PJM Generator Interconnection Queue #Y3-103 Valley – Raccoon 138kV 205MW (97MW Capacity) System Impact Study Report

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Preface

The intent of this System Impact Study is to determine a plan, with 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.

The PJM Reliability Planning Process utilizes PJM planning criteria, NERC Planning Standards, NERC Regional Council planning criteria, and the individual Transmission Owner FERC filed planning criteria. In all cases, PJM applies the most conservative of all applicable planning criteria when identifying reliability problems and determining the need for system upgrades on the PJM system. The application of the NERC Planning Standards is adapted to the specific needs of the PJM system.

In some instances an interconnection customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. All facilities required for interconnection of a generation interconnection project must be designed in compliance with the technical specifications (on PJM web site) for the appropriate Transmission Owner.

After the System Impact Study Agreement is executed and prior to execution of the Interconnection Service Agreement, an Interconnection Customer may modify its project to reduce the electrical output (MW) (in the case of a Generation Interconnection Request) of the proposed project by up to the larger of 20 percent of the capability considered in the System Impact Study or 50 MW.

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.

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General

Shell Chemical Appalachia LLC (Interconnection Customer) is proposing a 205MW (97MW Capacity) combined cycle natural gas facility to be interconnected to the Duquesne transmission system and located in Beaver County, PA. The proposed in-service date for this project is May 1, 2018. **Impacts on the MISO member transmission systems are not included in this analysis, but they will be included as a part of the Facilities Study, which may reveal upgrades needed in the MISO system not identified in this System Impact Study.**

The intent of the System Impact Study is to determine system reinforcements, associated costs and construction time estimates required to facilitate the addition of the new generating plant to the transmission system. The reinforcements include the direct connection of the generator to the system and any network upgrades necessary to maintain the reliability of the transmission system.

Facilities to Accommodate the Interconnection

Scope of Connection Work

The Y3-103 project will tap the Valley – Raccoon 138kV line (Z-81). To accommodate this interconnection, installation of a new three-breaker loop 138kV substation, relaying, metering, RTU, SCADA and other miscellaneous supporting equipment will be required (See **Figure 1** below). The direct connects are estimated to cost approximately **$2,435,000** (PJM Network Upgrade Number n**4085**), with an extra **$1,007,000** tax gross-up if applicable, to interconnect and take a minimum of **18 to 24 months** after the receipt of an executed Interconnection Service Agreement to complete this work. The cost estimate above is in 2013 dollars and does not include any of the upgrades listed in the Network Impacts section of the report.

The following assumptions were used in the preparation of this high-level cost estimate:

- DLCO will construct two new poles along the existing 138kV transmission line to accommodate a new looped substation.
- The estimates provided do not include relocation of DLCO transmission facilities traversing the site of the proposed petrochemical facility or system reinforcements required to serve the petrochemical facility load.
- DLCO will be responsible for the engineering, purchase, and construction of the high voltage equipment from the 138kV line entrance to the metering point within the customer substation including the line disconnect switch, 138kV breakers, and metering.
- DLCO will be responsible for the engineering of the foundations, structural steel, UG conduit and grounding associated with the DLCO high voltage equipment.
- The customer will be responsible for the engineering, purchasing and construction of the customer substation and equipment. DLCO will require the customer to supply current transformers and trip coils in all main breakers for exclusive use by DLCO.

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- The customer will be responsible for the construction associated with the installation of the DLCO engineered and procured equipment located at the customer substation.
- The customer must meet all National, State, Local, and DLCO requirements and must share control of the customer-purchased circuit breaker(s).
- DLCO will install and maintain relay protection and communications equipment, in a secure area, associated with line protection for the DLCO equipment at the customer substation.
- The line metering, protection, and supervisory control for the DLCO system will be located inside a customer provided secure and environmentally controlled structure within or adjacent to the customer substation.
- The customer is responsible for providing, installing, and maintaining the steel, foundations, conduit, grounding, fencing, and control house per DLCO specifications.
- The customer is responsible for providing station service for DLCO use per DLCO specifications. DLCO requests two independent sources of 200A, 3 phase, 4 wire 120/208 services.
- The customer is responsible for obtaining land for the interconnection substation per DLCO specification including but not limited to size, grading, and location.
- All customer substation equipment beyond the DLCO metering point must be coordinated and meet DLCO specification. Protection installed on the main interrupting device(s) must be capable of interrupting full fault current and coordinate with DLCO protection.

The Interconnection Customer is responsible for constructing all of the Interconnection Customer-owned facilities on the Interconnection Customer's side of the Point of Interconnection.

Revenue Metering and SCADA Requirements

For PJM: The Interconnection Customer will 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 Section 24.1 to 24.2.

