PJM Generator Interconnection

X2-082 Chesterfield 500 kV

1420 MW Capacity / 1575 MW Energy

Feasibility Study Report

December 2011
DMS #670437v1

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 Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Virginia Electric and Power Company.

Preface

The intent of this Feasibility Study is to determine a plan, with preliminary cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by IC. As a requirement for interconnection, IC may be responsible for the cost of constructing Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM and the underlying system. All facilities required for interconnection of a generation interconnection project must be designed to meet ITO technical specifications.

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. IC is responsible for its right of way, real estate, and construction permit issues.

General

Queue project X2-082 was studied as a 1575 MW (1420 MW of which was Capacity) injection into Dominion's portion of the Carson – Wake 500 kV line. Project X2-082 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

At the request of IC, this project had a primary, 500 kV, and secondary, 230 kV, interconnection request. The primary would be the Elmont to Surry 500 kV line. The secondary would be both of the Chesterfield 230 kV buses.

Network Impacts

Secondary Option: 230 kV

Generator Deliverability

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

1) (DVP) The Chesterfield 230 kV 2-Basin 230 kV 230 kV line (from bus 314287 to bus 314276 ckt 1) loads from 58.07% to 113.65% (DC power flow) of its emergency rating (470 MVA) for the single contingency 'LN 217'. This project contributes approximately 283.36 MW to the thermal violation.

```
CONTINGENCY 'LN 217'     /*, CHESTERFIELD-LAKESIDE & LAKESIDE TX #6
  OPEN BRANCH FROM BUS 314225 TO BUS 314227 CKT 1          /*LAKESIDE CHARLES CITY
  OPEN BRANCH FROM BUS 314225 TO BUS 314228 CKT 1          /*CHARLES CITY MESSER RD
  OPEN BRANCH FROM BUS 314228 TO BUS 314287 CKT 1          /*MESSER RD CHESTB
  OPEN BRANCH FROM BUS 314227 TO BUS 314226 CKT 1          /*LAKESIDE 230-115 #5
END
```

It is estimated to cost $24,000,000 to resolve this deficiency.

2) (DVP) The Chesterfield 230 kV 2-Tyler 230 kV 230 kV line (from bus 314287 to bus 314346 ckt 1) loads from 67.86% to 100.83% (DC power flow) of its emergency rating (478 MVA) for the single contingency 'LN 2003'. This project contributes approximately 186.34 MW to the thermal violation.

```
CONTINGENCY 'LN 2003'     /*, CHESTER POE
  OPEN BRANCH FROM BUS 314287 TO BUS 314299 CKT 1          /* CHESTER HARROGATE
  OPEN BRANCH FROM BUS 314299 TO BUS 314331 CKT 1          /* HARROGATE POE
END
```

It is estimated to cost $5,000,000 to resolve this deficiency.

3) (DVP) The Charles City Road 230 KV-Lakeside 230 kV 230 kV line (from bus 314225 to bus 314227 ckt 1) loads from 62.42% to 113.65% (DC power flow) of its emergency rating (399 MVA) for the single contingency 'LN 259'. This project contributes approximately 224.84 MW to the thermal violation.

```
CONTINGENCY 'LN 259'     /*
  OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1          /*BASIN CHESTERFIELD
END
```

See 5.

4) (DVP) The Messer Rd 230 kV-Charles City Road 230 KV 230 kV line (from bus 314228 to bus 314225 ckt 1) loads from 73.98% to 125.21% (DC power flow) of its emergency rating (399 MVA) for the single contingency 'LN 259'. This project contributes approximately 224.84 MW to the thermal violation.

```
CONTINGENCY 'LN 259'     /*
  OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1          /*BASIN CHESTERFIELD
END
```

See 5.

5) (DVP) The Chesterfield 230 kV 2-Messer Rd 230 kV 230 kV line (from bus 314287 to bus 314228 ckt 1) loads from 74.08% to 125.31% (DC power flow) of its emergency rating (399 MVA) for the single contingency 'LN 259'. This project contributes approximately 224.84 MW to the thermal violation.

```
CONTINGENCY 'LN 259'     /*
  OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1          /*BASIN CHESTERFIELD
END
```

Transmission line rebuild estimated to cost $42,000,000.

Multiple Facility Contingency

(Double Circuit Tower Line Contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

6) (DVP) The Charles City Road 230 KV-Lakeside 230 kV 230 kV line (from bus 314225 to bus 314227 ckt 1) loads from 86.02% to 145.25% (DC power flow) of its emergency rating (399 MVA) for the tower contingency '208&259'. This project contributes approximately 279.61 MW to the thermal violation.

```
CONTINGENCY '208&259'     /* LN 208 & 259
  OPEN BRANCH FROM BUS 314338 TO BUS 314309 CKT 1          /* 208 CHESTERFIELD
  OPEN BRANCH FROM BUS 314309 TO BUS 314286 CKT 1          /* 208
  OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1          /* 259 BASIN
END
```

The upgrade noted above would resolve this deficiency.

7) (DVP) The Chesterfield 230 kV 1-Chesterfield 115 kV 230/115 kV transformer (from bus 314286 to bus 314284 ckt

1) loads from 60.47% to 102.79% (DC power flow) of its emergency rating (250 MVA) for the tower contingency '208&259'. This project contributes approximately 105.81 MW to the thermal violation.

```
CONTINGENCY '208&259'     /* LN 208 & 259
  OPEN BRANCH FROM BUS 314338 TO BUS 314309 CKT 1          /* 208 CHESTERFIELD
  OPEN BRANCH FROM BUS 314309 TO BUS 314286 CKT 1          /* 208
  OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1          /* 259 BASIN
END
```

Generation re-dispatch would be used to resolve this deficiency.

8) (DVP) The Messer Rd 230 kV-Charles City Road 230 KV 230 kV line (from bus 314228 to bus 314225 ckt 1) loads from 97.58% to 156.81% (DC power flow) of its emergency rating (399 MVA) for the tower contingency '208&259'. This project contributes approximately 279.61 MW to the thermal violation.

```
CONTINGENCY '208&259'     /* LN 208 & 259
  OPEN BRANCH FROM BUS 314338 TO BUS 314309 CKT 1          /* 208 CHESTERFIELD
  OPEN BRANCH FROM BUS 314309 TO BUS 314286 CKT 1          /* 208
  OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1          /* 259 BASIN
END
```

See number three above.

9) (DVP) The Chesterfield 230 kV 2-Messer Rd 230 kV 230 kV line (from bus 314287 to bus 314228 ckt 1) loads from 97.68% to 156.91% (DC power flow) of its emergency rating (399 MVA) for the tower contingency '208&259'. This project contributes approximately 279.61 MW to the thermal violation.

```
CONTINGENCY '208&259'     /* LN 208 & 259
  OPEN BRANCH FROM BUS 314338 TO BUS 314309 CKT 1          /* 208 CHESTERFIELD
  OPEN BRANCH FROM BUS 314309 TO BUS 314286 CKT 1          /* 208
  OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1          /* 259 BASIN
END
```

See number three above.

