GENERATION INTERCONNECTION SYSTEM IMPACT STUDY REPORT

Southern Maryland Electric Cooperative, Inc.

Hughesville, Maryland

PJM Generation Interconnection Request

Queue Position AE2-017

Whitetail 6

“LEXINGTON PARK 69 KV”

DATE: FEBRUARY 26, 2020

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Preface

Either a SMECO Interconnection Project Scoping Meeting or a PJM interconnection queue project "kick-off" conference call will determine if and how a project ***Interconnection Feasibility Study*** will begin. The Feasibility Study cost may be pre-paid as part of an associated SMECO interconnection application engineering review fee, be covered under separate payment as part of a SMECO Feasibility study agreement, or be covered under separate payment as part of a PJM Feasibility Study agreement.

The Interconnection Feasibility Study analysis and report is intended to identify potential adverse system impact(s) to the local utility and regional PJM electric systems that may result from a proposed interconnection project. The study typically includes a high-level area analysis related to power flow, equipment interrupting ratings; protective coordination, steady-state and short duration voltage profiles, and overall interconnection impact to the associated electric systems. This study provides a preliminary determination, high-level cost, approximate construction schedule, and scope-of-work regarding any apparent utility electric system upgrades or additions necessary to allow the proposed project to interconnect to the electric system in a safe and reliable manner.

An ***Interconnection Impact Study*** agreement form will be included as part of the Feasibility Study document. This form, along with any associated study fee, will be used to initiate an Interconnection Impact Study. The Interconnection Impact Study expands upon the findings identified within the Interconnection Feasibility Study and is intended to provide a more concrete solution and alternatives to address any adverse system impacts identified in the Feasibility study. This study takes a more in-depth look at the proposed project and provides a better refined scope-of-work, construction cost, and schedule than what may be provided in the Feasibility Study. Project specifics may dictate that the Impact Study also include a transient stability power flow analysis. Dependent on the proposed project specifics, apparent scope, perceived complexity of the proposed interconnection, and at SMECO's / PJM's discretion, the Interconnection Feasibility and Impact Studies may be combined into a single study document.

An ***Interconnection Facilities Study*** agreement form will be included as part of the Impact Study document. This form, along with any associated study fee, will be used to initiate an Interconnection Facilities Study. The Interconnection Facilities Study expands upon the findings identified within the Interconnection Impact Study. This study is intended to provide the most

comprehensive analysis of the proposed interconnection. The Facilities Study will finalize, to the extent possible, a detailed cost estimate, scope-of-work, and construction schedule to help the interconnection project owner make an informed decision regarding moving the proposed project into construction.

Neither the Feasibility, Impact, nor Facilities Study obligates the utility to interconnect its facilities to or to construct, upgrade, or operate any of its facilities with the proposed interconnection project. Such obligation will only occur in conjunction with a ratified Interconnection Operating Agreement (IOA). The IOA is used to facilitate moving the proposed interconnection project into construction and sets the utility and project owner construction and operating terms for the proposed project. The final Facilities Study information is included within the ratified IOA document.

The interconnection study documents are based, in part, on information provided by the Interconnection Customer via the Interconnection application documentation and any subsequent information obtained through associated Scoping Meeting or PJM conference call discussions. The utility may not have direct control over the accuracy of such information. The utility does not make any warranty, expressed or implied, whether arising by operation of law, course of performance or customer dealings, usage in the trade or profession, or otherwise including without limitation implied warranties of merchantability and fitness for a particular purpose with the regard to the accuracy, content, or conclusion of any referenced study document.

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I. Background

Lightsource NE Development LLC, the interconnection customer (IC), is proposing a 28.8 MW d.c. / 24.75 MVA a.c. name plate solar generating facility to be located in Lexington Park, Maryland. The proposed facility plant controller and inverter settings limit the maximum facility output to 20.0 MW with 10.3 MW assigned capacity interconnection rights. The facility proposes to interconnect to the Southern Maryland Electric Cooperative (SMECO) electric system.

The IC originally identified both a primary and secondary point-of-interconnection (POI) option that was studied within the precursor Feasibility Study. The IC has since opted to move forward using only the primary POI for this System Impact Study and future Feasibility Study.

SMECO studied the proposed project POI local area impacts using the local SMECO 2018 model build summer 2022 PSSE power flow model configured as indicated in Attachment One Figure One. PJM studied the broader regional area impacts using the PJM 2019 series RTEP model build summer 2022 case at 69 kV bus #227002 “HEWTSME”.

The proposed IC project in-service date is March 31, 2021. The required PJM studies and proposed SMECO construction schedules provided in section VII do not support the proposed IC in-service date.

II. Point of Interconnection

The generating facility proposes to interconnect to the local electric system at SMECO’s existing 69 kV line #6767 approximate structure #34 at GPS coordinates 38.24121367 latitude and -76.41762436 longitude. The physical interconnection requires SMECO to construct a new 69 kV ring bus switching station to act as the defined point of interconnection (POI) between SMECO and the generating facility. A proposed interconnection block diagram, site plan, one-line, plan view, profile view, and functional relaying drawing set, indicating the point-of-interconnection (POI) and demarcation between SMECO and the IC, is provided in Attachment One.