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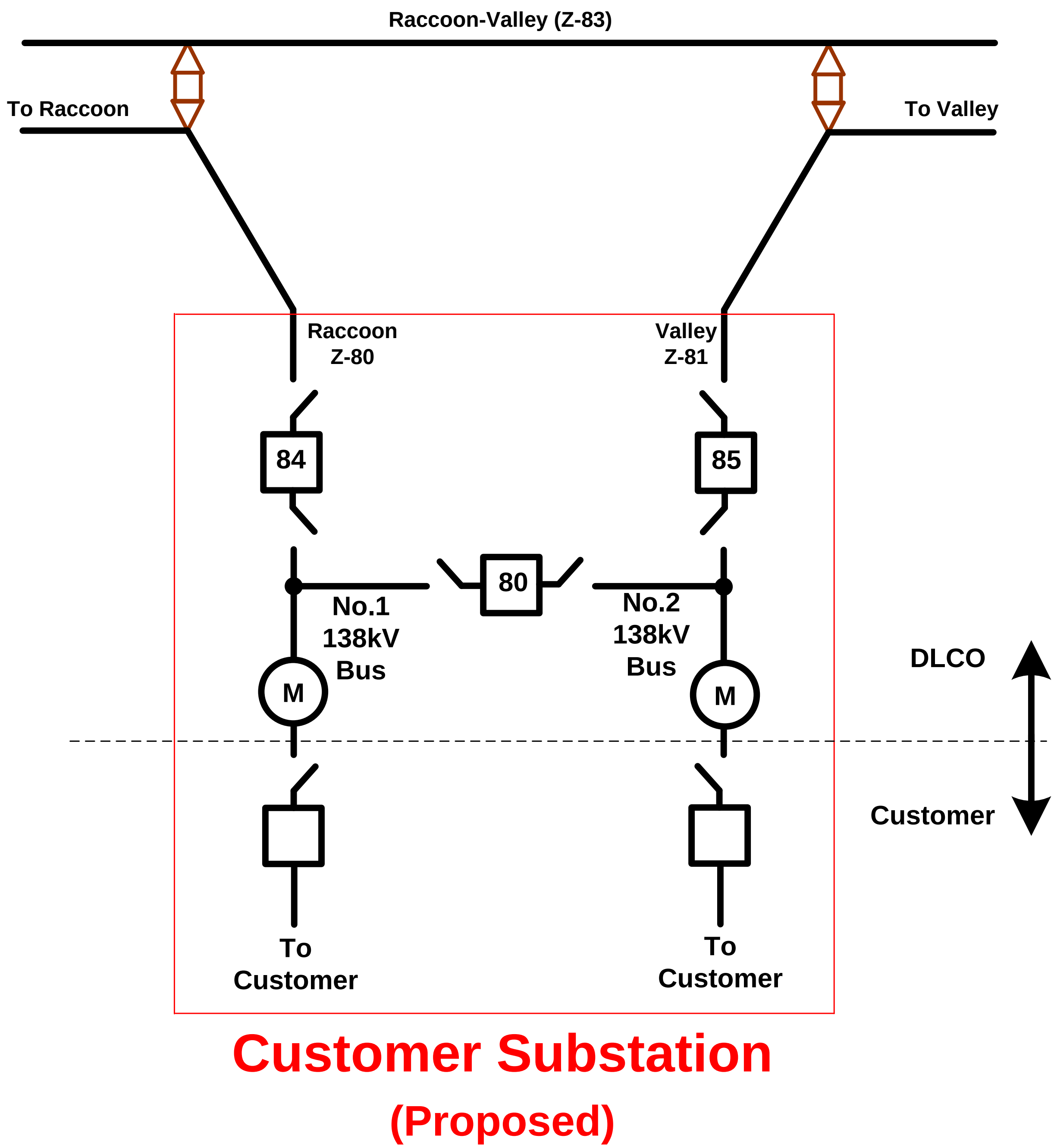

Figure 1. Interconnection Single Line Diagram

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Network Impacts

The Y3-103 project was studied as a 205.0MW (97.0MW Capacity) injection into the Duquesne area at the St. Joe 138kV substation. Project Y3-103 was evaluated for compliance with reliability criteria for summer peak conditions in 2017. Potential network impacts were as follows:

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

No violations were identified.

Generator Deliverability Impacts Caused By MISO Generator Interconnection Projects
(*Single or N-1 contingencies for the Capacity portion of the interconnection. Overloads initially caused by projects in the MISO Queue with additional contribution to the overload by this project.)*

MISO studies will be performed as a part of the Facilities Study.

Multiple Facility Contingency
(Double Circuit Tower Line contingencies only were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study)

No violations were identified.

Multiple Facility Contingency Impacts Caused By MISO Generator Interconnection Projects
(*Double Circuit Tower Line, Line with Failed Breaker and Bus Fault contingencies for the full energy output. Overloads initially caused by projects in the MISO Queue with additional contribution to the overload by this project.)*

MISO studies will be performed as a part of the Facilities Study.

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)

No violations were identified.

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Short Circuit

(Summary of impacted circuit breakers)

PJM has completed the short circuit analysis of the Y3-103 queue project **Valley-Raccoon 138kV**. One option was considered during this study: the option was direct connection to 15STJOE (tap of the Valley-Raccoon 138 kV line). PJM analysis found **1 new breaker** to be over-duty in DUQUESNE transmission area. The new over-duty breakers are listed below:

Bus_NO	BUS	BREAKER	Duty % with Y3-103_ATSI	Duty % without Y3-103_ATSI	Duty % Difference	Notes
0	BV Z2 138.kV	Z-37 RACOON	101.30%	98.50%	2.80%	New Overduty

The following upgrades in **Table 1** below will mitigate the Duquesne over-duty breakers listed above:

Table 1. Breaker Replacement Cost Estimate	
Description	**Total Cost**
Replace overdutied 138kV circuit breaker Z-37 at Raccoon(PJM Network Upgrade Number n**4086**)	$435,000
Tax Gross-up (if applicable)	$180,000
Total	**$615,000**

