Transmission Interconnection Facilities Study Report

For

PJM Transmission Interconnection Request Queue Position AD2-158

"Old Chapel-Millville 138 kV"

May 2021

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Preface

The intent of the Facility Study 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 Interconnection Customer. As a requirement for interconnection, the Interconnection Customer 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 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 transmission owner.

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.

The Facility Study estimates attempt to identify the estimated time required to obtain property rights and permits for construction of the required facilities. The project IC 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.

A. Transmission Owner Facilities Study Summary

1. Description of Project

Wild Hill Solar, Inc., (hereinafter referred to as "IC") has proposed a solar generating facility located in Charles Town City, Jefferson County, West Virginia. The installed facilities for AD2-158 will have a total capability of 77.5 MW with 46.5 MW of this output being recognized by PJM as capacity. The generation facility will interconnect with The Potomac Edison Company (PE) a First Energy Company (FE), hereinafter referred to as "Transmission Owner" (TO), at a newly constructed 138 kV three-breaker ring bus substation, Wheatland Substation, tapped off of the Old Chapel-Millville 138 kV transmission line.

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

No amendments to the System Impact Study or System Impact Study Results posted February 2020 were identified.

3. Interconnection Customer's Milestone Schedule

IC's proposed Commercial Operation Date (COD) for the generation facility is **September 1, 2023**.

Milestone Schedule:

06/01/2023	Initial Back-feed through Project Substation Date
09/01/2023	Project Commercial Operation Date

4. Customer's Scope of Work

IC is responsible for all design and construction related to activities on their side of the Point of Interconnection (POI). This includes, but is not limited to, the generation step-up (GSU) transformer, 138 kV (AD2-158) generator lead line and connection to the new 3 breaker ring bus interconnection substation.

Point of Interconnection (POI): The POI will be located within the new 138 kV ring bus interconnection substation where IC-owned 138 kV attachment line conductor will terminate on the insulators on the dead-end takeoff structure.

IC is required to own, install, and maintain a fully-rated, fault-interrupting circuit breaker on the high-side of the GSU transformer, as well as the necessary revenue metering equipment. The revenue metering current and voltage transformers shall be installed on the high voltage side of the GSU, on the generation side of the fault-interrupting device, and within the local zone of fault protection for the facility. The protective relaying and metering design must comply with First Energy's applicable standards as well as with PJM requirements.

The easements and associated rights of way for the TO owned substation along with the 138kV line taps to the substation will be acquired by the IC and transferred to the TO at no cost. Site preparation for the TO owned substation, including clearing, grading and an access road, as necessary, is assumed to be by the IC. The access road design must be approved by First Energy to ensure it provides adequate access to the substation to support construction and maintenance activities. Route selection, line design, and right-of-way acquisition for the IC's facilities are not included in this report and are the responsibility of the IC.

Assumptions / Notes:

- IC will coordinate design and alignment of proposed 138 kV generator lead line with the Transmission Owner for review of any clearance, right-of-way or right-of-way encroachment issues with TO owned facilities.
- IC will coordinate design and construction of proposed 138 kV Lead Line. For these areas, the IC shall provide TO with proposed drawings prior to construction and as-built drawings, confirmed by as-built survey data post-construction.
- Transmission Owner's preference would be to limit interference and avoid transmission line crossings with new 138 kV terminal positions. As a minimum, IC facilities should not encroach within 100 feet of TO centerline at blowout conditions. If IC's line design does not comply with this requirement TO would need to review this area as a special exception.

- Additional costs will be incurred by the IC, if final alignment of the 138 kV generator lead line causes encroachments, changes, or modifications to any existing or relocated TO facilities.
- IC is responsible to make all arrangements for electric distribution service (if required) for its generation station. No costs or schedule are included herein.
- The proposed Generator Step Up (GSU) transformer configuration represented in the one-line diagram provided by the IC in Attachment #2 does not meet the requirements of the TO. The IC will be required to install a transformer with a delta low side winding and a wye grounded winding on the 138kV side.

5. Description of Facilities Included in the Facilities Study

Attachment Facilities

The IC has exercised their option-to-build these facilities, so they will design, furnish and construct the new 138 kV line terminal and take off structure in the new Wheatland ring bus substation. This work will include, but not be limited to, installation of a 138 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 138 kV generator lead line. Transmission Owner will oversee the design and construction and perform testing and commissioning.

AD2-158 Customer Substation

Drawings and nameplates will be reviewed.

Direct Connection

Wheatland 138 kV

The IC has exercised their option-to-build these facilities, so they will design, furnish and construct a new three breaker ring bus substation, Wheatland 138 kV, along the Old Chapel-Millville 138 kV transmission line to interconnect the AD2-158 wind project with the Potomac Edison transmission system. The POI will be at the TO-owned deadend structure inside the substation yard where the generator lead line terminates. Transmission Owner will oversee the design and construction and perform testing and commissioning.

Non-Direct Connection

Old Chapel to Millville 138 kV line

The Old Chapel to Millville 138 kV line will be cut and looped into the new Wheatland 138 kV interconnect substation. This cut will take place at a location that is approximately 5.3 miles from the Milleville substation and 9.1 miles from the Old Chapel Substation. It is assumed that the Wheatland substation will be located within one span (approximately 300 feet) from the existing line.

Millville Substation

A new transmission line protection panel will be installed for the line section between the Millville and Wheatland substations. The wave trap and associated line tuner will be replaced. An anti-islanding transmitter will be installed.

Double Toll Gate Substation

A new transmission line protection panel will be installed for the line section between the Double Toll Gate and Wheatland substations. The wave trap and associated line tuner will be replaced. An anti-islanding transmitter will be installed. New CT's will be installed for the backup line relaying.

Old Chapel Substation

Drawings, nameplates, and high voltage circuit diagrams will be modified.