Contribution to Previously Identified Overloads

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

10) (BG&E) The High Ridge 2316-Howard 2332 230 kV line (from bus 220941 to bus 220954 ckt 1) loads from 112.09% to 113.35% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP1EB'. This project contributes approximately 73.66 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1           / 200003 BRIGHTON 500 200004
CNASTONE 500 1
END
```

See 1 under 500 kV option.

11) (PENELEC) The Roxbury-Roxbury 138/115 kV transformer (from bus 200532 to bus 200520 ckt 1) loads from 115.32% to 117.4% (DC power flow) of its emergency rating (138 MVA) for the single contingency 'PP1EB'. This project contributes approximately 17.76 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1           / 200003 BRIGHTON 500 200004
CNASTONE 500 1
END
```

See 2 under 500 kV option.

12) (BG&E/PL) The Conastone-Otter Creek Switchyard 230 kV line (from bus 220963 to bus 208048 ckt 1) loads from 141.37% to 143.11% (DC power flow) of its emergency rating (531 MVA) for the single contingency 'PJM17'. This project contributes approximately 58.43 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500
END
```

See 3 under 500 kV option.

13) (BG&E/PECO) The Graceton-Cooper 230 kV line (from bus 220964 to bus 214089 ckt 1) loads from 136.98% to 138.73% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 52.60 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

See 4 under 500 kV option.

14) (DVP) The North Anna 500 kV-Ladysmith 500 kV 500 kV line (from bus 314918 to bus 314911 ckt 1) loads from 111.43% to 112.27% (DC power flow) of its emergency rating (3117 MVA) for the single contingency '8MORRSVL _8NO ANNA _033'. This project contributes approximately 161.72 MW to the thermal violation.

```
CONTINGENCY '8MORRSVL _8NO ANNA _033'
  DISCONNECT BRANCH FROM BUS 314916 TO BUS 314918 CKT 1     /* 500/500KV, AREA 345/345.
END
```

It will be necessary to construct the second North Anna to Ladysmith 500 kV identified in Q65 to resolve this deficiency.

15) (DVP) The North Anna 500 kV-Morrisville 500 kV 500 kV line (from bus 314918 to bus 314916 ckt 1) loads from 120.06% to 121.41% (DC power flow) of its emergency rating (2598 MVA) for the single contingency '8LDYSMTH _8NO ANNA _025'. This project contributes approximately 217.24 MW to the thermal violation.

```
CONTINGENCY '8LDYSMTH _8NO ANNA _025'
  DISCONNECT BRANCH FROM BUS 314911 TO BUS 314918 CKT 1     /* 500/500KV, AREA 345/345.
END
```

It will be necessary to construct the second North Anna to Ladysmith 500 kV identified in Q65 to resolve this deficiency.

16) (PECO) The Cooper-Peach Bottom 230 kV line (from bus 214089 to bus 213869 ckt 1) loads from 134.49% to 136.24% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 52.60 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

See 7 in 500 kV section.

17) (PJM) The Conastone-Peach Bottom 500 kV line (from bus 200004 to bus 200013 ckt 1) loads from 128.97% to 130.0% (DC power flow) of its emergency rating (2815 MVA) for the single contingency 'PJM77'. This project contributes approximately 218.79 MW to the thermal violation.

```
CONTINGENCY 'PJM77'
  REMOVE MACHINE 1 FROM BUS 200035                        /* PB3
END
```

See 11 in 500 kV section.

18) (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 124.47% to 125.46% (DC power flow) of its emergency rating (2901 MVA) for the single contingency 'PJM67'. This project contributes approximately 195.51 MW to the thermal violation.

```
CONTINGENCY 'PJM67'
  DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1     /* HUNTERTN CNASTONE 500 500
END
```

See 13 in 500 kV section.

19) (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 135.50% to 136.63% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 202.75 MW to the thermal violation.

See 13 in 500 kV section.

20) (DVP) The Fredericksburg 230 kV-Cranes Corner 230 kV 230 kV line (from bus 314137 to bus 314134 ckt 1) loads from 100.08% to 109.16% (DC power flow) of its emergency rating (637 MVA) for the single contingency '8LDYSMTH _8POSSUM _026'. This project contributes approximately 96.53 MW to the thermal violation.

```
CONTINGENCY '8LDYSMTH _8POSSUM _026'
  DISCONNECT BRANCH FROM BUS 314911 TO BUS 314922 CKT 1     /* 500/500KV, AREA 345/345.
END
```

This is a base line upgrade which has been identified in the 2016 RTEP.

Short Circuit

(Report Overdutied breakers here)

21) Sixteen 230 kv breakers were identified for this option and it is estimated to cost $ 4,000,000 to replace all these breakers. It may also be necessary to replace all the substation infrastructure at Chesterfield 230 kV handle the new fault currents.

Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of the surrounding generation. Any potential 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 Transmission Interconnection request.

Note: 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 analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

22) (BG&E) The High Ridge 2316-Howard 2332 230 kV line (from bus 220941 to bus 220954 ckt 1) loads from 109.76% to 111.16% (DC power flow) of its emergency rating (941 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 81.69 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1 / BRIGHTON 500 CNASTONE 500 1
END
```

23) (PENELEC) The Roxbury-Roxbury 138/115 kV transformer (from bus 200532 to bus 200520 ckt 1) loads from 164.04% to 166.07% (DC power flow) of its emergency rating (138 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 21.70 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1            / 200003 BRIGHTON 500
200004 CNASTONE 500 1
END
```

24) (PENELEC) The Roxbury-Roxbury 138/115 kV transformer (from bus 200532 to bus 200520 ckt 1) loads from 117.59% to 119.58% (DC power flow) of its normal rating (124 MVA) for non contingency condition. This project contributes approximately 15.26 MW to the thermal violation.

25) (BG&E/PL) The Conastone-Otter Creek Switchyard 230 kV line (from bus 220963 to bus 208048 ckt 1) loads from 123.89% to 125.87% (DC power flow) of its emerency rating (531 MVA) for the operational contingency 'PJM17'. This project contributes approximately 64.81 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500
500
END
```

26) (DVP) The Chesterfield 230 kV 2-Basin 230 kV 230 kV line (from bus 314287 to bus 314276 ckt 1) loads from 69.47% to 131.11% (DC power flow) of its emergency rating (470 MVA) for the operational contingency 'LN 217'. This project contributes approximately 314.29 MW to the thermal violation.

```
CONTINGENCY 'LN 217'     /*, CHESTERFIELD-LAKESIDE & LAKESIDE TX #6
  OPEN BRANCH FROM BUS 314225 TO BUS 314227 CKT 1          /*LAKESIDE CHARLES CITY
  OPEN BRANCH FROM BUS 314225 TO BUS 314228 CKT 1          /*CHARLES CITY MESSER RD
  OPEN BRANCH FROM BUS 314228 TO BUS 314287 CKT 1          /*MESSER RD CHESTB
  OPEN BRANCH FROM BUS 314227 TO BUS 314226 CKT 1          /*LAKESIDE 230-115 #5
END
```

27) (BG&E/PECO) The Graceton-Cooper 230 kV line (from bus 220964 to bus 214089 ckt 1) loads from 130.09% to 131.62% (DC power flow) of its emergency rating (485 MVA) for the operational contingency 'PJM17'. This project contributes approximately 58.35 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500
500
END
```

28) (DVP) The North Anna 500 kV-Ladysmith 500 kV 500 kV line (from bus 314918 to bus 314911 ckt 1) loads from 115.44% to 116.36% (DC power flow) of its emergency rating (3117 MVA) for the operational contingency '8MORRSVL _8NO ANNA _033'. This project contributes approximately 179.38 MW to the thermal violation.

