
Consultancy Services for the Plant Audit in various Pump Stations and Reservoirs (OP18REFCS03)

Technical Report for R1P Pump Station (FDAS and Electrical Audit)
reference: OP18REFCS03-GHD-R1P-REP-G002A

Preliminary

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Chapter 1

Introduction

1.1 General introduction

The station is located in Alabang Village, Muntinlupa City (refer to Figure 1.1). It has a total capacity of 45 MLD and delivers treated water to the discharge line serving the vicinity. Pump gallery is shown by Figure 1.2.

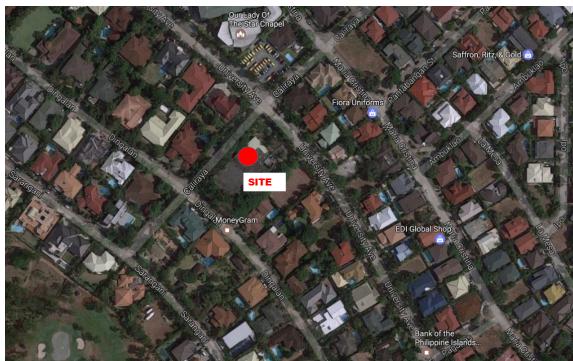


Figure 1.1: Location: Caliraya St. Corner University Avenue, Ayala Alabang, Muntinlupa City



Figure 1.2: Pump gallery

This PS has been included by the Client in the first cluster of pump stations for systems audit, benchmark establishment and asset management.

The Client has therefore awarded GHD and its sub-consultants (RB Sanchez and APSI) to conduct a plant audit project with an expectation to establish rigorous asset management framework based on reliability study and to determine optimal intervention program for the next five (5) years.

1.2 Objectives

The objectives of this work are as follows

- To evaluate the current operating condition of PS as compared to the original design intent and to provide recommendations for improving the operational efficiency and lowering operating cost;

- To be able to determine an optimal intervention program for the PS in the next 5 years with reference to the recommendations from the assessment and audit based on life cycle cost; and equipment efficiency study whether the equipment is subjected to replacement or repair. These equipment are:
 - Pumps;
 - Motors;
 - Generators;
 - Electrical System and Protective Device;
 - Substation (Transformer, Switchgears);
 - MCC (VFDs, Soft starters, Circuit Breakers, and Protective Devices);
 - Motorize Valves.

1.3 Scope of Work

Scope of Work (SOW) has been defined in the Contract Agreement and be in compliance with the GHD technical and financial proposal and the agreements made during a number of project meetings (refer to minutes of meeting of the project).

**IT IS IMPORTANT TO NOTE THAT THIS REPORT ONLY CONTAINS THE ANALYSIS AND RECOMMENDATION FOR FDAS AND ELECTRICAL AUDIT.
PRELIMINARY REPORT ON MECHANICAL TESTS HAS BEEN SUBMITTED TO THE CLIENT IN REVISION NUMBER OP18REFCS03-GHD-R1P-REP-G001A.**

1.4 Limitations

Results of the study with analysis, conclusion, and recommendations are only within the scope of work and agreements, and particularly under the following major constraints:

- Operational constraint: It was not possible to shutdown the entire PS for visual inspection of assets, particularly mechanical assets;
- Incomplete historical data: It was a matter of fact that Maynilad has not established an asset management system thus data regarding historical intervention is limited and incomplete, leading to non-optimal reliability analysis;

1.5 Glossaries

Following glossaries are defined and used in the report:

Level of Services (LOS)

A Level of Services (LOS) is any value or expectation of asset managers and beneficiaries regarding the functionality and serviability of an asset or a system of assets.

Intervention

Intervention is a generic and global term used to refer to non-physical and physical activities on assets. It encompasses do-nothing, or do somethings like repair, maintenance, rehabilitation, renewal, investment, and inspection and testing.

Corrective Intervention (CI)

A Corrective Intervention (CI) is an intervention executed without proper and systematic plan. An CI is often incurred by failure/breakdown of assets. In most of cases, it incurs significant negative impacts (e.g. cost to repair, disruption of service, loss in revenue).

Preventive Intervention (PI)

A Preventive Intervention (PI) is an intervention executed with proper and systematic plan. Note that an PI is executed on asset that is still working but not provide adequate level of services.

Intervention Type

An Intervention Type (IT) is a specific and well-defined type of work/task that can be executed on/for an asset (e.g. replacement of a bearing for a pump).

Intervention Strategy (IS)

An Intervention Strategy (IS) is a set/collection of intervention types.

Intervention Program (IP)

An Intervention Program (IP) is a set/collection of intervention strategies for one asset or more than one assets of the same system.

Work Program (WP)

A Work Program (WP) is an execution program consisting of Intervention Program and management program (e.g. project management, procurement) that shall be implemented in order to realize/actualize the Intervention Program.

Preliminary

Chapter 2

Data and Analysis

2.1 Visual inspection on electrical assets

Results of the visual inspection are reflected in the database that describes also the Asset Registry. Highlights of the outcome for this station are shown in Table 2.1 with visual images shown in Figure 2.1.

Table 2.1: Highlights of visual inspection - Electrical assets

Item	Description	Model	Brand	Status	Remarks
Item	Description	Model	Brand	Status	Remarks
1	Main Switch/Switchboard	MDP 460V/MDP230V	Local Fabrication	1	Functioning
2	Distribution Transformer	5kVA, 460V/230	Mega Masterlink	1	Functioning
3	Distribution Transformer	15kVA, 460V/230	Mega Masterlink	1	Functioning
4	Distribution Transformer	50kVA, 460V/230	Mega Masterlink	1	Functioning
5	Maynilad Owned Load Break Switch (LBS)	n/a	N/a	0	Low voltage installation
6	Power Cables (secondary side of DT to the Elect. Loads)	THHN cables		1	
7	Motor Control Center	230V and 460V MCC	Local Assembly	1	Complete with nameplates
8	Capacitor Bank	225 kVAR	Local Assembly	1	Functioning
9	TVSS	n/a	N/a	0	Not found
10	Power Meter	Digital	Siemens Sentron	1	Functioning
11	Filters and Reactors	125HP 460V 3ph	Danfoss	1	Functioning
12	Instrument Transformers	Current and Voltage		1	wiring acceptable
13	Electrical Protective Relays	n/a	n/a	0	Not found
14	Motor and Switches	Induction Motor	Teral	1	Functioning
15	Transfer Switch	Automatic	Gensys Controller	1	Functioning
16	Uninterruptible Power System (UPS)	Verify capacity	GE	1	Functioning
17	Distrbutioin Panelboards and assoc. appurtenances	DP and LPB	locally fabricated	1	Breakers are Schneider brand
18	Ground-Fault Circuit Interrupter (GFCI) or ELCB or (RCD)	n/a	n/a	0	Not found
19	Lighting and Lighting Control System	Verify wattage	Fixture w/ Diffuser	1	Functioning fixtures
20	Emergency Generator	Standby Genset	Cumper	1	Well maintained
21	Building Service and Distribution	utility owned	3 x 250kVA	1	Y-Y connection



Figure 2.1: Existing electrical assets

2.2 Short circuit calculations and evaluation

2.2.1 Short circuit calculation

Short circuit calculation (SCC) has been done using the software ETAP version 16.2 under following considerations:

- **Available MVA Short Circuit:** Utility supplying normal power to the PS via a 34.5 KV line is MERALCO. The maximum projected fault is to be requested by the owner from the utility. In the calculation, 1000MVA available short circuit was used;
- **Transformer:** The SCC was based on a 750kVA transformer feeding the transfer switch going to the motors. Transformer impedance used in the calculation is per standard;
- **GENSET:**
 - Emergency power will be supplied by 1 Genset, rated at 770 kVA feeding downstream distribution power lines;
 - Subtransient value of the generator should be provided for a more accurate calculation.
- **Length of wires and cables:** Actual measured length of wires and cables.

Calculation has been done for Three Phase of short circuit current. Results of the calculations are summarized in Table 2.2. Figure 2.2 and Figure 2.3 represent the graphical representation of Nodes and Links as well as associated values.

