP* | *7.52* |
| *925592* | *AC1-034 E OP* | *5.68* |
| *926071* | *AC1-086 C* | *14.39* |
| *926072* | *AC1-086 E* | *6.55* |
| *926201* | *AC1-098 C* | *8.* |
| *926202* | *AC1-098 E* | *4.77* |
| *926211* | *AC1-099 C* | *2.68* |
| *926212* | *AC1-099 E* | *1.58* |
| *LTF* | *AC1-133* | *9.11* |

| | | |
|---|---|---|
| *926771* | *AC1-163 C* | *1.14* |
| *926772* | *AC1-163 E* | *0.53* |
| *927021* | *AC1-189 C* | *5.16* |
| *927022* | *AC1-189 E* | *2.57* |
| *927051* | *AC1-193 C* | *1.42* |
| *927052* | *AC1-193 E* | *2.31* |
| *927111* | *AC1-206 C OP* | *5.12* |
| *927112* | *AC1-206 E OP* | *2.42* |
| *927141* | *AC1-208 C* | *10.07* |
| *927142* | *AC1-208 E* | *4.47* |

# Appendix 8

(DVP - DVP) The 6CLUBHSE-6SAPONY 230 kV line (from bus 314563 to bus 314435 ckt 1) loads from 126.04% to 128.28% (**DC power flow**) of its load dump rating (637 MVA) for the line fault with failed breaker contingency outage of '246T2034_A'. This project contributes approximately 14.31 MW to the thermal violation.

```
CONTINGENCY '246T2034_A'                                    /* EARLEYS
  OPEN BRANCH FROM BUS 314569 TO BUS 314575 CKT 1           /* 246
  OPEN BRANCH FROM BUS 314575 TO BUS 921571 CKT 1           /* 246 AA1-138
TAP
  OPEN BRANCH FROM BUS 314575 TO BUS 314590 CKT 1           /* 246 - NUCOR
  OPEN BRANCH FROM BUS 314569 TO BUS 314620 CKT 1           /* 2034
  OPEN BRANCH FROM BUS 314620 TO BUS 314616 CKT 1           /* 2034
  OPEN BRANCH FROM BUS 314616 TO BUS 314613 CKT 1           /* TROWBRIDGE
TX #1&2
  END
```

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *315131* | *1EDGECMA* | *11.38* |
| *315132* | *1EDGECMB* | *11.38* |
| *315139* | *1GASTONA* | *6.65* |
| *315141* | *1GASTONB* | *6.65* |
| *315126* | *1ROARAP2* | *2.41* |
| *315128* | *1ROARAP4* | *2.31* |
| *315134* | *1ROAVALA* | *57.8* |
| *315135* | *1ROAVALB* | *15.41* |
| *315136* | *1ROSEMG1* | *4.49* |
| *315138* | *1ROSEMG2* | *2.1* |
| *315137* | *1ROSEMS1* | *2.78* |
| *314704* | *3LAWRENC* | *0.7* |
| *314541* | *3WATKINS* | *0.52* |
| *931631* | *AC2-084 C* | *12.95* |
| *931632* | *AC2-084 E* | *6.38* |
| *932451* | *AC2-158 C OP* | *7.16* |
| *932452* | *AC2-158 E OP* | *7.16* |
| *932461* | *AC2-159 C OP* | *11.98* |
| *932462* | *AC2-159 E OP* | *11.98* |
| *932521* | *AC2-167 C* | *3.6* |
| *932522* | *AC2-167 E* | *5.87* |

