Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position X3-089

Sayreville 230kV

March 2012

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer 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 project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

The Interconnection Customer (IC), has proposed a natural gas generating facility located in Sayreville, New Jersey. The installed facilities will have a total capability of 744 MW with 744 MW of this output being recognized by PJM as capacity. This means that the remaining 744 MW will be curtailable should a system reliability constraint occur.

Point of Interconnection

X3-089 will interconnect with the Jersey Central Power & Light transmission system at the Raritan River 230kV substation.

Cost Summary

X3-089 will be responsible for the following costs:

Type	Cost
Attachment Facilities	$ 0
Direct Connection Facilities	$ 6,667,800
Non Direct Connection Facilities	$ 0

In addition, X3-089 will be responsible for all or a portion of the costs for network reinforcements. All allocations will be determined during the System Impact Study phase.

Type	Cost
New System Reinforcements	$ 38,907,600
Previously Identified Reinforcements	$361,712,300

Attachment Facilities

There are no Attachment Facilities being constructed by FirstEnergy. The IC is required to construct all connection facilities in accordance with the FirstEnergy published standards.

Direct Connection Cost Estimate

The Direct Connection of the X3-089 Project will consist of two 230 kV lines attached to the Raritan River 230 kV double breaker substation. Based on a review by the FE Substation Engineering group, due to space constraints at the peninsular Raritan River 230 kV substation, the Raritan River 115 kV substation will need to be physically moved to make room for the X3-089 Project connection. The proposed plan is to relocate the 115 kV facilities to an adjacent area where 69 kV facilities were once located that supported the retired Sayreville 1, 2 and 3 units. The remaining 69 kV facilities will be removed and a new 115 kV ring bus substation constructed using the existing facilities where possible. The relocation of the 115 kV substation is already required for the W4-009 project. Therefore the X3-089 project will only be responsible for expanding the 230 kV bus by two additional bays. If the W4-009 project withdraws from the queue process then the 115 kV substation relocation costs would transfer to the X3-089 Project. Since FE does not own the property at the Raritan River substation, the Interconnection Customer will be required to provide both the easements and the permits necessary two expand the Raritan River 230 kV substation. The Interconnection Customer will also be responsible for constructing, owning, operating and maintaining its attachment lines once commissioned.

The total preliminary cost estimate for Direct Connection work is **$6,667,800** and includes:

- Extend the 230kV double breaker substation bus facilities for two new positions
- Construct new center termination structure for the Project attachments
- Install four new 3000 amp, 80 kA interrupting breakers
- Install eight new 3000 amp disconnect switches
- All substation conductor to be bundled (2) 1590 ACSR conductor
- Provide fiber optics runs and control building facilities to support new connections
- Install new fiber optic relay protection panels in control building
- Miscellaneous metering, RTC, and SCADA
- Engineering oversight and commissioning support

An additional $2,162,400 from CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up may be added, if applicable.

Non-Direct Connection Cost Estimate

The only Non-Direct Connection facilities are identified in the Network Analysis section of this report.

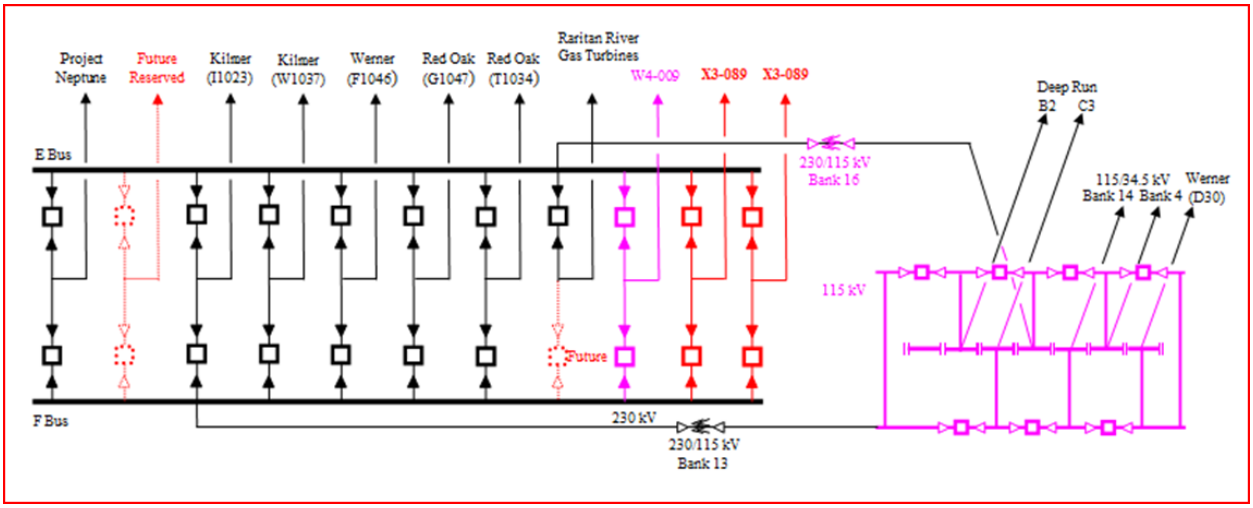

Figure 1. Single Line Diagram

Revenue Metering and SCADA Requirements

For PJM

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.