III. Interconnection Customer Project Information

The proposed generating facility is interconnecting to the 69 kV SMECO electric system. The proposed facility consists of PV solar panels mounted to a fixed tilt racking system with nine 2750 KVA rated DC-to–AC inverters. Major equipment information is as follows:

Solar Panels (77,895)	Jinko 370 watt modules, fixed tilt orientation
UL1741 Compliant Inverters (9)	Sungrow 2750 KVA SG2500
Distribution Transformers (9)	TBD Manufacturer, 2750 KVA, 2-winding, 34.5 kV delta : 550V wye, 6.0% Z, X/R = TBD
Power Transformer (1)	TBD manufacturer, 15/20/25 MVA, 69 KV gnd wye : 34.5 KV gnd wye : 13.8 kV delta tertiary, Z=7.5%
Sectionalizing cabinet (x)	TBD
Breakers (3)	One at 69 kV and two at 34.5 kV, 1200 amp
Protection Relays (11)	SEL-351, SEL-487, 87T2-1 SEL-387E, 87T2-2 SEL 387A, 87MB2 SEL-587Z, 2 @ SEL-311L, 87HB SEL-587Z, SEL-2505, and 2 @ SEL-735 meters
CT / PT Combo metering unit (1)	TBD
Gen Tie Line conductor	~500 circuit feet 397 MCM ACSR

IC Reactive capacity: Inverter capacity at 95% power factor is ~7.7 MVar leading (absorbing) or lagging (supplying) based on 24.75 MVA inverter nameplate rating. Provisions for an additional 34.5 kV capacitor rack is apparent if needed.

IC facilities Sequence of Operation not specified at this time, TBD.

IC engineering, permitting, and construction schedule not specified at this time, TBD.

IV. Analysis

In addition to building upon the findings identified in the precursor Feasibility Study, the Interconnection System Impact Study also includes: adjacent circuit and substation contingency switching analysis, a transient stability analysis (if necessary), a more refined detailed scope of work, and a more precise non-binding cost estimate for new or upgraded facilities required to interconnect the proposed project to the local area electric system in a safe and reliable manner.

SMECO utilizes a DNV-GL vendor software product called ***Synergi Electric*** to analyze potential generation impacts to the local area 15 kV electric system. A similar Siemens vendor product called ***PSS/E*** and Aspen vendor product called ***OneLiner*** are used to analyze potential generation impacts to the local area 69 kV and 230 kV electric system. PJM uses these same two products to evaluate potential generation impacts to the broader regional electric system.

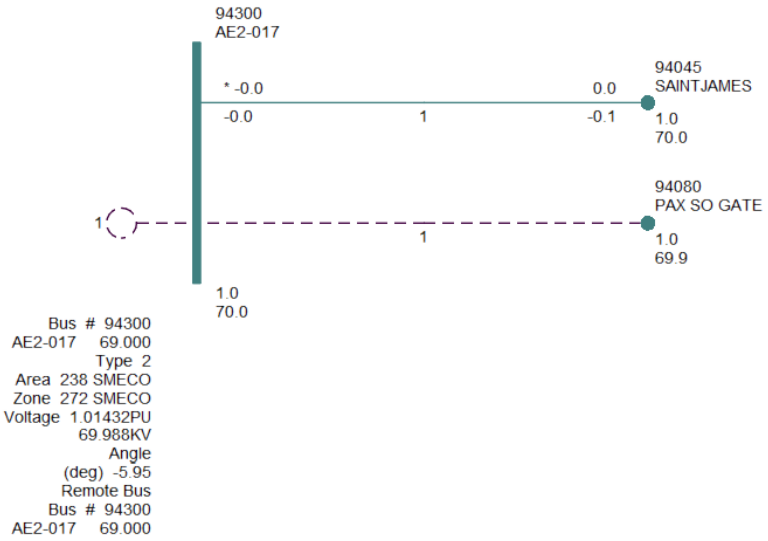
These products create a study area circuit model that includes the proposed project interconnection. In addition to traditional power flow and short circuit analysis, the model(s) may be used to determine the time-of-day impact of proposed intermittent generation (i.e. solar or battery ESS are two such examples) on the local electric system. Several different time-of-day model simulations may be systematically applied to determine what types of voltage and demand variations occur as random intermittent generator outputs change and how specific individual intermittent generators affect the local area electric system. The time-of-day model simulations consider: seasonal light and peak load conditions, hourly time-of-day impacts, generation output fluctuations, and the operational randomness of other pre-existing intermittent generation sources.

