Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC1-029

"South River 230 kV"

February 2017

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.

Note: PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment G-2 of Manual 14A. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, **PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, prior to the starting date of the System Impact Study (**See Section 2.2.2. of Manual 14A for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment G-1 of Manual 14A) in order to document the request for the study.

General

The Interconnection Customer (IC) has proposed an increase in output of their future South River R11/Z2-109 natural gas generating facility located in Sayreville, New Jersey. The uprate will increase the output of the facility by **140 MW** with **100 MW** being recognized by PJM as capacity. The proposed facilities will have a total generating capability of 600 MW, of which 540 MW will be recognized by PJM as a capacity resource (Attachment 1). The proposed in-

service date for the uprate is **May 29, 2019**. **This study does not imply a Jersey Central Power & Light Company commitment to this in-service date.**

Point of Interconnection

AC1-029 "South River 230 kV" will interconnect with the Jersey Central Power & Light Company transmission system at the same Point of Interconnection (POI) as the future R11/Z2-109 generation plant, also owned by IC (Attachment 2). The connection is from an available 230 kV breaker position in the R11/Z2-109 project's 230 kV switchgear and completely on the customer's side of the R11/Z2-109 project's POI. The AC1-029, Z2-109 and R11 projects will all interconnect to a common 230 kV breaker position of a three-breaker ring bus identified as R11 Ring Bus and located on the 230 kV line between the South River Generating Plant and the future 230 kV 6-breaker ring bus identified as South River Junction.

Cost Summary

The **AC1-029 "South River 230 kV"** project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 0
Total Costs	**$ 0**

In addition, the AC1-029 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 7,236,500
Previously Identified Upgrades	$ 0
Total Costs	**$ 7,236,500**

Cost allocations for these upgrades will be provided in the System Impact Study Report.

The AC1-029 generation project direct connection will not require facility upgrades. The (AC1-029) generation project will require network upgrades to the JCPL transmission system as defined in this report. The total estimated cost of the upgrades (illustrated in Attachment 3) is **$7,236,500**. This cost does not include a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129.

Attachment Facilities

This report assumes that the Interconnection Customer will build and own its own generator lead line up to the point of interconnection.

No additional Attachment facilities are required to support this AC1-029 interconnection.

Direct Connection Cost Estimate

No additional Direct Connection facilities are required to support this AC1-029 interconnection.

Non-Direct Connection Cost Estimate

No additional Non-Direct Connection facilities are required to support this AC1-029 interconnection.

Interconnection Customer Requirements

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

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

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

2. The execution of a back-up service agreement to serve the customer load supplied from the (AC1-029) generation project 230 kV interconnection point when the units are out-of-service. This assumes the intent of IC is to net the generation with the load.

The above requirements are in addition to any metering, any requirements for the R11/Z2-109 Generation Projects, or other requirements imposed by PJM.

Requirement from the PJM Open Access Transmission Tariff:

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

Schedule

Based on the extent of the JCPL system upgrades required to support the (AC1-029) generation project, it is expected to take a minimum of **thirty (30) months** from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. **Note that it may be determined that the Raritan River- South River 230 kV and Atlantic-South River 230 lines may not be able to be taken out at the same time to reconductor. If this is the case, the elapsed time to complete will extend as per the JCPL construction sequence which is yet to be determined.** Full payment of the estimated cost of the project will be required upon execution of the Interconnection Service Agreement/Interconnection Construction Service Agreement (ISA/CSA). True up of the actual cost versus estimated cost of the project will be performed by FE at the end of the project. It is assumed that IC will provide the property for the R11/Z2-109/AC1-029 generation project 230 kV interconnection substation and all right-of-way, permits, easements, etc. that will be needed. It also assumes 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 network upgrades, and that all system outages will be allowed when requested.

Note that the FE findings were made from a conceptual review of this project. Further note that the cost estimate data contained in this document should be considered high level estimates 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 reinforcements to the transmission systems.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

JCPL Metering Requirements

IC will be required to comply with all FE revenue metering requirements for generation interconnection customers. The FE revenue metering requirements may be found in the FE "Requirements for Transmission Connected Facilities" document located at the following link:

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

Because the (AC1-029) generation project connection is completely on the customer's side of the R11/Z2-109 project's POI, it is assumed no new metering requirements will be necessary beyond the requirements in the R11/Z2-109 Interconnection Service Agreement ("ISA").

Compliance Issues

The proposed interconnection facilities must be designed in accordance with the FE "Requirements for Transmission Connected Facilities" document located at:

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

IC will also be responsible for following the requirements of the FE "Approved Vendors and Contractors" document which is also located at the above link.

