<u>**Exhibit CS-BW-9**</u>

System Impact Study

System Impact Study
For
Bennington Solar, LLC
Russett Drive
Bennington, VT 05201

2,000kW Three-Phase, Inverter Based Photovoltaic Generation Assessed in Combination with the Queued 2,000kW Three-Phase, Inverter Based Photovoltaic Facility know as Apple Hill Solar

Interconnection to Green Mountain Power's 12.47kV System

GREEN MOUNTAIN POWER
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Executive Summary

ControlPoint Technologies (CPT) working with Green Mountain Power (the "Company") has completed the System Impact Study, for the interconnection of the Bennington Solar, LLC and the Apple Hill Solar, LLC, ("Interconnecting Customer" or "IC"), 2 - 2,000kW (AC) PV Facility, ("the Facility"), to its 12.47kV distribution system, ("the Project"), and presents the conclusions of the study herein. The Bennington Solar, LLC portion of the Project is also known as Chelsea Solar. The cost estimates listed in the report are exclusive to the Chelsea Solar project but some system upgrades that are jointly required for the Apple Hill project are discussed. If the Apple Hill project drops from the interconnection queue; the Chelsea Solar project will be responsible for some of the system upgrades currently assigned to the Apple Hill project. Any further design changes made by the Interconnection Customer post IA without the Company's and CPT's knowledge, review, and/or approval will render the findings of this report null and void.

The Facilities will be located off Line 2136, Willow Road, Bennington, VT 05201. The two projects are located on adjacent properties and will both be connecting to the MS50 circuit on Line 2136. Both projects are using similar components. For these reasons, this system impact study will combine the individual and collective impacts to Green Mountain Power's electric power system. This area is served via the Company's 12.47kV distribution circuit, MS50, Line 2136. The MS50 originates from the Mill Street Substation.

The purpose of this study was to:

- Conduct, as applicable, steady-state, stability, short circuit, and extreme contingency analyses and perform assessments of reliability performance of the Company's Electric Power System ("EPS") within the area of interconnection, with and without the proposed Facility, in accordance with applicable reliability standards and study practices, and in compliance with the applicable codes, standards, and guidelines referenced in Vermont Public Service Board's Rule 5.500 to determine the incremental impact and any potential adverse impacts associated with the interconnection of the Facility to the EPS.

- Determine any system modifications required.

- Evaluate the existing distribution protection scheme to ensure that there is no degradation of reliability to Green Mountain Power's customers.

- Provide a report describing the results of the System Impact Study.

The study determined what modifications will be required to be made to the Company's EPS and operating procedures before the Project can proceed to interconnect:

The existing circuit topology does not support interconnection of the facilities. As detailed in this report, utilizing existing GMP facilities from the substation to the initial POI's was determined not to be the best path. Instead, constructing a primary voltage three phase connecting line along Hewitt Drive (Configuration 4 described in Section 3.0) is being pursued. Three phase line extensions will be required for the facilities to interconnect. Starting at the Mill St. substation and working toward the Project, the required EPS modifications include, but are not limited to, the following:

- Three phase conductor upgrades were modeled between MS50_L12_P33 to MS50_LPARK_P42. This was previously identified as a capital budget project by GMP. *This work will be performed at GMP's cost.*
- Reconductoring 810' from Line Park Pole 47 to Pole 56 will be required. This will be the Project's cost responsibility.
- A three-phase line extension will be required to connect the PV Facilities. Approximately 1,900 feet of 3-phase 477 AL was modeled from pole MS50_LPARK_P62 to Willow Road, pole MS50_L2136_P21 via Hewitt Dr. The 1/0 AL modeled for the Apple Hill Interconnection is insufficient for the combined project outputs. The cost of increased conductor size will be the Project's cost responsibility.
- A three phase line extension of approximately 3,000 feet will be required from the Apple Hill POI to the Bennington Solar PCC. This will be the Project's cost responsibility.
- At the Point Of Interconnection, one recloser, one set of disconnect switches and one primary metering rack will be required. This will be the Project's cost responsibility.

If the recommended line modifications are made, the project should not have a negative impact on system voltage, under normal operating conditions and rapid cloud movement. For the most extreme case, the maximum voltage change for the facility's on/off switching is 3.83% which is above the Green Mountain Power threshold of 2.57%. This is with the inverters modeled at lagging 99% power factor (sourcing reactive power). It is believed that a leading or unity inverter power factor setting might help to mitigate the magnitude of voltage changes due to rapid cloud movement should they become a source of power quality issues. Per the Advanced Energy AE 500NX Unser Manual, the inverters have a real power output rating of 500 kW and an apparent power output rating of 526 kVA. As such, there should be no de-rating of the real power output necessary when operating at 99% power factor leading (absorbing reactive power).

The study indicates that the proposed design is effectively grounded when connected to the area EPS. The simulations run did not indicate excessive over-voltages during line-to-ground faults. The study indicates that the project does not create any thermal issues to the area EPS.

If an event occurs with a recorded over-voltage at the PCC exceeding limitations and/or any reported damage of customer equipment, The Company reserves the right to disconnect the Project from the EPS. The developer will be responsible for all associated claims and for mitigation to prevent re-occurrence. In this instance, The Company could require a Direct Transfer Trip (DTT) scheme from all upstream feeder sectionalizing devices to the PCC recloser.

It should also be noted that it may not be possible for the Company to keep the Project connected during all feeder backup scenarios. Reasonable attempts shall be made to keep the Project on during feeder backup.

The following documents and references pertain to this project:

- Vermont Public Service Board Rule 5.500
- IEEE 1547 – 2003 --IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems
- IEEE 1547.3 --IEEE Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected to Power Systems
- IEEE 1453-2004 --IEEE Recommended Practice for Measurement and Limits of Voltage Fluctuations and Associated Light Flicker on AC Power Systems
- ANSI C 84.1-2006 American National Standard for Power Systems and Equipment Voltage Ratings (60 Hz)
- IEEE Standard C37.90.1-2002 Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

1.0 Introduction

Apple Hill Solar, LLC and Bennington Solar, LLC have requested a Distributed Generation interconnection for two (2) - 2,000kW Photovoltaic System to a distribution feeder in the Company's EPS. The Interconnection Customer's proposed In-Service date for the Apple Hill Solar, LLC Project, included in the Interconnection Application dated May 24, 2013, is June 30, 2014, but, this date is not binding. The Interconnection Customer's proposed In-Service date for the Bennington Solar, LLC Project, included in the Interconnection Application dated May 24, 2013, is June 30, 2014, but, this date is not binding.

In accordance with the P.S.B. Rule 5.500, the Company has completed a System Impact Study to determine the scope of the required modifications to its EPS and/or the Facility for providing the requested interconnection service. The two facilities under review are located on adjacent properties and connect on a common branch of the area EPS. For these reasons the first project in the queue, Apple Hill, is mentioned frequently throughout the report. Analysis of Chelsea Solar was completed with the assumption the Apple Hill Solar facility was interconnected.

1.1 Study Objective

The primary objectives of this Impact Study are to:

1. Identify the System Modifications necessary for the Project to reliably interconnect to the Company's system;

2. Identify deficiencies in the proposed Facility;

3. Identify operating restrictions;

2.0 Project Description

2.1 Facility – Apple Hill Solar, LLC/Bennington Solar, LLC

Each facility consists of a 2,000kW PV generating site as depicted in the Interconnecting Customer's Site Diagram and One Line Diagram. The Apple Hill Solar Project, as originally proposed, is shown in Figures 1 & 2. The Bennington Solar Project, as originally proposed, is shown in Figures 3 & 4. As mentioned in the Exectutive Summary, a new three phase distribution line along Hewitt Drive is required for the interconnection of either or both project(s).

The design of the two facilities is identical beyond the PCC. Each of the three-phase 2,000kW generating systems consists of the following:

There are four (4) Advanced Energy NX500-HE, 500kW, 480V PV inverters. The outputs of the four inverters run through 1,000A breakers in a switchboard where they are ganged together on a 480V bus. The bus connects through a 3,500A breaker, to the low voltage side of a 2,000kVA transformer.

There is one (1) 2,000kVA Generator Step-Up (GSU) transformer. The transformer is a 3-phase, 480VYg - 12.47kVYg, 2,000kVA padmounted step-up transformer with 5.75% assumed impedance.

The high-side of the transformer connects to a 3-phase 900A generator disconnect switch and utility meter.

There will be a GMP owned PCC recloser for each project's point of interconnection. Adequate protection could be provided by a single recloser for the combined projects and GMP recommended grouping of facilities to minimize costs as permitted by PSB Rule 5.507(G)(6). The Customer has requested individual reclosers for each facility to maintain separation.

2.2 Service Configuration

The proposed location of the Facility is normally served by Green Mountain Power's 7.2/12.47V wye-grounded distribution line MS50 from the Mill Street Substation. Based on the Project design at the time the study was performed, the Interconnection Facilities to be paid for by the Customer but owned and maintained by the Company consist of:

- One PCC Recloser and a set of disconnect switches per project.
- One Primary Metering Assembly per project.
- A 3-phase "connecting line" line extension along Hewitt Drive from Line Park Pole 63 to Line 2136 Pole 19. The POI for the Apple Hill project is approximately MS50_L2136_P21 on Willow Road and the POI for Chelsea Solar is approximately MS50_L2136_P27.
- The 3-phase overhead line extension to be continued off of Line 2136 Pole 21 to the Chelsea PCC is exclusive to the Chelsea Solar Project.

In addition, the following will be required:

- A 3-phase underground "line extension" *to be paid for and owned by the Customer* from the end of the GMP owned 3-phase overhead described above to the Chelsea Solar facilities.

An interconnection one line is shown in Figure 5 for Apple Hill Solar, LLC. An interconnection one is line shown in Figure 6 for Bennington Solar, LLC.

2.3 Mill Street Substation

The Mill Street Distribution Substation is fed from a 6.83 mile radial tap off the 46 kV line circuit originating from Woodford Road Substation. This radial tap also feeds Lyons Street Substation, Silk Road Substation and N. Bennington Substation. A feeder back-up case will be considered for the Lyons Street Substation. The Mill Street Substation One-Line Diagram is shown in Figure 7.

The 46 kV transmission circuit is connected through switch #324 at Mill Street Substation. Switch #324 feeds a set of 200 Amp fuses that provide high-side transformer protection. The fuses connect to a single 10/12.5 MVA, 43.8 kV Δ – 12.47Y/7.2 kV station transformer. The transformer no-load-tap changer is set to the tap #1, the 46.2 kV tap. The transformer impedance is 6.6%.

The station transformer supplies a 12.47 kV bus with two distribution circuits, the MS50, and the MS51. Each of these circuits is protected by SEL-351S relays controlling the trip functions of the circuit breakers. The relays provide circuit reclosing control, phase sequence protection, overcurrent and ground overcurrent detection.

A second radial 46 kV line feeds the S. Bennington Substation. A circuit from the S. Bennington Substation will also be considered for feeder backup.

2.4 Area EPS

The proposed location of the Facility is normally served by Green Mountain Power's 7.2/12.47kV three-phase, 4 wire, multigrounded wye, effectively-grounded MS50 radial circuit from the Mill Street Distribution Substation, refer to Figure 8, MS50 One Line. The system is proposed to stay online during emergency situations when the MS50 feeder and the MS51 feeder are being fed via the same voltage regulator off of the Mill Street Substation Bus. As shown in Figure 7, there is a circuit tie outside the Mill Street Substation for feeder backup of each circuit. The MS50 and MS51 circuit characteristics are as follows:

- 12.47kV nominal, multi-grounded wye, effectively-grounded, regulated via voltage regulators at Mill Street Substation. There are no line regulators installed on any of the circuits under study. The existing regulator controls are being replaced due to issues not associated with the Project and will be capable of operating during reverse power flow conditions. The station regulators settings are shown in Table 1. The MS50 Regulators are highlighted in yellow.

Device Number	*Phase*	*Bandwidth (V)*	*CT Ratio*	*V Float*	*R*	*X*	*Delay (sec)*
MS50 Station Regs	**ABC**	**± 1.5 Volts**	**400**	**120**	**5**	**5**	**30**
MS51 Station Regs	ABC	± 1.5 Volts	400	120	5	5	30
LS61 Station Regs	ABC	± 1.5 Volts	400	120	4	4	30
SN40 Station Regs	ABC	± 1.5 Volts	400	122	4	4	30

Table 1: MS50 Voltage Regulators

- The loading of the Mill Street Substation has fluctuated between 2,264 and 7,118 kVA at the expected time of maximum generation over the past year. Substation load data was provided from January 1, 2012 to September 3, 2013. Loading on the MS50 circuit was modeled as 55% of the Mill Street Substation load.
- The MS50 has 23.7 kW of generation interconnected or in process at this time. This generation is not modeled.
- The MS51 has 0 kW of generation interconnected or in process at this time.
- The MS50 and MS51 have a tie (L-1 P-1) outside the Mill St. Substation.
- The location of the Apple Hill Project is 3.66 circuit miles from the Mill Street Substation. To utilize existing construction would require phase upgrades for 8,500 feet of overhead distribution line. This figure includes 6,600 feet of common circuit path to serve each Facility. As detailed in this report, utilizing existing GMP facilities from the substation to the initial POI's was determined not to be the best path. Instead, constructing a primary voltage three phase connecting line along Hewitt Drive is being pursued.
- The location of the Bennington Solar Project is 4.18 circuit miles from the Mill Street Substation. To utilize existing construction to the Bennington Solar Project would require phase upgrades for an additional 4,600 feet of overhead and underground distribution line. This 4,600 feet in is in addition to the construction required to reach the Apple Hill Facility. As detailed in this report, utilizing existing GMP

facilities from the substation to the initial POI's was determined not to be the best path. Instead, constructing a primary voltage three phase connecting line along Hewitt Drive is being pursued.

- The existing circuit paths from each Facility's originally proposed POIs intersect at Line 213 Pole 21. As detailed in this report, utilizing existing GMP facilities from the substation to the initial POI's was determined not to be the best path. Instead, constructing a primary voltage three phase connecting line along Hewitt Drive is being pursued.

- The MS50 and MS51 circuits are part of the Bennington Self-Healing Network.

- An S&C Intelliruptor Switch is installed at MS50_L1222_P1. This switch will isolate the downstream sections of the MS50 circuits during fault conditions. If the fault is upstream of this switch, the switch will open to allow for restoration with the LS61 tie.

- Automated tie at LS-MS_Tie_LPark_P41X with Lyons Street Substation LS61 Circuit will transfer the proposed Facilities onto the LS61.

- Lyons Street Substation is supplied by the same radial 46 kV transmission tap as Mill Street Substation. The transmission line originates from the Woodford 115 kV/46 kV Substation.

- Automated tie at SN-MS_Tie_L11_P16 with S. Bennington Substation SN40 Circuit will transfer the proposed facility onto the SN40. As described later in this report, that is not acceptable. For this reason, the Self Healing system will have to be modified to prevent this transfer.

- S. Bennington Substation is supplied by a different radial transmission tap from the Woodford 115 kV/46 kV Substation.

- There are two (2) total circuit capacitor banks on the two feeders totaling 1,350kVAR; one (1) on the MS51 totaling 450kVAR; two (2) on the MS50 totaling 900kVAR

Location	Size (kVAR)	Control
MS50_L1222_P12-1	450	Fixed (3φ)
MS50_L1_P22-1	450	Fixed (3φ)

MS51_LWashington_P3-1	450	Fixed (3φ)

Table 2: MS50, MS51 Circuit Capacitors

2.5 Monitoring Provisions

Per IEEE section 4.1.6 Monitoring Provisions, each Distributed Resource (DR) unit of 250kVA or more or DR aggregate of 250kVA or more at a single PCC shall have provisions for monitoring its connection status, real power output, reactive power output, and voltage at the point of DR connection. The project plans to install 2,000kW of PV generation, therefore monitoring provisions would be required. The Company intends to meet this requirement through bi-directional metering installed at the Point of Common Coupling (PCC).

In addition, the project will be responsible to pay for the material costs and on-going service fees for a wireless cell connection to provide engineering access and metering communications for the site. The Customer is responsible to provide a SIM card provisioned the Company APN following instructions provided by The Company. The Company includes the initial material and set-up costs in the interconnection estimate and specifies and orders all required equipment excluding the SIM card.

3.0 Power Flow Analysis

The power flow analysis was substantially performed using CYMDIST. The model of the MS50 and MS51 circuits was developed using data provided by GMP.

The analysis considered cases at peak load (4,349kVA @ 97.8% PF lagging) and minimum load (1,815kVA @ 97.71% PF leading) at time of maximum expected generation 2,000kW, (10:00 PM – 3:00 PM) on the Mill Street Substation bus. Each case was analyzed with any previously approved DG resource on and at unity power. The SCADA data available was for the Mill Street Substation load. The load split between the circuits was based on connected kVA. The existing and projected maximum daytime loads are shown in Tables 3 and 4 below. The existing and projected minimum daytime loads are shown in Tables 5 and 6 below.

Maximum Load without Proposed Generation				
Circuit Element	Data Source	MVA	MW	MVAR
Mill Street Station	SCADA	7.12	7.0	1.0
MS50	Derived	3.9	3.9	0.6

MS51	Derived	2.0	3.1	0.4

Table 3: Maximum Load w/o Generation

Projected Maximum Load with Proposed Generation				
Circuit Element	Data Source	MVA	MW	MVAR
Mill Street Station	SCADA	3.2	3.0	1.0
MS50	Derived	0.6	-0.1	.6
MS51	Derived	2.0	3.1	0.4

Table 4: Maximum Load with Generation

Minimum Load without Proposed Generation				
Circuit Element	Data Source	MVA	MW	MVAR
Mill Street Station	SCADA	2.3	2.2	-0.3
MS50	Derived	1.2	1.2	-0.2
MS51	Derived	1.0	1.0	-0.1

Table 5: Minimum Load w/o Generation

Projected Minimum Load with Proposed Generation[1]				
Circuit Element	Data Source	MVA	MW	MVAR
Mill Street Station	SCADA	1.56	-1.8	-0.3
MS50	Derived	-2.8	-2.8	-0.2
MS51	Derived	1.0	1.0	-0.1

Table 6: Minimum Load with Generation

The analysis considered cases at minimum and peak load on the distribution line MS50 at the time of expected maximum generation. The generator status and generator power factor were varied as listed in Table 7. The generator under study refers to the Apple Hill/Bennington Solar status. Except where noted, the combined effect of the 2 – 2,000 kW generating systems was studied. The study considered feeder backup cases consistent with existing operating practices. The feeder backup cases were:

1. MS51 on MS50 – Manual Tie outside Mill Street Substation. The circuit topology suggests equivalent results for the MS50 on the MS51 case.
2. Bennington Self-Healing Network (SNH), MS50-LS61: Open MS50_L1222_P1 and Close LS-MS_Tie_LPark)P41X.
3. Bennington SHN, MS50-SN40: Open MS50 breaker and Close SN-MS_Tie_L11_P16.

The following Load Flow Studies were performed on the Mill Street Distribution circuit MS50:

Feeder	Small Distributed PV	Feeder Load	Feeder Power Factor	Generator Under-Study Status	Generator Power Factor
MS50	ON	MAX\MIN	98.9%\99.2%	Off	NA
MS50	ON	MAX\MIN	98.9%\99.2%	On	100%
MS50	ON	MAX\MIN	98.9%\99.2%	On	99% (Leading)
MS50	ON	MAX\MIN	98.9%\99.2%	On	99% (Lagging)
MS51 on MS50	ON	MAX\MIN	98.9%\99.2%	Off	NA
MS51 on MS50	ON	MAX\MIN	98.9%\99.2%	On	100%
MS51 on MS50	ON	MAX\MIN	98.9%\99.2%	On	99% (Leading)
MS51 on MS50	ON	MAX\MIN	98.9%\99.2%	On	99% (Lagging)
MS50-SHN[1] with LS61	ON	MAX\MIN	98.9%\99.2%	Off	NA
MS50-SHN with LS61	ON	MAX\MIN	98.9%\99.2%	On	100%
MS50-SHN with LS61	ON	MAX\MIN	98.9%\99.2%	On	99% (Leading)
MS50-SHN with LS61	ON	MAX\MIN	98.9%\99.2%	On	99% (Lagging)
MS50-SHN with SN40	ON	MAX\MIN	98.9%\99.2%	Off	NA
MS50-SHN with SN40	ON	MAX\MIN	98.9%\99.2%	On	100%
MS50-SHN with SN40	ON	MAX\MIN	98.9%\99.2%	On	99% (Leading)
MS50-SHN with SN40	ON	MAX\MIN	98.9%\99.2%	On	99% (Lagging)

Table 7: Load Flow Cases

These load flow cases were considered for four (4) circuit configurations. One goal of this analysis was to screen the existing circuit construction and potential service options to identify a circuit configuration that maintains adequate service voltage levels and that does not present objectionable voltage flicker to GMP's other customers. The configurations studied were:

1. The existing circuit topology was modified to provide three-phase service to the proposed Projects. Following the existing electrical path to the proposed POI's, a

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[1] Refers to Bennington Self-Healing Network (SNH)

1/0 conductor was used in the model to extend the three-phase mainline. Existing conductor sizes were not upgrades. A section of three-phase mainline between MS50_LPark_P56 and MS50_LPark_P47 was modeled as 3-1/C-477. A simplified one-line diagram of the MS50 is shown in Figure 9. For the purposes of this study, this was considered as the base case.
2. The second configuration incorporated previously approved/budgeted phase and conductor upgrades. Conductor replacements on Park St. and East Rd were modeled using 3-1/C-477 Aluminum and 3-1/C-4/0 Copper Conductors. Phase upgrades on Willow Rd. and Russet Drive were 3-1/C-1/0 Aluminum.
3. A third configuration was modeled using an express overbuild circuit to connect the Projects.
4. The fourth configuration studied included modeling the budgeted conductor replacements. A new pole line of approximate 1,900 feet would be installed on Hewitt Rd. to shorten the electrical distance to the Projects. This configuration would extend the three-phase mainline to the Bennington Project along the path to Apple Hill. Figure 10 is shows a simplified one-line for this configuration.
5. A fifth and chosen configuration is detailed in Appendix C and studies configuration #4 using 336 ACSR in place of 477 ACSR.

Steady state analysis was run on the model for **Configuration #1**. A simulation was run for peak and minimum load conditions for the MS50 and the three feeder back-up scenarios. The Projects were modeled as either both on or both off. The Bennington Solar PCC is detailed in the report. This project is an additional 2,600 circuit feet from the Mill Street Substation. The additional line distance tends to increase the voltage variations observed in the study. The conclusions drawn from the results at Bennington Solar would not change if the Apple Hill PCC data was documented.

When the Facility is connected to the MS50 circuit, the steady state analysis indicates that the facility does create out-of-limit voltage conditions during normal circuit operation. The study considered the case of the Facility's steady state transition before voltage regulation controls compensate for the change in circuit conditions. The Company requires that for a full loss of the Projects' rated output, the resultant change in voltage shall be less than 2.6%. The requirement is further described to limit voltage changes to 1.8% for PV system output changes of 70%. Tables 8 – 9, detail the results of this analysis for normal operation of the Facility and the MS50 Circuit during maximum and minimum loading conditions. The maximum change in voltage at the PCC was 8.75%. This was with the inverters modeled with a +0.99 pf (exporting VARs to the utility). The inverters specified for this Project are AE 500NX-HE which purports to have the capability to run at a power factor between +0.95 and -0.95. When modeled at unity pf, output, the maximum voltage change was 7.25% which is well in excess of the 2.6% voltage change limit described above. When modeled at -0.99 pf (absorbing VARs from the utility) the maximum voltage change was 5.5% which is also unacceptable. The analysis also indicates that the voltage at the PCC will exceed ANSI-A limits.

The feeder back-up condition of the MS51 on the MS50 circuit was considered. The results of this analysis are shown in Table 10 for peak load conditions and Table 11 for minimum load conditions. The results indicate that the Project is likely to create unacceptable voltage conditions during this feeder back-up condition.

The MS50 circuit is a part of the Bennington Self-Healing Network. There were two automated switching sequences analyzed for project impact. The automated sequences would place the Project automatically onto either the LS61 circuit or the SN40 circuit.

The recloser at MS50_L1222_P1 was opened and the recloser at LS-MS_TIE_LPARK_P41X was closed. This placed the portion of the MS50 circuit connecting the Projects onto the LS61. The results of this analysis are shown in Tables 12 and 13. If the Self-Healing Network is not modified, the transferring of the Projects onto the LS61 circuit will likely result in unacceptable voltage conditions. During peak conditions the minimal voltage change is expected to be 4.5%. Unless the Project is run at a leading power factor, excessive voltages can result at the PCC.

The tie with the SN40 circuit was also analyzed. The study considered the case for the MS50 breaker open and the recloser at SN-MS_TIE_L11_P16 closed. This transfers the entire MS50 load onto the SN40 circuit. The results indicate that this contingency does not maintain adequate voltages near the proposed projects during peak conditions. With the addition of the Projects’ capacity, the voltage fluctuations and levels are unacceptable. The results of this analysis are detailed in Tables 14 and 15.

Configuration #1 - MS50																
	Max Load 3.91 MVA @ 98.9% PF lagging															
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							Mill St. Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	OFF	OFF	0.977	0.995	1.003	-	-	-	-	1.017	1.010	1.008	572	3872	99%
	NA	-3972	201	1.049	1.066	1.073	100%	7.25%	7.08%	7.00%	1.023	1.016	1.013	823	30	4%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3936	-371	1.064	1.080	1.088	99%	8.75%	8.50%	8.42%	1.030	1.022	1.019	240	57	23%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3933	775	1.032	1.048	1.057	-99%	5.50%	5.33%	5.33%	1.016	1.008	1.005	1444	85	6%

Table 8: Max Loading, MS50 only

Configuration #1 - MS50																
	Min Load 1.26 MVA @ 99.2% PF leading															
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							Mill St. Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	OFF	OFF	0.98	0.99	0.99	95%	-	-	-	0.996	0.995	0.993	-159	1250	99%
	NA	-3974	203	1.0500	1.0567	1.0600	100%	6.83%	6.67%	6.75%	0.998	0.997	0.994	219	-2510	-100%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3935	-369	1.064	1.072	1.074	99%	8.3%	8%	8%	1.003	1.003	1.000	-377	-2480	-99%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3933	777	1.033	1.041	1.043	-99%	5.17%	5.08%	5.08%	0.991	0.990	0.988	819	-2457	-95%

Table 9: Min Loading, MS50 only

Configuration #1 - MS51 ON MS50

	Max Load 7.11 MVA @ 99 % PF lagging															
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							Mill St. Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	OFF	OFF	0.996	1.013	1.016	-	-	-	-	1.036	1.028	1.020	999	7037	99%
	NA	-3975	195	1.068	1.083	1.085	100%	7.17%	7.00%	6.92%	1.042	1.034	1.025	1251	3190	93%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3936	-377	1.083	1.098	1.099	99%	8.75%	8.50%	8.33%	1.049	1.041	1.032	646	3219	98%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3934	769	1.051	1.067	1.069	-99%	5.50%	5.33%	5.33%	1.035	1.027	1.018	1863	3245	87%

Table 10: Max Loading w/MS51

Configuration #1 - MS51 ON MS50

	Min Load 2.26 MVA @ 99.2 % PF lagging															
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							Mill St. Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	OFF	OFF	0.99	1.00	1.00	95%	-	-	-	1.002	1.001	0.999	-293	2244	99%
	NA	-3974	201	1.0558	1.0633	1.0658	100%	6.75%	6.67%	6.67%	1.003	1.003	1.001	73	-1518	-100%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3935	-371	1.071	1.078	1.080	99%	8.3%	8%	8%	1.010	1.009	1.007	-529	-1488	-94%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3933	775	1.040	1.047	1.050	-99%	5.17%	5.00%	5.08%	0.997	0.997	0.994	679	-1465	-91%

Table 11: Min Loading w/MS51

Configuration #1 - MS50_L1222_P1 On LS61															
	Max Load 4.15 MVA @ 98.9% PF lagging														
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							Lyons St. Sub - Load Side of Regulators				
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	**OFF**	**OFF**	0.966	0.995	0.993	-	-	-	-	1.010	1.011	1.005	652	3901	99%
	NA	-3973	208	-3973	**1.056**	**1.054**	100%	**6.08%**	**6.08%**	**6.08%**	1.013	1.013	1.007	858	20	2%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3934	-365	-3934	**1.070**	**1.068**	99%	**7.58%**	**7.50%**	**7.42%**	1.018	1.018	1.012	265	49	18%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3932	782	-3932	1.040	1.038	-99%	**4.50%**	**4.50%**	**4.50%**	1.007	1.008	1.001	1460	76	5%

Table 12: Max Loading – SHN LS61

Configuration #1 - MS50_L1222_P1 On LS61															
	Min Load 2.44 MVA @ 99.2% PF leading														
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							Lyons St. Sub - Load Side of Regulators				
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	**OFF**	**OFF**	0.99	0.99	1.00	95%	-	-	-	1.003	0.996	0.999	-297	2418	99%
	NA	-3974	207	1.0450	1.0483	**1.0533**	100%	**5.83%**	**5.83%**	**5.75%**	1.003	0.997	0.999	10	-1400	-100%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3935	-366	**1.059**	**1.062**	**1.068**	99%	**7.2%**	**7%**	**7%**	1.008	1.002	1.004	-576	-1368	-92%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3932	780	1.030	1.033	1.038	-99%	**4.33%**	**4.25%**	**4.25%**	0.998	0.991	0.994	602	-1349	-91%

Table 13: Min Loading – SHN LS61

Configuration #1 - MS50 at SN-MS_Tie_L11_P16 On SN40

	Max Load 9.02 MVA @ 98% PF lagging															
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							S. Bennington Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	OFF	OFF	0.865	1.012	1.014	-	-	-	-	1.000	1.043	1.041	1785	8842	98%
	NA	-3974	196	0.990	1.121	1.121	100%	12.50%	10.92%	10.67%	1.028	1.064	1.059	1545	4817	95%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3936	-379	1.020	1.147	1.145	99%	15.50%	13.50%	13.08%	1.042	1.077	1.072	867	4835	98%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3932	775	0.954	1.092	1.092	-99%	8.92%	8.00%	7.75%	1.014	1.051	1.047	2255	4893	91%

Table 14: Max Loading SHN SN40

Configuration #1 - MS50 at SN-MS_Tie_L11_P16 On SN40

	Min Load 4.18 MVA @ 99.9 % PF leading															
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							S. Bennington Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	OFF	OFF	0.99	1.01	1.02	95%	-	-	-	1.022	1.025	1.022	-153	4184	99.9%
	NA	-3976	189	1.076	1.101	1.112	100%	9.08%	8.83%	8.83%	1.029	1.032	1.027	63	389	99%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3934	-385	1.100	1.125	1.134	99%	11.5%	11%	11%	1.039	1.043	1.038	-587	419	58%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3934	765	1.048	1.073	1.085	-99%	6.33%	6.08%	6.17%	1.018	1.020	1.016	728	448	52%

Table 15: Minimum Loading - SHN SN40

3.1 Load Flow Analysis – Alternate Configurations

Additional circuit configurations were listed in the previous section. The same analysis was applied to each of the configurations listed.

CONFIGURATION #2 – This configuration proposed using a thermally oversized conductor for required conductor replacements and upgrades. This provides a lower impedance path to the Projects interconnection. The conductor upgrades did have a positive effect on the voltage fluctuations and levels. During peak conditions, the maximum voltage change measured was 6.75%. The maximum voltage level recorded was 127 volts which exceeds the ANSI limits. The results did not differ significantly from the base case. Details of this analysis are not presented and can be provided upon request.

CONFIGURATION #3 - This configuration assumed a dedicated circuit to serve the Projects. The proposed circuit conductors would be overbuilt on the existing pole line. The initial assumption was that 1/0 conductors be installed to serve the Projects. The analysis showed that for 1/0 conductors the voltage fluctuations and levels exceeded GMP's requirements. When the analysis was run with larger conductors, these requirements could be met.

The merits of this configuration are few. Voltage conditions on a dedicated circuit will not affect other GMP customers. As a design consideration, this could allow the developer to utilize a 1/0 conductor to minimize construction costs. A 1/0 conductor is GMP's smallest standard conductor that can thermally carry the Project's output.

There would be substantial make-ready costs for an overbuilt circuit on the existing pole line. An overhead line of 3-1/C-336 conductors will provide adequate service voltages but will also increase the construction costs considerably.

The layout of the Mill Street Substation makes the addition of a third circuit problematic. The 12.47kV distribution equipment, at Mill Street Substation, consists of an enclosed bus and metal-clad breakers and regulators. Expanding this bus to include a third circuit will require significant site work, permitting, and equipment modifications/replacement.

For these reasons, the load flow analysis of this configuration is not presented.

CONFIGURATION #4 – This configuration was modeled using 3-1/C-477 mainline conductors for proposed mainline conductor upgrades. A new three phase extension will be built on Hewitt Road between East Road and Willow Road. This was modeled using 3-1/C-477 conductors. This line extension will eliminate the approximate 8,600 feet of overhead distribution circuit along

East Road and Willow Road. The new line extension was modeled as a 1,900 feet section of 477 Al conductors.

Table 16 and Table 17 detail the results of the analysis for the MS50 circuit during peak and minimum load conditions. The Bennington Solar PCC values are given and present the worst case results. During peak load conditions, the effect of the PV generation being switched produced a maximum 3.83% voltage change. If the Facilities are limited to a unity or leading power factor, the analysis indicates a maximum voltage change of 2.58%.

The feeder back-up case of the MS51 on MS50 was considered for this configuration. Table 18 and Table 19 detail the results for the peak and minimum load cases. The analysis indicates that during peak load conditions the voltage at the PCC may exceed the 126V upper limit. The maximum voltage change observed was 3.83%. If the Facilities are limited to a unity or leading power factor, the voltage levels and percent change are acceptable.

The MS50 circuit is a part of the Bennington Self-Healing Network. There were two automated switching sequences analyzed for project impact. The automated sequences would place the Project automatically onto either the LS61 circuit or the SN40 circuit.

The recloser at MS50_L1222_P1 was opened and the recloser at LS-MS_TIE_LPARK_P41X was closed. This placed the portion of the MS50 circuit connecting the Projects onto the LS61. The results of this analysis are shown in Tables 20 and 21. The maximum voltage change observed was also 3.83%. If the Facilities are limited to a unity or leading power factor, the voltage levels and percent change are acceptable.

The obvious similarities in the results for this and previous cases are attributed to the common electrical path in the first two cases. In this case, the transfer to the Lyons Street Substation circuit LS61 does not significantly increase the electrical distance to the PCC. The transfer of the combined facilities onto the LS61 circuit will likely cause reverse power flow during periods of peak generation.

The tie with the SN40 circuit was also analyzed. The study considered the case for the MS50 breaker open and the recloser at SN-MS_TIE_L11_P16 closed. This transfers the entire MS50 load onto the SN40 circuit. The results indicate that this contingency does not maintain adequate service voltages near the proposed projects. With the addition of the Projects' capacity, the voltage fluctuations and levels are unacceptable. The results of this analysis are detailed in Tables 22 and 23. The Self healing Network must be modified so as to prevent transfer of the Project onto the SN40

Configuration #4 - MS50

	Max Load 3.91 MVA @ 98.9% PF lagging																
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							Mill St. Sub - Load Side of Regulators						
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF	
GEN @ 1.0 PF	NA	OFF	OFF	0.995	1.005	1.007	-	-	-	-	1.013	1.011	1.008	364	3785	100%	
	NA	-3973	215	1.021	1.030	1.032	-100%	2.58%	2.50%	2.53%	1.018	1.017	1.014	606	-163	-26%	
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3934	-357	1.033	1.043	1.044	-100%	**3.83%**	**3.75%**	**3.75%**	1.025	1.023	1.020	12	-126	-100%	
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3932	789	1.007	1.017	1.019	-98%	1.17%	1.17%	1.25%	1.012	1.009	1.007	1205	-117	-10%	

Table 16: Configuration #4 - Max Loading, MS50 only

Configuration #4 - MS50

	Min Load 1.26 MVA @ 99.2% PF leading																
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							Mill St. Sub - Load Side of Regulators						
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF	
GEN @ 1.0 PF	NA	OFF	OFF	0.99	0.99	0.99	95%	-	-	-	0.996	0.995	0.993	-278	1250	98%	
	NA	-3972	221	1.0125	1.0150	1.0150	100%	2.17%	2.17%	2.17%	0.998	0.997	0.995	55	-2662	-100%	
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3933	-352	1.024	1.028	1.028	99%	**3.3%**	**3%**	**3%**	1.004	1.003	1.001	-536	-2625	-98%	
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3931	794	0.999	1.003	1.003	-99%	0.83%	0.92%	0.92%	0.992	0.991	0.988	650	-2618	-97%	

Table 17: Configuration #4 - Min Loading, MS50 only

Configuration #4 - MS51 ON MS50																
	Max Load 7.11 MVA @ 99 % PF lagging															
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							Mill St. Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	OFF	OFF	1.014	1.023	1.019	-	-	-	-	1.031	1.029	1.021	920	6908	99%
	NA	-3973	209	1.039	1.049	1.044	100%	2.50%	2.58%	2.50%	1.038	1.035	1.027	1148	2958	93%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3934	-363	**1.053**	**1.062**	**1.057**	99%	3.83%	3.83%	3.75%	1.044	1.043	1.033	548	29595	100%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3932	781	1.026	1.035	1.032	-99%	1.17%	1.17%	1.25%	1.030	1.028	1.019	1754	3004	86%

Table 18: Configuration #4 - Max Loading w/MS51

Configuration #4 - MS51 ON MS50																
	Min Load 2.26 MVA @ 99.2 % PF lagging															
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							Mill St. Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR	KW	PF
GEN @ 1.0 PF	NA	OFF	OFF	1.00	1.00	1.00	95%	-	-	-	1.002	1.001	0.999	-292	2245	99%
	NA	-3972	218	1.018	1.022	1.022	100%	2.17%	2.17%	2.17%	1.004	1.003	1.002	35	-1688	-100%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3933	-355	1.031	1.034	1.033	99%	3.4%	3%	3%	1.011	1.010	1.008	-563	-1632	-95%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3931	791	1.006	1.009	1.009	-99%	0.92%	0.92%	0.92%	0.998	0.997	0.995	635	-1613	-93%

Table 19: Configuration #4 - Min Loading w/MS51

Configuration #4 - MS50_L1222_P1 On LS61																
	Max Load 4.15 MVA @ 98.9% PF lagging															
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							Lyons St. Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	OFF	OFF	0.983	0.993	0.994	-	-	-	-	1.011	1.006	1.005	558	3873	99%
	NA	-3972	220	1.009	1.019	1.020	100%	2.67%	2.58%	2.58%	1.014	1.008	1.008	725	-113	-15%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3933	-353	1.021	1.032	1.032	99%	3.83%	3.83%	3.75%	1.020	1.014	1.013	137	-78	-49%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3931	793	0.996	1.007	1.008	-99%	1.33%	1.33%	1.33%	1.008	1.003	1.002	1320	-66	-5%

Table 20: Configuration #4 - Max Loading – SHN LS61

Configuration #4 - MS50_L1222_P1 On LS61																
	Min Load 2.44 MVA @ 99.2% PF leading															
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							Lyons St. Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	OFF	OFF	0.99	0.99	1.00	95%	-	-	-	1.003	0.996	0.999	-355	2419	99%
	NA	-3972	219	1.0175	1.0158	1.0192	100%	2.42%	2.42%	2.33%	1.003	0.998	1.000	-98	-1524	-100%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3933	-353	1.029	1.028	1.031	99%	3.6%	4%	3%	1.009	1.003	1.005	-680	-1486	-91%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3972	219	0.999	0.998	1.002	-99%	0.58%	0.67%	0.58%	0.998	0.992	0.995	489	-1482	-95%

Table 21: Configuration #4 - Min Loading – SHN LS61

Configuration #4 - MS50 at SN-MS_Tie_L11_P16 On SN40																
	Max Load 9.02 MVA @ 98% PF lagging															
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							S. Bennington Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	**OFF**	**OFF**	0.907	1.020	1.023	-	-	-	-	1.008	1.042	1.045	1528	8744	99%
	NA	-3973	206	0.981	**1.086**	**1.086**	100%	7.42%	6.58%	6.33%	1.036	1.063	1.065	1267	4621	96%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3935	-370	1.008	**1.108**	**1.108**	99%	10.17%	8.83%	8.58%	1.049	1.075	1.077	599	4651	99%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3931	785	0.951	**1.060**	**1.061**	-99%	4.42%	4.00%	3.83%	1.022	1.051	1.053	1959	4679	92%

Table 22: Configuration #4 - Max Loading SHN SN40

Configuration #4 - MS50 at SN-MS_Tie_L11_P16 On SN40																
	Min Load 4.18 MVA @ 99.9 % PF leading															
Gen Output (Combined)	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC							S. Bennington Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR	KW	PF
GEN @ 1.0 PF	NA	**OFF**	**OFF**	0.998	1.012	1.027	95%	-	-	-	1.024	1.020	1.023	-280	4185	99.8%
	NA	-3972	203	1.046	**1.059**	**1.073**	100%	4.83%	4.75%	4.58%	1.033	1.028	1.030	-107	251	92%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3934	-371	**1.068**	**1.081**	**1.094**	99%	7.0%	7%	7%	1.043	1.038	1.040	-748	288	36%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3930	779	1.021	1.035	**1.050**	-99%	2.33%	2.33%	2.33%	1.022	1.017	1.019	548	298	48%

Table 23: Configuration #4 - Minimum Loading - SHN SN40

3.2 General Loading Analysis

An analysis of the feeder loading, with and without the PV system, was performed and demonstrated that the addition of the Facility will not create thermal loading problems on the MS50 feeder, the Mill Street Substation, nor the MS51 feeder. Specifically, no conductor, or transformer overloads occur. All Green Mountain Power owned mainline conductor and distribution facilities are thermally large enough to accommodate the added capacity from the 2 X 2,000kW PV facilities.

3.3 Voltage Analysis

Per IEEE 1547 Section 4.1.1 Voltage Regulation, the DR shall not actively regulate the voltage at the PCC. The DR shall not cause the Area EPS service voltage at other Local EPSs to go outside the requirements of ANSI C84.1-1995, Range A. Range A of the ANSI standard requires the Company to hold voltage within +/- 5% of nominal at the customer service point under normal operating conditions with the system generation at full power. The Customer must maintain voltage at the PCC at +/- 5% of nominal under normal conditions.

The impact of this proposed generation was carefully reviewed for this site. If the recommended upgrades are implemented as in Configuration 4, there were no potential over-voltage conditions on the Company's EPS with the generation interconnection sites at full power during studied cases while connected to the MS50 under normal conditions. The output of the PV facility was modeled at full power output at unity power factor, a 99% lagging power factor and a 99% leading power factor. The largest PCC voltage during normal operating conditions was 1.044 V_{pu}. The largest voltage rise on the MS50 was a 3.8% rise in voltage at the PCC. This voltage rise was observed during a test case at maximum load while testing the project at a 99% lagging power factor.

During most feeder backup conditions, the voltage variations remained within acceptable limits. The largest PCC voltage during feeder backup operating conditions was 1.06 V_{pu}. The largest voltage rise on the MS50 was a 3.8% rise in voltage at the PCC. This voltage rise was observed during a test case at maximum load while testing the project at a 99% lagging power factor. The Self-Healing Network case with the MS50 on SN40, the voltage levels and changes generally unacceptable.

These conditions are not reflected in a dynamic loading analysis of the MS50 circuit. The dynamic loading analysis described in section 3.4 (below) considers a time varying load and generation level in measuring system response. For this analysis the metered output of a PV facility, with similar site conditions, was applied to the circuit. The metered data included five-second intervals which were applied to the model. The generator output data was screened to find the period of greatest volatility.

