Generation Interconnection Feasibility Study Report Web Version

For

PJM Generation Interconnection Request Queue Position X3-006

North Temple 230kV Project

October 2012

Feasibility Study Report

North Temple 230kV Generation Project

Introduction

This Feasibility Study report provides the documentation of an assessment performed by FirstEnergy (FE) in response to a request made by Interconnection Customer for an expansion of the North Temple 230 kV project with PJM queue number V4-020 by way of a substitution of the originally proposed turbine-generators to achieve an additional 150 MW (110 MW Capacity) of generation capability. This assessment was accomplished by: 1. Evaluating the reliability impact of the proposed facilities and connection on the interconnected transmission system by the performance of a power flow study; 2. Ensuring compliance with the NERC, ReliabilityFirst, PJM and FE Reliability Standards by identifying the system reinforcements that will need to be installed for an interconnection of the proposed project; 3. Coordinating and cooperating with the PJM staff and Interconnection Customer by participating in project meetings and issuing this report as a part of the RTEP study process; 4. Performing a Steady State, Short-Circuit and Dynamics Study as necessary; 5. Conducting all studies in accordance with the PJM Manuals and the "FE Requirements for Transmission Connected Facilities" documents that assure the assessment performed incorporates study assumptions, follows the documented system performance procedures, considers alternative connection and reinforcement plans, and jointly coordinates the study recommendations.

Connection Facilities

Interconnection Customer has submitted a "Generation Interconnection Feasibility Study Agreement" to PJM that identifies its plan to increase the previously proposed 2 x 1 gas fired Combined Cycle North Temple 230 kV (V4-020) Generation Project on a property adjacent to the existing Ontelaunee 230 kV plant by 150 MW (110 MW Capacity) for a total capability of 800 MW (See Attachment 1). As described in the North Temple 230 kV (V4-020) Project Impact Study report the units will be connected to the North Temple 230 kV substation by a single attachment line to be constructed by the Interconnection Customer. The customer requested in-service date for the North Temple 230 kV (X3-006) Project is June 1, 2014. This is not feasible given the scope of the Ontelaunee (V4-020 and X3-006) Project. A more feasible in-service date will be determined as part of the System Impact and/or Facility Study.

Attachment 2 shows a conceptual one-line diagram of the North Temple 230 kV substation as a result of the North Temple 230 kV (V4-020) Project Direct Connection. The X3-006 will not require additional Direct Connection requirements beyond the North Temple 230 kV (V4-020) Project.

PJM Interconnection Study Results

The following is the report describing the results of the analysis performed by PJM engineers with respect to the transmission system impacts.

Network Impacts

Queue project X3-006 was studied as a 150.0 MW (110.0 MW of which was Capacity) injection into Metropolitan Edison's (FirstEnergy) system at the N.TEMPLE 230.0 kV substation. Project X3-006 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. (METED) The North Temple-North Temple 230/69 kV transformer (from bus 204508 to bus 204607 circuit 4) loads from 96.88% to 100.57% (DC power flow) of its emergency rating (260 MVA) for the single contingency 'B_ME230-SX-#33'. This project contributes approximately 9.61 MW to the thermal violation.

```
CONTINGENCY 'B_ME230-SX-#33'     /* NORTH KILL-NORTH TEMPLE & N.TEMPLE BANK 6
  DISCONNECT BRANCH FROM BUS 204875 TO BUS 204508 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204607 CIRCUIT 6
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)

2. Violation originally identified by PJM removed in accordance with FirstEnergy criteria.

3. (METED/PL) the North Hershey-Hummelstown Transformer #2 230 kV line (from bus 204506 to bus 207988 circuit 1) loads from 93.47% to 100.09% (DC power flow) of its emergency rating (574 MVA) for the tower contingency 'C5_ME230-DCT-#3'. This project contributes approximately 38.65 MW to the thermal violation.

```
CONTINGENCY 'C5_ME230-DCT-#3'     /* N.TEMPLE-LYONS & N.TEMPLE-HOSENSACK 230 KV
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204503 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204983 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204607 CIRCUIT 4
END
```

Comment regarding this violation:
METED: FirstEnergy line rating is 648/802 MVA therefore this not a violation.
PPL: PPL does not see any limitations; hence no reinforcement will be required.
.

4. (METED/PL) The North Lebanon-Copperstone / North Lebanon 230 kV line (from bus 204507 to bus 207946 circuit 1) loads from 95.48% to 100.98% (DC power flow) of its emergency rating (554 MVA) for the tower contingency 'C5_ME230-DCT-#2_X1_013_A'. This project contributes approximately 30.48 MW to the thermal violation.

```
CONTINGENCY 'C5_ME230-DCT-#2_X1_013_A'    /* N.HERSHEY-IRONWOOD-N.TEMPLE &
NORTHKILL-N.TEMPLE 230 KV
  DISCONNECT BRANCH FROM BUS 204506 TO BUS 204517 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204517 TO BUS 907100 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204517 TO BUS 204518 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204875 TO BUS 204508 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204607 CIRCUIT 6
  DISCONNECT BUS 204517
END
```

5. Violation originally identified by PJM removed in accordance with FirstEnergy criteria.

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.)

6. (BG&E) The North West 2311 & 2310-Granite 2311 & 2312 230 kV line (from bus 220962 to bus 220972 circuit 1) loads from 132.28% to 132.66% (DC power flow) of its emergency rating (621 MVA) for the single contingency 'PP1EB'. This project contributes approximately 7.01 MW to the thermal violation.

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

7. (METED) The X1-013 TAP-North Lebanon 230 kV line (from bus 907090 to bus 204507 circuit 1) loads from 120.78% to 127.05% (DC power flow) of its emergency rating (554 MVA) for the tower contingency 'C5_ME230-DCT-#2_X1_013_A'. This project contributes approximately 34.75 MW to the thermal violation.

```
CONTINGENCY 'C5_ME230-DCT-#2_X1_013_A'    /* N.HERSHEY-IRONWOOD-N.TEMPLE &
NORTHKILL-N.TEMPLE 230 KV
  DISCONNECT BRANCH FROM BUS 204506 TO BUS 204517 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204517 TO BUS 907100 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204517 TO BUS 204518 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204875 TO BUS 204508 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204607 CIRCUIT 6
  DISCONNECT BUS 204517
END
```

8. (METED) The X1-013 TAP-North Lebanon 230 kV line (from bus 907090 to bus 204507 circuit 1) loads from 112.09% to 117.64% (DC power flow) of its emergency rating (554 MVA) for the single contingency 'B_ME230-SX-#11_X1_013_A'. This project contributes approximately 30.76 MW to the thermal violation.