```
CONTINGENCY '8MORRSVL _8NO ANNA _033'
  DISCONNECT BRANCH FROM BUS 314916 TO BUS 314918 CKT 1      /* 500/500KV, AREA
345/345.
END
```

29) (DVP) The Chesterfield 230 kV 2-Tyler 230 kV 230 kV line (from bus 314287 to bus 314346 ckt 1) loads from 66.48% to 103.04% (DC power flow) of its emergency rating (478 MVA) for the operational contingency 'LN 2003'. This project contributes approximately 206.68 MW to the thermal violation.

```
CONTINGENCY 'LN 2003'     /*, CHESTER POE
  OPEN BRANCH FROM BUS 314287 TO BUS 314299 CKT 1          /* CHESTER HARROGATE
  OPEN BRANCH FROM BUS 314299 TO BUS 314331 CKT 1          /* HARROGATE POE
```

```
END
```

30) (AP) The Lake Lynn-Lardin 138 kV line (from bus 235122 to bus 235207 ckt 2) loads from 99.47% to 100.65% (DC power flow) of its emergency rating (113 MVA) for the operational contingency 'APS_B_G100'. This project contributes approximately 8.27 MW to the thermal violation.

```
CONTINGENCY 'APS_B_G100'     / 235122 01LKLYNN 138 235207 01LARDIN 138 1
  OPEN BRANCH FROM BUS 235122 TO BUS 235207 CKT 1
END
```

31) (DVP) The North Anna 500 kV-Morrisville 500 kV 500 kV line (from bus 314918 to bus 314916 ckt 1) loads from 125.58% to 127.07% (DC power flow) of its emergency rating (2598 MVA) for the operational contingency '8LDYSMTH _8NO ANNA _025'. This project contributes approximately 240.95 MW to the thermal violation.

```
CONTINGENCY '8LDYSMTH _8NO ANNA _025'
  DISCONNECT BRANCH FROM BUS 314911 TO BUS 314918 CKT 1      /* 500/500KV, AREA
345/345.
END
```

32) (METED) The Germantown Reactor-Germantown 138/115 kV transformer (from bus 204531 to bus 204529 ckt 1) loads from 109.26% to 111.25% (DC power flow) of its emergency rating (104 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 12.83 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1            / 200003 BRIGHTON 500
200004 CNASTONE 500 1
END
```

33) (METED) The Germantown-Germantown Reactor 138 kV line (from bus 204530 to bus 204531 ckt 1) loads from 109.26% to 111.25% (DC power flow) of its emergency rating (104 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 12.83 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1            / 200003 BRIGHTON 500
200004 CNASTONE 500 1
END
```

34) (PECO) The Cooper-Peach Bottom 230 kV line (from bus 214089 to bus 213869 ckt 1) loads from 128.05% to 129.59%

(DC power flow) of its emergency rating (485 MVA) for the operational contingency 'PJM17'. This project contributes approximately 58.35 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500
500
END
```

35) (DVP) The Charles City Road 230 KV-Lakeside 230 kV 230 kV line (from bus 314225 to bus 314227 ckt 1) loads from 66.50% to 123.32% (DC power flow) of its emergency rating (399 MVA) for the operational contingency 'LN 259'. This project contributes approximately 249.38 MW to the thermal violation.

```
CONTINGENCY 'LN 259'     /*
  OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1          /*BASIN CHESTERFIELD
END
```

36) (AP) The Lake Lynn-Lardin 138 kV line (from bus 235122 to bus 235207 ckt 1) loads from 99.47% to 100.65% (DC power flow) of its emergency rating (113 MVA) for the operational contingency 'APS_B_G101'. This project contributes approximately 8.27 MW to the thermal violation.

```
CONTINGENCY 'APS_B_G101'     / 235122 01LKLYNN 138 235207 01LARDIN 138 2
  OPEN BRANCH FROM BUS 235122 TO BUS 235207 CKT 2
END
```

37) (DVP) The Messer Rd 230 kV-Charles City Road 230 KV 230 kV line (from bus 314228 to bus 314225 ckt 1) loads from 78.06% to 134.88% (DC power flow) of its emergency rating (399 MVA) for the operational contingency 'LN 259'. This project contributes approximately 249.38 MW to the thermal violation.

```
CONTINGENCY 'LN 259'     /*
  OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1          /*BASIN CHESTERFIELD
END
```

38) (AP/PENELEC) The Greene-Roxbury 138 kV line (from bus 235188 to bus 200532 ckt 1) loads from 109.24% to 111.09% (DC power flow) of its emergency rating (189 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 21.70 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1            / 200003 BRIGHTON 500
200004 CNASTONE 500 1
END
```

39) (PJM) The Conastone-Peach Bottom 500 kV line (from bus 200004 to bus 200013 ckt 1) loads from 113.67% to 114.76% (DC power flow) of its emergency rating (2815 MVA) for the operational contingency 'PJM77'. This project contributes approximately 242.68 MW to the thermal violation.

```
CONTINGENCY 'PJM77'
  REMOVE MACHINE 1 FROM BUS 200035                          /* PB3
END
```

40) (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 114.70% to 115.69% (DC power flow) of its emergency rating (2901 MVA) for the operational contingency 'PJM77'. This project contributes approximately 224.88 MW to the thermal violation.

```
CONTINGENCY 'PJM77'
  REMOVE MACHINE 1 FROM BUS 200035                          /* PB3
END
```

41) (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 124.94% to 126.17% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 224.88 MW to the thermal violation.

42) (DVP) The Fredericksburg 230 kV-Cranes Corner 230 kV 230 kV line (from bus 314137 to bus 314134 ckt 1) loads from 102.86% to 105.47% (DC power flow) of its emergency rating (637 MVA) for the operational contingency '8LDYSMTH _8POSSUM _026'. This project contributes approximately 107.07 MW to the thermal violation.

```
CONTINGENCY '8LDYSMTH _8POSSUM _026'
  DISCONNECT BRANCH FROM BUS 314911 TO BUS 314922 CKT 1      /* 500/500KV, AREA
345/345.
END
```

43) (DVP) The Chesterfield 230 kV 2-Messer Rd 230 kV 230 kV line (from bus 314287 to bus 314228 ckt 1) loads from 78.16% to 134.98% (DC power flow) of its emergency rating (399 MVA) for the operational contingency 'LN 259'. This

project contributes approximately 249.38 MW to the thermal violation.

```
CONTINGENCY 'LN 259'     /*
  OPEN BRANCH FROM BUS 314276 TO BUS 314287 CKT 1          /*BASIN CHESTERFIELD
END
```

Primary Option: 500 kV

Generator Deliverability

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

No violations identified.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

No violations identified.

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) (BG&E) The High Ridge 2316-Howard 2332 230 kV line (from bus 220941 to bus 220954 ckt 1) loads from 106.22% to 107.49% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP1EB'. This project contributes approximately 74.11 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1          / BRIGHTON 500 CNASTONE 500 1
END
```

Mitigation: Rebuild line to accommodate double bundle 1272 ACSR.
Estimates: $ 24 M & 5 yrs.

Assumptions:

- Length of line is 8.9 miles

- 2+ year CPCN process required
- Existing tower removal included

2) (PENELEC) The Roxbury-Roxbury 138/115 kV transformer (from bus 200532 to bus 200520 ckt 1) loads from 118.79% to 121.1% (DC power flow) of its emergency rating (138 MVA) for the single contingency 'PP1EB'. This project contributes approximately 19.68 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1          / BRIGHTON 500 CNASTONE 500 1
END
```

Mitigation: The overload can be alleviated by replacing the Roxbury 138/115 kV transformer and associated terminal equipment (circuit breaker, substation conductor, CT circuits), which is estimated to cost approximately $2,250,000 and require a lead time of at least 2 years.

3) (BG&E/PL) The Conastone-Otter Creek Switchyard 230 kV line (from bus 220963 to bus 208048 ckt 1) loads from 141.27% to 143.02% (DC power flow) of its emergency rating (531 MVA) for the single contingency 'PJM17'. This project contributes approximately 58.72 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

Mitigation:

The BG&E portion of the Conastone to Otter Creek line can be upgraded by Reconducting from Gorsuch Mills to the Pennsylvania State Line (change of ownership to PPL). The existing circuit 2302 conductor is 1,590 kcmil 45/7 ACSR from Conastone to Gorsuch Mills and 795 kcm 30/19 ACSR from Gorsuch Mills to the PA State Line.

Assumptions:

- Reconductor with 1,590 kcm ACSR from Gorsuch Mills to PA line to match capability of remainder of line.
- Length of this line section is 1.7 miles.

- Towers can be reinforced instead of replaced.
- Based on a previous estimate for PJM (B48) study on circuit 22008

The estimated cost of this upgrade is $700,000. Estimated construction time is 36 months.

A PPL project to re-conductor Manor-Conastone with 1590 ACSR is underway. This project will equip the line to handle 653/793 MVA (Summer Normal/Emergency). Estimated cost: $17M. Estimated in-service date: October 2013.

4) (BG&E) The Sandy Spring 2314-High Ridge 2316 230 kV line (from bus 220983 to bus 220941 ckt 1) loads from 100.65% to 101.57% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP28'. This project contributes approximately 53.39 MW to the thermal violation.

```
CONTINGENCY 'PP28'
  OPEN BRANCH FROM BUS 220984 TO BUS 223962 CKT 1  / 220984 SANDY34T 230 223962 BURT2334 230 1
END
```

Mitigation: Rebuild existing line using double bundle 1033 ACSR @ 125 °C (1227 MVA). Estimate: $10M, 5 years

Assumptions:

- Full structure replacement required
- Existing structure removal included
- Line length of 3.61 miles
- 2+ year CPCN process required

5) (BG&E/PECO) The Graceton-Cooper 230 kV line (from bus 220964 to bus 214089 ckt 1) loads from 136.87% to 138.63% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 52.82 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

Mitigation:

PECO portion: Reconductor Line 220-93 from Cooper Substation to Graceton Substation to get a minimum summer emergency rating of 725 MVA. The line is approximately 4 miles long. This cost is for the PECO portion only. The estimated cost to perform this wrk is $2.8M, and will require 24 months to complete.

BGE portion: a double circuit line will be built with 1033.5 kcmil ACSR creating one circuit by connecting the two lines into one. Rating for 2 – 1033.5 kcmil 45/7 ACSR (Ortolan) at 125°C = 968/1227MVA SN/SE. BGE ownership is for 1.85 miles and the rebuild of 11 structures. It would be built as a double circuit line with the conductors jumpered across at the terminal ends. The line construction is estimated at $3,000,000. Two breakers ($400,000/breaker) would need to be replaced at Graceton for a cost of $800,000. An additional cost of $200,000 would also be incurred for 4 breaker disconnects and line connections to cover thermal. The project is estimated to take 30 months to complete: 12 months for the CPCN process & design and an additional 18 months for construction. The total cost of the project is estimated at $4.0 M.

6) (DVP) The North Anna 500 kV-Morrisville 500 kV 500 kV line (from bus 314918 to bus 314916 ckt 1) loads from 120.06% to 121.06% (DC power flow) of its emergency rating (2598 MVA) for the single contingency '8LDYSMTH _8NO ANNA _025'. This project contributes approximately 161.30 MW to the thermal violation.

```
CONTINGENCY '8LDYSMTH _8NO ANNA _025'
  DISCONNECT BRANCH FROM BUS 314911 TO BUS 314918 CKT 1     /* 500/500KV, AREA 345/345.
END
```

Mitigation: This exceeds the conductor rating of the existing Line #575 (North Anna – Ladysmith) and will require the construction of the 2nd North Anna –Ladysmith 500 kV Line identified for PJM queue Q65 (n0718.1).

7) (PECO) The Cooper-Peach Bottom 230 kV line (from bus 214089 to bus 213869 ckt 1) loads from 134.39% to 136.15% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 52.82 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

Mitigation:

Reconductor Line 220-08 from PB Tap to Cooper Substation to get a minimum summer emergency rating of 741 MVA. The line is approximately 1.4 miles long. The estimated cost to perform this work is $1.0M, and will require 24 months to complete.

8) (BG&E) The Sandy Spring 2334-High Ridge 2316 230 kV line (from bus 220984 to bus 220941 ckt 1) loads from 101.11% to 102.02% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP27'. This project contributes approximately 53.21 MW to the thermal violation.

```
CONTINGENCY 'PP27'
  OPEN BRANCH FROM BUS 220983 TO BUS 223961 CKT 1   / 220983 SANDY14T 230 223961 BURT2314 230 1
END
```

Mitigation: Same as 4.

9) (PL) The Safe Harbor Units 3-4 Tap-Manor Substation 230 kV line (from bus 208071 to bus 208019 ckt 1) loads from 101.47% to 102.75% (DC power flow) of its emergency rating (579 MVA) for the single contingency 'PJM17'. This project contributes approximately 46.62 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

Mitigation: Upgrade current 795 kcmil 30/19 (140 degrees C) line section to 1590kcmil 45/7 (125 degrees) .The cost of this upgrade would be approximately $56,000.

10) (BG&E) The Howard 2312-Granite 2311 & 2312 230 kV line (from bus 220953 to bus 220972 ckt 1) loads from 104.92% to 106.35% (DC power flow) of its emergency rating (728 MVA) for the single contingency 'PP1EB'. This project

contributes approximately 64.65 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1           / 200003 BRIGHTON 500 200004 CNASTONE
500 1
END
```

Mitigation: Replace 500K wire drops and upgrade structures to give new rating of 825 MVA. Estimate: $100,000 and 12-18 months.

11) (PJM) The Conastone-Peach Bottom 500 kV line (from bus 200004 to bus 200013 ckt 1) loads from 128.93% to 129.97% (DC power flow) of its emergency rating (2815 MVA) for the single contingency 'PJM76'. This project contributes approximately 219.63 MW to the thermal violation.

```
CONTINGENCY 'PJM76'
  REMOVE MACHINE 1 FROM BUS 200034                          /* PB2
END
```

Mitigation:

BGE: (n2138) Rebuild bay with breakers A B C to 4000 A. New rating is 2939/3733. To rebuild bay cost estimate is $6,600,000, time estimate is 24-36 months.

