Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position W4-009

Raritan River 230kV

October 2011

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 combined cycle generating facility located in Woodbridge, New Jersey. The installed facilities will have a Maximum Facility Output of 725 MW with 725 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is May 15, 2015. **This study does not imply a First Energy commitment to this in-service date.**

Point of Interconnection

W4-009 will interconnect with the transmission system at one of two options. Option 1 is to connect to the Jersey Central Power & Light transmission system at the Raritan River 230kV substation. Option 2 is to connect to the PSEG transmission system at the Metuchen 230kV substation.

FirstEnergy Analysis

Based on a review by the FE Substation Engineering group, due to space constraints at the peninsular Raritan River 230 substation the Raritan River 115 kV substation will need to be physically moved to make room for the W4-009 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 proposal is to remove the remaining 69 kV facilities and constructing a new seven breaker 115 kV ring bus substation using the existing facilities where possible. With the movement and removal of these 115 kV facilities, the additional space needed to accommodate the W4-009 Project connection to the 230 kV substation will be created. 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 required for this reconfiguration. The Interconnection Customer will also be responsible for constructing the radial attachment line and the W4-009 Project substation in compliance with the FE Requirements for Transmission Connection Facilities.

In summary, Attachment 2 shows an aerial view of the Raritan River substation with the location of the 230 kV, 115 kV and now retired 69 kV facilities identified. Attachment 3 shows a simplified one line diagram of the Raritan River 230 kV and 115 kV substations as exists in the current configuration. Attachment 4 shows a conceptual one line of the proposed expansion of the Raritan River 230 kV substation and the relocation of the 115 kV substation that will be required to accommodate the W4-009 Project attachment. As identified, the Interconnection Customer will be expected to extend the project radial connection line to a riser pole or structure adjacent to the 230 kV substation position identified. Since the W4-009 Project substation is not located within the Jersey Central service territory, the project construction and station power may need to be provided from Public Service. An overview summary of the W4-009 Project Direct Connection facilities that will be required and their estimated cost are shown on Attachment 5.

Power Flow Analysis

A Power Flow study was conducted to determine the reliability impact of the proposed W4-009 Project on the FE Transmission System. This included the performance of a contingency analysis to identify any facility overload or voltage condition that violates the FE Planning Criteria. Any violation found that is either directly attributable to this project or for which it will have a shared responsibility is included in this report with a least cost plan identified to mitigate them.

The W4-009 Project Power Flow Analysis that was performed was completed using a 2014 summer peak load base case power flow provided by the PJM staff. This base case included a detailed representation of the Jersey Central transmission system in the area of the Raritan River 230 kV substation. A simulation of all possible contingencies within the NERC and FE Planning Standards that are impacted by the W4-009 Project was conducted to test for criteria compliance.

The results from the study Power Flow Analysis showing a comparison of the FE and PJM contingency study results is detailed on Attachment 6. As shown, the conclusion from this analysis is that there are no Jersey Central upgrades required for the W4-009 Project beyond the Direct Connection facilities. However, the FE findings show that The Raritan River - Kilmer (I1023) kV line can be contingency overloaded if all generation in the area is modeled at full

output. Since this is an unlikely event considering unit forced outage rates, the W4-009 Project will not be required to upgrade this facility.

Short Circuit and Dynamics Analysis

A short circuit analysis was conducted by PJM and confirmed by the FE Protection staff. This analysis showed that bus faults can occur that cause five Raritan River 230 kV (W1037E, W1037F, B27, B28, BK15) and two Red Oak 230 kV (T1034, G1047) breakers to exceed their rated current interrupting capability with the addition of the W4-009 Project. The estimated cost to upgrade these breakers is described in the Network Analysis section of this report.

In accordance with the RTEP Impact Study process, the PJM staff is responsible for the performance of a dynamic analysis for the W4-009 Project. The results of these studies will be included in the PJM Impact Study report that is issued.

System Protection Analysis

An analysis was conducted to assess the impact of the W4-009 Project on the system protection requirements in the area. The results of this review show that the following relay additions and upgrades will be required:

Raritan River Substation

Raritan River – Combine Cycle Generator (W4-009)

- (2) sets of Fiber from Raritan River substation to the W4-009 Combined Cycle Generator.
- 16 Point Analog DFR
- Arbiter 1094B (GPS time clock)
- Satec metering

Connection to Generating Plant

- If the plant is connected to the same ground grid as the substation two hard-wired differential relays may be used. (2) SEL-587Z
- If the plant is not connected to the same ground grid as the substation fiber optic differential relays are required. (SEL-387L & SEL-311L) Two independent fiber optic cables/paths are required.

230kV Breakers

- (2) SEL-352, BFT
- (1) SEL-279H-2, Reclosing

E Bus Differential Relay

- (1) SEL-587Z, Backup Differential

Metering

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. These FE requirements are detailed on Attachment 8 of this report.

Compliance Issues

The Interconnection Customer will be responsible for meeting all FE criteria as defined in the FE Requirements for Transmission Connected Facilities document. 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 between .95 leading (absorbing MVARs) and .90 lagging (producing MVARs).

The Interconnection Customer must also meet all PJM, Reliability*First* and NERC reliability criteria and operating procedures required 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 Reliability*First* 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.

Network Impacts

Queue project W4-009 was studied as a(n) 725.0 MW (725.0 MW of which was Capacity) injection into JCPL's system. Project W4-009 was evaluated for compliance with reliability criteria for summer peak conditions in 2014.