```
CONTINGENCY 'B_ME230-SX-#11_X1_013_A'     /* IRONWOOD TAP - N.HERSHEY,N.TEMPLE &
IRONWOOD 230 KV
  DISCONNECT BRANCH FROM BUS 204506 TO BUS 204517 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204517 TO BUS 907100 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204517 TO BUS 204518 CIRCUIT 1
  DISCONNECT BUS 204517
END
```

9. (PL/METED) The Brunner Island Bus-Yorkana 230 kV line (from bus 207922 to bus 204515 circuit 1) loads from 135.10% to 136.49% (DC power flow) of its emergency rating (617 MVA) for the single contingency 'PJM17'. This project contributes approximately 8.59 MW to the thermal violation.

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

10. (PL/BG&E) The Otter Creek Switchyard-Conastone 230 kV line (from bus 208048 to bus 220963 circuit 1) loads from 106.02% to 106.39% (DC power flow) of its emergency rating (531 MVA) for the single contingency 'PJM17'. This project contributes approximately 12.39 MW to the thermal violation.

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

11. (METED) The Ironwood-South Lebanon 230 kV line (from bus 204518 to bus 204511 circuit 1) loads from 149.19% to 154.49% (DC power flow) of its emergency rating (805 MVA) for the tower contingency 'C5_ME230-DCT-#7'. This project contributes approximately 42.60 MW to the thermal violation.

```
CONTINGENCY 'C5_ME230-DCT-#7'     /* MIDD JCT-NORTH LEBANON & HUMMELSTOWN-
N.HERSHEY 230 KV
  DISCONNECT BRANCH FROM BUS 207946 TO BUS 204507 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204507 TO BUS 204603 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204506 TO BUS 207988 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204506 TO BUS 204602 CIRCUIT 1
END
```

12. (METED) The Ironwood-South Lebanon 230 kV line (from bus 204518 to bus 204511 circuit 1) loads from 112.16% to 114.56% (DC power flow) of its emergency rating (805 MVA) for the single contingency 'B_ME230-SX-#31'. This project contributes approximately 19.33 MW to the thermal violation.

```
CONTINGENCY 'B_ME230-SX-#31'     /* N.HERSHEY-HUMMELSTOWN & N.HERSHEY,HUMM BNKS
  DISCONNECT BRANCH FROM BUS 204506 TO BUS 207988 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204506 TO BUS 204602 CIRCUIT 1
END
```

13. (METED) The Ironwood-South Lebanon 230 kV line (from bus 204518 to bus 204511 circuit 1) loads from 116.20% to 118.18% (DC power flow) of its normal rating (650 MVA) for non contingency condition. This project contributes approximately 12.90 MW to the thermal violation.

14. (METED) The North Temple-North Temple 230/69 kV transformer (from bus 204508 to bus 204607 circuit 6) loads from 143.07% to 151.89% (DC power flow) of its emergency rating (314 MVA) for the tower contingency 'C5_ME230-DCT-#3'. This project contributes approximately 27.69 MW to the thermal violation.

```
CONTINGENCY 'C5_ME230-DCT-#3'     /* N.TEMPLE-LYONS & N.TEMPLE-HOSENSACK 230 KV
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204503 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 207983 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204607 CIRCUIT 4
END
```

15. (METED) The North Temple-Lyons 230 kV line (from bus 204508 to bus 204503 circuit 1) loads from 103.42% to 108.68% (DC power flow) of its emergency rating (805 MVA) for the single contingency 'B_ME230-SX-#4'. This project contributes approximately 42.37 MW to the thermal violation.

```
CONTINGENCY 'B_ME230-SX-#4'     /* HOSENSACK-NORTH TEMPLE & NORTH TEMPLE BANK 6
  DISCONNECT BRANCH FROM BUS 207983 TO BUS 204508 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204607 CIRCUIT 4
END
```

16. (PJM) The Conastone-EMORY GR500 500 kV line (from bus 200004 to bus 200101 circuit 1) loads from 141.04% to 141.17% (DC power flow) of its emergency rating (2901 MVA) for the tower contingency 'CNSTN_NWESTA'. This project contributes approximately 38.08 MW to the thermal violation.

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

17. (PJM) The Conastone-EMORY GR500 500 kV line (from bus 200004 to bus 200101 circuit 1) loads from 117.25% to 117.41% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 23.38 MW to the thermal violation.

18. (METED/PL) The South Lebanon-Berks Bus 230 kV line (from bus 204511 to bus 207903 circuit 1) loads from 116.58% to 119.47% (DC power flow) of its emergency rating (554 MVA) for the tower contingency 'C5_ME230-DCT-#3'. This project contributes approximately 16.00 MW to the thermal violation.

```
CONTINGENCY 'C5_ME230-DCT-#3'     /* N.TEMPLE-LYONS & N.TEMPLE-HOSENSACK 230 KV
```

```
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204503 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 207983 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204607 CIRCUIT 4
END
```

19. (PJM/AP) The EMORY GR500-Kemptown 500 kV line (from bus 200101 to bus 235632 circuit 1) loads from 122.14% to 122.21% (DC power flow) of its emergency rating (2901 MVA) for the tower contingency 'CNSTN_NWESTB'. This project contributes approximately 38.43 MW to the thermal violation.

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

20. (BG&E) The Conastone-EMORY GRV230 230 kV line (from bus 220963 to bus 220400 circuit 1) loads from 128.60% to 128.68% (DC power flow) of its emergency rating (819 MVA) for the single contingency 'PP1EC'. This project contributes approximately 8.58 MW to the thermal violation.

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

21. (PL/BG&E) The Safe Harbor Units 3-4 Tap-Graceton 230 kV line (from bus 208071 to bus 220964 circuit 1) loads from 107.22% to 107.59% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 11.21 MW to the thermal violation.

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

22. (METED) The Three Mile Island-Jackson 1 230 kV line (from bus 204514 to bus 204502 circuit 1) loads from 106.07% to 107.37% (DC power flow) of its emergency rating (591 MVA) for the single contingency 'PJM17'. This project contributes approximately 7.69 MW to the thermal violation.

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

23. (METED) The X1-013 TAP-South Lebanon Tap 230 kV line (from bus 907100 to bus 204517 circuit 1) loads from 127.37% to 137.2% (DC power flow) of its emergency rating (805 MVA) for the tower contingency 'C5_ME230-DCT-#3'. This project contributes approximately 79.17 MW to the thermal violation.

```
CONTINGENCY 'C5_ME230-DCT-#3'     /* N.TEMPLE-LYONS & N.TEMPLE-HOSENSACK 230 KV
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204503 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 207983 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204607 CIRCUIT 4
END
```

24. (METED/PL) The North Temple-Hosensack-Ppl 230 kV line (from bus 204508 to bus 207983 circuit 1) loads from 146.45% to 157.11% (DC power flow) of its emergency rating (623 MVA) for the tower contingency 'C5_ME230-DCT-#2B_X1_013_A'. This project contributes approximately 66.39 MW to the thermal violation.