6. Total Cost of Transmission Owner Facilities Included in the Facilities Study

Description	Total
Attachment Facilities:	**$ 70,400**
Total Direct Connection (DC) Costs:	**$ 2,006,800**
Total Non-Direct Connection (NDC) Upgrade Costs:	**$ 1,719,600**
New System Upgrades	**$ 0**
TOTAL Costs (ALL Categories)	**$ 3,796,800**

7. Summary of the Schedule for Completion of Work for the Facilities Study

Attachment Facility	*Duration*
Engineering, Procurement, and Construction	21 months

B. Transmission Owner Facilities Study Results

This section describes facilities identified to be installed (attachment facilities), replaced, and/or upgraded (upgrade facilities) by First Energy to accommodate the project. During detailed design and analysis other components may be identified for installation or replacement due to this interconnection.

1. Transmission Lines –New

None

2. Transmission Lines – Upgrade

Double Toll Gate - Millville 138kV Line

- Cut the Double Toll Gate-Millville 138kV line and install a line loop to the proposed AD2-158 substation.
- The existing line is constructed on single circuit wood H-frame structures. Existing conductor is 556.5 kcmil ACSR, shielded with (2) ½" EHS shieldwires.
- Install (1) 138kV single circuit monopole vertical wood deadend structure (TR-138025) inside AD2-158 (Wheatland) substation.
- Install (2) 138kV single circuit 3-pole guyed wood deadend structures (TR-138075)
- Install two spans (approximately 500' total) of 556.5 kcmil ACSR conductor shielded by (2) ½" EHS steel wires between new deadend structures and proposed AD2-158 (Wheatland) substation.
- Transfer existing conductor and shieldwires to new 3-pole deadend structures.
- The substation is assumed to be constructed mid-span on the line between existing structures DT-139 and DT-140.
- The existing conductors and shieldwires are assumed to be in good condition and will be reused. Existing tangent structures DT-139 & DT-140 are assumed to be in good condition and have adequate capacity for any new loading arrangement. An engineering analysis will be required to confirm.
- Assumptions
    - Assume OPGW is not required.
    - An aerial LiDAR survey of the project area will be required
      IC will install conductor and shieldwire (if needed) between the new vertical deadend structure in AD2-158 (Wheatland) substation and the project substation. Conductor and shieldwire will be installed at a slack tension so that guy wires will not be required.

3. New Substation/Switchyard Facilities

AD2-158 Interconnect (Wheatland 138 kV Substation)

- Below Grade
    - Site grading, clearing, access road, and drainage to be completed by the IC.
    - Stone, and fence as required for the new 138kV yard
    - Foundations, conduit & cable trench, and ground grid as required for new 138kV equipment
- Above Grade
    - Install three (3) 138kV, 40kA SF6 circuit breakers
    - Install six (6) 138kV breaker disconnect switches
    - Install three (3) 138kV motor-operated line disconnect switches
    - Install two (2) 138kV wave traps, line tuners, and coax on the Double Toll Gate and Millville lines
    - Install nine (9) 138kV CVTs
    - Install nine (9) 138kV surge arresters
    - Install (1) prefabricated control building
    - Install one lot of steel structures and insulators for bus supports.
    - Install one lot of steel and insulators for three (3) H-Frame deadends.
    - Install one lot of steel for six (6) switch stands.

- Install one lot of rigid bus, wire, and fittings.

- R&C
  - Install relaying for Round Hill Solar, Double Toll Gate, and Millville 138kV lines in the prefabricated control building with the following equipment:
    - One (1) pre-wired panel to include dual (2) SEL-411L primary/backup relays with communication over fiber, SATEC meter, and SEL-501/dedicated LOR BF relays (for Round Hill Solar, LLC)
    - Two (2) pre-wired panels to include SEL-421 primary and SEL-411L backup relay with communication over PLC, SATEC meter, and SEL-501/dedicated LOR BF relays
    - Install one (1) receiver for Double Toll Gate line for anti-islanding
    - Install one (1) transmitter/receiver for Millville line for anti-islanding
    - Install (1) SCADA RTU and (1) lot of standard communication equipment.
  - GPS Clock
  - SCADA and annunciator
  - SEL RTAC for remote access to SEL protective relays
- Additional Equipment to be Removed
  - None
- Siting/Licensing
  - As required for new 138kV substation
- Assumptions
  - Property can be obtained and sited as required for new 138kV substation
  - Estimates assume no significant rock encountered during construction, and suitable soil conditions exist to accommodate a standard ground-grid and foundation installation.

4. Substation/Switchyard Facility Upgrades

Millville Substation

- Below Grade
  - None
- Above Grade
  - Replace (1) 1200A wave trap, line tuner, and coax with a wideband, 2000A unit.Update drawings and nameplates for line name change.
- R&C
  - Replace RFL-6785 with RFL-9785 for DCB blocking carrier
  - Add new RFL9780 Tx/Rx to send anti-islanding trip signal to Afton for open breaker or breaker failure condition at Albright
  - Add new RFL Hybrid chassis with one balanced hybrid
  - Install (1) PCM 5350
  - Change frequencies for existing DCB scheme if/as necessary
- Siting/Licensing
  - None
- Assumptions
  - Existing SCADA RTU is sufficient for upgrades.
  - Line relays have been updated and do not require replacement.
  - Existing AC and DC station service are sufficient for upgrades.
  - Existing wave trap stand can be reused.
  - Existing control building has room for new panel

Old Chapel Substation

- Below Grade
  - None
- Above Grade
  - Modify nameplates, drawings, and high voltage circuit diagram
- R&C
  - None

Double Toll Gate Substation

- Below Grade
  - Conduit for new CT cables.
- Above Grade
  - Install slip over CTs (3) for the backup line relaying
  - Replace (1) 1200A wave trap, line tuner, and coax with (1) 2000A wideband unit.
  - Update drawings and nameplates for line name change.
- R&C
  - Double Toll Gate to Wheatland – Install new line relaying panel that includes SEL-421 for primary relaying, SEL-411L for backup relaying, and SEL501 for BFT with UPLC for PLC
  - Install (1) RFL9780
  - Install (1) RFL Hybrid Chassis
  - Install (1) PCM 5350
- Additional Equipment to be Removed
  - Existing line protection panel and associated equipment.
- Siting/Licensing
  - None
- Assumptions
  - Existing SCADA RTU is sufficient for upgrades.
  - Existing control building has room for new panel
  - Existing AC and DC station service are sufficient for upgrades
  - Existing wave trap stand can be reused.