For the AC1-029 project, it will be mandatory for the existing 460 MW portion of the Customer Facility to retain its existing ability to maintain a power factor as described in the R11/Z2-109 Interconnection Service Agreement ("ISA"). The AC1-029 project increase of 140 MW to the Customer Facility shall be designed with the ability to maintain a power factor of at least 1.0 (unity) to 0.90 lagging (supplying VARs) measured at the Generator's Terminals. If the R11, Z2-109, and AC1-029 generation projects cannot meet these requirements, a dynamic device such as a STATCOM or SVC must be installed at the R11 project substation at IC cost.

IC will also be required to meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures for standards compliance. For example, IC 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 JCPL system.

Network Impacts (from JCPL)

Power Flow Analysis

A power flow study was conducted to determine the reliability impact of the proposed (AC1-029) generation project on the JCPL transmission system. This study was completed using a 2020 summer peak power flow model that contains a detailed representation of the Jersey Central Power & Light transmission networks in the area of the proposed (AC1-029) generation project. 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 attributable to this project. Note that in accordance with PJM RTEP study procedures, the (AC1-029) generation project under study and

earlier active queue projects are considered to be in-service. All active queue projects after the (AC1-029) project are considered not in-service.

The results of the analysis show that system reinforcements will be required for the deliverability of the (AC1-029) generation project generation to the JCPL transmission system. The power flow results are shown in Attachment 3.

Note that a further conclusion of this study is that it will be mandatory for the (AC1-029) generation project to have a range of dynamic reactive capability that supports its operation from a 1.0 leading to 0.90 lagging power factor at the generator's terminals. Should IC fail to provide dynamic reactive capability from the (AC1-029) generation project for any reason once interconnected, the FE and/or PJM Dispatchers may need to take action to curtail its output to prevent non-compliance with voltage criteria.

Short Circuit and Dynamics Analysis

In accordance with the RTEP process, short circuit and dynamics analysis will not be conducted by PJM since the (AC1-029) generation project capacity increase request has no change to the electrical characteristics of the IC generating facility as indicated by the developer.

System Protection Analysis

An analysis was conducted to assess the impact of the (AC1-029) generation project on the system protection requirements in the area. The results of this review have identified that there will be no protection upgrades needed.

The fault current values are as follows:

Three phase fault current:	47,600 Amps
Single line to ground fault current:	50,400 Amps
Positive Sequence Thevenin (ohms):	0.1645 + j 2.7845
Zero Sequence Thevenin (ohms):	0.2433 + j 2.3100

These values are for the future system configuration without the (AC1-029) generation project contribution. Any system changes in the area could have a significant impact on these values. It will be the responsibility of the Interconnection Customer to make any protection upgrades required should this occur. The proposed interconnection facilities must be designed in accordance with the FE "Requirements for Transmission Connected Facilities."

Network Impacts

The Queue Project AC1-029 was evaluated as a **140.0 MW** (Capacity **100.0 MW**) injection at the R11 substation in the JCPL area. Project AC1-029 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-029 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2020 Case

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
B2-JCC-230-007	CONTINGENCY 'B2-JCC-230-007' /* R11SS - SOUTH RIVER (P1030) 230 KV DISCONNECT BRANCH FROM BUS 206411 TO BUS 206321 CKT 1 END
B2-JCC-230-033	CONTINGENCY 'B2-JCC-230-033' /* 230/230KV, AREA 228/228. DISCONNECT BRANCH FROM BUS 206410 TO BUS 206411 CKT 1 END
B2-JCC-230-041	CONTINGENCY 'B2-JCC-230-041' /* SOUTH RIVER JUNCTION - R11 230 KV DISCONNECT BRANCH FROM BUS 206411 TO BUS 206412 CKT 1 /* 28R11RINGA 230 28R11 230 END

Contingency Name	Description
C5-JCC-230-4	CONTINGENCY 'C5-JCC-230-4' /* R11B-ATLANTIC (P1030) & PARLIN-FRENEAU (K1025) DISCONNECT BRANCH FROM BUS 206411 TO BUS 206286 CKT 1 /* P1030 R11B-ATLANTIC DISCONNECT BRANCH FROM BUS 206286 TO BUS 206272 CKT 1 /* P1030 ATLANTIC BANK1 DISCONNECT BRANCH FROM BUS 206322 TO BUS 206298 CKT 1 /* K1025 PARLIN-WILLIAMS DISCONNECT BRANCH FROM BUS 206298 TO BUS 206292 CKT 1 /* K1025 WILLIAMS-FRENEAU DISCONNECT BUS 206298 /* K1025 WILLIAMS DISCONNECT BRANCH FROM BUS 206292 TO BUS 206267 CKT 1 /* K1025 FRENEAU 1 SET BUS 206292 LOAD TO 30 MW /* K1025 FRENEAU 3 DISCONNECT BRANCH FROM BUS 206292 TO BUS 206267 CKT 6 /* K1025 FRENEAU 6 END