Table 2.2: Short circuit calculation - results

Item	Description	SCC (kA)	Kaic & CB (kA)	remarks
1	From Utility to transformer	13.633	Utility owned trafo	Protection c/o Utility
2	Pole Mounted transformer to main circuit breaker 1250A in pedestal	13.633	65	Existing is acceptable
3	Main circuit breaker to Automatic transfer switch panel	13.129	65	Existing is acceptable
4	Automatic transfer switch panel to MCC PANEL at control room	13.094	65	Existing acceptable
5	480V Bus to TVSS CB protection	13.094	25	Existing acceptable
6	480V Bus to Motor 1 CB protection	13.094	35	Existing acceptable
7	480V Bus to Motor 2 CB protection	13.094	35	Existing acceptable
8	480V Bus to Motor 3 CB protection	13.094	35	Existing acceptable
9	480V Bus to 10 HP Motor 3 CB protection	13.094	25	Existing acceptable
10	480V Bus to 10 HP Motor 3 CB protection	13.094	25	Existing acceptable
11	480V Bus to DP1 CB protection	13.094	35	Existing acceptable
12	480V Bus to 9.38kVA Motor CB protection	13.094	25	Existing acceptable
13	480V Bus to FTPP PANEL CB protection	13.094	25	Existing acceptable
14	480V Bus to 5kVA transformer CB protection	13.094	25	Existing acceptable
15	Transformer to CAPP panel	0.533	25	Existing acceptable

The values of SCC shown in the table indicates the followings:

- the values of the FAULT observed to be lower than the values of the protective devices. This infers that the existing protective devices are capable to protect the assets.

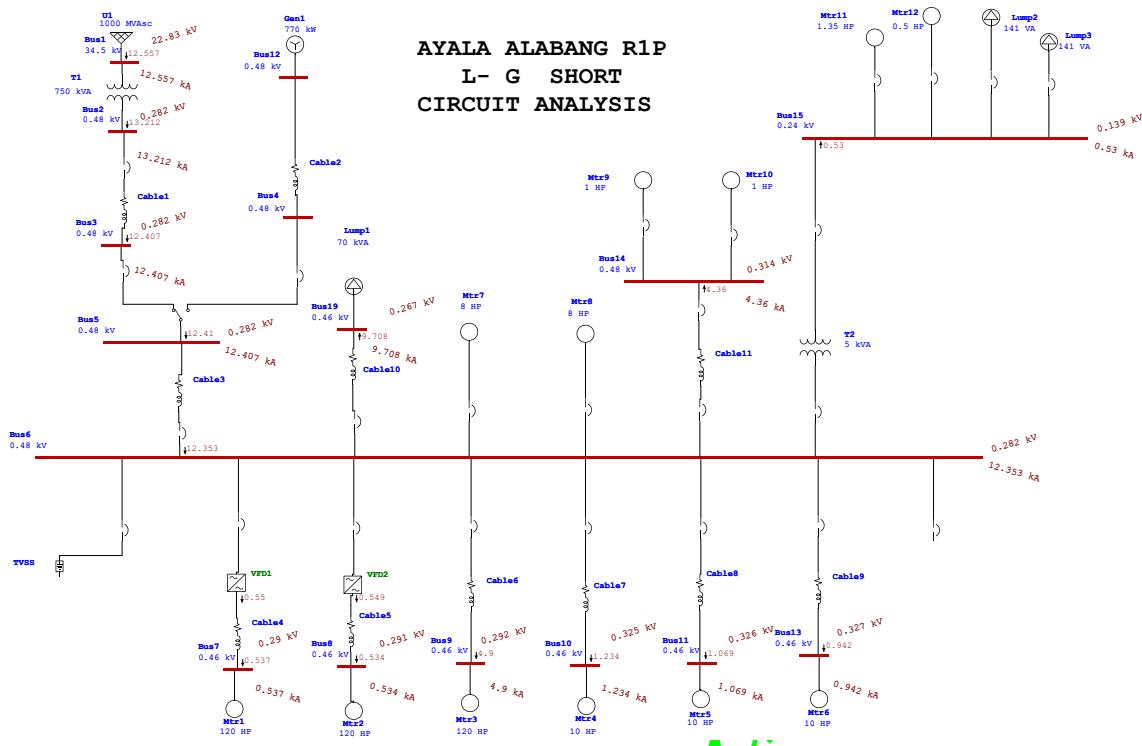


Figure 2.2: LGfault

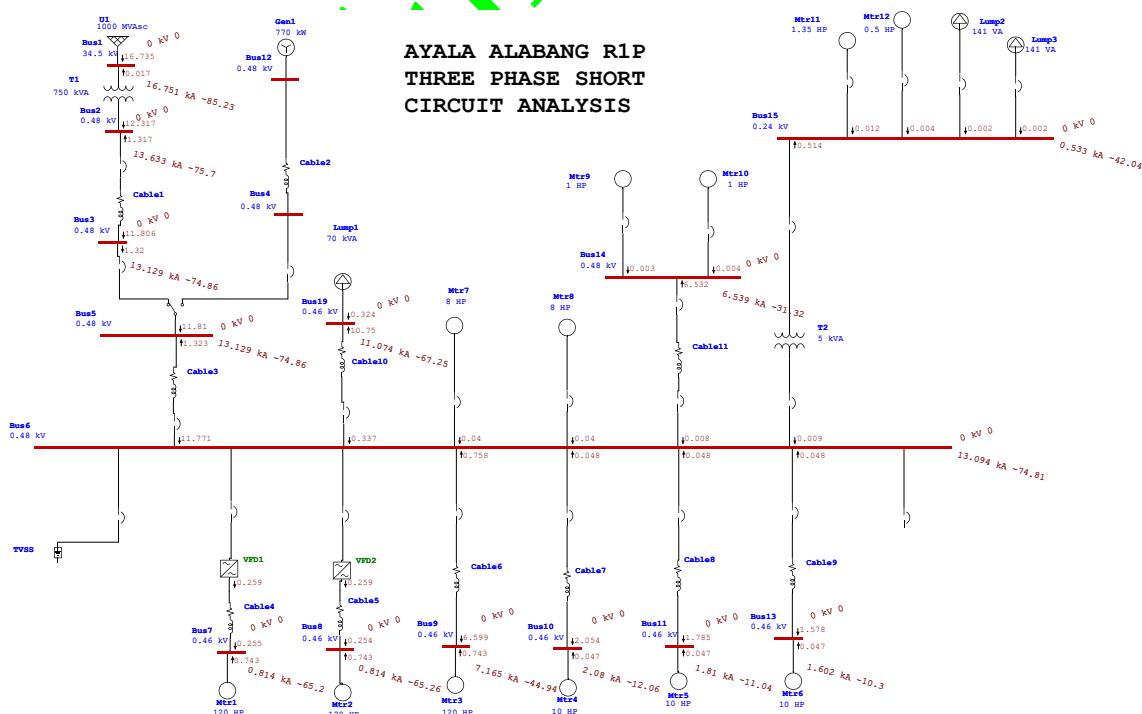


Figure 2.3: Three Phase SCC

2.2.2 Evaluation of protective devices and bus bars

It can be interpreted from the results of the SCC that

- the protective devices and bus bars are still provided adequate level of services and performed per applied standards;
- there is no undersized electrical components.

2.3 Voltage drop calculation

Voltage drop calculation (VDC) has been conducted in compliance with the code (PEC 2017 ARTICLE 2.15.1.2(A)(1)(b)FPN NO.2) which states the following

- Conductors for feeders, as defined in Article1.1, sized to prevent a voltage drop exceeding 3% at the farthest outlet of power, heating and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed 5% , will provide reasonable efficiency.