For FirstEnergy

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

http://www.firstenergycorp.com/feconnect
http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx

Network Impacts

Queue project X3-089 was studied as a(n) 744.0 MW (744.0 MW of which was Capacity) injection into JCPL's system at the RAR RVR 230.0 kV substation. Project X3-089 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

Potential transmission network impacts are as follows:

Generator Deliverability

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

1. (PSEG) The Lake Nelson W-MIDDLSEX2 230 kV line (from bus 218334 to bus 218522 ckt 1) loads from 74.19% to 116.02% (DC power flow) of its emergency rating (1000 MVA) for the single contingency 'B_NJC2-SX-#10'. This project contributes approximately 418.30 MW to the thermal violation.

```
CONTINGENCY 'B_NJC2-SX-#10'
     /* RARITAN RIVER - LAKE NELSON (I1023) 230 KV LINE
  DISCONNECT BUS 218331
END
```

2. (PSEG) The Lake Nelson I-Middlesex Sw. Rack 230 kV line (from bus 218333 to bus 218301 ckt 1) loads from 75.25% to 123.84% (DC power flow) of its emergency rating (831 MVA) for the single contingency 'B_NJC2-SX-#12'. This project contributes approximately 403.82 MW to the thermal violation.

```
CONTINGENCY 'B_NJC2-SX-#12'
     /* RARITAN RIVER - LAKE NELSON (W1037) 230 KV LINE
  DISCONNECT BUS 218332
END
```

3. (PECO) The Nottingham-Nottingham Reactor 230 kV line (from bus 213844 to bus 213846 ckt 1) loads from 99.79% to 101.32% (DC power flow) of its emergency rating (627 MVA) for the single contingency 'PJM17'. This project contributes approximately 59.35 MW to the thermal violation.

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

4. (JCPL) The Williams 230-W4-021 TAP 230 kV line (from bus 206298 to bus 905190 ckt 1) loads from 89.91% to 107.87% (DC power flow) of its emergency rating (772 MVA) for the single contingency 'B_CNJ2-SX-#8_W4_021_B'. This project contributes approximately 138.67 MW to the thermal violation.

```
CONTINGENCY 'B_CNJ2-SX-#8_W4_021_B'
     /* ATLANTIC - SOUTH RIVER (P1030) 230 KV
  DISCONNECT BRANCH FROM BUS 905180 TO BUS 295951 CKT 1
     / BUS 206321 -> 295951 DUE TO R11. FEB. 17, 2009.
END
```

5. (PECO) The Nottingham Reactor-Peach Bottom 230 kV line (from bus 213846 to bus 213869 ckt 1) loads from 99.73% to 101.25% (DC power flow) of its emergency rating (627 MVA) for the single contingency 'PJM17'. This project contributes approximately 59.35 MW to the thermal violation.

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

6. (JCPL/PSEG) The Raritan River-Kilmer W 230 kV line (from bus 206305 to bus 218332 ckt 1) loads from 71.65% to 107.92% (DC power flow) of its normal rating (650 MVA) for non contingency condition. This project contributes approximately 235.70 MW to the thermal violation.

7. (PSEG) The Kilmer I-Lake Nelson I 230 kV line (from bus 218331 to bus 218333 ckt 1) loads from 89.33% to 137.41% (DC power flow) of its emergency rating (872 MVA) for the single contingency 'B_NJC2-SX-#12'. This project contributes approximately 419.28 MW to the thermal violation.

```
CONTINGENCY 'B_NJC2-SX-#12'
     /* RARITAN RIVER - LAKE NELSON (W1037) 230 KV LINE
  DISCONNECT BUS 218332
END
```

8. (JCPL) The Parlin-Williams 230 230 kV line (from bus 206322 to bus 206298 ckt 1) loads from 90.60% to 108.56% (DC power flow) of its emergency rating (772 MVA) for the single contingency 'B_CNJ2-SX-#8_W4_021_B'. This project contributes approximately 138.67 MW to the thermal violation.

```
CONTINGENCY 'B_CNJ2-SX-#8_W4_021_B'
     /* ATLANTIC - SOUTH RIVER (P1030) 230 KV
  DISCONNECT BRANCH FROM BUS 905180 TO BUS 295951 CKT 1
     / BUS 206321 -> 295951 DUE TO R11. FEB. 17, 2009.
END
```

9. (JCPL) The Freneau-Atlantic 230 kV line (from bus 206292 to bus 206286 ckt 1) loads from 87.85% to 105.72% (DC power flow) of its emergency rating (731 MVA) for the single contingency 'B_CNJ2-SX-#8_W4_021_B'. This project contributes approximately 130.65 MW to the thermal violation.

```
CONTINGENCY 'B_CNJ2-SX-#8_W4_021_B'
     /* ATLANTIC - SOUTH RIVER (P1030) 230 KV
  DISCONNECT BRANCH FROM BUS 905180 TO BUS 295951 CKT 1
     / BUS 206321 -> 295951 DUE TO R11. FEB. 17, 2009.
END
```

