PJM Generation Interconnection Request
Feasibility Study Report

Queue Position #U2-098
South Amboy
1320 MW

June 2009

Preface

The intent of this System Impact Study is to determine a plan, with cost and construction time estimates, to interconnect 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 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 Upgrades cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement.

The System Impact 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 has submitted an Interconnection Request that identifies its proposed plan to install two (2) 2 x 1 combined cycle generation units with a total capability of 1,320 MW. The Customer Facility will be connected to the Werner 230 kV substation by two radial attachments. In addition, a new 230 kV double circuit tower line from Werner to Freneau will be required and the Werner to Raritan River 115 kV line will need to be converted to 230 kV operations for the delivery of the project generation to the transmission system. These upgrades will require the conversion of the Werner and Freneau 230 kV substations to a ring bus configuration and an expansion of both the Raritan River 230 kV and 115 kV substations to accommodate the new connections.

Attachment 1 to this report shows an overview of the South Amboy (U2-098) project site and the location of the proposed South Amboy (U2-098) project units. Attachment 2 shows a conceptual one-line drawing of the local transmission network that includes the direct connection facilities required for the South Amboy (U2-098) project. As shown, the Werner 230 kV substation will be rebuilt into an eight (8) breaker ring bus design and the Werner 115 kV substation will be eliminated. In addition, a new double circuit 230 kV line from Werner to Freneau is shown that utilizes the existing 69 kV and 34.5 kV tower line structures where possible. The Freneau 230 kV substation will also be expanded to a seven (7) breaker ring bus design. With the conversion of the Werner - Raritan River 115 kV line to 230 kV operations for the South Amboy (U2-098) project, the Raritan River 230 kV substation must be expanded by four breakers and the 115 kV substation relocated. Since the Werner 115 kV facilities are being converted to 230 kV, the existing Werner 230/115 kV transformer will be moved to the Raritan River substation to maintain the step-down capability to the local sub-transmission system. In addition, the Werner 115/34.5 kV (90 MVA) transformer will need to be replaced with two 230/34.5 kV banks due to a contingency overload of one for a loss of the Werner - Raritan River 230 kV lines. While FirstEnergy will permit a use of its right-of ways for this project, the Interconnection Customer will be responsible for acquiring any easements, properties and permits that may be required to construct the project connection facilities. A summary of the South Amboy Project Direct Connection facilities that will be required and an approximate estimate of their cost are shown on Attachment 3.

The Interconnection Customer will be responsible for meeting all FirstEnergy criteria as defined in the FirstEnergy Requirements for Transmission Connected Facilities document (link for document below under Direct Connection section). 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 will also be required to meet all PJM, Reliability First and NERC reliability criteria and operating procedures for standards compliance. For example, the Interconnection Customer 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 FirstEnergy system.

Metering

The Interconnection Customer will be required to install and maintain metering and telemetry equipment to provide revenue metering and real-time telemetry data to PJM and the Transmission Owner. The PJM requirements for this equipment are listed in Appendix 2, section 8 of Attachment O to the PJM Tariff, as well as PJM Manuals 01 and 14D.

The Transmission Owner requirements for Metering Equipment can be found in Attachment 3 to this report.

Summary

A complete list of the Direct Connection facilities that will be required for the South Amboy (U2-098) project and their estimated costs are defined in the Direct Connection section of this report. The total estimate for the Direct Connection facilities is $81,348,300. The Interconnection Customer will have full responsibility for this cost.

The network upgrades that will be required to mitigate all identified criteria violations resulting from this Feasibility Study and their estimated cost are identified under Network Impacts below. The total estimated cost of these Network Upgrades is **$252,020,320**. The Interconnection Customer's cost allocation for each of the required Network Upgrades identified in the System Impact Study will be determined during the System Impact Study of this project. No cost allocations are provided during the Feasibility Study of an Interconnection Request.

Note that all cost estimates contained in this document were produced without a detailed engineering review and are therefore subject to error. More accurate estimates will be determined as a part of the subsequent System Impact and Facilities Studies. The Interconnection Customer will be responsible for the actual cost of the upgrades that are implemented. FirstEnergy herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete the direct connection and/or network reinforcements to the transmission system.