| | | |
|---|---|---|
| *900671* | *V4-068 C* | *0.11* |
| *900672* | *V4-068 E* | *0.36* |
| *917331* | *Z2-043 C* | *0.57* |
| *917332* | *Z2-043 E* | *1.49* |
| *917341* | *Z2-044 C* | *0.28* |
| *917342* | *Z2-044 E* | *0.75* |
| *917511* | *Z2-088 C OP1* | *0.93* |
| *917512* | *Z2-088 E OP1* | *9.3* |
| *917591* | *Z2-099 C* | *0.18* |
| *917592* | *Z2-099 E* | *0.48* |
| *918411* | *AA1-050* | *0.78* |
| *LTF* | *AA1-058* | *0.57* |
| *921162* | *AA1-063AC* | *12.89* |
| *921163* | *AA1-063AE* | *6.08* |
| *918511* | *AA1-065 C OP* | *2.25* |
| *918512* | *AA1-065 E OP* | *6.79* |
| *921182* | *AA1-067 C* | *1.92* |
| *921183* | *AA1-067 E* | *0.82* |
| *918561* | *AA1-072 C* | *0.09* |
| *918562* | *AA1-072 E* | *0.25* |
| *921562* | *AA1-135 C* | *12.33* |
| *921563* | *AA1-135 E* | *5.29* |
| *921752* | *AA2-053 C* | *14.98* |
| *921753* | *AA2-053 E* | *6.43* |
| *921762* | *AA2-057 C* | *9.84* |
| *921763* | *AA2-057 E* | *4.92* |
| *921862* | *AA2-068 C* | *3.28* |
| *921863* | *AA2-068 E* | *1.51* |
| *LTF* | *AA2-074* | *2.67* |
| *920021* | *AA2-086 C* | *0.09* |
| *920022* | *AA2-086 E* | *0.26* |
| *921982* | *AA2-088 C* | *6.87* |
| *921983* | *AA2-088 E* | *11.21* |
| *922442* | *AA2-165 C* | *1.34* |
| *922443* | *AA2-165 E* | *0.65* |
| *922472* | *AA2-169 C* | *2.97* |
| *922473* | *AA2-169 E* | *1.36* |
| *922512* | *AA2-174 C* | *0.69* |
| *922513* | *AA2-174 E* | *0.74* |

| | | |
|---|---|---|
| *922922* | *AB1-081 C OP* | *10.89* |
| *922923* | *AB1-081 E OP* | *4.67* |
| *923262* | *AB1-132 C OP* | *31.06* |
| *923263* | *AB1-132 E OP* | *13.31* |
| *923572* | *AB1-173 C OP* | *5.13* |
| *923573* | *AB1-173 E OP* | *2.39* |
| *923582* | *AB1-173AC OP* | *5.13* |
| *923583* | *AB1-173AE OP* | *2.39* |
| *923911* | *AB2-031 C OP* | *5.09* |
| *923912* | *AB2-031 E OP* | *2.51* |
| *923941* | *AB2-035 C* | *0.4* |
| *923942* | *AB2-035 E* | *0.17* |
| *923991* | *AB2-040 C OP* | *16.73* |
| *923992* | *AB2-040 E OP* | *13.69* |
| *924021* | *AB2-043 C OP* | *2.79* |
| *924022* | *AB2-043 E OP* | *4.58* |
| *924151* | *AB2-059 C OP* | *12.83* |
| *924152* | *AB2-059 E OP* | *6.61* |
| *924301* | *AB2-077 C OP* | *1.75* |
| *924302* | *AB2-077 E OP* | *1.17* |
| *924311* | *AB2-078 C OP* | *1.75* |
| *924312* | *AB2-078 E OP* | *1.17* |
| *924321* | *AB2-079 C OP* | *1.75* |
| *924322* | *AB2-079 E OP* | *1.17* |
| *924381* | *AB2-087 C* | *0.86* |
| *924382* | *AB2-087 E* | *0.4* |
| *924391* | *AB2-088 C* | *0.52* |
| *924392* | *AB2-088 E* | *0.25* |
| *924401* | *AB2-089 C* | *2.43* |
| *924402* | *AB2-089 E* | *1.25* |
| *924411* | *AB2-090 C* | *3.52* |
| *924412* | *AB2-090 E* | *1.8* |
| *924491* | *AB2-098 C* | *0.64* |
| *924492* | *AB2-098 E* | *0.27* |
| *924501* | *AB2-099 C* | *0.84* |
| *924502* | *AB2-099 E* | *0.36* |
| *924511* | *AB2-100 C* | *31.44* |
| *924512* | *AB2-100 E* | *15.49* |
| *924761* | *AB2-128 C* | *26.94* |