PJM analysis found **14 new breakers** to be over-duty in the ATSI transmission area. **This is originally a DUQUESNE project but an ATSI bus is 3 or more buses away.** The new over-duty breakers are listed below:

Bus_NO	BUS	BREAKER	Duty % with Y3-103_ATSI	Duty % without Y3-103_ATSI	Duty % Difference	Notes
9728	B.MNSFLD 345 345.kV	BVLY1-HOYT : 50	100.10%	99.30%	0.80%	New Overduty
9728	B.MNSFLD 345 345.kV	BVLY1-S. BUS 54	100.10%	99.30%	0.80%	New Overduty
9728	B.MNSFLD 345 345.kV	BVLY2-GEN1 : 34	100.10%	99.30%	0.80%	New Overduty
9728	B.MNSFLD 345 345.kV	BVLY2-S. BUS 38	100.10%	99.30%	0.80%	New Overduty
9728	B.MNSFLD 345 345.kV	CHAMB-S. BUS 27	100.10%	99.30%	0.80%	New Overduty
9728	B.MNSFLD 345 345.kV	CRESENT-S. B 65	100.10%	99.30%	0.80%	New Overduty
9728	B.MNSFLD 345 345.kV	GEN NO 1-N. 30	100.10%	99.30%	0.80%	New Overduty

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9728	B.MNSFLD 345 345.kV	GEN NO 2-N. 19	100.10%	99.30%	0.80%	New Overduty
9728	B.MNSFLD 345 345.kV	GEN NO 3-N. 8	100.10%	99.30%	0.80%	New Overduty
9728	B.MNSFLD 345 345.kV	GEN2-CHAMB : 23	100.10%	99.30%	0.80%	New Overduty
9728	B.MNSFLD 345 345.kV	GEN3-S. BUS 12	100.10%	99.30%	0.80%	New Overduty
9728	B.MNSFLD 345 345.kV	HIGH-CRESCEN 61	100.10%	99.30%	0.80%	New Overduty
9728	B.MNSFLD 345 345.kV	HIGH-N. BUS 57	100.10%	99.30%	0.80%	New Overduty
9728	B.MNSFLD 345 345.kV	HOYT-N. BUS 46	100.10%	99.30%	0.80%	New Overduty

The following upgrades in **Table 2** below will mitigate the ATSI over-duty breakers listed above:

Table 2. Breaker Replacement Cost Estimate			
Description	**Total Cost**	**Tax**	**Total with Tax**
Replace overdutied 345kV circuit breaker 50 at Bruce Mansfield(PJM Network Upgrade Number n**4087**).	$969,700	$234,200	$1,203,900
Replace overdutied 345kV circuit breaker 54 at Bruce Mansfield(PJM Network Upgrade Number n**4088**).	$969,700	$234,200	$1,203,900
Replace overdutied 345kV circuit breaker 34 at Bruce Mansfield(PJM Network Upgrade Number n**4089**).	$969,700	$234,200	$1,203,900
Replace overdutied 345kV circuit breaker 38 at Bruce Mansfield(PJM Network Upgrade Number n**4090**).	$969,700	$234,200	$1,203,900
Replace overdutied 345kV circuit breaker 27 at Bruce Mansfield(PJM Network Upgrade Number n**4091**).	$969,700	$234,200	$1,203,900
Replace overdutied 345kV circuit breaker 65 at Bruce Mansfield(PJM Network Upgrade Number n**4092**).	$969,700	$234,200	$1,203,900
Replace overdutied 345kV circuit breaker 30 at Bruce Mansfield(PJM Network Upgrade Number n**4093**).	$969,700	$234,200	$1,203,900
Replace overdutied 345kV circuit breaker 19 at Bruce Mansfield(PJM Network Upgrade Number n**4094**).	$969,700	$234,200	$1,203,900
Replace overdutied 345kV circuit breaker 8 at Bruce Mansfield(PJM Network Upgrade Number n**4095**).	$969,700	$234,200	$1,203,900
Replace overdutied 345kV circuit breaker 23 at Bruce Mansfield(PJM Network Upgrade Number n**4096**).	$969,700	$234,200	$1,203,900
Replace overdutied 345kV circuit breaker 12 at Bruce Mansfield(PJM Network Upgrade Number n**4097**).	$969,700	$234,200	$1,203,900
Replace overdutied 345kV circuit breaker 61 at Bruce Mansfield(PJM Network Upgrade Number n**4098**).	$969,700	$234,200	$1,203,900

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Replace overdutied 345kV circuit breaker 57 at Bruce Mansfield(PJM Network Upgrade Number n**4099**).	$969,700	$234,200	$1,203,900
Replace overdutied 345kV circuit breaker 46 at Bruce Mansfield(PJM Network Upgrade Number n**4100**).	$969,700	$234,200	$1,203,900
Total	**$13,575,800**	**$3,278,800**	**$16,854,600**

It will take approximately **40 months** to complete the breaker upgrades due to outage scheduling issues.

Steady-State Voltage Requirements

(Summary of VAR requirements based upon the results of the steady-state voltage studies.)

None.

Light Load Reliability Analysis

(Summary of any reinforcements required to mitigate system reliability issues during light load periods.)

Not required.

Stability and Reactive Power Requirement

(Summary of VAR requirements based upon the results of the dynamic studies.)