```
CONTINGENCY 'C5_ME230-DCT-#2B_X1_013_A'     /* N.HERSHEY-IRONWOOD-N.TEMPLE &
N.LEBANON-NORTHKIL 230 KV
  DISCONNECT BRANCH FROM BUS 204506 TO BUS 204517 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204517 TO BUS 907100 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204517 TO BUS 204518 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204507 TO BUS 907090 CIRCUIT 1
  DISCONNECT BUS 204517
END
```

25. (METED/PL) The North Temple-Hosensack-Ppl 230 kV line (from bus 204508 to bus 207983 circuit 1) loads from 130.03% to 136.76% (DC power flow) of its emergency rating (623 MVA) for the single contingency 'B_ME230-SX-#16'. This project contributes approximately 42.19 MW to the thermal violation.

```
CONTINGENCY 'B_ME230-SX-#16'     /* LYONS - NORTH TEMPLE 230 KV
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204503 CIRCUIT 1
END
```

26. (METED/PL) The North Temple-Hosensack-Ppl 230 kV line (from bus 204508 to bus 207983 circuit 1) loads from 118.40% to 124.53% (DC power flow) of its normal rating (491 MVA) for non contingency condition. This project contributes approximately 30.25 MW to the thermal violation.

New System Reinforcements

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

Note: Included in this section are those reinforcements that are required to facilities owned by FirstEnergy as well as those owned by affected Transmission Owners (e.g. PPL, BG&E). The reinforcements required on the FirstEnergy System are listed here but explained in detail in Attachment 4 of this report. The reinforcements that are on affected Transmission Onwers' system are explained in the text below. The reinforcements listed below and those on Attachment 4 are identified by numbers corresponding to the contingencies/violations listed above.

1. See Attachment 4
2. See note in Contingencies/Violations section above
3. No reinforcement required. See note above and in Attachment 4. PPL: PPL does not see any limitations; hence no reinforcement will be required.

4. No reinforcement required. See note above and in Attachment 4. PPL: PPL does not see any limitations; hence no reinforcement will be required
5. See note in Contingencies/Violations section above

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.)

Note: Included in this section are those reinforcements that are required to facilities owned by FirstEnergy as well as those owned by affected Transmission Owners (e.g. PPL, BG&E). The reinforcements required on the FirstEnergy System are listed here but explained in detail in Attachment 4 of this report. The reinforcements that are on affected Transmission Onwers' system are explained in the text below. The reinforcements listed below and those on Attachment 4 are identified by numbers corresponding to the contingencies/violations listed above.

6. BG&E: The overload can be alleviated by re-conductoring 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 total cost estimate of the reinforcement is approximately **$23, 600,000** and the time estimate for completion is about **6 years**.
7. See Attachment 4.
8. See Attachment 4.

9. For MetEd (FirstEnergy) portion of this reinforcement see Attachment 4.

   PPL Portion: PPL EU will 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 to conform the higher line ratings.PPL EU will require **24 months** to construct this upgrade after the ISA/CSA are signed. The total transmission and substation upgrade cost is **$1,300,000**.

10. PPL: 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: **$17,000,000.** Estimated in-service date**: October 2013**.

    BGE: The BG&E portion of the Conastone to Otter Creek line can be upgraded by re-conductoring 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 795kcm 30/19 ACSR from Gorsuch Mills to the PA State Line. Assumptions:

    Reconductor with 1,590kcm 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 previous estimate by R.W.M. for PJM (B48) study on circuit 22008
The estimated cost of this upgrade is **$700,000**. Estimated construction time is **36 months**.

11. See Attachment 4

12. See Attachment 4

13. See Attachment 4

14. See Attachment 4

15. See Attachment 4

16. See 19 below

17. See 19 below

18. See Attachment 4

19. 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. Estimated cost is **$3,000,000** and will take **24 to 36 months** to complete. New rating will be 3710.

20. BG&E: Construct a new double circuit 230kV line from Conastone-NW using 1590 MCM conductor. Total cost estimated at **$ 54,700,000** and with an estimated **72-84** months to complete. A CPCN will be required.
(This estimate is based on a cursory review of BGE land for transmission lines. A detailed study will be conducted when the facility study is done. Proposed work is: Conastone - install two new bays with 2 bus breakers: $3,600,000. Northwest sub - install (2) 230KV breakers on existing foundations: $700,000. Note, these breakers are 63kA. Line: 230KV line length 23.7 miles. ROW land - purchase and clear 80' x 3 miles RW (10 acres) for a 230KV double Circuit line: $3,000,000 or $300K per acre. Build a 230KV double Circuit. Line $47,400,000 or $2,000,000 per mile. Total for line: $50,400,000)

21. PPL: A PPL 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). Estimated cost: **$22,700,000.** Estimated in-service date: **November 2013**
BG&E: Remove sag limitation rate to 550 MVA from Graceton to PA line. Estimated cost **$500,000** and **36 months** estimated time to complete. Existing circuit 2303 is 795 kcm 30/19 ACSR@125C. Estimates assume line is 1.4 miles long.

22. See Attachment 4

23. See Attachment 4

24. See Attachment 4

25. See Attachment 4

26. See Attachment 4

Short Circuit

PJM has completed the short circuit analysis of the X3-006 queue project North Temple 230 kV. One option was considered during this study: the option was a direct connection to N. TEMPLE 230 kV substation. Our analysis found no new breakers to be over-duty in the METED transmission area.

The study also showed no significant fault current contribution (i.e. above 3%) for the already identified over-duty breakers. This study was performed on the 100 kV and above system.

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*.

27. (BG&E) The North West 2311 & 2310-Granite 2311 & 2312 230 kV line (from bus 220962 to bus 220972 circuit 1) loads from 156.00% to 156.24% (DC power flow) of its emergency rating (621 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 9.57 MW to the thermal violation.

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

28. (METED) The X1-013 TAP-North Lebanon 230 kV line (from bus 907090 to bus 204507 circuit 1) loads from 111.95% to 119.53% (DC power flow) of its emergency rating (554 MVA) for the operational contingency 'B_ME230-SX-#11_X1_013_A'. This project contributes approximately 41.95 MW to the thermal violation.