10. (PENELEC) The Roxbury-Roxbury 115/138 kV transformer (from bus 200520 to bus 200532 ckt 1) loads from 96.69% to 98.32% (DC power flow) of its emergency rating (138 MVA) for the single contingency 'PP1EC'. This project contributes approximately 13.93 MW to the thermal violation.

```
CONTINGENCY 'PP1EC'
     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 200004 CKT 1
           / 200003 BRIGHTON 500 200004 CNASTONE 500 1
END
```

11. (PSEG) The Kilmer W-Lake Nelson W 230 kV line (from bus 218332 to bus 218334 ckt 1) loads from 88.98% to 136.95% (DC power flow) of its emergency rating (872 MVA) for the single contingency 'B_NJC2-SX-#10'. This project contributes approximately 418.30 MW to the thermal violation.

```
CONTINGENCY 'B_NJC2-SX-#10'
     /* RARITAN RIVER - LAKE NELSON (I1023) 230 KV LINE
  DISCONNECT BUS 218331
END
```

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.)

12. (BG&E) The North West 2311 & 2310-Granite 2311 & 2312 230 kV line (from bus 220962 to bus 220972 ckt 1) loads from 143.02% to 145.67% (DC power flow) of its emergency rating (621 MVA) for the single contingency 'PP1EB'. This project contributes approximately 49.01 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
```

13. (BG&E) The Conastone-EMORY GRV230 230 kV line (from bus 220963 to bus 220400 ckt 2) loads from 116.46% to 116.91% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP1EC'. This project contributes approximately 58.27 MW to the thermal violation.

```
CONTINGENCY 'PP1EC'
     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 200004 CKT 1
           / 200003 BRIGHTON 500 200004 CNASTONE 500 1
END
```

14. (PECO/BG&E) The Cooper-Graceton 230 kV line (from bus 214089 to bus 220964 ckt 1) loads from 131.12% to 133.09% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 59.35 MW to the thermal violation.

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

15. (PL/METED) The Brunner Island Bus-Yorkana 230 kV line (from bus 207922 to bus 204515 ckt 1) loads from 136.39% to 137.42% (DC power flow) of its emergency rating (617 MVA) for the single contingency 'PJM17'. This project contributes approximately 39.59 MW to the thermal violation.

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

16. (PL/BG&E) The Otter Creek Switchyard-Conastone 230 kV line (from bus 208048 to bus 220963 ckt 1) loads from 108.31% to 109.98% (DC power flow) of its emergency rating (531 MVA) for the single contingency 'PJM17'. This project contributes approximately 55.47 MW to the thermal violation.

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

17. (BG&E) The North West 2326 & 2322-Granite 2326 & 2332 230 kV line (from bus 220961 to bus 220973 ckt 1) loads from 120.22% to 122.84% (DC power flow) of its emergency rating (728 MVA) for the single contingency 'PP1EB'. This project contributes approximately 47.34 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
```

18. (PJM) The Peach Bottom-Conastone 500 kV line (from bus 200013 to bus 200004 ckt 1) loads from 151.73% to 154.36% (DC power flow) of its emergency rating (2815 MVA) for the single contingency 'PJM40'. This project contributes approximately 218.36 MW to the thermal violation.

```
CONTINGENCY 'PJM40'
  DISCONNECT BRANCH FROM BUS 200013 TO BUS 200024 CKT 1
     /* PEACHBTM LIMERICK 500 500
END
```

19. (PJM) The Peach Bottom-Conastone 500 kV line (from bus 200013 to bus 200004 ckt 1) loads from 147.52% to 149.11% (DC power flow) of its normal rating (2490 MVA) for non contingency condition. This project contributes approximately 245.33 MW to the thermal violation.

20. (BG&E) The EMORY GRV230-North West 2326 & 2322 230 kV line (from bus 220400 to bus 220961 ckt 1) loads from 105.57% to 105.94% (DC power flow) of its emergency rating (1800 MVA) for the single contingency 'BG_CKT2322A'. This project contributes approximately 42.04 MW to the thermal violation.

```
CONTINGENCY 'BG_CKT2322A'
     /*CONASTONE TO NORTHWEST CKT #2322
  DISCONNECT BRANCH FROM BUS 220962 TO BUS 220400 CKT 1
     /* CONASTONE TO NORTHWEST CKT #2322
END
```

21. (PJM) The Conastone-EMORY GR500 500 kV line (from bus 200004 to bus 200101 ckt 1) loads from 141.93% to 142.62% (DC power flow) of its emergency rating (2901 MVA) for the tower contingency 'CNSTN_NWESTA'. This project contributes approximately 206.48 MW to the thermal violation.

```
CONTINGENCY 'CNSTN_NWESTA'
     /* CONASTONE TO NORTHWEST CKTS #2310 & #2322
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220400 CKT 1
     /* CONASTONE TO NORTHWEST CKT#2310
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220400 CKT 2
     /* CONASTONE TO NORTHWEST CKT #2322
END
```

22. (PJM) The Conastone-EMORY GR500 500 kV line (from bus 200004 to bus 200101 ckt 1) loads from 103.54% to 104.58% (DC power flow) of its emergency rating (2901 MVA) for the single contingency 'CNSTN__230-4'. This project contributes approximately 186.13 MW to the thermal violation.

```
CONTINGENCY 'CNSTN__230-4'
     /* CONASTONE 230-4 TRANSFORMER
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 200004 CKT 2
     /* CONASTONE 500-4 TRANSFORMER
END
```

23. (PJM) The Conastone-EMORY GR500 500 kV line (from bus 200004 to bus 200101 ckt 1) loads from 118.85% to 120.1% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 181.02 MW to the thermal violation.