V. Results

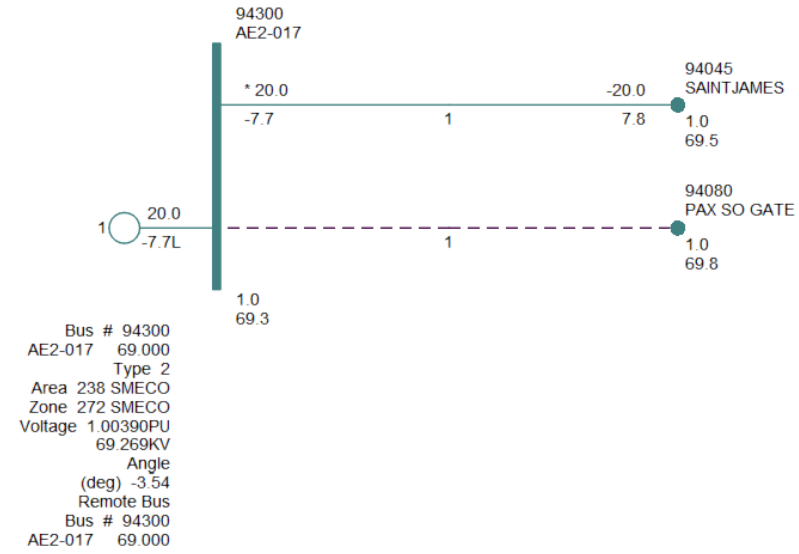
Local Area Power Flow Analysis: SMECO evaluated local area power flow for summer, winter, and minimum light load seasonal conditions based on year 2022 area configuration and forecasted loads. No adverse power flow or bus voltage conditions are evident based on this analysis. The summer 2022 case analysis topology for the primary POI location is provided here:

PRIMARY POI

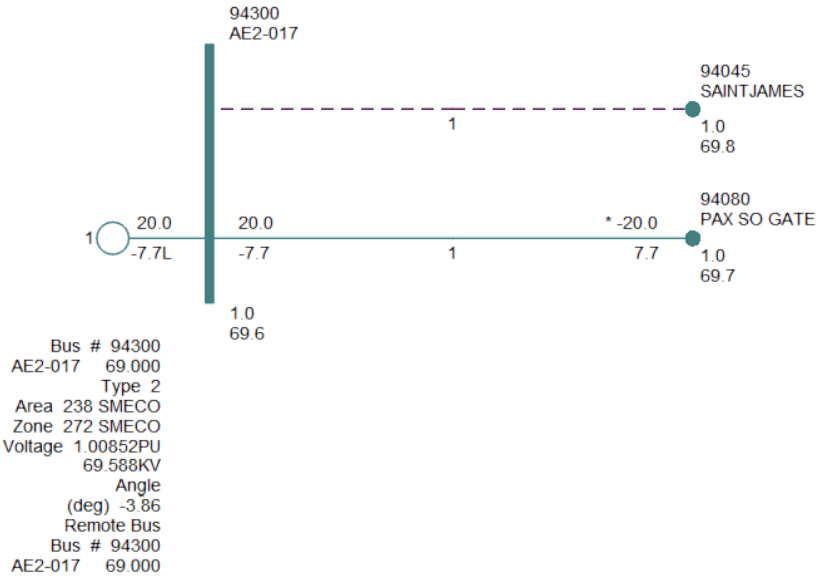
Existing configuration, AE2-017 generation not in service



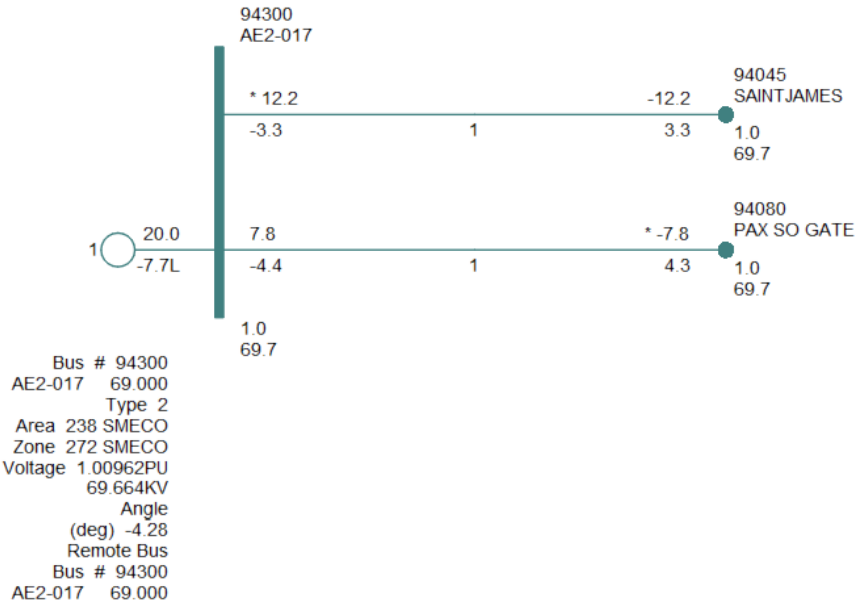
AE2-017 generation in service, #6767 Pax So Gate loop end open



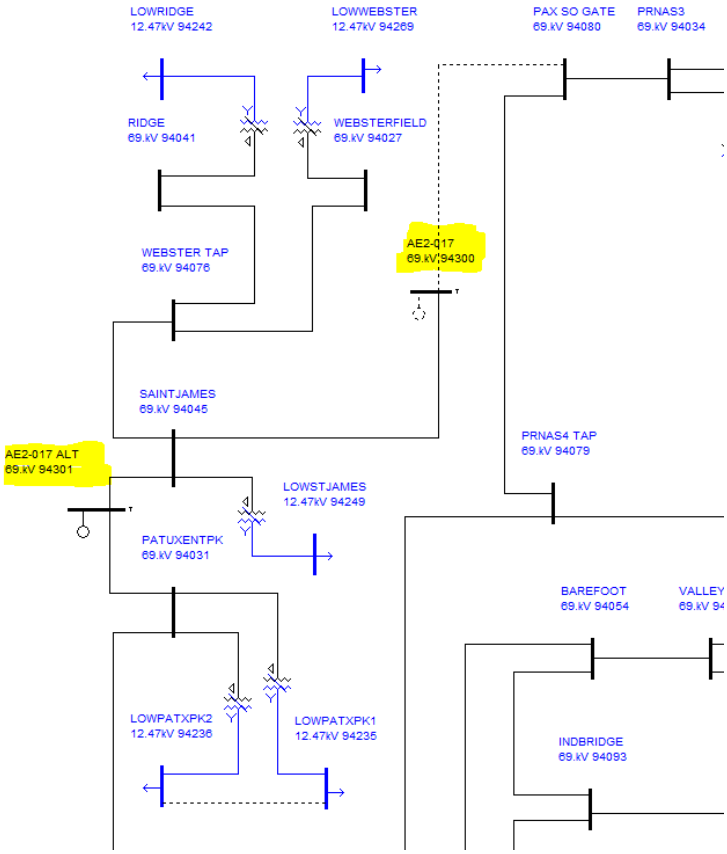
AE2-017 generation in service, #6767 Saint James loop end open



AE2-017 generation in service, #6767 loop closed



Local Area Short-Circuit Analysis: SMECO evaluated local area fault current contributions based on the year 2020 local SMECO area configuration and the regional PJM 2018 series Aspen short-circuit model "PJMSC_2023_07162018" connected generation sources. No adverse fault current contribution issues are evident.



Description	69 kV Bus			12.47 kV Bus		
	Breaker Rating (A)	SLG (A)	TPH (A)	Breaker Rating (A)	SLG (A)	TPH (A)
Existing Year 2020 Conditions – St. James	31,000	3,804	5,560	16,000	6,970	6,481
With AE2-017 Contribution – Saint James	31,000	3,879	5,807	16,000	7,015	6,540
Existing Year 2020 Conditions – Patuxent Pk	31,000	11,426	12,948	16,000	7,580	7,322
With AE2-017 Contribution – Patuxent Pk	31,000	11,550	13,189	16,000	7,590	7,336

VI. Scope of Work

The proposed POI and physical demarcation between SMECO and the IC is a SMECO owned and installed self-supporting dead-end structure within the confines of a new SMECO owned 69 kV ring bus switching station. The physical connection between the switching station and the POI dead-end structure is overhead line conductor jumpers.

The 69 kV ring bus switching station is a low-profile design with three breakers, disconnect switches, bus work, revenue metering, and protective relaying / control circuits with associated communications in a climate controlled building. Additional land is required to physically permit and build the new SMECO switching station.

A new 69 kV line breaker #6767 is required at the Saint James substation remote terminal end. The new line breaker includes: line current differential protective relaying, a new control house, relay panels, batteries, communications, and a SCADA RTU. Approximately five miles of underground fiber optic cable is being installed between Saint James substation and the Patuxent River Naval Air Station South Gate GOAB to provide required high-speed communication between the associated station line breakers.

SMECO Scope of Work Clarifications:

1. Cost estimate includes: a) site design and grading for SMECO owned facilities, b) existing 69 kV SMECO line modifications, c) switching station site work including associated foundations, steel and equipment, bus work, control house, relays, construction, testing and commissioning, d) a Saint James substation remote terminal line breaker, and ADSS high-speed fiber communications.
2. Cost estimate does not include any associated new right-of-way, land acquisition, or real estate costs. Associated permitting costs will be determined at a future date once the new switching station site location is finalized. Permitting costs are in addition to estimated project costs.
3. SMECO will coordinate necessary 69 kV planned line outages and existing 69 kV line modifications to facilitate SMECO switching station construction activities.
4. SMECO will engineer, specify, permit, procure, construct, manage, and maintain all aspects of the proposed new switching station and all other associated facilities on its side of the POI.
5. SMECO is responsible for the OH conductor, equipment, and associated jumpers from the dead end structure to the switching station 69 kV bus.
6. Protective relaying and associated monitoring and control communications will be installed within a new SMECO switching station control building.

IC Scope of Work Clarifications:

1. The IC is responsible for installing and terminating the generation tap line on the dead end structure.
2. Dependent on the distance between the SMECO switching station and IC collector substation locations, the IC may be required to install separate 69 kV line disconnect switches near the POI switching station dead end structure and at the IC collector substation.
3. The IC is responsible for all aspects of the new 69 kV tap line and collector substation facilities including but not limited to the isolation step-up transformer, substation protection, and associated solar distribution feeder circuits. All such facilities are subject to SMECO review and approval.
4. The IC is responsible for securing all permits, right-of-way easements, and any other associated real estate needs for the 69 kV generation tap line.
5. The IC is responsible for conveying additional land to SMECO to accommodate the proposed SMECO switching station POI. A SMECO approved environmental assessment is to accompany the land conveyance prior to SMECO accepting the land conveyance and proceeding with the new switching station site work. Physical switching station site dimensions and actual location are subject to change dependent on future detailed engineering design specifications and permitting requirements. The conveyed land is to be adjoining with the existing SMECO 69 kV line easement area and have direct immediate access to a main paved County or State road (i.e. land seperation by a State or County road is allowed assuming appropriate permitting permissions to cross the road with 69 kV SMECO facilities is obtainable).
6. Prior to commencing with a subsequent Facilities Study for this project, the IC is to provide engineering documentation and drawings to SMECO depicting: a) a revised site plan including the proposed new SMECO owned switching station facility, IC collector substation site, and IC generation tap line, b) a revised one-line diagram showing the complete 34.5 kV and 69 kV IC facilities and associated solar AC and DC layout c) any missing or modified preliminary manufacturer specification information for the major equipment identified in section III of the SMECO System Impact Study document, d) proposed sequence of operation description for the solar inverters including reactive power regulation, and e) available 69 kV generation tap line design and routing information.
7. Informational note only at this time: End-use customer (i.e. energy delivered from SMECO to the customer-owned facilities as measured at the POI) power factor shall be in accordance with the “Power Factor” language found in a future TBD SMECO Tariff Schedule. Generation customers (i.e. energy delivered from the customer-owned facilities to SMECO as measured at the POI) interconnected to the SMECO electric system will operate in accordance with applicable PJM Tariff reactive power requirements. If not subject to PJM Tariff requirements, interconnected customer generation may be required to hold a power factor between 0.95 leading (absorbing MVars) and 0.95 lagging (supplying MVars) as specified by SMECO. SMECO will coordinate and confirm the desired reactive control mode for the IC generation facilities at a later date and may instead request the IC operate its generation using a volt-var control strategy to maintain the POI between 1.0 - 1.02 per unit voltage.
8. Informational note only at this time: Express written authorization from SMECO is required

before any IC facilities are installed or associated improvements made within SMECO's existing property and line easement areas. SMECO access to its facilities and any associated easement areas must remain clear at all times. Storing or depositing equipment or materials within the SMECO property and easement areas is prohibited.

VII. Cost and Schedule

PJM AE2 Queue Report and Agreement Schedule	Start Date	End Date
Feasibility Study	May 1, 2019	July 31, 2019
System Impact Study	November 1, 2019	February 29, 2020
Facilities Study	April 1, 2020	September 30, 2020
Wholesale Market Participant Agreement (WMPA)	November 1, 2020	November 30, 2020
Interconnection Agreement (IA)	December 1, 2020	January 31, 2021

Project Schedule: The estimated project schedule is 24 months after receiving the signed interconnection agreement and initial milestone payment. Associated permit delays can affect the proposed project schedule. SMECO prefers that construction be scheduled between March and October if possible to do so.

SMECO Project Schedule	Date
Permitting (12 month)	February 2021
Engineering Begins (6 month)	February 2021
Land expansion deeded to SMECO	October 2021
Order Material (6 month)	August 2021
Switching Station Site Grading (3 month)	February 2022
Physical Construction Begins (9 month)	June 2022
POI In Service	February 2023
Project Complete and Closeout	March 2023
Note: SMECO will make all possible effort to comply with the listed construction schedule; however, SMECO is not liable for inadvertent schedule delays.	

SMECO's estimated primary POI project cost is $5,500,000 and includes: engineering, project management, labor and materials, construction, and construction management. Associated permitting costs will be determined at a future date and are in addition to estimated project costs. Estimated material and labor costs include 20% contingency. The estimated project cost breakdown is:

Engineering, Company Labor, and Overhead	$ 1,350,000
Material	$ 1,850,000
Construction	$ 2,300,000
Total	$ 5,500,000

VIII. Summary Findings

1. No adverse 15 kV or 69 kV local area power flow issues are evident.
2. No adverse 15 kV or 69 kV local area bus voltage issues are evident.
3. No adverse 15 kV or 69 kV local area fault current contribution issues are evident.
4. No apparent baseline or supplemental projects are required to support the proposed generation interconnection project.
5. A local network project is required to support the proposed generation interconnection project. A preliminary scope-of-work, project schedule, and project cost is included within this report.
6. Prior to commencing with any subsequent Facilities Study for this project, the IC is to provide additional and revised engineering documentation and drawings to SMECO as indicated within SMECO System Impact Study report section VI.
7. It is recommended that PJM conduct a transient stability analysis for this project during the System Impact or Facilities Study phases of this project.
8. The PJM studies and proposed SMECO construction schedules do not support the proposed project March 31, 2021 in-service date.