Generator Deliverability

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

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
1	N-1	B2-JCC-230-033	JCPL - JCPL	28RED OAKA-28RAR RVR 230 kV line	206314	206305	1	DC	92.32	100.86	ER	869	74.24	
2	N-1	B2-JCC-230-041	JCPL - JCPL	28S RIVER-28R11RINGA 230 kV line	206321	206411	1	DC	91.36	103.55	ER	817	99.62	1

Note: Please see Attachment 4 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper Appendix in the Attachment.

Multiple Facility Contingency

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

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
3	DCTL	C5-JCC-230-4	JCPL - JCPL	28RED OAKA-28RAR RVR 230 kV line	206314	206305	1	DC	98.42	107.3	ER	869	77.16	2

Note: Please see Attachment 4 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper Appendix in the Attachment.

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)

None.

Steady-State Voltage Requirements

To be provided in the System Impact Study.

Short Circuit

(Summary of impacted circuit breakers)

Short circuit analysis not required with this uprate.

Stability and Reactive Power Requirement

To be provided in the System Impact Study if required.

Affected System Analysis & Mitigation

NYISO Impacts:

NYISO Impacts to be determined during later study phases (as applicable).

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any 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 Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. 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 shall study all overload conditions associated with the overloaded element(s) identified.

	Contingency		Affected		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
4	N-1	B2-JCC-230-041	JCPL - JCPL	28S RIVER-28R11RINGA 230 kV line	206321	206411	1	DC	93.8	110.87	ER	817	139.47	
5	N-1	B2-JCC-230-007	JCPL - JCPL	28R11-28R11RINGA 230 kV line	206412	206411	1	DC	88.18	104.23	ER	869	139.47	
6	Non	Non	JCPL - JCPL	28R11-28R11RINGA 230 kV line	206412	206411	1	DC	82.76	100.99	NR	709	129.28	

Light Load Analysis – 2020 Case

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

System Reinforcements

Short Circuit

(Summary form of Cost allocation for breakers will be inserted here if any)

Not applicable to this uprate.

Stability and Reactive Power Requirement
(Results of the dynamic studies should be inserted here)

To be determined in Impact Study.

Summer Peak Load Flow Analysis Reinforcements

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

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AC1-029 Allocation
1, 3	28RED OAKA-28RAR RVR 230 kV line	**JCPL**: a) Raritan River Substation- Revise relay setting on Red Oak line relaying. b) Red Oak Substation- Revise relay settings on Raritan River line relaying. c) Raritan River-South River 230 kV (T1034) circuit- reconductor from Raritan River to the Red Oak Tap (2.6 miles) with 1590 ACSS, replacing the existing 1590 ACSR Time to Complete: 29 months	Pending	**$ 6,144,200**	To be determined in Impact study
2	28S RIVER-28R11RINGA 230 kV line	**JCPL**: a) South River 230 kV Substation- Adjust remote relay and metering settings. b) South River Junction 230 kV Substation- Adjust remote relay and metering settings. c) Atlantic- South River 230 kV (P1030) circuit- reconductor from the proposed South River Junction ring bus to South River Substation (approximately 0.6 miles) with 1590 ACSS, replacing the existing 1590 ACSR Time to Complete: 30 months	Pending	**$1,092,300**	To be determined in Impact study
				Total New Network Upgrades	**$ 7,236,500**

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)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

None.

Light Load Load Flow Analysis Reinforcements

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

To be determined.

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)

(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

To be determined.