3.4 Flicker Analysis

The IEEE Recommended Practice for Measurement and Limits of Voltage Fluctuations and Associated Light Flicker on AC Power Systems, IEEE Std. 1453-2004 provides guidance on flicker and voltage fluctuations.

An analysis for this impact study was conducted using the long-term dynamic modeling capability of Cyme. The intent was to determine the frequency and magnitude of the voltage changes caused by a varying output from the Facility. Using 5 second output data from an existing GMP solar facility and the available 30 minute load data, we created generation curves and load curves as inputs into the Cyme model. The generator output data was reviewed to identify the period with the greatest variation in output. The output curve was expanded to create one second data points by filling the intervals between readings with the previous value.

The peak and minimum load curves were created based on 15 minute SCADA data for the Mill Street Substation.

A Dynamic load flow was conducted on the MS50 circuit under light load and peak load conditions for Configuration #1. This model is of the existing circuit layout to include minimal three phase upgrades to provide service without exceeding thermal limits.

The analysis for this impact study has determined that if the reactive contribution of the PV at the Point of Common Coupling operates between 99% leading and lagging power factor, the predicted flicker and voltage fluctuations are expected to be unacceptable. The case analyzed the voltage at the Bennington Solar PCC, the Apple Hill PCC, MS50_L2136_P12 (the 1st common node in the model), and the station getaway. The results are shown for the Bennington Solar PCC as it is the more distant interconnection. The conclusions drawn would be equally valid for the Apple Hill PCC.

Figure 11 summarizes the results results during maximum load with the Facility operating at a varying output at unity power factor. The voltage at the PCC did exceed ANSI A limits. The maximum voltage fluctuation recorded was 1.9%. There was a maximum occurrence of 9 flicker events in a rolling 60 second interval. The average magnitude of these six events was 0.7%. The simulation indicates that there were 190 events that exceeded the borderline of visibility during the 6 hour simulation. Figure 12 is a voltage profile of the PCC. The thresholds of visibility and irritability were derived from the GE flicker curve, see Figure 13. The clouded regions represent the level of the maximum ∆V and the maximum flicker events per minute. Both of these levels are above the threshold of visibility.

The same analysis was conducted with the Facility output operating at +99% power factor. The resultant flicker analysis is shown in Figure 14. The voltage at the PCC exceeds ANSI A limits. The maximum voltage fluctuation recorded was 1.92%. There was a maximum occurrence of 9 flicker events in a rolling 60 second interval. The average magnitude of these nine events was 0.7%. The simulation indicates that there were 190 events that exceeded the borderline of visibility. Both of these levels are above the threshold of visibility. A voltage profile of this case is shown in Figure 15.

The same analysis was conducted with the Facility output operating at -99% power factor. The resultant flicker analysis is shown in Figure 16. The voltage at the PCC exceeds ANSI A limits. The maximum voltage fluctuation recorded was 1.92%. There was maximum occurrence of 9 flicker events in a rolling 60 second interval. The average magnitude of these nine events was 0.7%. The simulation indicates that there were 190 events that exceeded the borderline of visibility. Both of these levels are slightly above the threshold of visibility. A voltage profile of this case is shown in Figure 17.

This analysis confirms the load flow results that the base configuration cannot support the proposed generation without diminishing the service quality to existing customers.

A Dynamic load flow was also conducted on the MS50 circuit under light load and peak load conditions for Configuration #4. This model reflects selected conductor upgrades and a new three phase line along Hewett Road.

The analysis for this impact study has determined that if the reactive contribution of the PV at the Point of Common Coupling operates between 99% leading and lagging power factor, the predicted flicker and voltage fluctuations are expected to be acceptable. The case analyzed the voltage at the Bennington Solar PCC, the Apple Hill PCC, MS50_L2136_P12 (the 1st common node in the model), and the station getaway. The results are shown for the Bennington Solar PCC as it is the more distant interconnection. The conclusions drawn would be equally valid for the Apple Hill PCC.

Figure 18 summarizes the results results during maximum load with the Facility operating at a varying output at unity power factor. The voltage at the PCC did not exceed ANSI A limits. The maximum voltage fluctuation recorded was 0.75%. There was a maximum occurrence of 2 flicker events in a rolling 60 second interval. The average magnitude of these two events was 0.42%. The simulation indicates that there were 3 events that exceeded the borderline of visibility during the 6 hour simulation. Figure 19 is a voltage profile of the PCC. The thresholds of visibility and irritability were derived from the GE flicker curve, see Figure 20. The clouded regions represent the level of the maximum ∆V and the maximum flicker events per minute.

The same analysis was conducted with the Facility output operating at +99% power factor. The resultant flicker analysis is shown in Figure 21. The voltage at the PCC did not exceed ANSI A limits. The maximum voltage fluctuation recorded was 0.66%. There was a maximum occurrence of 2 flicker events in a rolling 60 second interval. The average magnitude of these two events was 0.41%. The simulation indicates that there was 1 event that exceeded the borderline of visibility. A voltage profile of this case is shown in Figure 22.

The same analysis was conducted with the Facility output operating at -99% power factor. The resultant flicker analysis is shown in Figure 23. The voltage at the PCC does not exceed ANSI A limits. The maximum voltage fluctuation recorded was 0.66%. There was maximum occurrence of 2 flicker events in a rolling 60 second interval. The average magnitude of these two events was 0.41%. The simulation indicates that there was 1 event that exceeded the borderline of visibility. A voltage profile of this case is shown in Figure 24.

3.5 Reverse Power Flow

Voltage regulation for the MS50 circuit is provided by a voltage regulator, rated 328A, at the Mill Street Distribution Substation. The following settings were provided by the Company:

Bandwidth Volts: ±1.5
CT Ratio: 400
V Float: 120
R: 5
X: 5

The possibility of this interconnection causing reverse power flow was reviewed. When the generating systems are at peak export, excess generation from the Combined Apple Hill Solar and Bennington Solar projects will flow back through the MS50 circuit and onto the 12.47kV Bus at the Mill Street Distribution Substation. The minimum projected bus load is less than the total connected and proposed Distributed Generation capability. This project will cause reverse power flow through the transformer at Mill Street Sub and onto the 46kV supply line.

The voltage regulator controls for the MS50 at the Mill Street Sub are not capable of proper operation during reverse power flow at present. They are being replaced due to issues not associated with the Project and will be capable of proper operation during reverse power flow.

The voltage regulators for the MS51 are not capable of proper operation and will need to be replaced at the Interconnecting Customer's expense if the Project wishes to remain interconnected when the MS50 is placed on the MS51.

The voltage regulator controls for the LS61 at the Lyons Street Sub are not capable of proper operation during reverse power flow at present. These controls must be replaced at the Interconnecting Customer's expense in order for the Project to remain online during times when that part of the MS50 is transferred onto LS61. If the Customer chooses not to fund the control replacement, the Self Healing Network will have to be modified to take the Project offline.

4.0 Relay and Protection Review

ControlPoint performed a protection review of Combined Apple Hill Solar and Bennington Solar LLC, proposed interconnection of a 2 - 2,000kW PV generators to the Company's MS50, a 7.2/12.47kV distribution circuit served from the Mill Street Distribution Substation. This review identified distribution system enhancements that may be necessary to complete the interconnection project and its ability to meet IEEE 1547 Standards and Vermont Public Service Board Rule 5.500 that are applicable for this interconnection.

4.1 Integration with Area EPS Grounding

Per IEEE 1547 Section 4.1.2 Integration with Area EPS grounding, the grounding scheme of the Facility's interconnection shall not cause over-voltages that exceed 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.

As stated in section 2.2 the Facility will interconnect to the 7.2/12.47kV three-phase, 4-wire, multi-grounded wye, effectively-grounded MS50 radial circuit from the Mill Street Substation. In order to avoid over-voltage on the area EPS during outage conditions, it is recommended that the proposed DR being interconnected to the 4-wire circuit provide an effectively grounded system with respect to the Company circuit.

Effectively grounded, which is grounded through a connection of sufficiently low impedance, is defined as the ratio X_0/X_1 being less than 3 and the ratio R_0/X_1 being less than 1 (IEEE standard 142).

The proposed Projects were modeled using ASPEN OneLiner V12.2. The analysis conducted indicates the proposed design is effectively grounded when the system is connected to the area EPS. The interconnected system presents an X_0/X_1 ratio of 1.77169 and an R_0/X_1 ratio of 0.54479. The voltage on the un-faulted phases during a line-to-ground fault does not exceed 118% which is deemed acceptable.

The proposed system does not appear to be effectively grounded if disconnected from the area EPS. For faults within the Facility, the PCC recloser will prevent Ground Fault Over-Voltage (GFOV) conditions from occurring on the Company's EPS. If the MS50 circuit breaker opens, then the area EPS is no longer effectively grounded when connected to the Facility. The study indicates that the potential for GFOV is present if the inverter does not quickly clear the generator from the system.

The proposed inverters are UL listed. As such, they are required to clear any over-voltage greater than 120% of nominal with 10 cycles. Depending on fault conditions, the anti-islanding algorithms and under-voltage schemes may operate before the over-voltage trips. This would decrease the exposure of GFOV.

4.2 Fault Current Contributions

The Pre-Project fault duty was derived from a model of the existing circuit topology modified as a three phase circuit to the proposed facilities. The locations are presently served by single phase lines. The Pre-Project Amps is based on the three-phase topology of Configuration #1 and Configuration #4. The Post-project fault duty reflects the generators contribution to the circuit model. The circuit topology had no impact on fault currents at the substation bus. The following table shows the fault duties at the Mill Street Distribution Substation and at the POI for Configurations #1 and #4:

Fault Location	Fault Type	Pre-Project Amps (No Generation)	Post- Project Amps	Δ%
Mill Street 12.47kV Substation Bus	**Line to Grd**	**5,245**	**5,255**	**0.19**
	Three Phase	**4,592**	**4,621**	**0.64**
POI Configuration #1	Line to Grd	1,220	1,225	0.40
	Three Phase	1,557	1,587	1.97
POI Configuration #4	**Line to Grd**	**1,847**	**1,852**	**0.31**
	Three Phase	**2,317**	**2,348**	**1.35**

Table 24: Fault Current Contribution

Post-Project fault current contribution was derived by modeling the inverters as a current limited generator, using ASPEN recommended instructions.

The effect of the 2 - 2MVA generation, at the Apple Hill Solar and Bennington solar sites, was analyzed for its effect on available fault current. Putting this generation on-line increased the short circuit current available at the 12.47kV distribution bus by 0.64%. As can be seen, the short circuit current available at the POI increases by roughly 50% due to the reconductoring and shortened circuit path length associated with Configuration #4 as compared to Configuration #1. The increase in available fault current due to the proposed generation is less than 2%. The existing reclosers protecting the MS50 and LS61 mainline conductors are capable of interrupting the new fault current levels.

Apple Hill Solar, LLC and Bennington Solar, LLC are responsible for ensuring that their equipment is rated to withstand the available fault current.

4.3 Bennington Self-Healing Network

The Facilities are connecting to a portion of the MS50 circuit that is protected by the Bennington Self-Healing Network. This network provides automated isolation of faulted sections and restoration of non-faulted sections of the MS50.

The analysis considered two cases where restoration of the MS50 circuit is accomplished. The case where load is transferred from the MS50 circuit, downstream of the S&C Intelliruptor Switch at MS50_L1222_P1 onto the LS61 circuit via the recloser at LS-MS_TIE_LPARK_P41X, was found to maintain voltage levels and flickers within acceptable levels. The Lyons Street Substation is supplied from the same radial transmission line and provides a circuit path of a similar length to the proposed projects. The analysis results reflect this similarity in topology.

The second case involved transferring the entire MS50 circuit on the South Bennington Substation circuit SN40 via the S&C Intelliruptor Switch at SN_MS_TIE_L11_P16. The MS50 recloser was opened and the tie switch was closed to complete the transfer. The voltage levels and flicker for this case did not produce acceptable results. The project shall not be allowed to operate during this contingency. The likelihood of having to shift the entire MS50 onto SN40 is extremely low.

4.4 Temporary Over-Voltages on Transmission Supply

The possibility of Temporary Over-Voltages on the Transmission Supply is of concern when there is a reverse of power onto the Supply that cannot be dampened during line to ground faults. In screening the project for $3V_0$ protection, it was determined that the minimum bus loading is less than the connected DG resources. The minimum loading on the Mill Street Substation bus is 2,246kW and the peak combined generation is 4,000kW. However, the 46 kV transmission line that feeds Mill St. is protected by the Woodford Rd. B1 breaker. Also protected by the B1 breaker are the N. Bennington, Silk Rd., and Lyons St. substations. Minimum load, as seen by the B1 breaker, is approximately 7 MW which is substantially greater than the Project's capability.

The Developer is responsible for inverter shutdown during ground faults. Over-voltage protection will conform to IEEE 1547, Section 4.2.3. The Project does not require a change in overvoltage protection at the substation.

4.5 Temporary Over-Voltage on Distribution System

The maximum generation capacity on the MS50 exceeds the minimum load on the circuit. This condition can create a TOV in some instances. Because the inverters act as a constant current source, they can create a transient over-voltage event when a switch opens and forces all of the inverter current through a fixed load impedance.

Per IEEE 1547 Section *4.2.3 Voltage*, *The protection functions of the interconnection system shall detect the phase-to-neutral voltage where the transformer connecting the Local EPS to the Area EPS is a grounded wye-wye configuration*.

The voltages shall be detected at either the PCC or the point of DR connection when any of the following conditions exist:

a) The aggregate capacity of DR systems connected to a single PCC is less than or equal to 30kW.

b) The interconnection equipment is certified to pass a non-islanding test for the system to which it is to be connected.

c) The aggregate DR capacity is less than 50% of the total Local EPS minimum annual integrated electrical demand for a 15 minute time period, and export of real or reactive power by the DR to the Area EPS is not permitted.

Voltage range (% of base voltage[a])	Clearing time(s)[b]
V< 50	0.16
50 ≤ V< 88	2.00
110 < V < 120	1.00
V ≥ 120	0.16

[a]Base voltages are the nominal system voltages stated in ANSI C84.1-1995, Table 1.
[b]DR ≤ 30 kW, maximum clearing times; DR > 30kW, default clearing times.

Table 24: IEEE Interconnection system response to abnormal voltages

The inverter manufacturer is UL listed. As such, it will meet these requirements.

The project will require the installation of a PCC recloser to isolate any faults within the project facilities from affecting the Company's customers. To verify that the Project does not generate over-voltage conditions, the PCC recloser may be equipped with an event recorder capable of capturing A, B, and C phase voltages on the utility side of the PCC with a resolution of 1ms and capable of capturing ¼ cycle events. If an event occurs with a recorded over-voltage at the PCC exceeding limitations and/or any reported damage of customer equipment, The Company reserves the right to disconnect the Project from the EPS. The developer will be responsible for all associated claims and for mitigation to prevent re-occurrence. In this instance, The Company could require a Direct Transfer Trip (DTT) scheme from all upstream feeder sectionalizing devices to the PCC recloser.

4.6 Isolation Device

Per IEEE 1547 section 4.1.7 Isolation device, when required by the area EPS operating practices, a readily accessible, lockable, visible-break isolation device shall be located between the Area EPS and the DR unit.

The Company will consider the combination of a PCC recloser and a set solid cutouts as satisfying this requirement. The Customer is responsible to design the Facility to meet all code requirements and the Project may be subject to inspection by the State Electrical Inspector.

4.7 Unintentional Islanding

Per IEEE 1547 section 4.4.1 Unintentional Islanding, for an unintentional island in which the DR energizes a portion of the Area EPS through the PCC, the DR interconnection system shall detect the island and cease to energize the Area EPS within two seconds of the formation of an island.

The project was screened for the potential of islanding during abnormal operating conditions. The evaluation was performed at peak, light load, and median load conditions. The screening criteria[2] provide guidelines to determine whether a detailed Anti-Islanding study, which determines the need for Direct Transfer Trip, will be required. The following are the guidelines used to determine this requirement:

1. If there are other PV's on the circuit that utilize a different inverter manufacturer than the proposed PV for this project the inverter Anti-Islanding function may not operate as designed. Therefore, a detailed ANTI-ISLANDING STUDY will be required.

2. If Existing or Proposed Reciprocating Generation is greater than 20% of the Total Aggregate Inverter based PV then an ANTI-ISLANDING STUDY will be required.

3. If the following Anti-Islanding Criteria calculates between 0.99 and 1.01 then an ANTI-ISLANDING STUDY is required.

$$0.99 \leq \frac{Q_{cap}}{Q_{PV}+Q_{load}} \leq 1.01$$

The evaluation indicates that the proposed project does not have the potential to create an island during system outage conditions, refer to *Figure 13: Anti-Islanding Analysis*. A detailed anti-islanding study is not recommended, provided the customer can provide documentation that certifies the inverters are UL 1741-2005/ IEEE1547 compliant

[2] Screening criteria derived from the Sandia Report on "Suggested Guidelines for Anti-Islanding Screening".

4.8 Direct Transfer Tripping

A direct transfer tripping system, if one is required by either the Interconnecting Customer or by the Company, shall use equipment generally accepted for use by the Company and shall, at the option of the Company, use dual channels.

DTT is not required for this interconnection, refer to section 4.7 above.

4.9 Surge-Withstand capability

Per IEEE 1547 Section 4.1.8.2 Surge Withstand Performance, the interconnection system shall have the capability to withstand voltage and current surges in accordance with the environments defined in IEEE Standard C62.41.2-2002 or IEEE Standard C37.90.1-2002 as applicable.

4.10 Protection Scheme Assessment

The project will require the installation of at least one recloser at the PCC/POI. Coordination will be required between the MS50 feeder breaker, the recloser at MS50_L1222_P1 and the PCC recloser. Existing sectionalizing fuses at MS50_LPARK_P57 will need to be removed. This section of line will be rebuilt.

This section of the MS50 is transferred as part of the Bennington Self-Healing Network. The study indicates that the automatic transfer of this generation may affect the logic for this network.

5.0 Cost Estimate

A budgetary estimate of the interconnection costs will follow under separate cover. This cost estimate will be in good faith and will not include the 32.98% federal tax adder on Contribution In aid of Construction (CIAC). If required, the Customer is responsible to demonstrate compliance with the De Minimis Expectations for exemption listed in IRS Notice 2001-82. Please be aware that claiming CIAC tax exemption status may have an effect on the Project's accounting practices, the decision to claim exemption should be discussed with the Project Accountant.

6.0 Conclusion

The project can be allowed to interconnect with the following modifications and additions to the local EPS

1. Reconductor approximately 1,800' (Line Park Pole 57 to Pole 62+-) of existing three phase distribution line to 336 ACSR for voltage drop mitigation (Some costs borne by the Apple Hill Project).
2. Install approximately 1,900' of new 336 ACSR three phase distribution line along Hewitt Drive to be owned by GMP for a more direct route and voltage drop mitigation (Some costs borne by the Apple Hill Project).
3. Reconductor approximately 355' of existing single phase distribution line along Willow Rd. and add two phases of 336 ACSR (Some costs borne by the Apple Hill Project).
4. Replace the existing set of three 100T line fuses at Line Park Pole 57 with 600 amp disconnects (Full cost borne by the Apple Hill Project).
5. Install three 100T line fuses at or beyond Line Park Pole 63 (Full cost borne by the Apple Hill Project).
6. Line extension as needed to Chelsea Solar from the end of item #3 above.
7. Install one PCC Recloser.
8. Install one overhead primary metering package.
9. Install approximately 1,800' of new overhead 1/0 6201AAAC three phase distribution line (or equivalent) starting from the POI for Apple Hill, approximately L2136 P21, and continuing to the PCC for Chelsea Solar, approximately L2136 P29. The estimate below includes the cost to install this line section and install the Company's interconnection equipment on Poles 28 and 29. The Customer would be responsible to provide a maintained access road beside the GMP owned poles and other equipment which is not presently shown in the customer site plan. Alternatively the Customer may choose to install and own approximately poles 24 through 29 and GMP will install the interconnection equipment for Chelsea Solar on poles 22 and 23, adjacent to the take-off and access road for Apple Hill Solar

The Interconnecting Customer is responsible for:

10. Procure and install approximately 1,500' of new underground 1/0 CU (or equivalent) three phase distribution line starting at the end of Item #9 above.. This is the underground portion of the feed to Chelsea from the Apple Hill POI and will be owned by the project.
11. Procure and install all components associated with the Facility
12. Provide a portion of the communications for data reporting and conduits as required.
13. Provide maintained access to all Company owned facilities with distances specified by the Company.

If the Interconnecting Customer wishes to keep the Project online during periods when the MS50 is fed from the MS51, the MS51 regulator controls must be upgraded at the

Interconnecting Customer's expense. The upgrade estimate is currently assigned to Apple Hill Solar estimated as $6,820.

If the Interconnecting Customer wishes to keep the Project online during periods when the MS50 is fed from the LS61 via the Self healing network, the LS61 regulator controls must be upgraded at the Interconnecting Customer's expense. The upgrade estimate is currently assigned to the Chelsea Solar interconnection as $6,820.

If the recommended line upgrades are completed and the inverters are operated between 100% and -99% (absorbing VARs), the projects should not cause out-of-limits voltage levels or flicker. The upgraded distribution system will be thermally capable of interconnection with the Facilities. As mentioned above, per the Advanced Energy AE 500NX Unser Manual, the inverters have a real power output rating of 500 kW and an apparent power output rating of 526 kVA. As such, there should be no de-rating of the real power output necessary when operating at 99% power factor leading.

The feeder back-up cases studied indicate that the facilities do not negatively impact system operation in most cases. The Bennington Self-Healing Network logic must be altered to prevent the SN40 circuit from picking up the entire MS50 circuit. The operations of the Facilities, if the entire MS50 is transferred onto the SN40 during this contingency, will likely lead to high voltage conditions and excessive flicker. A budgetary quote to modify the Self-Healing Network logic is $10,000 and is included in the interconnection costs for Apple Hill Solar.