IX. PJM Transmission Network Impacts

Summer Peak Load Flow

1 Generation Deliverability

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

None

2 Multiple Facility Contingency

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

None

3 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

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

None

5 System Reinforcements

None

6 Short Circuit

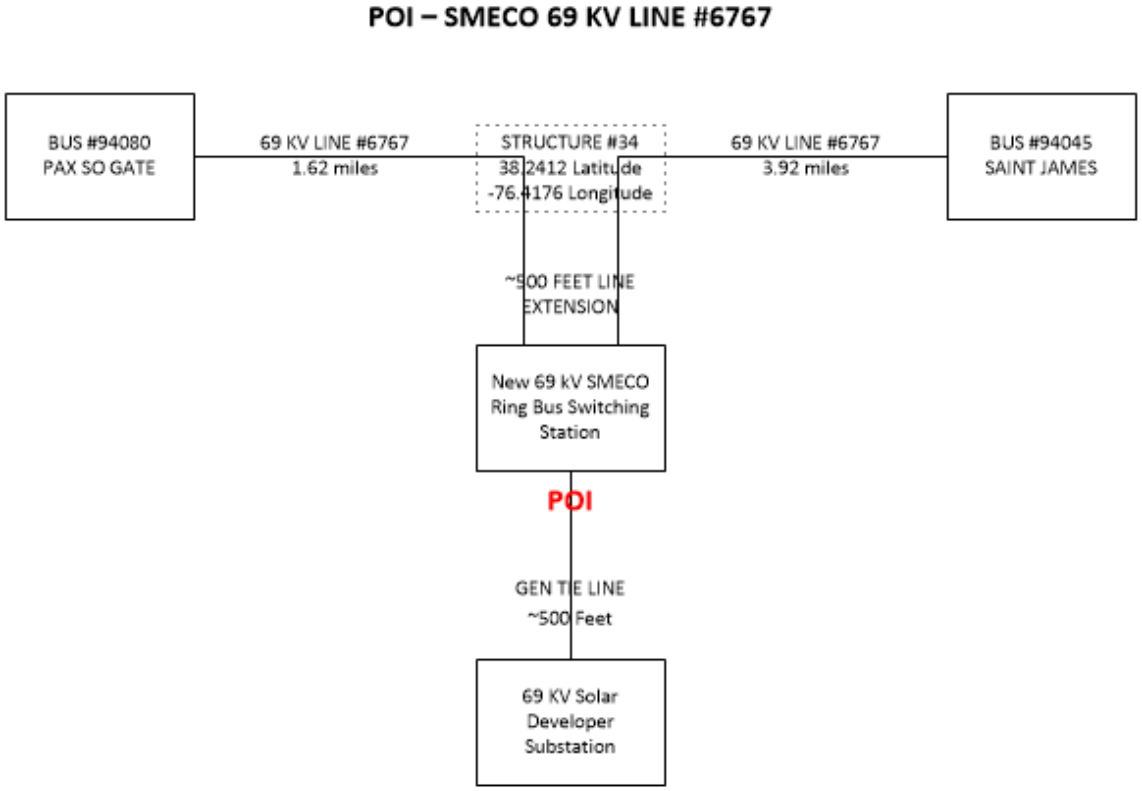
No violations

7 Stability

To be completed in the Facilities Study phase.