Results of the VDC is presented in Table 2.3

Table 2.3: Voltage drop calculation - results

Item	From	To	Wire Size mm ²	I Ampe	L m	R Ω/305 m	X Ω/305 m	Vd	%Vd	Remarks
1	Transformer	Main circuit Breaker at 1250A pedestal	4-200	360	15	0.035	0.049	0.461	0.10	Within Limits
2	Main circuit Breaker at 1250A pedestal	Automatic Transfer Switch 1250A	4-200	360	21.14	0.035	0.049	0.650	0.14	Within Limits
3	Automatic Transfer Switch 1250A	MCC PANEL at control room	4-200	360	1.5	0.035	0.049	0.046	0.01	Within Limits
4	MCC PANEL at control room	Motor1, 120HP	60.0	170	1.8	0.10	0.054	0.114	0.02	Within Limits
5	MCC PANEL at control room	Motor2, 120HP	60.0	170	2.1	0.10	0.054	0.230	0.05	Within Limits
6	MCC PANEL at control room	Motor3, 120HP	60.0	170	2.4	0.10	0.054	0.152	0.03	Within Limits
7	MCC PANEL at control room	DOL 10HP	3.5	30.0	2.4	2	0.068	0.817	0.17	Within Limits
8	MCC PANEL at control room	DP1 PANEL-BOARD	3.5	30.0	10	2	0.068	3.405	0.71	Within Limits
9	MCC PANEL at control room	Dry type trafo	5.5	40	7.8	1.2	0.063	2.127	0.44	Within Limits
10	MCC PANEL at control room	Capacitor bank 225 kVAR	175.0	345	5.52	0.039	0.05	0.685	0.14	Within Limits

It can be interpreted from the values of the calculation that the VDC is within the limits defined in the applied standard.

2.4 Load flow study

The load flow study (analysis) has been conducted per applied standard. Following Terms are important in the study, thus being extracted from the Philippines Distribution Code for ease of readers.

- **Active Power:** The time average of the instantaneous power over one period of the electrical wave, measured in watts (W) or multiples thereof. For AC circuit or Systems , it is the product of the root-mean -square (RMS) or Effective value of the voltage and the RMS value of the in-phase component of the current. In a three phase system, it is the sum of the Active Power of the individual phases;
- **Apparent Power:** The product of the root-mean -square (RMS) or Effective value of the current and root -mean -square of the voltage. For AC circuit Systems, it is the square

Table 2.4: Alert setting

	% Alert Settings	
	Critical	Marginal
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Inverter/Charger	100.0	95.0
Bus Voltage		
OverVoltage	105.0	102.0
UnderVoltage	95.0	98.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

root of the sum of the squares of the Active Power and Reactive power, measured in volt-amperes (VA) or multiples thereof;

- **Reactive Power:** The component of the electrical power representing the alternating exchange of stored energy (inductive or capacitive) between sources and loads or between two systems, measured in VAR, or multiples thereof. For AC circuits or systems, it is the product of the RMS voltage and the RMS value of the quadrature component of alternating current. In a three phase system, it is the sum of the Reactive power of the individual phases;
- **Harmonics (THD):** Harmonics shall be defined as sinusoidal voltage and currents having frequencies that are integral multiples of the fundamental frequency.

2.4.1 Analysis based on design

The analysis has been conducted under the assumption of the Alerting Setting shown in Table 2.4. Results of the analysis are shown in the diagram (refer to Figure 2.4) with all details summarized in tabular forms (refer to the Appendix A)

Summaries on the results are also shown in Table 2.5, Table 2.6, and Table 2.7.

It is concluded from this analysis that all parameter values are within the acceptable ranges.

2.4.2 Analysis based on measured data from the PQA

Analysis has been conducted for the overall system (refer herein as MAIN), for Feeder to motor with VFD1, VFD2, and softstarter, respectively. The detailed reports were obtained from the analytical software (refer to Appendix) with highlights presented in Figure 2.5, Figure 2.6, and Figure 2.8.

Conclusion on the load flow analysis shall be in combination with the power quality analysis, which is presented in the following subsections.

2.5 Protection coordination study

In protection coordination study, the protective devices nearest to the FAULT shall trip first and the remaining of the protective devices shall not be affected. The results were obtained from the ETAB software and shown in Table 2.8, Table 2.9, and Tables 2.10, 2.11, and 2.12.

Further illustration of the coordination is shown in Figure 2.9.

Following remarks/recommendations can be interpreted from values shown in the tables and figure.

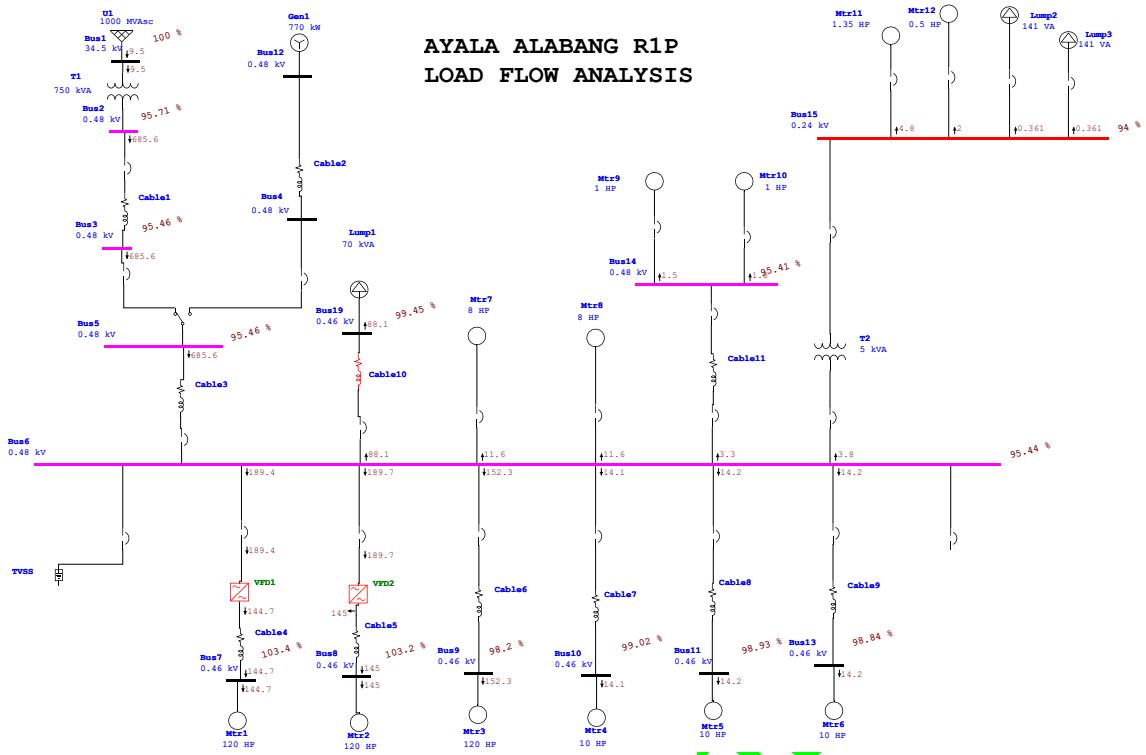


Figure 2.4: Load flow analysis

Table 2.5: Summary of total generation, loading, and demand

	MW	Mvar	MVA	% PF
Source (Swing Buses):	0.449	0.351	0.570	78.79 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	0.449	0.351	0.570	78.79 Lagging
Total Motor Load:	0.424	0.203	0.470	90.18 Lagging
Total Static Load:	0.012	0.007	0.014	85.00 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.013	0.140		
System Mismatch:	0.000	0.000		

Number of Iterations: 3

Table 2.6: Bus loading

Bus			Directly Connected Load				Total Bus Load				
ID	kV	Rated Amp	Constant kVA		Constant Z		Constant I		Generic		Percent Loading
			MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	
Bus1		34,500									0.570
Bus2		0.480									0.546
Bus3		0.480									0.544
Bus5		0.480									0.544
Bus6		0.480	0.236	0.214							0.544
Bus7		0.460	0.109	0.048							0.119
Bus8		0.460	0.109	0.048							0.119
Bus9		0.460	0.109	0.048							0.119
Bus10		0.460	0.010	0.006							0.011
Bus11		0.460	0.010	0.006							0.011
Bus13		0.460	0.010	0.006							0.011
Bus14		0.480	0.002	0.002							0.003
Bus15		0.240	0.002	0.002							0.003
Bus16		0.460									0.120
Bus17		0.460									0.121
Bus19		0.460	0.048	0.029	0.012	0.007					0.070