The study indicates that under normal operation of the 12.47kV distribution system, the interconnection is essentially effectively grounded. As modeled, there were no overvoltage conditions during ground faults greater than 123% on the un-faulted phases. The potential for ground fault over-voltages exists if the inverters do not quickly open from the area EPS once the MS50 circuit recloser open. The potential for ground fault over-voltages exists if the station breaker isolates the circuit before the inverters shut down. The inverter's U.L. listing promises fast response to loss-of-source. Recording instruments will be deployed to verify proper operation. The Customer will be responsible for mitigating any demonstrated over-voltage conditions generated at the PCC and exceeding 125% of the nominal line to neutral voltage.

If an event occurs with a recorded over-voltage at the PCC exceeding limitations and/or any reported damage of customer equipment, The Company reserves the right to disconnect the Project from the EPS. The developer will be responsible for all associated claims and for mitigation to prevent re-occurrence. In this instance, The Company could require a Direct Transfer Trip (DTT) scheme from all upstream feeder sectionalizing devices to the PCC recloser.

It should also be noted that it may not be possible for the Company to keep the Project connected during all feeder backup scenarios. Reasonable attempts shall be made to keep the Project on during feeder backup.

At the PCC, a recloser, primary metering rack, and a disconnect switch will be required. It may be possible for a single PCC recloser to protect both PV systems. However, the determining factor is business/legal based rather than technical. As such, two PCC reclosers are included in the design and cost estimate.

A State Electrical Inspector must inspect the Project's electrical system to ensure it complies with the National Electric Code.

Authorization for parallel operation will not be issued without a fully executed Interconnection Agreement, receipt of the necessary insurance documentation, and successful completion of the Company approved witness testing per IEEE 1547 Section 5. This testing shall be coordinated with and witnessed by the Company's representatives.

The Company will also require copies of the inverter factory test reports certifying compliance with IEEE requirements.

7.0 Revision History

Version	Date	Description of Revision
Draft 1.0	12/20/2013	First Draft submittal
Final 1.0	1/20/2014	Final
Final 1.1	2/5/2014	Appendix C – Configuration #5
Final 1.2	3/28/2014	Project Name Clarification

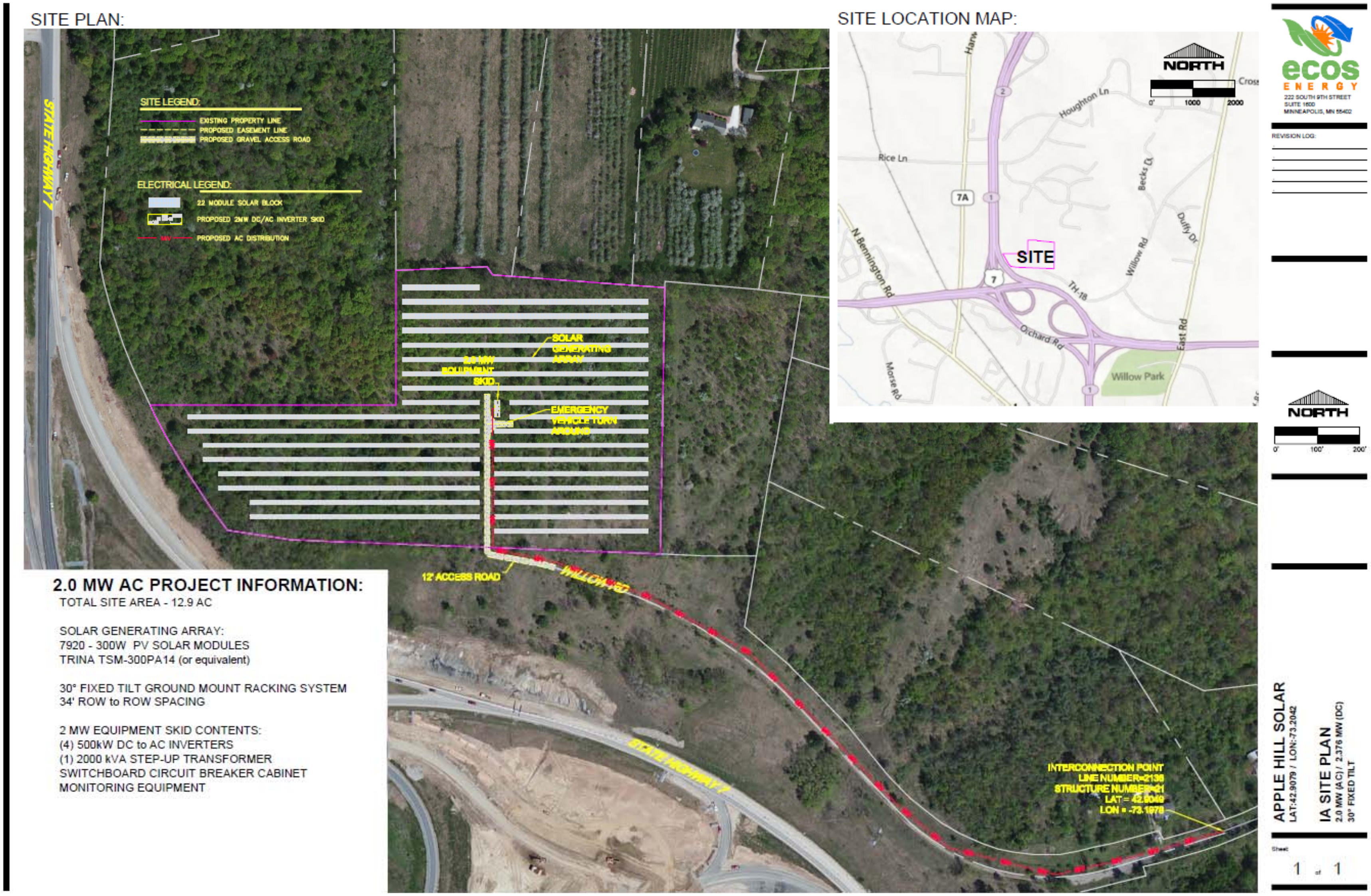


Figure 1: Apple Hill Site Diagram

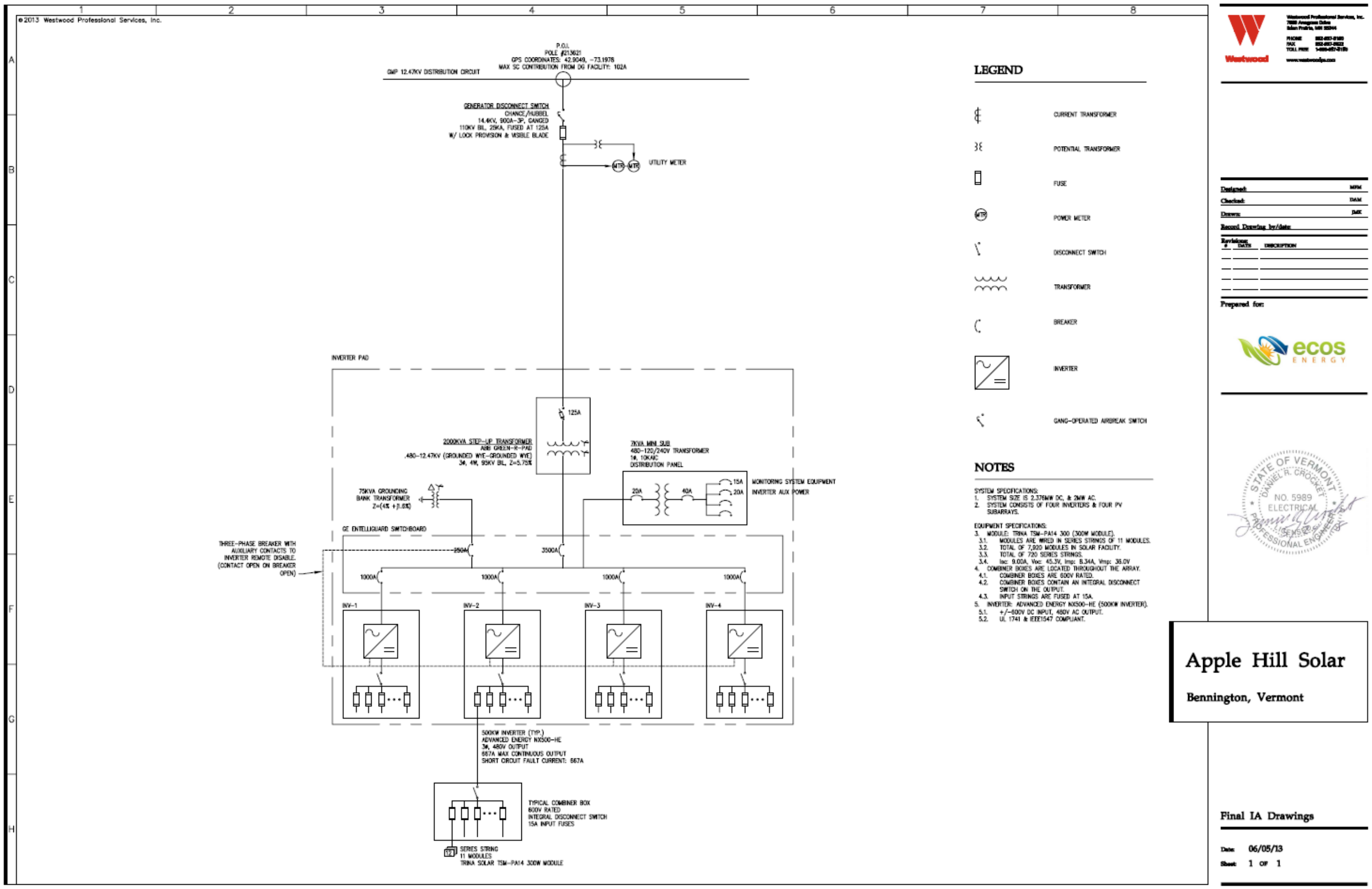


Figure 2: Apple Hill Project One-Line Diagram

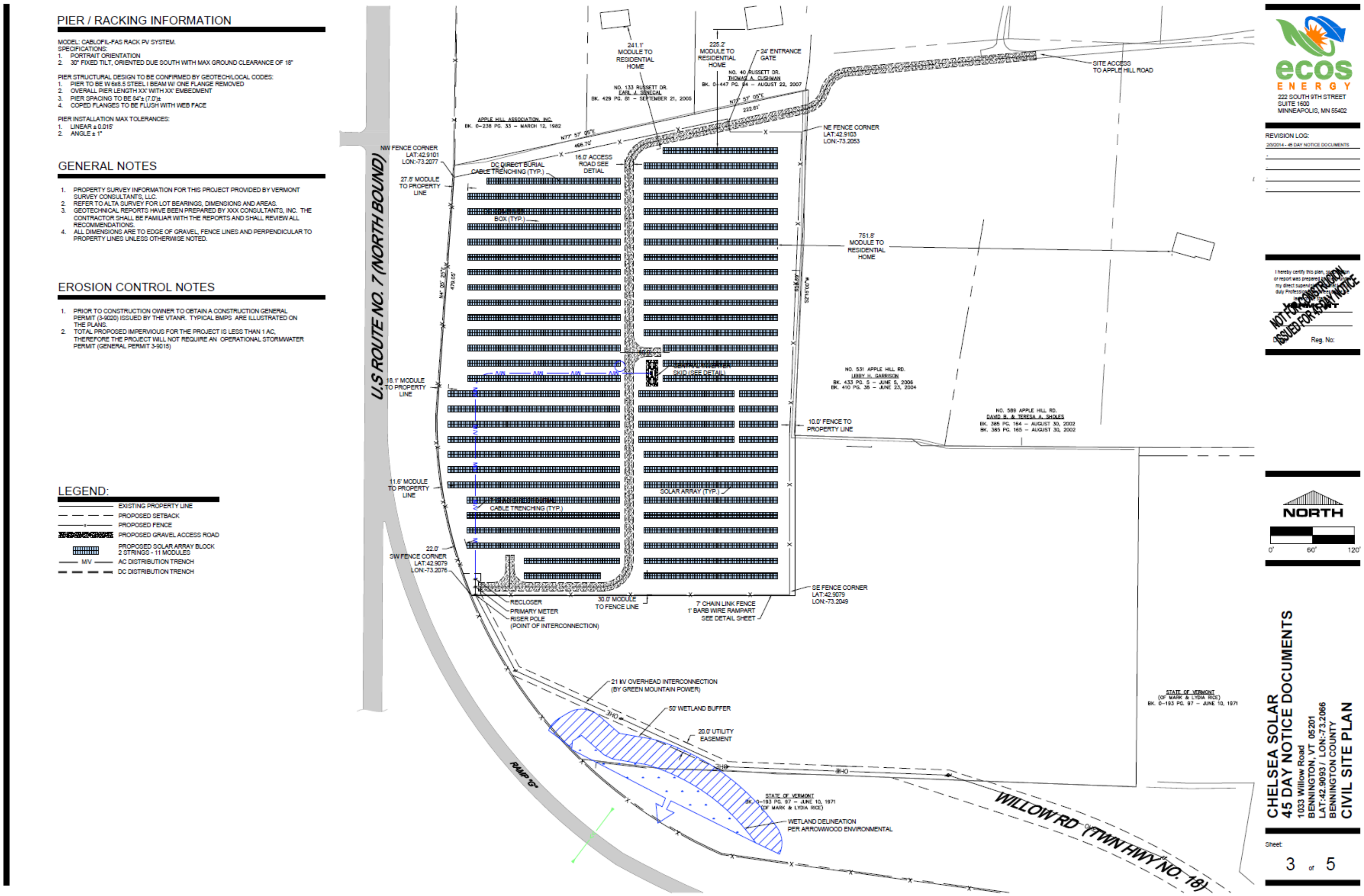


Figure 3: Bennington Solar - Site Layout (Requires update to show road access to all GMP poles)

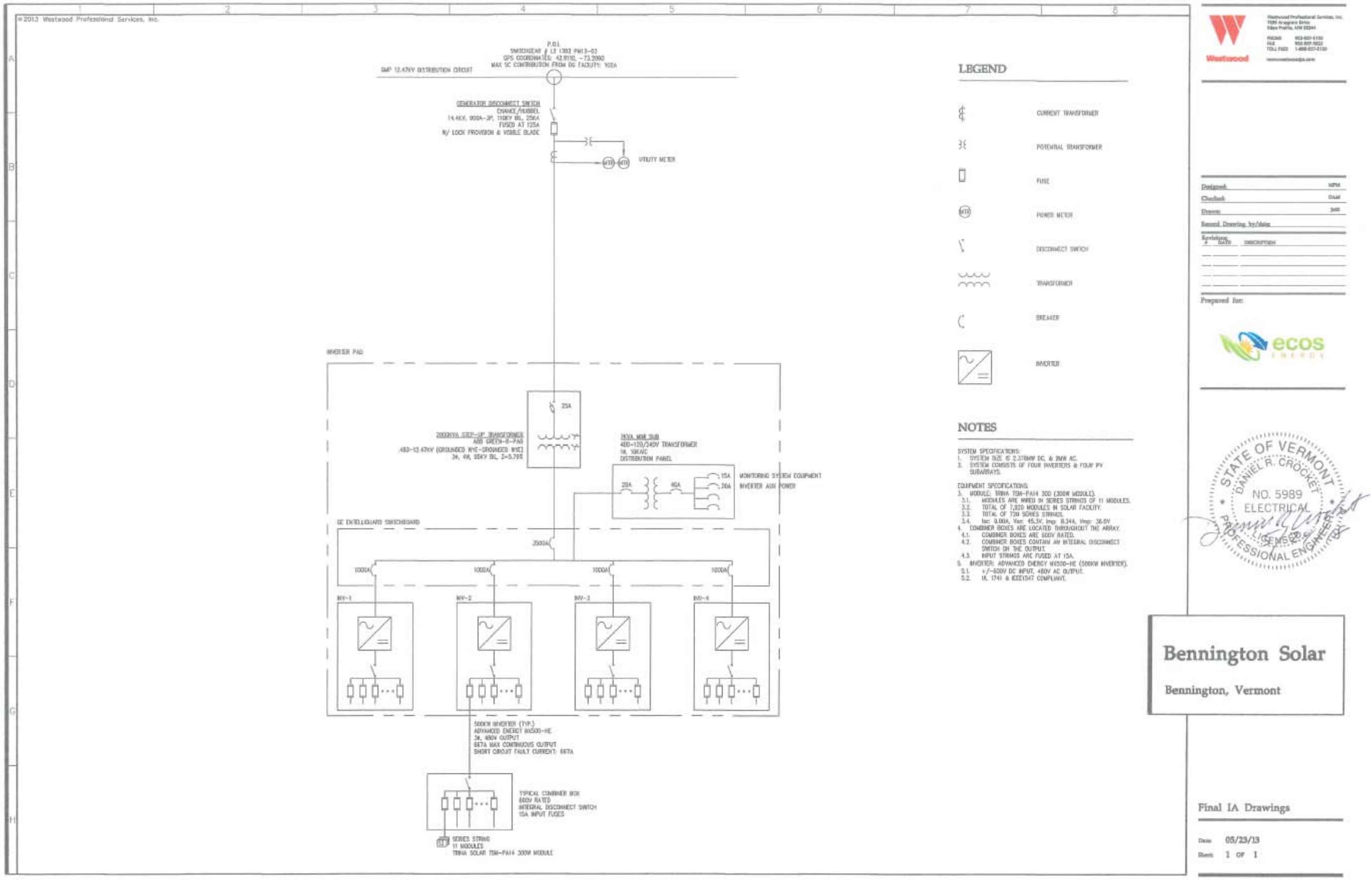


Figure 4: Bennington Solar - One-Line Diagram (POI requires update)

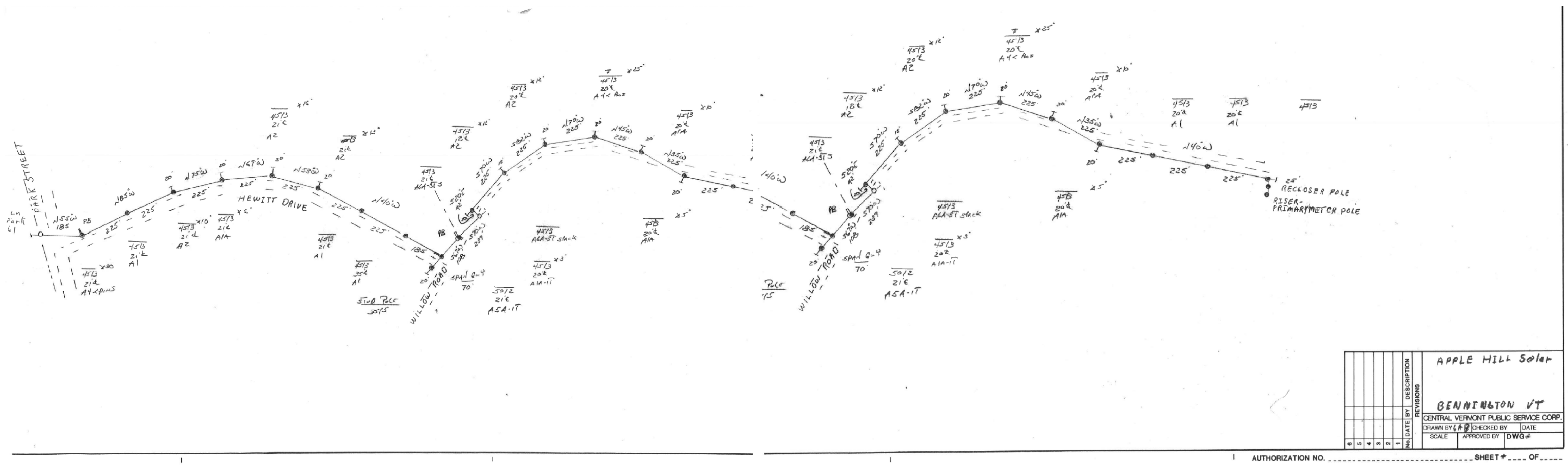


Figure 5: Sketch of Line Upgrades for the interconnection of Apple Hill Solar. The 1,800 ft Chelsea Solar extension beyond the point of interconnection for Apple Hill Solar is not shown. The Company is unable to stake the Chelsea Solar until the site is cleared. If the application for Apple Hill Solar is removed from the queue, the above system upgrades are the full responsibility of Chelsea Solar.

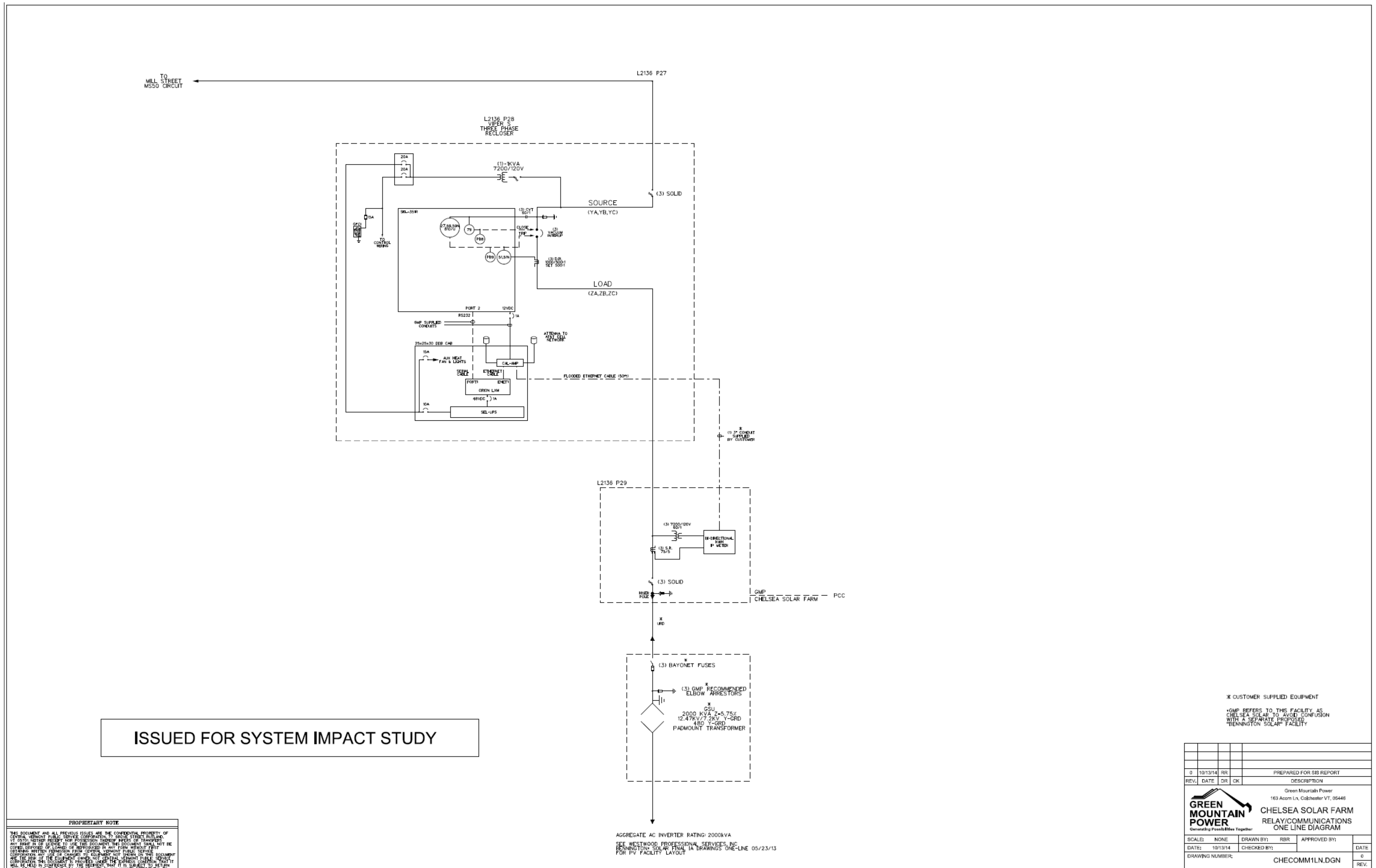


Figure 5: Chelsea Solar Interconnection One-Line

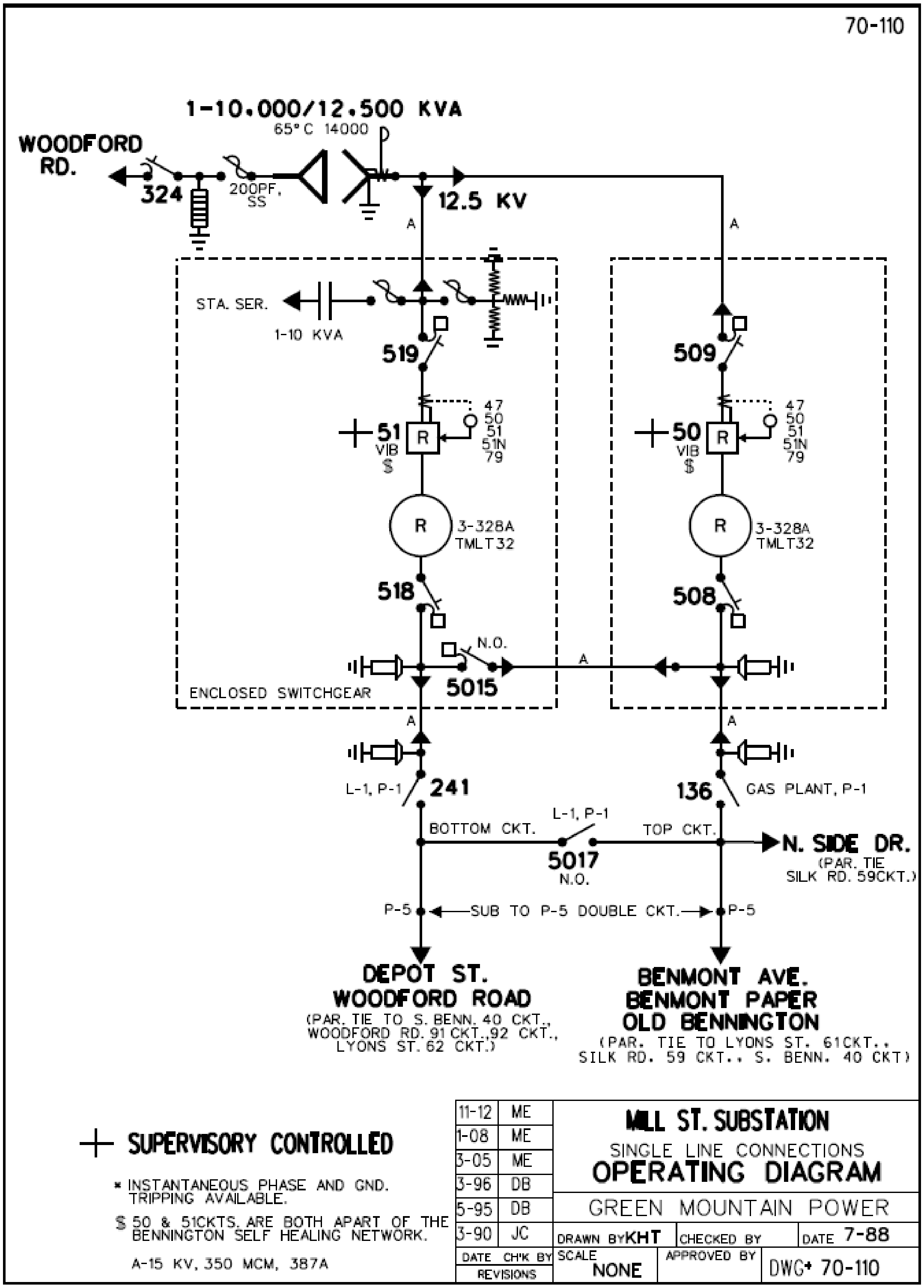


Figure 6: Mill Street Sub One-line

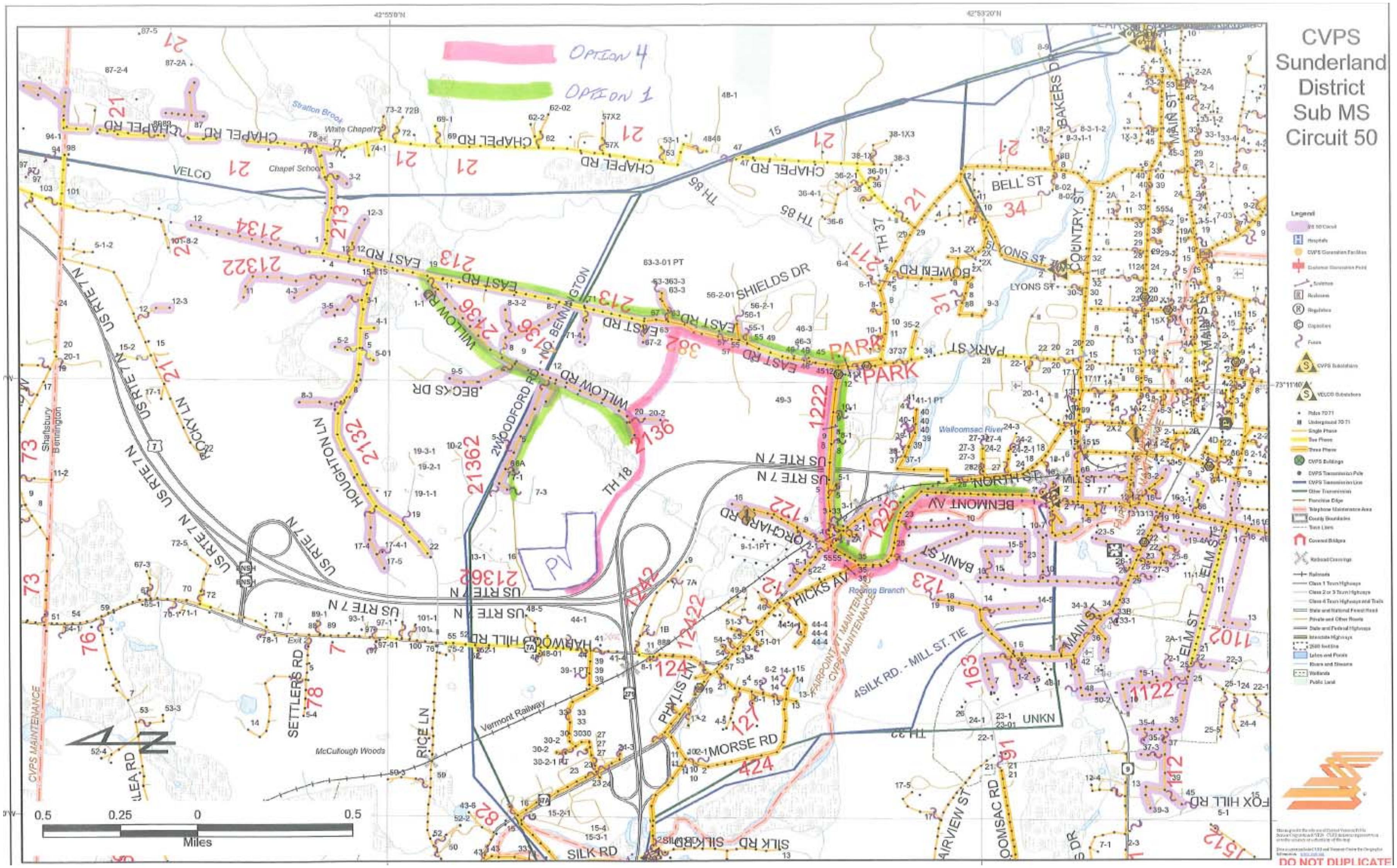


Figure 7: MS50 One Line

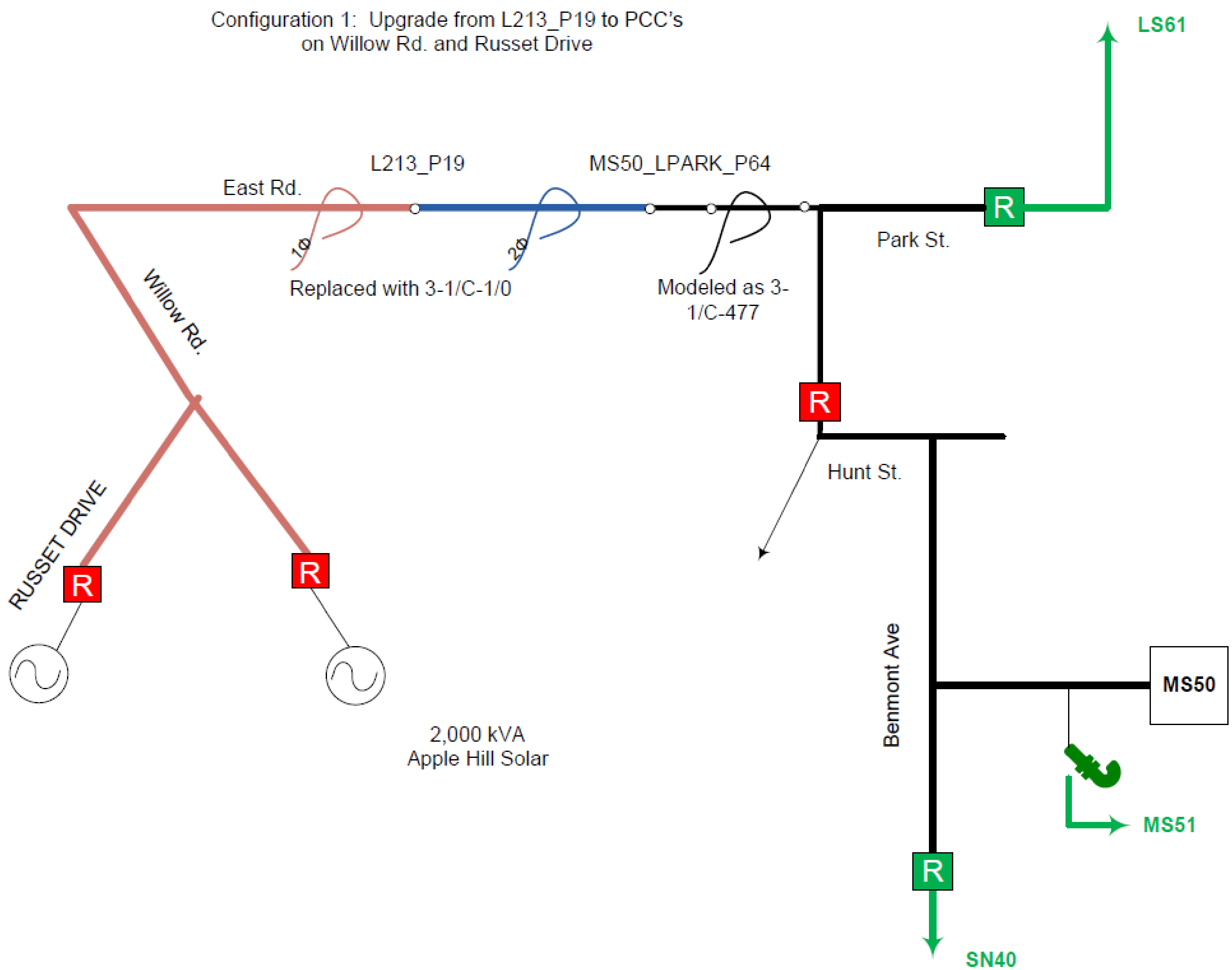


Figure 8: Configuration #1 - Simplified One-Line

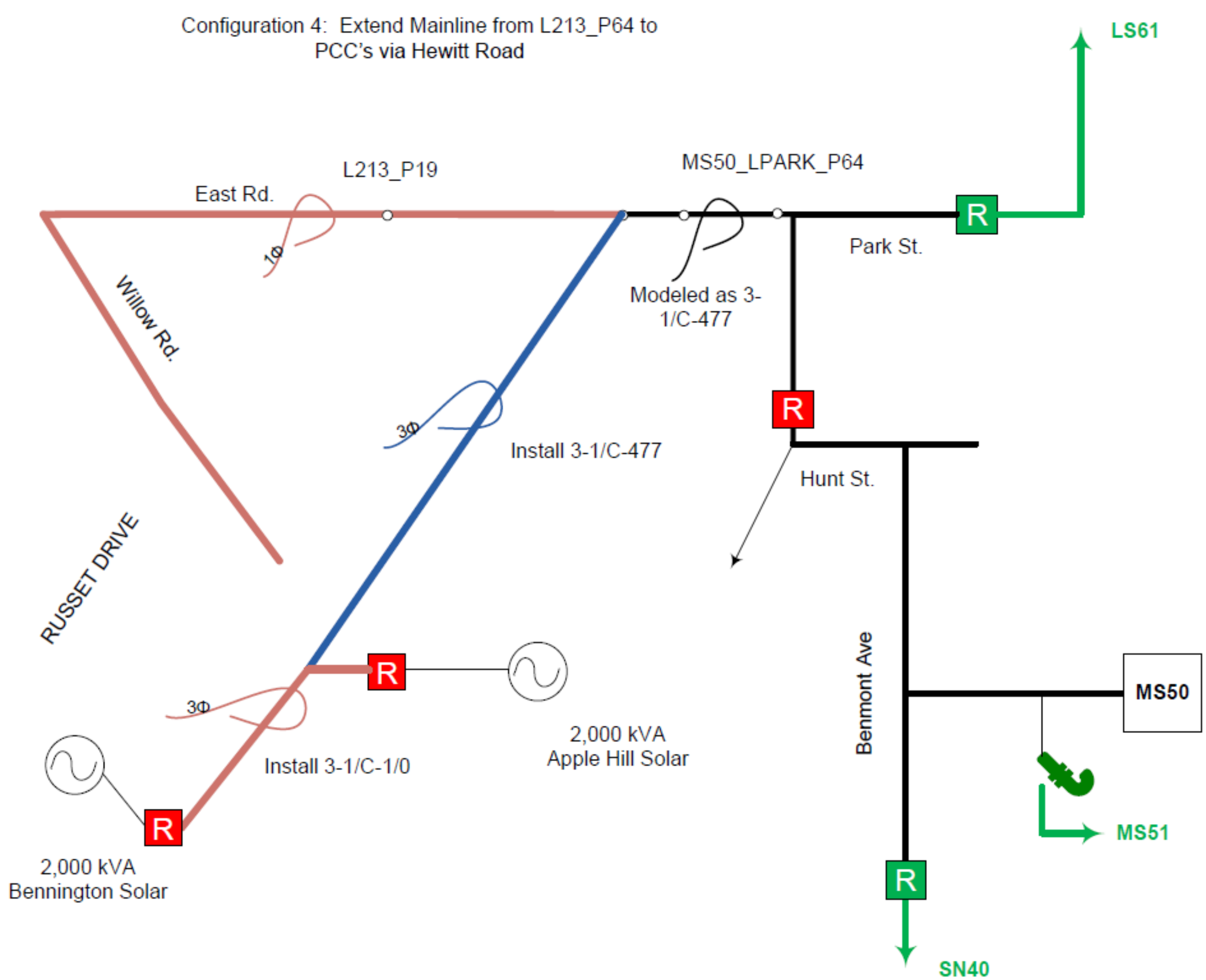


Figure 9: Configuration #4 – Simplified One-Line

Flicker Data Summary
Configuration #1
MS50_L21362_P13-03PM

Minute Nodal Analysis

	Times Above Borderline of Irritation/Minute	Times Above Borderline of Visibility/Minute
A Phase	1	190
B Phase	0	155
C Phase	0	155

Maximum % Change (V/s) in Sample		
A Phase	Max Delta Va	1.92%
B Phase	Max Delta Vb	1.79%
C Phase	Max Delta Vc	1.85%

Maximum % Change in a rolling 60 Second Sample

		% Change	Flicker/Minute
A Phase	%Va Average Fluctuation	1.92%	1
B Phase	%Vb Average Fluctuation	1.79%	1
C Phase	%Vc Average Fluctuation	1.85%	1

Maximum Observed Voltage	Volts
A Phase	125.1
B Phase	127.8
C Phase	128.8

Maximum Fluctuations per Minute

		Flicker/Minute	% Change
A Phase	Max Per Minute Fluctuation	9	0.70%
B Phase	Max Per Minute Fluctuation	9	0.68%
C Phase	Max Per Minute Fluctuation	8	0.70%

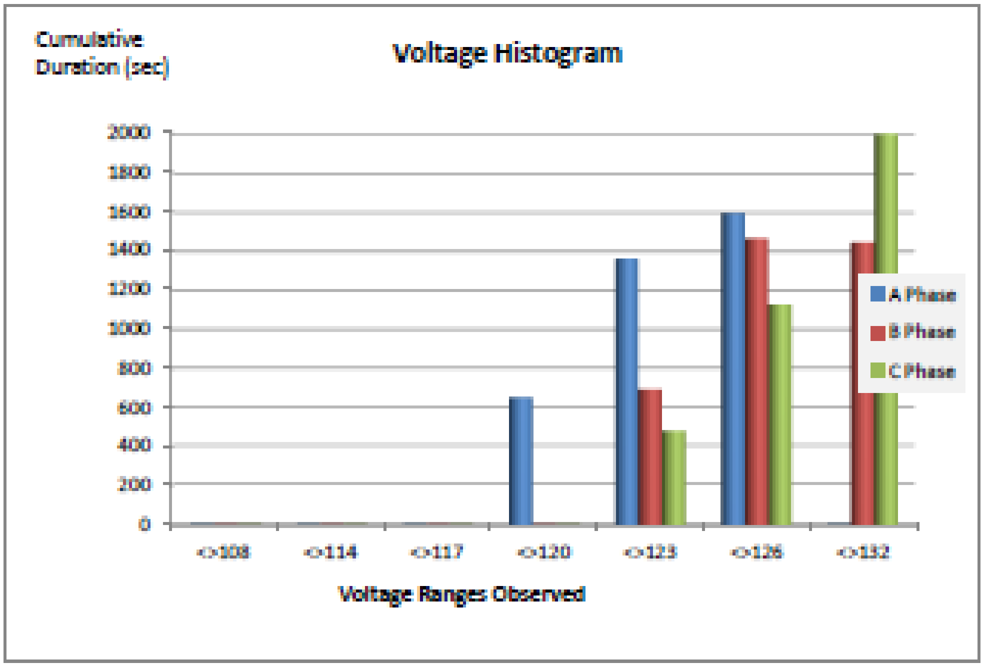


Figure 10: PCC Flicker Results Configuration 1 @ Unity PF

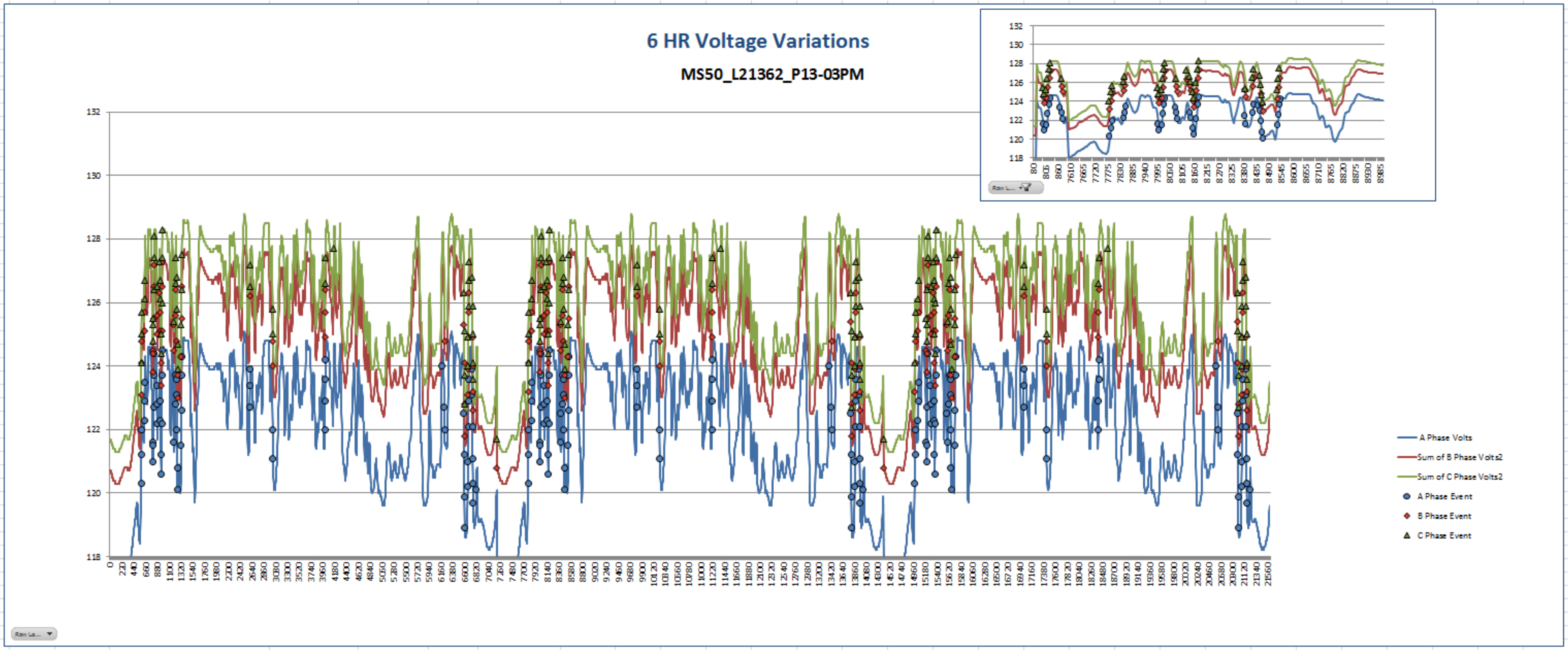
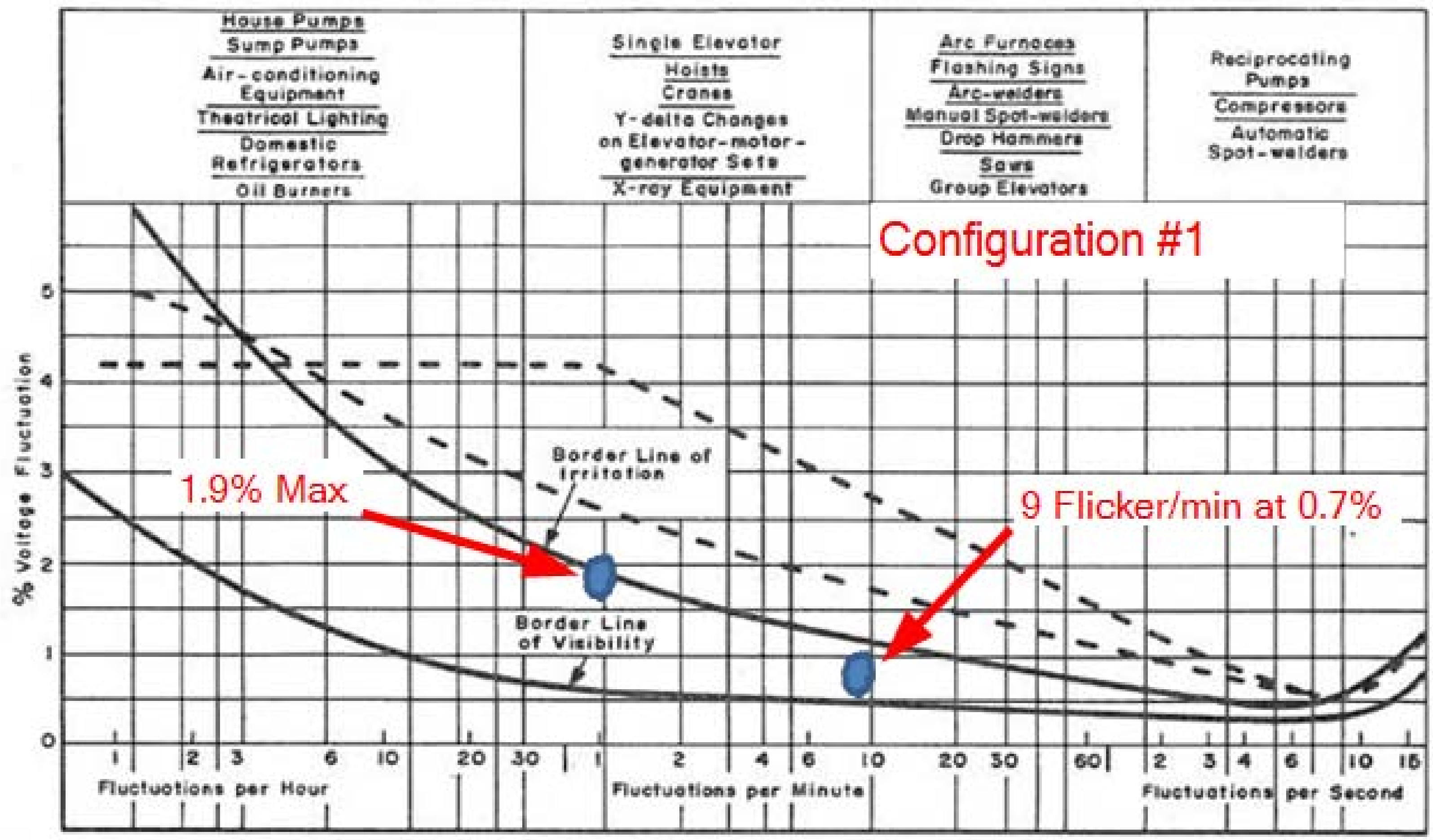


Figure 11: PCC Voltage Profile Configuration 1 @ Unity PF



Solid Lines composite curves of voltage flicker studies by General Electric Company, *General Electric Review* August 1925; Kansas City Power & Light Company, *Electrical World*, May 19, 1934; T. & D. Committee, EEI, October 24, 1934, Chicago; Detroit Edison Company; West Pennsylvania Power Company; Public Service Company of Northern Illinois.

Dotted Lines voltage flicker allowed by two utilities, references *Electrical World* November 3, 1958 and June 26, 1961.

Figure 12: GE Flicker Curve Configuration #1

Flicker Data Summary
Configuration #1
MS50_L21362_P13-03PM

Minute Nodal Analysis

	Times Above Borderline of Irritation/Minute	Times Above Borderline of Visibility/Minute
A Phase	1	190
B Phase	0	155
C Phase	0	155

Maximum % Change (V/s) in Sample		
A Phase	Max Delta Va	1.92%
B Phase	Max Delta Vb	1.79%
C Phase	Max Delta Vc	1.85%

Maximum % Change in a rolling 60 Second Sample

		% Change	Flicker/Minute
A Phase	%Va Average Fluctuation	1.92%	1
B Phase	%Vb Average Fluctuation	1.79%	1
C Phase	%Vc Average Fluctuation	1.85%	1

Maximum Observed Voltage	Volts
A Phase	125.1
B Phase	127.8
C Phase	128.8

Maximum Fluctuations per Minute

		Flicker/Minute	% Change
A Phase	Max Per Minute Fluctuation	9	0.70%
B Phase	Max Per Minute Fluctuation	9	0.68%
C Phase	Max Per Minute Fluctuation	8	0.70%

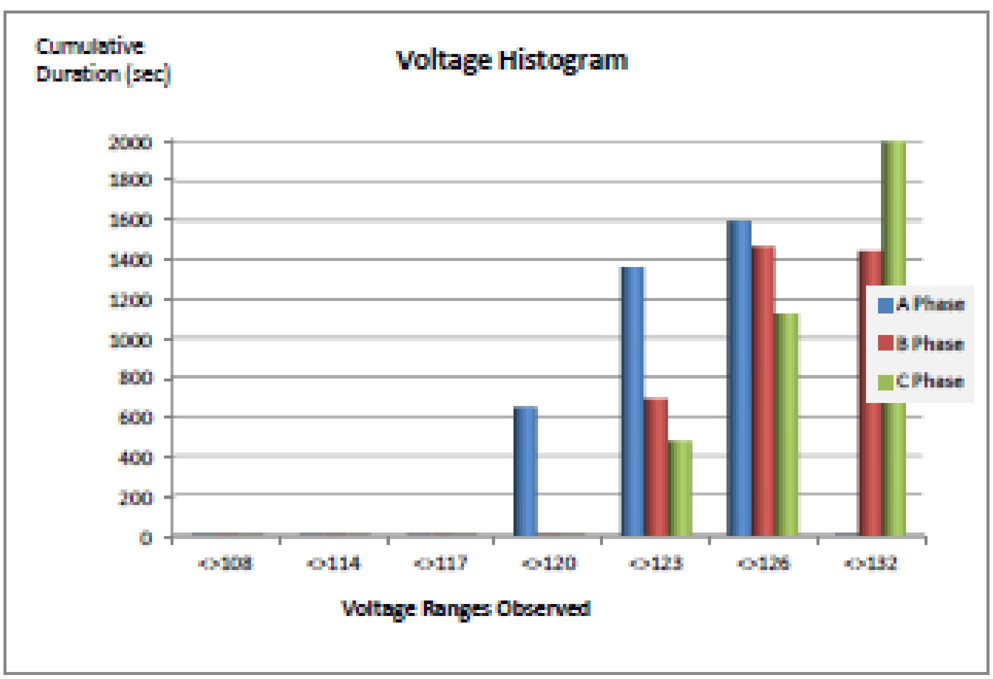


Figure 13: PCC Flicker Summary Configuration #1 @ +99% PF

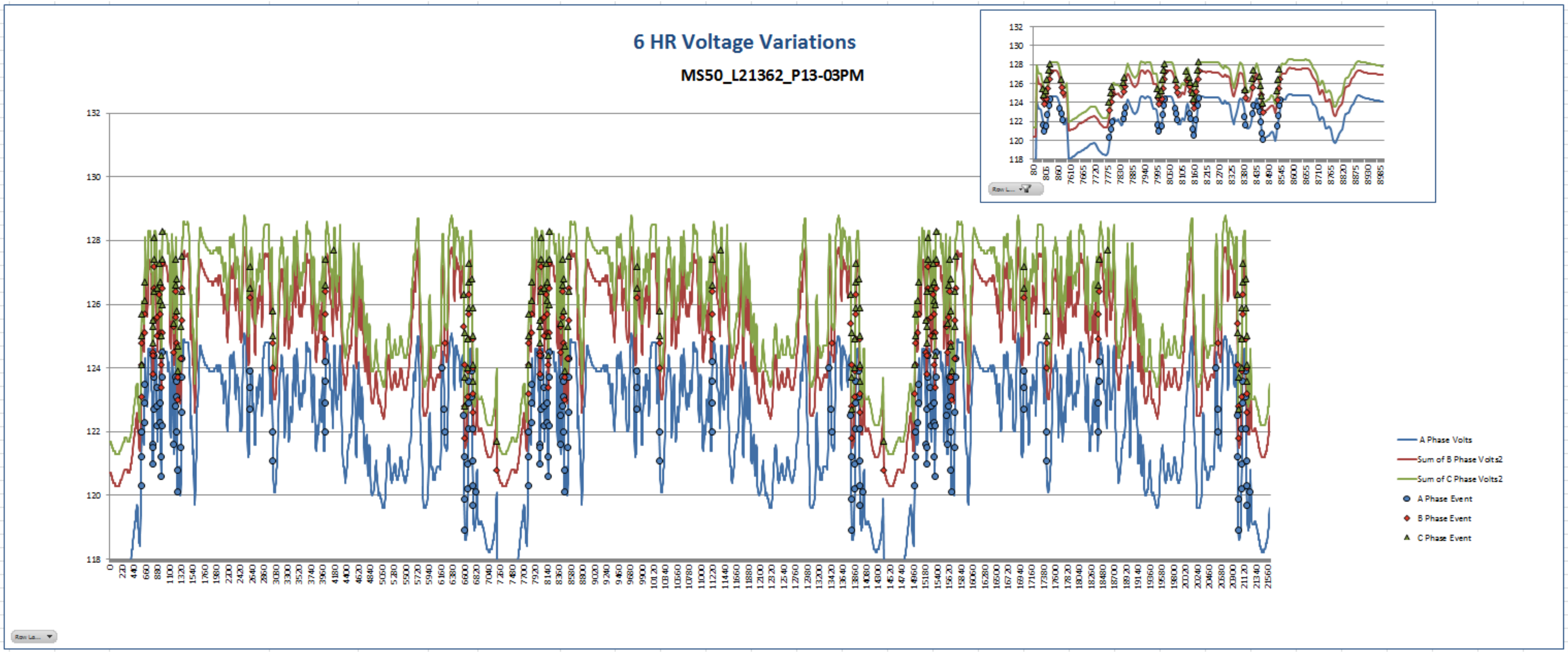


Figure 14: PCC Voltage Profile Configuration #1 @ +99% PF

Flicker Data Summary
Configuration #1
MS50_L21362_P13-03PM

Minute Nodal Analysis

	Times Above Borderline of Irritation/Minute	Times Above Borderline of Visibility/Minute
A Phase	1	190
B Phase	0	155
C Phase	0	155

Maximum % Change (V/s) in Sample		
A Phase	Max Delta Va	1.92%
B Phase	Max Delta Vb	1.79%
C Phase	Max Delta Vc	1.85%

Maximum % Change in a rolling 60 Second Sample

		% Change	Flicker/Minute
A Phase	%Va Average Fluctuation	1.92%	1
B Phase	%Vb Average Fluctuation	1.79%	1
C Phase	%Vc Average Fluctuation	1.85%	1

Maximum Observed Voltage	Volts
A Phase	125.1
B Phase	127.8
C Phase	128.8

Maximum Fluctuations per Minute

		Flicker/Minute	% Change
A Phase	Max Per Minute Fluctuation	9	0.70%
B Phase	Max Per Minute Fluctuation	9	0.68%
C Phase	Max Per Minute Fluctuation	8	0.70%

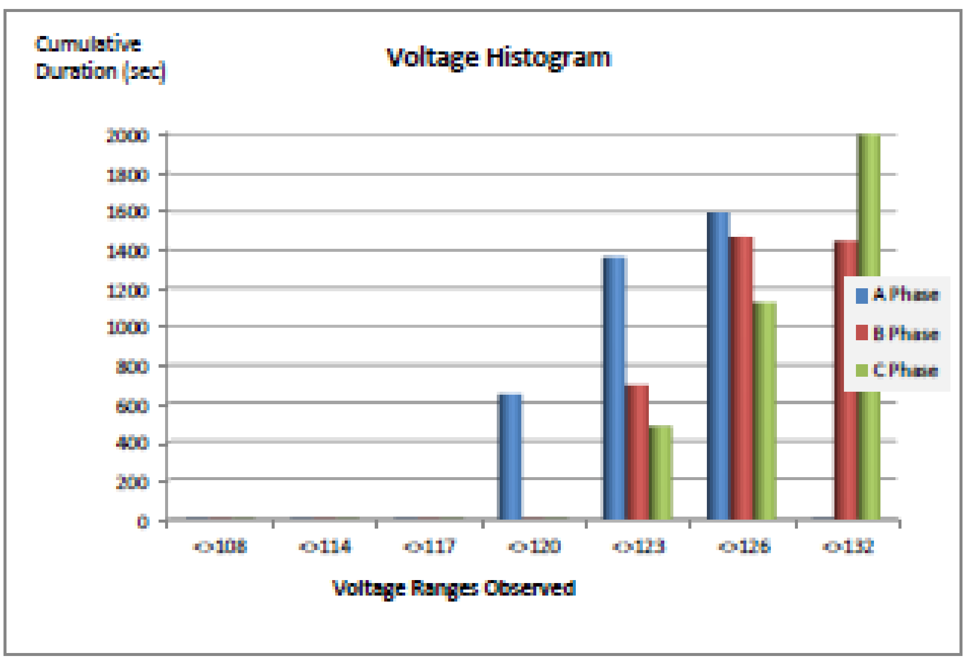


Figure 15: PCC Flicker Summary Configuration #1 @ -99% PF

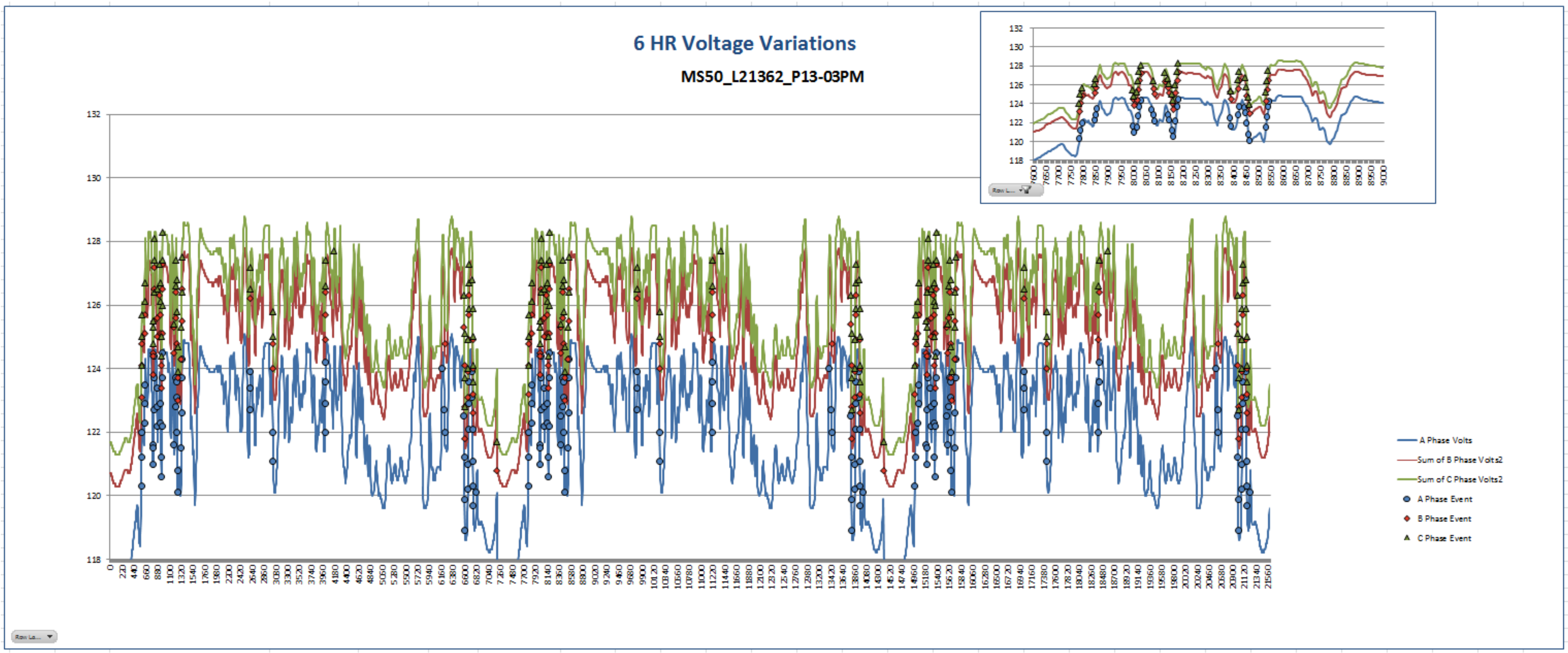


Figure 16: PCC Voltage Profile Configuration #1 @ -99% PF

Flicker Data Summary
Configuration #4
Bennington PCC

Minute Nodal Analysis

	Times Above Borderline of Irritation/Minute	Times Above Borderline of Visibility/Minute
A Phase	0	1
B Phase	0	2
C Phase	0	3

Maximum % Change (V/s) in Sample

A Phase	Max Delta Va	0.67%
B Phase	Max Delta Vb	0.75%
C Phase	Max Delta Vc	0.75%

Maximum % Change in a rolling 60 Second Sample

		% Change	Flicker/Minute
A Phase	%Va Average Fluctuation	0.67%	1
B Phase	%Vb Average Fluctuation	0.75%	1
C Phase	%Vc Average Fluctuation	0.75%	1

Maximum Observed Voltage

	Volts
A Phase	121
B Phase	122.3
C Phase	122.4

Maximum Fluctuations per Minute

		Flicker/Minute	% Change
A Phase	Max Per Minute Fluctuation	2	0.42%
B Phase	Max Per Minute Fluctuation	2	0.41%
C Phase	Max Per Minute Fluctuation	2	0.41%

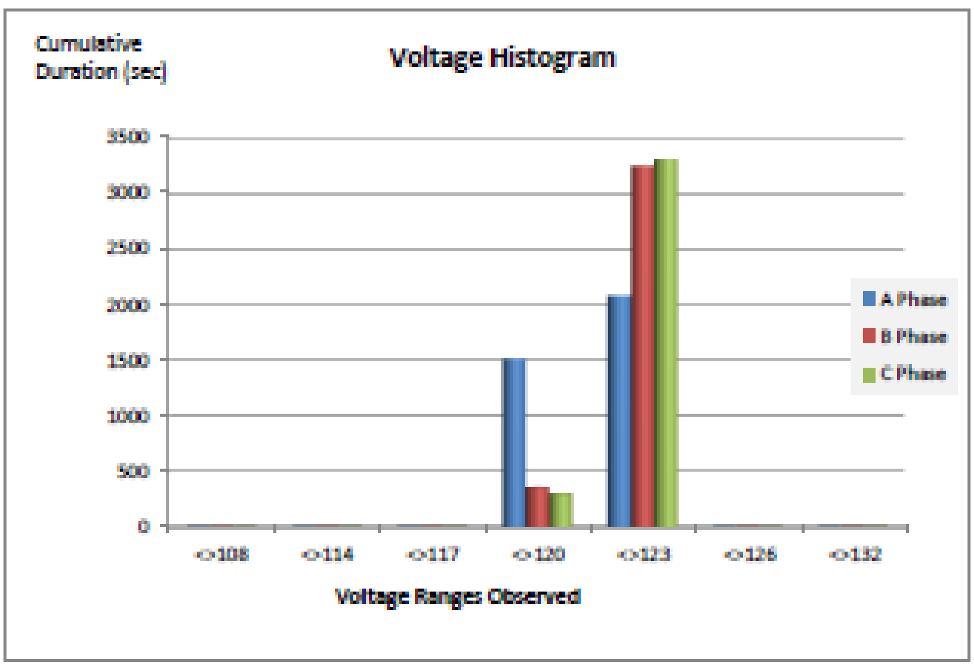


Figure 17: PCC Flicker Results - Configuration 4 @ Unity PF

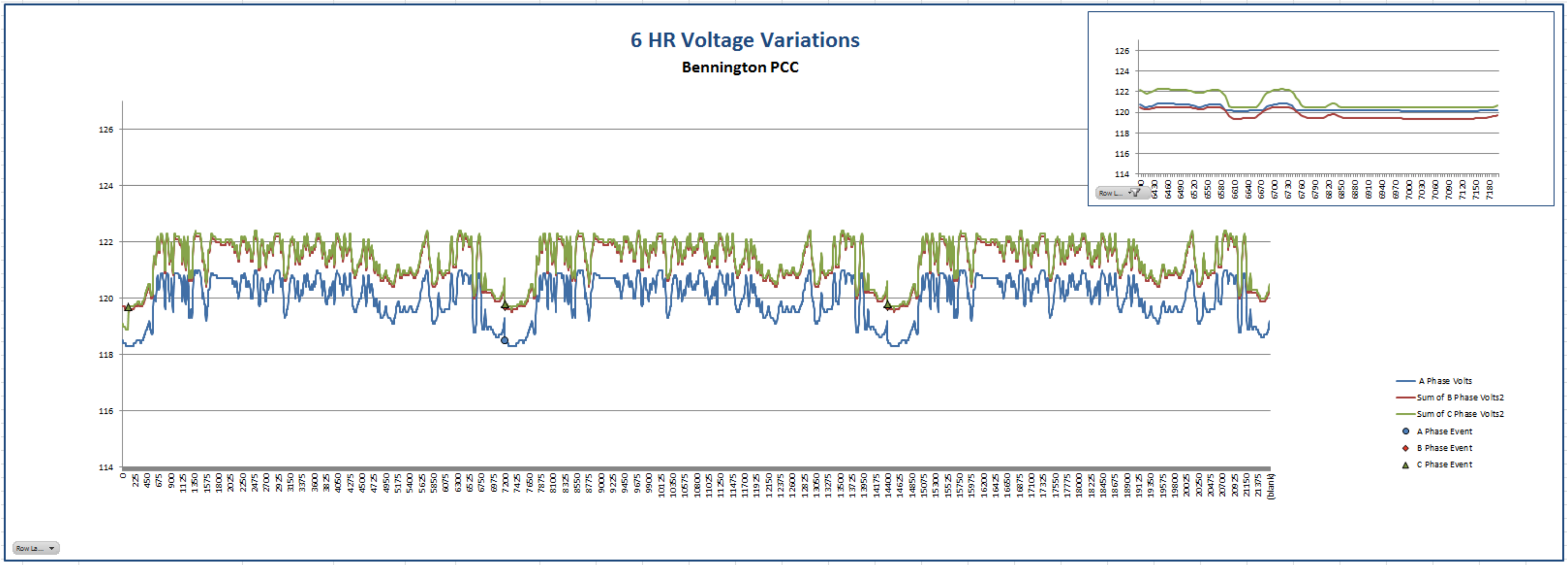
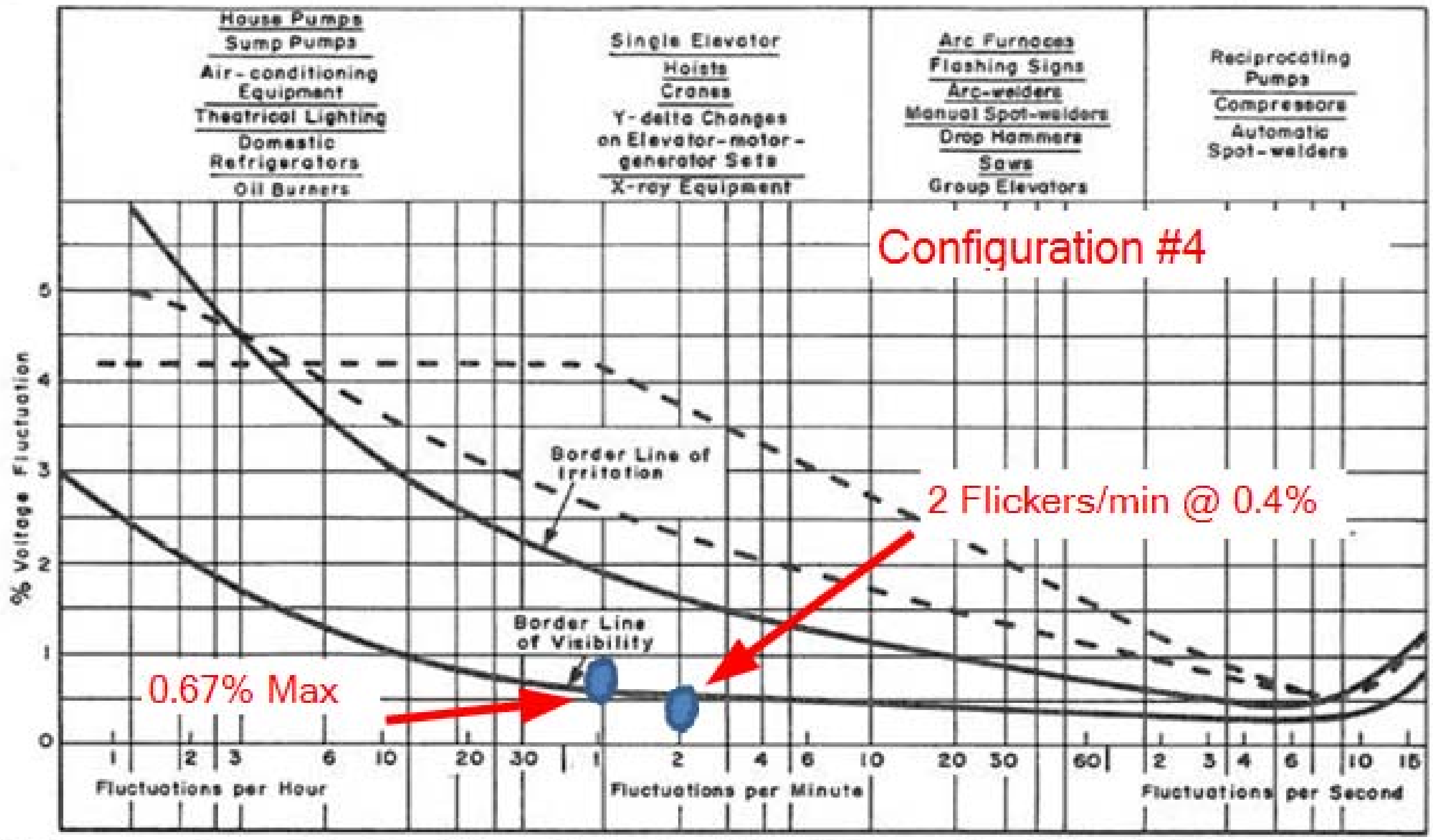


Figure 18: PCC Voltage Profile Configuration 4 @ Unity PF



Solid Lines composite curves of voltage flicker studies by General Electric Company, *General Electric Review* August 1925; Kansas City Power & Light Company, *Electrical World*, May 19, 1934; T. & D. Committee, EEI, October 24, 1934, Chicago; Detroit Edison Company; West Pennsylvania Power Company; Public Service Company of Northern Illinois.

Dotted Lines voltage flicker allowed by two utilities, references *Electrical World* November 3, 1958 and June 26, 1961.

Figure 19: GE Flicker Curve Configuration #4

Flicker Data Summary
Configuration #4
Bennington PCC

Minute Nodal Analysis

	Times Above Borderline of Irritation/Minute	Times Above Borderline of Visibility/Minute
A Phase	0	1
B Phase	0	1
C Phase	0	1

Maximum % Change (V/s) in Sample		
A Phase	Max Delta Va	0.66%
B Phase	Max Delta Vb	0.66%
C Phase	Max Delta Vc	0.66%

Maximum % Change in a rolling 60 Second Sample

		% Change	Flicker/Minute
A Phase	%Va Average Fluctuation	0.66%	1
B Phase	%Vb Average Fluctuation	0.66%	1
C Phase	%Vc Average Fluctuation	0.66%	1

Maximum Observed Voltage	Volts
A Phase	122.5
B Phase	122.9
C Phase	123.1

Maximum Fluctuations per Minute

		Flicker/Minute	% Change
A Phase	Max Per Minute Fluctuation	2	0.41%
B Phase	Max Per Minute Fluctuation	2	0.41%
C Phase	Max Per Minute Fluctuation	2	0.41%

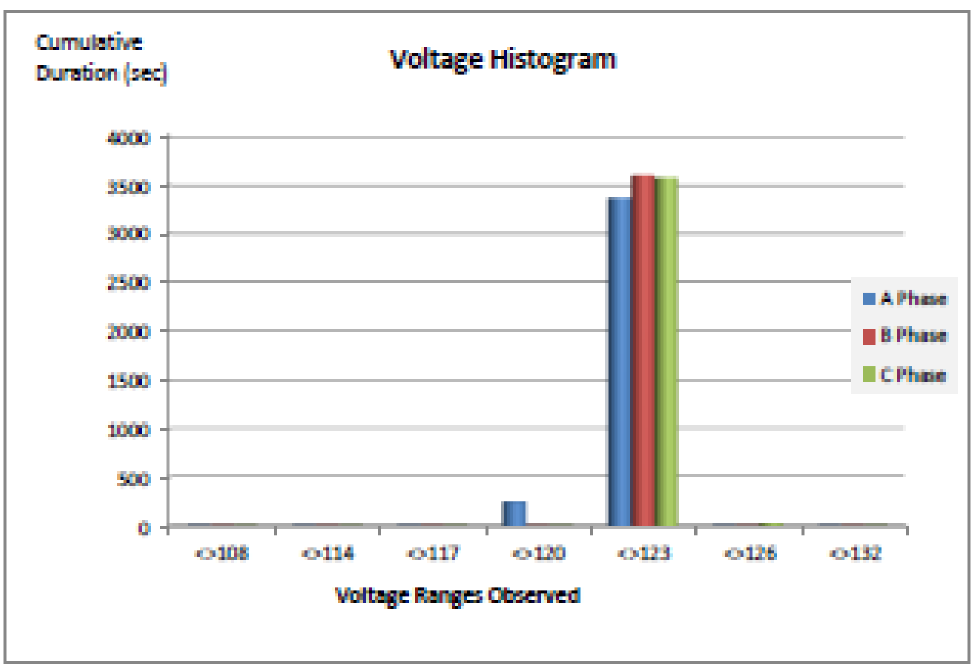


Figure 20: PCC Flicker Summary – Configuration 4 @ +99% PF

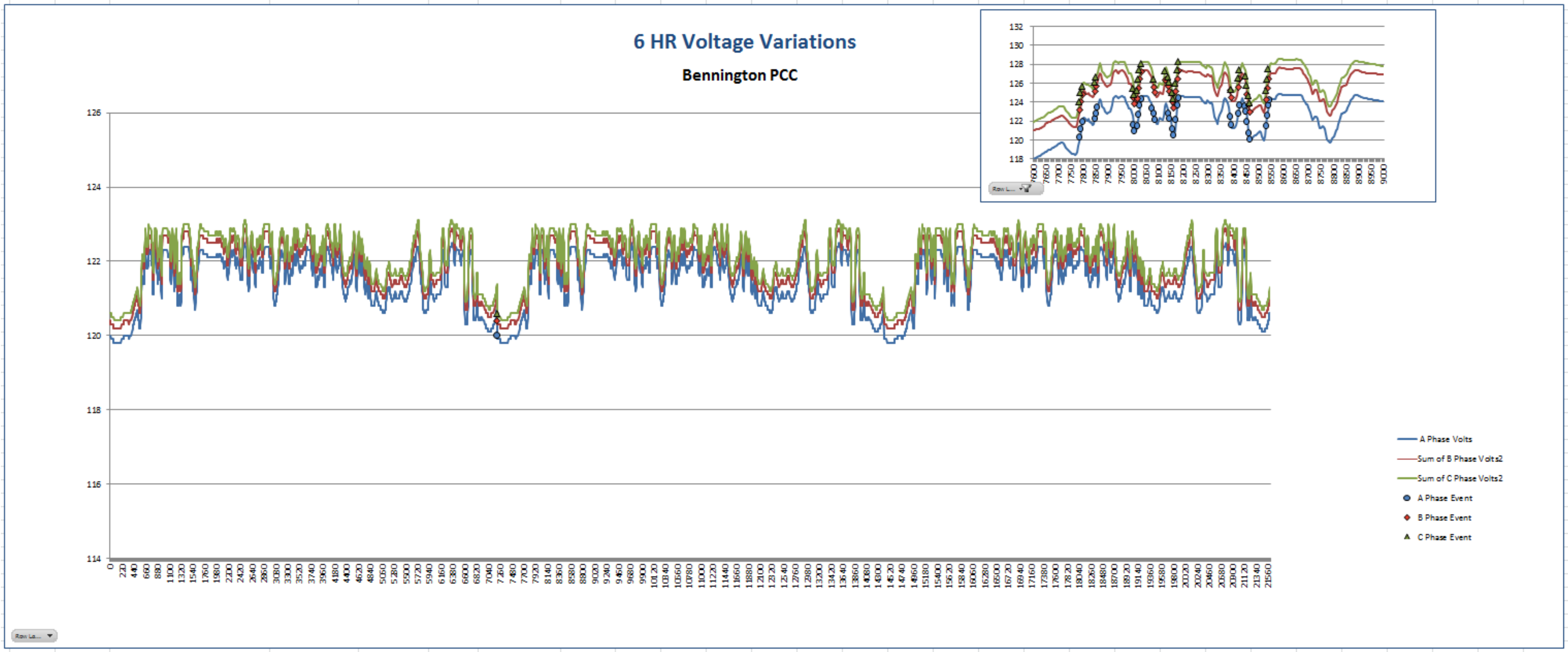


Figure 21: PCC Voltage Profile – Configuration 4 @ +99% PF

Flicker Data Summary
Configuration #4
Bennington PCC

Minute Nodal Analysis

	Times Above Borderline of Irritation/Minute	Times Above Borderline of Visibility/Minute
A Phase	0	1
B Phase	0	1
C Phase	0	1

Maximum % Change (V/s) in Sample		
A Phase	Max Delta Va	0.66%
B Phase	Max Delta Vb	0.66%
C Phase	Max Delta Vc	0.66%

Maximum % Change in a rolling 60 Second Sample

		% Change	Flicker/Minute
A Phase	%Va Average Fluctuation	0.66%	1
B Phase	%Vb Average Fluctuation	0.66%	1
C Phase	%Vc Average Fluctuation	0.66%	1

Maximum Observed Voltage	Volts
A Phase	122.5
B Phase	122.9
C Phase	123.1

Maximum Fluctuations per Minute

		Flicker/Minute	% Change
A Phase	Max Per Minute Fluctuation	2	0.41%
B Phase	Max Per Minute Fluctuation	2	0.41%
C Phase	Max Per Minute Fluctuation	2	0.41%

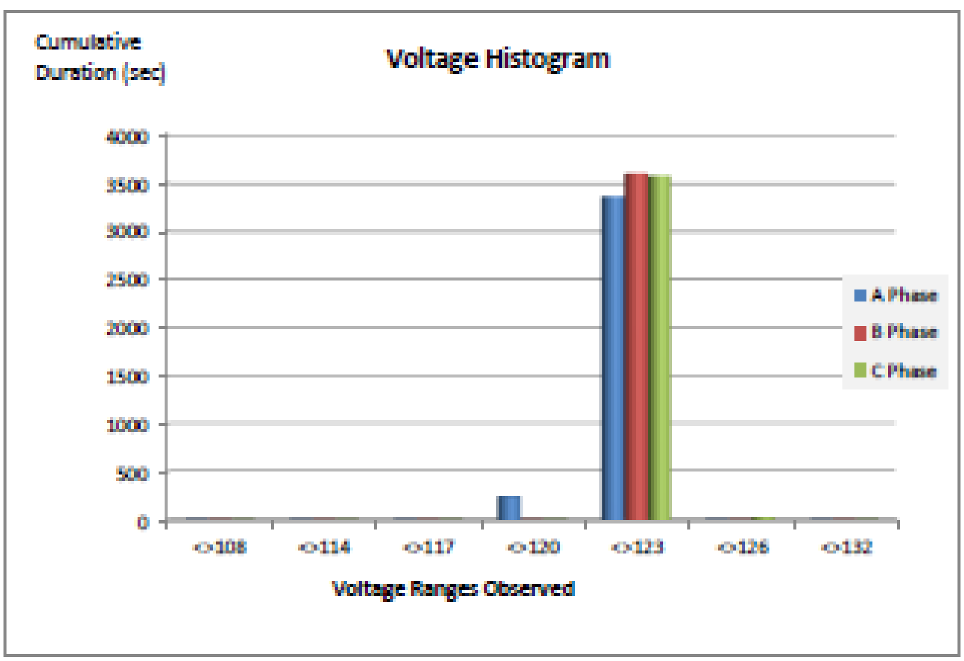


Figure 22: PCC Flicker Summary – Configuration 4 @ -99% PF

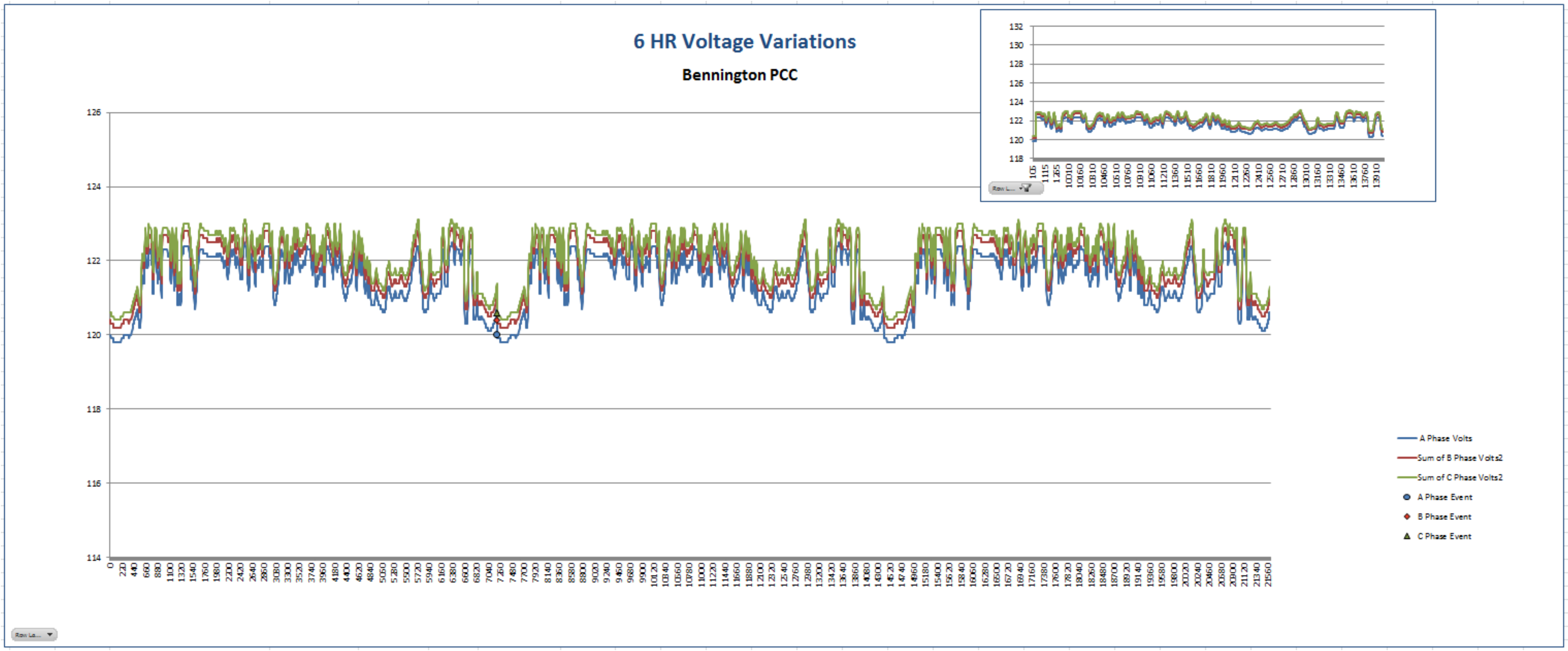


Figure 23: PCC Voltage Profile Configuration #4 @ -99% PF

This Sheet is to be used when Circuit True Power (kW) and Reactive Power (kVAR) are known.
All values in **BLACK BOLD** are User Entered.
All values in **RED BOLD** are calculated.