Stability and Reactive Power Requirement studies will be performed as a part of the Facilities Study.

New System Reinforcements

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

None.

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.

Potential Issues

As noted above, Stability impacts have yet to be determined. These studies will be completed in parallel with the Facilities Study. This project will be responsible for mitigating any violations identified in those studies.

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Impacts on the MISO member transmission systems are not included in this analysis, but they will be included as a part of the Facilities Study, which may reveal upgrades needed in the MISO system not identified in this System Impact Study. This project will be responsible for mitigating any violations identified in that study.

Potential Congestion Issues

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.

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 will study all overload conditions associated with the overloaded element(s) identified.

As a result of the aggregate energy resources in the area, no violations were identified.

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Generation Interconnection
System Impact Study Report

For

PJM Generation Interconnection Request
Queue Position Y3-103

Potter 138kV

Revised January 2015

Introduction

This revised System Impact Study (SIS) was required due to the configuration change necessary to support the new load which is at this same location. The SIS has been prepared in accordance with the PJM Open Access Transmission Tariff, Section 205, as well as the Study Agreement between Shell Chemical Appalachia LLC (Interconnection Customer (IC)) and PJM Interconnection LLC (Transmission Provider (TP)). The Interconnected Transmission Owner (ITO) is Duquesne Light (DLCO).

Preface

The intent of the SIS is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the IC. As a requirement for interconnection, the IC may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the TP system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate ITO.

In some instances an IC may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, 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 SIS is performed.

The SIS 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 ITO, the costs may be included in the study.

General

Shell Chemical Appalachia LLC (IC), has proposed a natural gas generating facility (simple cycle 3 GTG and 2 STG) located at 300 Frankfort Road in Monaca, PA. The installed facilities will have a total capability of 205 MW with 97 MW of this output being recognized by TP as capacity. The proposed in-service date for this project is July 1, 2018. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

Y3-103 will interconnect with the ITO transmission system with two (2) radial transmission lines from the planned Potter 138kV substation. The addition of the Potter substation is included in the scope of PJM supplemental project id s0670 and must be completed prior to the operation of this queue project. The Point of Interconnection(s) will be the IC side of the line disconnect switches in the Customer West Substation and this proposed substation will be located approximately at the site of the former St. Joseph Mineral 138kV substation.

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Cost Summary

The Y3-103 project will be responsible for the following costs which are estimated in 2015 dollars:

Description	Total Cost
Attachment Facilities	$490,641
Direct Connection Network Upgrades	$0
Non Direct Connection Network Upgrades	$605,780
Allocation for New System Upgrades	$0
Contribution for Previously Identified Upgrades	$0
Total Costs	**$1,096,421**

Attachment Facilities

The proposed generation project will be connected to the ITO transmission system via two (2) radial transmission lines from the planned Potter 138 kV substation which will be comprised of a seven (7) breaker-ring bus configuration (PJM id s0670).

For the ITO Potter Substation, the ITO will purchase and install protective relays.

For the Customer West Substation, the ITO will be responsible for the engineering, purchasing, and construction of the high voltage equipment, including revenue class metering equipment, from the 138 kV line entrance (structures 138T & 138W) to the Point of Interconnection which includes 2000A disconnect switches within the Customer West substation. The ITO will be responsible for the engineering of the foundations, structural steel and grounding associated with the ITO high voltage equipment. The IC is responsible for providing, installing, and maintaining the steel, foundations, conduit, grounding, fencing, lighting, security, access roads and control area per ITO specifications.

For the Customer East Substation, the ITO requires the IC to supply current transformers and trip coils in all main breakers (denoted as breakers 84 & 85 in Figure 2) as well as the DC system for use by ITO. The protection and supervisory control for the ITO system will be located inside a customer provided secure, segregated and environmentally controlled structure within or adjacent to the customer substation.

The estimated cost for this work is $490,641 and it is estimated to take 12 months to complete this work after execution of the ISA and ICSA. These costs do not include CIAC Tax Gross-up. The single line is shown below in Attachment 1.

Direct Connection Cost Estimate

None

Non-Direct Connection Cost Estimate

At Duquesne Light's Beaver Valley substation, one (1) 138 kV circuit breaker, the Crescent 138kV (Z-29) breaker, was identified as over-dutied and needs to be replaced. The replacement breaker will have a 3000A continuous rating and a 63kA interrupting rating. The ITO will

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replace the primary protection at the Crescent and Raccoon substations to coordinate with the protection system of the replaced breaker at Beaver Valley. It is estimated to take 12 to 16 months to complete this work after execution of ISA and ICSA.

The total preliminary cost estimate for Non-Direct Connection work is given in the table below:

Description	Total Cost
‘n4322 Beaver Valley substation circuit breaker replacement on 138kV Z-29 line to Crescent plus associated protection systems	$605,780
	$605,7890

Interconnection Customer Requirements

ITO Facility connection Requirements as posted on PJM's website

http://www.pjm.com/~/media/planning/plan-standards/private-duquesne/duquesnelight-connection-standards.ashx

Revenue Metering and SCADA Requirements

PJM Requirements

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

ITO Requirements

The ITO will install equipment necessary to provide Revenue Metering (KWH, KVARH) at the Point of Interconnection.