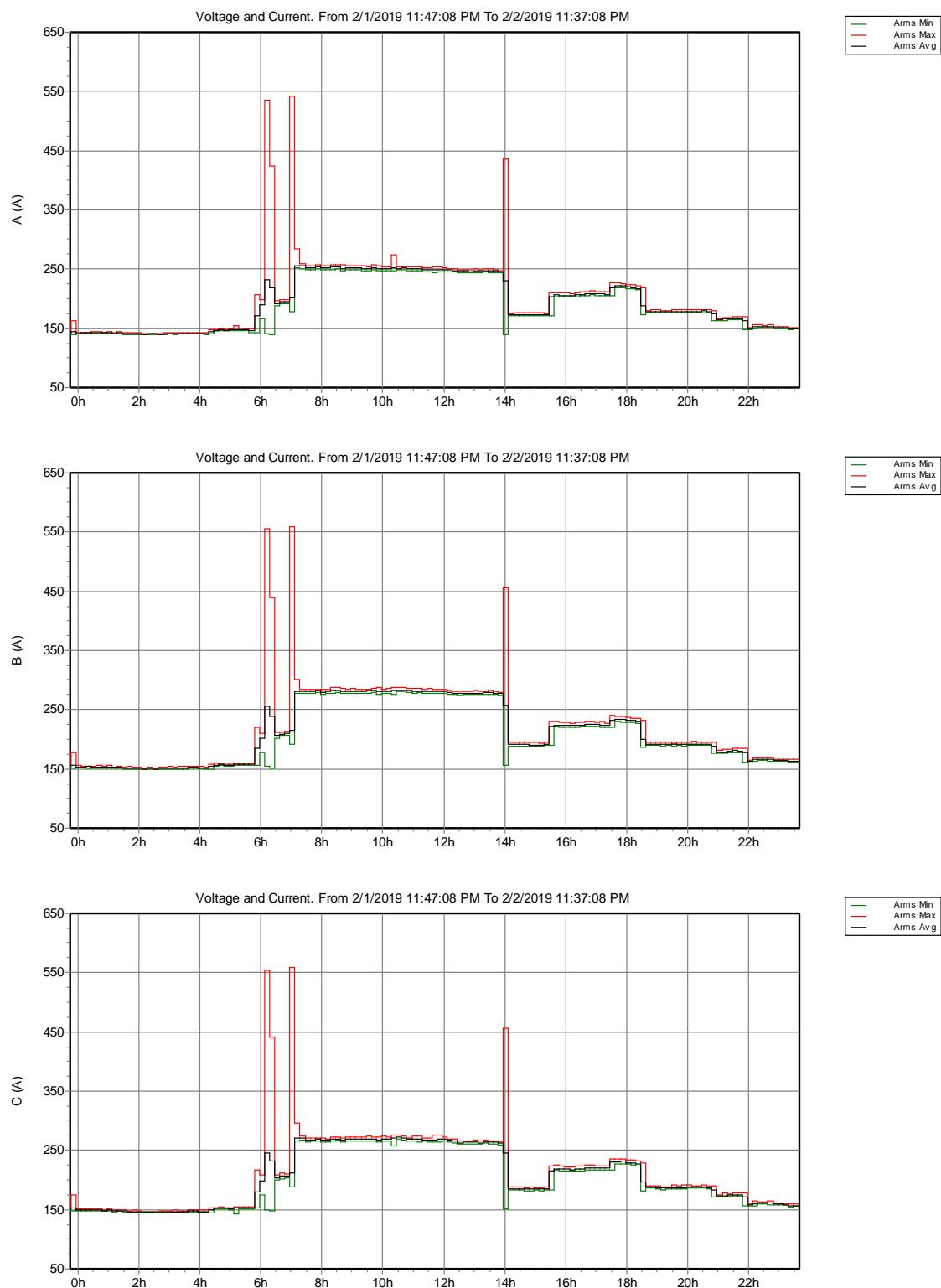
* Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating).

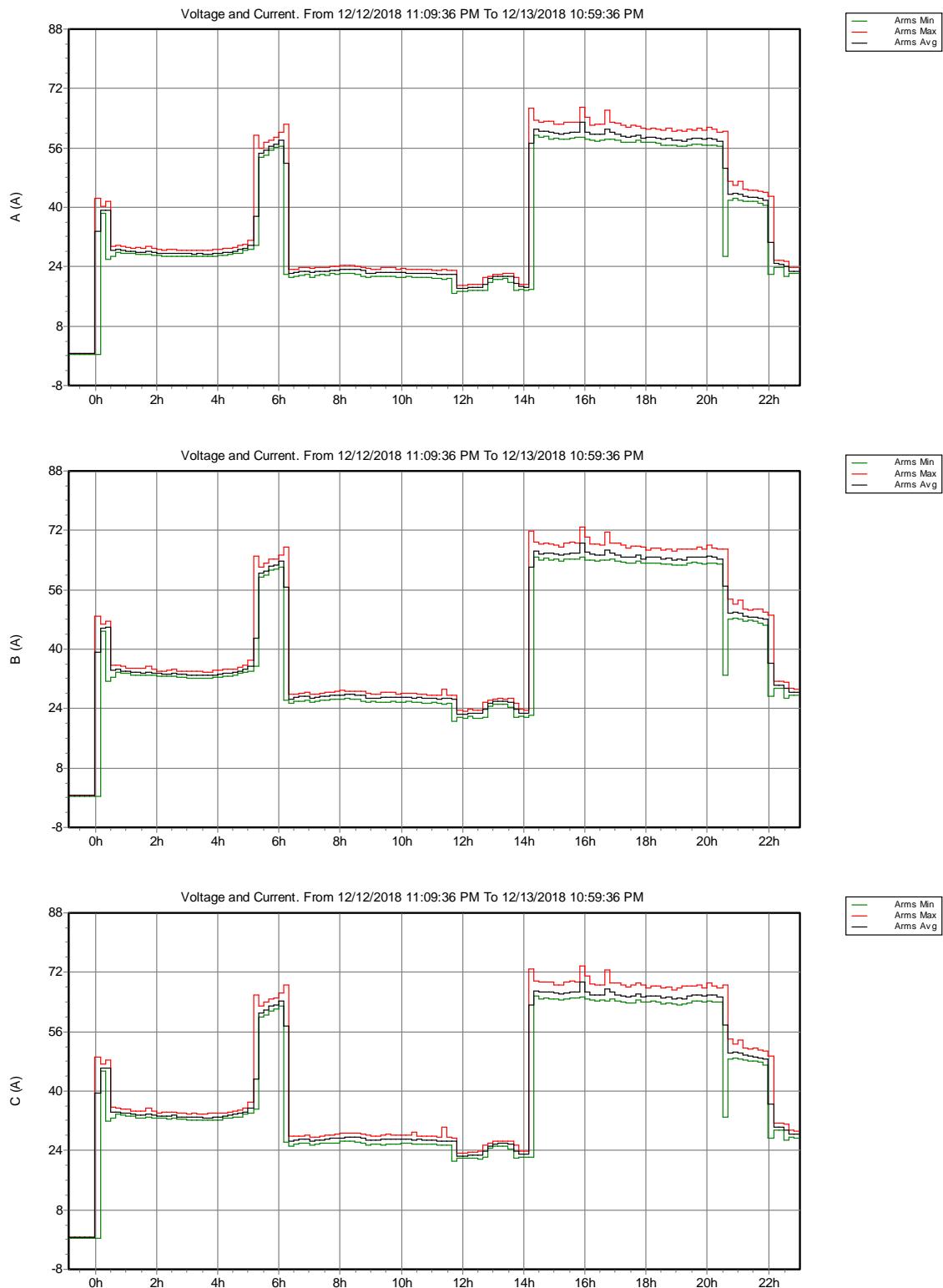
Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