Is there a Possible Load Match	Y
Are there other PV's on proposed circuit a with different Manufacturer than this Project.	**N**
Are there Reciprocating Generators on this Circuit, if yes move to #3 if no move to #4	**N**
Reciprocating Generator Rating	**0**
Total Aggregate PV on Circuit	**4,000**
Circuit Power Factor	**0.992155065**
Circuit Apparent Power	**2263.759042**
Circuit True Power	**2246**
Circuit Reactive Power	**-283**
Total Aggregate Line Capacitors **Qcap**	**900**
PV System Reactive Output **Qpv**	**564**
Circuit Load Reactive Part **Qload**	**617**
ANTI ISLANDING CRITERIA	**0.762066046**
	ANTI ISLANDING STUDY NOT REQUIRED

Figure 24: Anti-Islanding Analysis

Appendix A – Chelsea Solar Interconnection Estimate

10/14/14

WR #: 254216

Green Mountain Power
Line Extension Cost Calculation

Town Bennington
Line Park
Pole From
Pole To
Chelsea Solar

Est. Date: 10/13/2014 08:52:29

3 Ø OHD NJ CO CONST
Tariff Eff. 10/8/2008

Customer ECOS ENERGY LLC
Address SUITE 1600
222 SOUTH 9TH STREET
MINNEAPOLIS,MN 55402

Description	Qty	Unit Cost/ Percent	Total Cost
APPLICATION FEE- NONREFUNDABLE	1.00	580.00	$580.00
PRIMARY LINE - LAST POLE	1.00	1,820.00	$1820.00
PRIMARY LINE - EACH ADD POLE	7.00	980.00	$6860.00
PRIMARY LINE - CONDUCTOR/FOOT	1,240.00	6.10	$7564.00
SECONDARY LINE - LAST POLE		1,190.00	
SECONDARY LINE - EACH ADD POLE		550.00	
SECONDARY LINE CONDUCTOR/FOOT		2.80	
TRIMMING			$2000.00
EACH GUY/ANCHOR/BRACE	6.00	130.00	$780.00
ADDITIONAL CHG FOR ROCK LEDGE		410.00	
SERVICE DROP/FT (100 AMP) 1 Ø		2.10	
SERVICE DROP/FT (200 AMP) 1 Ø		2.90	
SERVICE DROP/FT (300 AMP) 1 Ø		6.40	
SERVICE DROP/FT (400 AMP) 1 Ø		7.30	
SERVICE DROP/FT (175 AMP) 3 Ø		3.20	
SERVICE DROP/FT (270 AMP) 3 Ø		7.10	
SERVICE DROP/FT (330 AMP) 3 Ø		8.60	
URD SERVICE CONNECTION	1.00	210.00	$210.00
RIGHT OF WAY IN EXCESS OF 1		220.00	
OTHER SPECIAL CONST CHARGES			$78560.00
TRAFFIC CONTROL			
RELOC &/OR ADD Ø EST (PRE-TAX)			
SERVICE CREDIT	1.00	-210.00	($210.00)
OTHER CUSTOMER CREDIT			
LIVING UNITS IN EXCESS OF 1		-210.00	
Subtotal for Tax Assessment Purposes			$98164.00
UTILITY TAX LIABILITY ARISING UNDER FEDERAL TAX REFORM ACT OF 1986		34.80	
Total Contribution in Aid of Construction			$98164.00
Less:			
MISC OR RELOC AFTER TAX CREDIT			
Total credits after tax			$0.00
Plus:			
REMOVAL COST/HR		49.00	

Appendix A – Chelsea Solar Interconnection Estimate

10/14/14

WR #: 254216

Green Mountain Power
Line Extension Cost Calculation

Town __________
Line __________
Pole From __________
Pole To __________

Est. Date: 10/13/2014 08:52:29

3 Ø OHD NJ CO CONST
Tariff Eff. 10/8/2008

Customer ECOS ENERGY LLC
Address SUITE 1600
222 SOUTH 9TH STREET
MINNEAPOLIS MN 55402

Description	Qty	Unit Cost/ Percent	Total Cost
Plus:			
TRANSFER COST/HR		49.00	
Total other costs			$0.00
Subtotal of charges and credits			$98,164.00
PRORATA SHARE OF EXISTING LNEX			
Total Balance Due the Company			$98,164.00
Prepaid:			
APPLICATION FEE- ALREADY PAID			($580.00)
SUBTOTAL OF OTHER PAYMENTS			
Remaining Balance Due the Company			$97,584.00

Signature of Applicant: ____________________ Date: __________

Comments:

RECEIVED
By Ryan Rainville at 4:20 pm, May 30, 2013

Vermont Public Service Board Standard Application Form to Rule 5.500

STANDARD APPLICATION FOR INTERCONNECTION OF GENERATION RESOURCES IN PARALLEL TO THE ELECTRIC SYSTEM OF: Green Mountain Power
(Name of Utility)

Shaded area to be completed by Interconnecting Utility

Interconnecting Utility: Green Mountain Power
Interconnecting Utility's Designated Contact Person: Melinda Humphrey
Interconnecting Utility's Address: Energy Innovation Center, 67 Merchants Row Suite 104, Rutland, VT 05701
Interconnecting Utility's Fax Number: ______
Interconnecting Utility's E-Mail Address: Melinda.Humphrey@greenmountainpower.com
Substation ______ Circuit ______ ☒ Distribution ☐ Transmission

Preamble and Instructions:
An owner of a generation resource who requests interconnection to a State regulated distribution or transmission facility must submit an application to the Interconnecting Utility. An application is accepted as complete when it provides all applicable information required. There is a **$300.00** Application fee that must be submitted to the Interconnecting Utility along with the Application.

Section 1. Applicant Information
A. Legal Name of Interconnecting Applicant (or, if an Individual, Individual's Name)
Name: Bennington Solar LLC
Mailing Address: 222 South 9th Street Suite 1600
City: Minneapolis State: MN Zip Code: 55402
Facility Location: End of Russett Drive, Bennington VT - Switchgear # L2 1362 PM13-03
(Facility E-911 address)
Telephone (Daytime): (612) 655 - 9749 (Alternate): (____) ____ - ______
Fax Number: ______ E-Mail Address: tim.young@ecosrenewable.com

B. Alternative Contact Information (if different from Applicant)
Contact Name: Timothy Young
Contact Title: Vice President
Address: 222 South 9th Street Suite 1600
______
Telephone (Daytime): (612) 655 - 9749 (Alternate): (____) ____ - ______
Fax Number: ______ E-Mail Address: tim.young@ecosrenewable.com

C. Will the Generation Resource be used for any of the following:
To supply power to internal loads (other than the station itself)? ☐ Yes ☐ No
To participate in the SPEED Standard Offer Program? ☒ Yes ☐ No

D. For generators installed at locations with existing electric service:
(Local Electric Service Provider*) ______
(Existing Account Number*) ______

E. Additional Information
Requested Point of Interconnection: End of Russett Drive, Bennington VT - Switchgear # L2 1362 PM13-03
Interconnection Applicant's requested in-service date: 6/30/2014

Section 2. Generator Qualifications
All data applicable only to the generator facility, NOT the necessary interconnection facilities

Energy source:
☒ Solar ☐ Wind ☐ Hydro ☐ Diesel ☐ Natural Gas ☐ Fuel Oil ☐ Other__________
(state type)

Type of Generator:
☐ Synchronous ☐ Induction ☒ Inverter (DC Generator or Solar)

Generator Manufacturer: Advanced Energy
Generator Model Name & Number: (4) NX-500HE
Generator Nameplate Rating: 2,000 kW (Total if multiple units)
Generator Nameplate kVAR: >0.99 PF @ rated pwr., +-.95 PF range
Applicant or Customer-Site Load: None kW (if none, so state)
Typical Reactive Load (if known) +-164kVAr range
Maximum Physical Export Capability Requested: 2,000 kW

Section 3. Generator Technical Information

a. *Induction or Synchronous Generators (for rotating machines)*

N/A

Rated Po ____________
Rated Po ____________
List of Ac protective equipment or software: ____________
Direct Axis Transient Reactance, X'd: ____________ P.U.
Direct Axis Unsaturated Transient Reactance, X'di: ____________ P.U.
Direct Axis Subtransient Reactance, X"d: ____________ P.U.
Generator Saturation Constant (1.0): ____________
Generation Saturation Constant (1.2): ____________
Negative Sequence Reactance: ____________ P.U.
Zero Sequence Reactance: ____________ P.U.
kVA Base: ____________
RPM Frequency: ____________
*Field Volts ____________
*Field Amperes ____________
*Motoring Power (kW) ____________
*Neutral Grounding Resistor (If Applicable) ____________
*I22t or K (Heating Time Constant) ____________
*Rotor Resistance ____________
*Stator Resistance *Stator Reactance ____________
*Rotor Reactance*Magnetizing Reactance ____________
*Short Circuit Reactance ____________
*Exciting Current ____________
*Temperature Rise ____________
*Frame Size *Design Letter ____________
*Reactive Power Required In Vars (No Load) ____________
*Reactive Power Required In Vars (Full Load) ____________
*Total Rotating Inertia, H: ____________ Per Unit on kVA Base

b. For Wind Turbines

Total Number of turbines to be interconnected pursuant to this application:_______________

Height to blade t[ip] Blade diameter __________

Quantity of Turb[ines] Size (KW) Each __________

N/A

c. For Solar or DC sources

Inverter Manufacturer, Model Name & Number : Advanced Energy NX-500HE

Quantity of Inverters 4 Size KW Each 500

Panel Manufacturer, Model Name & Number: Trina TSM-PA14

Quantity of panels 7,920 Size (Watts) Each 300

Inverters are UL1741 listed ☒ Yes ☐ No

Section 4. Interconnection Equipment Technical Data *(for generation over 20 KW)*

Will a transformer (GSU) be used between the generator and the point of interconnection? ☒ Yes ☐ No

Will the transformer be provided by Interconnection Applicant? ☒ Yes ☐ No

Is the Transformer three phase? ☒ Yes ☐ No

Is the Transformer pad mounted or Pole mounted? ☒ Pad ☐ Pole

Transformer Size: 2,000 kVA Impedance: 5.75 % on 2,000 kVA Base

Interconnection Voltage (GSU Data)

Transformer Primary: 12,470 Volts ☐ Single Phase ☐ Delta ☐ Wye ☒ Grounded Wye

Transformer Secondary: 480 Volts ☐ Single Phase ☐ Delta ☐ Wye ☒ Grounded Wye

Other Transformer information ____

Interconnecting Circuit Breaker (if applicable):

Manufacturer: Hubble Type: D7 (Pole or Pad) Load Rating: 125A Interrupting Rating: 900A

Trip Speed: TBD

Current Transformer (CT) Data (if applicable):

Manufacturer: NA Type: __________ Accuracy Class: ________ Ratio: _______

Potential Transformer Data (if applicable):

Manufacturer: NA Type: __________ Accuracy Class: ________ Ratio: _______

Section 5. General Site Information

a. Enclose copy of site electrical One-Line Diagrams showing the configuration of all generating facility equipment, current and potential circuits, and protection and control schemes.
[Note: This one-line diagram must be signed and stamped by a licensed Professional Engineer if the generating facility is larger than 150 kW.]

b. Enclose copy of any site documentation that describes and details the operation of the protection and control schemes.

c. Enclose copies of schematic drawings for all protection and control circuits, relay current circuits, relay potential circuits, and alarm/monitoring circuits (if applicable).

d. Enclose copy of any site documentation that indicates the precise physical location of the proposed generating facility (e.g. USGS topographic map or other diagram).

Section 6. Check List: Required Fee and Enclosures

Is an application fee enclosed? [X] Yes
Are One-Line Diagrams enclosed? [X] Yes
Is site documentation enclosed? [X] Yes
Are schematic drawings enclosed? [X] Yes [ ] No
Are site maps enclosed? [X] Yes

Section 7. Applicant Signature

I hereby certify that, to the best of my knowledge, all the information provided in the Interconnection Application is true and correct.

Signature of Applicant: ____________ Date: 05-24-13

Appendix C
Configuration #5

A fifth circuit configuration was considered and a screening was completed with this model. This configuration has the same circuit path as Configuration #4 but the three phase mainline extension was modeled as an extension of 3-1/C-336 Al with a 1/0 neutral instead of 3-1/C-477 Al. The screening analysis was completed for peak periods. The feeder back-up cases considered were the MS51 on the MS50, and the transfer of MS50 load onto the LS61.

During normal circuit conditions, there were no indications of out-of-limit voltages on the MS50. The results of the simulation are shown in Table 26 below. When run at unity or -99% power factor, the generator does not adversely affect the voltage change or voltage levels. When compared to the analysis for Configuration #4 (Table 16), the change in voltage is slightly higher. The voltage level at the PCC is also slightly higher. This trend is visible in the results for the feeder back-up cases.

Configuration #5 - MS50																
	Max Load 3.91 MVA @ 98.9% PF lagging															
Gen Output	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC - Bennington Solar							Mill St. Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	OFF	OFF	0.995	1.004	1.007	-	-	-	-	1.013	1.011	1.008	364	3786	100%
	NA	-3973	214	1.023	1.032	1.033	-100%	2.75%	2.75%	2.67%	1.018	1.017	1.014	597	-157	-25%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3934	-358	1.035	1.044	1.046	-100%	4.00%	4.00%	3.92%	1.025	1.023	1.020	4	-121	-100%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3932	787	1.009	1.021	1.021	-98%	1.42%	1.67%	1.42%	1.012	1.009	1.008	1195	-112	-9%

Table 25: Configuration 5 – Maximum Load, MS50

The feeder back-up case was considered for the MS51 on MS50 during peak conditions. The results are shown in Table 27. When operated at a unity or -99% power factor, the facility does not adversely affect the voltage change or voltage levels. As noted for the prior case, the percent voltage change and voltage levels are slightly higher than the results for Configuration #4 (Table 18).

Configuration #5 - MS51 ON MS50																
	Max Load 7.11 MVA @ 99% PF lagging															
Gen Output	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC - Bennington Solar							Mill St. Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	OFF	OFF	1.014	1.023	1.019	-	-	-	-	1.031	1.029	1.021	921	6909	99%
	NA	-3973	207	1.042	1.051	1.046	100%	2.75%	2.75%	2.67%	1.038	1.035	1.027	1139	2963	93%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3934	-365	1.054	1.063	1.058	99%	4.00%	3.92%	3.92%	1.044	1.043	1.033	540	3000	98%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3932	781	1.028	1.038	1.033	-99%	1.42%	1.42%	1.42%	1.030	1.028	1.020	1744	3009	87%

Table 26: Configuration #5 – Maximum Load, MS51 on MS50

The Bennington Self-Healing Network condition for transfer of the MS50 on the LS61 was also considered for peak conditions. The results are shown in Table 28. When operated at a unity or -99% power factor, the facility does not adversely affect the voltage change or voltage levels.

Appendix C
Configuration #5

Configuration #5 - MS50_L1222_P1 On LS61																
	Max Load 4.15 MVA @ 98.9% PF lagging															
Gen Output	Switched Capacitor Status	GEN Status kW	GEN Status kVAR	PCC - Bennington Solar							Lyons St. Sub - Load Side of Regulators					
				V PU A	V PU B	V PU C	PF	Delta VA	Delta VB	Delta VC	V PU A	V PU B	V PU C	KVAR*	KW	PF
GEN @ 1.0 PF	NA	OFF	OFF	0.983	0.993	0.993	-	-	-	-	1.011	1.006	1.005	558	3873	99%
	NA	-3972	219	1.011	1.021	1.022	100%	2.83%	2.83%	2.83%	1.014	1.008	1.008	716	-108	-15%
*GEN @ +0.99 PF (exporting Vars/Lagging)	NA	-3933	-353	1.023	1.033	1.033	99%	4.00%	4.00%	4.00%	1.020	1.014	1.013	129	-72	-49%
GEN @ -0.99 PF (importing Vars/Leading)	NA	-3931	793	0.998	1.008	1.009	-99%	1.50%	1.58%	1.58%	1.008	1.003	1.003	1311	-61	-5%

Table 27: Configuration #5 - Maximum Load, SNH L

The results of this screening analysis indicate that this configuration should not expose GMP customers to objectionable voltage changes or voltage levels if the Projects are limited to operating at unity or -99% power factor.

A dynamic load flow screening was completed for this configuration. The model was run at unity power factor during peak load conditions. The solar generator output was varied as previously completed. The flicker summary for configuration #5 is shown in Figure 26 below. A voltage profile for this analysis is shown in Figure 27.

The screening indicates that using the 3-1/C-336 conductors for the three phase extension should not create excessive flicker or voltage conditions. The maximum system voltage at the PCC is slightly higher in this configuration. The higher impedance path tends to create higher voltages during fluctuations in PV output.

Appendix C
Configuration #5

Flicker Data Summary
Configuration #5
Bennington PCC

Minute Nodal Analysis

	Times Above Borderline of Irritation/Minute	Times Above Borderline of Visibility/Minute
A Phase	0	2
B Phase	0	2
C Phase	0	2

Maximum % Change (V/s) in Sample		
A Phase	Max Delta Va	0.74%
B Phase	Max Delta Vb	0.74%
C Phase	Max Delta Vc	0.74%

Maximum % Change in a rolling 60 Second Sample

		% Change	Flicker/Minute
A Phase	%Va Average Fluctuation	0.74%	1
B Phase	%Vb Average Fluctuation	0.74%	1
C Phase	%Vc Average Fluctuation	0.74%	1

Maximum Observed Voltage	Volts
A Phase	122.7
B Phase	123.1
C Phase	123.3

Maximum Fluctuations per Minute

		Flicker/Minute	% Change
A Phase	Max Per Minute Fluctuation	2	0.41%
B Phase	Max Per Minute Fluctuation	2	0.41%
C Phase	Max Per Minute Fluctuation	2	0.41%

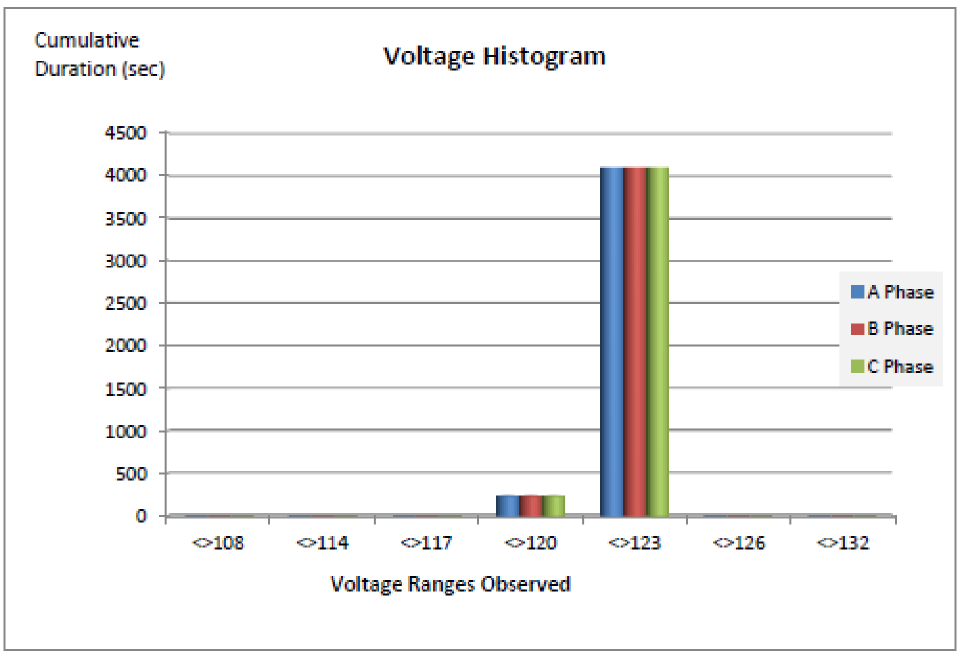


Figure 25: PCC Flicker Summary - Configuration #5 - Unity PF

Appendix C
Configuration #5

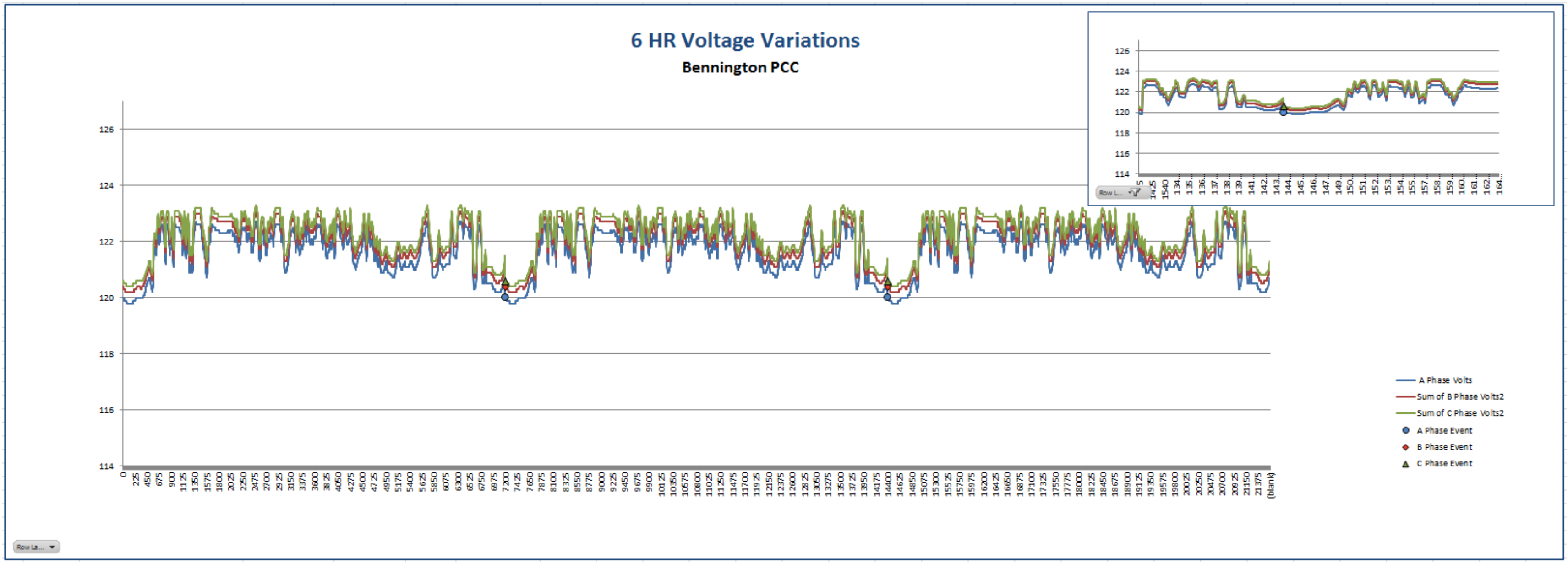


Figure 26: PCC Voltage Profile - Configuration #5 - Unity PF