```
CONTINGENCY 'B_ME230-SX-#11_X1_013_A'     /* IRONWOOD TAP - N.HERSHEY,N.TEMPLE &
IRONWOOD 230 KV
  DISCONNECT BRANCH FROM BUS 204506 TO BUS 204517 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204517 TO BUS 907100 CIRCUIT 1
```

```
  DISCONNECT BRANCH FROM BUS 204517 TO BUS 204518 CIRCUIT 1
  DISCONNECT BUS 204517
END
```

29. (BG&E) The Conastone-EMORY GRV230 230 kV line (from bus 220963 to bus 220400 circuit 2) loads from 136.18% to 136.37% (DC power flow) of its emergency rating (941 MVA) for the operational contingency 'PP1EC'. This project contributes approximately 11.84 MW to the thermal violation.

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

30. (PL/METED) The Brunner Island Bus-Yorkana 230 kV line (from bus 207922 to bus 204515 circuit 1) loads from 147.97% to 148.27% (DC power flow) of its emergency rating (617 MVA) for the operational contingency 'PJM17'. This project contributes approximately 11.72 MW to the thermal violation.

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

31. (PL/BG&E) The Otter Creek Switchyard-Conastone 230 kV line (from bus 208048 to bus 220963 circuit 1) loads from 156.56% to 157.02% (DC power flow) of its emergency rating (531 MVA) for the operational contingency 'PJM17'. This project contributes approximately 16.89 MW to the thermal violation.

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

32. (METED) The Ironwood-South Lebanon 230 kV line (from bus 204518 to bus 204511 circuit 1) loads from 112.08% to 115.36% (DC power flow) of its emergency rating (805 MVA) for the operational contingency 'B_ME230-SX-#31'. This project contributes approximately 26.36 MW to the thermal violation.

```
CONTINGENCY 'B_ME230-SX-#31'     /* N.HERSHEY-HUMMELSTOWN & N.HERSHEY,HUMM BNKS
  DISCONNECT BRANCH FROM BUS 204506 TO BUS 207988 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204506 TO BUS 204602 CIRCUIT 1
END
```

33. (METED) The Ironwood-South Lebanon 230 kV line (from bus 204518 to bus 204511 circuit 1) loads from 116.03% to 118.73% (DC power flow) of its normal rating (650 MVA) for non contingency condition. This project contributes approximately 17.59 MW to the thermal violation.

34. (BG&E) The North West 2326 & 2322-Granite 2326 & 2332 230 kV line (from bus 220961 to bus 220973 circuit 1) loads from 128.98% to 129.18% (DC power flow) of its emergency rating (728 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 9.18 MW to the thermal violation.

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

35. (BG&E) The Granite 2326 & 2332-Howard 2332 230 kV line (from bus 220973 to bus 220954 circuit 1) loads from 104.52% to 104.72% (DC power flow) of its emergency rating (728 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 9.32 MW to the thermal violation.

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

36. (METED/PL) The Yorkana-Otter Creek Switchyard 230 kV line (from bus 204515 to bus 208048 circuit 1) loads from 100.46% to 100.58% (DC power flow) of its emergency rating (793 MVA) for the operational contingency 'PJM17'. This project contributes approximately 13.02 MW to the thermal violation.

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

37. (METED) The North Temple-Lyons 230 kV line (from bus 204508 to bus 204503 circuit 1) loads from 101.99% to 109.16% (DC power flow) of its emergency rating (805 MVA) for the operational contingency 'B_ME230-SX-#4'. This project contributes approximately 57.77 MW to the thermal violation.

```
CONTINGENCY 'B_ME230-SX-#4'     /* HOSENSACK-NORTH TEMPLE & NORTH TEMPLE BANK 6
  DISCONNECT BRANCH FROM BUS 207983 TO BUS 204508 CIRCUIT 1
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204607 CIRCUIT 4
END
```

38. (PJM) The Conastone-EMORY GR500 500 kV line (from bus 200004 to bus 200101 circuit 1) loads from 146.29% to 146.43% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 31.89 MW to the thermal violation.

39. (PJM/AP) The EMORY GR500-Kemptown 500 kV line (from bus 200101 to bus 235632 circuit 1) loads from 101.51% to 101.65% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 33.44 MW to the thermal violation.

40. (BG&E) The Granite 2311 & 2312-Howard 2312 230 kV line (from bus 220972 to bus 220953 circuit 1) loads from 103.96% to 104.17% (DC power flow) of its emergency rating (728 MVA) for the operational contingency 'PP1EB'. This project contributes approximately 10.01 MW to the thermal violation.

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

41. (BG&E) The Conastone-EMORY GRV230 230 kV line (from bus 220963 to bus 220400 circuit 1) loads from 154.96% to 155.17% (DC power flow) of its emergency rating (819 MVA) for the operational contingency 'PP1EC'. This project contributes approximately 11.70 MW to the thermal violation.

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

42. (PL/BG&E) The Safe Harbor Units 3-4 Tap-Graceton 230 kV line (from bus 208071 to bus 220964 circuit 1) loads from 154.93% to 155.22% (DC power flow) of its emergency rating (485 MVA) for the operational contingency 'PJM17'. This project contributes approximately 15.29 MW to the thermal violation.

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

43. (METED) The Three Mile Island-Jackson 1 230 kV line (from bus 204514 to bus 204502 circuit 1) loads from 102.29% to 102.57% (DC power flow) of its emergency rating (591 MVA) for the operational contingency 'PJM17'. This project contributes approximately 10.48 MW to the thermal violation.

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

44. (METED/PL) The North Temple-Hosensack-Ppl 230 kV line (from bus 204508 to bus 207983 circuit 1) loads from 128.93% to 138.16% (DC power flow) of its emergency rating (623 MVA) for the operational contingency 'B_ME230-SX-#16'. This project contributes approximately 57.53 MW to the thermal violation.