Option 1: RAR RVR 230.0 kV substation

Potential transmission network impacts are as follows:

Generator Deliverability

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

1. (PL/BG&E) The Safe Harbor Units 3-4 Tap-Graceton 230 kV line (from bus 208071 to bus 220964 ckt 1) loads from 94.54% to 95.96% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 42.77 MW to the thermal violation.

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

2. (PECO/BG&E) The Cooper-Graceton 230 kV line (from bus 214089 to bus 220964 ckt 1) loads from 136.89% to 138.7% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 55.49 MW to the thermal violation.

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

3. (BG&E) The BAGLEY13-Raphael Road 230 kV line (from bus 220999 to bus 220980 ckt 1) loads from 145.79% to 146.85% (DC power flow) of its emergency rating (674 MVA) for the tower contingency 'CNSTN_NWEST'. This project contributes approximately 44.22 MW to the thermal violation.

```
CONTINGENCY 'CNSTN_NWEST'
     /* CONASTONE TO NORTHWEST CKTS #2310 & #2322
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220962 CKT 1
     /* CONASTONE TO NORTHWEST CKT#2310
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220961 CKT 1
     /* CONASTONE TO NORTHWEST CKT #2322
END
```

4. (PL/BG&E) The Otter Creek Switchyard-Conastone 230 kV line (from bus 208048 to bus 220963 ckt 1) loads from 119.69% to 121.13% (DC power flow) of its emergency rating (531 MVA) for the single contingency 'PJM17'. This project contributes approximately 47.10 MW to the thermal violation.

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

5. (PJM) The Peach Bottom-Conastone 500 kV line (from bus 200013 to bus 200004 ckt 1) loads from 136.98% to 138.23% (DC power flow) of its emergency rating (2815 MVA) for the single contingency 'PJM67'. This project contributes approximately 217.28 MW to the thermal violation.

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

6. (PJM) The Peach Bottom-Conastone 500 kV line (from bus 200013 to bus 200004 ckt 1) loads from 136.93% to 138.42% (DC power flow) of its normal rating (2490 MVA) for non contingency condition. This project contributes approximately 229.38 MW to the thermal violation.

7. (PECO) The Nottingham-Nottingham Reactor 230 kV line (from bus 213844 to bus 213846 ckt 1) loads from 108.27% to 109.67% (DC power flow) of its emergency rating (627 MVA) for the single contingency 'PJM17'. This project contributes approximately 55.49 MW to the thermal violation.

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

8. (PECO) The Nottingham Reactor-Peach Bottom 230 kV line (from bus 213846 to bus 213869 ckt 1) loads from 108.27% to 109.66% (DC power flow) of its emergency rating (627 MVA) for the single contingency 'PJM17'. This project contributes approximately 55.49 MW to the thermal violation.

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

9. (BG&E) The Graceton-BAGLEY13 230 kV line (from bus 220964 to bus 220999 ckt 1) loads from 129.83% to 130.72% (DC power flow) of its emergency rating (802 MVA) for the tower contingency 'CNSTN_NWEST'. This project contributes approximately 44.22 MW to the thermal violation.

```
CONTINGENCY 'CNSTN_NWEST'
     /* CONASTONE TO NORTHWEST CKTS #2310 & #2322
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220962 CKT 1
     /* CONASTONE TO NORTHWEST CKT#2310
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220961 CKT 1
     /* CONASTONE TO NORTHWEST CKT #2322
END
```

10. (BG&E) The Glen Arm 110512-Windy Edge 1 115 kV line (from bus 221090 to bus 221089 ckt 1) loads from 112.54% to 113.5% (DC power flow) of its emergency rating (156 MVA) for the tower contingency 'CNSTN_NWEST'. This project contributes approximately 9.25 MW to the thermal violation.

```
CONTINGENCY 'CNSTN_NWEST'
     /* CONASTONE TO NORTHWEST CKTS #2310 & #2322
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220962 CKT 1
     /* CONASTONE TO NORTHWEST CKT#2310
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220961 CKT 1
     /* CONASTONE TO NORTHWEST CKT #2322
END
```

11. (PECO) The Peach Bottom-Cooper 230 kV line (from bus 213869 to bus 214089 ckt 1) loads from 139.96% to 141.77% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 55.49 MW to the thermal violation.

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

12. (PL/METED) The Brunner Island Bus-Yorkana 230 kV line (from bus 207922 to bus 204515 ckt 1) loads from 120.16% to 121.11% (DC power flow) of its emergency rating (617 MVA) for the single contingency 'PJM17'. This project contributes approximately 37.42 MW to the thermal violation.

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

13. (PJM/METED) The Three Mile Island-Three Mile Island 500/230 kV transformer (from bus 200016 to bus 204514 ckt 2) loads from 114.07% to 115.13% (DC power flow) of its emergency rating (1072 MVA) for the single contingency 'PJM17'. This project contributes approximately 70.09 MW to the thermal violation.

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

New System Reinforcements

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

1. Line rated 559/674. There are substation limitations at Graceton that will be removed with project b0497

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.)

2. PECO portion: Reconductor Line 220-93 from Cooper Substation to Graceton Substation to get a minimum summer emergency rating of 725 MVA. The line is approximately 4 miles long. This cost is for the PECO portion only. The estimated cost to perform this wrk is **$2,800,000**, and will require 24 months to complete.