Attachment One

Figure One – Point of Interconnection (POI) Block Diagram

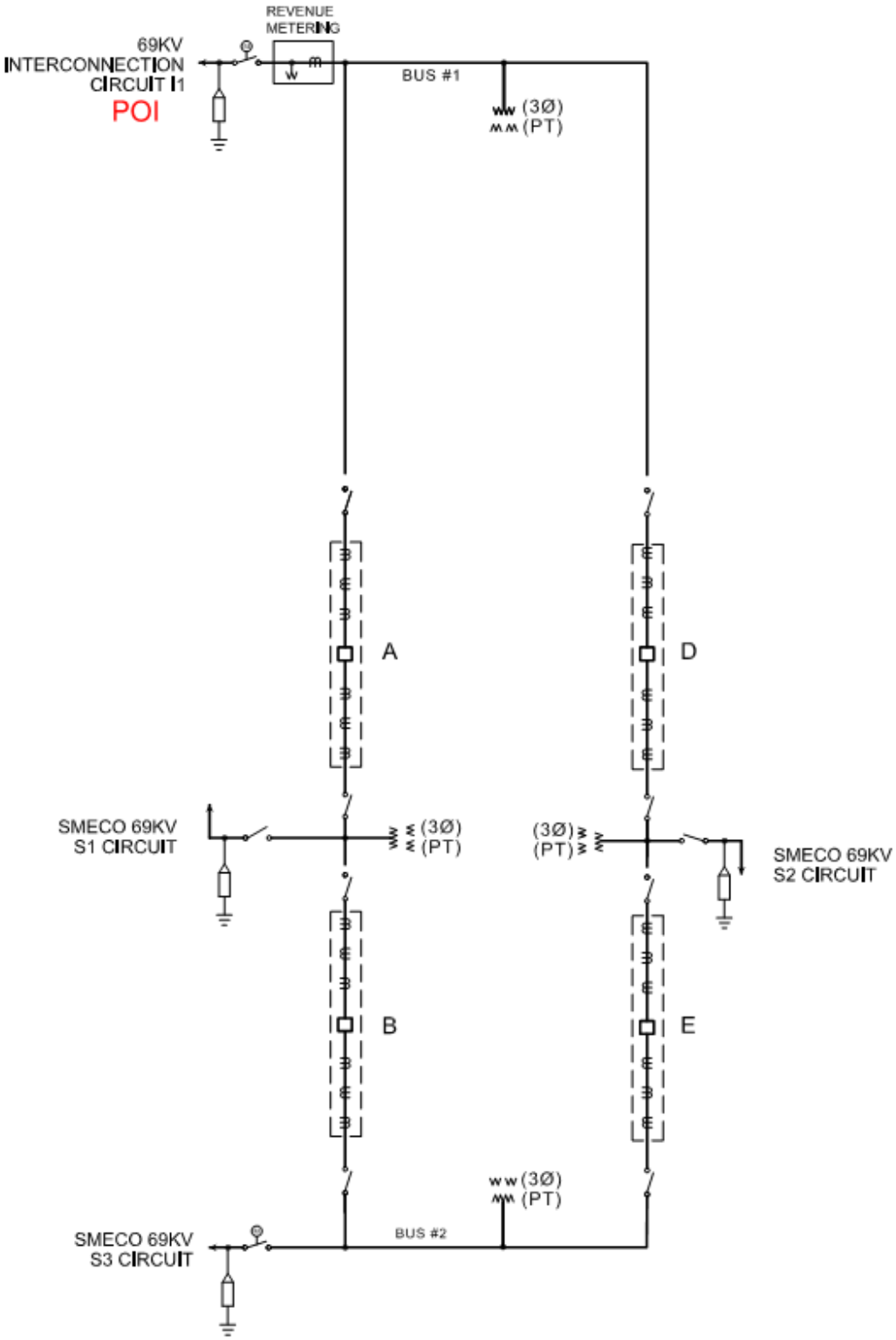


Attachment One

Figure Two – Proposed Solar Developer Site Plan

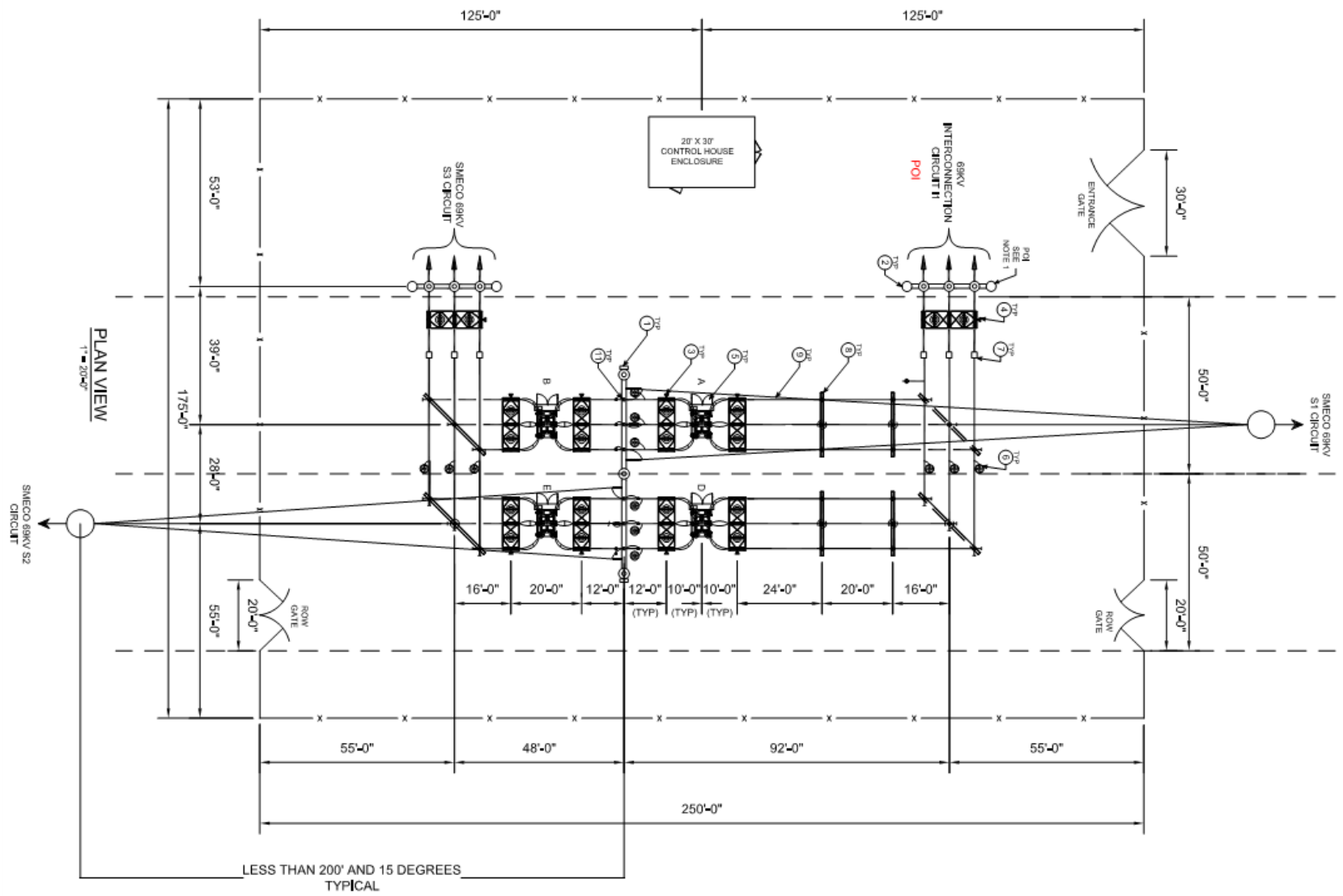
Attachment One

Figure Three – Typical New SMECO Ring Bus Switching Station One-Line Diagram



Attachment One