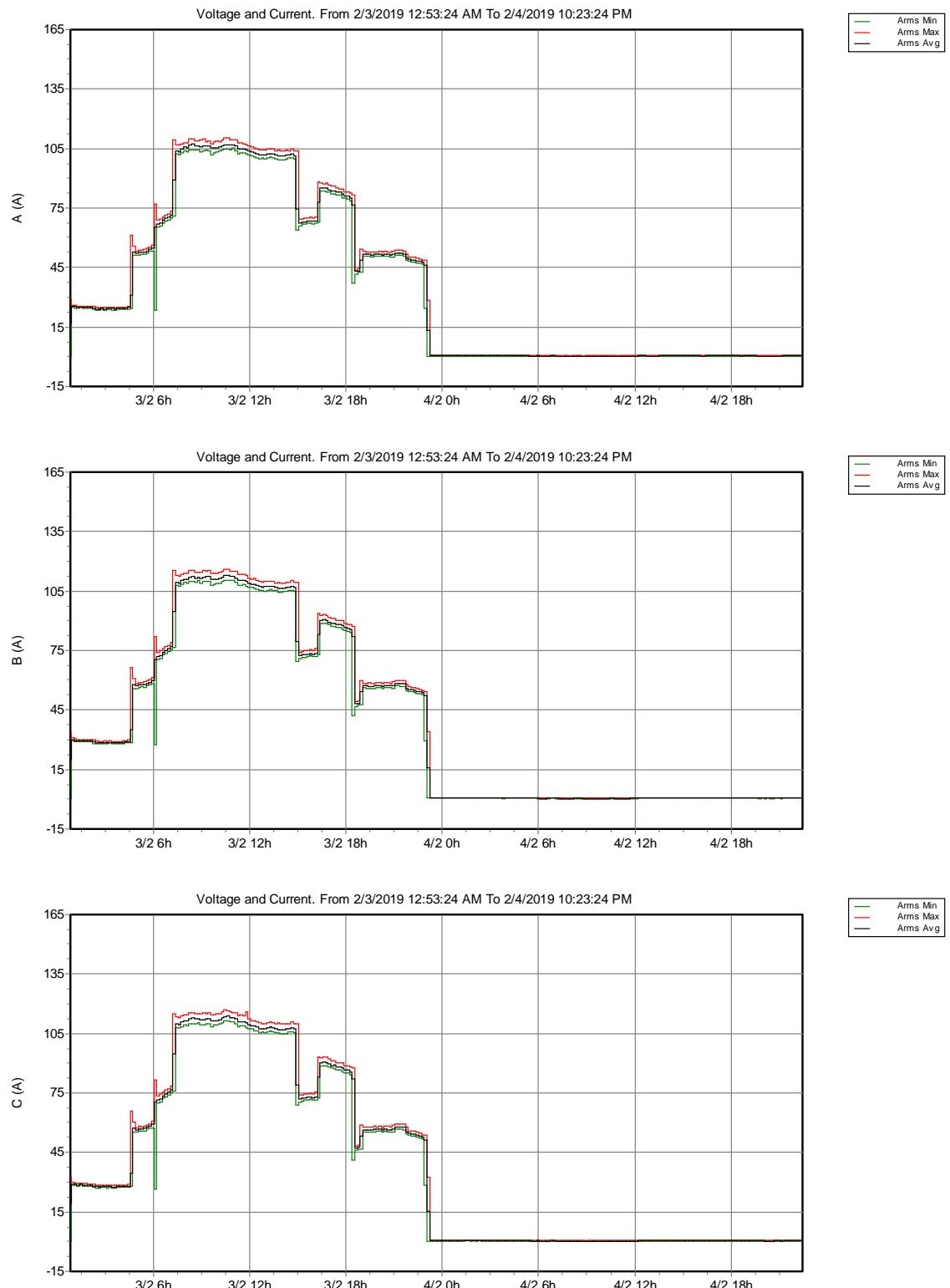
Table 2.7: Branch loading

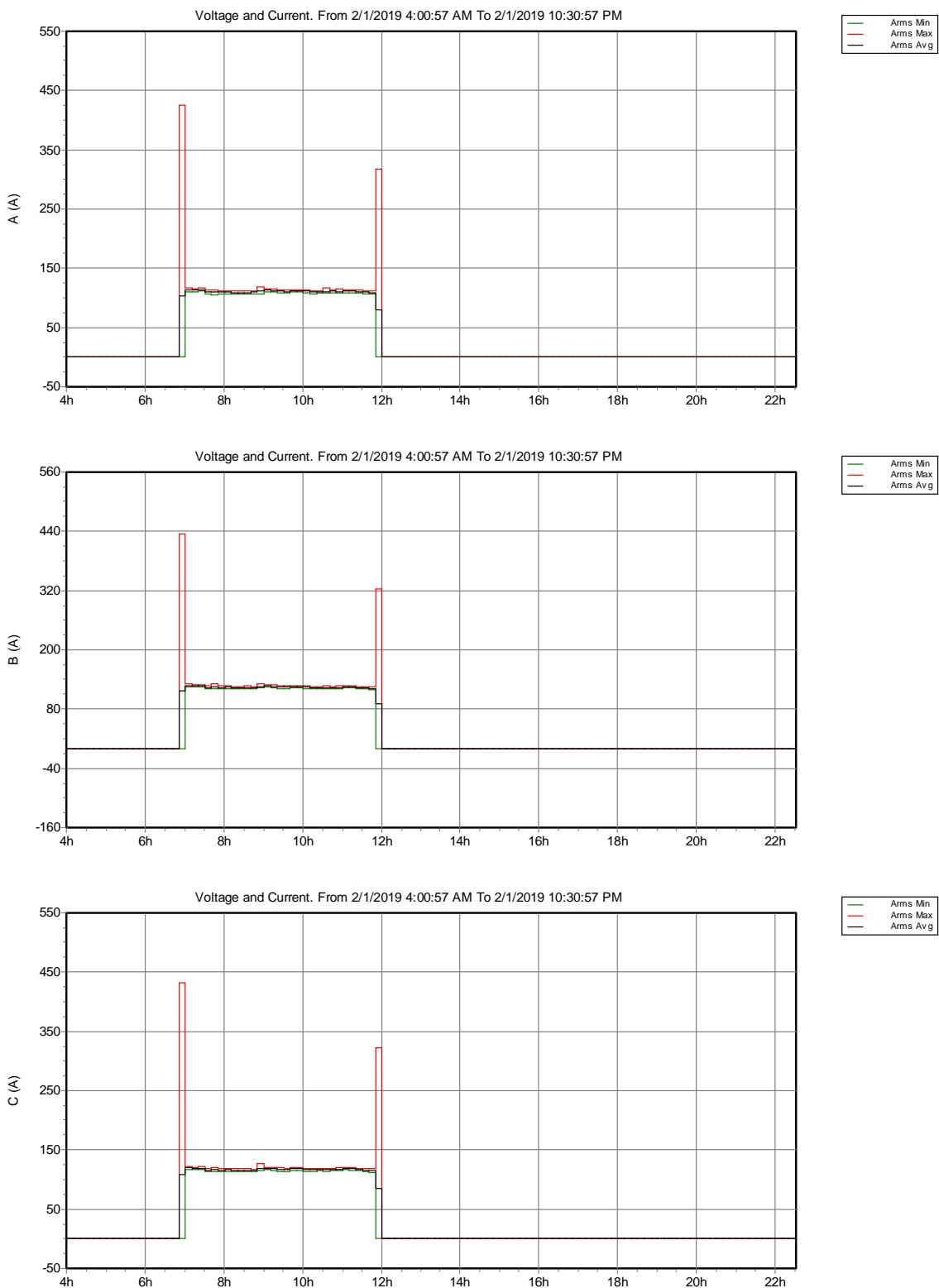
CKT / Branch		Cable & Reactor			Transformer				
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input)		Loading (output)	
					MVA	%		MVA	%
Cable1	Cable	1003.37	685.58	68.33					
Cable3	Cable	1003.37	685.58	68.33					
* Cable10	Cable	76.20	88.15	115.68					
T1	Transformer				0.750	0.570	76.0	0.546	72.7
T2	Transformer				0.005	0.003	60.1	0.003	59.2

* Indicates a branch with operating load exceeding the branch capability.

**Figure 2.5:** Main

**Figure 2.6:** VFD-1

**Figure 2.7:** VFD-2

**Figure 2.8:** soft starter

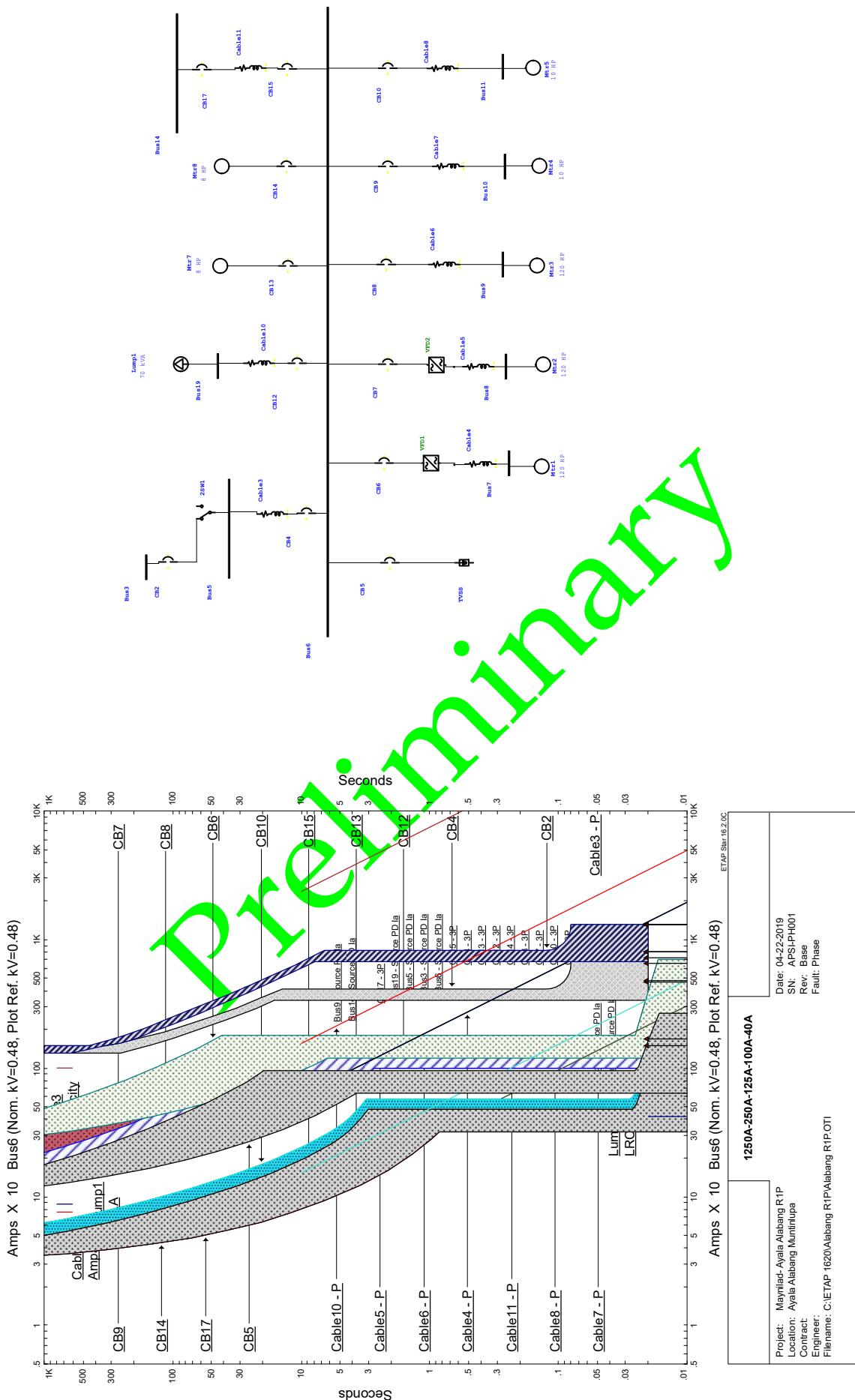


Figure 2.9: Coordination plot

Table 2.8: Protective Device Settings - Low Voltage Circuit Breaker with Thermal-Magnetic Trip Device

Protective Device Settings - Low Voltage Circuit Breaker with Thermal-Magnetic Trip Device							
LVCB ID	Manufacturer	Breaker		Thermal		Magnetic (Inst.)	
		Model	Size	Setting	Trip (Amps)	Setting	Trip (Amps)
CB2	Schneider	NWH1	1250	Adjustable	1250.00	Fixed	6 xIn
CB4	Schneider	NWH1	1250	Adjustable	1250.00	Fixed	4xIn
CB5	Schneider	EZC	100	Fixed	100.00	Fixed	
CB6-CB8	Schneider	EZC	250	Fixed	2500.00	Fixed	
CB9-CB11	Schneider	EZC	40	Fixed	40.00	Fixed	
CB12	Schneider	EZC	125	Fixed	125.00	Fixed	
CB13-CB16	Schneider	EZC	32	Fixed	32.00	Fixed	
CB25	Schneider	EZC	50	Fixed	50.00	Fixed	

Table 2.9: Cable-circuit breaker coordination

Cable / Line ID	Protective Device			Cable Protection				Max Fault 3Ph-Amps	Reference kV
	Location	Device ID	Type	Pickup Limit	Ampacity	Damage Curve	Condition		
Cable1	Load	CB2	SST-LT	Alert	Alert	Pass	LT Pickup 1250 A above max. limit of 1003 A = Ampacity x 100%	11806	0.48
			SST-ST	-	-	Pass	LT Pickup 1250 A is set above 1003 A = Ampacity		
	Source	CB1	SST-INST	-	-	-	Trip curve protects the damage curve	12317	0.48
			SST-LT	Alert	Alert	Pass	LT Pickup 1200 A above max. limit of 1003 A = Ampacity x 100%		
			SST-ST	-	-	Pass	LT Pickup 1200 A is set above 1003 A = Ampacity		
	Cable10	CB12	TM-Magnetic	-	-	Warning	Trip curve is too close to the damage curve	12761	0.48
			TM-Thermal	Alert	Alert	-	Therm. Trip 125 A above max. limit of 76.2 A = Ampacity x 100%		
							Therm. Trip 125 A is set above 76.2 A = Ampacity		
Cable3	Load	CB4	SST-LT	Alert	Alert	Pass	LT Pickup 1250 A above max. limit of 1003 A = Ampacity x 100%	11771	0.48
			SST-ST	-	-	Pass	LT Pickup 1250 A is set above 1003 A = Ampacity		

- Trip curve of CB2 is covered by CB4 in the instantaneous region. Hence coordination is deemed to be partial since the feeder breaker CB4 TCC curve crossed the TCC curve of Main breaker on the instantaneous region. For better coordination, main breaker should be of higher trip unit model wherein the instantaneous region is not fixed and can be defeated..

Table 2.10: Circuit Breaker Coordination -a)

Zone ID	Zone Type	Upstream PD	Downstream PD	Max Fault		Reference kV	Coordination Status	Amp Range		Condition
				Type	Amp			From	To	
Bus6	Bus	CB4	CB5	3Ph	13094	0.48	Pass	125.2	2678	Devices are coordinated between amp range of 125.2 A to 2678A @ 0.48 kV
				L-G	12353	0.48	Pass	125.2	2678	Devices are coordinated between amp range of 125.2 A to 2678A @ 0.48 kV
			CB16	3Ph	13087	0.48	Pass	28.1	991.5	Devices are coordinated between amp range of 28.1 A to 991.5A @ 0.48 kV
				L-G	12353	0.48	Pass	28.1	991.9	Devices are coordinated between amp range of 28.1 A to 991.9A @ 0.48 kV
			CB6	3Ph	13094	0.48	Pass	309.9	7028	Devices are coordinated between amp range of 309.9 A to 7028A @ 0.48 kV
				L-G	12353	0.48	Pass	309.9	7028	Devices are coordinated between amp range of 309.9 A to 7028A @ 0.48 kV
			CB7	3Ph	13094	0.48	Pass	309.9	7028	Devices are coordinated between amp range of 309.9 A to 7028A @ 0.48 kV
				L-G	12353	0.48	Pass	309.9	7028	Devices are coordinated between amp range of 309.9 A to 7028A @ 0.48 kV
			CB8	3Ph	12339	0.48	Pass	309.9	7028	Devices are coordinated between amp range of 309.9 A to 7028A @ 0.48 kV

- Almost all feeder circuit breaker trip devices are fixed and can not be adjusted but are well coordinated with upstream breaker CB4. L-G fault protection not possible. Trip unit of protective device has no ground fault protection due to the type of breaker supplied. However , this is allowed under the Philippine Electrical Code.

2.6 Harmonic study

Harmonic study has been conducted under the following basics

- Harmonics shall be defined as sinusoidal voltage and currents having frequencies that are integral multiples of the fundamental frequency;
- The total harmonic distortion (THD) shall be defined as the ratio of the RMS value of the harmonic content to the RMS value of the fundamental quantity, expressed in percent;
- PHILIPPINE DISTRIBUTION CODE sets the THD of the voltage at any user system to not exceed 5% during normal operating conditions.

2.6.1 As per design

Results of the study as per design are shown in Figure 2.10 and Figure 2.11

It can be seen from the figures that there are a number of distortions, which are connected to bus6. It is notable to observe that the percentage of the THD is 18.66%, which is way above the acceptable limit of 5%. The current harmonics have high values as per design.

2.6.2 Per actual

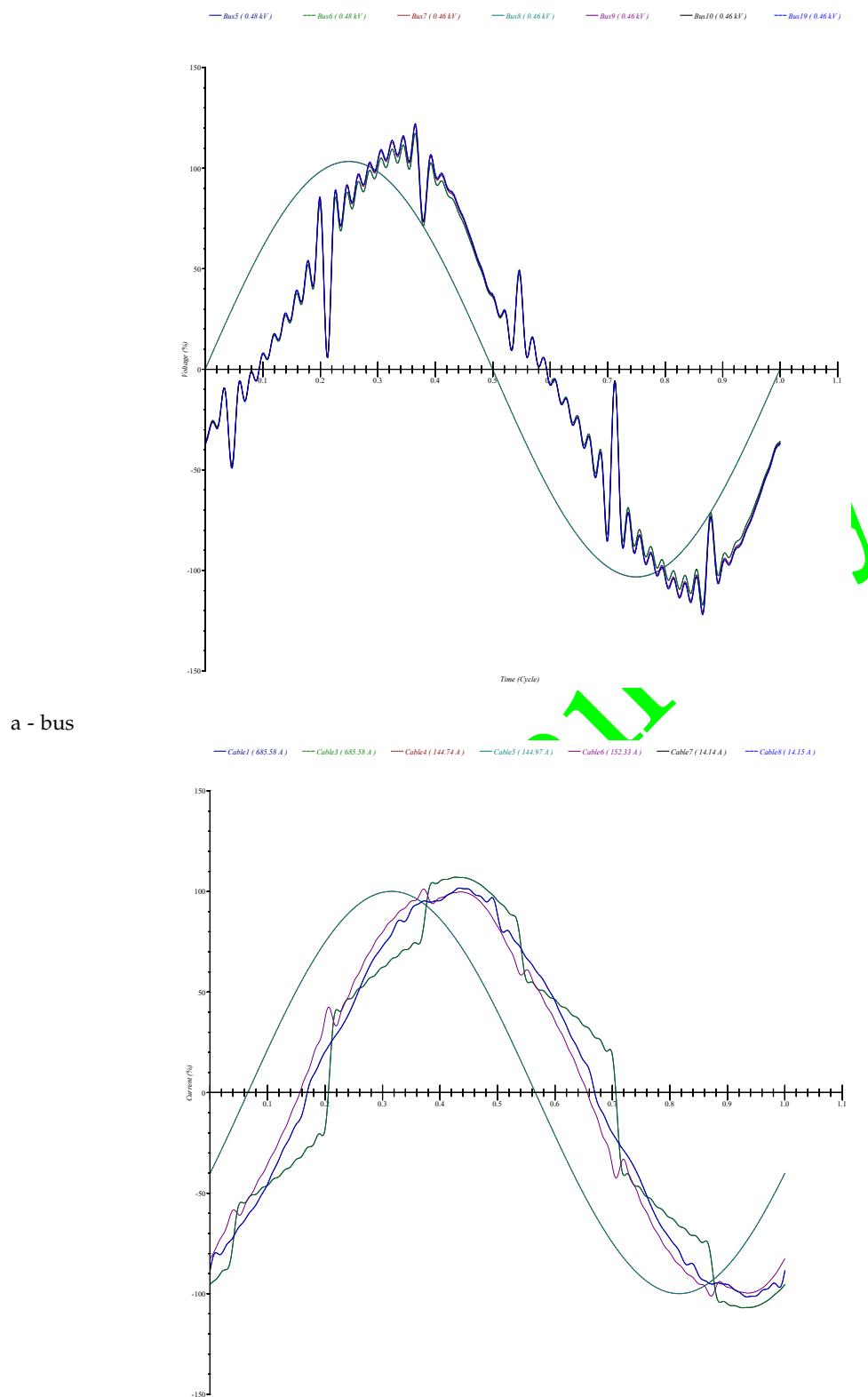
Results of the study based on the PQA are presented in Figures shown in the Appendix C and B with summary shown in Table 2.16, with the min, average, and max values are presented along

Table 2.11: Circuit Breaker Coordination -b)

Zone ID	Zone Type	Upstream PD	Downstream PD	Max Fault		Reference kV	Coordination Status	Amp Range		Condition
				Type	Amp			From	To	
Bus6	Bus	CB4	CB8	L-G	12353	0.48	Pass	322.3	7309	Devices are coordinated between amp range of 322.3 A to 7309A @ 0.48 kV
				3Ph	13047	0.48	Pass	50.1	1239	Devices are coordinated between amp range of 50.1 A to 1239A @ 0.48 kV
			CB9	L-G	12353	0.48	Pass	50.2	1242	Devices are coordinated between amp range of 50.2 A to 1242A @ 0.48 kV
				3Ph	13047	0.48	Pass	50.1	1239	Devices are coordinated between amp range of 50.1 A to 1239A @ 0.48 kV
			CB10	L-G	12353	0.48	Pass	50.2	1242	Devices are coordinated between amp range of 50.2 A to 1242A @ 0.48 kV
				3Ph	13047	0.48	Pass	50.1	1239	Devices are coordinated between amp range of 50.1 A to 1239A @ 0.48 kV
			CB11	L-G	12353	0.48	Pass	50.2	1242	Devices are coordinated between amp range of 50.2 A to 1242A @ 0.48 kV
				3Ph	12761	0.48	Pass	157.9	3726	Devices are coordinated between amp range of 157.9 A to 3726A @ 0.48 kV
			CB12	L-G	12353	0.48	Pass	160.6	3790	Devices are coordinated between amp range of 160.6 A to 3790A @ 0.48 kV
				3Ph	12353	0.48	Pass	160.6	3790	Devices are coordinated between amp range of 160.6 A to 3790A @ 0.48 kV