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

   Total estimated cost for reinforcement: $6,800,000

3,9. This upgrade requires Graceton station to add 6-230kV breakers with an estimated cost of **$10,000,000** and Raphael Road station to add 6-230kV breakers **$10,000,000**. It also requires rebuilding Graceton to Raphael Rd to double circuit 2-conductor bundled with an estimated cost of **$30,000,000**. This work would take an estimate of 2-3 years for the substation work concurrently with 5-6 years for the line work.

Total estimated cost for reinforcement: $50,000,000

4. The magnitude cost estimate to rebuild PPL's portion of the Otter Creek - Conastone 230kV line is **$0**. PPL has recently submitted plans to PJM to rebuild the Otter Creek - Conastone 230kV line as part of a modernization project (submitted to PJM as supplemental project S0233). This project is tentatively scheduled to be complete by May 2013. The S0233 upgrade will consist of rebuilding approximately 12 miles of 795 kcmil 30/19 ACSR (current ratings 425/531MVA Summer Normal/Summer Emergency based on conductor temp @ 125 Deg C) with new 1590 kcmil 45/7 ACSR or equivalent (new ratings 653/793MVA Summer Normal/Summer Emergency based on conductor temp @ 125 Deg C). The new circuit will be designed for double circuit but built single circuit initially. Existing structures will need to be removed and rebuilt as part of this upgrade. This does not include rebuilding of the remaining ~5 miles of the BG&E portion of the line or the upgrade of any substation terminal equipment required at Conastone 230 kV substation. BG&E will need to provide comments on the proposed upgrade and the associated cost estimate.

BGE portion of Otter Creek to Conastone 230 kV line: Otter Creek to Conastone 230Kv line 4.7 mile total rebuild 2302 to Pa Border. New rating 648/802. Total time 60 months cost $19 million. Notes: Rebuild to 230Kv single 1590 MCM conductor circuit cost **$19,000,000**, 36 – 48 months to complete. CPCN require adds about 18 months.

Total estimated cost for reinforcement: $19,000,000

5,6. Conastone to Peachbottom 500 kV line 2nd line. Total Cost **$56,700,000,** ~ 7 yrs. rating 2939/3733

Notes: Line estimate
Build new 500 kV line adjacent to circuit 5012 from Conastone to PA line - $48M ~ 7 yrs.

Assumptions: Acquire 150 ft. wide R/W adjacent to existing R/W, mostly rural land at $100,000 per acre. 2 - 3 year CPCN process prior to land acquisition. Length of line 9.6 miles

7. Replace Line 220-08 reactor and by-pass circuit switcher at Nottingham substation to get a minimum summer emergency rating of 741 MVA. The estimated cost to perform this work is **$1,700,000**, and will require 24 months to complete.

8. 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. The estimated cost to perform this work is **$10,000,000**, and will require 48 months to complete.

10. Upgrade wire drop terminations at Windy Edge. The estimated cost to perform this work is **$200,000** and will require 12 months to complete.

11. Reconductor Line 220-08 from PB Tap to Cooper Substation to get a minimum summer emergency rating of 741 MVA. The line is approximately 1.4 miles long. The estimated cost to perform this work is **$1,000,000**, and will require 24 months to complete.

12. PPL: To relieve the Brunner – Yorkana 230kV line overload due to the IPPs X2-013 and X2-074 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**.

    ME: FirstEnergy is determining the cost of this upgrade. This number will be provided, along with the appropriate cost allocation, in System Impact Study report.

13. To mitigate the 3 MILE I-TMI 500/230kV (METED) transformer overload would require the addition of a second 500/230kV transformer at TMI as well as transmission line upgrades between the 230kV and 500kV substations. The estimated cost to perform this work is **$15,000,000** and will take 36 months to complete.

Short Circuit

(Report over-dutied breakers.)

PJM analysis found 9 new breakers, to be over-duty in the JCPL transmission area. The new over-duty breakers are listed below:

Bus Number	Bus	Breaker	Rating Type	Duty Percent With W4-009	Duty Percent Without W4-009	Duty Percent Difference
0	RARTN RV 230.kV	W1037E	S	115.20%	90.60%	24.60%
0	RARTN RV 230.kV	W1037F	S	115.20%	90.60%	24.60%
0	RARTN RV 230.kV	NEPTUNE B27	S	111.30%	86.70%	24.60%
0	RARTN RV 230.kV	NEPTUNE B28	S	111.30%	86.70%	24.60%
0	RED OAK 2881 230.kV	T1034	S	107.70%	96.60%	11.10%
0	RED OAK 2882 230.kV	G1047	S	107.00%	95.80%	11.20%
90320	G07_MTX1H 230.kV	4 OTHER BRKR	S	105.50%	85.00%	20.50%
90320	G07_MTX1H 230.kV	NY LINE	S	101.10%	82.50%	18.60%
90320	G07_MTX1H 230.kV	RAR RVR LINE	S	101.10%	82.50%	18.60%

The total estimated costs to replace the circuit breakers at Raritan River (W1037E, W1037F, and BK15) and the circuit breakers at Red Oak (T1034 and G1047) to circuit breakers rated for 63 kA interrupting capability and to replace the circuit breakers at Raritan River (B27 and B28) to circuit breakers rated for 80 kA interrupting capability is **$3,436,100**.

In addition, the analysis also showed a significant fault contribution (i.e. above 3%) to 11 breakers, which were already identified as over-duty. The breakers are listed below:

Bus Number	Bus	Breaker	Rating Type	Duty Percent With W4-009	Duty Percent Without W4-009	Duty Percent Difference
0	RARTN RV 230.kV	G1047E	S	139.70%	110.50%	29.20%
0	RARTN RV 230.kV	I1023E	S	139.70%	110.50%	29.20%
0	RARTN RV 230.kV	I1023F	S	139.70%	110.50%	29.20%
0	RARTN RV 230.kV	T1034E	S	139.70%	110.50%	29.20%
0	RARTN RV 230.kV	T1034F	S	139.70%	110.50%	29.20%
0	RARTN RV 230.kV	BK15	S	130.40%	101.30%	29.10%
0	RARTN RV 230.kV	G1047F	S	130.10%	100.70%	29.40%
0	RED OAK 2882 230.kV	MT1	S	118.80%	107.40%	11.40%
0	RED OAK 2881 230.kV	MT2	S	115.90%	104.80%	11.10%
0	RED OAK 2881 230.kV	MT3	S	115.90%	104.70%	11.20%
0	RED OAK 2882 230.kV	MT4	S	115.40%	104.10%	11.30%

The total estimated costs to replace the circuit breakers at Raritan River (G1047E, I023E, I023F, T1034E, T1034F, and G1047) to circuit breakers rated for 63 kA interrupting capability is **$2,193,800**.

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.

Option 2: METUCHEN 230.0 kV substation

Potential transmission network impacts are as follows:

Generator Deliverability

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

1. (PL/BG&E) The Safe Harbor Units 3-4 Tap-Graceton 230 kV line (from bus 208071 to bus 220964 ckt 1) loads from 94.50% to 95.92% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 42.61 MW to the thermal violation.

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

2. (PSEG) The Warinanco-Aldene 1 230 kV line (from bus 218316 to bus 217122 ckt 1) loads from 86.46% to 103.65% (DC power flow) of its emergency rating (831 MVA) for the single contingency 'PS52A'. This project contributes approximately 142.85 MW to the thermal violation.

```
CONTINGENCY 'PS52A'
  DISCONNECT BRANCH FROM BUS 218358 TO BUS 218469 CKT 1
     /* METUCHEN SEWAREN 230 230 / BUS 218311 -> 218358.
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.)

3. (PECO/BG&E) The Cooper-Graceton 230 kV line (from bus 214089 to bus 220964 ckt 1) loads from 136.88% to 138.69% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 55.66 MW to the thermal violation.

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

4. (BG&E) The BAGLEY13-Raphael Road 230 kV line (from bus 220999 to bus 220980 ckt 1) loads from 145.73% to 146.79% (DC power flow) of its emergency rating (674 MVA) for the tower contingency 'CNSTN_NWEST'. This project contributes approximately 44.21 MW to the thermal violation.

```
CONTINGENCY 'CNSTN_NWEST'     /* CONASTONE TO NORTHWEST CKTS #2310 &
#2322
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220962 CKT 1
     /* CONASTONE TO NORTHWEST CKT#2310
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220961 CKT 1
     /* CONASTONE TO NORTHWEST CKT #2322
END
```

5. (PL/BG&E) The Otter Creek Switchyard-Conastone 230 kV line (from bus 208048 to bus 220963 ckt 1) loads from 119.66% to 121.09% (DC power flow) of its emergency rating (531 MVA) for the single contingency 'PJM17'. This project contributes approximately 47.05 MW to the thermal violation.

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

6. (PJM) The Peach Bottom-Conastone 500 kV line (from bus 200013 to bus 200004 ckt 1) loads from 136.98% to 138.23% (DC power flow) of its emergency rating (2815 MVA) for the single contingency 'PJM67'. This project contributes approximately 218.24 MW to the thermal violation.

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

7. (PJM) The Peach Bottom-Conastone 500 kV line (from bus 200013 to bus 200004 ckt 1) loads from 136.92% to 138.42% (DC power flow) of its normal rating (2490 MVA) for non contingency condition. This project contributes approximately 230.46 MW to the thermal violation.

8. (PSEG) The Tosco Vft G22-Warinanco 230 kV line (from bus 218441 to bus 218316 ckt 1) loads from 117.58% to 119.8% (DC power flow) of its emergency rating (752 MVA) for the tower contingency '21PS'. This project contributes approximately 103.46 MW to the thermal violation.

```
CONTINGENCY '21PS'
     /* SEWAREN-WOODBRIDGE 138KV DCTL
  TRIP LINE FROM BUS 218320 TO BUS 216950
  TRIP LINE FROM BUS 218320 TO BUS 218355
  TRIP LINE FROM BUS 218355 TO BUS 218341
  TRIP LINE FROM BUS 218341 TO BUS 218311
  TRIP LINE FROM BUS 218400 TO BUS 218361
  TRIP LINE FROM BUS 218367 TO BUS 218400
  TRIP LINE FROM BUS 218367 TO BUS 218335
  TRIP LINE FROM BUS 218335 TO BUS 218314
  TRIP LINE FROM BUS 218400 TO BUS 218362
  MOVE 100 PERCENT LOAD FROM BUS 218380 TO BUS 218381
     /* FANWOOD T2 T1
  MOVE 100 PERCENT LOAD FROM BUS 218398 TO BUS 218399
     /* NEW DOVER T1 T2
  MOVE 50 PERCENT LOAD FROM BUS 218413 TO BUS 218414
     /* WOODBRIDGE T3 T1
  MOVE 50 PERCENT LOAD FROM BUS 218412 TO BUS 218414
     /* WOODBRIDGE T2 T1
  MOVE 100 PERCENT LOAD FROM BUS 218390 TO BUS 218391
     /* LAFAYETTE RD T2 T1
END
```

9. (PSEG) The Tosco Vft G22-Warinanco 230 kV line (from bus 218441 to bus 218316 ckt 1) loads from 115.70% to 117.92% (DC power flow) of its emergency rating (752 MVA) for the single contingency 'SEWAREN WDBRDG O'. This project contributes approximately 103.37 MW to the thermal violation.

```
CONTINGENCY 'SEWAREN WDBRDG O'
  DISCONNECT BRANCH FROM BUS 218311 TO BUS 218341 CKT 1
END
```

10. (PSEG) The Tosco Vft G22-Warinanco 230 kV line (from bus 218441 to bus 218316 ckt 1) loads from 113.14% to 114.96% (DC power flow) of its normal rating (653 MVA) for non contingency condition. This project contributes approximately 73.48 MW to the thermal violation.

11. (PECO) The Nottingham-Nottingham Reactor 230 kV line (from bus 213844 to bus 213846 ckt 1) loads from 108.26% to 109.66% (DC power flow) of its emergency rating (627 MVA) for the single contingency 'PJM17'. This project contributes approximately 55.66 MW to the thermal violation.

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

12. (PSEG) The Deans-Brunswick B 230 kV line (from bus 218306 to bus 218342 ckt 1) loads from 104.93% to 124.98% (DC power flow) of its emergency rating (740 MVA) for the single contingency 'BRUN_ED'. This project contributes approximately 148.39 MW to the thermal violation.

```
CONTINGENCY 'BRUN_ED'
     /* BRUNSWICK-EDISON 138KV
  TRIP LINE FROM BUS 218303 TO BUS 218330
  TRIP LINE FROM BUS 218330 TO BUS 218352
  TRIP LINE FROM BUS 218352 TO BUS 218315
  TRIP LINE FROM BUS 218352 TO BUS 218393
  TRIP LINE FROM BUS 218330 TO BUS 218327
  MOVE 100 PERCENT LOAD FROM BUS 218393 TO BUS 218392
  REMOVE UNIT 1 FROM BUS 218327
END
```

13. (PSEG) The Deans-Brunswick B 230 kV line (from bus 218306 to bus 218342 ckt 1) loads from 104.43% to 121.54% (DC power flow) of its normal rating (651 MVA) for non contingency condition. This project contributes approximately 111.37 MW to the thermal violation.

14. (PECO) The Nottingham Reactor-Peach Bottom 230 kV line (from bus 213846 to bus 213869 ckt 1) loads from 108.25% to 109.65% (DC power flow) of its emergency rating (627 MVA) for the single contingency 'PJM17'. This project contributes approximately 55.66 MW to the thermal violation.

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

15. (BG&E) The Graceton-BAGLEY13 230 kV line (from bus 220964 to bus 220999 ckt 1) loads from 129.78% to 130.67% (DC power flow) of its emergency rating (802 MVA) for the tower contingency 'CNSTN_NWEST'. This project contributes approximately 44.21 MW to the thermal violation.

```
CONTINGENCY 'CNSTN_NWEST'
     /* CONASTONE TO NORTHWEST CKTS #2310 & #2322
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220962 CKT 1
     /* CONASTONE TO NORTHWEST CKT#2310
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220961 CKT 1
     /* CONASTONE TO NORTHWEST CKT #2322
END
```

16. (BG&E) The Glen Arm 110512-Windy Edge 1 115 kV line (from bus 221090 to bus 221089 ckt 1) loads from 112.49% to 113.45% (DC power flow) of its emergency rating (156 MVA) for the tower contingency 'CNSTN_NWEST'. This project contributes approximately 9.24 MW to the thermal violation.

```
CONTINGENCY 'CNSTN_NWEST'
     /* CONASTONE TO NORTHWEST CKTS #2310 & #2322
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220962 CKT 1
     /* CONASTONE TO NORTHWEST CKT#2310
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 220961 CKT 1
     /* CONASTONE TO NORTHWEST CKT #2322
END
```

17. (PECO) The Peach Bottom-Cooper 230 kV line (from bus 213869 to bus 214089 ckt 1) loads from 139.95% to 141.76% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 55.66 MW to the thermal violation.

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

18. (PSEG) The Linden-Tosco 230 kV line (from bus 218300 to bus 218343 ckt 1) loads from 117.73% to 127.83% (DC power flow) of its normal rating (732 MVA) for non contingency condition. This project contributes approximately 73.98 MW to the thermal violation.

19. (PL/METED) The Brunner Island Bus-Yorkana 230 kV line (from bus 207922 to bus 204515 ckt 1) loads from 120.15% to 121.1% (DC power flow) of its emergency rating (617 MVA) for the single contingency 'PJM17'. This project contributes approximately 37.38 MW to the thermal violation.

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

20. (PJM/METED) The Three Mile Island-Three Mile Island 500/230 kV transformer (from bus 200016 to bus 204514 ckt 2) loads from 114.07% to 115.13% (DC power flow) of its emergency rating (1072 MVA) for the single contingency 'PJM17'. This project contributes approximately 70.95 MW to the thermal violation.

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

New System Reinforcements

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

Will be confirmed in the System Impact Study phase if Option 2 is selected.

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.)

None required.

Short Circuit

(Report over-dutied breakers.)

The study also showed no significant fault current contribution (i.e. above 3%) for the already identified over-duty breakers.

Energy Portion of Interconnection Request

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

Note: Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

No violations identified.

Interconnection Customer Requirements

In addition to the FE facilities, the 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:

1. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.

2. The purchase and installation of the standard voice grade (analog) telephone line and associated conduit between the telephone company source and the meter socket or enclosure.

3. The purchase and installation of a 230 kV interconnection metering instrument transformer. FE will provide the ratio and accuracy specifications based on the customer load and generation levels.

4. The purchase and installation of a revenue class meter for the Interconnection Customer unit to measure the power delivered in compliance with the FE standards.

5. A compliance with the FE and PJM generator power factor and voltage control requirements.

6. Since the location of the W4-009 Project is in Public Service territory, it will be the responsibility of the Interconnection Customer to arrange the agreements for local station and back up service in compliance with the existing PJM and State tariffs prior to energizing the connection line to the Raritan River substation.

7. The purchase and installation of supervisory control and data acquisition (SCADA) equipment to provide information in a compatible format to the FE Transmission System Control Center. The RTU, the communications channel and all related equipment will be furnished and maintained by the Interconnection Customer. The RTU must communicate with the FirstEnergy EMS via DNP 3.0 protocol.

8. The following status and metering points will be required:

    a. Interconnection breaker position.

    b. Generator real and reactive power output measured at the high-side of the generator step-up transformer.

    c. Generator voltage at the point of interconnection.

9. The establishment of dedicated communication circuits for SCADA report to the FE Transmission System Control Center.

10. The rough grade of the property for the Runyon 230 kV substation that is adjacent to the existing 230 kV right of way and an access road for the delivery of equipment to this site.

11. The construction of the 230 kV attachment line from the W4-009 Project site to a structure adjacent to the new Runyon 230 kV substation for its Direct Connection.

12. The Interconnection Customer will not excavate, construct facilities or locate its attachment line under the existing FE transmission facilities or on FE right-of-ways without the express permission of FE.

The above requirements are in addition to any metering required by PJM.

Summary

The W4-009 Project direct connection will require the facility upgrades defined in Attachment 5. As shown, the total estimated cost of the Raritan River 230 kV substation expansion and the relocation of the 115 kV substation is $18,270,500. Note that all costs given in this report include a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of 32.43%. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129.

The cost contributions related to the reinforcements described in the Network Analysis section will be provided as part of the System Impact Study.

Based on the extent and number of FE direct connection and system upgrades required to support this project, it is expected to take a minimum of three (3) years from the signing of a Connection Service Agreement to complete the upgrades required for the W4-009 Project. This includes a preliminary payment that compensates FE for the first three months of the engineering design work that is related to the expansion and reconfiguration of the Raritan River substation and the connection of the W4-009 Project attachment line. It also assumes that the Interconnection Customer will provide the property for the attachment substation and all right-of-way, permits, easements, etc. that will be needed. 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.

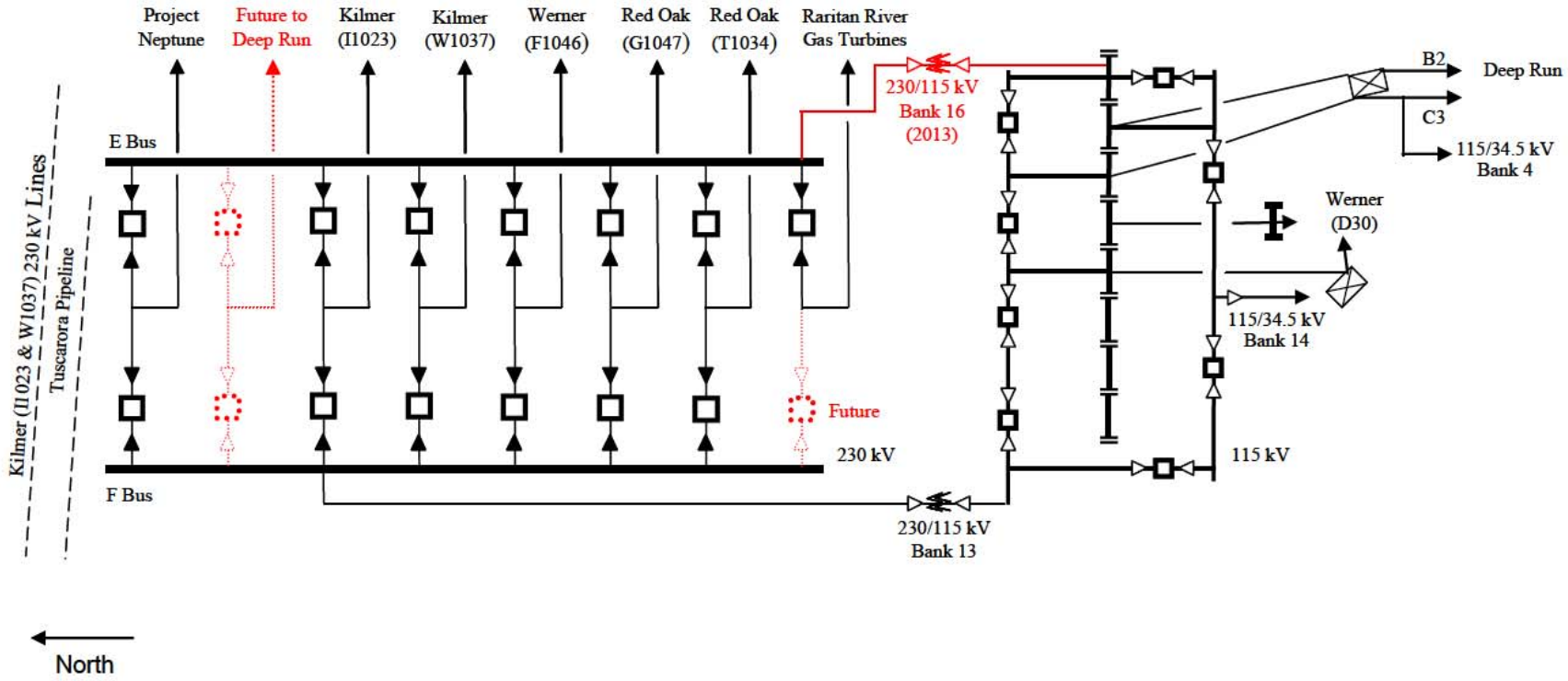
Note that the FE findings were made from a conceptual review of this project. A more detailed review of the connection facilities and their cost will be identified in the System Impact Study. Further note that the cost estimate data contained in this document should be considered as only ballpark since it was produced without a detailed engineering review. The applicant will be responsible for the actual cost of construction. FE 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.

Attachment 1
Site View

Attachment 2
Aerial View

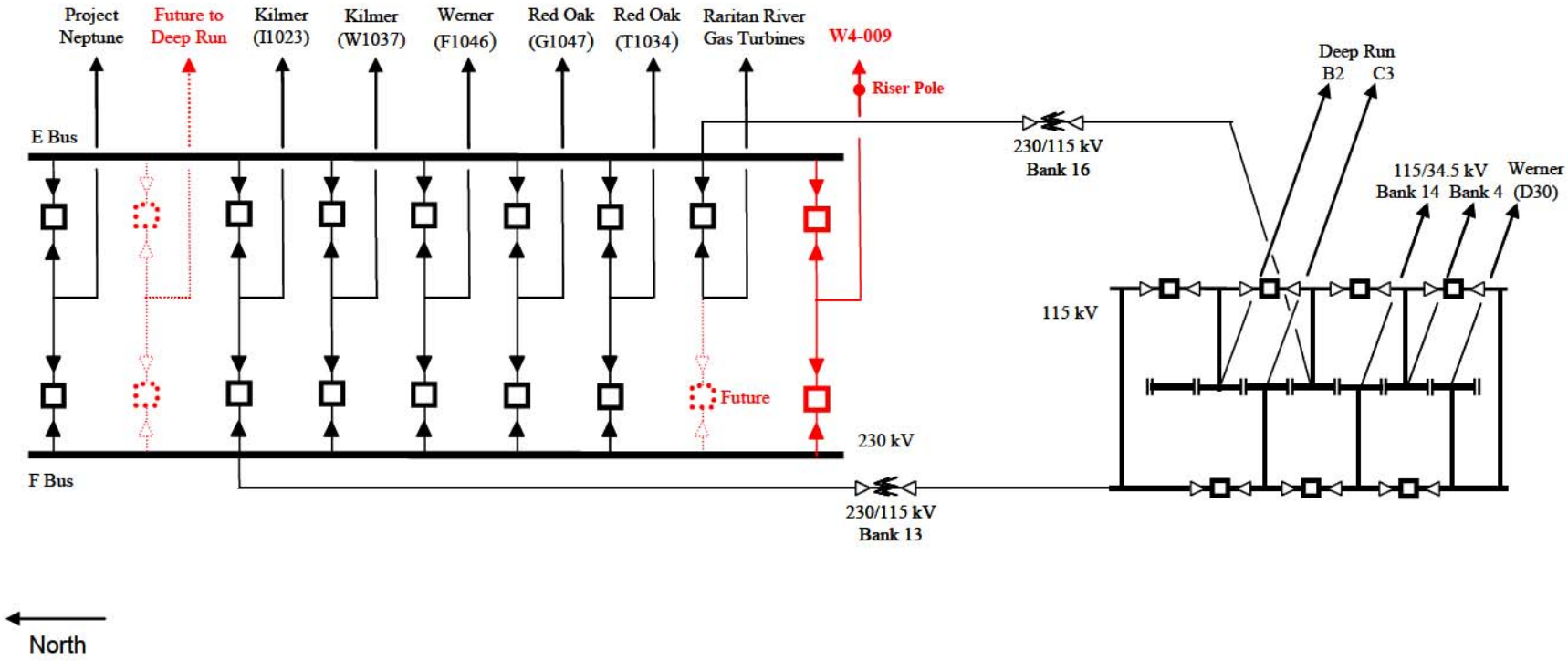
Attachment 3

Conceptual Layout of Existing Raritan River Substation



Attachment 4

Conceptual Reconfiguration of Raritan River Substation with W4-009 Project



Attachment 5
Direct Connection Requirements

Substation Facilities

Substation	Connection Facilities	Cost
Raritan River 230 kV	• Extend the 230 kV double breaker station bus facilities for a new position • Construct new center termination structure for the Project attachment • Interconnection Customer to provide all permits for construction in coordination with Jersey Central • Install two new 3000 amp 60 kA interrupting breakers • Install four new 3000 am disconnect switches • All substation conductor to be bundled (2) 1590 ACSR conductor • Provide fiber optic runs and control building facilities to support Project radial line connection • Install new fiber optic relay protection panels in control building • Miscellaneous metering, RTU, SCADA • Engineering oversight and commission support	
Raritan River 115 kV	• Construct a new seven breaker 115 kV substation • Remove existing 69 kV facilities and grade area • Remove existing 115kV facilities and grade area • Interconnection Customer to provide all permits for construction in coordination with Jersey Central • Construct 115 kV ring bus for seven attachments and one spare position • Install seven new 2000 amp 40 kA interrupting breakers • Install fourteen new 2000 amp disconnect switches • Construct termination structures for three lines and two transformers • Relocate all system protection and metering to new 115 kV substation • Miscellaneous metering, RTU, SCADA • Engineering oversight and commission support	
	Substation Costs:	**$ 12,874,000**
	Taxes:	**$ 4,175,000**
	Subtotal:	**$ 17,049,000**

Transmission Facilities

Substation	Connection Facilities	Cost
Raritan River – Woodbridge 230 kV	• Drop loop/bus conductor for line connections (250 feet each – bundled (2) 1590 Kcmil 54/19 ACSR) • Engineering oversight and commissioning support	
	Transmission Costs:	**$ 922,400**
	Taxes:	**$ 299,100**
	Subtotal:	**$ 1,221,500**

Total Direct Connection Substation and Transmission Costs: $ 13,796,400
Taxes: $ 4,474,100

Total Direct Connection Upgrade Cost: $ 18,270,500

Attachment 6

FirstEnergy Contingency Analysis Results

Identified New Project Upgrades

PJM #	FE Contingency	Outage Description	Overloaded Element	N/4-Hr Rating	FE Results MVA Flow	FE Results % Rating	PJM Results MVA Flow	PJM Results % Rating
None	b_NJC2-SX-#1	Raritan River – Kilmer – Lake Nelson (W1037) 230 kV	Raritan Rive – Kilmer (I1023) 230 kV	650 / 772	775	100.4	691.1	89.2
	c2_CNJ2-SB-#22	Raritan River – Kilmer – Lake Nelson – Middlesex (W1037) 230 kV	Raritan Rive – Kilmer (I1023) 230 kV		776	100.5		
	c2_CNJ2-SB-#25	Raritan River – Kilmer – Lake Nelson – Middlesex (W1037) & Raritan River BK13	Raritan Rive – Kilmer (I1023) 230 kV		790	102.3		

Contributions to Previously Identified Overloads

PJM #	Type	Outage Description	Overloaded Element	N/4-Hr Rating	FE Results MVA Flow	FE Results % Rating	PJM Results MVA Flow	PJM Results % Rating
13	PJM17	Conastone – Peach Bottom 500 kV	TMI 500/230 kV	840 / 1072	-	-	1234	115.1

*** Note**: The JM findings for the TMI 500/230 kV bank are based on RTEP project generation shifts that FE cannot model. However, the W4-009 Project contribution to the flow on the TMI 500/230 kV transformer was confirmed. Therefore, an increase of the TMI 500/230 kV bank flow from 114.07% to 115.13% of its emergency rating as reported by PJM is accepted.

Attachment 7

FirstEnergy Revenue Metering Requirements for Generation Facilities Connected 69 kV and Higher

This document addresses the revenue metering requirements for new generation-only facilities connected to FirstEnergy (FE) system voltages 69 kV and higher. This document is not intended for existing retail or wholesale load facilities where behind-the-meter generation is being installed.

The Interconnection Customer (IC) shall install, own, operate, test, and maintain the necessary revenue metering equipment. This includes current transformers, voltage transformers, mounting structures, wiring, meters, communication circuits, and associated devices. The metering equipment must meet the specifications listed in the FE and PJM connection documents.

The revenue metering equipment shall be located at the generation facility on the high voltage side of the generator step-up transformers or facility main step-up transformer and/or station service power transformers. Power flows to and from the facility shall be compensated to the Point of Interconnection.

FE will provide revenue metering equipment for a station service power supply at a generation facility if the supply is from the local FE distribution system.

The revenue metering equipment shall be capable of collecting and storing bidirectional billing data. The billing data shall be stored in intervals specified by FE, typically fifteen minutes or thirty minutes. The IC must provide FE with remote access to the billing data in the revenue meter via a dedicated voice-grade analog telephone circuit. The IC shall provide FE with contact information for the person or persons responsible for meter programming and metering equipment maintenance.

The IC shall consult with FE regarding the revenue metering system design and provide the following information:

- Facility one line and revenue metering installation drawings (schematics, wiring diagrams, etc.)
- Estimated power flows to and from the facility at all revenue metering points
- Current transformer and voltage transformer specifications, including manufacturer, type, nameplate drawings, and certified accuracy test reports
- Revenue meter specifications including manufacturer, type, model number, and accuracy
- Revenue meter program information including but not limited to billing data recorder channel assignments, recorder pulse weights (Ke), and read-only password for access to interval data by the FE billing data collection system (MV-90)

- Revenue meter telephone number
- Revenue meter loss compensation data (if applicable)

The IC shall provide FE with prior notification of any modifications at the facility that will affect the revenue meter measurements, including substation reconfigurations and meter program changes.

The revenue metering system at each location shall be tested for accuracy by the IC once every two years. The IC shall give reasonable notice to FE of the time when the testing is scheduled so that FE may have representatives present. FE and PJM shall have the right to audit the revenue metering equipment and/or related documents. The IC shall be given a reasonable period of time to comply with any requests associated with an audit.