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Network Impacts

The Queue Project #Y3-103 was studied as a 205.0 MW (Capacity 97.0 MW) injection into the Potter 138 kV substation in the DLCO area. Project #Y3-103 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners) for summer peak conditions in 2017. Project Y3-103 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

None

Generator Deliverability

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

None

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

#	Area	Bus No.	Bus	Breaker	Rating Type	Duty Percent Without [Y3-103]	Duty Percent With [Y3-103]	Duty Percent Difference
1	**DL**	**0**	**BV Z1 138.kV**	**Z-29 CRESCEN**	**S**	**99.42%**	**102.57%**	**3.15%**

Contributions to previously identified circuit breakers found to be over-duty:

#	Area	Bus No.	Bus	Breaker	Rating Type	Duty Percent Without [Y3-103]	Duty Percent With [Y3-103]	Duty Percent Difference
2	**DL**	**0**	**BV Z2 138.kV**	**Z-37 RACOON**	**S**	**101.15%**	**104.12%**	**2.96%**

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Note: PJM Short Circuit Allocation Method will only trigger cost allocation if the results are greater than a 3% increase in the fault current at the substation where a Network Upgrade is required.

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

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

None

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

No stability problems identified, for more details see Attachment 2.

Light Load Analysis

(Study to determine that the Transmission System is capable of delivering the system generating capacity at light load)

Not required for simple cycle gas turbines.

New System Reinforcements

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

None

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

Potential Congestion due to Local Energy Deliverability

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

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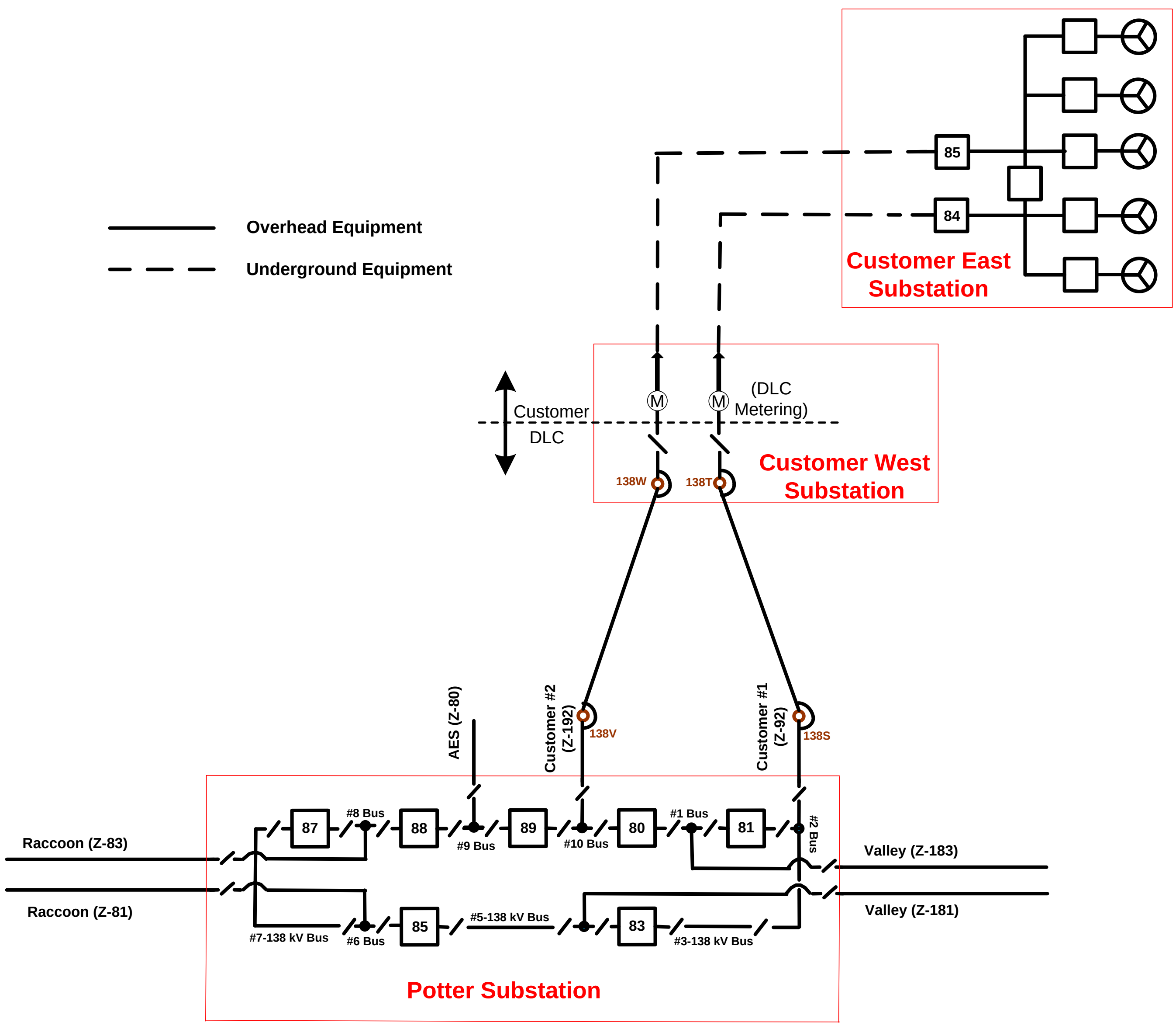
Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

None

Attachment 1. Queue Y3-103

Single Line Diagram



Note: Point of Interconnection(s) will be the IC side of the line disconnect switches in the Customer West substation.

