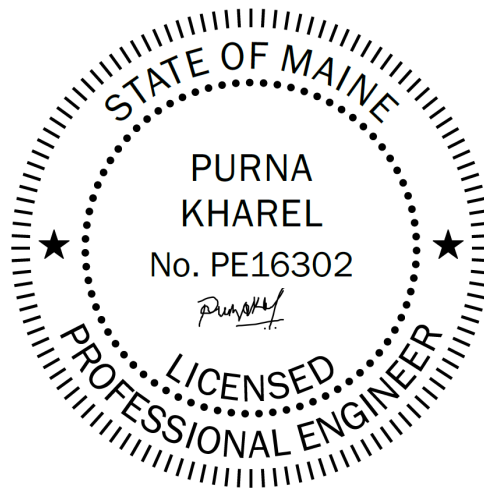


PRJ 392
Maine Dot Environmental Office
(Augusta)
Final Report
Distribution Interconnection Impact Study
-- POI: Pole 60.3, Western Ave, Augusta, ME--



June 10th, 2020

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1. Introduction

The purpose of this study is to identify any potential adverse impacts to the Distribution System that would result from the interconnection of **1.703 MW** of photovoltaic (PV) generation, applied by **Maine Dot Environmental Office** to **Circuit 215D3 (12.47 kV)** out of the **Capitol Street Substation**. The proposed Point of Interconnection (POI) will be at **pole #60.3 on Western Ave, Augusta, ME**.

The study was conducted in accordance with Central Maine Power Company (CMP) reliability and design standards, study guidelines, procedures and practices and Chapter 324 Rules governing distributed generation interconnection as approved by the Maine Public Utilities Commission (MPUC).

It is assumed that the customer (**Maine Dot Environmental Office**) will conduct further studies of their facilities as they deem necessary to assure adequacy of any customer-owned equipment in conjunction with the addition of the proposed generation equipment.

The following studies were done to evaluate the impact to distribution equipment and performance of the circuit and the substation:

- Load-Flow
- Steady State Voltage Analysis
- Voltage Change Analysis
- Short-Circuit
- Transformer Inrush
- Circuit Protection and Coordination
- Intertie Relay Review
- Effective Grounding
- Harmonics Evaluation

In addition, the study will provide a brief description and non-binding cost estimate of upgrades to the distribution system required to interconnect the project.

2. Project Description

The **1.703 MW** of photovoltaic (PV) generation (the project) will be connected to the existing overhead distribution lines at pole #60.3 on Western Ave, Augusta, ME as shown in Figure 1. The connection will be made to the primary voltage of 12.47 kV via Circuit **215D3** which is served from the **Capitol Street Substation**.

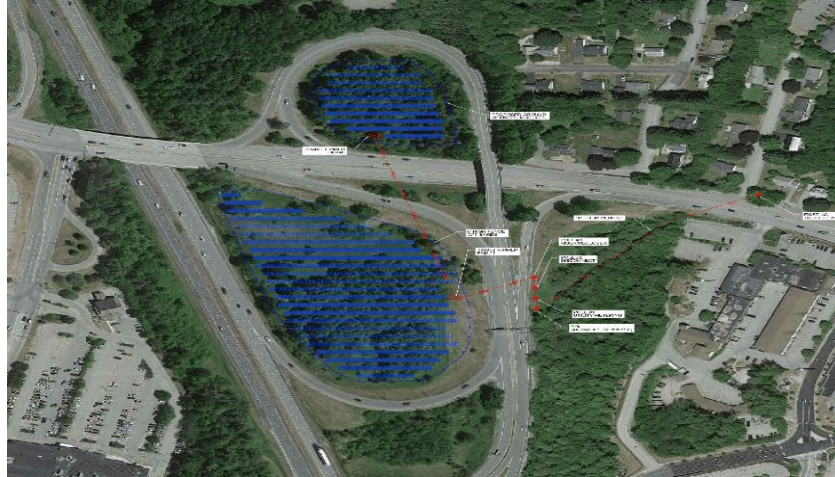


Figure 1. Site plan proposed by the project.

The approximate distance from POI to the nearest three phase line is approximately **0.12 miles**, upgrade from **1P_AAAC1/0_AAAC1/0N** to **3P_AL336.4_AL336.4N** is required and implemented for this study, and approximately **1.45 miles** to the substation.

The total project AC kW output capacity is limited to **1.703 MW** with eight (8) 166 kW inverters and three (3) 125 kW inverters. One (1) 1,500 kVA and one (1) 300 kVA, wye grounded-wye grounded transformers, along with one (1) 45 kVA, dry type wye grounded-delta grounding transformer is proposed as part of the customer one-line configuration for the project to connect to CMP's 12.47 kV grounded-wye distribution system. Appendix F summarizes useful data from the customer application report.

Customer Information:

Maine DOT Environmental Office – c/o David Gardner
 24 Child Street
 Augusta, ME, 04333
 Phone: 1-207-592-2471

3. Study Method

Both off-peak and peak loads recorded from the past 24 months were reviewed to determine the necessary base case(s). The PV generation project was studied to analyze its operation in conjunction with, without negatively affecting, the distribution system. The study used worst case scenarios and aids to determine possible mitigation techniques for observed adverse impacts. Various studies were done on the base case to identify existing issues, and any that were found, prior to interconnection, were considered pre-existing conditions. For study purposes, these conditions were addressed by modification of the base case as appropriate to preclude their impact on the generation studies.

4. **Study Assumptions**

The **Capitol Street Substation** transformer (10 / 14 MVA), with Load Tap Changer (LTC), regulates the 12.47 kV circuit voltage. To maintain satisfactory service and normal load flow to customers connected to Circuit **215D3**, and provide for operational flexibility, the circuit voltage must be maintained within the normal Company Planning criteria of 123 volts minimum and a maximum of 126 volts at the substation, on a 120-volt basis.

The base voltage and LTC settings are:

Base Voltage: 124.0 V

Bandwidth: 3.0 V

Delay: 30.0s

To the extent permissible, the project generation is assumed to operate in unity power factor mode by the Customer. It is also assumed that ISO New England will review the proposed project separately and may require the generator to operate in voltage control mode. In that case, their requirements may determine the operating mode and power factor.

Customer equipment and facilities were modeled to the extent necessary to evaluate the impact of Company facilities equipment ratings, service voltage, circuit reliability, protection, and system operation. It is the customer's responsibility to ensure that their facilities are adequate for the proposed project.

It is assumed that the Customer may, at their discretion, utilize transformer taps, if available, on each GSU to adjust the secondary voltage to levels they deem acceptable for their inverters, etc. This should have no direct impact on the utility side voltage of the GSU transformers.

The CMP **Capitol Street Substation** Transformer is rated for 10/ 14 MVA and it serves two (2) 12.47 kV circuits, **215D2** and **215D3**. Since the project will off-set normal circuit loading, the worst-case scenario to be analyzed, for steady state study purposes, is minimum load and maximum project output.

There are two generation sites present on the secondary Circuit **215D2**, PRJ 391 and a 420 kW generation site. These projects are considered pre-existing throughout the study to follow.

Unintentional Islanding - The generator must adhere to IEEE Standard 1547 that mandates a DG must detect an unintentional islanding condition and cease to energize the Electric Power System (EPS) within two seconds of the occurrence. An islanding condition results whenever the DG continues to power a location even though electrical grid power from the local EPS is no longer present. This would occur if the feeder breaker is opened for any reason other than for a fault on the feeder, or if any other

manual switching device in the feeder main line to the DG is opened. It should be noted that there may be interaction with other generators on the feeder.

SCADA Requirement - All facilities that have a generating capacity of 1,000 kW or greater must be equipped with SCADA equipment (as described in Chapter V, “Supervisory Control and Data Acquisition” of CMP’s Transmission and Distribution Interconnection requirements for Generation) and, for manned facilities, a telephone line dedicated to voice communications for Energy Control Center purposes. For unmanned facilities, the Generator must provide an alternative means of communications for Energy Control Center purposes.

5. Historical Loads

Historical load from the past 24 months for circuits **215D2**, **215D3** and **208D3 & 233D1** (contingency circuits) were used as the basis for the load modeling in the base and generation cases. The following Tables, 1 & 2, give an overview of the historical load for peak and off-peak conditions on the circuits **215D2**, **215D3** and **208D3 & 233D1**. Refer to Appendix E for the Capitol Street Substation one-line diagram.

Table 1. Peak Load at Circuits 215D2, 215D3, 208D3 & 233D1.

| Device | Amps Phase A | Amps Phase B | Amps Phase C | PF (%) |
|---------------|---------------------|---------------------|---------------------|---------------|
| 215D2 | 128.39 | 129.69 | 142.59 | 96.80 |
| 215D3 | 190.55 | 207.15 | 217.85 | 93.70 |
| 233D1 | 138.20 | 133.50 | 134.75 | 97.60 |
| 208D3 | 218.00 | 194.00 | 190.00 | 99.70 |

Table 2. Off-Peak Load at Circuits 215D2, 215D3, 208D3 & 233D1.

| Device | Amps Phase A | Amps Phase B | Amps Phase C | PF (%) |
|---------------|---------------------|---------------------|---------------------|---------------|
| 215D2 | 19.26 | 19.45 | 21.39 | 96.80 |
| 215D3 | 28.58 | 31.07 | 32.68 | 93.70 |
| 233D1 | 20.73 | 20.03 | 20.21 | 97.60 |
| 208D3 | 32.70 | 29.10 | 28.50 | 99.70 |

6. Load Flow Analysis

6.1 Equipment Loading

Several Load Flow studies were conducted to determine the project’s impact on the distribution equipment thermal loading. Utilizing peak and off-peak loading conditions with maximum generation, Circuit **215D3** was analyzed to identify overloads and equipment incompatibility with reverse power flow, if present. Figures 2 and 3 show the load flow under peak and off-peak conditions, without and with the proposed project

interconnection and with PRJ 391 and a solar generation of 420 kW in secondary circuit connected in all scenarios.

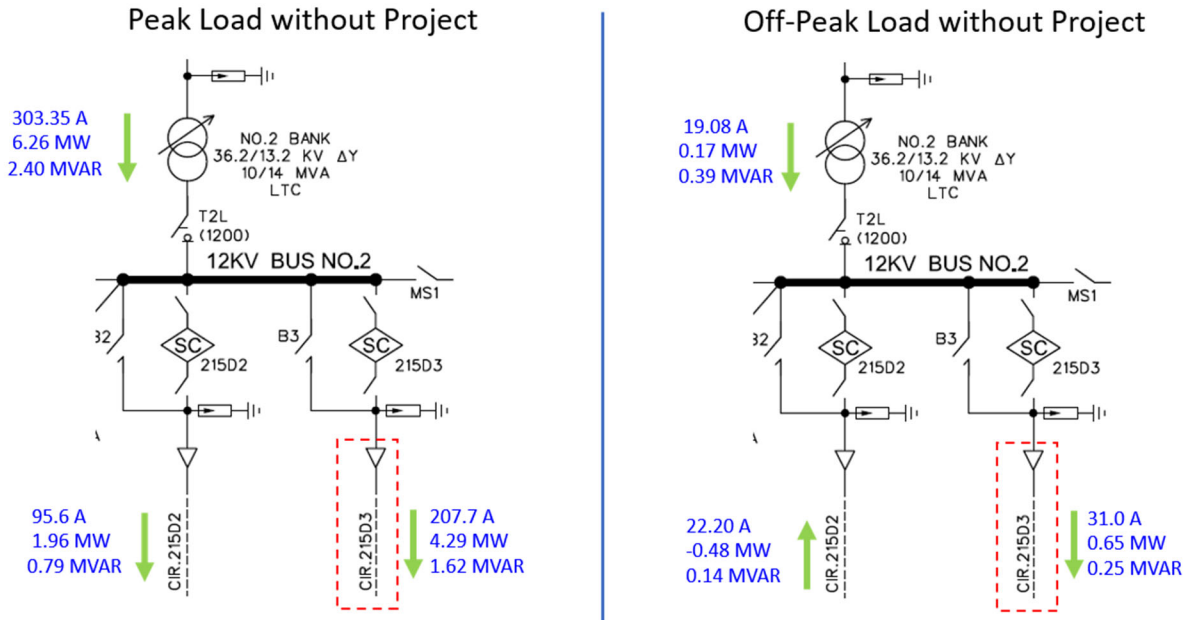


Figure 2. Substation Bank Loading under peak and off-peak conditions without Proposed Project.

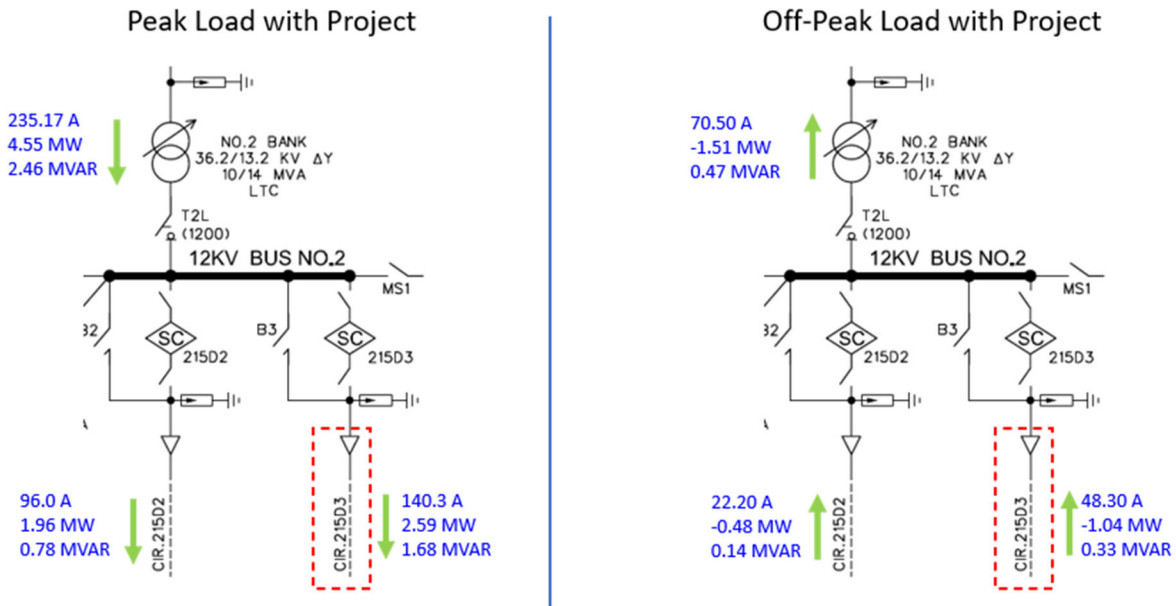


Figure 3. Substation Bank Loading under peak and off-peak conditions with proposed project.

The worst-case scenario, maximum project output under off peak load conditions, does not cause the substation transformer rating to be exceeded. However, reverse power flow through the substation circuit and transformer is observed during off-peak load condition with the interconnection of the proposed project. Therefore, the reverse power setting and handling capabilities for the substation transformer LTC control will need to be verified.

7. Voltage Impact

7.1 Steady State Voltage Analysis

A Steady State Voltage Analysis was conducted to determine the project's impact on the distribution circuit voltage. To ensure adequate service voltage to customers, 114 to 126 volts, the circuit voltage must remain within the range of 117 to 126 volts (120 volt base) during normal operation. In general, the circuit voltage at the substation must remain in the range of 123 to 126 volts to maintain an adequate voltage on **Circuit 215D3** under all anticipated load conditions, regardless of project operation. Table 3 shows the simulation results for voltage impact on **215D3**.

Table 3. Simulation Results for Voltage Impact on circuit 215D3 under Peak and Off-peak loads due to proposed project interconnection.

| Circuit 215D3 Load | 1.703 MW PV (ON/OFF) | Substation Voltage (V) | POI Voltage (V) | V-max (V) | V-min (V) | Threshold (V) |
|---------------------|----------------------|------------------------|-----------------|-----------|-----------|---------------|
| Peak (1.033 pu) | OFF | 122.72 | 121.58 | 122.92 | 120.86 | 117 - 126 |
| Peak (1.033 pu) | ON | 122.32 | 121.67 | 122.79 | 120.82 | |
| Off-peak (1.045 pu) | OFF | 124.89 | 124.80 | 125.30 | 124.66 | |
| Off-peak (1.045 pu) | ON | 125.07 | 125.46 | 125.83 | 124.99 | |

There are no voltage violations upon interconnection of the proposed project.

7.2 Voltage Change Analysis

A Voltage Change Analysis was performed to determine the instantaneous change in voltage (voltage change/flicker) that would occur in the distribution system upon sudden loss of the **1.703 MW** project. The voltage flicker at the POI given a 100% loss of the project must be " $< / = 3\%$ ". Similarly, the voltage change at the substation LTC must be less than or equal to half its bandwidth " $< / = 1.5 \text{ V}$ ".

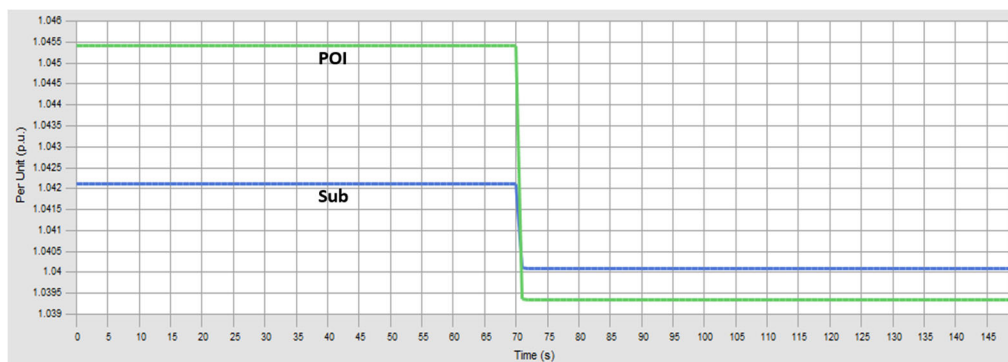


Figure 4. Circuit 215D3 POI and Substation Voltage Change at peak Loads Due to Sudden 100% Loss of the 1.703 MW PV Project.

Peak Load with 100% sudden loss of the proposed project, results:

$$\Delta V = 1.0454 - 1.0393 = 0.0061 \text{ p.u.} \Rightarrow 0.61 \% < 3\% \text{ @ POI}$$

$$\Delta V = 1.0421 - 1.0401 = 0.002 \text{ p.u.} \Rightarrow 0.24 V < 1.5 V \text{ @ Substation LTC}$$

The voltage flicker is below the allowable 3% limit at the POI for the project and the substation voltage change is less than half the LTC bandwidth. Therefore, the project passes this section of study.

7.3 Contingency Circuit Analysis

Circuit **208D3**, served from the substation Bond Brook (12 kV) and Circuit **233D1**, served from the substation Manchester (12 kV) which has existing PRJ 95, are the contingency circuits for circuit 215D3.

Simulation results show no over-voltage or voltage flicker violations, Vmax of 125.89 V and voltage flicker of less than 3%, during both Peak and Off-Peak scenarios when Circuit **208D3** picks up the load from Circuit **215D3**.

Similarly, simulation results show no over-voltage and voltage flicker violations, Vmax of 124.96 V and voltage flicker of less than 3%, during both Peak and Off-Peak scenarios when Circuit **233D1** picks up the load from Circuit **215D3**.

Therefore, the proposed project can operate during the contingency conditions when both circuits **208D3** and **233D1** picks up load from the circuit **215D3**.

8. Short Circuit Analysis

A short circuit analysis was performed to determine the fault duty at various points and identify if any circuit reclosers exceeded their interrupting capability as a result of the interconnection project.

Below is a summary of the maximum fault levels on the 12.47 kV Distribution System Circuit **215D3**. The difference in percentage before and after the interconnection at the substation is shown in Table 4 and the point-of-interconnection (POI) in Table 5.

Table 4. Summary of Short Circuit Analysis at Substation.

| DER Status | LLL (A) | LLG (A) | LL (A) | LG (A) |
|------------|--------------|--------------|--------------|--------------|
| OFF | 4474 | 4934 | 3852 | 4928 |
| ON | 4564 | 5010 | 3891 | 4979 |
| Difference | 2.01% | 1.54% | 1.01% | 1.03% |

Table 5. Summary of Short Circuit Analysis at POI.

| DER Status | LLL (A) | LLG (A) | LL (A) | LG (A) |
|-------------------|----------------|----------------|---------------|---------------|
| OFF | 2815 | 2685 | 2429 | 2487 |
| ON | 2905 | 2751 | 2467 | 2552 |
| Difference | 3.20% | 2.46% | 1.56% | 2.61% |

The short circuit study detected no violations for LLL/LLG/LL/LG faults as a result of the addition and operation of the proposed generation.

Addition of the DER project does not cause any protective devices on Circuit **215D3** to exceed 87.5% of their short circuit interrupting capability. The substation recloser and customer proposed recloser can interrupt the increased short circuit current. Protection coordination will be evaluated in the following section.

9. Circuit Protection Review

The project is located at about **1.45 miles** from Capitol Street Substation. The approximate distance from POI to the nearest three phase line is **0.12 miles**.



Figure 5. Distribution Circuit 215D3.

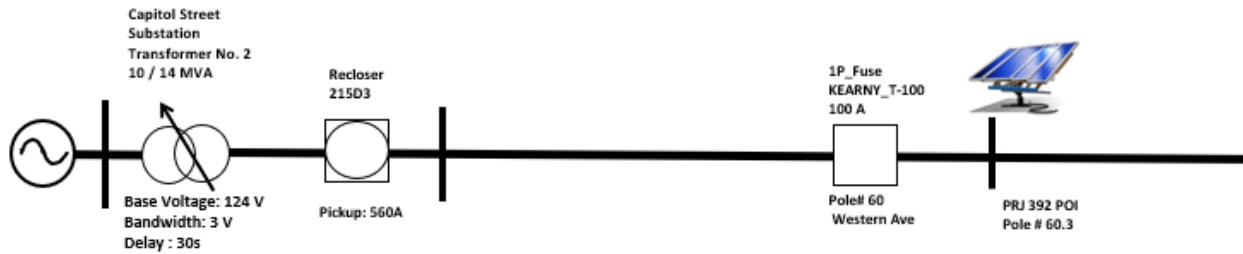


Figure 6. Protection Review from POI to Substation of Circuit 215D3.

One (1) existing single-phase fuse at pole #60 (Western Ave.) needs to be removed and upgraded to a new three phase recloser with second harmonic blocking logic.

9.1 Transformer Inrush

The transformer inrush current is highly non-linear, it peaks at 1/2 cycle (0.008 sec) after the transformer is energized. The current then drops to normal after about 6 cycles (0.1 sec). The magnitude of the inrush current depends on the following:

- Time that you throw the switch.
- Length and size of the conductors feeding the transformer.
- Stiffness (available fault current) of the system feeding the transformer.
- The size of the transformer.
- The type of transformer.

The worst case of the transformer inrush is when the one (1) 1,500 kVA transformer and one (1) 400 kVA generating step-up (GSU) transformers are energized. The inrush current is determined as:

$$10 \times \text{FLA} = 10 \times 87.9 \text{ A} = 879 \text{ A}$$

Review of the TCC settings for substation recloser **215D3** with SEL351R control shows that the inrush will not trip its settings within 6 cycles. Therefore, Circuit **215D3** is adequately protected from inrush current due to the project GSU transformer energization. See TCC curve located in Appendix D, for more details.

9.2 Intertie Relay

Protection Review for the PV GENERATION

Maine Dot Environmental Office (Western Ave) has proposed to use Electric SEL-651R recloser as the intertie relay as shown below. The site intertie relay will need to be able to detect ground bank transformer faults and remove the project generation from service for all project system current, frequency, or voltage abnormalities. The SEL-651R

overcurrent protection for Maine Dot Environmental Office (Western Ave) will need to coordinate with the new recloser on pole #60 on Western Ave.

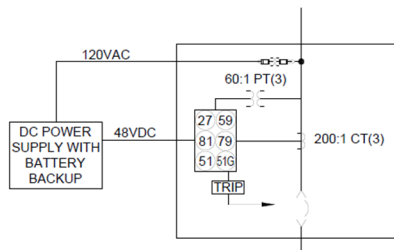


Figure 7. New Pole-mount recloser provided by the customer.

Table 6. Relay Settings.

| PROPOSED PROTECTION RELAY SETTINGS | | | | | | | |
|------------------------------------|---------|-------------------|---------------------------|---------------------|-----------|----------|--|
| DEVICE | PICKUP | | Time Delay | Total Clearing Time | | | |
| | Primary | Secondary | | | | | |
| 27-1 | 50% | (3599.8 V) | 63 CYC | 1.05 SEC | 66 CYC | 1.1 SEC | |
| 27-2 | 88% | (6335.6 V) | 117 CYC | 1.95 SEC | 120 CYC | 2 SEC | |
| 59-1 | 110% | (7919.5 V) | 117 CYC | 1.95 SEC | 120 CYC | 2 SEC | |
| 59-2 | 120% | (8639.5 V) | 6.6 CYC | 0.11 SEC | 9.6 CYC | 0.16 SEC | |
| 81U-1 | | 58.5 HZ | 17997 CYC | 299.95 SEC | 18000 CYC | 300 SEC | |
| 81U-2 | | 56.5 HZ | 6.6 CYC | 0.11 SEC | 9.6 CYC | 0.16 SEC | |
| 81O-1 | | 61.2 HZ | 17997 CYC | 299.95 SEC | 18000 CYC | 300 SEC | |
| 81O-2 | | 62 HZ | 6.6 CYC | 0.11 SEC | 9.6 CYC | 0.16 SEC | |
| 51 | | 98 A | SET PER UTILITY STANDARDS | | | | |
| 51G | | 33 A | SET PER UTILITY STANDARDS | | | | |
| 79 | | 0.95 PU - 1.05 PU | 17997 CYC | 299.95 SEC | 18000 CYC | 300 SEC | |
| | | 59 HZ - 60.5 HZ | | | | | |

SETTINGS ASSUME 3 CYCLE ESTIMATED DEVICE TRIP OPENING TIME
 SETTINGS ARE BASED ON IEEE 1547-2018 TABLE 1 (VOLT) AND 2 (FREQ).
 SETTINGS ARE BASED ON A 108V SECONDARY PT BASE.

9.3 Single Phasing

The behavior of three-phase transformers, when one of the phases is lost, is commonly called "single phasing." Upon a single phasing condition voltages and currents, on both the HV side and LV side, depend greatly on the transformer winding connection (delta, wye, wye-grounded, etc.) as well as the transformer's core construction. A single phasing condition is very difficult to detect by relays where the CTs are monitoring current on the LV side of the transformer.

On the customer side, with the presence of long underground cables (high capacitance); the most important factor affected by this is the Ferranti effect. It is more pronounced in cables than in lines. This induces several limitations. Also, with increased capacitance, the charging current drawn is also increased. Underground cables have 20 to 75 times the line charging current compared to overhead lines. Due to these two conditions, it is suggested that the recloser have the ability of monitoring zero-sequence voltage to eliminate the single-phasing concerns.

10. Effective Grounding

Utilities in the Northeastern part of the United States currently use the conventional effective grounding concept prescribed in IEEE 142. The standard says, "The grounding

scheme of the DR interconnection shall not cause overvoltage that exceeds the rating of the equipment connected to the Area EPS and shall not disrupt the coordination of the ground fault protection on the Area EPS.” The grounding impedance (X_0) is calculated based on the positive sequence impedance (X_1) provided by the inverter manufacturer and $X_0/X_1 < 3$, $R_0/X_1 < 1$ are generally used. Refer to Appendix G for the customer proposed one-line diagram of the project.

Table 7. Effective Grounding Values at POI.

| Status | R_0/X_1 | X_0/X_1 | Threshold |
|-------------|-----------|-----------|---------------|
| w/o project | 0.351 | 1.392 | $R_0/X_1 < 3$ |
| w/ project | 0.352 | 1.375 | $X_0/X_1 < 3$ |

The proposed one (1) 1,500 kVA and one (1) 300 kVA, Wye-grounded to Wye-grounded, pad mounted transformers, with one (1) 45 kVA dry type Wye-grounded / Delta grounding transformer is effectively grounded and will not worsen the grounding conditions, hence, not creating adverse impacts to distribution Circuit **215D3**.

11. Harmonics Evaluation

According to the small generating facility characteristic data that is provided for inverter-based machines, **harmonics characteristics is (THD) <3 %**. In IEEE 519, the accepted THD is 5%. Therefore, harmonics will not be a concern or a problem for the project. Project passes this section of the study.

12. Conclusions

1. Load Flow Analysis

- No adverse impact was detected with the interconnection of proposed project at Circuit **215D3**.
- The substation transformer LTC control reverse power settings and handling capabilities will need to be verified.

2. Equipment Loading

- Remove a single-phase 100 A fuse and upgraded to a new three phase recloser with second harmonic blocking logic, Pole #60 (Western Ave.).

3. Voltage Impact

- No over-voltages were observed with the project interconnection.
- The voltage flicker at the POI and the voltage change at the substation LTC are within the allowable limit during a 100% loss of the proposed project.

4. Contingency Analysis
 - The proposed project can operate under the contingency condition when either Circuit **208D3** or Circuit **233D1** picks up load from circuit 215D3.
5. Short circuit Analysis
 - Protective devices can interrupt the available short circuit with PV Generation project interconnection.
6. Circuit Protection Coordinate/Protection Review
 - Circuit is adequately protected.
 - Line upgrade of **0.12** miles from **1P_AAAC1/0_AAAC1/0N** to **3P_AL336.4_AL336.4N** required, Pole #60.3 (POI) to Pole #60 (Western Ave).
7. Effective grounding
 - No adverse impacts were found in the effective grounding study due to the interconnection of the project.
8. Harmonics
 - No adverse impacts were found in the harmonics study.

The project passes all sections of the Impact Study and is therefore able to interconnect, Contingency Circuit Analysis section pertains only to the ability of the project to operate during contingencies. The interconnection is contingent upon upgrades and mitigation methods applied (if any) throughout the study in order to maintain the distribution system's reliability and integrity

13. Suggested Solutions and cost estimation (total \$135,452 +TBD costs)

Note:

- This estimate is in accordance with the guidance provided under the Maine Public Utilities Commission Chapter 324 Rule. Under §12.N, the rule states the Utility “should endeavor to estimate within +/- 25%.” While the intent of this estimate is to refine costs to upgrade to a figure within that tolerance, the total amount to upgrade is an estimate of costs and may not reflect all known costs at the time of the estimate. Should a project desire more refinement or a detailed breakdown of an estimate, please refer to the last paragraph of Section N where it states, “The detailed system modifications and more accurate costs of the modifications necessary to interconnect the ICGF shall be identified in the Facilities Study.” If the project desires a Facilities Study, please advise the Interconnection Services Group.
- Estimate is based on Distribution Planning Estimating Guide Version 1.3 Appendix A.
- Estimate assumes a 25% overall contingency.
- Estimate Includes Project Engineering, Project Manager, Administrative Support, Miscellaneous Overheads, and Allocations.
- TBD costs are not included in the total dollar amount and are a separate cost “high level” associated with the project interconnection.

System Upgrade/Revisions

- Modify substation LTC control for reverse power flow-----**\$10,000 TBD**
- Replace one (1) existing single-phase 100 A fuse with a new three phase line recloser with second harmonic blocking, Pole #60 (Western Ave.).
- SCADA implementation-----cost **TBD**.

Line Upgrade/Revision

- Reconductor approximately **0.12 miles** from **1P_1/0 AAAC_AAAC1/0N** to **3P_AL 336.4_AL336.4N**.
 - Pole#60.3 (POI) to Pole #60 (Western Ave).

Interconnection Cost

- The project will require a **bi-directional pole mounted primary metering package** located off the existing 12.47 kV overhead CMP distribution circuit. The facility includes one solid state meter, three 12.47 kV CT and three 12.47 kV VT, the detailed price is listed in Appendix B.-----**\$14,522 (total installed cost)/\$225.4 (per month maintenance and translation)**
- Install (1) new pole for primary metering equipment and connect the overhead line to pole #60.3 Western Ave, Augusta, ME.
- Install a GOAB switch.
- Install (1) new pole for GOAB switch.

Customer Responsibilities

- Everything on the load side or customer side of the Gang Operated Air Break Switch (GOAB) representing the Point of Common Coupling (PCC) will be the responsibility of the customer or developer. This includes any protective reclosers, breakers, the telephone line to the Revenue Meter and all associated equipment.
- All facilities that have a generating capacity of 1,000 kW or greater must be equipped with SCADA equipment.

Appendix

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A. Planning Cost Estimate

| Project Name: Maine Dot Environmental Office | | | | Project #: PRJ392 | | | | | | | | | |
|---|--------------|---|-------|---------------------|----------|----------|-------------------------|----------|----------|-------------|----------------------|----------|----------|
| Location: Western Ave, Augusta, ME | | | | Org Date: 29-May-20 | | | | | | | | | |
| Section: | | | | Rev Date: | | | | | | | | | |
| By: Distribution Planning | | | | Rev by: | | | | | | | | | |
| Project Stage: Concept | | This is a Planning Grade Estimate with tolerance of -50% to +200% | | | | | | | | | | | |
| Contingency value = 25% | | | | | | | | | | | | | |
| Item | Quantity to: | | | Average Unit Cost | | | Estimated SubTotal Cost | | | Contingency | Estimated Total Cost | | |
| | Install | Remove | Shift | CAP | COR | O&M | CAP | COR | O&M | | CAP | COR | O&M |
| Poles - Electric Owned and Maintained | | | | | | | | | | | | | |
| 15KV - Reinsulate Single Phase | 0 | 0 | 0 | \$ - | \$ 50 | \$ 100 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Reinsulate Three Phase | 0 | 0 | 0 | \$ - | \$ 50 | \$ 300 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - New Single Phase | 0 | 0 | 0 | \$ 1,500 | \$ - | \$ - | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - New Three Phase | 0 | 0 | 0 | \$ 3,000 | \$ - | \$ - | 6,000 | \$ - | \$ - | 25% | 7,500 | \$ - | \$ - |
| 15KV - Replace Single Phase | 0 | 5 | 0 | \$ 2,000 | \$ 400 | \$ 200 | \$ - | \$ 2,000 | \$ - | 25% | \$ - | \$ 2,500 | \$ - |
| 15KV - Replace Three Phase | 5 | 0 | 0 | \$ 3,000 | \$ 600 | \$ 300 | 15,000 | \$ - | \$ - | 25% | 18,750 | \$ - | \$ - |
| 15KV - Dress for aerial cable | 0 | 0 | 0 | \$ 700 | \$ - | \$ 70 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Pole Set Asset | 0 | 0 | 0 | \$ 1,000 | \$ - | \$ 100 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - H-Frame, Two Pole Structure | 0 | 0 | 0 | \$ 15,000 | \$ 4,500 | \$ - | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| Poles - Telco Owned and maintained | | | | | | | | | | | | | |
| 15KV - New Single Phase | 0 | 0 | 0 | \$ 500 | \$ - | \$ - | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - New Three Phase | 0 | 0 | 0 | \$ 2,500 | \$ - | \$ - | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Replace Single Phase | 0 | 0 | 0 | \$ 1,000 | \$ 200 | \$ 100 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Replace Three Phase | 0 | 0 | 0 | \$ 2,500 | \$ 500 | \$ 250 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| OH Conductor (per section - 150ft) | | | | | | | | | | | | | |
| 15KV - Single Phase | 0 | 5 | 0 | \$ 125 | \$ 25 | \$ 13 | \$ - | \$ 125 | \$ - | 25% | \$ - | \$ 156 | \$ - |
| 15KV - Three Phase Tap | 0 | 0 | 0 | \$ 250 | \$ 50 | \$ 25 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Three Phase Mainline | 5 | 0 | 0 | \$ 450 | \$ 90 | \$ 45 | 2,250 | \$ - | \$ - | 25% | 2,813 | \$ - | \$ - |
| 15KV - Three Phase Mainline - Spacer | 0 | 0 | 0 | \$ 800 | \$ 160 | \$ 80 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Replace Secondary/Service Conductor | 0 | 0 | 0 | \$ 150 | \$ 30 | \$ 15 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Aerial Cable - Express | 0 | 0 | 0 | \$ 4,000 | \$ 800 | \$ 400 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| UPZ Vegetation Management | 0 | 0 | 0 | \$ 2,000 | \$ 400 | \$ 200 | \$ - | \$ - | \$ 1,000 | 25% | \$ - | \$ - | \$ 1,250 |
| Major OH Equipment | | | | | | | | | | | | | |
| 15KV - Cutout - Single | 0 | 1 | 0 | \$ 200 | \$ 40 | \$ 20 | \$ - | \$ 40 | \$ - | 25% | \$ - | \$ 50 | \$ - |
| 15KV - Cutout - Three | 0 | 0 | 0 | \$ 600 | \$ 120 | \$ 60 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Bulls - 1st | 0 | 0 | 0 | \$ 150 | \$ 30 | \$ 15 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Bulls - 3rd | 0 | 0 | 0 | \$ 400 | \$ 80 | \$ 40 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Disc Switch - InLine | 0 | 0 | 0 | \$ 1,000 | \$ 200 | \$ 100 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Disc Switch - Underarm | 0 | 0 | 0 | \$ 1,800 | \$ 360 | \$ 180 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Load Break Switch | 1 | 0 | 0 | \$ 5,000 | \$ 1,000 | \$ 500 | 5,000 | \$ - | \$ - | 25% | 6,250 | \$ - | \$ - |
| 15KV - OH Recloser | 0 | 0 | 0 | \$ 30,000 | \$ 6,000 | \$ 3,000 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - OH Cap Bank | 0 | 0 | 0 | \$ 17,000 | \$ 3,400 | \$ 1,700 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - OH Arrestors | 0 | 0 | 0 | \$ 500 | \$ 100 | \$ 50 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - SCADA Controlled Recloser - 30 | 1 | 0 | 0 | \$ 31,000 | \$ 6,200 | \$ 2,500 | 31,000 | \$ - | \$ - | 25% | 38,750 | \$ - | \$ - |
| 15KV - SCADA Switch - 30 | 0 | 0 | 0 | \$ 26,000 | \$ 6,200 | \$ 2,500 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - SCADA Single Phase Reclosers | 0 | 0 | 0 | \$ 21,000 | \$ 4,200 | \$ 2,000 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - TripSavers - 10 | 0 | 0 | 0 | \$ 4,500 | \$ 900 | \$ 250 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - FuseSavers - 10 | 0 | 0 | 0 | \$ 2,500 | \$ 450 | \$ 250 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| Transformer - includes the Txf | | | | | | | | | | | | | |
| 15KV - Single Phase OH Txf's | 0 | 0 | 0 | \$ 1,200 | \$ 240 | \$ 120 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Three Phase OH Txf's | 0 | 0 | 0 | \$ 3,700 | \$ 740 | \$ 370 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Single Phase SDB OH Txf's | 0 | 0 | 0 | \$ 3,400 | \$ 680 | \$ 340 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Three Phase SDB OH Txf's | 0 | 0 | 0 | \$ 20,000 | \$ 4,000 | \$ 2,000 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Three Phase SDB Txf's 2 pole structure | 0 | 0 | 0 | \$ 32,000 | \$ 6,400 | \$ 3,200 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Single Phase URD Pad Txf's | 0 | 0 | 0 | \$ 5,000 | \$ 1,000 | \$ 500 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Three Phase URD Pad Txf's | 0 | 0 | 0 | \$ 12,000 | \$ 2,400 | \$ 1,200 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Single Phase Submrs | 0 | 0 | 0 | \$ 6,000 | \$ 1,200 | \$ 600 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - 3 Single Phase Submrs | 0 | 0 | 0 | \$ 18,000 | \$ 3,600 | \$ 1,800 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Three Phase Submrs | 0 | 0 | 0 | \$ 35,000 | \$ 7,000 | \$ 3,500 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Polemounted Regulators - 10 | 0 | 0 | 0 | \$ 15,000 | \$ 3,500 | \$ 1,500 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| 15KV - Platform Mounted Regulators - 10 | 0 | 0 | 0 | \$ 28,000 | \$ 5,000 | \$ 2,000 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| Misc Labor not accounted for in listed Activities | | | | | | | | | | | | | |
| Overhead Department Labor in Hours | 0 | 0 | 0 | \$ 140 | \$ 140 | \$ 140 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| Underground Department Labor in Hours | 0 | 0 | 0 | \$ 140 | \$ 140 | \$ 140 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| Trans/Station Department Labor in Hours | 0 | 0 | 0 | \$ 140 | \$ 140 | \$ 140 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| Test Department Labor in Hours | 0 | 0 | 0 | \$ 140 | \$ 140 | \$ 140 | \$ - | \$ - | \$ - | 25% | \$ - | \$ - | \$ - |
| Subtotal | | | | | | | \$ 59,250 | \$ 2,165 | \$ 1,000 | | \$ 74,063 | \$ 2,706 | \$ 1,250 |
| Project Engineering | | | | | | | \$ 5,925 | \$ 217 | \$ 100 | 10% | \$ 7,406 | \$ 271 | \$ 125 |
| Project/Construction Manager | | | | | | | \$ 2,963 | \$ 108 | \$ 50 | 5% | \$ 3,703 | \$ 135 | \$ 63 |
| Administrative Support | | | | | | | \$ 2,963 | \$ 108 | \$ 50 | 5% | \$ 3,703 | \$ 135 | \$ 63 |
| Misc Overheads | | | | | | | \$ 17,775 | \$ 650 | \$ 300 | 30% | \$ 22,219 | \$ 812 | \$ 375 |
| Allocations | | | | | | | \$ 2,963 | \$ 108 | \$ 50 | 5% | \$ 3,703 | \$ 135 | \$ 63 |
| Total | | | | | | | \$ 91,838 | \$ 3,356 | \$ 1,550 | | \$ 114,797 | \$ 4,195 | \$ 1,938 |
| | | | | | | | CAP | COR | O&M | | CAP | COR | O&M |

Table 8. Planning Cost Estimate.

B. Metering Equipment Cost Estimates

12/19/2019

METERING EQUIPMENT COST ESTIMATE
Maine Dot Environmental Office (Augusta)

SJD

Monthly O&M Charge for Metering Equipment

| <u>Item</u> | <u>Type</u> | <u>Serial</u> | | <u>Equipment</u> | <u>Installation</u> | <u>Installed</u> |
|---|-------------|----------------|------------|------------------|---------------------|------------------|
| | | <u>Numbers</u> | <u>Qty</u> | <u>Cost</u> | <u>Cost</u> | <u>Cost</u> |
| Solid State Meter | EMR | | 1 | 5000.00 | 1200.00 | 6,200.00 |
| 12KV Current Transformer | CT | | 3 | 1,500.00 | 1,500.00 | 3,000.00 |
| 12kV Voltage Transformer | VT | | 3 | 3,000.00 | 1,500.00 | 4,500.00 |
| Sub-Total Installed Equipment Cost | | | | | | \$13,700.00 |
| General Expense @ 6% | | | | | | 822.00 |
| Total Installed Cost | | | | | | \$14,522.00 |
| Monthly Maintenance Charge @ 1.38% of Total Installed Cost | | | | | | \$200.40 |
| Monthly Translation | | | | | | \$25.00 |
| Total Monthly Meter Charges | | | | | | \$225.40 |

Note: The Interconnection Customer is responsible for providing a phone line for the metering equipment and is responsible for owning, maintaining, and paying all associated monthly costs for the metering phone line.

C. Circuits Map

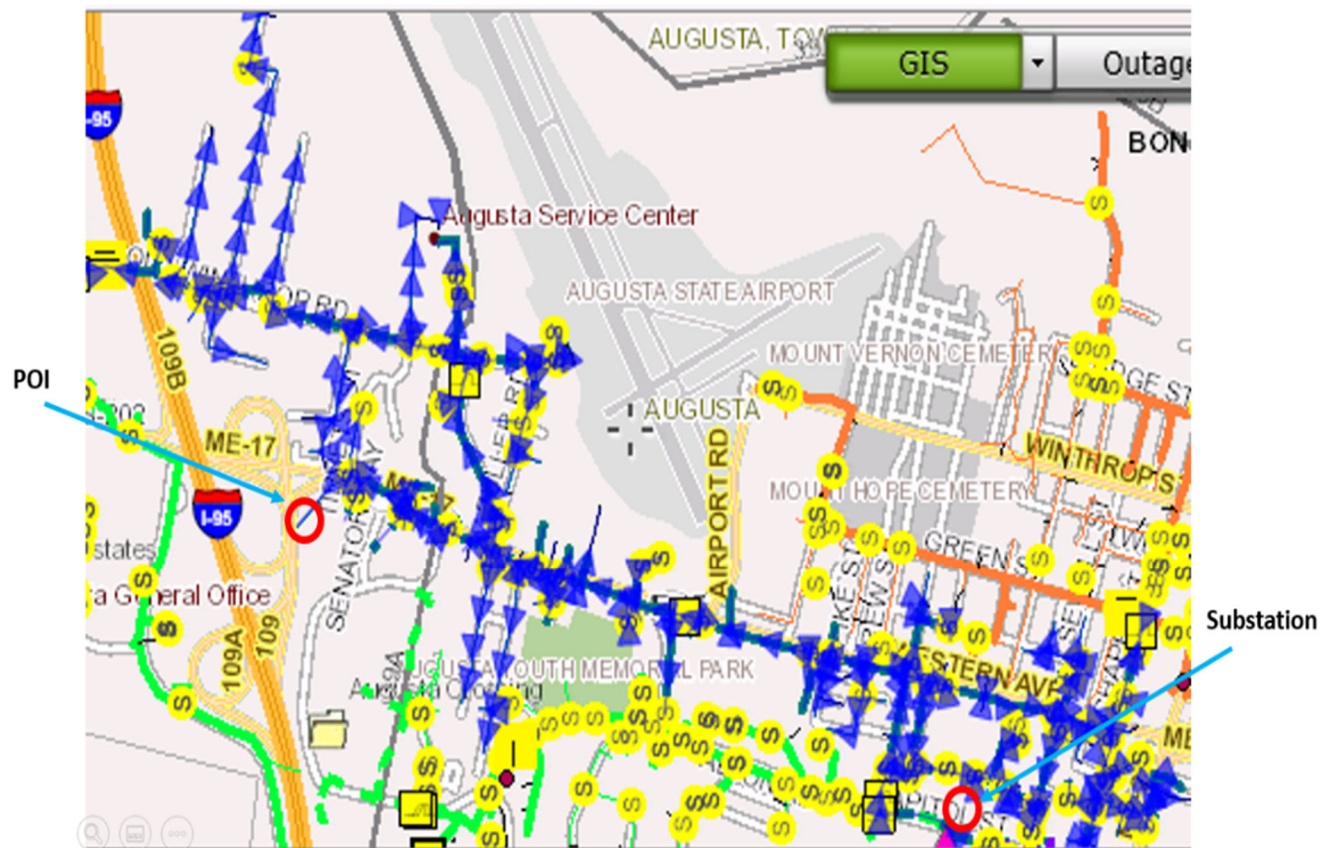


Figure 8. Circuit 215D3 in Smart-Map.

D. TCC Settings

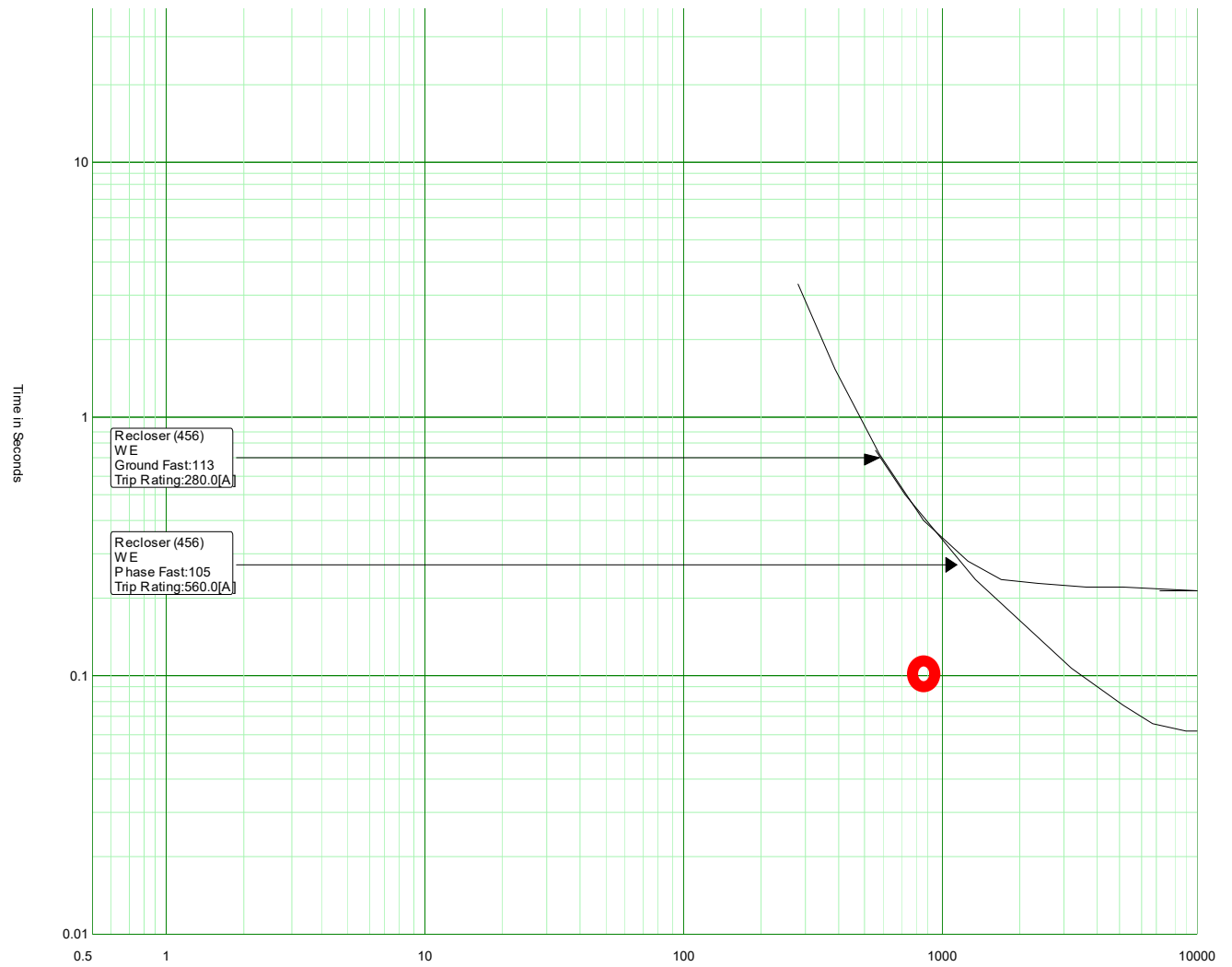


Figure 9. TCC for Substation Recloser.

