Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AC1-145

Gretna DP 69kV
19 MW Capacity / 50 MW Energy

June / 2019

General

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff §207, as well as the Facilities Study Agreement between SoCore Energy, LLC, (Interconnection Customer (IC)) and PJM Interconnection, LLC (Transmission Provider (TP)). IC has proposed a solar generating facility located at in Pittsylvania County, VA. The installed facilities will have a total capability of 50 MW with 19 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 18, 2020. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AC1-145 will interconnect with the ITO transmission system at a three breaker ring-bus tapping the Chatham - Gretna DP 69kV line #173.

Cost Summary

The AC1-145 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 518,731
Direct Connection Network Upgrades	$ 5,063,075
Non Direct Connection Network Upgrades	$ 1,816,215
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 7,398,021**

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A. Transmission Owner Facilities Study Summary

1. Description of Project

Queue AC1-145 is a request to interconnect a 50 MW new solar generating facility to be located in Pittsylvania County, Virginia. The proposed generating facility will interconnect with the ITO's new AC1-145 69kV Switching Station via a new three breaker ring-bus switching station. The requested in-service date is December 18, 2020. Attachment Facility and Network upgrade construction is estimated to be 8 – 12 months.

2. Amendments to the System Impact Study data or System Impact Study Results

Transformer change from delta to grounded wye high side

3. Interconnection Customer's Submitted Milestone Schedule

- Plan to break ground January 31, 2019
- Permits – state level Permit By Rule and county level Final Site Plan approval complete by December 20, 2019
- Substantial site work completed May 17, 2020
- Delivery of major electrical equipment June 21, 2020
- Back Feed Power October 1, 2020
- Commercial Operation December 18, 2020

4. Scope of Customer's Work

IC will build a solar generating facility in Pittsylvania County, Virginia. The generating facility (Whitethorn Solar) will be comprised of solar arrays. AC1-145 consists of 400 x 0.125 MWA Sungrow Power SG125HV inverters. The 20 x 34.5/0.60 kV grounded wye / grounded wye 3.0 MVA generator step up (GSU) transformers will connect to the solar inverters to the 34.5 kV collector system. The collector bus will also have 6 x 4 MVar Capacitor Banks and 2 x 4MVar Reactors. The generating facility will connect to the Point of Interconnection (POI) via a 69/34.5 kV wye grounded / wye grounded main power transformer with a rating of 50 MVA. The IC's collector substation will be adjacent to the new three breaker ring bus substation. The AC1-145 POI will be as shown on the single line diagram in Attachment 1.

5. Description of Facilities Included in the Facilities Study

The ITO will connect the proposed generator lead via Attachment Facilities to a new AC1-145 69kV ring bus switching station adjacent to the transmission right of way. The solar generating facility will be located south of the existing Gretna Substation. The position of the switching station will be adjacent to the right of way of the existing 69kV Transmission Line #173, on a property provided and rough graded by the IC. The station will be positioned in such a way that the two Light Duty Backbones will be installed perpendicular with the existing transmission line. The line will be cut at Structure #173/115 and routed into the proposed New Three Breaker Ring Substation. The cut lines will consume two of the three positions in the ring bus. The third position will be for the 69kV feed from the collector station for the solar farm, located adjacent to the New Three Breaker Ring Substation. The demarcation point between the New Three

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Breaker Ring Substation and the collector station will be the 4-hole pads on the collector station disconnect switch. ITO will bring its bus to the demarcation point. Metering equipment will be required between the ITO switching station bus and the IC collector station. The grounding systems for both the stations will be tied together. All substation permitting, site preparation and grading activity will be performed by IC. The Attachment Facilities include the portion of the interconnecting switching station which is associated solely with the single feed to the generating facilities collector station. The equipment associated with the Attachment Facilities include the bus, structures, disconnect switch, metering accuracy CCVT's, metering accuracy CT's, metering and associated protection equipment. ITO will renumber structures between the new three breaker ring substation and Bearskin substation.