| | | |
|---|---|---|
| *924762* | *AB2-128 E* | *10.61* |
| *924931* | *AB2-147 C* | *6.66* |
| *924932* | *AB2-147 E* | *10.87* |
| *924951* | *AB2-150 C OP* | *6.66* |
| *924952* | *AB2-150 E OP* | *10.87* |
| *925141* | *AB2-171 C OP* | *4.02* |
| *925142* | *AB2-171 E OP* | *6.56* |
| *925171* | *AB2-174 C OP* | *16.96* |
| *925172* | *AB2-174 E OP* | *15.34* |
| *925221* | *AB2-176 C* | *1.45* |
| *925222* | *AB2-176 E* | *0.62* |
| *925591* | *AC1-034 C OP* | *8.19* |
| *925592* | *AC1-034 E OP* | *6.18* |
| *925781* | *AC1-054 C OP* | *8.75* |
| *925782* | *AC1-054 E OP* | *4.03* |
| *926071* | *AC1-086 C* | *45.74* |
| *926072* | *AC1-086 E* | *20.82* |
| *926201* | *AC1-098 C* | *9.09* |
| *926202* | *AC1-098 E* | *5.41* |
| *926211* | *AC1-099 C* | *3.05* |
| *926212* | *AC1-099 E* | *1.79* |
| *926771* | *AC1-163 C* | *3.04* |
| *926772* | *AC1-163 E* | *1.42* |
| *927021* | *AC1-189 C* | *9.89* |
| *927022* | *AC1-189 E* | *4.93* |
| *927051* | *AC1-193 C* | *2.95* |
| *927052* | *AC1-193 E* | *4.81* |
| *927111* | *AC1-206 C OP* | *38.63* |
| *927112* | *AC1-206 E OP* | *18.26* |
| *927141* | *AC1-208 C* | *15.07* |
| *927142* | *AC1-208 E* | *6.69* |
| *927211* | *AC1-215 C* | *9.21* |
| *927212* | *AC1-215 E* | *4.17* |

# Appendix 9

(DVP - DVP) The 6LAKEVEW-AB2-100 TAP 230 kV line (from bus 314583 to bus 924510 ckt 1) loads from 108.03% to 110.99% (**DC power flow**) of its load dump rating (459 MVA) for the line fault with failed breaker contingency outage of '246T2034_A'. This project contributes approximately 13.61 MW to the thermal violation.

```
CONTINGENCY '246T2034_A'                                    /* EARLEYS
  OPEN BRANCH FROM BUS 314569 TO BUS 314575 CKT 1           /* 246
  OPEN BRANCH FROM BUS 314575 TO BUS 921571 CKT 1           /* 246 AA1-138
TAP
  OPEN BRANCH FROM BUS 314575 TO BUS 314590 CKT 1           /* 246 - NUCOR
  OPEN BRANCH FROM BUS 314569 TO BUS 314620 CKT 1           /* 2034
  OPEN BRANCH FROM BUS 314620 TO BUS 314616 CKT 1           /* 2034
  OPEN BRANCH FROM BUS 314616 TO BUS 314613 CKT 1           /* TROWBRIDGE
TX #1&2
  END
```

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *315131* | *1EDGECMA* | *11.* |
| *315132* | *1EDGECMB* | *11.* |
| *315139* | *1GASTONA* | *6.92* |
| *315141* | *1GASTONB* | *6.92* |
| *315126* | *1ROARAP2* | *1.48* |
| *315128* | *1ROARAP4* | *1.43* |
| *315134* | *1ROAVALA* | *58.79* |
| *315135* | *1ROAVALB* | *15.68* |
| *315136* | *1ROSEMG1* | *4.65* |
| *315138* | *1ROSEMG2* | *2.18* |
| *315137* | *1ROSEMS1* | *2.88* |
| *314784* | *1WEYRHSB* | *1.18* |
| *314541* | *3WATKINS* | *0.36* |
| *931631* | *AC2-084 C* | *10.43* |
| *931632* | *AC2-084 E* | *5.14* |
| *932451* | *AC2-158 C OP* | *6.8* |
| *932452* | *AC2-158 E OP* | *6.8* |
| *932461* | *AC2-159 C OP* | *11.81* |
| *932462* | *AC2-159 E OP* | *11.81* |
| *932521* | *AC2-167 C* | *2.55* |
| *932522* | *AC2-167 E* | *4.16* |