The total cost for the facilities required for the South Amboy (U2-098) Project is therefore **$333,368,620**. PJM staff will determine the cost allocation of this total cost to the Interconnection Customer in compliance with the existing PJM procedures.

Based on the extent and number of direct connection and system upgrades required to support the South Amboy (U2-098) project, it is expected to take four (4) years from the signing of a Construction Service Agreement for their completion. This assumes that the Interconnection Customer provides all right-of-way, permits, easements, etc. that will be needed for the defined upgrades and that PJM grants the facility outages required when

requested. It further assumes that the substation and right-of-way properties provided have no environmental issues and that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades.

Note that the findings were made from a conceptual review of this project. A more detailed review of the connection and network upgrade facilities and their cost will be identified in the System Impact and Facilities Study Reports.

Additional Requirements

In addition to the FirstEnergy facilities, The Interconnection Customer will also be responsible for meeting all criteria as specified in the applicable sections of the "FirstEnergy Requirements for Transmission Connected Facilities" document including:

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

3. The purchase and installation of a revenue class meter for each South Amboy unit to measure the power delivered in compliance with the FirstEnergy standards.

4. The purchase and installation of supervisory control and data acquisition (SCADA) equipment to provide information in a compatible format to the FirstEnergy Transmission System Control Center.

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

6. A compliance with the FirstEnergy and PJM generator power factor and voltage control requirements. This may include the installation of a switched shunt capacitor bank if the units do not meet the established design criteria.

7. The execution of a back-up service agreement (if needed) to serve generator station service load when the unit is off-line.

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

Direct Connection

The proposed Interconnection Facilities must be designed in accordance with the FirstEnergy "Requirements for Transmission Connected Facilities" document.

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

All cost data contained in this document should be considered estimated. 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.

Below are conceptual estimates for the engineering/construction associated with direct connection requirements based upon similar projects that have been designed and/or constructed.

Item	Description	Conceptual Cost Estimate ($)
1	Werner: • Construct new Werner 230kV eight (8) breaker ring bus, including control building, protection, metering, SCADA, RTU, etc. • Install new 230/34.5kV transformer in place of the existing 115/34.5kV transformer • Install second new 230/34.5kV transformer and associated 34.5kV expansion required at existing substation • Remove 230/115kV transformer for installation at Raritan River substation (additional costs below under item #3)	$20,141,100
2	Reconfigure existing Freneau 230kV substation to a seven (7) breaker ring bus substation	$8,948,600
3	Raritan River • Expand existing substation and install 230/115kV transformer removed from Werner substation in item #1 above • Remove unused 115kV facilities and reconfigure 115kV substation to accommodate new 230/115kV transformer	$10,847,600
4	• Construct new double circuit 230kV lines from Werner to Freneau in place of existing 69kV and 34.5kV facilities • Convert existing Werner to Raritan River 115kV to 230kV operations	$41,411,000

Conceptual Estimate Total: **$81,348,300**
Estimated Lead Time: 4 years from signed Construction Service Agreement

Notes:
Detailed Engineering & Construction Estimates TBD via Facilities Study
The above estimates do not include 1) tax gross-up, 2) property costs and site development up to rough grade which is to be provided by the Interconnection Customer, 3) interconnection metering and generation SCADA to be provided by the Interconnection Customer, 4) engineering and field activities for design review and commissioning of the Interconnection Customer's facilities, and 5) Real estate costs

Network Impacts

The Queue Position #U2-098 project was studied as an injection in the JCPL area. The Queue Position #U2-098 project was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

Generator Deliverability

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

1. The RAR RVR-KILMER I 230kV line (from bus 2872 to bus 5104 ckt 1) loads from 76.4% to 145.1% (DC power flow) of its emergency rating (739MVA) for the single line contingency outage (PS56D). This project contributes approximately 508.0MW to cause this thermal violation.

2. The RAR RVR-KILMER I 230kV line (from bus 2872 to bus 5104 ckt 1) loads from 50.8% to 110.6% (DC power flow) of its normal rating (650MVA) for non-contingency condition. This project contributes approximately 388.7MW to cause this thermal violation.

   To mitigate overloads identified in #1 & 2 above would require reconductoring the Raritan River-Kilmer (I1023) 230kV line, replacement of a line trap and drop loop/bus conductor at the Raritan River substation, replacement of drop loop/bus conductor and a disconnect switch at the Kilmer substation which is estimated to cost $3,407,100.

3. The RAR RVR-KILMER W 230kV line (from bus 2872 to bus 5105 ckt 1) loads from 88.6% to 133.7% (DC power flow) of its emergency rating (805MVA) for the single line contingency outage (PS56A). This project contributes approximately 363.3MW to cause this thermal violation. To mitigate this overload would require reconductoring the Raritan River-Kilmer (W1037) 230kV line, replacement of a line trap and drop loop/bus conductor at the Raritan River substation, replacement of drop loop/bus conductor and a disconnect switch at the Kilmer substation which is estimated to cost $3,407,100.

4. The KILMER I-L.NELSNI 230kV line (from bus 5104 to bus 5106 ckt 1) loads from 61.5% to 129.6% (DC power flow) of its emergency rating (745MVA) for the single line contingency outage (PS56C). This project contributes approximately 507.6MW to cause this thermal violation. To mitigate this overload would require reconductoring the Kilmer-Lake Nelson (I1023) 230kV line, replacement of drop loop/bus conductor and a circuit switcher at the Lake Nelson substation, and replacement of drop loop/bus conductor at the Kilmer substation which is estimated to cost $1,397,300.

5. The KILMER W-L.NELSNW 230kV line (from bus 5105 to bus 5107 ckt 1) loads from 81.2% to 127.0% (DC power flow) of its emergency rating (793MVA) for the single line contingency outage (PS56A_U2-040). This project contributes

approximately 363.3MW to cause this thermal violation. To mitigate this overload would require reconductoring the Kilmer-Lake Nelson (W1037) 230kV line, replacement of drop loop/bus conductor and a circuit switcher at the Lake Nelson substation, and replacement of drop loop/bus conductor at the Kilmer substation which is estimated to cost $1,397,300.

6. The FRENEAU-ATLANTIC 230kV line (from bus 2857 to bus 2851 ckt 1) loads from 77.3% to 120.2% (DC power flow) of its emergency rating (737MVA) for the single line contingency outage (R39_8). This project contributes approximately 316.7MW to cause this thermal violation. To mitigate this overload would require reconductoring the Freneau-Atlantic (H1022) 230kV line, replacement of drop loop/bus conductor at the Freneau substation, and replacement of a disconnect switch and a line trap at the Atlantic substation which is estimated to cost $7,337,100.

7. The L.NELSNW-GREENBKW 230kV line (from bus 5107 to bus 5001 ckt 1) loads from 73.7% to 120.1% (DC power flow) of its emergency rating (783MVA) for the single line contingency outage (PS56A). This project contributes approximately 363.3MW to cause this thermal violation. To mitigate this overload would require reconductoring the Lake Nelson-Green Brook (W1037) 230kV line, replacement of drop loop/bus conductor and a circuit switcher at the Lake Nelson substation, and replacement of drop loop/bus conductor and terminal equipment at the Green brook substation which is estimated to cost $1,927,600.

8. The GILBERT-SPRINGF 230kV line (from bus 2528 to bus 3447 ckt 1) loads from 98.3% to 104.3% (DC power flow) of its emergency rating (805MVA) for the single line contingency outage (PJM28A). This project contributes approximately 49.0MW to cause this thermal violation. To mitigate this overload would require reconductoring the Gilbert-Springfield (A1015) 230kV line (includes Delaware River crossing), replacement of drop loop/bus conductor at the Gilbert substation, and replacement of drop loop/bus conductor at the Springfield substation which is estimated to cost $6,654,500.

9. The U2-049-LARRABEE 230kV line (from bus 92970 to bus 2859 ckt 1) loads from 72.9% to 117.0% (DC power flow) of its normal rating (650MVA) for non-contingency condition. This project contributes approximately 286.3MW to cause this thermal violation. To mitigate this overload would require reconductoring the U2-049-Larrabee (R1032) 230kV line, replacement of drop loop/bus conductor, a line trap and disconnect switch at the Larrabee substation which is estimated to cost $271,100.

10. The GREENBKW-GILLET W 230kV line (from bus 5001 to bus 2532 ckt 1) loads from 66.6% to 115.9% (DC power flow) of its emergency rating (737MVA) for the single line contingency outage (PS56A). This project contributes approximately 363.3MW to cause this thermal violation. To mitigate this overload

would require reconductoring the Green Brook-Gillette W 230kV line, replacement of bus conductor, two (2) disconnect switches, and a CT tap at the Gillette substation which is estimated to cost $3,456,700.

11. The L.NELSNI-MIDDLSEX 230kV line (from bus 5106 to bus 4963 ckt 1) loads from 44.0% to 108.9% (DC power flow) of its emergency rating (783MVA) for the single line contingency outage (JC29B). This project contributes approximately 508.0MW to cause this thermal violation. To mitigate this overload would require reconductoring the Lake Nelson-Middlesex tap 230kV line, replacement of drop loop/bus conductor and a disconnect switch at the Lake Nelson substation which is estimated to cost $268,300.

Multiple Facility Contingency

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

12. The U2-049-LARRABEE 230kV line (from bus 92970 to bus 2859 ckt 1) loads from 71.52% to 146.60% (DC power flow) of its emergency rating (805MVA) for the tower line outage (37PS_B). This project contributes approximately 604.4MW to cause this thermal violation. This overload is mitigated by the reinforcement identified in #9 above.

13. The RAR RVR-DEEP R C 115kV line (from bus 2870 to bus 2854 ckt 1) loads from 60.09% to 107.58% (DC power flow) of its emergency rating (175MVA) for the tower line outage (37PS_B). This project contributes approximately 83.1MW to cause this thermal violation. To mitigate this overload would require replacement of a line trap at the Raritan River substation which is estimated to cost $61,460.

14. The RAR RVR-DEEP R B 115kV line (from bus 2870 to bus 2853 ckt 1) loads from 60.10% to 107.58% (DC power flow) of its emergency rating (175MVA) for the tower line outage (37PS_B). This project contributes approximately 83.1MW to cause this thermal violation. To mitigate this overload would require replacement of a line trap at the Raritan River substation which is estimated to cost $61,460.

15. The NJ STEEL-RAR RVR 230kV line (from bus 2864 to bus 2872 ckt 1) loads from 59.90% to 107.39% (DC power flow) of its emergency rating (739MVA) for the tower line outage (31JCA_Q08OP1A). This project contributes approximately 351.0MW to cause this thermal violation. To mitigate this overload would require reconductoring the Raritan River-NJ Steel (F1046) 230kV line and replacement of a line trap at the Raritan River substation which is estimated to cost $1,032,700.

16. The WERNER-NJ STEEL 230kV line (from bus 2880 to bus 2864 ckt 1) loads from 57.24% to 100.84% (DC power flow) of its emergency rating (805MVA) for the tower line outage (31JCA_Q08OP1A). This project contributes approximately 351.0MW to cause this thermal violation. To mitigate this overload would require reconductoring the Werner-NJ Steel (F1046) 230kV line, replacement of drop loop/bus conductor at Werner and replacement of drop loop/bus conductor at the NJ Steel substation which is estimated to cost $1,340,600.

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)

17. The CNASTONE-N-NWEST 500kV line (from bus 4 to bus 119 ckt 2) loads from 152.59% to 160.87% (DC power flow) of its emergency rating (2901MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 240.3MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 152.5%) already exists in the 2012 base case.

18. The CNASTONE-N-NWEST 500kV line (from bus 4 to bus 119 ckt 1) loads from 152.59% to 160.87% (DC power flow) of its emergency rating (2901MVA) for the single line contingency outage (U_queue_reinforcement_59). This project contributes approximately 240.3MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 152.5%) already exists in the 2012 base case.

19. The CNASTONE-N-NWEST 500kV line (from bus 4 to bus 119 ckt 1) loads from 133.16% to 140.12% (DC power flow) of its normal rating (2078MVA) for non-contingency condition. This project contributes approximately 144.6MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 133.1%) already exists in the 2012 base case.

20. The CNASTONE-N-NWEST 500kV line (from bus 4 to bus 119 ckt 2) loads from 133.16% to 140.12% (DC power flow) of its normal rating (2078MVA) for non-contingency condition. This project contributes approximately 144.6MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 133.1%) already exists in the 2012 base case.

To mitigate the overloads identified in items 17, 18, 19, & 20 requires the installation of the North Northwest substation which includes 2-500/230kV xfmrs, 4-500 kV breakers, 7-230 kV breakers, related substation equipment, and land at a cost of $70M. It also requires reconductoring Conastone to Northwest #2322 with

an estimated cost of $8.21M. This work would take 3-4 years to build substation and 18-24 months for the line work.

- 2 new single circuit lines with the following assumptions:

  A new 200 ft. wide ROW paralleling the existing Conastone to Northwest ROW
  Total ROW length = 19.6 miles
  3 - bundle 1,590 kcm conductor
  North Northwest substation is located 4 miles north of Northwest substation

  Additional substation work to include:
  Expand NNW substation to accommodate 2 new lines for $10M
  Expand Conastone substation to accommodate 2 new lines for $8M

  Substation Terminations (all in 2012 dollars):
  Conastone - Install a 1 breaker bay $3.2M
  NNW - Install a 2 breaker bay $6.4M

The total estimated cost of this upgrade, which includes breakers and terminations, is $220M. The upgrade will take approximately 10 years to complete.

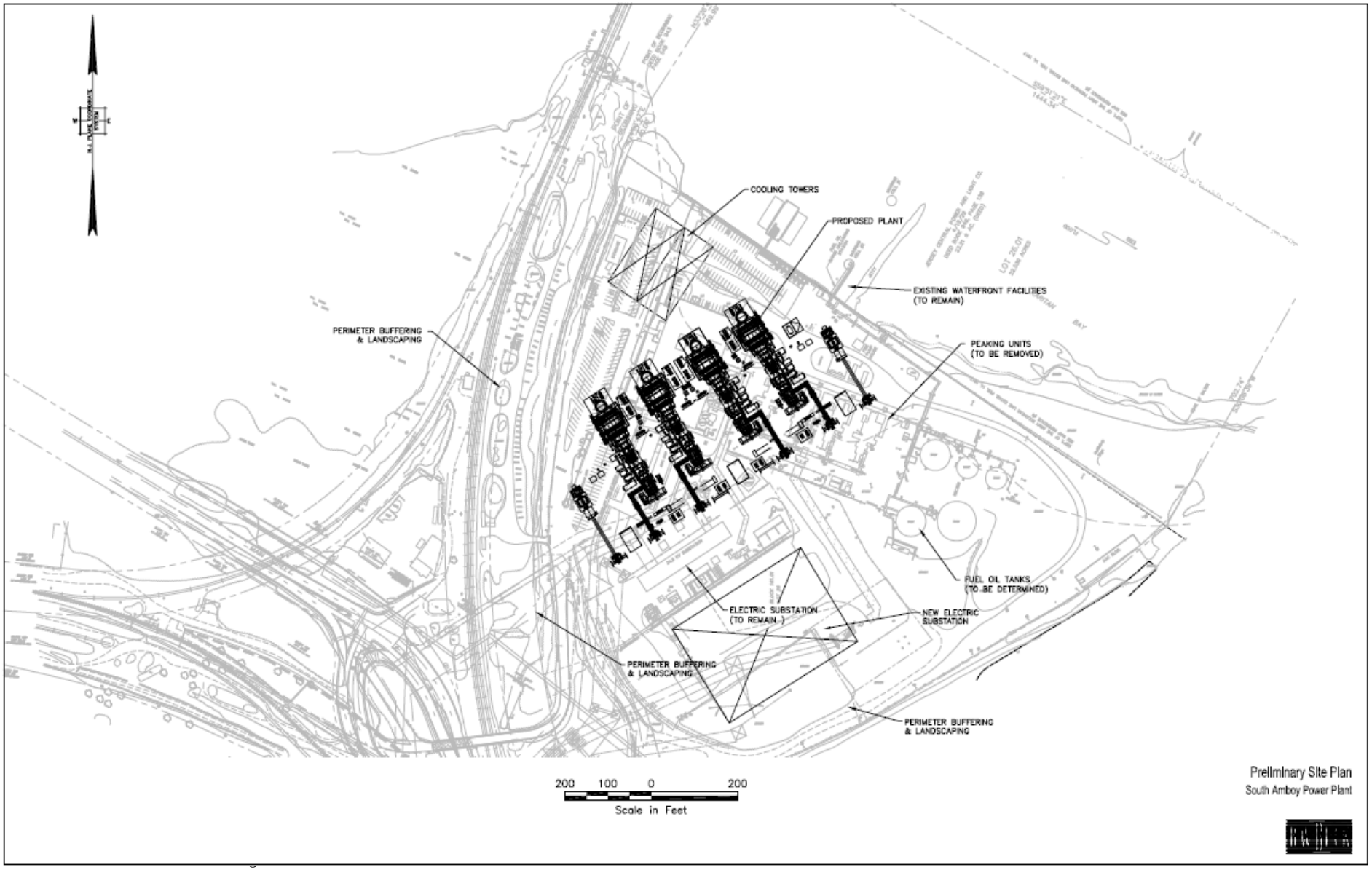
Short Circuit

Due to the magnitude of the South Amboy (U2-098) project and the fact that there are several preceding RTEP generation projects in the Central New Jersey region that will affect the study results, an FirstEnergy short circuit analysis is being deferred to the subsequent Impact Study. While no formal FirstEnergy analysis has been performed, the PJM studies indicate that there are eight (8) Raritan River and two (2) Smithburg 230 kV substation breakers that will exceed their fault interrupting capability with the South Amboy (U2-098) project modeled. These same breakers were defined as needing upgrade in the studies performed for preceding Interconnection Requests. From those studies it was defined that the total estimated cost to upgrade these circuit breakers is $1.3 million. When the System Impact Study is completed, the PJM staff will determine the breakers impacted by the South Amboy (U2-098) project and the cost allocation in compliance with PJM procedures.

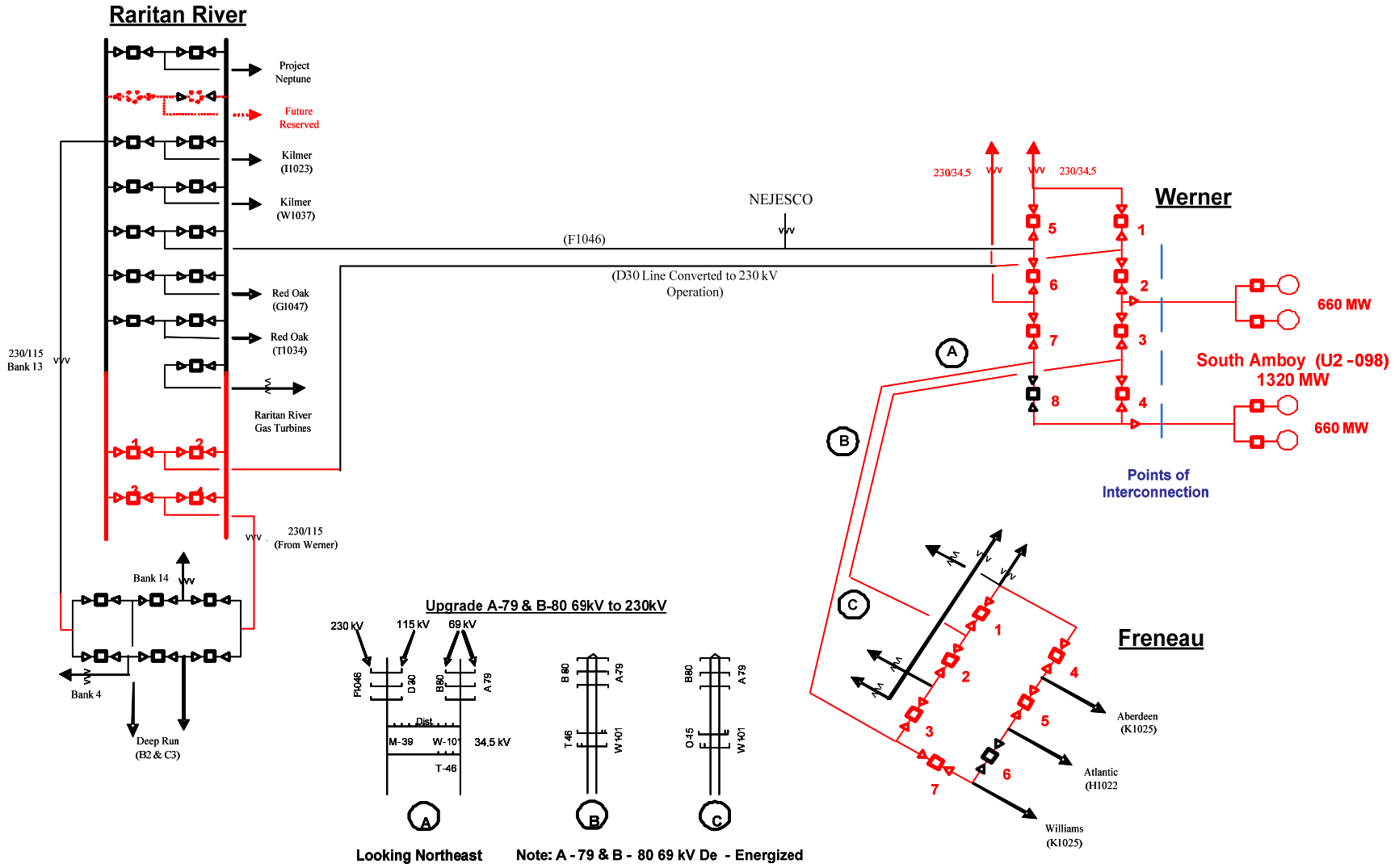
System Protection Analysis

As per FirstEnergy process, a detailed system protection analysis of the South Amboy (U2-098) Project will be conducted as a part of the Impact Study. However, the FirstEnergy Direct Connection and Network Upgrade costs identified in this Feasibility Study Report will include an adder to reflect the typical system protection facilities that will be needed.

Attachment 1



Attachment 2



Attachment 3

FirstEnergy Revenue Metering Requirements for Generation Interconnection Customer

Interconnection Customer shall install, own, operate, test and maintain the necessary revenue quality 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 FirstEnergy connection documents. The FirstEnergy "Requirements for Transmission Connected Facilities" are located at: http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx

The 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.

FirstEnergy will provide revenue quality Metering Equipment for a station service power supply at a generation facility if the supply is from the local FirstEnergy distribution system.
The revenue quality Metering Equipment shall be capable of collecting and storing bidirectional billing data. The billing data shall be stored in intervals specified by FirstEnergy, typically fifteen minutes or thirty minutes. The Interconnection Customer must provide FirstEnergy with remote access to the billing data in the Metering Equipment via a dedicated voice-grade analog telephone circuit. The Interconnection Customer shall provide FirstEnergy with contact information for the person or persons responsible for meter programming and Metering Equipment maintenance.

The Interconnection Customer shall consult with FirstEnergy regarding the revenue quality 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 FirstEnergy billing data collection system (MV-90)
- Revenue meter telephone number
- Revenue meter loss compensation data (if applicable)

The Interconnection Customer shall provide FirstEnergy 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 Interconnection Customer once every two years. The Interconnection Customer shall give reasonable notice to FirstEnergy of the time when the testing is scheduled so that FirstEnergy may have representatives present. FirstEnergy shall have the right to audit the revenue metering equipment and/or related documents. The Interconnection Customer shall be given a reasonable period of time to comply with any requests associated with an audit.

FirstEnergy Revenue Metering Requirements for Generation Interconnection Customer 1-21-09.doc