PECO: (n2139)Replace existing Peach Bottom-Conastone 500kV Line (5012) terminal equipment at Peach Bottom Substation to match the conductor summer normal and emergency rating of 2920 / 3707 MVA (PECO portion only). Estimate: $5 million, 3 years.

12) (BG&E) The High Ridge 2316-Columbia 230 kV line (from bus 220941 to bus 221010 ckt 1) loads from 101.07% to 102.17% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP1EB'. This project contributes approximately 64.27 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1     / 200003 BRIGHTON 500 200004 CNASTONE 500 1
END
```

Mitigation: $15M for the 4.4 mile 230kV line. CPCN needed and 4-5 years to build. Will rebuild with bundle 1590 MCM, rating 1604 Summer Emergency. Further studies by PJM are need to be done once the final rating is determined.

13) (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 124.59% to 125.59% (DC power flow) of its emergency rating (2901 MVA) for the single contingency 'PJM67'. This project contributes approximately 196.14 MW to the thermal violation.

```
CONTINGENCY 'PJM67'
  DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1     /* HUNTERTN CNASTONE 500 500
END
```

Mitigation: The two breaker bay at Conastone for the Brighton line is over the continuous rating. Upgrade Conastone bay with two 4000A breakers, four 4000A breaker disconnects and a 4000 A line switch need to be either. The new rating will be 3710 MVA. Estimate: $3M, 24-36 months.

14) (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 135.63% to 136.77% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 203.56 MW to the thermal violation.

Mitigation: same as 13.

15) (DVP) The Fredericksburg 230 kV-Cranes Corner 230 kV 230 kV line (from bus 314137 to bus 314134 ckt 1) loads from 100.08% to 102.25% (DC power flow) of its emergency rating (637 MVA) for the single contingency '8LDYSMTH _8POSSUM _026'. This project contributes approximately 85.58 MW to the thermal violation.

```
CONTINGENCY '8LDYSMTH _8POSSUM _026'
  DISCONNECT BRANCH FROM BUS 314911 TO BUS 314922 CKT 1     /* 500/500KV, AREA 345/345.
END
```

PJM has identified this as a Base Line Reliability Upgrade b1701. While not assigned to the project, this must be completed before operations that would impact this overload would be permitted.

16) (DVP) The Cannon Branch 230 kV-Prince WillamsDel Pt 230 kV 230 kV line (from bus 314016 to bus 314117 ckt 1) loads from 132.69% to 133.71% (DC power flow) of its

emergency rating (319 MVA) for the single contingency 'LN 2030'. This project contributes approximately 20.25 MW to the thermal violation.

```
CONTINGENCY 'LN 2030'     /* LOUDOUN - GAINESVILLE AND TX 2 & LN 172
  OPEN BRANCH FROM BUS 314061 TO BUS 314037 CKT 1          /* LOUDON TO GAINESVILLE
  OPEN BRANCH FROM BUS 314037 TO BUS 314115 CKT 1          /* GAINESVILLE TX 2 (DVP LN 172)
  OPEN BRANCH FROM BUS 314037 TO BUS 314045 CKT 1          /* GAINESVILLE TX 3 TO NOVEC
  OPEN BRANCH FROM BUS 314115 TO BUS 314123 CKT 1          /* GAINESVILLE TO WELLINGTON DP
  OPEN BRANCH FROM BUS 314123 TO BUS 314157 CKT 1          /* WELLINGTON DP TO GODW172
  OPEN BRANCH FROM BUS 314147 TO BUS 314157 CKT 1          /* LN 197 MICRON TO GODWIN
  OPEN BRANCH FROM BUS 314049 TO BUS 314147 CKT 1          /* MICR172 - LOMA172
  OPEN BRANCH FROM BUS 314049 TO BUS 314159 CKT 1          /* LOMAR TX
  OPEN BRANCH FROM BUS 314147 TO BUS 314160 CKT 1          /* MICRON TX
  OPEN BRANCH FROM BUS 314147 TO BUS 314161 CKT 1          /* MICRON TX
  OPEN BRANCH FROM BUS 314157 TO BUS 314162 CKT 1          /* GODWIN TX
END
```

Network Protectors on 13 kV side of transformer's uprate to prevent reverse power flow and associated overloads.

Short Circuit

(Report over-dutied breakers.)

17) Four 230 kV breakers were identified as being over-dutied. It is estimated to cost $1,000,000 to replace these breakers.

Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of the surrounding generation. Any potential 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 Transmission Interconnection request.
Note: 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 analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

18) (BG&E) The High Ridge 2316-Howard 2332 230 kV line (from bus 220941 to bus 220954 ckt 1) loads from 109.58% to 110.99% (DC power flow) of its emergency rating (941 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 82.20 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
```

```
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1           / 200003 BRIGHTON 500 200004 CNASTONE
500 1
END
```

19) (PENELEC) The Roxbury-Roxbury 138/115 kV transformer (from bus 200532 to bus 200520 ckt 1) loads from 165.41% to 167.48% (DC power flow) of its emergency rating (138 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 21.83 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1           / 200003 BRIGHTON 500 200004 CNASTONE
500 1
END
```

20) (PENELEC) The Roxbury-Roxbury 138/115 kV transformer (from bus 200532 to bus 200520 ckt 1) loads from 117.69% to 119.7% (DC power flow) of its normal rating (124 MVA) for non contingency condition. This project contributes approximately 15.37 MW to the thermal violation.

21) (BG&E/PL) The Conastone-Otter Creek Switchyard 230 kV line (from bus 220963 to bus 208048 ckt 1) loads from 123.79% to 125.77% (DC power flow) of its emergency rating (531 MVA) for the operational contingency 'PJM17'. This project contributes approximately 65.13 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

22) (BG&E) The Sandy Spring 2314-High Ridge 2316 230 kV line (from bus 220983 to bus 220941 ckt 1) loads from 103.61% to 104.62% (DC power flow) of its emergency rating (941 MVA) for the operational contingency 'PP28'. This project contributes approximately 59.22 MW to the thermal violation.

```
CONTINGENCY 'PP28'
  OPEN BRANCH FROM BUS 220984 TO BUS 223962 CKT 1           / 220984 SANDY34T 230 223962 BURT2334
230 1
END
```

23) (PEPCO) The Ft Slocum Par-Ft Slocum 69 kV line (from bus 224121 to bus 224122 ckt 1) loads from 108.00% to 108.83% (DC power flow) of its emergency rating (150 MVA) for the operational contingency 'PP31'. This project contributes approximately 7.75 MW to the thermal violation.

```
CONTINGENCY 'PP31'
  OPEN BRANCH FROM BUS 223961 TO BUS 223978 CKT 1           / 223961 BURT2314 230 223978 BOWIE045
230 1
END
```

24) (DVP) The Chickahominy 500kV-Chickahominy 230 kV 500/230 kV transformer (from bus 314903 to bus 314214 ckt 1) loads from 19.00% to 102.7% (DC power flow) of its emergency rating (89699975586 MVA) for the operational contingency '8ELMONT _8CHCKAHM _020'. This project contributes approximately 750.22 MW to the thermal violation.

```
CONTINGENCY '8ELMONT _8CHCKAHM _020'
  DISCONNECT BRANCH FROM BUS 314908 TO BUS 314903 CKT 1     /* 500/500KV, AREA 345/345.
END
```

25) (BG&E/PECO) The Graceton-Cooper 230 kV line (from bus 220964 to bus 214089 ckt 1) loads from 129.97% to 131.51% (DC power flow) of its emergency rating (485 MVA) for the operational contingency 'PJM17'. This project contributes approximately 58.59 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

26) (AP) The Lake Lynn-Lardin 138 kV line (from bus 235122 to bus 235207 ckt 2) loads from 99.50% to 100.7% (DC power flow) of its emergency rating (113 MVA) for the operational contingency 'APS_B_G100'. This project contributes approximately 8.40 MW to the thermal violation.

```
CONTINGENCY 'APS_B_G100'     / 235122 01LKLYNN 138 235207 01LARDIN 138 1
  OPEN BRANCH FROM BUS 235122 TO BUS 235207 CKT 1
END
```

27) (DVP) The North Anna 500 kV-Morrisville 500 kV 500 kV line (from bus 314918 to bus 314916 ckt 1) loads from 125.58% to 126.69% (DC power flow) of its emergency rating (2598 MVA) for the operational contingency '8LDYSMTH _8NO ANNA _025'. This project contributes approximately 178.90 MW to the thermal violation.

```
CONTINGENCY '8LDYSMTH _8NO ANNA _025'
  DISCONNECT BRANCH FROM BUS 314911 TO BUS 314918 CKT 1     /* 500/500KV, AREA 345/345.
END
```

28) (METED) The Germantown Reactor-Germantown 138/115 kV transformer (from bus 204531 to bus 204529 ckt 1) loads from 109.40% to 111.41% (DC power flow) of its emergency rating (104 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 12.90 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1           / 200003 BRIGHTON 500 200004 CNASTONE
500 1
END
```

29) (METED) The Germantown-Germantown Reactor 138 kV line (from bus 204530 to bus 204531 ckt 1) loads from 109.41% to 111.42% (DC power flow) of its emergency rating (104 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 12.90 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1           / 200003 BRIGHTON 500 200004 CNASTONE
500 1
END
```

30) (PECO) The Cooper-Peach Bottom 230 kV line (from bus 214089 to bus 213869 ckt 1) loads from 127.95% to 129.49% (DC power flow) of its emergency rating (485 MVA) for the operational contingency 'PJM17'. This project contributes approximately 58.59 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

31) (PEPCO) The 12Th & Irving-Ft Slocum Par 69 kV line (from bus 224119 to bus 224121 ckt 1) loads from 145.79% to 146.79% (DC power flow) of its emergency rating (125 MVA) for the operational contingency 'PP31'. This project contributes approximately 7.75 MW to the thermal violation.

```
CONTINGENCY 'PP31'
  OPEN BRANCH FROM BUS 223961 TO BUS 223978 CKT 1           / 223961 BURT2314 230 223978 BOWIE045
230 1
END
```

32) (BG&E) The Sandy Spring 2334-High Ridge 2316 230 kV line (from bus 220984 to bus 220941 ckt 1) loads from 104.12% to 105.13% (DC power flow) of its emergency rating (941 MVA) for the operational contingency 'PP27'. This project contributes approximately 59.02 MW to the thermal violation.

```
CONTINGENCY 'PP27'
  OPEN BRANCH FROM BUS 220983 TO BUS 223961 CKT 1           / 220983 SANDY14T 230 223961 BURT2314
230 1
END
```

33) (AP) The Lake Lynn-Lardin 138 kV line (from bus 235122 to bus 235207 ckt 1) loads from 99.50% to 100.7% (DC power flow) of its emergency rating (113 MVA) for the operational contingency 'APS_B_G101'. This project contributes approximately 8.40 MW to the thermal violation.

```
CONTINGENCY 'APS_B_G101'     / 235122 01LKLYNN 138 235207 01LARDIN 138 2
  OPEN BRANCH FROM BUS 235122 TO BUS 235207 CKT 2
END
```

34) (PL) The Safe Harbor Units 3-4 Tap-Manor Substation 230 kV line (from bus 208071 to bus 208019 ckt 1) loads from 108.00% to 109.44% (DC power flow) of its emergency rating (579 MVA) for the operational contingency 'PJM17'. This project contributes approximately 51.71 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

35) (AP) The West Run-Lake Lynn 138 kV line (from bus 235424 to bus 235122 ckt 1) loads from 112.93% to 113.91% (DC power flow) of its emergency rating (176 MVA) for the operational contingency '01YUKON _01BRNRUN _084_A'. This project contributes approximately 10.69 MW to the thermal violation.

```
CONTINGENCY '01YUKON _01BRNRUN _084_A'
  DISCONNECT BRANCH FROM BUS 235116 TO BUS 292625 CKT 1      /* 500/500KV, AREA 201/201. / BUS
235850 -> 292625. T174.
END
```

36) (BG&E) The Riverside 2317-Northeast 2315 & 2317 230 kV line (from bus 220966 to bus 220979 ckt 1) loads from 105.43% to 106.47% (DC power flow) of its emergency rating (632 MVA) for the operational contingency 'BG_CKT2344'. This project contributes approximately 41.01 MW to the thermal violation.

```
CONTINGENCY 'BG_CKT2344'     /* BRANDON TO RIVERSIDE CKT #2344
  DISCONNECT BUS 220989      /*CKT 2344 BRANDON – HAWKINS-SOLLERS
  DISCONNECT BUS 220990      /*CKT 2344 HAWKINS-SOLLERS-RIVERSIDE
  DISCONNECT BUS 220977      /* RIVERSIDE 230-1 H/S AND 2339 TO NORTHEAST
  DISCONNECT BUS 221230      /*RIVERSIDE 230-1 & L/S BUS CONNECTION
END
```

37) (BG&E) The Sollers Point 2344-Riverside 2339 230 kV line (from bus 220990 to bus 220977 ckt 1) loads from 109.14% to 109.96% (DC power flow) of its emergency rating (1036 MVA) for the operational contingency 'BG_RIV230-2'. This project contributes approximately 52.37 MW to the thermal violation.

```
CONTINGENCY 'BG_RIV230-2'     /* RIVERSIDE 230-2 TRANSFORMER & CKT 2345
  DISCONNECT BRANCH FROM BUS 220966 TO BUS 220988 CKT 1     /* CKT #2345 RIVERSIDE TO SOLLERS PT
  DISCONNECT BRANCH FROM BUS 220966 TO BUS 221231 CKT 1     /* RIVERSIDE 230-2 TRANSFORMER
  DISCONNECT BRANCH FROM BUS 221231 TO BUS 221147 CKT 1     /* RIVERSIDE 230-2 L/S BUS CONNECTION
END
```

38) (AP/PENELEC) The Greene-Roxbury 138 kV line (from bus 235188 to bus 200532 ckt 1) loads from 110.26% to 112.12% (DC power flow) of its emergency rating (189 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 21.83 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1           / 200003 BRIGHTON 500 200004 CNASTONE
500 1
```

```
END
```

39) (PJM) The Conastone-Peach Bottom 500 kV line (from bus 200004 to bus 200013 ckt 1) loads from 113.64% to 114.73% (DC power flow) of its emergency rating (2815 MVA) for the operational contingency 'PJM76'. This project contributes approximately 243.60 MW to the thermal violation.

```
CONTINGENCY 'PJM76'
  REMOVE MACHINE 1 FROM BUS 200034                        /* PB2
END
```

40) (DVP) The Bristers 500 kV-Ox 500 kV 500 kV line (from bus 314900 to bus 314919 ckt 1) loads from 93.00% to 101.77% (DC power flow) of its emergency rating (2598 MVA) for the operational contingency '8LDYSMTH _8POSSUM _026'. This project contributes approximately 227.76 MW to the thermal violation.

```
CONTINGENCY '8LDYSMTH _8POSSUM _026'
  DISCONNECT BRANCH FROM BUS 314911 TO BUS 314922 CKT 1     /* 500/500KV, AREA 345/345.
END
```

41) (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 114.80% to 115.8% (DC power flow) of its emergency rating (2901 MVA) for the operational contingency 'PJM76'. This project contributes approximately 225.78 MW to the thermal violation.

```
CONTINGENCY 'PJM76'
  REMOVE MACHINE 1 FROM BUS 200034                        /* PB2
END
```

42) (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 125.08% to 126.32% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 225.78 MW to the thermal violation.

43) (DVP) The Fredericksburg 230 kV-Cranes Corner 230 kV 230 kV line (from bus 314137 to bus 314134 ckt 1) loads from 102.86% to 105.16% (DC power flow) of its emergency

rating (637 MVA) for the operational contingency '8LDYSMTH _8POSSUM _026'. This project contributes approximately 94.93 MW to the thermal violation.

```
CONTINGENCY '8LDYSMTH _8POSSUM _026'
  DISCONNECT BRANCH FROM BUS 314911 TO BUS 314922 CKT 1     /* 500/500KV, AREA 345/345.
END
```

44) (DVP) The Cannon Branch 230 kV-Prince WillamsDel Pt 230 kV 230 kV line (from bus 314016 to bus 314117 ckt 1) loads from 131.75% to 132.88% (DC power flow) of its emergency rating (319 MVA) for the operational contingency 'LN 2030'. This project contributes approximately 22.46 MW to the thermal violation.

```
CONTINGENCY 'LN 2030'     /* LOUDOUN - GAINESVILLE AND TX 2 & LN 172
  OPEN BRANCH FROM BUS 314061 TO BUS 314037 CKT 1          /* LOUDON TO GAINESVILLE
  OPEN BRANCH FROM BUS 314037 TO BUS 314115 CKT 1          /* GAINESVILLE TX 2 (DVP LN 172)
  OPEN BRANCH FROM BUS 314037 TO BUS 314045 CKT 1          /* GAINESVILLE TX 3 TO NOVEC
  OPEN BRANCH FROM BUS 314115 TO BUS 314123 CKT 1          /* GAINESVILLE TO WELLINGTON DP
  OPEN BRANCH FROM BUS 314123 TO BUS 314157 CKT 1          /* WELLINGTON DP TO GODW172
  OPEN BRANCH FROM BUS 314147 TO BUS 314157 CKT 1          /* LN 197 MICRON TO GODWIN
  OPEN BRANCH FROM BUS 314049 TO BUS 314147 CKT 1          /* MICR172 - LOMA172
  OPEN BRANCH FROM BUS 314049 TO BUS 314159 CKT 1          /* LOMAR TX
  OPEN BRANCH FROM BUS 314147 TO BUS 314160 CKT 1          /* MICRON TX
  OPEN BRANCH FROM BUS 314147 TO BUS 314161 CKT 1          /* MICRON TX
  OPEN BRANCH FROM BUS 314157 TO BUS 314162 CKT 1          /* GODWIN TX
END
```

ITO Analysis

ITO assessed the impact of the proposed queue project X2-082 interconnection as a 1575 MW of energy (1420 MW Capacity) injection into the ITO syste. The system was assessed using the summer 2015 RTEP case provided to ITO by PJM, this 1420 MW capacity injection occurred at the Chickahominy 500 kV substation bus a secondary interconnection point was also evaluated at the Chesterfield 230 kV Substation A. This analysis did include the impacts of the generation capacity for all W-queue and X-queue generators within the ITO system. When performing a generation analysis, ITO main analysis will be load flow study results under single contingency (both normal and stressed system conditions) and import/export system conditions. ITO criteria considers a transmission facility overloaded if it exceeds 94% of its emergency rating under normal and stressed system conditions. For import/export studies, ITO considers a transmission facility overloaded if it exceeded 100% of its emergency rating. A full listing of ITO planning criteria and interconnection requirements

can be found in the ITO facility connection requirements which are publicly available at: http://www.dom.com.

As part of its generation impact analysis 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. The results of these studies are discussed in more detail below.

PRIMARY INTERCONNECTION POINT – CHICKAHOMINY 500 KV BUS

1) The first being when local generation including the proposed X2-082 Facility is operated at their maximum capability. The result of this study is shown below.

   The Possum Point to Dumfries section of Line #2002 is loaded to 101% of its STE Rating(633 MVA) for an outage of Line #237. (This line and associated upgrade to resolve this deficiency has been identified as a network upgrade required for V1-031. Should this project not sign a ISA this deficiency condition and associated network upgrade may no longer be valid or may become the responsibility of this request.)

2) Two different critical system conditions were studied. The first critical system condition studied was when Possum Point Unit #5 is off-line.

   No identified deficiencies.

3) The second critical system condition which was studied was when Yorktown Unit #3 is off-line.

   No identified deficiencies.

4) The fourth being import and export conditions into and out of the Dominion System. Any new facility that is interconnected with the Dominion System should not

significantly decrement FCITC between utilities. The results of these studies can be found in Tables A and B.

Table A: Import Study Results

Area	Summer 2015	Summer 2015 with X2-082	Limiting Element
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

Table B: Export Study Results

Area	Summer 2015	Summer 2015 with X2-82	Limiting Element
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

ITO planning criteria indicates a need to have approximately 2000 MW of import and export capability. The results of these import and export studies are indicate that the proposed generation facility will not impact ITO import or export capability.

The results of these studies evaluate the system under a limited set of operating conditions and do not guarantee the full delivery of the Capacity and associated energy of this proposed generation facility under all operating conditions. NERC Planning and Operating Reliability Criteria allow for the re-dispatch of generating units to resolve projected and actual deficiencies in real time and planning studies. Specifically NERC Category C Contingency Conditions (bus Fault, tower line, N-1-1, and stuck breaker scenarios) allow for re-dispatch of generating units to resolve potential reliability deficiencies. For ITO planning criteria the re-dispatch of generating units for these contingency conditions is allowed as long as the projected loading does not exceed 130% of a facility Short Term Emergency Rating. These study results are also predicated on the PJM baseline PATH and MAPP projects being in-service. Both of these projects have been deferred by PJM. The System Impact Study will capture this change in target date(s) and this change may impact the study results.

