

**PJM Generator Interconnection
X4-046 Southwest Substation 18
0 MW Capacity / 19.5 MW Energy Resource
Feasibility Study Report**

***** REVISION 2 *****

*July 2012
DMS #656482v3*

Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, §36.2, as well as the Feasibility Study Agreement between Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Potomac Electric Power Company.

Preface

The intent of this Feasibility Study is to determine a plan, with preliminary cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by IC. As a requirement for interconnection, 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 PJM and the underlying system. All facilities required for interconnection of a generation interconnection project must be designed to meet ITO technical specifications.

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. IC is responsible for its right of way, real estate, and construction permit issues.

General

Queue project X4-046 was studied as a 19.5 MW (0 MW of which was Capacity) injection into ITO system at the Southwest Substation 18. Project X4-046 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

Network Impacts:

Generator Deliverability

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

No problems identified.

Multiple Facility Contingency

(Double Circuit Tower Line Contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study.)

No problems identified.

Contribution to Previously Identified Overloads

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have % allocation of cost responsibility which will be calculated and reported for the Impact Study.)

No problems identified.

Short Circuit

(Report Overduty breakers here)

PJM: Identified four breakers that are over duty as a result of the interconnection. PJM estimates \$200k per breaker and 12-18 months to replace. Additional evaluation will be provided at the System Impact Study.

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With x4-046 PEPCO	Duty Percent Without x4-046 PEPCO	Duty Percent Difference	Note
-	GSB13842 138.kV	PT OCB	T	100.20%	98.90%	1.30%	New Overduty
224069	GSB-T5 138.kV	PT OCB	T	100.00%	98.70%	1.30%	New Overduty
224070	GSB-T6 138.kV	PT OCB	T	100.00%	98.70%	1.30%	New Overduty
-	GSB13841 138.kV	PT OCB	T	100.00%	98.80%	1.20%	New Overduty

ITO: ITO verified revised PJM results and performed short circuit analysis for the addition of X4-046 generation on the distribution system. X4-046 will increase duty to 100.5% to three breakers (see Attachment A, short circuit analysis table #2, to the 13.8 kV breakers at Southwest Substation 18).

Energy Portion of Interconnection Request

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

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

No problems identified.

ITO Analysis

Attachment Facilities

IC will design and construct all facilities on the IC side of the Point of Interconnection (POI).

1. The IC currently is connected to the ITO distribution system via a IC owned 13.2 kV vault supplied by five ITO feeders (Feeders 15607, 15608, 15609, 15610, and 15611) from the Southwest Substation. IC is building a new 13.2 kV vault in order to connect the generation to their load and the ITO system. ITO will provide five 13.8 kV (operating voltage) supplies to the IC proposed new switchgear from Feeders 15607, 15608, 15609, 15610, and 15611. IC is responsible for constructing any conduit on its property. ITO will not install a transformer between the POI and the ITO substation. Based on the current configuration of the IC's facility and the ITO supplies, ITO estimates the cost to extend cables to the customer's switchgear will be on the order of magnitude of about \$250,000. Additional design information is needed from IC to be more certain with this estimate.

ITO requires transfer trip equipment between the ITO normal supply feeder breakers for Feeders 15607, 15608, 15609, 15610, and 15611 and the IC inter-tie breakers at the POI. When the ITO supply feeders are reconfigured to feeders other than feeders 15607, 15608, 15609, 15610, and 15611, ITO Operations Center will notify the IC and request that the intertie breakers be opened by the IC. If the IC has not responded to this request within a

reasonable time period then the intertie breakers will be tripped by ITO supervisory control until the normal supply feeders are returned to service. It is difficult to estimate the frequency of such requests, but it will be an operational constraint for ITO as well. The transfer trip scheme should also be designed such that loss of communication between ITO normal supply substation and the IC facility should result in tripping of the intertie breakers. The alternatives to employing this operating restriction are either:

- (1) to install direct transfer trip of Queue X4-046 from each possible source substation; or
 - (2) interconnect Queue X4-046 via dedicated feeders to Southwest substation at an estimated cost of approximately \$6,000,000 (\$1,200,000 per feeder).
2. IC shall supply transformers that will be used as isolation transformers. The transformers shall have a BIL level of 95 kV. ITO recommends the isolation transformers be connected in a delta-wye configuration according to ITO "Engineering Requirements and Performance Standards for Interconnection Customers on the Potomac Electric Power Company System", Revision I, Dated 1-31-2007. A delta-wye configuration is desirable between the ITO and IC systems, in order to block zero sequence current flow through the transformer. It also does not contribute to over-voltages on unfaulted phases when single-phase faults occur on the ITO side of the transformer.
3. Islanding-protection requirements: A transfer trip scheme for feeders 15607, 15608, 15609, 15610, and 15611 is required to provide islanding-protection. This protection is required for the event where feeder breakers 15607, 15608, 15609, 15610, and 15611 at Southwest Substation open and leave queue X4-046 generation islanded as the only source of generation connected to ITO retail customer load. Islanding-protection involves the installation of a dedicated communications system between queue X4-046 facility and ITO Southwest Substation. ITO will be responsible for providing communications from its control center and its Southwest Substation. IC will be responsible for providing suitable DC power and 19" rack space in close

proximity to the inter-tie breakers where ITO can terminate a “dry” contact from the audio tone equipment for the purposes of tripping the inter-tie breakers at the POI in the event Feeders 15607, 15608, 15609, 15610, and 15611 trip or are otherwise opened by ITO.

ITO will develop a sequence of operation document with concurrence from IC on how the generators will interact with the ITO system. This document will address all combinations of the loss, scheduled and unscheduled maintenance on the ITO supply feeders.

4. Fiber and Telemetry Cost (Excluding Revenue Metering Requirement):

IC is responsible for the Fiber and Telemetry costs as follows:

1. Purchase and install fiber and related equipment between Southwest Substation and Customer’s facility = \$70,000;
2. Purchase and install transfer trip and related equipment at Southwest Substation = \$30,000

Total Cost = \$100,000*

* ITO recommends that IC assume a 30% cost contingency for this work.

5. Metering & SCADA

Revenue Metering Requirements - ITO will install revenue quality metering at each POI. IC will be given an output of each meter. These meters will be the official measurement of the interchange of energy between the IC Facility and the ITO System.

IC is required to make provisions for a voice quality phone line within approximately 3 feet of each ITO metering position to facilitate remote interrogation and data collection.

IC is responsible to send data that PJM and ITO require directly to PJM. IC will grant permission for PJM to send ITO the following telemetry that the IC sends to PJM. IC

will use the ARCOM director-based internet option as described in Attachment H, "Small Generator (10 MW and Below) Technical Requirements and Standards", to PJM Manual 14B.

IC must provide the following status data:

- real time KW for the generators;
 - real time amperes for the generators;
 - Single-phase voltage for the generators
 - open/close status for IC inter-tie circuit breakers;
 - trip control of the IC inter-tie breaker(s);
 - three phase amperes for the IC inter-tie circuit breaker; and
 - KWH from bi-directional revenue meter
6. IC must submit a switching sequence of operation as well as additional documentation for ITO review.
 7. ITO will require the capability to remotely isolate the generator from the grid from its System Operations facility. In this case Trip control of the IC inter-tie breaker(s) shall be provided.
 8. A mutually acceptable means of interrupting and disconnecting the generator with a visible break, able to be tagged and locked out, shall be worked out with ITO Distribution Engineering.
 9. ITO reserves the right to charge the IC operation and maintenance expenses to maintain the IC Attachment Facilities, including metering and telecommunications facilities, owned by ITO.

Non-Direct Connection Local Upgrades

Three alternatives were considered for the breaker duty issue. If IC cannot modify its design parameters, alternative three, ITO would pursue the proposed first solution:

The first solution to reduce the fault current at Southwest Substation 18 would be to replace the existing four (4) .3 ohm reactors installed on the existing 138/13kV transformer secondary with four (4) new .75 ohm reactors. The estimate

for replacing the reactors is approximately estimated at \$1.95 M without CIAC tax. The schedule to complete the project is approximately 24-30 months and is outage dependent. More detailed design will need to be completed to verify feasibility of installing the reactors.

A second alternative solution to installing the 0.75 ohm reactors would require replacing the existing 1000 MVA switchgear with a 1200 MVA Switchgear to increase the interrupting capability at the station. This is estimated at \$10,000,000.

A third alternative solution would be for the IC to review the design of their connected generation. IC may be able to reduce the fault current contribution by making changes to their proposed design.