5. Telecommunications Facilities – Upgrades

IC will design, provide, install, own and maintain a fiber-optic communications cable between the new **interconnection** substation, and IC's **generation** (collector) substation. Two (2) fiber-optic channels are required for each generator protection scheme to obtain high-speed tripping capability for any fault within the zone of protection. Should subsequent/additional PJM studies indicate that stability issues exist, the primary and backup relay fiber-optic communication channels must be in separately-routed cable paths and additional fiber-optic connection costs would apply (not included herein).

The IC will make the fiber-optic cable termination connections for its cable(s) at the interconnection substation control house.

Transmission Owner will make the fiber termination connections for its cable(s) at the interconnection substation control house. IC is responsible for obtaining and maintaining all associated Rights-of-Way (ROW), Easements, and Permits for its fiber cable.

Approximately one mile of ADSS fiber will be ran from Wheatland to an MPLS hub for SCADA communication.

6. Metering & Communications

IC shall install, own, operate, test and maintain the necessary revenue metering equipment. IC shall provide Transmission Owner with dial-up communication to the revenue meter.

The revenue metering system (particularly the revenue metering current transformers) shall be designed to accurately meter the light loads that will occur when the facility is not generating power and only back-feeding station service from the Transmission Owner. This may require the use of high accuracy extended range current transformers.

Transmission Owner's Revenue Metering Requirements may be found in the *Requirements for Transmission Connected Facilities* document located at the following links:

www.firstenergycorp.com/feconnect

www.pjm.com/planning/design-engineering/to-tech-standards.aspx

These requirements are in addition to any metering required by PJM.

Transmission Owner will provide the telecommunication circuits for the SCADA RTU and the telephone in the Transmission Owner interconnection substation.

Transmission Owner will obtain real-time, site-specific, generation data from PJM, via the required communication link from IC to PJM. Transmission Owner will work with PJM and IC to ensure the generation data provided to PJM meets Transmission Owner's requirements.

Communications for transmission line protection between the new **interconnection** substation, and IC's **generation** (collector) substation, will be via fiber optics (see "Telecommunication Facilities" section above).

7. Environmental, Real Estate and Permitting

The following are possible environmental, real estate and permitting issues:

- Environmental permitting, Real Estate acquisition, and West Virginia Public Service Commision (WVPSC) notifications vary, some up to twelve (12) months after preliminary engineering is completed to secure the required approvals.

- Prior to agreement by IC to purchase the property, a Phase 1 Environmental Assessment should be conducted for the entire site to avoid assumption of environmental liabilities by IC or Transmission Owner.
- The Transmission Owner interconnection substation may involve environmental surveys, permits, approvals and plans with federal, state, and/or local agencies.
- Assumed IC is to provide all access rights, easements, ROW and permits necessary to complete the Project to the satisfaction of Transmission Owner. Environmental permitting shall encompass all federal, state and local requirements, consultations and agency coordination. Confirmation of meeting all permitting requirements shall be provided to Transmission Owner, prior to start of construction. Following construction and energization, confirmation of permit closeout shall be provided to the satisfaction of Transmission Owner, prior to transfer of ownership. If any of these elements are not included in the final agreement between Transmission Owner and IC, twelve (12)-to-eighteen (18) months should be added to the Project Schedule to secure necessary permits, and additional costs would apply.
- IC will provide copies of all of the relative environmental permits and other necessary approvals to Transmission Owner before Transmission Owner accepts the interconnection facilities.
- IC is required to install an access road from the new interconnection substation to the nearest public road (must be approved by Transmission Owner), and obtain access rights for Transmission Owner. IC is responsible to maintain access road and ensure unimpeded access for Transmission Owner at all times.
- IC is responsible for all property acquisition (including easements/rights-of-way (ROW)) for transmission, distribution and communication facilities needed for the generator interconnection.
- If IC owns the project property, in fee title, Transmission Owner will require a fee property transfer for the interconnection substation site which may require subdivision approval, together with permanent access rights to and from the substation, as well as a perpetual easement for any transmission lines to the substation. IC is responsible for all costs, including but not limited to subdivision, associated with the property transfer.
- If IC leases the project property, the IC will be required to obtain fee property from the underlying fee property owner, on behalf of Transmission Owner, for the interconnection substation site, together with permanent access rights to and from the substation, as well as a perpetual easement for any transmission lines to the substation.
- All property rights must be surveyed and metes and bounds descriptions prepared for incorporation into Transmission Owner's document forms, for transfer of title.
- The Transmission Owner interconnection substation and transmission line loop will involve West Virginia Public Service Commission (WVPSC) notification/approval.
- All work occurs within an existing transmission line right-of-way or on IC's property with access to all existing structures possible via that property and the right-of- way following established access routes that do not cross wetlands or streams.
- IC will develop, and secure regulatory approval for, all necessary Erosion and Sediment Control (E&SC) plans and National Pollutant Discharge Elimination System (NPDES) permits.
- IC will obtain all necessary permits within their scope of work. IC will not be responsible for permitting of work that is in the TO's scope to complete.
- IC will conduct all necessary wetlands and waterways studies and permits within their scope of work. IC will not be responsible for studies and permits of work that is in the TO's scope to complete.
- IC will conduct all necessary historical and archaeological studies within their scope of work. IC will not be responsible for historical and archaeological studies of work that is in the TO's scope to complete.
- If the IC plans to cross the transmission line right of way with facilities or access roads, please refer to the Transmission Rights-of-Way Restrictions information located at:

https://www.firstenergycorp.com/help/safety/real-estate-power-lines/transmission-right-of-way.html#ROWform

8. Summary of Results of Study

Since the IC has exercised the option to build the direct connect and attachment facilities, only the TO's estimated costs to oversee engineering and construction and to perform any required testing and commissioning activities are included. All other costs in these categories will be determined by the IC.