| | | |
|---|---|---|
| *900671* | *V4-068 C* | *0.08* |
| *900672* | *V4-068 E* | *0.28* |
| *917331* | *Z2-043 C* | *0.49* |
| *917332* | *Z2-043 E* | *1.27* |
| *917341* | *Z2-044 C* | *0.25* |
| *917342* | *Z2-044 E* | *0.65* |
| *917511* | *Z2-088 C OP1* | *0.89* |
| *917512* | *Z2-088 E OP1* | *8.9* |
| *917591* | *Z2-099 C* | *0.12* |
| *917592* | *Z2-099 E* | *0.34* |
| *918411* | *AA1-050* | *0.75* |
| *LTF* | *AA1-058* | *0.53* |
| *921162* | *AA1-063AC* | *8.24* |
| *921163* | *AA1-063AE* | *3.88* |
| *918511* | *AA1-065 C OP* | *2.14* |
| *918512* | *AA1-065 E OP* | *6.45* |
| *921182* | *AA1-067 C* | *1.83* |
| *921183* | *AA1-067 E* | *0.78* |
| *918561* | *AA1-072 C* | *0.07* |
| *918562* | *AA1-072 E* | *0.21* |
| *921562* | *AA1-135 C* | *11.73* |
| *921563* | *AA1-135 E* | *5.03* |
| *921752* | *AA2-053 C* | *10.06* |
| *921753* | *AA2-053 E* | *4.32* |
| *921762* | *AA2-057 C* | *8.12* |
| *921763* | *AA2-057 E* | *4.06* |
| *921862* | *AA2-068 C* | *2.57* |
| *921863* | *AA2-068 E* | *1.18* |
| *LTF* | *AA2-074* | *2.31* |
| *920021* | *AA2-086 C* | *0.07* |
| *920022* | *AA2-086 E* | *0.18* |
| *921982* | *AA2-088 C* | *4.78* |
| *921983* | *AA2-088 E* | *7.79* |
| *922442* | *AA2-165 C* | *1.11* |
| *922443* | *AA2-165 E* | *0.54* |
| *922472* | *AA2-169 C* | *1.51* |
| *922473* | *AA2-169 E* | *0.7* |
| *922512* | *AA2-174 C* | *0.46* |
| *922513* | *AA2-174 E* | *0.5* |

| | | |
|---|---|---|
| *922922* | *AB1-081 C OP* | *10.12* |
| *922923* | *AB1-081 E OP* | *4.34* |
| *923262* | *AB1-132 C OP* | *32.32* |
| *923263* | *AB1-132 E OP* | *13.85* |
| *923941* | *AB2-035 C* | *0.39* |
| *923942* | *AB2-035 E* | *0.17* |
| *924151* | *AB2-059 C OP* | *11.92* |
| *924152* | *AB2-059 E OP* | *6.14* |
| *924381* | *AB2-087 C* | *0.76* |
| *924382* | *AB2-087 E* | *0.36* |
| *924391* | *AB2-088 C* | *0.5* |
| *924392* | *AB2-088 E* | *0.24* |
| *924491* | *AB2-098 C* | *0.61* |
| *924492* | *AB2-098 E* | *0.26* |
| *924501* | *AB2-099 C* | *0.73* |
| *924502* | *AB2-099 E* | *0.31* |
| *925121* | *AB2-169 C OP* | *4.44* |
| *925122* | *AB2-169 E OP* | *3.98* |
| *925141* | *AB2-171 C OP* | *2.79* |
| *925142* | *AB2-171 E OP* | *4.55* |
| *925591* | *AC1-034 C OP* | *7.88* |
| *925592* | *AC1-034 E OP* | *5.95* |
| *925781* | *AC1-054 C OP* | *4.12* |
| *925782* | *AC1-054 E OP* | *1.9* |
| *926071* | *AC1-086 C* | *47.59* |
| *926072* | *AC1-086 E* | *21.66* |
| *926201* | *AC1-098 C* | *7.31* |
| *926202* | *AC1-098 E* | *4.36* |
| *926211* | *AC1-099 C* | *2.45* |
| *926212* | *AC1-099 E* | *1.44* |
| *926771* | *AC1-163 C* | *2.61* |
| *926772* | *AC1-163 E* | *1.22* |
| *927021* | *AC1-189 C* | *9.45* |
| *927022* | *AC1-189 E* | *4.71* |
| *927051* | *AC1-193 C* | *2.04* |
| *927052* | *AC1-193 E* | *3.34* |
| *927141* | *AC1-208 C* | *15.22* |
| *927142* | *AC1-208 E* | *6.76* |