Direct Connection Local Upgrade Requirements

Voltage Regulation:

Based on the supply of connecting the IC generation by connecting five ITO 13.8 feeders to a IC built 13 kV solidly tied bus, IC proposed generation will not produce any steady state power flow issue at the Southwest Substation 18. High voltage on the feeders may occur for the loss of load without prompt generation shutdown at the IC facility. It is recommended that the IC generation have leading voltage regulation capability to control bus voltage.

Standby Service Charge:

The customer has asked that Pepco provide standby capacity to supply the customer's load in the event the customer's generation is offline for any reason. Based on the customer's request to extend five feeders into a new set of switchgear in order to connect the customer's generation, Pepco has estimated the monthly standby service charge the customer would pay. The Schedule "S" Standby Service tariff stipulates the monthly Standby Service charge shall consist of a Facilities Charge only. The calculations for these charges are as follows:

Facilities Charge:

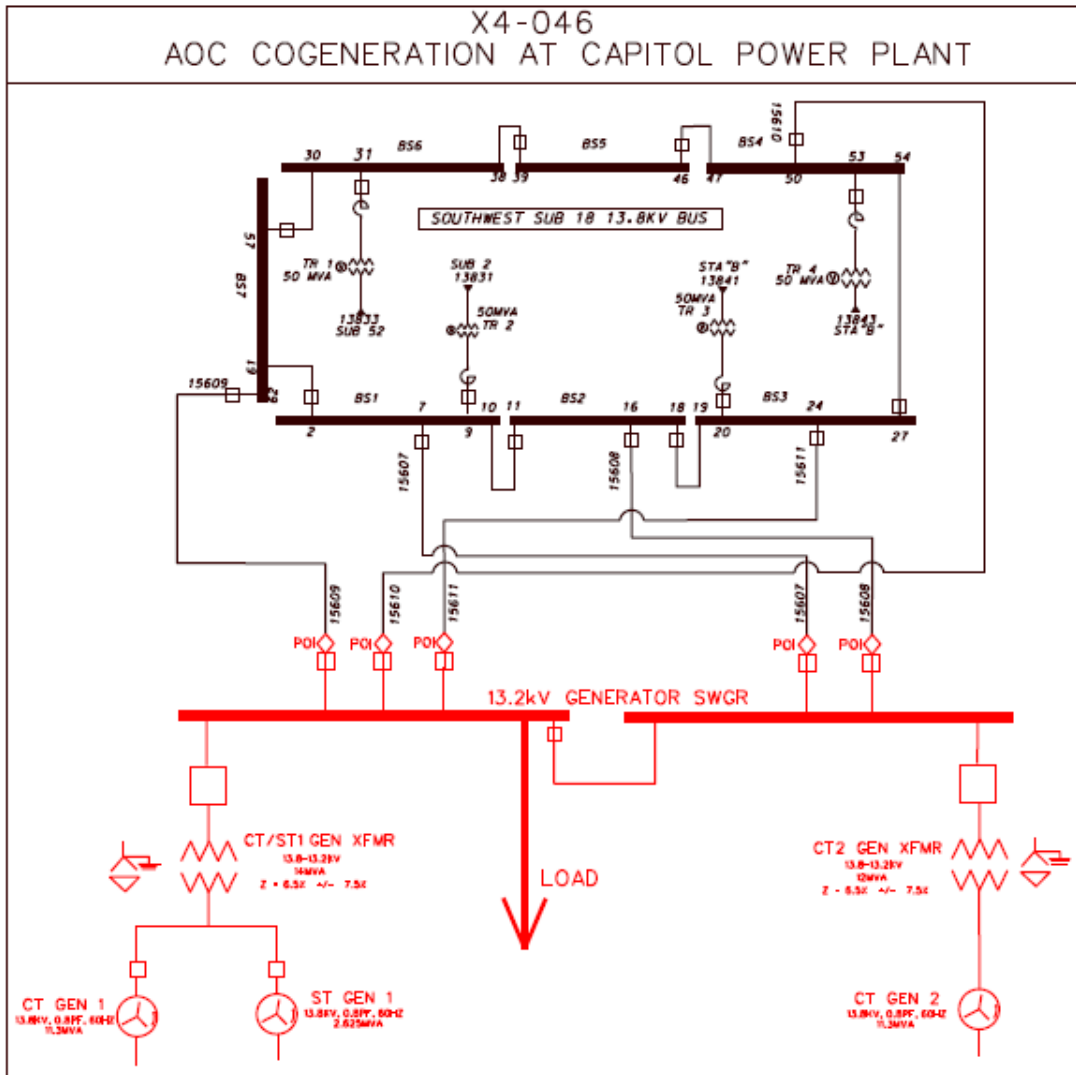
2% of the total installed cost of facilities constructed specifically to provide standby service:

Cost estimate for extending five 13.8 kV feeders from street to IC facility = \$250,000

Monthly Facilities Charge = \$250,000 X 2% = \$5,000

TOTAL MONTHLY STANDBY CHARGE ESTIMATE = \$5,000

Proposed One-Line



Attachment A: ITO Short Circuit Analyses

Description:

The fault study was performed by modeling an Aspen Oneliner file that depicts the proposed configuration of the X4-046 project at the IC facility in Washington, DC. The system modeled consisted of two (2) 13.8 kV 11.3 MVA combustion turbines and one (1) 13.8 kV 2.625 MVA steam turbine connected to the main-incoming 13.8 kV bus at X4-046. The main incoming 13.8kV bus at X4-046 is supplied by five (5) 13.8kV feeders from ITO Southwest substation.

Assumptions:

Generation at Buzzard Point Station B is assumed retired in Summer 2012 and the in-service date for X4-046 is in the third quarter of 2014.

Modeling Tool:

Aspen Oneliner Version 11.8; modeling data for the analysis was provided to ITO by PJM.

Analysis:

The following cases were evaluated for this project:

Case 1

The short-circuit program was used to determine the existing three-phase and single-phase fault duties at the Buzzard Point Subsystem which encompasses the Southwest Substation supplying IC switchgear.

The ANSI X/R ratio was determined.

X4-046 generation: excluded

Case 2

The short-circuit program was used to determine the three-phase and single-phase fault duties at the Buzzard Point subsystem which encompasses the Southwest Substation when two combustion turbines (2 CT) and one steam turbine (1 ST) are connected to the 13.8 kV bus at IC's Capitol Power Plant, CVG-132.

The ANSI X/R ratio was determined.

X4-046 generation included: (2 CT 2 x 11.3 MVA, and 1 ST 2.625 MVA; [Total Generation = 19.5MW])

Short Circuit Results

Existing Condition - No X4-046 Generation

Location	Circuit Breaker Types	Actual Short Circuit Duty (kA)	ANSI X/R Ratio	Adjusted Duty [AD] (kA)	Breaker Interrupting Rating [BIR] (kA)	Percent Interrupting Rating [AD/BIR] (%)	Remarks
Southwest Sub 18 13.8 kV	GE AM-13.8-1000 Three Phase	28.1	46.5	35.2	40.2	87.4	
	GE AM-13.8-1000 Single Phase	29.8	48.5	37.6	46.3	81.2	
Southwest Sub 18 13.8 kV	GE AM-13.8-1000 Three Phase	28.1	46.5	35.2	40.2	87.4	
	GE AM-13.8-1000 Single Phase	29.8	48.5	37.6	46.3	81.2	

Addition of X4-046 Generation (19.5MW)

Location	Circuit Breaker Types	Actual Short Circuit Duty (kA)	ANSI X/R Ratio	Adjusted Duty [AD] (kA)	Breaker Interrupting Rating [BIR] (kA)	Percent Interrupting Rating (%)	Remarks
Southwest Sub 18 13.8 kV	GE AM-13.8-1000 Three Phase	32.4	46.0	40.4	40.2	100.5	Overduty by X4-046
	GE AM-13.8-1000 Single Phase	36.6	43.6	45.1	46.3	97.6	
Southwest Sub 18 13.8 kV	GE AM-13.8-1000 Three Phase	32.4	46.0	40.4	40.2	100.5	Overduty by X4-046
	GE AM-13.8-1000 Single Phase	36.6	43.6	45.1	46.3	97.6	

Conclusion:

The 13.8kV circuit breakers at ITO Southwest Substation are overdutied due to the addition of X4-046 generation.

Note: The conclusions derived from this study are based on IC supplied estimated impedance values for the proposed equipment additions to PJM. If actual impedance values are less than the estimated values, any resulting ramifications will be at the expense of the IC.