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
AD2-158 Generator Lead Termination: Installation of a 138 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 138 kV generator lead line.	$ 25,700	$ 0	$ 9,300	$ 0	$ 35,000
AD2-158 Customer Drawing Review: Review drawings, nameplates, and relay settings for FE standards.	$ 23,000	$ 0	$ 8,300	$ 0	$ 31,300
AD2-158 Customer Metering: Customer-owned revenue metering at AD2-158 facility.	$ 3,000	$ 0	$ 1,100	$ 0	$ 4,100
Total Attachment Facilities Cost	**$ 51,700**	**$ 0**	**$ 18,700**	**$ 0**	**$ 70,400**
AD2-158 Wheatland Substation Oversight: Customer Selected Option-To-Build for new 138kV station with a 3-breaker ring bus. (PJM Network Upgrade Number N6079)	$ 231,000	$ 0	$ 83,600	$ 0	$ 314,600
SCADA Communication at AD2-158 Wheatland Substation: Design, install, and test/commission MPLS Equipment for SCADA transport. (PJM Network Upgrade Number N6078)	$ 96,700	$ 67,600	$ 35,000	$ 5,200	$ 204,500

Fiber Installation @ AD2-158 to Backbone: Install fiber from AD2-158 to backbone for communication transport. (PJM Network Upgrade Number N6078)	$ 253,400	$ 26,500	$ 91,600	$ 2,000	$ 373,500
SCADA at Millville and Double Toll Gate: Estimated SCADA work at Millville & Double Toll Gate substations to support wave trap & relay installations. Estimated (1) in-sub fiber run from AD2-158 substation control house to IC built fiber run to support communications and control to generator site. (PJM Network Upgrade Number N6078)	$ 61,100	$ 4,100	$ 22,100	$ 300	$ 87,600
Project Management: Project Management, Environmental, Forestry, Real Estate, and Right of Way. (PJM Network Upgrade Number N6079)	$ 741,300	$ 16,000	$ 268,100	$ 1,200	$ 1,026,600
Total Direct Connection Cost	**$ 1,383,500**	**$ 114,200**	**$ 500,400**	**$ 8,700**	**$ 2,006,800**
Double Toll Gate-Millville 138kV Line Loop : Cut the Double Toll Gate-Millville 138kV line and install a line loop to the proposed AD2-158 (Wheatland) substation. (PJM Network Upgrade Number N6080)	$ 492,700	$ 72,500	$ 178,100	$ 5,500	$ 748,800
Double Toll Gate 138 kV Substation Modifications: Upgrade carrier & line relaying and wave trap. (PJM Network Upgrade Number N6081)	$ 254,800	$ 188,900	$ 92,200	$ 14,400	$ 550,300
Millville 138 kV Substation Modifications: Upgrade carrier relaying and wave trap. (PJM Network Upgrade Number	$ 174,600	$ 113,900	$ 63,100	$ 8,700	$ 360,300

N6082)					
Old Chapel 138 kV Substation Modifications: Modify nameplates, drawings, and high voltage circuit diagram. (PJM Network Upgrade Number N7279)	$ 44,200	$ 0	$ 16,000	$ 0	$ 60,200
Total Non-Direct Connection Cost	**$ 966,300**	**$ 375,300**	**$ 349,400**	**$ 28,600**	**$ 1,719,600**
Total Project Costs	**$ 2,401,500**	**$ 489,500**	**$ 868,500**	**$ 37,300**	**$ 3,796,800**

Generation projects meeting IRS "Safe Harbor" provisions generally do not incur "CIAC" (Contribution in Aid to Construction), a tax collected by the utility for the state or federal government. First Energy does not expect to collect CIAC for this project. If for any reason, "CIAC" would be required for this project, it would be the responsibility of the party owning the generator to pay this cost.

First Energy reserves the right to charge the Interconnection Customer operation and maintenance expenses to maintain the Interconnection Customer attachment facilities, including metering facilities, owned by First Energy.

9. Schedules and Assumptions

A proposed **twenty-one (21) month Direct Connection** schedule is estimated to complete the engineering, construction and the associated activities, from the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting. This schedule assumes that all issues covered by the "Environmental, Real Estate and Permitting Issues" section of this document are resolved, and outages (typically not granted from June through September) will occur as planned. Construction cannot begin until after all applicable permits and/or easements have been obtained.

21 month Schedule (assume September, 2021 start)

Activity	Start Month	End Month
Preliminary Engineering	1	3
Siting, Permits & Real Estate	2	12
Detailed Engineering	2	12
Equipment Delivery	11	12
Below Grade Construction – Substation	12	15
Below Grade Construction – T-Lines	18	19
Above Grade Construction – Substation	15	20
Above Grade Construction – T-Lines	19	20
Testing & Commissioning	21	21

Attachment #1: Protection Study

PROTECTION SCOPE

SHORT CIRCUIT DATA for a fault at the proposed location of the connection of Wheatland SS on the existing Double Toll Gate - Millville 138kV line (Symmetrical Values Only)

Initial conditions (percent on 100 MVA base)

	138kV
Z1 =	0.647 + j 3.723%
Z0 =	0.986 + j 5.530%

3 phase fault – 11,109A
Single line to ground fault – 9957A 3I0

Note: These fault values do not include the AD2-158 Generator or GSU step up transformer as being modeled in the calculations.