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Attachment 2. Transient Stability Study

Y3-103 Generation Interconnection

This report evaluates the transient stability of PJM Y3-103 project, which is a gross 347.42 MW (221.62 MW net) combined cycle generation unit. The unit owned by Shell Chemical Appalachia LLC is comprised of two 92.7 MW steam turbines and three 54.04 MW combustion turbines. The combined cycle generation unit is connected to ITO's 138 kV system at the location of former St. Joe Mineral customer.

The stability analysis for the interconnection project Y3-103 was performed at 2017 light load condition. The maximum generation output (347.42 MW gross output, 221.6 MW net output) was considered for the queue project under study. Throughout the study, the Y3-103 combined cycle plant had an initial net output of 221.0 MW, -58.4 Mvar to 138 kV System with point of interconnection bus (POI) voltage at 1.016 p.u. The range of contingencies evaluated was limited to that necessary to assess expected compliance with ITO and TP criteria. The simulation time period was 15 seconds for each contingency.

This study involves transient simulations of approximately 35 contingencies that include:

(a) 3-phase faults with normal clearing

(b) Single line to ground (SLG) for delayed clearing time due to stuck breaker condition

(c) Single line to ground (SLG) for delayed clearing time due to protection failure

Specific fault descriptions and breaker clearing times used for this study are provided in Appendix A. Generation equipment data is shown in Appendix B.

Results

The Y3-103 Project was tested using the following conditions:

	Project Y3-103				
	CTG1	CTG2	CTG3	STG1	STG2
Gross power output (MW)	54.04	54.04	54.04	92.7	92.7
Reactive power output (Mvars)	2.1	2.1	2.1	15.7	15.7
Total Auxiliary load	125.9MW, -78.2 Mvar				
Net real power injection (138 kV)	221.0 MW, 58.4 Mvar				

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All facilities in service:

1. Voltage Recovery: For all cases studied, the Y3-103 queue Project recovers to an acceptable steady state voltage within 15 seconds.
2. Transient Stability: For all cases studied, transient stability is maintained with all oscillations stabilized in less than 15 seconds. Also, the voltage levels returned to normal for all cases following the fault clearance.

Note 1: ***Contingencies 11a, 12a and 13a, which involve tripping of 345 kV circuits from Beaver Valley, show that oscillations for Y3-103 and existing machines are decaying slowly. Those circuits are four electrical buses away from POI.***

Similarly, slowly decaying oscillations for the same contingencies were observed, without the Y3-103 plant in service. Therefore, this indicates that the slowly decaying oscillations are not caused by introduction of the Y3-103 project.

While the stability analysis has been performed at extreme system conditions, there is a potential that evaluation at a different level of generator MW and/or MVAR output at different system load levels and operating conditions may disclose unforeseen stability problems. The regional reliability analysis routinely performed to test all system changes will include one such evaluation. Any problems uncovered in that or other operating or planning studies will need to be resolved.

Moreover, when the proposed generating station is designed and plant specific dynamic data for the plant and its controls are available, it must be forwarded to PJM. If it is different than the data provided for this study, a transient stability analysis at a variety of expected operating conditions using the more accurate data shall be performed to verify impact on the dynamic performance of the system. Note that any and all changes to the generation equipment's dynamic data, including the GSU data, must be submitted to PJM for evaluation.

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APPENDIX A

A.1) POWER FLOW CONDITIONS

2017 Summer Light Load Base Case

A.2) BREAKER CLEARING TIMES (CYCLES)

Table A.1. Clearing Times (Cycles)

Contingencies		Total Clearance Time DLCO 138 kV	Total Clearance Time DLCO 345 kV
1	Three phase or SLG fault w/ Normal Clearing- All relaying in service	4.0	4.0
2	SLG fault w/ delayed Clearing - Due to failure of primary relaying	28	n/a
3	SLG fault w/Delayed Clearing - Due to Stuck Breaker (both generating and non-generating stations)	14.5	14.5

A.3) FAULTS CONSIDERED (All facilities in service)

Note: For simplicity of fault type identification, TP has adopted the following notation:

(a): *3-phase faults with normal clearing*

(b): *Single line to ground (SLG) for delayed clearing time due to stuck breaker condition*

(c): *SLG fault with delayed clearing due to communications failure of primary relaying (trip by zone 2 relays).*

This notation is for internal purposes only, and does not necessarily correspond with the NERC category definition stated in TPL-001.

Fault list

3 PH Contingencies

1a. 3 PH @ Shell – Potter 138 kV (Z-92)
2a. 3 PH @ Shell – Potter 138 kV (Z-192)
3a. 3 PH @ Potter – Raccoon 138 kV (Z-81)
4a. 3 PH @ Potter – Raccoon 138 kV (Z-83)
5a. 3 PH @ Raccoon – Beaver Valley 138 kV (Z-37)
6a. 3 PH @ Raccoon – Beaver Valley / Crescent 138 kV (Z-29)
7a. 3 PH @ Raccoon – Midland 138 kV (Z-30)
8a. 3 PH @ Raccoon – JL Midland 138 kV (Z-33)
9a. 3 PH @ Beaver Valley 138 / 345 kV TF1
10a. 3 PH @ Beaver Valley 138 / 345 kV TF2
11a. 3 PH @ Beaver Valley – Mansfield 345 kV (316)
12a. 3 PH @ Beaver Valley – Crescent 345 kV (318)

