Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AA1-038

Lexington – Low Moor 230kV

10.1MW Capacity / 78.2MW Energy

December / 2016

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 Rocky Forge Wind, LLC, (Interconnection Customer (IC)) and PJM Interconnection, LLC (Transmission Provider (TP)). IC has proposed a wind generating facility located south east of Daggers Springs, VA. The installed facilities will have a total capability of 78.2 MW with 10.1 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 31, 2018. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AA1-038 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects on to the Lexington – Low Moor 230kV transmission line.

Cost Summary

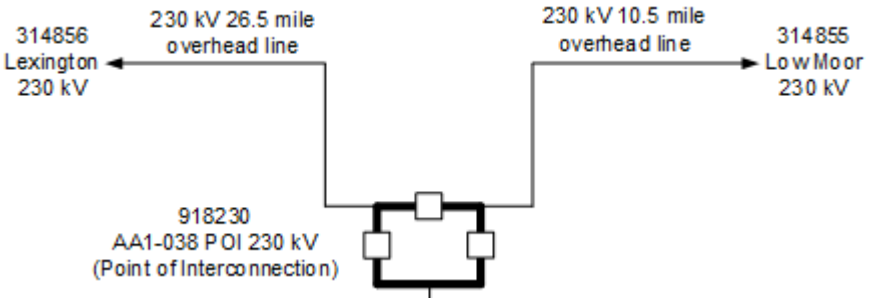
The AA1-038 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 551,728
Direct Connection Network Upgrades	$6,758,725
Non Direct Connection Network Upgrades	$1,000,056
Allocation for New System Upgrades	$0
Contribution for Previously Identified Upgrades	$0
Total Costs	**$8,310,509**

A. Transmission Owner Facilities Study Summary

1. Description of Project

Queue AA1-038 is a request to interconnect 78.2 MW (Capacity 10.1 MW) of energy from a new wind facility to be located near Daggers Springs VA (Botetourt County). The proposed facility will interconnect with ITO's existing Lexington – Lowmoor 230 kV Line #2084 approximately 26.5 miles away from Lexington Substation via a new three breaker 230 kV Rocky Forge Switching Station. The requested in-service date is December 31, 2018. Attachment Facility and Direct Connection Network upgrade construction is estimated to be 12-14 months.



2. Interconnection Customer's Submitted Milestone Schedule

The Interconnection Customer's milestone schedule does not match the ITO's construction duration of 12 – 14 months.

- Turnover flat, graded site with 1" gravel to ITO for new switching station: January 31, 2018
- Substantial Site Work completed June 1, 2018
- Backfeed: October 1, 2018
- Delivery of major electrical equipment August 1, 2018 for 6 turbines
- Commercial Operation
    - December 31, 2018 for 20 turbines
    - January 31, 2019 all turbines

3. Scope of Customer's Work

IC will build a wind generating facility in Botetourt County, Virginia. The generating facility connects to the Dominion transmission systems Lexington – Lowmoor 230 kV circuit via a 0.018 mile 230kV generator lead. The generating facility will comprise of a main generator step up transformer that is 230/34.5/12.5 kV with a rating of 50/67/83 (OA/F1/F2) MVA and a 34.5/0.69 kV generator step up (GSU) transformer with a rating of 85 MVA. AA1-038 consists

of 34 x 2.3 MW Siemens VS wind turbines. There is a 15MVar capacitor bank connected to the 34.5kV generator bus for reactive support.

4. Description of Facilities Included in the Facilities Study

The ITO will connect the proposed generator lead via Attachment Facilities to a new Rocky Forge 230kV ring bus switching station. The Lexington–Low Moor 230kV line #2084 will looped into and out of the Rocky Forge switching station. There will be transmission line protection and anti-islanding work required at the remote lines terminals in Lexington and Low Moor 230kV substations. The IC location of the generator step-up transformer and an exact site was developed during the Interim ISA (see Attachment 3). The single line is shown in Attachment 2.

Attachment Facilities:	$ 551,728
Network Upgrades:	$ 7,758,781
Total Cost:	$ 8,310,509

The estimated time to construct and build the proposed facilities is based on typical permitting timelines actual permitting requirements required by local zoning conditions may impact this schedule.

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

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Attachment Facilities	$282,047	$206,569	$52,091	$11,021	$551,728
Total Attachment Facilities Cost	$282,047	$206,569	$52,091	$11,021	$551,728
Rocky Forge 230 kV Switching Station (n4784)	$2,521,153	$3,078,102	$898,995	$260,475	$6,758,725
Line #2084 Transmission Work (n4785)	$225,215	$455,769	$91,839	$146,648	$919,471
Remote Protection and Communication (n4786)	$56,177	$11,481	$11,312	$1,615	$80,585
Total Network Upgrades	$2,802,545	$3,545,352	$1,002,146	$408,738	$7,758,781
Total Project Costs	$3,084,592	$3,751,921	$1,054,237	$419,759	$8,310,509

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

Facilities are estimated to take 8 months to construct and may require local zoning approval. Total Timeline to Engineer and Construct the proposed facilities is 12-14 months and is based on the ability to obtain outages to construct and test the proposed facilities. Engineering and construction timelines are based on the IC providing a graded and permitted site

- Engineering 4-6 months
- Construction 8 months

B. Transmission Owner Facilities Study Results

1. Attachment Facilities

The attachment facilities include that portion of the interconnecting switching station which is associated solely with the single feed to the generating facilities. The equipment associated with the Attachment Facilities includes the following. The work required is as follows:

Purchase and install:

1. One (1), 230-kV, 3000A Center Break Switch
2. Three (3), 230-kV, Metering Accuracy CCVT's
3. Three (3), 230-kV,1000:5 Metering Accuracy CT's
4. Conductors, connectors, conduit, control cable, foundations 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), 1421 – Generation/NUG/PJM/IPP Metering Panel
4. One (1), 4524 – Revenue Metering C.T. M.U. Box
5. One (1), 4531 – Generator Interconnect CCVT Potential M.U. Box
6. One (1), 1611 – 28" SEL-451 PMU Panel w/SEL 735/735
7. One (1), Customer Interface Box

2. Transmission Line – Upgrades

PJM Upgrade n4785 – Transmission Line Work:

Re-arrange the Lexington–Low Moor 230kV line #2084 will looped into and out of the Rocky Forge switching station. The loop is to be located approximately 26.5 miles from Lexington and 10.5 miles from Low Moor substations located in the existing line number 2084 right-of-way at existing structure number 2084/131. The work required is as follows:

1. Remove one 230kV wood H-frame structure (2084/131).
2. Remove one 230kV wood 3-pole running angle structure (2084/132).
3. Remove one 230kV wood 3-pole double deadend structure (2084/130).
4. Install one 230kV single circuit backbone (2084/131) with foundations in the proposed Rocky Forge station. Transfer the existing conductor and shield wires to the backbone and install dampers.
5. Install two sets of 3-phase Tee connectors at the backbone for the Substation installed/supplied risers.
6. Install one 230kV Dom-pole guyed 3-pole double deadend structure (2084/130). Height of structure to be similar to the existing structure. Transfer the existing conductor and shield wires to the 3-pole structure.

7. Install one 230kV Dom-pole guyed 3-pole double deadend structure (2084/132). Height of structure to be similar to the existing structure. Transfer the existing conductor and shield wires to the 3-pole structure.
8. Re-number the existing line #2084 between the new Rocky Forge station and Low Moor substation. This will involve changing the lower number on 93 structures and aerial number on 18 structures.
9. Install two shield wire poles with foundations inside the Rocky Forge station.
10. Install approximately 866', a total of three spans, of 7#7 alumoweld shield wire between the backbone structure and shield wire poles inside Rocky Forge. This shall include the installation of dampers.

3. New Substation/Switchyard Facilities

PJM Upgrade n4784 – Rocky Forge 230 kV Switching Station

Build a three breaker 230 kV "Rocky Forge" switching station. These costs include the following:

Purchase and install the following:

1. Approximately 345' X 325' site preparation and grading as required for installation of the switching station (by Apex Clean Energy, Inc.)
2. Approximately 1300 linear FT of 5/8" Chain Link, 12 FT tall, perimeter fence around the station along with the security cameras and integrators as per security standards
3. Full substation ground grid as per engineering standards
4. One (1) 230 kV, Heavy Duty Steel Backbone
5. Two (2) shield wire poles and three span of shield wires
6. Three (3) 230 kV, 3000A, 50 kA SF6 Circuit Breakers
7. Six (6) 230 kV, 3000A, 3-phase Center Break Gang Operated Switches
8. Nine (9) 180 kV, Station Class Arresters
9. Six (6) 230 kV CCVTs, Relay Accuracy
10. Two (2), 230 kV, 3000 Amps Waves Traps and Line Tuners
11. One (1) 24' X 40' Control Enclosure
12. One (1) 125 VDC, 200 Ah Station Battery and 50 Amp Charger
13. Cable Trough, concrete w/cover, 2' 6'' wide, approximately 250 FT, with a 20 FT road crossing section.
14. Four (4) 100 KVA Power Potential Transformers for station service
15. Two (2) 230 kV, 3000A, 2-phase Center Break Gang Operated Switches
16. Steel structures as required including switch stands, bus supports, station service transformers, CCVT and wave trap supports
17. Foundations as required including control house, equipment and bus support stands
18. Conductors, connectors, conduits, control cables, cable trough, 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 – 800A 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. One (1), 4153 – Wall Mount Station Battery Monitor
11. One (1), 5612 - SEL-3530 Data Concentrator Panel
12. One (1), 1255 – Station Annunciator Panel
13. One (1), 5021 – SEL-2411 RTU Panel
14. One (1), 5609 – Fiber Optic Management Panel
15. Three (3), 4526A – Circuit Breaker Fiber Optic M.U. Box
16. One (1), 5202 – 26" APP 601 Digital Fault Recorder
17. One (1), 5603 – Station Network Panel
18. One (1), 4523 – Security Camera Interface Box
19. One (1), 5603 – Station Network Panel
20. One (1), 5611 – Transmission Fiber Patch Panel
21. One (1), Telephone Interface Box

4. Upgrades to Substation / Switchyard Facilities

Remote protection and communication work (PJM Network Upgrade #n4786). ITO protection requirements to reliably interconnect the proposed generating facility with the transmission system determined that work is required at Lexington and Low Moor 230kV substations.

Lexington 230 kV Substation

Project Summary
Drawing work, relay resets, and field support necessary to change the Line 2084 destination to the new Rocky Forge Substation. It also provides for the reconfiguration of the existing Islanding Transfer Trip scheme to work with the new generator interconnect. This also will require drawing work, relay resets and field support.

Purchase and install substation material:

1. No Material

Low Moor 230 kV Substation

Project Summary
Drawing work, relay resets, and field support necessary to change the Line 2084 number & destination to the new Rocky Forge Substation. It also provides for the installation of an

Islanding Transfer Trip Transmitter and reconfiguration of the existing Islanding Transfer Trip scheme to work with the new generator interconnects. This also will require drawing work, relay resets and field support.

Purchase and install relay material:

1. One (1), CT-51C Transfer Trip Transmitter Set

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 Sections 24.1 and 24.2.

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.

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.

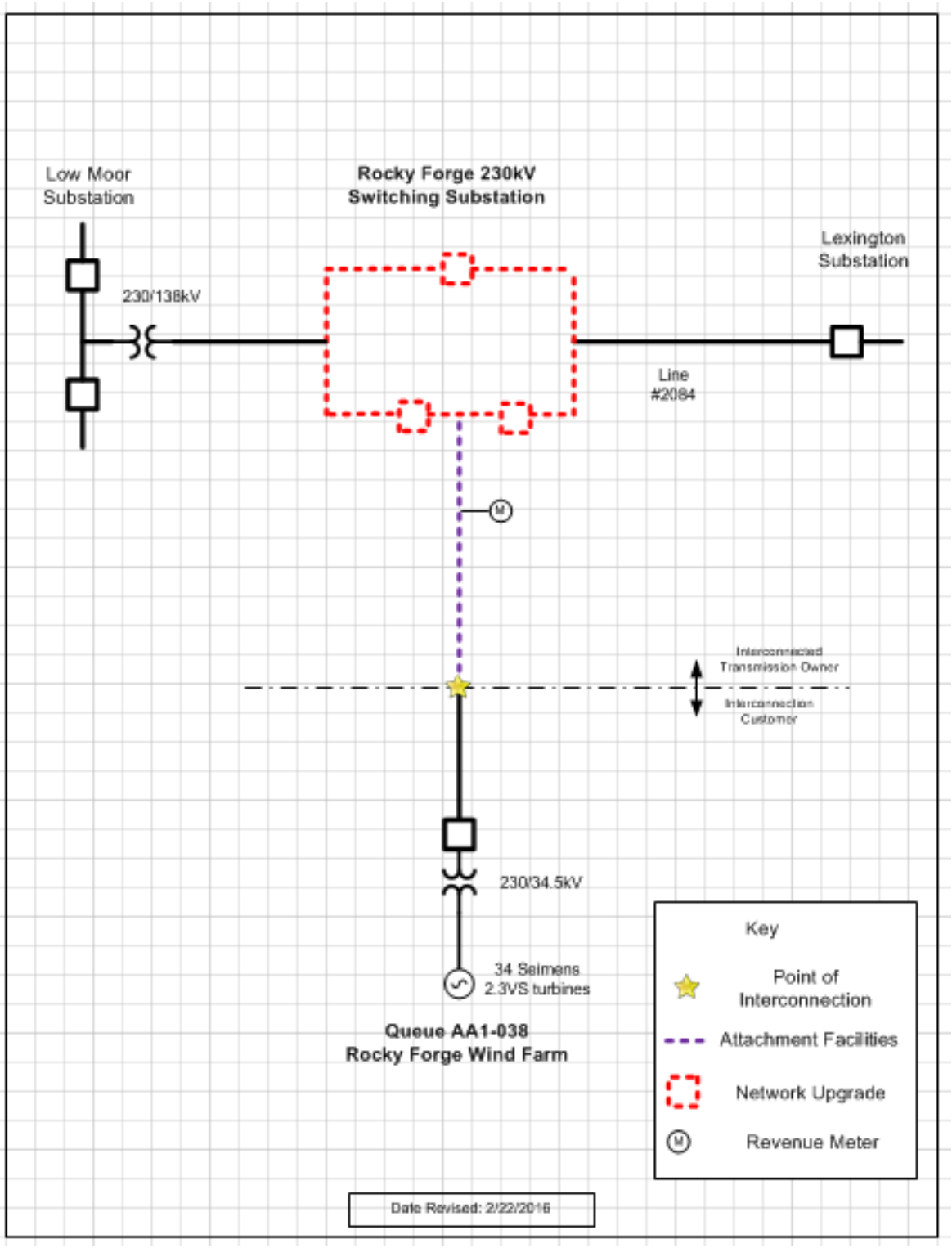
6. Environmental, Real Estate and Permitting Issues

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

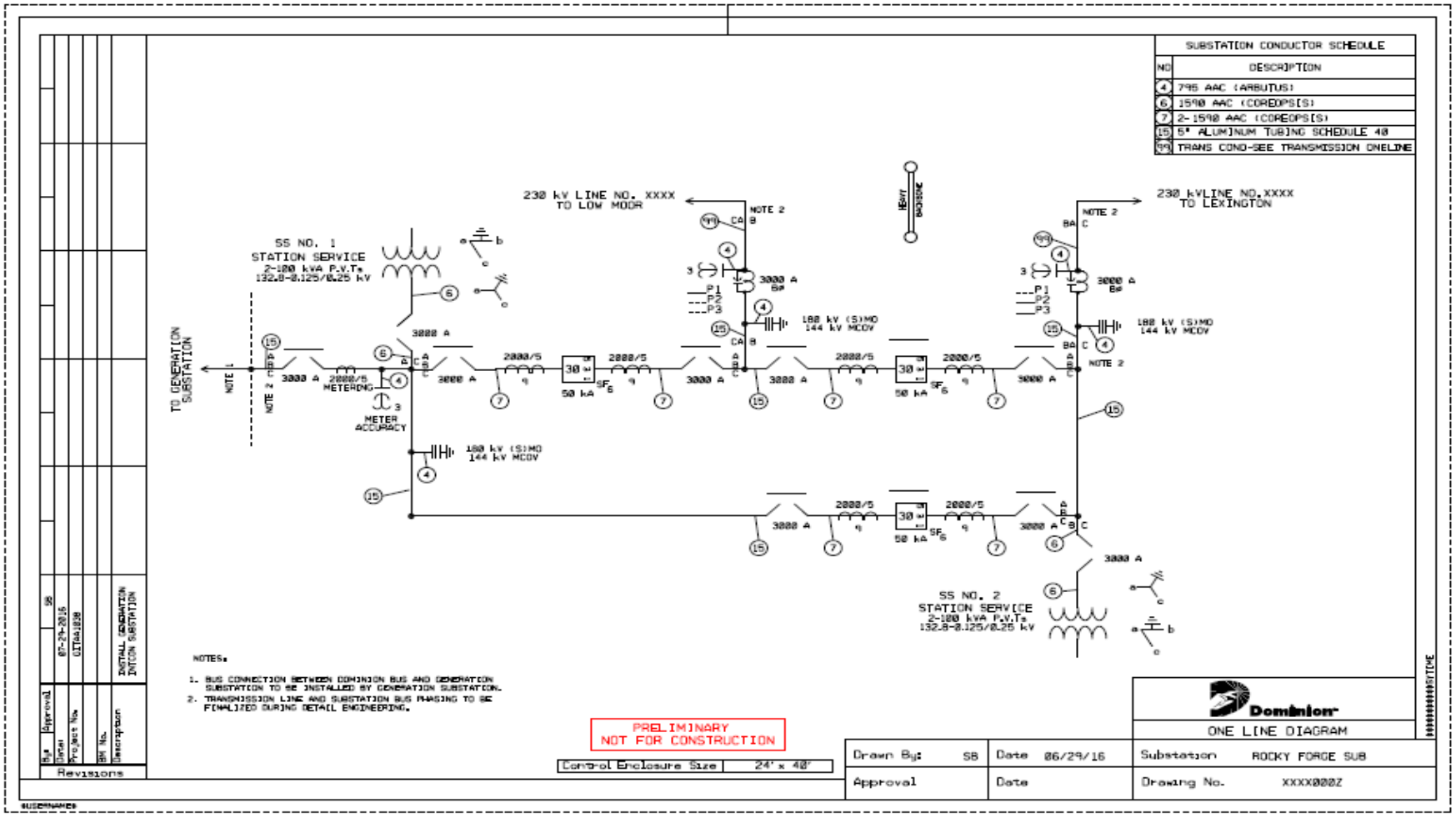
- Suitable Access Road from Substation to a North Carolina State Maintained Roadway.
- Any additional land needed for Storm Water Management, Landscaping, and Wetlands/Wetlands Mitigation.
- Conditional Use Permit for Substation.
- Any other Land/Permitting requirements required by the Substation.
- ITO would prefer to own the Substation in fee simple but would accept a perpetual easement.

The expected substation fence line (NOT INCLUDING Storm Water Management) is 335’ x 315’. An additional 5’ is needed out the fence line for the perimeter ground so a 345’ x 325’ graded site is required.

Attachment 1.
Single Line



Attachment 2.
Detail Single Line



Attachment 3.
Plan View