24. (JCPL) The W4-021 TAP-Freneau 230 kV line (from bus 905190 to bus 206292 ckt 1) loads from 132.17% to 150.13% (DC power flow) of its emergency rating (772 MVA) for the single contingency 'B_CNJ2-SX-#8_W4_021_B'. This project contributes approximately 138.67 MW to the thermal violation.

```
CONTINGENCY 'B_CNJ2-SX-#8_W4_021_B'
     /* ATLANTIC - SOUTH RIVER (P1030) 230 KV
  DISCONNECT BRANCH FROM BUS 905180 TO BUS 295951 CKT 1
     / BUS 206321 -> 295951 DUE TO R11. FEB. 17, 2009.
END
```

25. (JCPL) The W4-021 TAP-Freneau 230 kV line (from bus 905190 to bus 206292 ckt 1) loads from 123.33% to 136.54% (DC power flow) of its normal rating (650 MVA) for non contingency condition. This project contributes approximately 85.86 MW to the thermal violation.

26. (JCPL/PSEG) The Raritan River-Kilmer I 230 kV line (from bus 206305 to bus 218331 ckt 1) loads from 117.34% to 174.07% (DC power flow) of its emergency rating (739 MVA) for the single contingency 'PS56D'. This project contributes approximately 419.28 MW to the thermal violation.

```
CONTINGENCY 'PS56D'
  DISCONNECT BRANCH FROM BUS 206305 TO BUS 218332
           /* RARITAN RIVER KILMER W 230 230
  DISCONNECT BRANCH FROM BUS 218334 TO BUS 218332
           /* LK NELSON KILMER W 230 230
  DISCONNECT BRANCH FROM BUS 218332 TO BUS 218387
           /* KILMER T3
  DISCONNECT BRANCH FROM BUS 218332 TO BUS 218386
           /* KILMER T1
  MOVE 100 PERCENT LOAD FROM BUS 218386 TO BUS 218384
       /* KILMER W T1 T2
  MOVE 100 PERCENT LOAD FROM BUS 218387 TO BUS 218385
       /* KILMER W T3 T4
END
```

27. (PJM/AP) The EMORY GR500-Kemptown 500 kV line (from bus 200101 to bus 235632 ckt 1) loads from 122.60% to 122.93% (DC power flow) of its emergency rating (2901 MVA) for the tower contingency 'CNSTN_NWESTB'. This project contributes approximately 203.37 MW to the thermal violation.

```
CONTINGENCY 'CNSTN_NWESTB'
     /* CONASTONE TO NORTHWEST CKTS #2310 & #2322
  DISCONNECT BRANCH FROM BUS 220400 TO BUS 220962 CKT 1
     /* CONASTONE TO NORTHWEST CKT#2310
  DISCONNECT BRANCH FROM BUS 220400 TO BUS 220961 CKT 1
     /* CONASTONE TO NORTHWEST CKT #2322
END
```

28. (JCPL/PSEG) The Raritan River-Kilmer W 230 kV line (from bus 206305 to bus 218332 ckt 1) loads from 105.88% to 157.67% (DC power flow) of its emergency rating (805 MVA) for the single contingency 'PS56B'. This project contributes approximately 416.94 MW to the thermal violation.

```
CONTINGENCY 'PS56B'
  DISCONNECT BRANCH FROM BUS 206305 TO BUS 218331
            /* RARITAN RIVER KILMER I 230 230
  DISCONNECT BRANCH FROM BUS 218333 TO BUS 218331
            /* KILMER LAKE NELSON 230 230
  DISCONNECT BRANCH FROM BUS 218333 TO BUS 218427
            /* LAKE NELSON 230 69
  MOVE 100 PERCENT LOAD FROM BUS 218384 TO BUS 218386
       /* KILMER I T2 T1
  MOVE 100 PERCENT LOAD FROM BUS 218385 TO BUS 218387
       /* KILMER I T4 T3
  MOVE 50 PERCENT LOAD FROM BUS 218427 TO BUS 218348
        /* LK NELSON 69 BRIDGWTR 26
  MOVE 50 PERCENT LOAD FROM BUS 218427 TO BUS 218349
        /* LK NELSON 69 BRIDGWTR 69
END
```

29. (JCPL) The W4-021 TAP-Atlantic 230 kV line (from bus 905180 to bus 206286 ckt 1) loads from 104.35% to 123.81% (DC power flow) of its emergency rating (805 MVA) for the single contingency 'B_CNJ2-SX-#18_W4_021_A'. This project contributes approximately 156.62 MW to the thermal violation.

```
CONTINGENCY 'B_CNJ2-SX-#18_W4_021_A'
     /* FRENEAU - PARLIN (K1025) 230 KV & FRENEAU BANK 1
  DISCONNECT BRANCH FROM BUS 206292 TO BUS 905190 CKT 1
  DISCONNECT BRANCH FROM BUS 206292 TO BUS 206267 CKT 1
  DISCONNECT BRANCH FROM BUS 206292 TO BUS 206267 CKT 6
  DISCONNECT BRANCH FROM BUS 206292 TO BUS 206317 CKT 1
  SET BUS 206292 LOAD TO 0 MW
  DISCONNECT BUS 206317
END
```