```
CONTINGENCY 'B_ME230-SX-#16'     /* LYONS - NORTH TEMPLE 230 KV
  DISCONNECT BRANCH FROM BUS 204508 TO BUS 204503 CIRCUIT 1
END
```

45. (METED/PL) The North Temple-Hosensack-Ppl 230 kV line (from bus 204508 to bus 207983 circuit 1) loads from 118.01% to 126.41% (DC power flow) of its normal rating (491 MVA) for non contingency condition. This project contributes approximately 41.24 MW to the thermal violation.

Interconnected Transmission Owner's Analysis Results

The following was generated by FirstEnergy (Metropolitan Edison) the Interconnected Transmission Owner, based upon its analysis, as well as that of PJM, for mitigation of the project's impacts on the transmission and lower voltage system as applicable. It includes the costs and schedules for any system upgrades.
Costs for affected Transmission owners other than FirstEnergy are included and reported in the "New System Reinforcements" and "Contribution to Previously Identified System Reinforcements" sections of the "PJM Interconnection Study Results" above.

FirstEnergy Power Flow Analysis

A Power Flow study was conducted to determine the reliability impact of the proposed North Temple 230 kV (X3-006) Project on the FE Transmission System. This study was completed using a 2015 summer peak load power flow that contained a detailed representation of the Met-Ed transmission networks in the area of the proposed North Temple 230 kV (X3-006) Project. The North Temple 230 kV (X3-006) Project was evaluated at its requested Capacity output of 110 MW. The findings and the recommendations from this analysis are based on a contingency review that was performed to identify the facility loadings and/or voltage conditions that violate the ReliabilityFirst, PJM or FE Planning Criteria and are either directly attributable to this project or for which it will have a shared responsibility. As a part of this review, a simulation of all possible contingencies within the NERC and FE Planning Standards that are impacted by the North Temple 230 kV (X3-006) Project was conducted.

The results from the Power Flow Analysis are detailed on Attachment 3. As shown, several criteria violations were identified. The bulk transmission analysis identified the North Temple 230/ 69 kV transformer, North Hersey – Hummelstown 230 kV line, and North Lebanon – Copperstone 230 kV line components exceed their emergency ratings for contingency events. Further analysis of the bulk results revealed that both the North Temple 230/ 69 kV Transformer and the North Lebanon – Copperstone 230 kV line reinforcements are already addressed by a previous generator project and therefore the North Temple 230 kV (X3-006) Project will only be responsible for the cost associated with contributing to these violations. The North Hersey – Hummelstown 230 kV line was found to have a greater emergency rating than indicated in the load flow model. The bulk analysis also identified that the North Temple 230 kV (X3-006) Project contributes to previously identified overload constraints on the X1-013 Tap – North Lebanon, Brunner Island – Yorkana, Ironwood – South Lebanon, N. Temple – Lyons, South Lebanon – Berks, Three Mile Island – Jackson, X1-013 Tap – South Lebanon Tap, North Temple – Hosensack 230 kV lines and the North Temple 230/69 kV transformer. The sub-transmission analysis identified the North Temple – Lehigh Chemical Co. (837) 69 kV line exceeds its emergency rating for contingency events and was found to be directly attributable to the North Temple 230 kV (X3-006) Project. In addition, the sub-transmission analysis showed the North Temple 230 kV (X3-006) Project contributes to previously identified overload constraints on the North Temple – Riverview – Car Tech (836), North Temple – Rosedale – Muhlenburg (834), Outer Station – Muhlenburg (23), North Temple – Lehigh Cement Co. (837), Lehigh Cement Co. – St. Peters Tap – Lyons (838), and the Bernville – Northkill (835) 69 kV lines and the North Temple 230/69 kV transformer. All of the aforementioned constraints with their proposed reinforcements are identified on Attachment 4.

A Power Flow study was also conducted for the North Temple 230 kV (X3-006) Project's full Energy output of 150 MW. Reinforcements for the constraints identified for the full Energy output results are not mandatory. The results of this study identified several additional thermal constraints. However, all of the FE identified thermal constraints are resolved by the aforementioned Capacity related constraints and their associated required reinforcements.

Note that this report covers only the FE system constraints which were identified jointly by PJM and FE. The constraints and associated reinforcements for all other Transmission Owner utilities are not covered by this report.

Short Circuit and Dynamics Analysis

A short circuit analysis was conducted by PJM and FE Protection staff. This analysis resulted in no over-dutied breakers on the Metropolitan Edison system caused by the North Temple 230 kV (X3-006) Project.

In accordance with the PJM Feasibility Study process, the PJM staff is responsible for the performance of a dynamic analysis for the North Temple 230 kV (X3-006) Project. The results of these studies will be included in the PJM System Impact and/or Facility Study reports.

System Protection Analysis

There are no Direct Connection system protection requirements for the North Temple 230 kV (X3-006) Project. All Direct Connection system protection requirements are identified in the North Temple 230 kV (V4-020) Project report.

Metering

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

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

Compliance Issues

Interconnection Customer will be responsible for meeting all FE criteria as defined in the FE Requirements for Transmission Connected Facilities document referenced above. This includes the provision of a reactive power capability sufficient to maintain a composite power delivery for the facility at the interconnection point at a power factor from .95 leading (absorbing MVARs) to .90 lagging (producing MVARs).

Interconnection Customer will also be required to meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures for standards compliance. For example, the Developer will need to properly locate and report the over and under-voltage and over and under-frequency system protection elements for its units as well as the submission of the

generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE system.

FE Facility Network Upgrades and Costs

The results of the FE Power Flow analysis are shown on Attachment 3. As identified, there are several system constraints that are attributable to the North Temple 230 kV (X3-006) Project. A definition of the Network Upgrades required to mitigate the identified contingency overloads and their estimated costs are shown on Attachment 4. The total estimated cost for the upgrades is shown to be $199,255,231 including taxes (see summary for more details). However; in accordance with the procedures defined in the PJM Open Access Transmission Tariff and PJM Manuals the PJM staff will determine the Interconnection Customer cost allocation that will be assessed. A summary of both the constraining facilities attributed to this project and the Interconnection Customer cost will be defined in the PJM Feasibility Study Report.

Note that all cost data contained in this document should be considered as only ballpark estimates produced without a detailed engineering review. The applicant will be responsible for the actual cost of construction. FirstEnergy herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any connections to the transmission system.

Interconnection Customer Requirements

In addition to the FE facilities, Interconnection Customer will also be responsible for meeting all criteria as specified in the applicable sections of the "FE Requirements for Transmission Connected Facilities" document including the highlighted items defined in the North Temple 230 kV (V4-020) Project Impact Study report.

Summary

There will be no Direct Connection requirements for the North Temple 230 kV (X3-006) generation project. The Direct Connection requirements are covered under the North Temple 230 kV (V4-020) generation project scope. The Network Upgrades required to maintain reliability of the FE and PJM transmission systems and their associated costs are defined in Attachment 4. The Network Upgrade estimated cost which the North Temple 230 kV (X3-006) project is directly responsible for is **$3,883,400.** The FirstEnergy Network Upgrade estimated cost which the North Temple 230 kV (X3-006) project is found to contribute to is **$145,304,450**. Therefore, the total cost of the FirstEnergy facility upgrades attributable to the North Temple 230 kV (X3-006) Project is **$149,187,850**. Those reinforcements/upgrades required by all affected Transmission Owners sum to $123,000,000. That brings the project overall total to **$272,187,850.** This is the total cost of all reinforcements. The individual and aggregated costs allocated to this project will be provided in the System Impact Study report.

PJM will be responsible for determining the allocation of this total to Interconnection Customer in compliance with the existing procedures. Note that all costs stated in the paragraph above are presented without their associated CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of 32.43%. The FirstEnergy costs shown on Attachment 4 are presented alongside the CIAC taxes as well as added to the totals. The CIAC tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129.

Based on the extent and number of FE system upgrades required to support this project, it is expected to take a minimum of **three and a half (3.5) years** of continuous construction from the signing of an Interconnection Construction Service Agreement (ISA) to complete the FirstEnergy upgrades required for the North Temple 230 kV (X3-006) project. However, other affected Transmission Owners have work extending out for **6-7 years** after the signing of the ISA.

This report assumes that the Interconnection Customer will construct all facilities to the point of interconnection at the North Temple 230 kV substation. A further assumption is that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and that PJM will allow all transmission system outages when requested. Given the above information it would seem unrealistic to complete this construction by June 1, 2014. The construction timeline will be examined in greater detail in the System Impact and/or Facility Study reports. A preliminary payment is required for the first three months of the engineering design work that is related to the expansion of the North Temple 230 kV and 69 kV substations and the required attachment facilities.

Feasibility Study Contingency Analysis Results

Transmission Network Constraints

ID #	Contingency	Outage description	Overloaded Element	N/4-Hr Rating	Results MVA Flow
1	B_ME230-SX-#33	Northkill - North Temple & N.Temple XFMR 6	North Temple 230/69 kV Transformer #4	XXX/260	261.5
3	C5_ME230-DCT-#3	N. Temple - Lyons & N.Temple - Hosensack 230 kV	North Hershey - Hummelstown Transformer #2 230 kV line	XXX/574 (802)	574.5
4	C5_ME230-DCT-#2_X1_0	N.Hersey - Ironwood - N.Temple & Northkill - N.Temple 230 KV	North Lebanon-Copperstone / North Lebanon 230 kV line	XXX/554	559.4
		Contribution to Previously Identified Overloads			
7	C5_ME230-DCT-#2_X1_0	N.Hersey - Ironwood - N.Temple & Northkill - N.Temple 230 KV	X1-013 Tap - North Lebanon 230 kV line	XXX/554	703.9
8	B_ME230-SX-#11_X1_01	Ironwood Tap - N.Hersey, N.Temple & Ironwood 230 KV	X1-013 Tap - North Lebanon 230 kV line	XXX/554	651.7
9	PJM17	Conastone - Peach Bottom 500kV Line Outage	Brunner Island Bus-Yorkana 230 kV line	XXX/617	842.1
11	C5_ME230-DCT-#7	Middle Jct. - North Lebanon & Hummelstown - N.Hersey 230 KV	Ironwood - South Lebanon 230 kV line	XXX/805	1243.6
12	B_ME230-SX-#31	N.Hersey - Hummelstown & N.Hersey, Humm XFMR	Ironwood - South Lebanon 230 kV line	XXX/805	922.2
13	Base	No Contingency	Ironwood - South Lebanon 230 kV line	650/805	768.2
14	C5_ME230-DCT-#3	N. Temple - Lyons & N.Temple - Hosensack 230 kV	North Temple 230/69 kV Transformer #6	XXX/314	476.9
15	B_ME230-SX-#4	Hosensack - North Temple & N. Temple XFMR 6	North Temple - Lyons 230 kV line	XXX/805	874.9
18	C5_ME230-DCT-#3	N. Temple - Lyons & N.Temple - Hosensack 230 kV	South Lebanon - Berks Bus 230 kV line	XXX/554	661.9
22	PJM17	Conastone - Peach Bottom 500kV Line Outage	Three Mile Island - Jackson 1 (1051) 230 kV line	XXX/591	634.6
23	C5_ME230-DCT-#3	N. Temple - Lyons & N.Temple - Hosensack 230 kV	X1-013 Tap - South Lebanon Tap 230 kV line	XXX/805	1104.5
24	C5_ME230-DCT-#2B_X1_	N.Hersey - Ironwood - N.Temple & N.Lebanon - Northkill 230 KV	North Temple-Hosensack-Ppl (1003) 230 kV line	XXX/623	978.8