Required Interconnection Facilities:

Attachment Facilities:

Generation Substation:

a) Install metering and associated Protection Equipment. Estimated Cost $700,000.

b) Construct a four breaker 500 kV Switching Station at the proposed generation site. Estimated cost $8,000,000. This work is estimated to take 24-30 months to complete. As noted in Attachment A (One-Line).

Transmission Line:

Construct two half-mile long 500 kV Attachment line(s) between the generation substation and the proposed Generating Station. Estimated cost $3,500,000. This work is estimated to take 24-30 months to complete. As noted in Attachment A (One-Line).

Direct Connection Network Facilities:

Chickahominy Substation:

Add three new 500 kV Breakers to interconnect the two network transmission lines from the generating site to the Chickahominy Substation as shown in Attachment A (One –Line). The estimated cost of this work is $7,000,000.

Transmission Line:

It will be necessary to construct a looped (approximately 16 miles each way) 500 kV line in and out of the proposed generation site to the existing Chickahominy Substation. The estimated cost of this work is $97,500,000 and is estimated to take 36-42 months to complete.

The estimated total cost of the Attachment Facilities is $12,200,000 and the estimated cost of the Network

Upgrades is $ 104,500,000. These preliminary cost estimates are based on typical engineering costs and detailed engineering cost estimates are normally done during the Facility Study phase and also will not be done until the developer provides an exact site plan location for the generation substation and proposed Chesterfield Generation Site.

The generation developer has indicated to the Interconnected Transmission Owner (Dominion Electric Transmission) that it would like it to support a November 2012 CPCN Filing in Virginia. To accomplish this ITO will need to start routing and permitting studies by December 2011. The ITO has estimated that this work would cost $1,000,000 and this would need to be funded by the generation developer.

SECONDARY OPTION: CHESTERFIELD 230 KV SUBSTATION A

A high level overview of the impacts of a 1376 MW capacity injection into the Chesterfield 230 kV Substation A was done. Stress System Conditions and Import/Export studies were not done. The results of these studies are shown below.

1) The first being when local generation including the proposed X2-082 Facility is operated at their maximum capability. The result of this study is shown below.
   a. The Chesterfield to Chickahominy Line #287 is overloaded to 121% of its STE Rating(622 MVA) for an outage of Line #2049. Several other transmission contingencies also over load this line. It is estimated to cost $30,000,000 to rebuild this line.
   b. The Chesterfield to Hopewell Line #228 is overloaded to 94.5% of its STE Rating(470 MVA) for an outage of Line #208. It is estimated to cost $33,000,000 to resolve this overload condition.
   c. The Chesterfiled 230-115 kv Tx overloads to 123% of its STE Rating(250 MVA) for an outage of Line

#208. It is estimated to cost $5,500,000 to resolve this overload condition.

d. The Chesterfield to Southwest 230 kV Line #208 is overloaded to 103% of its STE Rating(706 MVA) for an outage of Line #287. It will be necessary to construct a Midlothian to Chesterfield 230 kV line to resolve this overload. The estimated cost is $32,000,000.

A 'Preliminary Fault Study identified nine 230 kV breakers at Chesterfield 230 kV Substation A which will need to be replaced. The estimated cost for this work is $2,100,000. It would also be necessary to review the existing ground grid and 230 kV bus to determine if fault current levels are high enough that these facilities would need to be rebuilt. No common mode studies have been done to evaluate this alternate interconnection point. These studies are likely to identify additional upgrades that are required.

The estimated cost of these 'preliminary' identified upgrades is $102,600,000 and is estimated to take 36-48 months to complete. A significant amount of work has been identified on the 230 kV lines which emanate from Chesterfield 230 kV Substation. To accomplish this work and support the generation developers requested in-service date of December 2015 significant system outages will be required. These outages will potentially restrict the availability of generation that is located in the Chesterfield and Hopewell area.

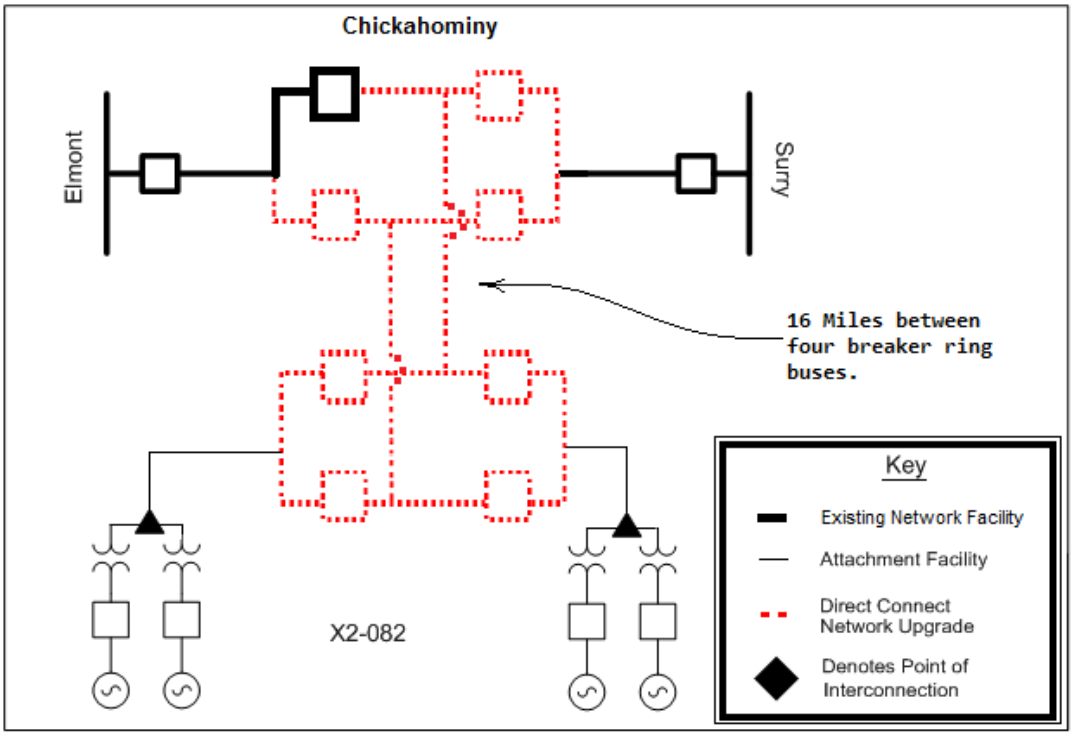
To construct the attachment facilities as shown in Attachment B(One-Line) are estimated to cost $3,000,000. To construct the Direct Connect Network Facilities as shown in Attachment B(One-Line) are estimated to cost $12,000,000.

As part of the Dominion analysis the proposed queue request was just interconnected to Chesterfield 230 kV Bus 314286. This change significantly reduced the number of breakers which were overdutied and reduced the number of potential overloaded facilitates. Specifically the following facilities no longer showed up as being overloaded.

- Line #259 (Chesterfield #314287 to Basin #314276)
- Line #217 (Chesterfield #314287 to Messer #314228 to Charles City #314225 to Lakeside #314227)
- Line #205 (Chesterfield #314287 to Tyler #314346) line segment.

ITO recommends that the IC evaluate this possibility further at the System Impact Study as it may result in reduced costs.

Primary Option One-Line



Secondary Option One-Line