30. (BG&E) The Conastone-EMORY GRV230 230 kV line (from bus 220963 to bus 220400 ckt 1) loads from 132.02% to 133.08% (DC power flow) of its emergency rating (819 MVA) for the single contingency 'PP1EC'. This project contributes approximately 57.58 MW to the thermal violation.

```
CONTINGENCY 'PP1EC'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 200004 CKT 1
            / 200003 BRIGHTON 500 200004 CNASTONE 500 1
END
```

31. (PL/BG&E) The Safe Harbor Units 3-4 Tap-Graceton 230 kV line (from bus 208071 to bus 220964 ckt 1) loads from 105.58% to 107.04% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 43.96 MW to the thermal violation.

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

32. (METED) The Three Mile Island-Jackson 1 230 kV line (from bus 204514 to bus 204502 ckt 1) loads from 107.25% to 108.27% (DC power flow) of its emergency rating (591 MVA) for the single contingency 'PJM17'. This project contributes approximately 37.43 MW to the thermal violation.

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

33. (PECO) The Peach Bottom-Cooper 230 kV line (from bus 213869 to bus 214089 ckt 1) loads from 132.59% to 134.57% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 59.35 MW to the thermal violation.

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

34. (JCPL) The R11 B-W4-021 TAP 230 kV line (from bus 295951 to bus 905180 ckt 1) loads from 104.43% to 123.88% (DC power flow) of its emergency rating (805 MVA) for the single contingency 'B_CNJ2-SX-#18_W4_021_A'. This project contributes approximately 156.62 MW to the thermal violation.

```
CONTINGENCY 'B_CNJ2-SX-#18_W4_021_A'
     /* FRENEAU - PARLIN (K1025) 230 KV & FRENEAU BANK 1
  DISCONNECT BRANCH FROM BUS 206292 TO BUS 905190 CKT 1
  DISCONNECT BRANCH FROM BUS 206292 TO BUS 206267 CKT 1
  DISCONNECT BRANCH FROM BUS 206292 TO BUS 206267 CKT 6
  DISCONNECT BRANCH FROM BUS 206292 TO BUS 206317 CKT 1
  SET BUS 206292 LOAD TO 0 MW
  DISCONNECT BUS 206317
END
```

35. (BG&E) The EMORY GRV230-North West 2311 & 2310 230 kV line (from bus 220400 to bus 220962 ckt 1) loads from 105.80% to 106.17% (DC power flow) of its emergency rating (1800 MVA) for the single contingency 'BG_CKT2310A'. This project contributes approximately 42.19 MW to the thermal violation.

```
CONTINGENCY 'BG_CKT2310A'
     /* CONASTONE TO NORTHWEST CKT #2310
  DISCONNECT BRANCH FROM BUS 220961 TO BUS 220400 CKT 1
     /* CONASTONE TO NORTHWEST CKT#2310
END
```

36. (PJM/METED) The Three Mile Island-Three Mile Island 500/230 kV transformer (from bus 200016 to bus 204514 ckt 2) loads from 126.90% to 128.06% (DC power flow) of its emergency rating (1072 MVA) for the single contingency 'PJM17'. This project contributes approximately 77.35 MW to the thermal violation.

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

Short Circuit

(Report over-dutied breakers.)

PJM identified seven new circuit breakers to be over-duty in the JCPL area:

Bus No.	Bus	Breaker	Rating Type	Duty Percent With X3-089	Duty Percent Without X3-089	Duty Percent Difference
2872	RARTN RV 230.kV	F1046E	S	120.70%	98.30%	22.40%
2872	RARTN RV 230.kV	F1046F	S	120.70%	98.30%	22.40%
2891	S.RIVER 230.kV	PA	S	107.80%	99.40%	8.40%
2870	RARTN RV 115.kV	78	S	100.20%	96.40%	3.80%
2870	RARTN RV 115.kV	B42 (813)	S	100.20%	96.40%	3.80%
2870	RARTN RV 115.kV	B43 (1311)	S	100.20%	96.40%	3.80%
2870	RARTN RV 115.kV	B44 (1114)	S	100.20%	96.40%	3.80%

In addition, the PJM analysis also showed a significant fault contribution (i.e. above 3%) to 20 breakers, which were already identified as over-duty. The breakers are listed below:

Bus No	Bus	Breaker	Rating Type	Duty Percent With X3-089	Duty Percent Without X3-089	Duty Percent Difference
2872	RARTN RV 230.kV	G1047E	S	170.50%	138.80%	31.70%
2872	RARTN RV 230.kV	G1047F	S	170.50%	138.80%	31.70%
2872	RARTN RV 230.kV	I1023E	S	170.50%	138.80%	31.70%
2872	RARTN RV 230.kV	I1023F	S	170.50%	138.80%	31.70%
2872	RARTN RV 230.kV	T1034E	S	170.50%	138.80%	31.70%
2872	RARTN RV 230.kV	T1034F	S	170.50%	138.80%	31.70%
2872	RARTN RV 230.kV	BK15	S	162.00%	130.60%	31.40%
2872	RARTN RV 230.kV	NEPTUNE B27	S	140.60%	113.50%	27.10%