Figure Four – Typical SMECO 69 kV Switching Station Plan View



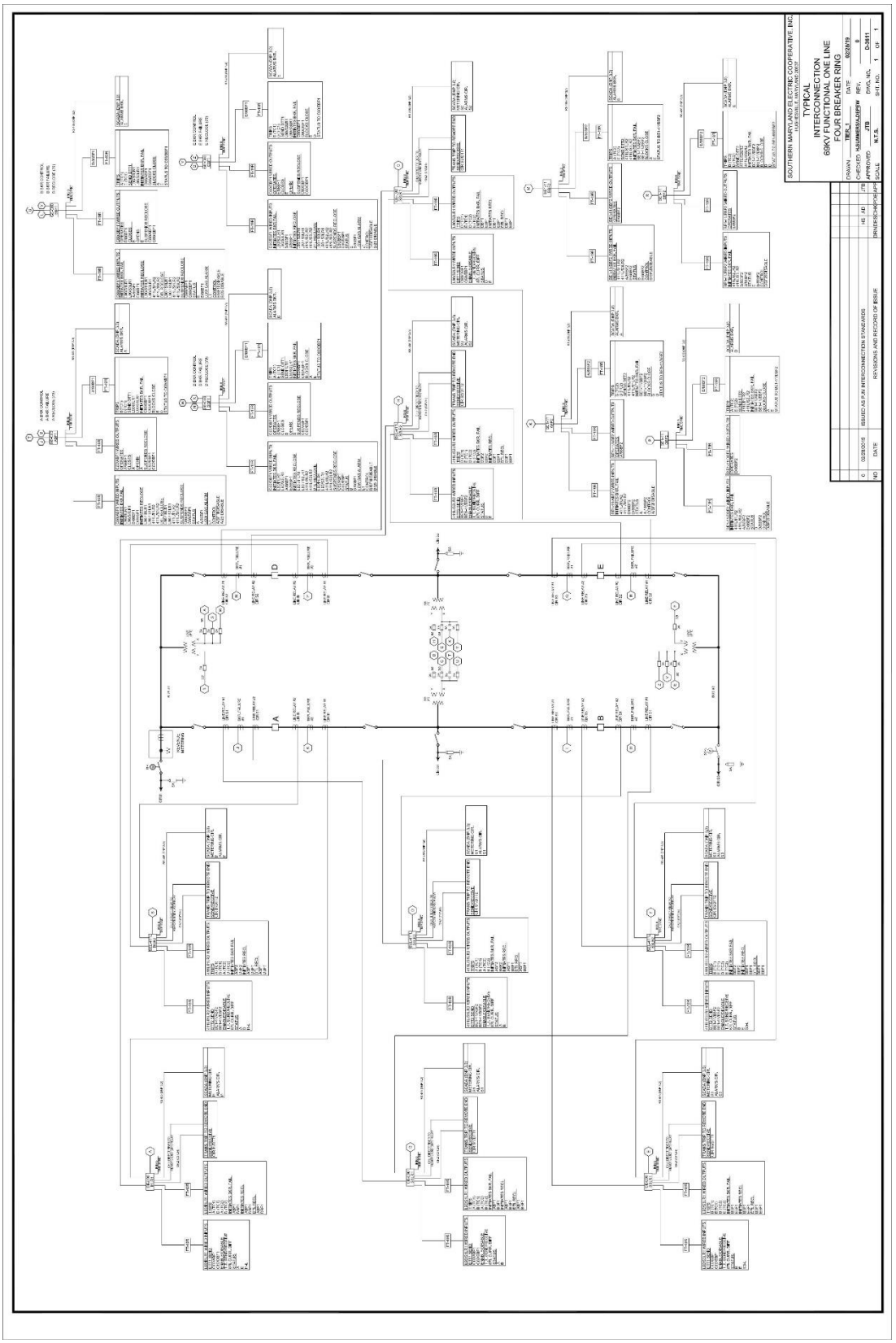
Attachment One

Figure Five – Typical SMECO 69 kV Switching Station Profile View

To be completed as part of a future TBD Facilities study

Attachment One

Figure Six – Typical SMECO 69 kV Functional Protection One-Line



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