Impedances are given on a 100 MVA and 138kV bases. The faults provided are bolted, symmetrical values for normal system conditions. Future increases in fault currents are possible and it is the customer's responsibility to upgrade their equipment and/or protective equipment coordination when necessary.

All proposed generation interconnection points and load-serving delivery points must comply with the technical requirements detailed in FE's "Requirements for Transmission Connected Facilities" document.

RELAY AND COMMUNICATION EQUIPMENT SCOPE

At Wheatland SS:

138kV Line Exit to Double Toll Gate

Install the following:

- Three single-phase dual winding capacitor voltage transformers, dual ratio = 1200/700/1 (carrier facilities are only required on phase Z, but may be included with all three CVTs)
- 2000A wide band line trap (phase Z only)
- Wide band line tuner (phase Z only)

The protective relaying for the 138kV line to Double Toll Gate shall contain the following:

- SEL-421 relay for the primary line protection, which shall utilize a DCB scheme
- SEL-411L relay for the backup line protection, which shall utilize a step distance scheme, and also reclose the B-1 breaker for faults on the Double Toll Gate 138kV line
- SEL-501 relay for Bkr B-1 breaker failure
- LOR relay for Bkr B-1 breaker failure tripping
- RFL-9785 for DCB blocking carrier
- RFL-9780 Rx, for anti-islanding receive from Double Toll Gate
- SATEC digital multimeter

- RFL Hybrid chassis with one skewed hybrid
- PowerComm PCM5350

138kV Line Exit to Millville

Install the following:

- Three single-phase dual winding capacitor voltage transformers, dual ratio = 1200/700/1 (carrier facilities are only required on phase Z, but may be included with all three CVTs)
- 2000A wide band line trap (phase Z only)
- Wide band line tuner (phase Z only)

The protective relaying for the 138kV line to Millville shall contain the following:

- SEL-421 relay for the primary line protection, which shall utilize a DCB scheme
- SEL-411L relay for the backup line protection, which shall utilize a step distance scheme, and also reclose the B-1 breaker for faults on the Millville 138kV line
- SEL-501 relay for Bkr B-3 breaker failure
- LOR relay for Bkr B-3 breaker failure tripping
- RFL-9785 for DCB blocking carrier
- RFL-9780 Tx/Rx, for anti-islanding transmit and receive from Millville
- SATEC digital multimeter
- RFL Hybrid chassis with one skewed and one balanced hybrid
- PowerComm PCM5350

138kV Line Exit to Generator – Customer SS

Install the following:

- Three single-phase dual winding capacitor voltage transformer, dual ratio = 1200/700/1 (carrier facilities are not required)
- OPGW fiber optic cable to customer substation for relaying digital communication channel

The protective relaying for the 138kV line to the generator shall contain the following:

- SEL-411L relay for the primary line protection, which shall utilize a line differential scheme with step distance backup
- SEL-411L relay for the backup line protection, which shall utilize a line differential scheme with step distance backup
- SEL-501 relay for Bkr B-2 breaker failure
- LOR relay for Bkr B-2 breaker failure tripping
- LOR relay for generation station breaker failure tripping (operate from transfer trip receive)
- SATEC digital multimeter
- SD relay (“27L”) for line potential monitoring (blocks all closing of Bkrs B-2 and B-3 if line from generator is hot)

AD2-158 will only close into this line of it is dead. All synchronizing is to be performed at the Generator Substation. No automatic reclosing will be applied.

Additional items

- GPS Clock, Arbiter 1094B, with antenna, 50 feet of cable, and antenna mounting kit
- SCADA and annunciator, details to be determined by Real Time Operations
- SEL RTAC for remote access to SEL protective relays
- Test switches, fuses, and terminal blocks as deemed necessary

At Millville SS:

- Replace existing 1200A single frequency line trap with new 2000A wide band trap
- Replace existing single frequency line tuner with new wide band tuner
- Replace RFL-6785 with RFL-9785 for DCB blocking carrier
- Add new RFL9780 Tx/Rx to send anti-islanding trip signal to Afton for open breaker or breaker failure condition at Albright
- Add new RFL Hybrid chassis with one balanced hybrid
- Change frequencies for existing DCB scheme if/as necessary

At Double Toll Gate SS:

- Replace existing 1200A single frequency line trap with new 2000A wide band trap
- Replace existing single frequency line tuner with new wide band tuner
- Replace line relays to properly operate with new relays at Wheatland SS as follows:
  - SEL-421 relay for the primary line protection, which shall utilize a DCB scheme
  - SEL-411L relay for the backup line protection, which shall utilize a step distance scheme, and also reclose the line terminal breaker
- SEL-501 relay for line terminal breaker failure
- LOR relay for line terminal breaker failure tripping
- RFL-9785 for DCB blocking carrier
- RFL-9780 Tx, for anti-islanding transmit to Wheatland
- SATEC digital multimeter
- RFL Hybrid chassis with one balanced hybrid
- PowerComm PCM5350
- Change frequencies for existing DCB scheme if/as necessary

Generation Substation Protection Requirements for 138kV line to Wheatland SS

It is the responsibility of the Generator Owner (GO) to assure protection, coordination and equipment adequacy within their facility for conditions including but not limited to:

- Single phasing of supply
- System faults
- Equipment failures
- Deviations from nominal voltage or frequency
- Lightning and switching surges
- Harmonic voltages
- Negative sequence voltages
- Separation from FE supply
- Synchronizing generation
- Synchronizing facilities between independent transmission system and FE
- Transmission System

The generator owner (GO) is to design their protective system to clear any faults within their zones of protection with one or more of their local breakers. Each zone of protection covering the 138kV portion of the GO system (including the GSU(s)) is to be protected by two fully independent relay schemes that each provides high speed fault protection. The terminal breaker at the GO end of the direct connection line is to be included in one of these zones of protection. Two SEL-411L relays shall be used for protection of the interconnect line, to match the companion relays at AD2-158 Substation.