# Appendix 10

(DVP - DVP) The AB2-100 TAP-6CLUBHSE 230 kV line (from bus 924510 to bus 314563 ckt 1) loads from 128.82% to 131.78% (**DC power flow**) of its load dump rating (459 MVA) for the line fault with failed breaker contingency outage of '246T2034_A'. This project contributes approximately 13.61 MW to the thermal violation.

```
CONTINGENCY '246T2034_A'                                    /* EARLEYS
  OPEN BRANCH FROM BUS 314569 TO BUS 314575 CKT 1           /* 246
  OPEN BRANCH FROM BUS 314575 TO BUS 921571 CKT 1           /* 246 AA1-138
TAP
  OPEN BRANCH FROM BUS 314575 TO BUS 314590 CKT 1           /* 246 - NUCOR
  OPEN BRANCH FROM BUS 314569 TO BUS 314620 CKT 1           /* 2034
  OPEN BRANCH FROM BUS 314620 TO BUS 314616 CKT 1           /* 2034
  OPEN BRANCH FROM BUS 314616 TO BUS 314613 CKT 1           /* TROWBRIDGE
TX #1&2
  END
```

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *315131* | *1EDGECMA* | *11.* |
| *315132* | *1EDGECMB* | *11.* |
| *315139* | *1GASTONA* | *6.92* |
| *315141* | *1GASTONB* | *6.92* |
| *315126* | *1ROARAP2* | *1.48* |
| *315128* | *1ROARAP4* | *1.43* |
| *315134* | *1ROAVALA* | *58.79* |
| *315135* | *1ROAVALB* | *15.68* |
| *315136* | *1ROSEMG1* | *4.65* |
| *315138* | *1ROSEMG2* | *2.18* |
| *315137* | *1ROSEMS1* | *2.88* |
| *314784* | *1WEYRHSB* | *1.18* |
| *931631* | *AC2-084 C* | *10.43* |
| *931632* | *AC2-084 E* | *5.14* |
| *932451* | *AC2-158 C OP* | *6.8* |
| *932452* | *AC2-158 E OP* | *6.8* |
| *932461* | *AC2-159 C OP* | *11.81* |
| *932462* | *AC2-159 E OP* | *11.81* |
| *932521* | *AC2-167 C* | *2.55* |
| *932522* | *AC2-167 E* | *4.16* |
| *900671* | *V4-068 C* | *0.08* |