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13a. 3 PH @ Beaver valley – Clinton 345 kV (318)
14a. 3 PH @ Beaver Valley – Sammis 345 kV
15a. 3 PH @ Potter – Valley 138 kV (Z-181)
16a. 3 PH @ Potter – Valley 138 kV (Z-183)
17a. 3 PH @ Valley – Crescent 138 kV (Z-82)
18a. 3 PH @ Valley – Wolf Run – Legionville 138 kV (Z-84)
19a. 3 PH @ Valley 138 / 69 kV TF

SLG faults with delayed clearing due to stuck breaker

1b1. SLG @ Potter – Shell 138 kV (Z-192), SB '80'@ Potter 138 kV
Apply fault @ Potter – Shell 138 kV (Z-192)
Run for 4.0 cycles
Trip Potter – Shell 138 kV (Z-192)
Run for 10.5 cycles
Trip Potter – Valley 138 kV (Z-181)
Clear Fault @ (4.0+10.5) = 14.5 cycles

2b1. SLG @ Potter – Shell 138 kV (Z-192), SB '81'@ Potter 138 kV
Apply fault @ Potter – Shell 138 kV (Z-92)
Run for 4.0 cycles
Trip Potter – Shell 138 kV (Z-192)
Run for 10.5 cycles
Trip Potter – Valley 138 kV (Z-183)
Clear Fault @ (4.0+10.5) = 14.5 cycles

3b1. SLG @ Potter – Raccoon 138 kV (Z-81), SB '87' @ Potter 138 kV
Apply Fault @ Potter – Raccoon 138 kV (Z-81)
Run for 4.0 cycles
Trip @ Potter – Raccoon 138 kV (Z-81)
Run for 105 cycles
Trip Potter – Raccoon 138 kV (Z-83)
Clear Fault @ (4.0+10.5) = 14.5 cycles

4b1. SLG @ Raccoon – Potter 138 kV (Z-83), SB '10' @ Raccoon 138 kV
Apply Fault @ Raccoon – Potter 138 kV (Z-83)
Run for 4.0 cycles
Trip @ Raccoon – Potter 138 kV (Z-83)
Run for 10.5 cycles
Trip Erie Raccoon – Beaver Valley 138 kV (Z-37) kV
Clear Fault @ (4.0+10.5) = 14.5 cycles

5b1. SLG @ Raccoon – Beaver Valley 138 kV (Z-37), SB '25' @ Raccoon 138 kV
Apply Fault @ Raccoon – Beaver Valley 138 kV (Z-37)
Run for 4.0 cycles
Trip Raccoon – Beaver Valley 138 kV (Z-37)
Run for 105 cycles
Trip Raccoon – Potter 138 kV (Z-83)
Clear Fault @ (4.0+10.5) = 14.5 cycles

6b1. SLG @ Raccoon – Beaver Valley / Crescent 138 kV (Z-29), SB '15' @ Raccoon 138 kV
Apply Fault @ Raccoon – Beaver Valley / Crescent 138 V (Z-29)

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Run for 4.0 cycles
Trip Raccoon – Beaver Valley / Crescent 138 V (Z-29)
Run for 10.5 cycles
Trip Raccoon – Potter 138 kV (Z-81)
Clear Fault @ (4.0+10.5) = 14.5 cycles

6b2. SLG @ Raccoon – Potter 138 kV (Z-81), SB '24' @ Raccoon 138 kV
Apply Fault @ Raccoon – Potter 138 kV (Z-81)
Run for 4.0 cycles
Trip Raccoon – Potter 138 kV (Z-81)
Run for 10.5 cycles
Trip Raccoon – Beaver Valley / Crescent 138 V (Z-29)
Clear Fault @ (4.0+10.5) = 14.5 cycles

15b1. SLG @ Potter – Valley 138 kV (Z-181), SB '85' @ Potter 138 kV
Apply Fault @ Potter – Valley 138 kV (Z-181)
Run for 4.0 cycles
Trip Potter – Valley 138 kV (Z-181)
Run for 10.5 cycles
Trip Potter – Raccoon 138 kV (Z-81)
Clear Fault @ (4.0 + 10.5) = 14.5 cycles

15b2. SLG @ Potter – Raccoon 138 kV (Z-81), SB '85' @ Potter 138 kV
Apply Fault @ Potter – Raccoon 138 kV (Z-81)
Run for 4.0 cycles
Trip Potter – Raccoon 138 kV (Z-81)
Run for 10.5 cycles
Trip Potter – Valley 138 kV (Z-181)
Clear Fault @ (4.0 + 10.5) = 14.5 cycles

16b1. SLG @ Potter – Valley 138 kV (Z-183), SB '81' @ Potter 138 kV
Apply Fault @ Potter – Valley 138 kV (Z-183)
Run for 4.0 cycles
Trip Potter – Valley 138 kV (Z-183)
Run for 10.5 cycles
Trip Potter – Shell 138 kV (Z-92)
Clear Fault @ (4.0 + 10.5) = 14.5 cycles

16b2. SLG @ Valley – Potter 138 kV (Z-183), SB '5' @ Valley 138 kV
Apply Fault @ Valley - Potter 138 kV (Z-183)
Run for 4.0 cycles
Trip Valley - Potter 138 kV (Z-183)
Run for 10.5 cycles
Trip Valley 138/69 kV TF
Clear Fault @ (4.0 + 10.5) = 14.5 cycles