6. Total Costs of Transmission Owner Facilities included in Facilities Study

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Attachment Facilities	$288,253	$163,524	$49,858	$17,096	$518,731
Total Attachment Facilities Cost	$288,253	$163,524	$49,858	$17,096	$518,731
AC1-145 69 kV Switching Station (n6046)	$2,208,522	$2,050,933	$555,330	$248,290	$5,063,075
Line #173 Transmission work (n6047)	$827,867	$657,030	$136,811	$71,317	$1,693,025
Remote relay (n6048)	$92,975	$8,815	$20,253	$1,147	$123,190
Total Network Upgrades	$3,129,364	$2,716,778	$712,394	$320,754	$6,879,290
Total Project Costs	$3,417,617	$2,880,302	$762,252	$337,850	$7,398,021

7. Summary of Milestone Schedules for Completion of Work Included in Facilities Study:

Facilities are estimated to take 14 - 24 months to construct and this is based on the ability to obtain outages to construct and test the proposed facilities.

Proposed Schedule

- Detailed design: 6-12 months
- Permitting: 6-12 months (Timeline runs concurrent with design)
- Construction 8 to 12 months

ITO requires the site to be fully graded and permitted site so they can start construction by September 2019.

B. Transmission Owner Facilities Study Results

1. Attachment Facilities

The Attachment Facilities include the portion of the interconnecting switching station which is

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associated solely with the single feed to the generating facilities collector station. The Point of Interconnection with the generator will be the 4-hole pads on the collector station disconnect switch. The equipment associated with the Attachment Facilities include the bus, structures, disconnect switch, metering accuracy CCVT's, metering accuracy CT's, metering and associated protection equipment.

Purchase and install substation material :

1. One (1), 69kV, 2000A Center Break Switch
2. Three (3), 69kV, Metering Accuracy CCVT's
3. Three (3), 69kV, Metering Accuracy CT's
4. Conductors, connectors, conduits, control cables, foundations, steel structures and grounding material

Purchase and install relay material:

1. One (1), 1109 – 28" Dual SEL-587Z Transmission Bus Panel
2. One (1), 4200 – Bus Differential C.T. M.U. Box
3. One (1), 1425 – 28" Dual SEL-735 Metering Panel (Transmission & Generation Interconnect)
4. One (1), 4524 – Revenue Metering C.T. M.U. Box
5. One (1), 4506 – Generator Interconnect CCVT Potential M.U. Box
6. One (1), 1323 – 28" SEL-487E/735 PMU & PQ Monitoring Panel
7. Two (2), 4541 - Control Cable M.U. Box

2. Transmission Line – Upgrades

PJM Network Upgrade #n6047 - Re-arrange Line #173 to loop into and out of the new three breaker AC1-145 69 kV switching station between existing Chatham - Gretna DP 69kV line #173 substation.

Constructed in 2008 on Weathering Steel Dom-pole structures, the 173 line is an existing 69 kV line that runs from Bearskin Substation to Gretna Substation. Project AC1-145 will split the 173 line at the proposed AC1-145 Substation in Gretna, VA and will include a three breaker ring-bus that will provide a connection point for the solar generation interconnection.

The following estimate is for the construction of a new substation connection on Transmission Line 173 between Bearskin Substation and Gretna Substation. The line connection will require the installation of (2) backbone structures, two (2) static pole structures, one (1) Double-Circuit monopole structure, and approximately 1.06 miles of OPGW. The conceptual design and estimate includes costs for the following:

Transmission facilities to be installed:

1. Install two (2) 115 kV SC Heavy-Duty Steel DDE Backbone structures (no switches) with foundations (Strs. 173/115A and XX/115B).
2. Install two (2) Galvanized Steel Static Poles with foundations (Strs. 173/115C and 173/115D).
3. Install one (1) DDE DC monopole tap structure (Str. 173/115).
4. Transfer the existing 477 ACSR "Hawk" conductor to new Str. 173/115.

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5. Transfer the existing 3#6 ALWD Static wire to the Bearskin Sub side of new Str. 173/115.
6. Install approximately 1.08 miles of one (1) new OPGW cable from Gretna Substation to the new AC1-145 substation.
7. Install approximately 0.2 miles of new 1-7#7 static wire at AC1-145 Substation.
8. Install approximately 0.04 miles of new 636 ACSR 24/7 "Rook" conductor from new Str. 173/115 to Backbone Strs. 173/115A and XX/115B (.02 miles of conductor to each Backbone).
9. Renumber approximately 14 structures with new line number XX between AC1-145 Substation and Gretna Substation.

Transmission facilities to be removed:

1. Remove one (1) Existing DDE Weathering Steel monopole Str. 173/115.
2. Remove approximately 1.06 miles of 3#6 ALWD from Str. 173/115 – 173/128.

Miscellaneous transmission items:

1. Additional permanent Right of Way will need to be obtained for the tap span as it enters the new substation.
2. The new OPGW from AC1-145 Sub to Gretna Sub will be a 24-fiber OPGW.
3. The 173 line will be taken out of service between SW17396 and SW17349 to construct AC1-145 Switching station.

3. New Substation/Switchyard Facilities

PJM Network Upgrade #n6046 - Build a three breaker AC1-145 69 kV switching station

The solar generating facility will be located south of the existing Gretna Substation. The position of the switching station will be adjacent to the right of way of the existing 69kV Transmission Line #173, on a property provided and rough graded by IC. The station will be positioned in such a way that the two Light Duty Backbones will be installed perpendicular with the existing transmission line. The line will be at Structure #173/115 and routed into the proposed New Three Breaker Ring Substation. The cut lines will consume two of the three positions in the ring bus. The third position will be for the 69kV feed from the collector station for the solar farm, located adjacent to the New Three Breaker Ring Substation.

The work required is as follows:

Purchase and install substation material:

1. Approximately 300' X 230' site preparation and grading as required for installation of the switching station (by IC) not including any added land as required for SWM, etc
2. Approximately 1060 linear FT of 5/8" Chain Link, 12 FT tall, perimeter fence around the station along with the security cameras and integrators (Design 4 Standard).
3. Full substation ground grid as per engineering standards
4. Two (2), Single Circuit Backbones
5. Two (2), Shield wire poles and three spans of shield wires
6. Three (3), 69kV, 3000A, 40 kA, SF6 Circuit Breakers
7. Six (6), 69kV, 2000A Center Break Switches

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8. Six (6), 115kV, CCVT's, relay accuracy
9. One (1), 2000A, Vertically Mounted, Wave Traps along with two (1), Line Tuners
10. Nine (9), 60kV MO, 48kV MCOV Station Class Arresters
11. Four (4), 69kV, 100 KVA Power PT's for Station Service
12. Two (2), 69kV, 2000A, 2-Pole Center Break Switches (for PVT's)
13. One (1), 24' x 40' Control Enclosure
14. One (1), 135VDC, 577Ah Batteries and 50A Charger
15. Oil Containment system for the 115kV PVT's.
16. Cable Trough, concrete w/cover, 2' 6'' wide, approximately 250 FT, with a 20 FT road crossing section.
17. Steel structures as required including switch stands, bus supports, station service transformers, CCVT and wave trap supports
18. Foundations as required including control house, equipment and bus support stands
19. Conductors, connectors, conduits, control cables and grounding materials

Purchase and install relay material:

1. Three (3), 1510 – 28" Dual SEL-351-7 Transmission Breaker w/ Reclosing Panel
2. Three (3), 4510 - SEL-2411 Breaker Annunciator
3. Two (2), 1320 – 28" Dual SEL-421-5 DCB Line Panel
4. Two (2), 4506 – 3 Phase CCVT Potential M.U. Box
5. One (1), 1603 – 28" SEL-451 Islanding Control Scheme Panel
6. Two (2), 4000 – Station Service Potential M.U. Box
7. Two (2), 4018 – 500A Station Service AC Distribution Panel
8. Two (2), 4007 – 225A Outdoor Transmission Yard AC NQOD
9. Two (2), 4019 – 225A Three Phase Throwover Switch
10. Two (2), 4016 – 600A PVT Disconnect Switch
11. One (1), 4153 – Wall Mount Station Battery Monitor
12. One (1), 5612 - SEL-3530 Data Concentrator Panel
13. One (1), 1255 – Station Annunciator Panel
14. One (1), 5021 – SEL-2411 RTU Panel
15. One (1), 5609 – Fiber Optic Management Panel
16. Three (3), 4526_A – Circuit Breaker Fiber Optic M.U. Box
17. One (1), 5202 – 26" APP 601 Digital Fault Recorder
18. One (1), 5603 – Station Network Panel 1
19. One (1), 5603 – Station Network Panel 2
20. One (1), 5616 – Station Security Panel
21. One (1), Telephone Interface Box
22. One (1), High Voltage Protection (HVP) Box (Provided by IT)

4. Upgrades to Substation / Switchyard Facilities

PJM Network Upgrade #n6048 - Remote protection and communication work. ITO protection requirements to reliably interconnect the proposed generating facility with the transmission system determined that work is required at Bearskin, Chatham and Gretna 69kV substations. These costs include the following:

Bearskin 69 kV Substation

Project Summary

At Bearskin station, update drawings accordingly to support the AC1-145 switching station.

Chatham 69 kV Substation

Project Summary

At Chatham station, update drawings accordingly to support the AC1-145 switching station.

Gretna 69 kV Substation

Project Summary

At Gretna station remove the existing Line 173 Wave Trap. Line 173 is to be renumbered under this project as a result of the proximity of the new AC1-145 three breaker ring substation.

Remove:
1. One (1), 1600A Wave Trap

Purchase and install relay material:
1. One (1), SEL-2411 Islanding TT Transmitter
2. One (1), 7609 – SEL-2505 Transfer Trip Send Package
3. One (1), 7609 – SEL-2505 Transfer Trip Receive Package
4. One (1), 5603 – Station Network Panel No. 2 (Fiber Panel)

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Bearskin	$8,939	$0	$2,688	$0	$11,627
Chatham	$8,939	$0	$2,688	$0	$11,627
Gretna	$75,097	$8,815	$14,877	$1,147	$99,936
Total Remote Relay Upgrades	$92,975	$8,815	$20,253	$1,147	$123,190

5. Metering & Communications

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. See PJM Manuals M-01 and M-14D, and PJM Tariff Section 8 of Attachment O Appendix 2.

ITO Requirements

Metering and SCADA/Communication equipment must meet the requirements outlined in section 3.1.6 Metering and Telecommunications of ITO's Facility Interconnection Connection Requirement NERC Standard FAC-001 which is publically available at www.dom.com.

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At the IC's expense, the ITO will supply and own at the Point of Interconnection bi-directional revenue metering equipment that will provide the following data:

a. Hourly compensated MWh received from the Customer Facility to the ITO;
b. Hourly compensated MVARh received from the Customer Facility to the ITO;
c. Hourly compensated MWh delivered from the ITO to the Customer Facility; and
d. Hourly compensated MVARh delivered from the ITO to the Customer Facility.

The IC will supply and own metering equipment that will provide Instantaneous net MW and MVar per unit values in accordance with PJM Manuals M-01 and M-14D, and Sections 8.1 through 8.5 of Appendix 2 to the ISA;

The IC will access revenue meter via wireless transceivers or fiber cabling to meter with RS-485 or Ethernet communication port for dial-up reads. IC must provide revenue and real time data to PJM from Interconnection Customer Market Operations Center per "PJM Telemetry Data Exchange Summary" document available at PJM.com.

6. Environmental, Real Estate and Permitting Issues

The IC would be responsible for the following expectations in the area of Environmental, Real Estate and Permitting:

- Suitable Access Road from Substation to a Virginia State Maintained Roadway.
- Any additional land needed for Storm Water Management, Landscaping, and Wetlands/Wetlands Mitigation.
- Conditional Use Permit for Substation.
- Any other Land/Permitting requirements required by the Substation.

ITO Real Estate Needs:

- The substation layout is complete and ITO requires a 230'x 300' piece of property (title in fee) to build the substation. The property includes the piece of property between the substation and collector station for the strain bus.
    - ITO requires ownership transfer of the substation site before they start construction. Target for the deed by September 2019.
    - The size of the station assumes ITO will not need a separate storm water management system for the substation. If the county rules differently then the ITO will need to revisit the land requirements.
- ITO will need a letter similar to the zoning letter from the county stating that if the solar farm is retired and / or decommissioned the substation will remain.

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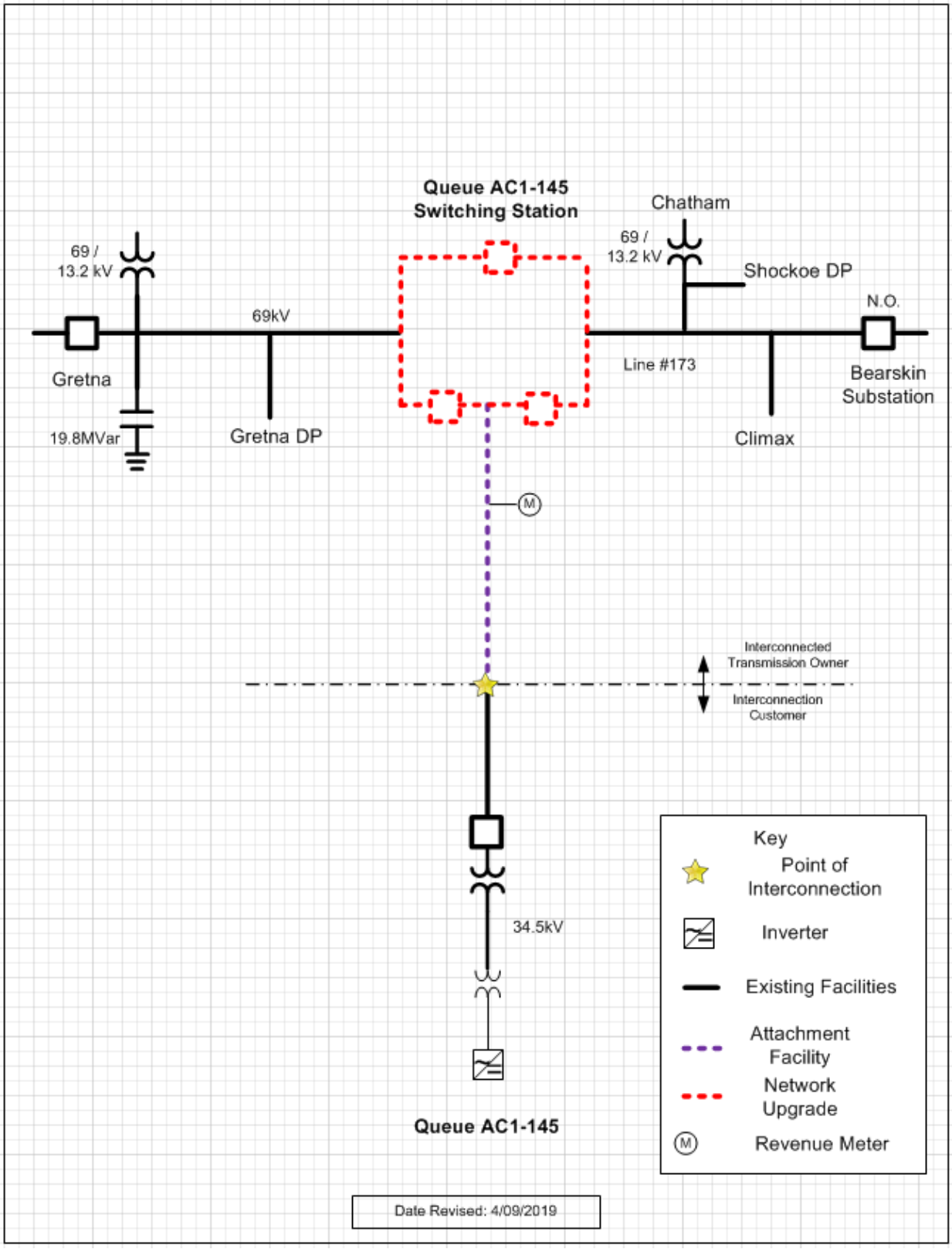
Attachment 1.
Single Line



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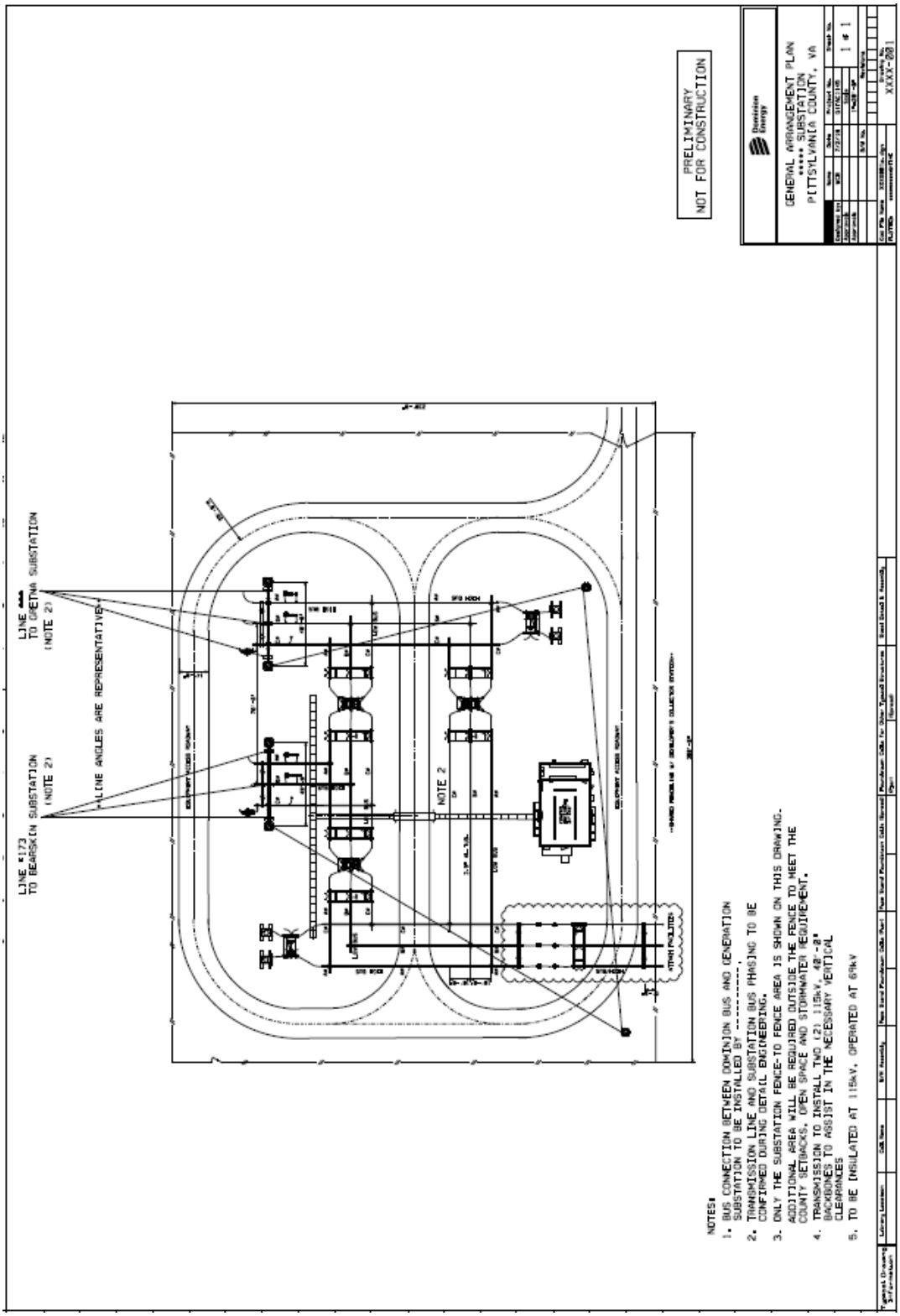
Attachment 2.
AC1-145 Switching station site plan



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