Bus No	Bus	Breaker	Rating Type	Duty Percent With X3-089	Duty Percent Without X3-089	Duty Percent Difference
2872	RARTN RV 230.kV	NEPTUNE B28	S	140.60%	113.50%	27.10%
2872	RARTN RV 230.kV	W1037E	S	140.60%	113.50%	27.10%
2872	RARTN RV 230.kV	W1037F	S	140.60%	113.50%	27.10%
2882	Red Oak B 230.kV	MT1	S	135.50%	123.90%	11.60%
2881	Red Oak A 230.kV	MT2	S	133.00%	121.50%	11.50%
2881	Red Oak A 230.kV	MT3	S	133.00%	121.50%	11.50%
2882	Red Oak B 230.kV	MT4	S	132.60%	121.00%	11.60%
2881	Red Oak A 230.kV	T1034	S	125.10%	113.90%	11.20%
2882	Red Oak B 230.kV	G1047	S	124.50%	113.20%	11.30%
90320	G07_MTX1H 230.kV	4 OTHER BRKR	S	124.20%	106.00%	18.20%
90320	G07_MTX1H 230.kV	NY LINE	S	124.20%	106.00%	18.20%
90320	G07_MTX1H 230.kV	RAR RVR LINE	S	124.20%	106.00%	18.20%

FirstEnergy identified one new circuit breakers to be over-duty in the JCPL area:

				3 Phase		Ground	
Region	Substation	Breaker	Breaker Mode	Symm Fault Amps	% Brk Marg	Symm Fault Amps	% Bkr Marg
CNJ	FRENEAU	Z104	72-PM-40-30	38109	-0.4	26179	18.6

New System Reinforcements

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

Please see Attachment 1 for a table summarizing all New System Reinforcements.

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.)

Please see Attachment 2 for a table summarizing all Contributions to Previously Identified System Reinforcements.

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.

No violations identified.

Attachment 1. New System Reinforcements

Transmission Line Upgrades

Violation #	Overloaded Facility	Upgrade Description	Upgrade Cost
1	Lake Nelson W – Middlesex 230kV Line	JCPL: Install bundled 1590 ACSR conductor (0.8 miles). Upgrade drop loops and limiting substation conductor.	**$ 3,449,700**
2	Lake Nelson I - Middlesex	JCPL: Reconductor to 1590 ACSR conductor (0.8 miles). Upgrade drop loops and limiting substation conductor.	**$ 1,477,800**
3	Nottingham 230kV Reactor	PECO: Replace Line 220-08 reactor and by-pass circuit switcher at Nottingham substation to get a minimum summer emergency rating of 741 MVA. This upgrade will take 24 months to complete.	**$ 1,700,000**
4	Williams – W4-021 Tap 230kV Line	JCPL: Reconductor to 1590 ACSR conductor (0.66 miles). Upgrade drop loops and limiting substation conductor.	**$ 2,102,700**
5	Nottingham – Peach Bottom 230kV Line	PECO: Reconductor Line 220-08 from Nottingham Reactor to PB Tap to get a minimum summer emergency rating of 741 MVA. The line is approximately 14 miles long. This upgrade will take 48 months to complete.	**$ 10,000,000**
6	Raritan River – Kilmer W 230kV Line	See violations #26 & 28 for upgrade.	**$ 0**
7	Kilmer I – Lake Nelson I 230kV Line	JCPL: Install bundled 1590 ACSR conductor (1.95 miles). Upgrade drop loops and limiting substation conductor.	**$ 4,010,900**
8	Parlin – Williams 230kV Line	The Parlin-Williams 230kV line overload can be alleviated by reconductoring the line from 1590 Kcmil 45/7 ACSR (2.9 mile DCT) to 1590 Kcmil 54/19 ACSS/AW -Bundled (1.7 mile DCT) for 1642/1850 MVA summer normal/emergency ratings. It also requires replacement of a 2000 amp disconnect switch with a 4000 ampunit, bundled drop loop conductor at Williams substation and at Parlin substation.	**$ 3,860,400**
9	Freneau – Atlantic 230kV Line	JCPL: Install bundled 1590 ACSR conductor for substation conductor in series with the line and a wavetrap.	**$ 245,500**
10	Roxbury 115/138kV Transformer	Install a standard 115kV Circuit Breaker with 3000A	**$ 717,300**

Violation #	Overloaded Facility	Upgrade Description	Upgrade Cost
11	Kilmer W – Lake Nelson W 230kV Line	Install bundled 1590 ACSR conductor (1.95 miles). Upgrade drop loops and limiting substation conductor.	**$ 7,564,500**
		Total New Transmission Upgrades	**$ 35,128,800**