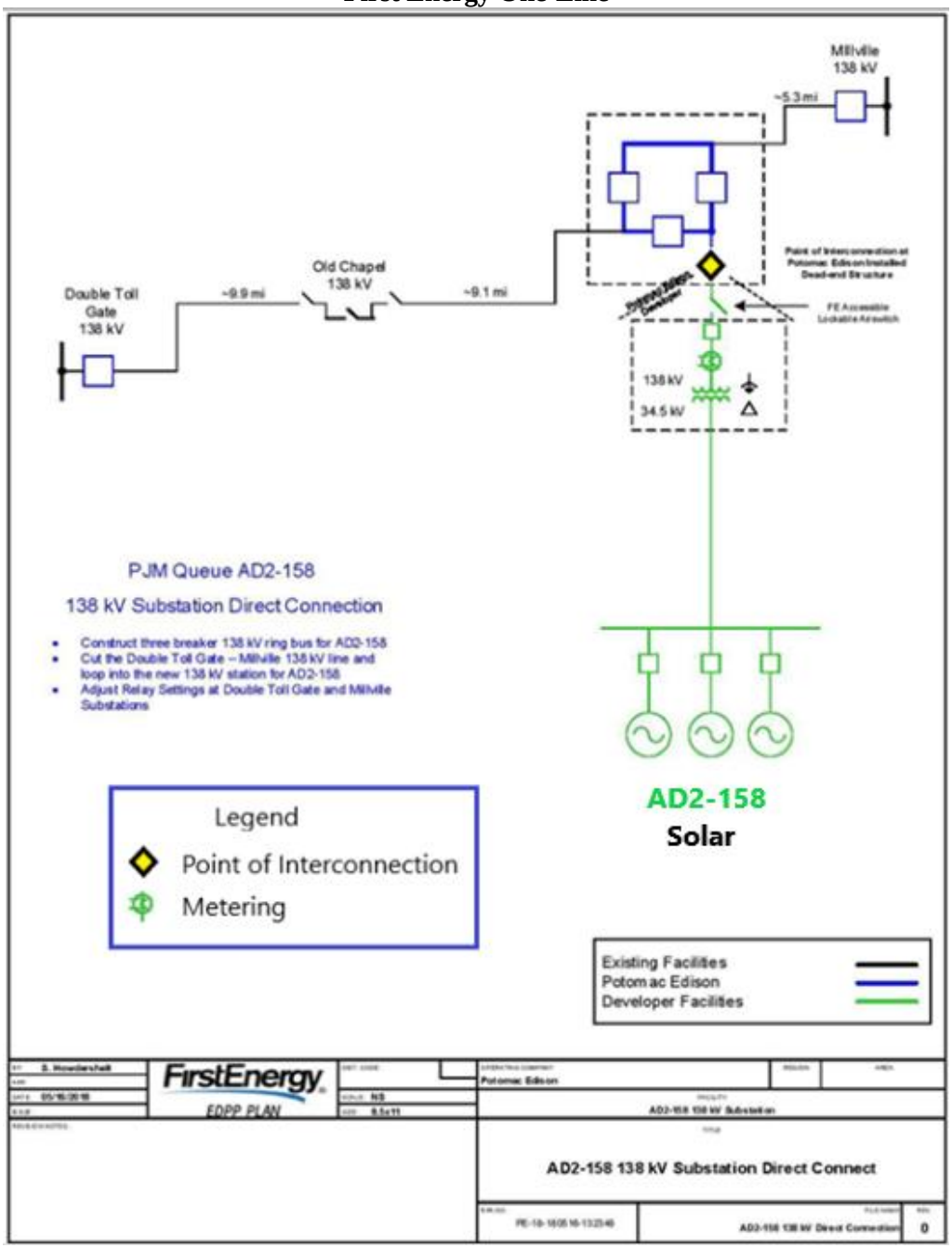
The customer is solely responsible for protecting its own equipment in such a manner that electrical faults or other disturbances on the FE system do not damage its equipment.

Generator Step-Up Transformer Requirements

As per section 14.2.6 of the First Energy Requirements for Transmission Connected Facilities document, because this area of the system is effectively grounded, the transformer shall have a wye grounded winding on the high (transmission system) side and have a delta connected winding on the low side. This is required to maintain proper ground relay coordination on the First Energy system. No exceptions to this standard shall be granted.

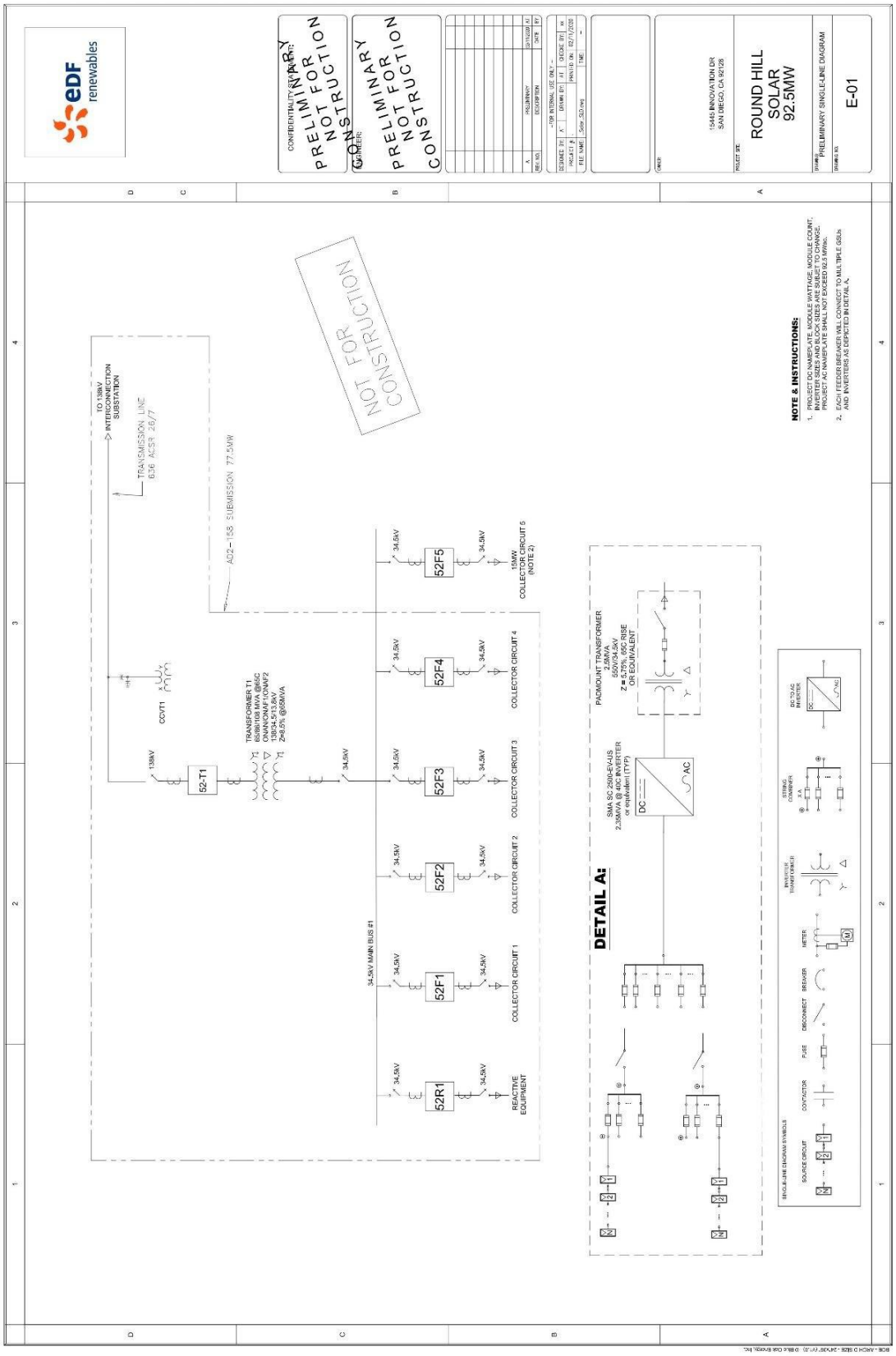
Attachment #2: One-Line Diagrams

First Energy One-Line



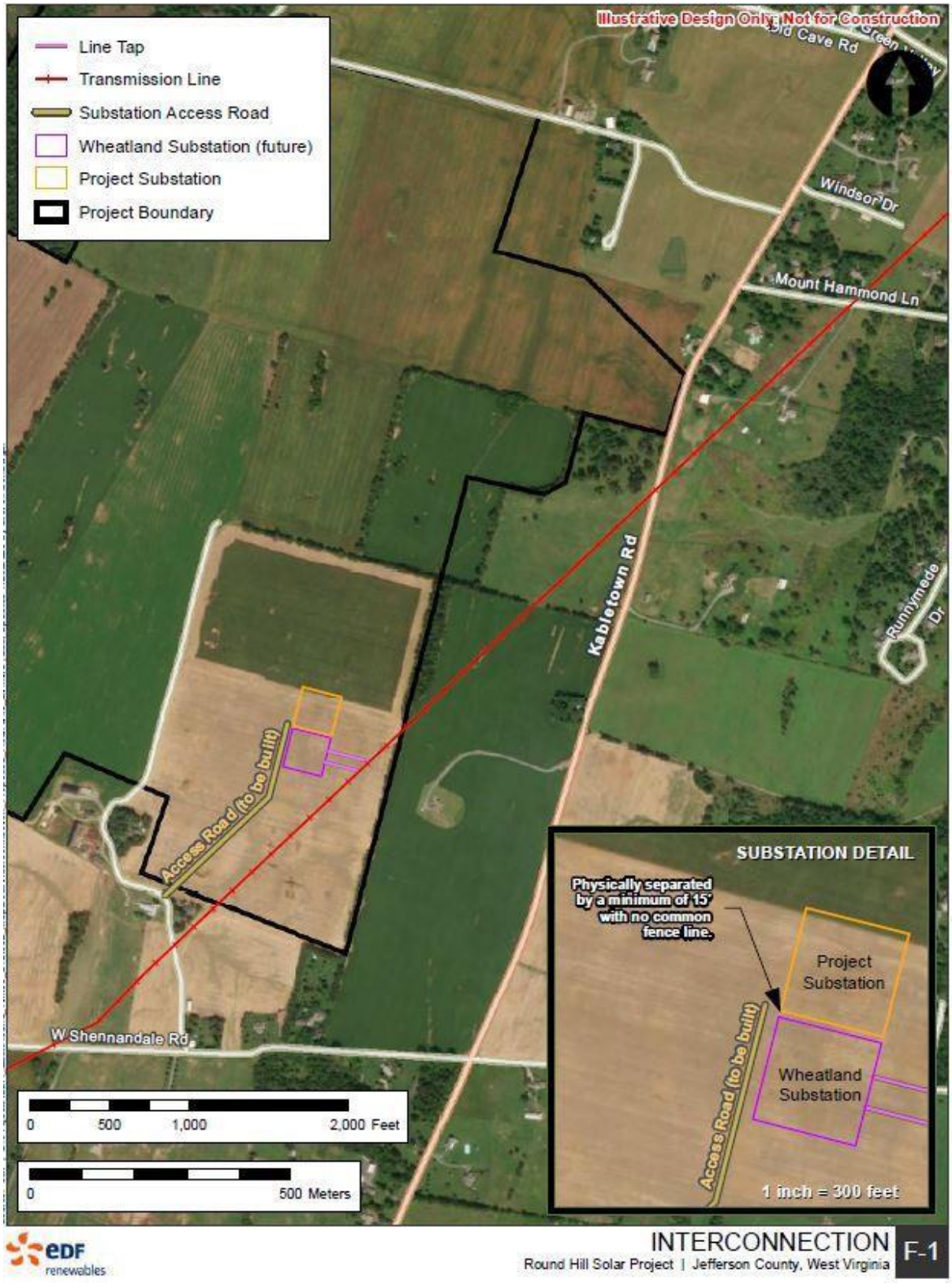
IC One-Line

Not approved for Construction – See Assumptions/Notes in Section A.4



Attachment #3: IC Site Plan and Substation Attachment Facilities

IC Substation Locations



Attachment #4: Generation Connection Requirements

Generation Connection Requirements

The proposed interconnection facilities must be designed in accordance with the Transmission Owner's *Requirements for Transmission Connected Facilities* documents located at either of the following links:

www.firstenergycorp.com/feconnect

www.pjm.com/planning/design-engineering/to-tech-standards.aspx

The following is an excerpt taken from Transmission Owner's *Requirements for Transmission Connected Facilities* document:

> *For all generation facilities, other than wind-powered and other non-synchronous generating facilities, the minimum requirement shall be the provision of a reactive power capability sufficient to maintain a composite power delivery at continuous rated power output at a power factor as defined in the table below. This requirement will be measured at either the POI or generator terminals as specified in the table below. These reactive requirements apply to both the initial installation as well as to any incremental change in unit MW capability. FE will coordinate with the Connecting Party to identify the optimal generator step-up transformer tap to make such a capability available when demanded.*
>
> *For all wind-powered or other non-synchronous generating facilities the minimum requirement shall be the provision of a reactive power capability sufficient to maintain a composite power delivery at a power factor as defined in the table. This requirement will be measured at either the POI or generator's terminals as specified in the table below. These reactive requirements apply to both the initial installation as well as to any incremental change in unit MW capability. FE will coordinate with the Connecting Party to identify the optimal generator step-up transformer tap to make such a capability available when needed.*

For projects that entered PJM's New Service Queue after November 1, 2016, the power factor requirement will be as follows:

Generation Type	New / Increase	Size	Power Factor Requirement	Measurement Location
Synchronous	New	> 20 MW	0.95 leading to 0.90 lagging	Generator's Terminals
Synchronous	New	<= 20 MW	0.95 leading to 0.90 lagging	Point of Interconnection

Wind or Non-Synchronous	New	All	0.95 leading to 0.95 lagging	High Side of the Facility Substation Transformers
Synchronous	Increase	> 20 MW	1.0 (unity) to 0.90 lagging	Generator's Terminals
Synchronous	Increase	<= 20 MW	1.0 (unity) to 0.90 lagging	Point of Interconnection
Wind or Non-Synchronous	Increase	All	0.95 leading to 0.95 lagging	High Side of the Facility Substation Transformers

Any different reactive power requirements that FE and/or PJM determines to be appropriate for wind-powered or other non-synchronous generation facilities will be stated in the applicable interconnection agreement(s).

Induction generators and other generators with no inherent VAR (reactive power) control capability, or those that have a restricted VAR capability less than the defined requirements, must provide dynamic supplementary reactive support located at the generation facility with electrical characteristics equivalent to that provided by a similar-sized synchronous generator.

Design Requirements

IC is responsible for specifying appropriate equipment and facilities such that the parallel generation is compatible with Transmission Owner's Transmission System. IC is also responsible for meeting any applicable federal, state, and local codes.

Transmission Design Requirements

Design Criteria

Facilities owned and operated by Transmission Owner shall comply with the applicable Transmission Owner technical requirements and standards posted on the PJM website per the PJM Tariff, and the following criteria. Where there are different requirements for the same criterion, the more restrictive shall apply. IC must abide by any PJM, RFC or NERC criteria imposed that is more restrictive than those of Transmission Owner.

General Design Requirements

- System phasing (counter clockwise) X-Y-Z
- System frequency: 60 hertz
- Elevation, AMSL: Less than 1000 meters
- Isokeraunic level: 40
- Maximum ambient temperature: 40 degrees C
- Minimum ambient temperature: -40 degrees C
- Maximum conductor operating temperature: Contact Transmission Owner
- Wind Loading (round shapes): Per ASCE 7-98, per Fig. 6-1 depending on location

- Ice loading – Substations (no wind): 25 mm
- Seismic zone: Per ASCE 7-98, per Fig. 9.4.1.1(a) and (b). Equipment qualification per IEEE 693-97

Voltage and Current Ratings

- Nominal phase-to-phase: 138 kV
- Maximum phase-to-phase: 145 kV
- Basic impulse level (BIL): 650 kV
- Maximum continuous current carrying capacity: 2000 A
- Design fault current: 40 kA
- Single Contingency (breaker failure) clearing time: 60 cycles

Clearances and Spacing

- Recommended rigid bus center-to-center phase spacing: 96”
- Minimum phase-to-phase, metal-to-metal distance: 63”
- Recommended phase-to-ground: 52.5”
- Minimum phase-to-ground: 50”
- Low bus height above top of foundations (match existing): 16’-0”
- High bus height above top of foundations (match existing): 24’-0”
- Minimum vertical clearance from live parts to grade: 12’-2”
- Minimum horizontal clearance from live parts: 6’-8”
- Minimum conductor clearance above roads in switchyard: 25’-0”
- Minimum bottom of insulator to top of foundation: 8’-6”