Attachment 1
"South River 230 kV (AC1-029) Generation Project"
Project Location

Attachment 2
"South River 230 kV (AC1-029) Generation Project"

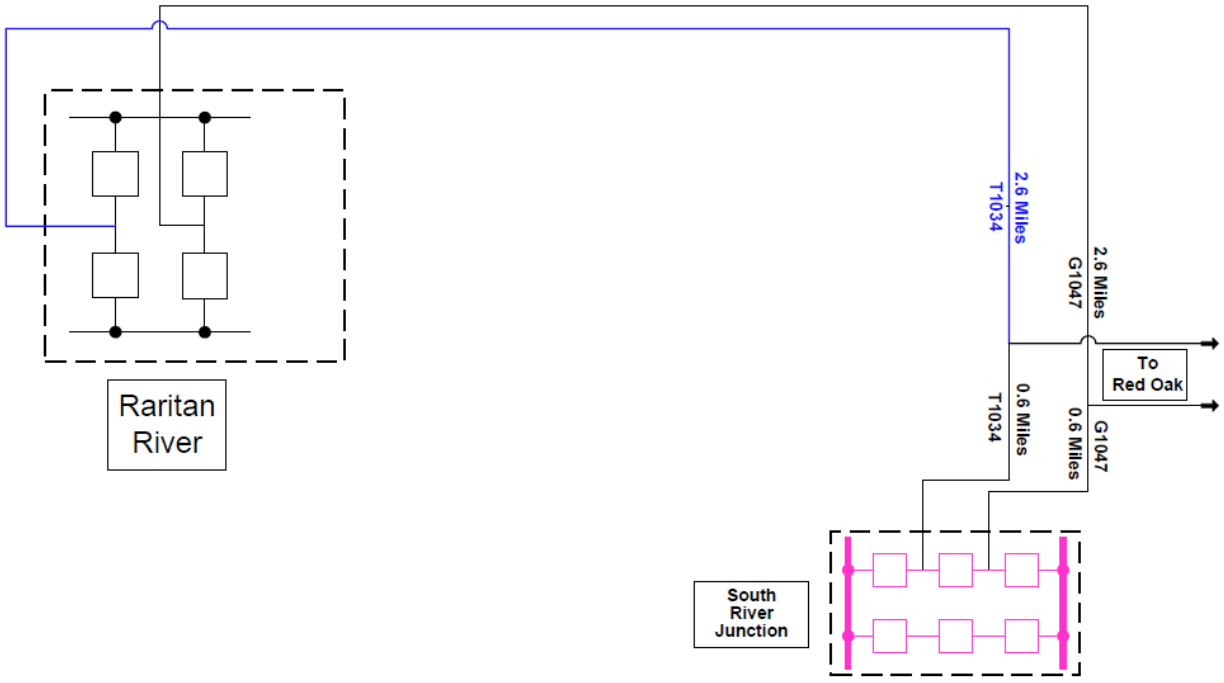
Interconnection Single Line Diagram

Attachment 3

South River 230 kV (AC1-029) Generation Project

Network Facility Reinforcement Conceptual One Line Diagrams

Reconductor Red Oak Tap to Raritan River T1034 230 kV Line



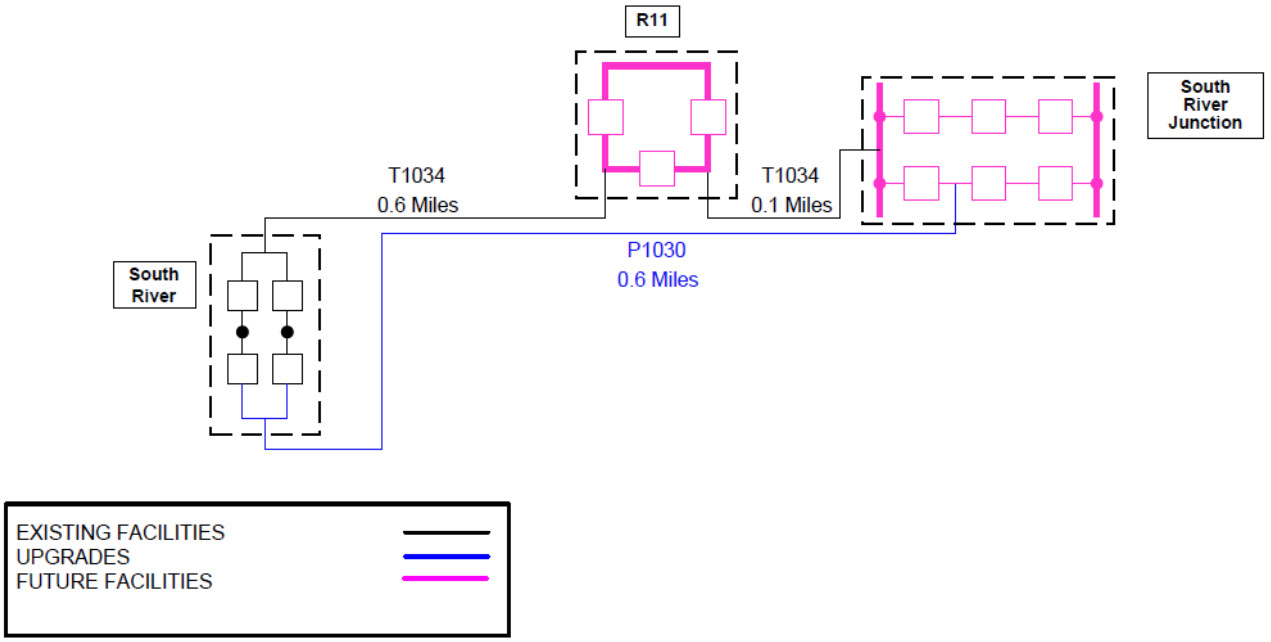
EXISTING FACILITIES
UPGRADES
FUTURE FACILITIES

By 6/1/2020:
- Reconductor Raritan River - Red Oak Tap (T1034) 230 kV line with 1590 ACSS

Attachment 3

(Continued)

Reconductor South River to South River Junction P1030 230 kV Line



By 6/1/2020:
- Reconductor South River – South River Junction (P1030) 230 kV line with 1590 ACSS

Attachment 4
Flowgate Details

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(JCPL - JCPL) The 28S RIVER-28R11RINGA 230 kV line (from bus 206321 to bus 206411 ckt 1) loads from 91.36% to 103.55% (**DC power flow**) of its emergency rating (817 MVA) for the single line contingency outage of 'B2-JCC-230-041'. This project contributes approximately 99.62 MW to the thermal violation.

```
CONTINGENCY 'B2-JCC-230-041'                    /* SOUTH RIVER JUNCTION - R11 230 KV
  DISCONNECT BRANCH FROM BUS 206411 TO BUS 206412 CKT 1        /* 28R11RINGA 230 28R11 230
  END
```

Appendix 1							
Bus Number	Bus Name	Full Contribution	Project Status	Bus Number	Bus Name	Full Contribution	Project Status
206412	28R11	85.99		206329	28S RIV G3	19.28	
206327	28S RIV G1	19.66		925541	AC1-029 C	99.62	Active