25	B_ME230-SX-#16	Lyons - North Temple 230 KV line	North Temple-Hosensack-Ppl (1003) 230 kV lin	XXX/623	852.0
26	Base	No Contingency	North Temple-Hosensack-Ppl (1003) 230 kV line	491/623	611.4

Sub-Transmission Network Constraints

H	b_ME230-SX-#19	LYONS - NORTH TEMPLE 230 KV	North Temple - Lehigh Cem Co. (837) 69 kV line	XXX/82	94
		Contribution to Previously Identified Overloads			
A	b_ME230-SX-#6	HOSENSACK-NORTH TEMPLE & NORTH TEMPLE TRANSFORMER 4	North Temple 230/69 kV Transformer #6	XXX/314	331
B	b_ME230-SX-34B	NORTHKILL-NORTH TEMPLE & N.TEMPLE TRANSFORMER #6	North Temple 230/69 kV Transformer #4	XXX/260	280
C	b_ME69R-LS-#37	NORTH TEMPLE-ROSEDALE 69 KV	North Temple - Riverview (836) 69 kV line	XXX/166	228
D	b_ME69R-LS-#37	NORTH TEMPLE-ROSEDALE 69 KV	Riverview - Car Tech (836) 69 kV line	XXX/130	202
E	b_ME69R-LS-#36	NORTH TEMPLE - RIVERVIEW 69 KV	Rosedale - Muhlenburg (834) 69 kV line	XXX/154	176
F	b_ME69R-LS-#36	NORTH TEMPLE - RIVERVIEW 69 KV	Outer Station - Muhlenburg (23) 69 kV line	XXX/86	93
G	b_ME69R-LS-#36	NORTH TEMPLE - RIVERVIEW 69 KV	North Temple - Rosedale (834) 69 kV line	XXX/120	191
H	b_ME230-SX-#19	LYONS - NORTH TEMPLE 230 KV	North Temple - Lehigh Cem Co. (837) 69 kV line	XXX/82	94
J	b_ME230-SX-#19	LYONS - NORTH TEMPLE 230 KV	Lehigh Cem Co. - St. Peters Tp (838) 69 kV line	XXX/64	75
K	b_ME230-SX-#19	LYONS - NORTH TEMPLE 230 KV	Moselem - Lyons (838) 69 kV line	XXX/64	82
L	b_ME230-SX-#6	HOSENSACK-NORTH TEMPLE & NORTH TEMPLE TRANSFORMER 4	Bernville - Northkill (835) 69 kV line	XXX/77	83

Attachment 4
Ontelaunee (X3-006) Project
FE Network Facility Upgrades

PJM Transmission Analysis							
Violation #	**Constraining Facility**	**Location**	**Constraining Equipment**	**Mitigation Upgrade**	**Total w/ tax**	**Cost**	**Tax**
1	North Temple 230/69 kV Transformer #4	North Temple Sub	Transformer (224 MVA Name Plate)	Intsall a Third 230/ 69 kV Transformer. (Reinforcement already required for a previous project. Refer to Contribution to Previously Identified Overloads.)	N/A	N/A	N/A
3	North Hershey - Hummelstown (1099) Transformer #2 230 kV line	N/A	None	Records indicate that this line FE line rating is 648 (Normal)/ 802 (Emergency) and therefore no violaiton exists.	N/A	N/A	N/A
4	North Lebanon-Copperstone / North Lebanon (1094) 230 kV line	N. Lebanon Sub	Circuit Breaker (1200A)	Replace with 3000A Circuit Breaker. (Reinforcement already required for a previous project. Refer to Contribution to Previously Identified Overloads.)	N/A	N/A	N/A
Contribution to Previously Identified Overloads							
7/8	X1-013 TAP-North Lebanon (1071) 230 kV line	N. Lebanon Sub	Circuit Breaker (1200A)	Replace with 3000A Circuit Breaker.			
			Current Transformers (1200A)	Upgrade/ Replace 109462 A, B CTs.[4]	886,000	663,400	222,600
9	Brunner Island Bus-Yorkana (1055) 230 kV line	Transmission Line	1590 ACSR Line Conductor	Reconductor to 1590 ACSS conductor (12.6 miles). Upgrade drop loops and limiting substation conductor.[3]			
			PPL Componenet Upgrades Required[5]		16,542,300	12,385,700	4,156,600
11/12/13	Ironwood - South Lebanon (1054) 230 kV line	Transmission Line	1590 ACSR Line Conductor	Install bundled 1590 ACSR conductor (2.85 miles). Upgrade drop loops and limiting substation conductor.[3]	12,953,600	9,698,700	3,254,900
		Ironwood Sub	1590 ACSR Substation Conductor	Install double 1590 ACSR for substation conductor in series with Line.			
			Disconnect Switch (2000A)	Install a 3000A Disconnect Switch	178,200	133,400	44,800
		S. Lebanon Sub	1590 ACSR Substation Conductor	Install double 1590 ACSR for substation conductor in series with Line.			
			2.5" AL Pipe	Install 3.5" AL Pipe			
			(2) Disconnect Switches (2000A)	Install two 3000A Disconnect Switch	245,100	183,500	61,600
14	North Temple 230/69 kV Transformer #6	North Temple Sub	Transformer (224 MVA Name Plate)	Intsall a Third 230/ 69 kV Transformer (224 MVA) - Install one new 230 KV Circuit Breaker in the N. Temple Ring. - Create a separate 69 kV bus.	See violation 'A' and 'B' for costs		

Attachment 4 (Continued)
Ontelaunee (X3-006) Project
FE Network Facility Upgrades

PJM Transmission Analysis							
Violation #	**Constraining Facility**	**Location**	**Constraining Equipment**	**Mitigation Upgrade**	**Total w/ tax**	**Cost**	**Tax**
15	North Temple - Lyons (1031) 230 kV line	Transmission Line	1590 ACSR Line Conductor	Reconductor to 1590 ACSS conductor (12.09 miles). Upgrade drop loops and limiting substation conductor.[3]	16,535,000	12,380,200	4,154,800
		Lyons Sub	1590 ACSR TL Line Conductor	Install double 1590 ACSR for substation conductor in series with Line.	56,600	42,400	14,200
18	South Lebanon - Berks Bus (1074) 230 kV line	Transmission Line	1033 ACSR Line Conductor	Reconductor to 1590 ACSR conductor (19.74 miles). Upgrade drop loops and limiting substation conductor.[3]	48,013,000	35,948,600	12,064,400
		South Lebanon Sub	Circuit Breaker (1200A)	Replace with 3000A Circuit Breaker.			
			Current Transformers (1200A)	Upgrade/ Replace 107422 A, B, C, D CTs.[4]	566,600	424,200	142,400
22	Three Mile Island - Jackson 1 (1051) 230 kV line	Transmission Line	1033 ACSR Line Conductor	Reconductor to 1590 ACSR conductor (3.97 miles). Upgrade drop loops and limiting substation conductor.[3]	10,446,100	7,821,300	2,624,800
		TMI Sub	1033 ACSR Substation Conductor	Install double 1590 ACSR for substation conductor in series with Line.	44,700	33,500	11,200
23	X1-013 Tap - South Lebanon Tap (1001) 230 kV line	Transmission Line	1590 ACSR Line Conductor	Install bundled 1590 ACSR conductor (0.91 miles). Upgrade drop loops and limiting substation conductor.[3]	4,193,800	3,140,000	1,053,800
24/25/26	North Temple-Hosensack-Ppl (1003) 230 kV line	Transmission Line	1108.6 ACAR Line Conductor	Reconductor to 1590 ACSS conductor (23.13 miles). Upgrade drop loops and limiting substation conductor.[3]	54,563,100	40,852,900	13,710,200
		Hosensack Sub	1590 ACSR Substation Conductor	Install double 1590 ACSR for substation conductor in series with Line.			
			1590 ACSR Substation Conductor	Install double 1590 ACSR for substation conductor in series with Line.			
			Circuit Breaker (2000A)	Replace with 3000A Circuit Breaker.			
			Relay Thermal Limit (RT - RFL9300)	Upgrade/ Replace RT - RFL9300 Relay.[4]			
			Meter Thermal Limit (DFR)	Upgrade/ Replace Meter (DFR).[4]	528,600	395,800	132,800

Attachment 4 (Continued)
Ontelaunee (X3-006) Project
FE Network Facility Upgrades

FE Sub-Transmission Analysis 69 kV							