| | | |
|---|---|---|
| *900672* | *V4-068 E* | *0.28* |
| *917331* | *Z2-043 C* | *0.49* |
| *917332* | *Z2-043 E* | *1.27* |
| *917341* | *Z2-044 C* | *0.25* |
| *917342* | *Z2-044 E* | *0.65* |
| *917511* | *Z2-088 C OP1* | *0.89* |
| *917512* | *Z2-088 E OP1* | *8.9* |
| *917591* | *Z2-099 C* | *0.12* |
| *917592* | *Z2-099 E* | *0.34* |
| *918411* | *AA1-050* | *0.75* |
| *LTF* | *AA1-058* | *0.53* |
| *921162* | *AA1-063AC* | *8.24* |
| *921163* | *AA1-063AE* | *3.88* |
| *918511* | *AA1-065 C OP* | *2.14* |
| *918512* | *AA1-065 E OP* | *6.45* |
| *921182* | *AA1-067 C* | *1.83* |
| *921183* | *AA1-067 E* | *0.78* |
| *918561* | *AA1-072 C* | *0.07* |
| *918562* | *AA1-072 E* | *0.21* |
| *921562* | *AA1-135 C* | *11.73* |
| *921563* | *AA1-135 E* | *5.03* |
| *921752* | *AA2-053 C* | *10.06* |
| *921753* | *AA2-053 E* | *4.32* |
| *921762* | *AA2-057 C* | *8.12* |
| *921763* | *AA2-057 E* | *4.06* |
| *921862* | *AA2-068 C* | *2.57* |
| *921863* | *AA2-068 E* | *1.18* |
| *LTF* | *AA2-074* | *2.31* |
| *920021* | *AA2-086 C* | *0.07* |
| *920022* | *AA2-086 E* | *0.18* |
| *921982* | *AA2-088 C* | *4.78* |
| *921983* | *AA2-088 E* | *7.79* |
| *922442* | *AA2-165 C* | *1.11* |
| *922443* | *AA2-165 E* | *0.54* |
| *922472* | *AA2-169 C* | *1.51* |
| *922473* | *AA2-169 E* | *0.7* |
| *922512* | *AA2-174 C* | *0.46* |
| *922513* | *AA2-174 E* | *0.5* |
| *922922* | *AB1-081 C OP* | *10.12* |

| | | |
|---|---|---|
| *922923* | *AB1-081 E OP* | *4.34* |
| *923262* | *AB1-132 C OP* | *32.32* |
| *923263* | *AB1-132 E OP* | *13.85* |
| *923941* | *AB2-035 C* | *0.39* |
| *923942* | *AB2-035 E* | *0.17* |
| *924151* | *AB2-059 C OP* | *11.92* |
| *924152* | *AB2-059 E OP* | *6.14* |
| *924381* | *AB2-087 C* | *0.76* |
| *924382* | *AB2-087 E* | *0.36* |
| *924391* | *AB2-088 C* | *0.5* |
| *924392* | *AB2-088 E* | *0.24* |
| *924491* | *AB2-098 C* | *0.61* |
| *924492* | *AB2-098 E* | *0.26* |
| *924501* | *AB2-099 C* | *0.73* |
| *924502* | *AB2-099 E* | *0.31* |
| *924511* | *AB2-100 C* | *35.67* |
| *924512* | *AB2-100 E* | *17.57* |
| *924761* | *AB2-128 C* | *30.56* |
| *924762* | *AB2-128 E* | *12.03* |
| *925121* | *AB2-169 C OP* | *4.44* |
| *925122* | *AB2-169 E OP* | *3.98* |
| *925141* | *AB2-171 C OP* | *2.79* |
| *925142* | *AB2-171 E OP* | *4.55* |
| *925591* | *AC1-034 C OP* | *7.88* |
| *925592* | *AC1-034 E OP* | *5.95* |
| *925781* | *AC1-054 C OP* | *4.12* |
| *925782* | *AC1-054 E OP* | *1.9* |
| *926071* | *AC1-086 C* | *47.59* |
| *926072* | *AC1-086 E* | *21.66* |
| *926201* | *AC1-098 C* | *7.31* |
| *926202* | *AC1-098 E* | *4.36* |
| *926211* | *AC1-099 C* | *2.45* |
| *926212* | *AC1-099 E* | *1.44* |
| *926771* | *AC1-163 C* | *2.61* |
| *926772* | *AC1-163 E* | *1.22* |
| *927021* | *AC1-189 C* | *9.45* |
| *927022* | *AC1-189 E* | *4.71* |
| *927051* | *AC1-193 C* | *2.04* |
| *927052* | *AC1-193 E* | *3.34* |

| | | |
|---|---|---|
| *927141* | *AC1-208 C* | *15.22* |
| *927142* | *AC1-208 E* | *6.76* |