206328	28S RIV G2	19.66					

Appendix 2

(JCPL - JCPL) The 28RED OAKA-28RAR RVR 230 kV line (from bus 206314 to bus 206305 ckt 1) loads from 98.42% to 107.3% (**DC power flow**) of its emergency rating (869 MVA) for the tower line contingency outage of 'C5-JCC-230-4'. This project contributes approximately 77.16 MW to the thermal violation.

```
CONTINGENCY 'C5-JCC-230-4'                          /* R11B-ATLANTIC (P1030) & PARLIN-FRENEAU (K1025)
  DISCONNECT BRANCH FROM BUS 206411 TO BUS 206286 CKT 1      /* P1030 R11B-ATLANTIC
  DISCONNECT BRANCH FROM BUS 206286 TO BUS 206272 CKT 1      /* P1030 ATLANTIC BANK1
  DISCONNECT BRANCH FROM BUS 206322 TO BUS 206298 CKT 1      /* K1025 PARLIN-WILLIAMS
  DISCONNECT BRANCH FROM BUS 206298 TO BUS 206292 CKT 1      /* K1025 WILLIAMS-FRENEAU
  DISCONNECT BUS 206298                             /* K1025 WILLIAMS
  DISCONNECT BRANCH FROM BUS 206292 TO BUS 206267 CKT 1      /* K1025 FRENEAU 1
  SET BUS 206292 LOAD TO 30 MW                      /* K1025 FRENEAU 3
  DISCONNECT BRANCH FROM BUS 206292 TO BUS 206267 CKT 6      /* K1025 FRENEAU 6
  END
```

Appendix 2							
Bus Number	Bus Name	Full Contribution	Project Status	Bus Number	Bus Name	Full Contribution	Project Status
206358	28PARLN1&2	4.91		206327	28S RIV G1	10.88	
206359	28PARLN3&4	4.91		206328	28S RIV G2	10.88	
206412	28R11	47.57		206329	28S RIV G3	10.66	
206362	28RDOAKCT1	12.04		920282	X1-068	0.68	IS
206363	28RDOAKCT2	21.41		920863	Z2-109 E	11.02	Suspended
206364	28RDOAKCT3	21.41		925541	AC1-029 C	55.11	Active
206365	28RDOAKST1	16.88		925542	AC1-029 E	22.04	Active