Circuit Breaker Upgrades

Substation	Circuit Breaker	Upgrade Description	Upgrade Cost
Raritan River 230kV	F1046E	Upgrade with a 80 kA interrupting breaker.	$ 735,600
	F1046F	Upgrade with a 80 kA interrupting breaker.	$ 735,600
South River 230 kV	PA	Upgrade with a 63 kA interrupting breaker	$ 419,000
Raritan River 115 kV	78	Upgrade with a 50 kA interrupting breaker.	$ 349,700
	B42 (813)	Upgrade with a 50 kA interrupting breaker.	$ 349,700
	B43 (1331)	Upgrade with a 50 kA interrupting breaker.	$ 349,700
	B44 (1114)	Upgrade with a 50 kA interrupting breaker.	$ 349,700
Freneau 34.5 kV	Z104	Upgrade with a 63 kA interrupting breaker.	$ 489,800
		Total New Circuit Breaker Upgrades	**$ 3,778,800**

Attachment 2. Contributions to Previously Identified Reinforcements

The following upgrades are contributions to previously identified upgrades. Cost allocations will be defined in the System Impact Study Report.

Transmission Line Upgrades

Violation #	Overloaded Facility	Upgrade Description	Activity Cost	Upgrade Cost
12, 17	North West – Granite 230kV Lines	BGE: The overload can be alleviated by reconductoring the line with 2,167 ACSR which will increase the rating to 1105MVA. There will also be substation terminal cost upgrades associated with the reinforcement. The upgrade is expected to take 6 years to complete.	$ 23,600,000	**$ 23,600,000**
13, 20, 30, 35	Conastone – Emory Grv and Emory Grv – North West 230kV Lines	BGE: Construct a new double circuit 230kV line from Conastone-NW using 1590 MCM conductor. The upgrade is expected to take 72-84 months to complete.		**$ 54,700,000**
		Details:		
		Conastone Substation: Install two new bays with 2 bus breakers.	$ 3,600,000	
		Northwest Substation: Install (2) 230KV 63kA breakers on existing foundations.	$ 700,000	
		Transmission Lines: 230kV line at 23.7 miles.		
		ROW land - purchase and clear 80' x 3 miles RW (10 acres) for a 230KV double circuit line would be $3M or $300K per acre.	$ 3,000,000	
		To build a 230KV double circuit line would be $47.4M or $2M per mile.	$ 47,400,000	

Violation #	Overloaded Facility	Upgrade Description	Activity Cost	Upgrade Cost
14	Cooper – Graceton 230kV Line	PECO: 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. The upgrade is expected to take 24 months to complete. BGE: Construct a 1.8 Mile from Graceton to the PA border, connect line to Graceton Sub. <u>Option 1: 230kV Line</u> (least cost selected for Upgrade Cost) Transmission Line: Construct a line using 2167 MCM conductor (60 months to complete) Right of Way Substation: Install a tie breaker into an existing bay (27 months to complete) <u>Option 2: 500kV Line</u> (details provided for information only) Transmission Line: Construct a line (64 months to complete) Right of Way Substation: Install a 3-breaker 500kV ring bus	$ 2,800,000 $ 6,000,000 $ 5,000,000 $ 400,000 $ 8,000,000 $ 8,000,000 $ 8,000,000	**$ 14,200,000**
15	Brunner Island – Yorkana 230kV Line	PPL: Rebuild and upgrade approximately 0.6 miles of PPL EU owned Brunner Island – Yorkana 230kV line and the substation line terminal equipment. The existing 1033 kcmil ACSR conductor will be replaced with new 1590 kcmil ACSR conductor or equivalent with and operating temperature of 140deg C to achieve the summer normal and emergency ratings of 712 MVA and 865 MVA respectively. The Yorkana 230kV bay conductors at Brunner Island 230kV switchyard will also be upgraded. This upgrade will take 24 months to complete. MetEd: Reconductor Met-Ed's 12.5 mile section of the Brunner -Yorkana (1055) 230 kV line with 1590 ACSS conductor. This upgrade will take 36 months to complete.	$ 1,300,000 $ 9,270,900	**$ 10,570,900**
16	Otter Creek – Conastone 230kV Line	BGE: Rebuild the line to the PA border (4.7 miles) to achieve a new rating of 648 (summer normal)/802 (summer emergency). This upgrade will take 60 months to complete. PPL: A 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). This upgrade is expected to be in service by October 2013.	$ 19,000,000 $ 17,000,000	**$**