17b1. SLG @ Valley – Crescent 138 kV (Z-82), SB '10'@ Valley 138 kV
Apply Fault @ Valley – Crescent 138 kV (Z-82)
Run for 4.0 cycles
Trip Valley – Crescent 138 kV (Z-82)
Run for 10.5 cycles
Trip Valley – Wolf Run – Legionville 138 kV (Z-84)

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Clear Fault @ (4.0 + 10.5) = 14.5 cycles

18b1. SLG @ Valley – Wolf Run – Legionville 138 kV (Z-84), SB @ Valley 138 kV
Apply Fault @ Valley – Wolf Run – Legionville 138 kV (Z-84)
Run for 4.0 cycles
Trip Valley – Wolf Run – Legionville 138 kV (Z-84)
Run for 10.5 cycles
Trip Valley 138/69 kV TF
Clear Fault @ (4.0 + 10.5) = 14.5 cycles

SLG faults with delayed clearing due to stuck breaker

1c. SLG @ Shell - Potter 138 kV (Z-92)
Apply Fault near Potter End (zone 2)
Run for 4.0 cycles
Open breaker at Potter End
Run for 24 Cycles
Open breaker at Shell end
Clear Fault @ (4.0 + 24.0) = 28 cycles

3c. SLG @ Potter - Raccoon 138 kV (Z-81)
Apply Fault near Raccoon End (zone 2)
Run for 4.0 cycles
Open breaker at Raccoon End
Run for 24 Cycles
Open breaker at Potter end
Clear Fault @ (4.0 + 24.0) = 28 cycles

15c. SLG @ Potter – Valley 138 kV (Z-181)
Apply Fault near Valley End (zone 2)
Run for 4.0 cycles
Open breaker at Valley End
Run for 24 Cycles
Open breaker at Potter end
Clear Fault @ (4.0 + 24.0) = 28 cycles

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APPENDIX B

Y3-103 Project Data

Table 1: Y3-103 Plant Model

	Impact Study Data	Model
Gas turbine generators	3 x 54.04 MW gas turbine generators MVA base = 60.04 MVA Vt = 13.8 kV Unsaturated sub-transient reactance = j0.173pu @ MBASE	3 x 54.04 MW generators Pgen 54.04 MW Pmax 54.04 MW Pmin 43.23 MW Qgen -12.9 MVAr Qmax 23 MVAr Qmin -27 MVAr Mbase 60.04 MVA Zsource j0.173pu @ MBASE
Steam turbine generators	2 x 92.7 MW steam turbine generator MVA base = 103 MVA Vt = 13.8 kV Unsaturated sub-transient reactance = j0.218pu @ MBASE	2 x 92.7 MW generator Pgen 92.7 MW Pmax 92.7 MW Pmin 74.2 MW Qgen -13.5 MVAr Qmax 57 MVAr Qmin -38 MVAr Mbase 103 MVA Zsource j0.218pu @ MBASE
Gas turbine generator GSU transformer	138/13.2 kV Rating = 50.4/67.2/84.0 MVA (OA/F1/F2) Transformer base = 45 MVA Impedance = 0.00305 + j0.08995 pu @ 45 MVA Number of taps = 4 Tap step size = 2.5%	138/13.2 kV Rating = 50.4/67.2/84.0 MVA (OA/F1/F2) Transformer base = 45 MVA Impedance = 0.00305 + j0.08995 pu @ 45 MVA Number of taps = 4* Tap step size = 2.5%

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	Impact Study Data	Model
Steam turbine generator GSU transformer	138/13.2 kV Rating = 84/112/140 MVA (OA/F1/F2) Transformer base = 75 MVA Impedance = 0.00264 + j0.08996 pu @ 75 MVA Number of taps = 4 Tap step size = 2.5%	138/13.2 kV Rating = 84/112/140 MVA (OA/F1/F2) Transformer base = 75 MVA Impedance = 0.00264 + j0.08996 pu @ 75 MVA Number of taps = 4* Tap step size = 2.5%
Gas turbine generator auxiliary load	15.5 MW + 9.5 MVAr	15.5 MW + 9.5 MVAr at each CTG bus
Steam turbine generator auxiliary load	38.5 MW + 24.0 MVAr	38.5 MW + 24.0 MVAr at each STG bus
Gas turbine generator station demand	0.4 MW + 0.25 MVAr	0.4 MW + 0.25 MVAr at each CTG bus
Steam turbine generator station demand	0.6 MW + 0.37 MVAr	0.6 MW + 0.37 MVAr at each STG bus
Transmission line	Length, 0.25 miles	Not modeled

* Transformer tap data has been entered into the PSS/E model assuming a single tap step down and two tap steps up from nominal.

Note:
The interconnection request for Y3-103 is for a MFO of 205 MW, however, the net winter maximum output as specified by the IC is 221.62 MW. The IC was made aware of this discrepancy and asked for clarification, for which they confirmed that the net winter maximum is 221.62 MW. While the stability study may be performed at the 221.62 MW, the MFO for Y3-103 will be limited to the requested MFO of 205 MW. Therefore, IC's specified net winter maximum of 221.62 MW for the study was used.

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APPENDIX C

PSSE MODEL

Single Line Diagram: