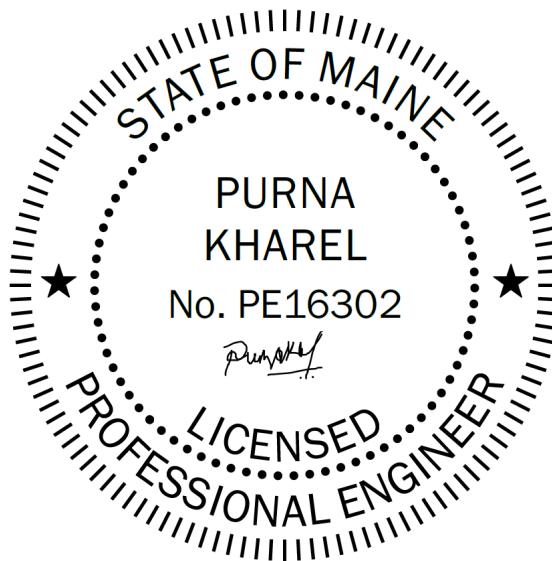


PRJ 388
MaineDOT Environmental Office.
(Augusta)
Final Report

Distribution Interconnection Impact Study

-- POI: Pole 48, 25 Bond Brook Rd., 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 **4.875 MW** of photovoltaic (PV) generation, limited to **4.875 MW** of total export applied by **MaineDOT Environmental Office** to **Circuit 208D1 (12.47 kV)** out of the **Bond Brook Substation**. The proposed Point of Interconnection (POI) will be at **Pole #48** on **25 Bond Brook Rd, 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 (**MaineDOT 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 required to interconnect the project to the distribution system.

2. Project Description

The **4.875 MW** of photovoltaic (PV) generation (the project) will be connected to the existing overhead distribution lines at pole #48 on 25 Bond Brook Rd., Augusta, ME. as shown in Figure 1. The connection will be made to the primary voltage of 12.47 kV via Circuit **208D1** which is served from the **Bond Brook Substation**.



Figure 1. Site plan proposed by the project.

The approximate distance from POI to the nearest three phase line is **0 miles** and approximately **1.272 miles** to the substation.

The total project AC kW output capacity is limited to **4.875 MW** with thirty-nine (39) 125 kW inverters. Two (2) 2,500 kVA wye grounded-wye GSU transformers, along with one (1) 45 kVA dry type grounding transformer are 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:

MaineDOT Environmental Office
24 Child Street
Augusta, ME, 04333
Phone: 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 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 **Bond Brook Substation** Transformer Bank No.1 (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 **208D1**, 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

Time Delay: 30 s

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 **Bond Brook Substation** Transformer Bank No.1 is rated for 10 / 14 MVA and it serves three (3) 12.47 kV circuits, **208D1**, **208D2** and **208D3**. 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.

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 **208D1, 208D2, 208D3, 272D3 (contingency circuit) and 272D4(contingency circuit)** was 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 load conditions on circuits **208D1, 208D2, 208D3, 272D3 and 272D4** Refer to Appendix E for the Bond Brook Substation one-line diagram.

Table 1. Peak Load at Circuits 208D1, 208D2, 208D3, 272D3 and 272D4.

Device	Amps Phase A	Amps Phase B	Amps Phase C	PF (%)
208D1	150.00	145.00	152.00	92.60
208D2	198.00	146.00	154.00	94.90
208D3	218.00	194.00	190.00	99.70
272D3	182.84	185.86	179.06	91.60
272D4	205.19	220.20	235.02	92.80

Table 2. Off-Peak Load at Circuits 208D1, 208D2, 208D3, 272D3 and 272D4.

Device	Amps Phase A	Amps Phase B	Amps Phase C	PF (%)
208D1	22.50	21.75	22.80	92.60
208D2	29.70	21.90	23.10	94.90
208D3	32.70	29.10	28.50	99.70
272D3	27.43	27.88	26.86	91.60
272D4	30.78	33.03	35.26	92.80

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 **208D1** 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.

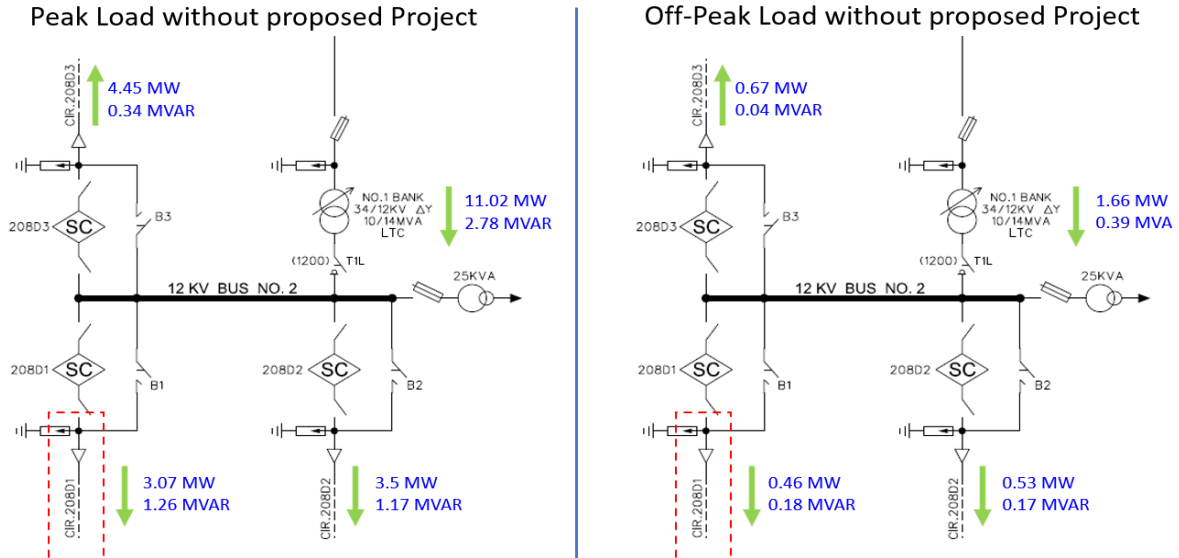


Figure 2. Substation Bank Loading under peak and off-peak conditions without Proposed Project.

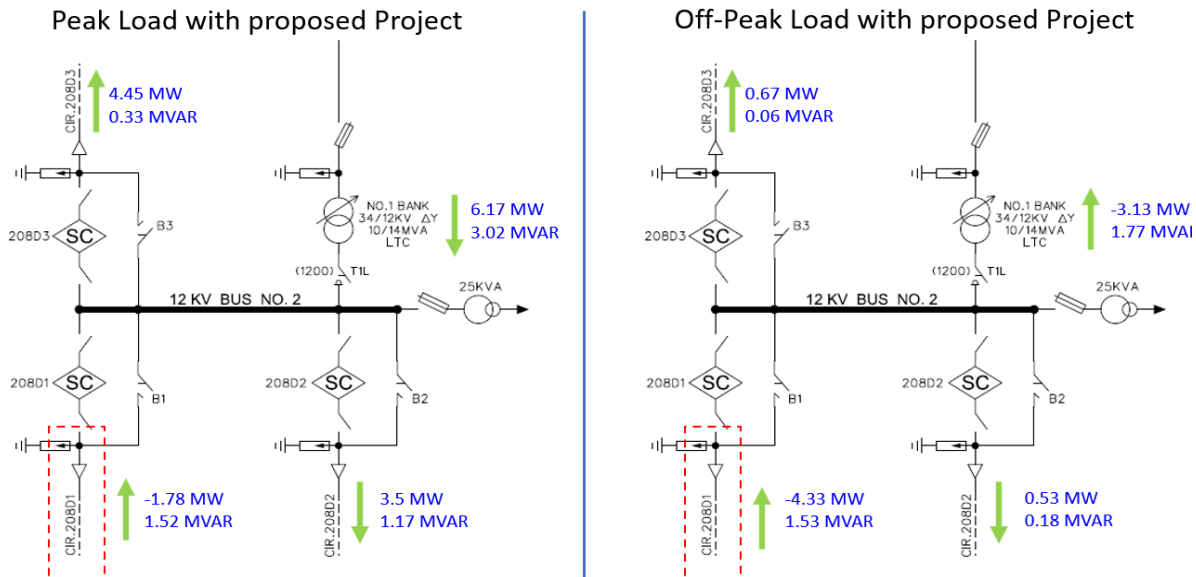


Figure 3. Substation Bank Loading under peak and off-peak conditions with proposed project. The worst-case scenario, maximum project output under off peak load conditions, does not cause the substation transformer rating to be exceeded. However, reverse power flow through the circuit and transformer is observed during off-peak load condition with the proposed project interconnected. Therefore, the LTC reverse power handling capabilities and settings 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 208D1** under all anticipated load conditions, regardless of project operation. Table 3 shows the simulation results for voltage impact on **208D1**.

Table 3. Simulation Results for Voltage Impact on Circuit 208D1 under Peak and Off-peak loads due to proposed project interconnection.

Circuit 208D1 Load	4.875 MW PV (ON/OFF)	Substation Voltage (V)	POI Voltage (V)	V-max (V)	V-min (V)	Threshold (V)
Peak (1.033 pu)	OFF	123.39	122.04	123.79	121.01	117 - 126
Peak (1.033 pu)	ON	123.69	123.57	124.09	122.43	
Off-peak (1.045 pu)	OFF	124.68	124.50	124.73	124.34	
Off-peak (1.045 pu)	ON	124.98	125.99	126.07	124.92	

The study results show over voltage upon interconnection of the proposed project. Multiple methods were attempted to correct the violations, ultimately the mitigation methods listed below resulted in being the most effective.

Mitigation:

- Upgrade the existing fixed 900 kVAR capacitor bank to a switchable capacitor bank with [115 V, 126 V] as control range, Pole #524 on New Oakland Rd. (Civic Center Dr.).

Table 4 shows voltage levels on the circuit **208D1** with mitigation methods considered.

Table 4. Simulation Results for Voltage Impact on Circuit 208D1 under Peak and Off-peak loads due to proposed project interconnection after mitigation.

Circuit 208D1 Load	4.875 MW PV (ON/OFF)	Substation Voltage (V)	POI Voltage (V)	V-max (V)	V-min (V)	Threshold (V)
Peak (1.033 pu)	OFF	123.39	122.04	123.79	121.01	117 - 126
Peak (1.033 pu)	ON	123.69	123.57	123.86	122.43	
Off-peak (1.045 pu)	OFF	124.68	124.50	124.73	124.34	
Off-peak (1.045 pu)	ON	123.76	124.23	124.26	123.56	

The results show overvoltage is resolved with the mitigation methods applied.

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 **4.875 MW** project. The voltage flicker at the POI given a 100% loss of the project must be “< / = 3%”. Similarly, voltage change at the substation LTC must be less than or equal to half the bandwidth “< / = 1.5 V”.

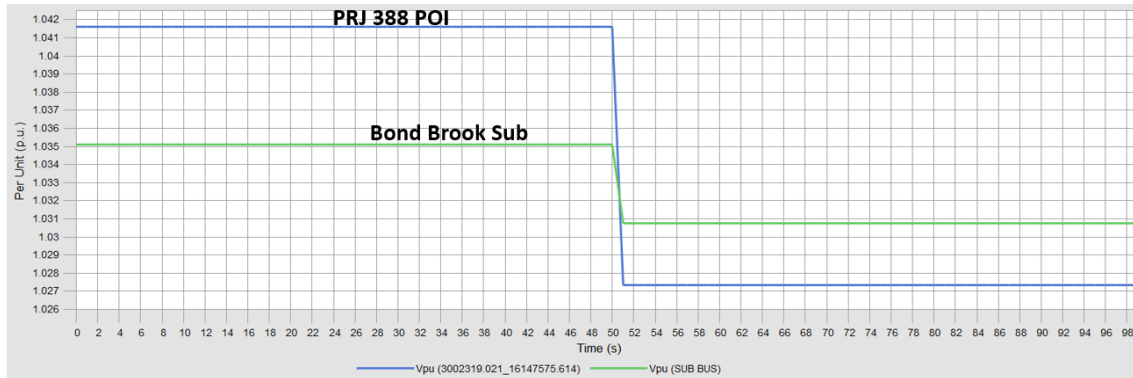


Figure 4. Circuit 208D1 POI and Substation Voltage Change at peak Loads Due to Sudden 100% Loss of the 4.875 MW PV Project.

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

$$\Delta V = 1.0416 - 1.0273 = 0.0143 \text{ p.u.} \Rightarrow 1.43 \% < 3\% \text{ @ POI}$$

$$\Delta V = 1.0351 - 1.0308 = 0.0043 \text{ p.u.} \Rightarrow 0.516 \text{ V} < 1.5 \text{ V @ Substation LTC}$$

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

7.3 Contingency Circuit Analysis

Circuits **272D3** and **272D4** served from the North Augusta Substation Transformer Bank No.1 (12 kV), are the contingency circuits for circuit **208D1**.

Simulation results shows a voltage flicker violation with 3.26% > 3% at POI, during Peak loads, when Circuit **272D3** picks up the load from Circuit **208D1**.

Similarly, simulation results show voltage flicker violation with a voltage flicker of 3.74% > 3% at the POI, during Peak loads when Circuit **272D4** picks up the load from Circuit **208D1**.

Therefore, the proposed project cannot operate when either **272D3** or **272D4** picks up the load from Circuit **208D1** during the contingency conditions.

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 project interconnection.

Below is a summary of the maximum fault levels on the 12.47 kV Distribution System Circuit **208D1**. The difference in percentage before and after the interconnection at the substation is shown in Table 5 and the point-of-interconnection (POI) in Table 6.

Table 5. Summary of Short Circuit Analysis at Substation.

DER Status	LLL (A)	LLG (A)	LL (A)	LG (A)
OFF	4599	7966	3983	6898
ON	4851	8401	4089	7082
Difference	5.48 %	5.46 %	2.66 %	2.67 %

Table 6. Summary of Short Circuit Analysis at POI.

DER Status	LLL (A)	LLG (A)	LL (A)	LG (A)
OFF	2947	3058	2552	3001
ON	3200	3247	2657	3112
Difference	8.59 %	6.18 %	4.11 %	3.69 %

The short circuit study detected no violations for LLL/LLG/LL/LG faults with the interconnection of the proposed project.

Additionally, the DER project does not cause any protective devices on Circuit **208D1** to exceed 87.5% of their short circuit interrupting capabilities. 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 about **1.272 miles** from the Bond Brook Substation. The approximate distance from POI to the nearest three phase line is **0 miles**.

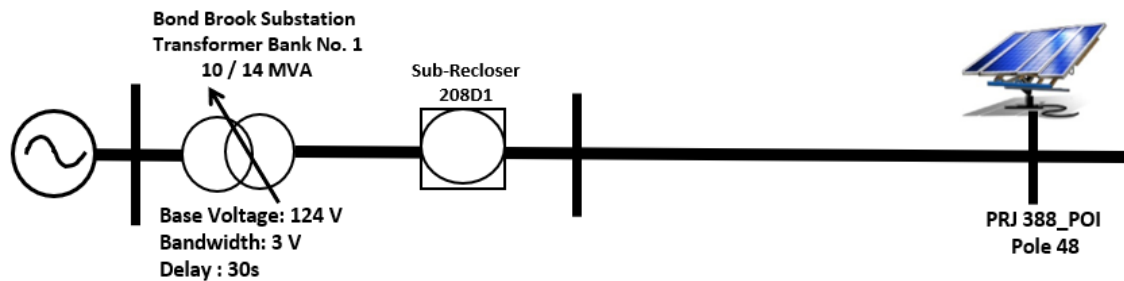


Figure 5. Protection Review from POI to Substation of Circuit 208D1.

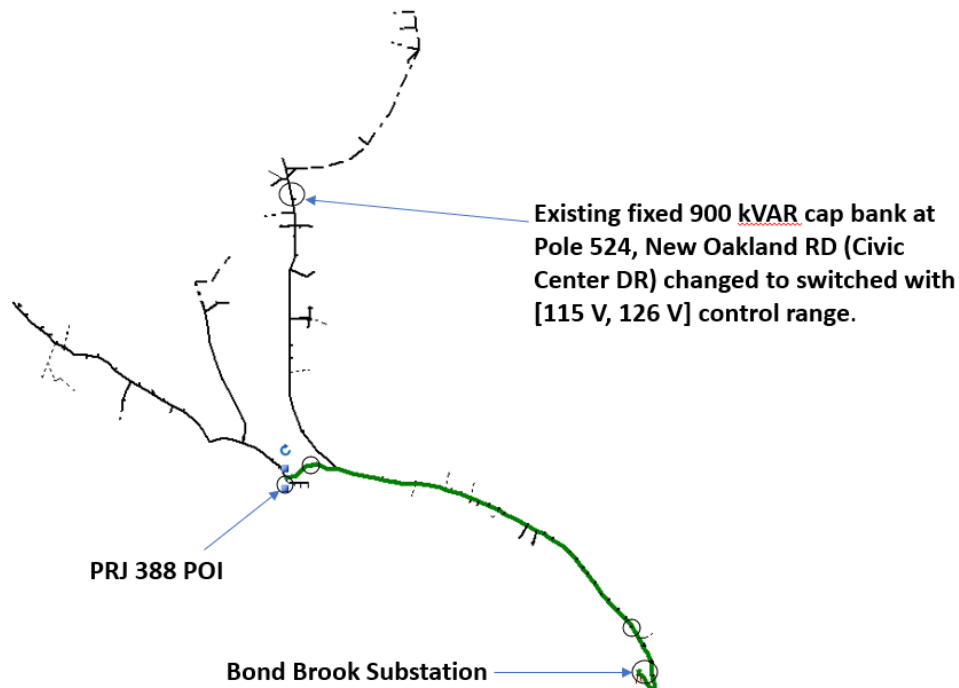


Figure 6. Distribution Circuit 208D1.

A new three-phase line recloser with second harmonic blocking needs to be installed at/near pole #44 on Oakland Road.

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 two (2) 2,500 kVA generating step-up (GSU) transformers are energized. The inrush current is determined as:

$$10 \times \text{FLA} = 10 \times 231.50 \text{ A} = 2,315 \text{ A}$$

Review of the TCC settings for substation recloser **208D1** with SEL351R control shows that the inrush will trip its settings within 6 cycles. Therefore, Circuit **208D1** may have undesirable trips from inrush current due to GSU transformer energization. A settings revision for the substation recloser is required. See TCC curve located in Appendix D, for more details.

9.2 Intertie Relay

Protection Review for the PV GENERATION

MaineDOT Environmental Office has proposed to use a recloser as shown below with a SEL-651R as the intertie relay. 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 MaineDOT Environmental Office will need to coordinate with the new recloser at/near pole #44 on Oakland Road.

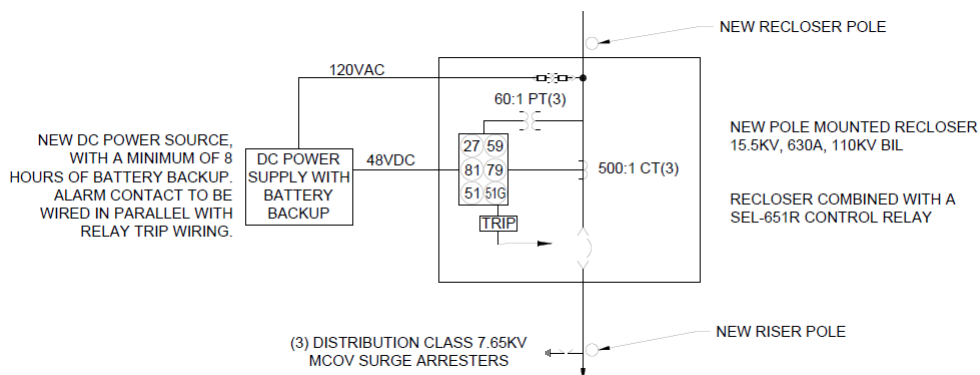


Figure 7. New Pole-mount recloser provided by the customer.

Table 7. Relay Settings.

PROPOSED PROTECTION RELAY SETTINGS						
DEVICE	PICKUP		Time Delay		Total Clearing Time	
	Primary	Secondary				
27-1	50% (3599.8 V)	(60 V)	63 CYC	1.05 SEC	66 CYC	1.1 SEC
27-2	88% (6335.6 V)	(105.6 V)	117 CYC	1.95 SEC	120 CYC	2 SEC
59-1	110% (7919.5 V)	(132 V)	117 CYC	1.95 SEC	120 CYC	2 SEC
59-2	120% (8639.5 V)	(144 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	282 A	0.56 A	SET PER UTILITY STANDARDS			
51G	94 A	0.19 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 120V 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 8. Effective Grounding Values at POI.

Status	R_0/X_1	X_0/X_1	Threshold
w/o project	0.328	0.921	$R_0/X_1 < 1$
w/ project	0.345	0.969	$X_0/X_1 < 3$

The proposed two (2) 2,500 kVA Wye-grounded to Wye, pad mounted GSU transformers, along with one (1) 45 kVA dry type Grounded-Wye to Delta grounding transformer are effectively grounded and will not worsen the grounding conditions, hence, not creating adverse impacts to distribution Circuit **208D1**.

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

- Reverse power observed due to interconnection of the proposed project.
- The LTC reverse power handling capabilities and settings need to be verified.

2. Equipment Loading

- No overloads observed between POI and substation.

3. Voltage Impact

- Over-voltages were detected due to the project interconnection.
 - Mitigation Includes:
 - Upgrade the existing fixed 900 kVAR capacitor bank at Pole #524, New Oakland Rd (Civic Center Dr) to a switchable capacitor bank with [115 V, 126 V] as control range.
- The voltage flicker at the POI and the voltage change at the substation are within the allowable limit during a 100% loss of the project, consider mitigations applied in Section 7.1.

4. Contingency Analysis

- The proposed project cannot operate when either **272D3** or **272D4** picks up the load from Circuit **208D1** during the contingency conditions.

5. Short circuit Analysis
 - Protective devices can interrupt the available short circuit with PV project interconnection.
6. Circuit Protection Coordinate/Protection Review
 - The substation recloser requires a settings revision, **208D1**.
A new three-phase line recloser with second harmonic blocking needs to be installed at/near pole #44 on Oakland Road.
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 \$151,273 +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

- Substation Transformer LTC control for reverse power flow - **\$10,000 TBD**
- Substation recloser settings revision.
 - Additional **\$5,000** for recloser coordination study.
- Install a new three phase line recloser with second order harmonic blocking, at Pole #44 (Oakland Rd (Bond Brook Rd)).
- Upgrade the existing fixed cap bank to a switchable capacitor bank at Pole #524, New Oakland Rd (Civic Center Dr).
 - Settings: [115 V, 126 V] as control range
- SCADA implementation-----cost **TBD**.

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 #48 on 25 Bond Brook Rd, 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:	MaineDOT - Airport - Augusta	Project #:	PRJ 388
Location:	25 Bond Brook Rd	Org Date:	25-May-20
Section:	TBD	Rev Date:	TBD
By:	TBD	Rev by:	TBD
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	2	0	0	\$ 3,000	\$ -	\$ -	\$ 6,000	\$ -	\$ -	25%	7,500	\$ -	\$ -	
15KV - Replace Single Phase	0	0	0	\$ 2,000	\$ 400	\$ 200	\$ -	\$ -	\$ -	25%	\$ -	\$ -	\$ -	
15KV - Replace Three Phase	0	0	0	\$ 3,000	\$ 600	\$ 300	\$ -	\$ -	\$ -	25%	\$ -	\$ -	\$ -	
15KV - Dress for aerial cable	0	0	0	\$ 700	\$ -	\$ 70	\$ -	\$ -	\$ -	25%	\$ -	\$ -	\$ -	
15KV - Pole Set Assist	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	0	0	\$ 125	\$ 25	\$ 13	\$ -	\$ -	\$ -	25%	\$ -	\$ -	\$ -	
15KV - Three Phase Tap	0	0	0	\$ 250	\$ 50	\$ 25	\$ -	\$ -	\$ -	25%	\$ -	\$ -	\$ -	
15KV - Three Phase Mainline	0	0	0	\$ 450	\$ 90	\$ 45	\$ -	\$ -	\$ -	25%	\$ -	\$ -	\$ -	
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	\$ -	\$ -	\$ -	25%	\$ -	\$ -	\$ -	
Major OH Equipment														
15KV - Cutout - Single	0	0	0	\$ 200	\$ 40	\$ 20	\$ -	\$ -	\$ -	25%	\$ -	\$ -	\$ -	
15KV - Cutout - Three	0	0	0	\$ 600	\$ 120	\$ 60	\$ -	\$ -	\$ -	25%	\$ -	\$ -	\$ -	
15KV - Bells - 1p	0	0	0	\$ 150	\$ 30	\$ 15	\$ -	\$ -	\$ -	25%	\$ -	\$ -	\$ -	
15KV - Bells - 3p	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	1	1	0	\$ 17,000	\$ 3,400	\$ 1,700	17,000	3,400	\$ -	25%	21,250	4,250	\$ -	
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	\$ 850	\$ 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	40	0	0	\$ 140	\$ 140	\$ 140	\$ 5,600	\$ -	\$ -	25%	7,000	\$ -	\$ -	
Test Department Labor in Hours	0	0	0	\$ 140	\$ 140	\$ 140	\$ -	\$ -	\$ -	25%	\$ -	\$ -	\$ -	
Subtotal							\$ 64,600	\$ 3,400	\$ -		\$ 80,750	\$ 4,250	\$ -	
Project Engineering							\$ 6,460	\$ 340	\$ -	10%	\$ 8,075	\$ 425	\$ -	
Project/Construction Manager							\$ 3,230	\$ 170	\$ -	5%	\$ 4,038	\$ 213	\$ -	
Administrative Support							\$ 3,230	\$ 170	\$ -	5%	\$ 4,038	\$ 213	\$ -	
Misc Overheads							\$ 19,380	\$ 1,020	\$ -	30%	\$ 24,225	\$ 1,275	\$ -	
Allocations							\$ 3,230	\$ 170	\$ -	5%	\$ 4,038	\$ 213	\$ -	
Total							\$ 100,130	\$ 5,270	\$ -		\$ 125,163	\$ 6,588	\$ -	
							CAP	COR	O&M		CAP	COR	O&M	

Table 9. Planning Cost Estimate.

B. Metering Equipment Cost Estimates

12/19/2019

METERING EQUIPMENT COST ESTIMATE MaineDOT Environmental Office

SJD

Monthly O&M Charge for Metering Equipment

		Serial		Equipment	Installation	Installed
<u>Item</u>	<u>Type</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

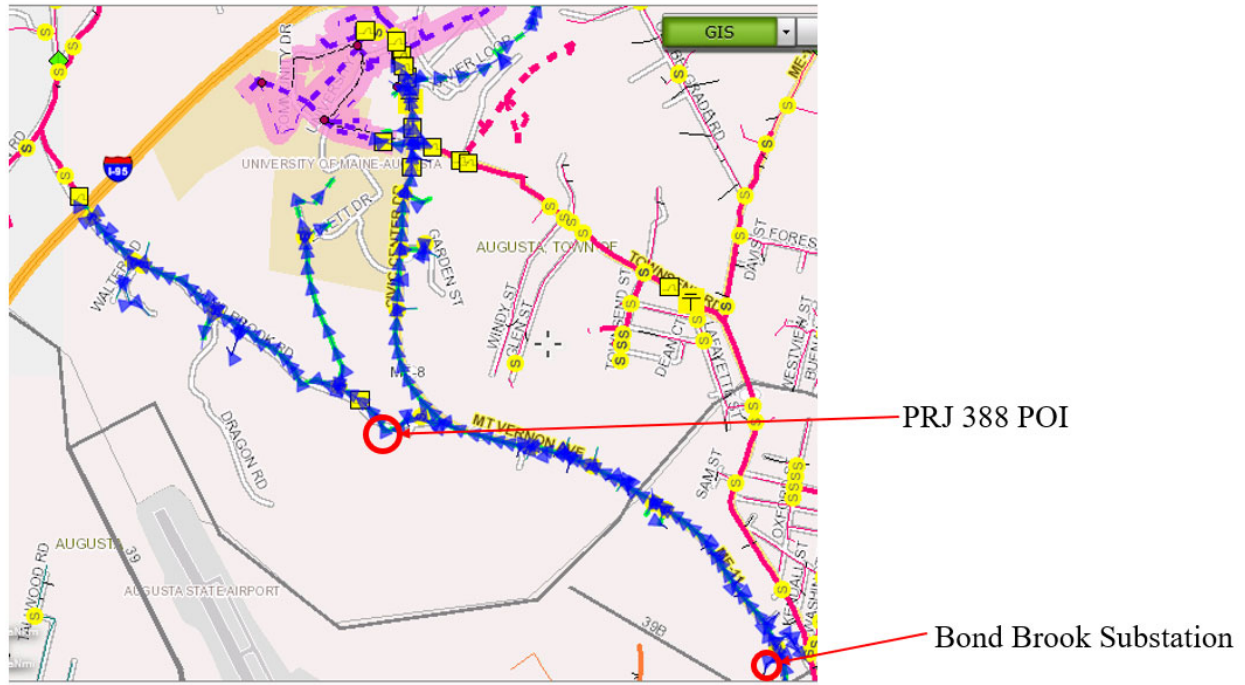


Figure 8. Circuit 208D1 in Smart-Map.

D. TCC Settings

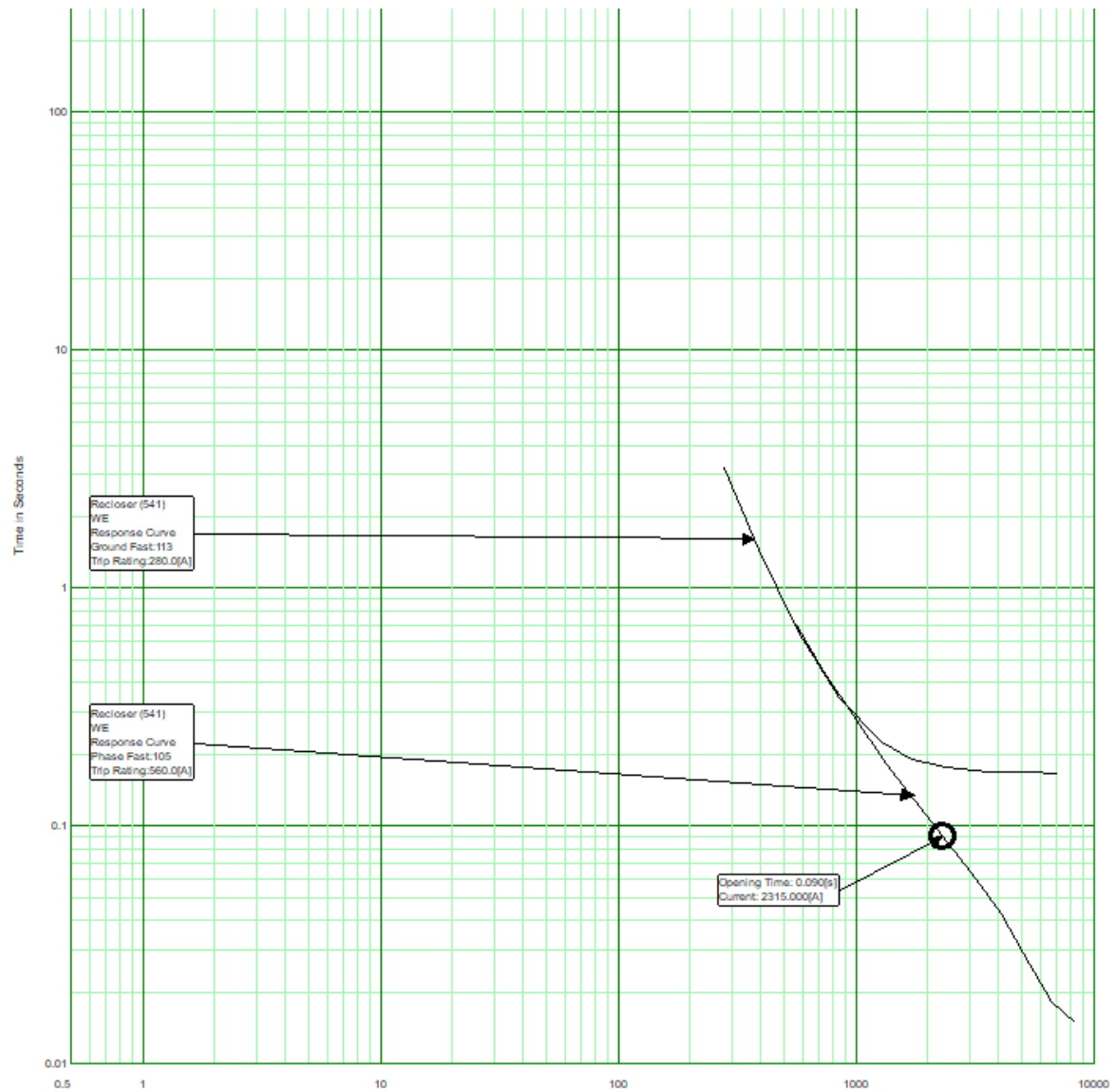


Figure 9. TCC for Substation Recloser 208D1.