Violation #	Overloaded Facility	Upgrade Description	Activity Cost	Upgrade Cost
18, 19	Peach Bottom – Conastone 500kV Line	<u>BGE</u> At Conastone construct a new two breaker 4000A bay (breakers D, F) with two 63 kA breakers. Includes line termination structures, allowance for a second line and the relocation of the 500kV cap bank. 36 months to complete Construct a new 500kV line from Conastone - Peachbotton rated for a minimum of 2939/3733 SN/SE. Build 9.6 miles 500KV line from Conastone to Pennsylvania line. Purchase 150' R/W. 5-7 years to complete <u>PECO</u> 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)- 3 years Build new second Peach Bottom-Conastone 500kV Line on separate towers from existing 5012 Line with a minimum summer emergency rating of 3510 MVA (PECO portion only)- 5 years	 $ 14,000,000 $ 46,800,000 $ 5,000,000 $ 20,000,000	**$ 85,800,000**
21, 22, 23, 27	Conastone – Emory Gr and Emory Gr – Kempton 500kV Lines	BGE: Upgrade the two breaker bay at Conastone for the Brighton line with two 4000A breakers, four 4000A breaker disconnects and a 4000 A line switch. This upgrade will take 24-36 months to complete.	$ 3,000,000	**$ 3,000,000**
24, 25	W4-021 Tap – Freneau 230kV Line	JCPL: Install bundled 1590 ACSR conductor (7.9 miles). Upgrade drop loops and limiting substation conductor and Upgrade CTs and Relay Thermal to exceed the "Rating to Exceed" value.	$ 48,165,800	**$ 48,165,800**
6, 26, 28	Raritan River – Kilmer I and Raritan River – Kilmer W 230kV Lines	Replacement of a 2000 amp wave trap with one rated for 3000 amps at the Raritan river substation.	$ 117,000	**$ 117,000**
29	W4-021 Tap – Atlantic 230kV Line	JCPL: Reconductor to 1590 ACSR conductor (17.20 miles). Upgrade drop loops and limiting substation conductor. Upgrade meter thermal limits and relay thermals to exceed the "Rating to Exceed" value.	$ 24,497,100	**$ 24,497,100**

Violation #	Overloaded Facility	Upgrade Description	Activity Cost	Upgrade Cost
31	Safe Harbor – Graceton 230kV Line	PPL: A project to re-conductor Manor-Graceton 230 kV with 1590 ACSR is underway. This project will equip the line to handle 653/793 MVA (Summer Normal/Emergency). This upgrade is expected to be in service by November 2013. BGE: Line rated 559/674. There are substation limitations at Graceton that will be removed with project b0497	$ 22,700,000 $	**$ 22,700,000**
32	Three Mile Island – Jackson 230kV Line	MetEd: Replace 18.05 miles of 230kV line and install drop loop/bus conductor at Three Mile Island and Jackson substations.	$ 10,910,000	**$ 10,910,000**
33	Peach Bottom – Cooper 230kV Line	PECO: 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. This upgrade is expected to take 24 months to complete.	$ 1,000,000	**$ 1,000,000**
34	R11B – W4-021 Tap 230kV Line	JCPL: Reconductor to 1590 ACSR conductor (1.25 miles). Upgrade drop loops and limiting substation conductor.	$ 2,020,100	**$ 2,020,100**
36	Three Mile Island 500/230kV Transformer	MetEd: Install a second 500/230kV transformer at TMI as well as transmission line upgrades between the 230kV and 500kV substations. This upgrade is expected to take 36 months to complete.	$ 15,000,000	**$ 15,000,000**
			Total Previously Identified Transmission Upgrades	**$ 352,280,900**

Circuit Breaker Upgrades

Substation	Circuit Breaker	Upgrade Description	Upgrade Cost
Raritan River 230kV	G1047E	Upgrade with a 80 kA interrupting breaker.	**$ 735,600**
	G1047F	Upgrade with a 80 kA interrupting breaker.	**$ 735,600**
	I1023E	Upgrade with a 80 kA interrupting breaker.	**$ 735,600**
	I1023F	Upgrade with a 80 kA interrupting breaker.	**$ 735,600**
	T1034E	Upgrade with a 80 kA interrupting breaker.	**$ 735,600**
	T1034F	Upgrade with a 80 kA interrupting breaker.	**$ 735,600**
	BK15	Upgrade with a 80 kA interrupting breaker.	**$ 735,600**
	B27	Upgrade with a 80 kA interrupting breaker.	**$ 735,600**

	B28	Upgrade with a 80 kA interrupting breaker.	**$ 735,600**
	W1037E	Upgrade with a 80 kA interrupting breaker.	**$ 735,600**
	W1037F	Upgrade with a 80 kA interrupting breaker.	**$ 735,600**
Red Oak 230kV (JCPL)	T1034	Upgrade with a 63 kA interrupting breaker.	**$ 419,900**
	G1047	Upgrade with a 63 kA interrupting breaker.	**$ 419,900**
Red Oak 230kV (AES)	MT1	Replace circuit breaker	**$ 125,000**
	MT2	Replace circuit breaker	**$ 125,000**
	MT3	Replace circuit breaker	**$ 125,000**
	MT4	Replace circuit breaker	**$ 125,000**
G07 MTX1H 230kV	4 BKRS	Replace circuit breaker	**Note 2**
	NY LINE	Replace circuit breaker	**Note 2**
	RAR RVR	Replace circuit breaker	**Note 2**
		Total Previously Identified Circuit Breaker Upgrades	**$ 9,431,400**

Note 1: Several of the breakers are identified as baseline reinforcements. Therefore, this project will not have any cost responsibility for these upgrades. If this project plans to go in-service before the baseline reinforcements are completely built, an Interim Deliverability Study will have to be completed to assess if there will be any reduced deliverability during that interim period.

Note 2: The Transmission Owner is still working to identify the cost of these upgrades. These costs will be confirmed during the System Impact Study phase.