Violation #	**Constraining Facility**	**Location**	**Constraining Equipment**	**Mitigation Upgrade**	**Total w/ tax**	**Cost**	**Tax**
H	North Temple - Lehigh Cem Co. (837) 69 kV line	Transmission Line	336 ACSR Line Conductor	Reconductor to minimum 556 ACSR conductor (5.2 miles)[1] Upgrade drop loops and limiting substation conductor.[2]	5,186,700	3,883,400	1,303,300
Contribution to Previously Identified Overloads							
A	North Temple 230/69 kV Transformer #6	N. Temple Sub	795 ACSR Substation Conductor 230/69 kV Transformer #6 (224MVA)	Intsall a Third 230/ 69 kV Transformer (224 MVA) - Install one new 230 KV Circuit Breaker in the N. Temple Ring. - Create a separate 69 kV bus.			
B	North Temple 230/69 kV Transformer #4	N. Temple Sub	230/69 kV Transformer #4 (224MVA)		11,589,400	8,677,300	2,912,100
C	North Temple - Riverview (836) 69 kV line	Transmission Line	795 ACSR Line Conductor	Build Parallel Car Tech - Riverview 69 kV line Car Tech Sub: - Install One 69 kV Circuit Breaker (2000 amp) - Install Two 69 kV Disconnect Switches (2000 amp) - Construct line end structure - Install System Protection, Metering, SCADA etc. New 69 kV Line: - Convert 3.17 miles of Car Tech - Riverview (836) 69 kV line to double circuit. Use 795 ACSR 26/7 wire for new circuit. - Connect new line into Riverview substation.[6] Riverview Sub: - Install two supervisory controlled line disconnect switches similar to 83626 on the new N.Temple - Car Tech 69 kV line at Riverview substation.			
		N. Temple Sub	OC JBC51 Relay (2) Disconnect Switches 1200A 2" Type B Cu Substation Pipe				
		Riverview Sub	1.5" SPS AL Substation Pipe (2) Disconnect Switches 1200A				
D	Riverview - Car Tech (836) 69 kV line	Transmission Line	556 AA & 795 ACSR Line Conductor		1,368,700	1,024,800	343,900
		Riverview Sub	556 AA Substation Conductor 1.5" SPS AL Substation Pipe				
		Car Tech Sub	795 ACSR Substation Conductor 1200A Circuit Breaker		4,232,800	3,169,200	1,063,600
E	Rosedale - Muhlenburg (834) 69 kV line	Transmission Line	556 & 795 ACSR Line Conductor				
		Rosedale Sub	556 ACSR Substation Conductor				
		Muhlenberg Sub	795 ACSR Substation Conductor				
F	Outer Station - Muhlenburg (23) 69 kV line	Muhlenberg Sub	350 Cu Substation Conductor		872,500	653,300	219,200
G	North Temple - Rosedale (834) 69 kV line	Transmission Line	795 ACSR Line Conductor				
		N. Temple Sub	556 ACSR Line Conductor 750 Cu Substation Conductor 1200A Circuit Breaker Relay Thermal (GCX17A)				
		Rosedale Sub	795 ACSR Line Conductor				

Attachment 4 (Continued)
Ontelaunee (X3-006) Project
FE Network Facility Upgrades

FE Sub-Transmission Analysis 69 kV							
Violation #	**Constraining Facility**	**Location**	**Constraining Equipment**	**Mitigation Upgrade**	**Total w/ tax**	**Cost**	**Tax**
H	North Temple - Lehigh Cem Co. (837) 69 kV line	Transmission Line	336 ACSR (19 Strd) Line Conductor	Reconductor to minimum 556 ACSR conductor (0.1 miles)[1] Upgrade drop loops and limiting substation conductor.[2]	76,900	57,600	19,300
		N. Temple Sub	336 ACSR & 350 Cu Substation Conductor	Install 954 ACSR substation conductor.[2]			
			Relay Thermal (JBC51M)	Upgrade/ Replace JBC51M Relay.[4]	144,900	108,500	36,400
J	Lehigh Cem Co. - St. Peters Tp (838) 69 kV line	Transmission Line	4/O ACSR Line Conductor	Reconductor to minimum 336 ACSR conductor (minimum size)[1] (1.71 miles). Upgrade drop loops and limiting substation conductor.[2]	1,224,900	917,100	307,800
K	Moselem - Lyons (838) 69 kV line	Transmission Line	4/O ACSR Line Conductor	Reconductor to minimum 336 ACSR conductor (4.17 miles).[1] Upgrade drop loops and limiting substation conductor.[2]	2,925,500	2,190,400	735,100
		Lyons Sub	4/O Cu Substation Conductor	Install 954 ACSR substation conductor.[2]			
			Relay Thermal (GXC51)	Upgrade/ Replace GXC51 Relay.[4]	139,600	104,500	35,100
L	Bernville - Northkill (835) 69 kV line	Bernville Sub	4/O Cu Substation Conductor	Install 954 ACSR substation conductor.[2]	48,900	36,600	12,300
C	N.Temple - Riverview (836) 69 kV Line	Transmission Line	795 ACSR Line Conductor	Build Parallel North Temple - Riverview 69 kV line N. Temple Sub: - Extend N.Temple 69 kV 8 Bus for second Riverview line - Install One 69 kV Circuit Breaker (2000 amp) - Install Two 69 kV Disconnect Switches (2000 amp) - Construct line end structure - Install System Protection, Metering, SCADA etc. New 69 kV Line: - Convert first .5 mile of North Temple - Riverview (836) 69 kV line to double circuit. Replace exsting poles. Use 795 ACSR 26/7 wire. - Utililize .7 miles of existing double circuit 69 kV structures for second North Temple - Riverview line - Use existing 556 AA wire. - Convert last .3 mile of North Temple - Riverview (836) 69 kV line to double circuit. Replace structures. Use 795 ACSR wire. - Connect new line into Riverview as a radial feed (normally open 83629 line disconnect switch) Riverview Sub: - Install two supervisory controlled line disconnect switches similar to 83629 on the new N.Temple - Car Tech 69 kV line at Riverview for backup of the new radial feed and line to Car Tech. N.Temple - Riverview (869) 69 kV Line Reconfiguration - Bypass of the Riverview substation - Connect to the Car Tech I(869) 69 kV line. Relocate Berkley - Riverview (797) 34.5 kV Line - Construct new .7 mile 34.5 kV line for the section of the Berkely - Riverview (797) circuit removed from the 69 kV structures. (Note that there is a Route 61 cloverleaf that must be spanned.)	1,254,700	939,400	315,300
		N. Temple Sub	OC JBC51 Relay				
			(2) Disconnect Switches 1200A		3,430,900	2,568,800	862,100
			2" Type B Cu Substation Pipe				
		Riverview Sub	1.5" SPS AL Substation Pipe		871,600	652,600	219,000
			(2) Disconnect Switches 1200A		77,931	58,350	19,581

Attachment 4 (Continued)
Ontelaunee (X3-006) Project
FE Network Facility Upgrades

FE Sub-Transmission Analysis 69 kV							
Violation #	**Constraining Facility**	**Location**	**Constraining Equipment**	**Mitigation Upgrade**	**Total w/ tax**	**Cost**	**Tax**
G	North Temple - Rosedale (834) 69 kV line	N. Temple Sub	556 ACSR Line Conductor	Replace limiting 556 ACSR and 750 CU substation conductor with 954 ACSR conductor.[2]			
			750 Cu Substation Conductor				
			1200A Circuit Breaker				
			Relay Thermal (GCX17A)				
		Rosedale Sub	795 ACSR Line Conductor		56,600	42,400	14,200
				Total Costs (Directly Attributible):	5,186,700	3,883,400	1,303,300
				Total Costs (Contribution To):	194,068,531	145,304,450	48,764,081
				Total Cost:	**199,255,231**	**149,187,850**	**50,067,381**