E. Bond Brook Substation One-Line Diagram

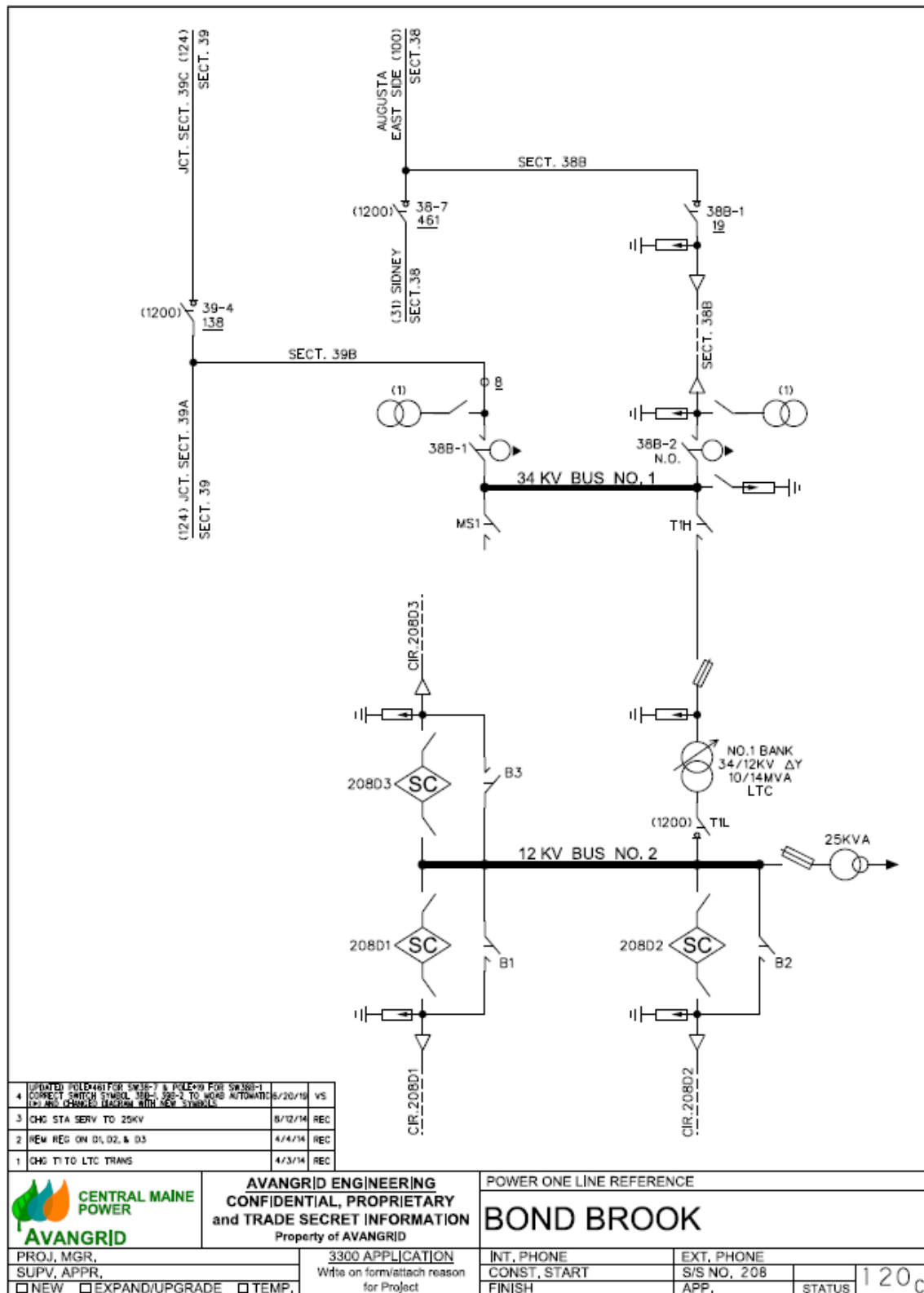


Figure 10. One Line Diagram of Bond Brook Substation.

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): 25 Bond Brook Rd, Augusta, ME 04330
44.330738°, -69.793557° "Augusta Airport 1"
Telephone (Daytime): 207-592-2471
Telephone (Evening): 207-592-2471
Fax Number: _____
E-Mail Address: david.gardner@maine.gov

CMP
(Utility)

3001-216-7190
(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,
X ___ Energy Only, ___ 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: 125 kW (39 Units)

Generator Nameplate kVA: 125 kVA (39 Units)

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

Typical Reactive Load (if known): NONE

Maximum Physical Export Capability Requested: 4,875 kW

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

Equipment Type	Certifying Entity
1. <u>Sungrow SG125HV-20</u>	<u>UL 1741 SA</u>
2. <u>Canadian Solar KuMax CS3U-390MS</u>	<u>UL 1703</u>
3. _____	_____
4. _____	_____
5. _____	_____

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

Yes X No ___

Generator (or solar collector):

Manufacturer, Model Name & Number: Sungrow SG125HV-20

Version Number: TBD

Nameplate Output Power Rating in kW: (Summer) 125 kW (Winter) 125 kW

Nameplate Output Power Rating in kVA: (Summer) 125 kVA (Winter) 125 kVA

Figure 11. Proposed project One Line Diagram.



Figure 11. Proposed project One Line Diagram.