E. Capitol Street Substation One-Line Diagram

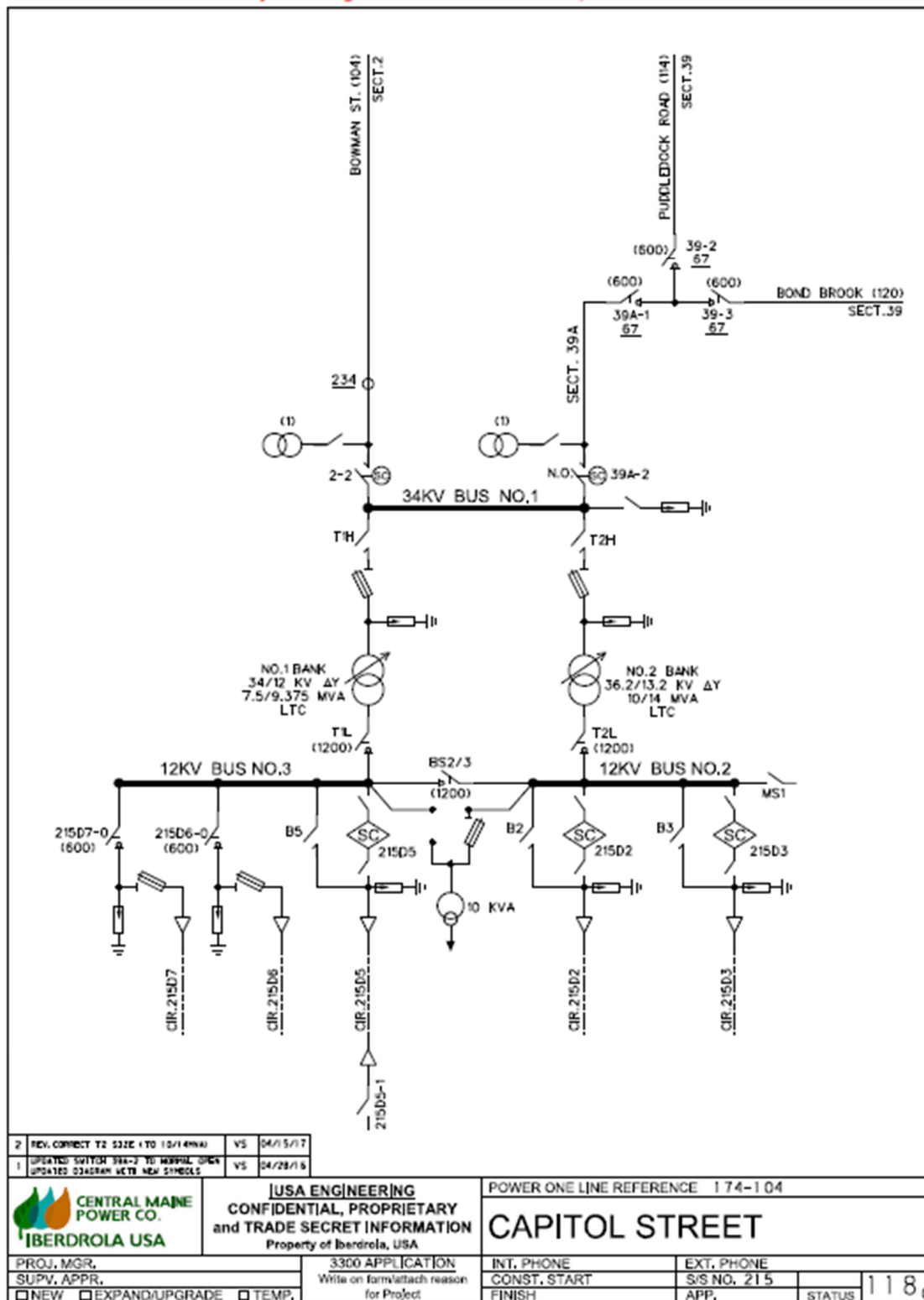


Figure 10. One Line Diagram of Capitol Street Substation.

F. Application

PUC Chapter 324 – Forms and Agreements

Forms and Agreements 4: Level 2, Level 3 and Level 4 Interconnection Application

A Customer-Generator applicant ("Applicant") hereby makes application to CMP (Utility or T & D Utility) to install and operate a generating facility interconnected with the CMP utility system. This application will be considered as an application for interconnection of generators under Expedited interconnection review provided the generator is not greater than 2 MW but shall serve as an Application for Standard interconnection review if greater than 2 MW or if Expedited review does not qualify the generator for interconnection.

Written applications should be submitted by mail, e-mail or fax to Central Maine Power Company (CMPCO), as follows:

[Utility]: Central Maine Power Company (CMPCO)

[Utility's address]: 83 Edison Drive, Augusta, ME 04336

Telephone Number: 207.621.4732

E-Mail Address: nathan.pelletier@cmpco.com

[Utility] Contact Name: C/O Nick Pelletier

[Utility] Contact Title: _____

An application is a Complete Application when it provides all applicable information required below. (Additional information to evaluate a request for interconnection may be required and will be so requested from the Interconnection Applicant by Utility after the application is deemed complete).

Section 1. Applicant Information

Legal Name of Interconnecting Applicant (or, if an Individual, Individual's Name)

Name: MaineDOT Environmental Office – c/o David Gardner

Mailing Address: 24 Child Street

City: Augusta State: ME Zip Code: 04333

Facility Location (if different from above): 44.315064 , -69.809702 (Site)

44.314939, -69.808273 (POI)

Telephone (Daytime): 1-207-592-2471

Telephone (Evening): 1-207-592-2471

Fax Number:

E-Mail Address: david.gardner@maine.gov

Not Applicable _____
(Utility)

30012198245
(Existing Account Number, if generator to be
interconnected on the Customer side of a utility
revenue meter)

PUC Chapter 324 – Forms and Agreements

Type of Interconnect Service Applied for _____ Network Resource, _____
(choose one)

Energy Only, X Load Response (no export) _____ Net metering

Section 2. Generator Qualifications

Data apply only to the Small Generating Facility, not the Interconnection Facilities.

Energy Source: X Solar _____ Wind _____ Hydro _____ Hydro Type (e.g. Run-of-River): _____

Diesel _____ Natural Gas _____ Fuel Oil _____ Other (state type) _____

Prime Mover: Fuel Cell _____ Recip. Engine _____ Gas Turb. _____ Steam Turb. _____
Microturbine _____ PV X Other _____

Type of Generator: Synchronous _____ Induction _____ Inverter X

Generator Nameplate Rating: 166 kW (8 Units) 125KW (3 Units)

Generator Nameplate kVA: 166 kVA (8 Units) 125KVA (3 Units)

Interconnection Customer or Customer-Site Load: NONE kW (if none, so state)

Typical Reactive Load (if known): N/A

Maximum Physical Export Capability Requested 4,980 kW

List components of the Small Generating Facility Equipment Package that are currently certified:

| Equipment Type | Certifying Entity |
|--------------------------------------|-------------------|
| 1. <u>Solectria XGI 1500-166/166</u> | <u>UL 1741 SA</u> |
| 2. <u>Solectria XGI 1500-125/125</u> | <u>UL 1741 SA</u> |
| 3. <u>Longi LR6-72BP 380M</u> | <u>UL 1703</u> |
| 4. _____ | _____ |
| 5. _____ | _____ |

Is the prime mover compatible with the certified protective relay package?

Yes X No _____

Generator (or solar collector):

Manufacturer, Model Name & Number: Solectria XGI 1500-166/166 & 125/125

Version Number: TBD

Nameplate Output Power Rating in kW:

Figure 11. Proposed project One Line Diagram.