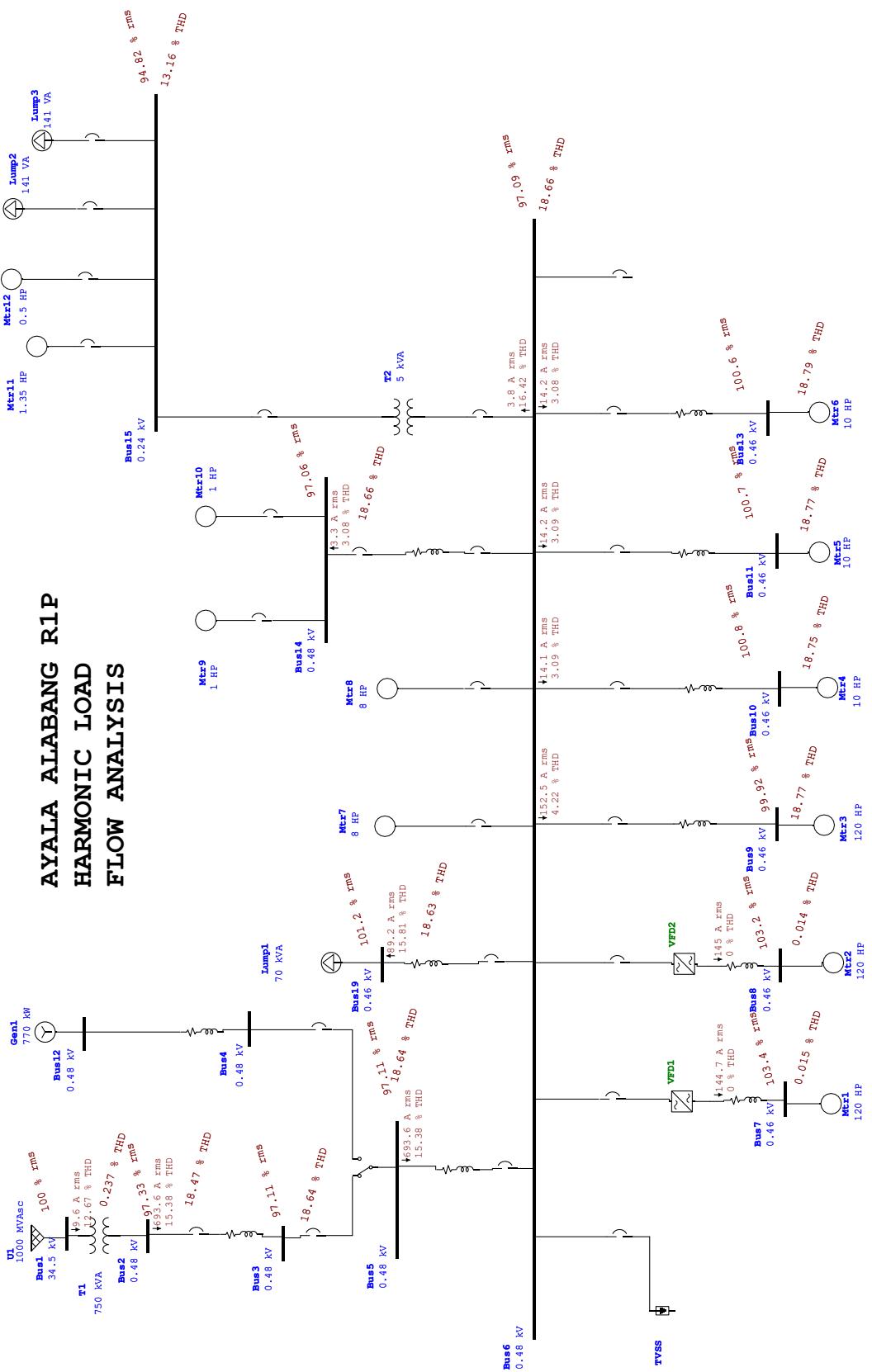
Table 2.12: Circuit Breaker Coordination -c)

Zone ID	Zone Type	Upstream PD	Downstream PD	Max Fault		Reference kV	Coordination Status	Amp Range		Condition
				Type	Amp			From	To	
Bus6	Bus	CB4	CB13	3Ph	13055	0.48	Pass	40.1	991.5	Devices are coordinated between amp range of 40.1 A to 991.5A @ 0.48 kV
				L-G	12353	0.48	Pass	40.2	993.5	Devices are coordinated between amp range of 40.2 A to 993.5A @ 0.48 kV
			CB14	3Ph	13055	0.48	Pass	40.1	991.5	Devices are coordinated between amp range of 40.1 A to 991.5A @ 0.48 kV
				L-G	12353	0.48	Pass	40.2	993.5	Devices are coordinated between amp range of 40.2 A to 993.5A @ 0.48 kV
			CB15	3Ph	13088	0.48	Pass	40.1	991.5	Devices are coordinated between amp range of 40.1 A to 991.5A @ 0.48 kV
				L-G	12353	0.48	Pass	40.1	991.8	Devices are coordinated between amp range of 40.1 A to 991.8A @ 0.48 kV
			CB25	3Ph	13094	0.48	Pass	50.1	1239	Devices are coordinated between amp range of 50.1 A to 1239A @ 0.48 kV
				L-G	12353	0.48	Pass	50.1	1239	Devices are coordinated between amp range of 50.1 A to 1239A @ 0.48 kV



b - cable

Figure 2.10: Harmonic wave form

**Figure 2.11:** Load flow

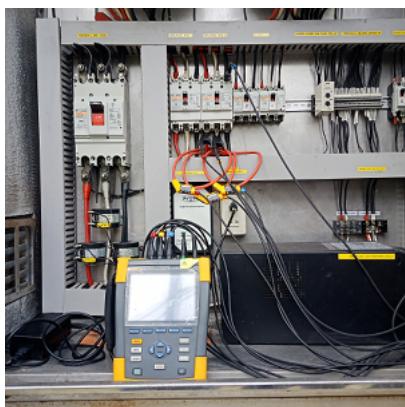


Figure 2.12: Power quality analyzer plugging during measurement

with the limit of 5%.

It can be interpreted from the table that values Main, VFD1 VFD2, and softstarter are within the acceptable limits. The low value of Harmonics (THD) can be attributed to the Harmonic filter installed inside the switchgear. However, the Total Demand Distortion values remain high as per acutal .Recommendation shall be realized together with the recommendation from the study of Power Quality Analysis

Recommendation shall be realized together with the recommendation from the study of Power Quality Analysis (refer to subsection 2.7)

2.7 Power quality analysis

The Power Quality Analysis (TQA) has been conducted on the Main system, VFD1, VFD2, and the softstarter of this PS. The Power Quality Analyzer used is FLUKE 430-II. Figure 2.12 shows the analyzer during the course of measurement for the station.

2.7.1 Objectives and expected outcomes

The preliminary objectives and expected outcomes from this analysis are

- Record the voltage and current profile on the load side of Circuit Breaker with the recording interval set every five (10) minutes;
- Record power profile (KW, KVA, KVAR) on the load side of Circuit Breaker with the recording interval set every ten (10) minutes.
- Record Total Harmonic Distortion (THD);
- Record Values of Short Duration Voltage Variation that will exceed the limit set by Philippine Distribution code;
- Record values of Long Duration Voltage Variation that will exceed the limit set by the Philippine Distribution Code;
- Record values of Frequency Variation that will exceed the limit set by Philippine Distribution code;
- Record Transient voltage Surge defined by PDC and using Computer Business Equipment Manufacturer's Association(CBEMA) and Information Technology Industry Council (ITIC) Curve International Standard;
- Compute for Voltage Unbalance and compare it on the Voltage unbalance limit set by PDC;
- Recommendations.

2.7.2 Basic

The assessments made in this report are in accordance to IEEE Standard 1159-1995 "IEEE Recommended Practice for Monitoring Electric Power Quality".

The Philippine Distribution Code was used as the local reference for power quality standards. According to the Philippine Distribution Code, a power quality problem exists when at least one of the categories in the tables of following sections is present during the normal operation of the electrical system

2.7.3 Results

Results are summarized in this section together with the enclosed tables and graphs in the Appendix C

Any values outside these limits are noted in the report. Values within the limits are considered to be within safe operating range.

2.7.3.1 RMS Voltage compliance

The steady-state rms voltage must remain within the range of 90.00% to 110.00%.

- Over Voltage – if the RMS value of the voltage is greater than or equal to 110% of the nominal value
- Under Voltage – if the RMS value of the voltage is less than or equal to 90% of the nominal voltage

Results are shown in Table 2.13.

Table 2.13: Power quality - RMS Voltage compliance

RMS VOLTAGE (480 VOLTS)	Phase	Minimum	Average	Maximum	Limits	Remarks
Main 1250A (Load side)	AB	457.60	476.60	482.56	$\pm 10\%$ (432-528V)	Within Limits
	BC	459.74	482.80	488.64		
	CA	457.60	476.60	482.56		
VFD-1	AB	451.46	474.80	487.30	$\pm 10\%$ (432-528V)	Within Limits
	BC	459.94	482.60	494.00		
	CA	451.46	474.80	487.30		
VFD-2	AB	456.02	477.70	483.02	$\pm 10\%$ (432-528V)	Within Limits
	BC	464.3	484.20	489.02		
	CA	456.02	477.70	483.02		
Soft Starter	AB	459.2	476.10	481.38	$\pm 10\%$ (432-528V)	Within Limits
	BC	465.4	482.70	487.58		
	CA	459.2	476.10	481.38		

2.7.3.2 Voltage unbalance compliance

Voltage Unbalance shall be defined as the maximum deviation from the average of the three phase voltages divided by the average of the three phase voltages expressed in percent. The maximum voltage unbalance at the connection point of any user, excluding the voltage unbalance passed on from the grid shall not exceed 2.5% during normal operating conditions.

Results are shown in Table 2.14.

Table 2.14: Power quality -Voltage unbalance

Voltage unbalance	Minimum	Average	Maximum	Limits (%)	Remarks
MAIN (Load Side)	0.31	0.86	0.84	2.5	Within Limits
VFD-1	1.24	1.09	0.91	2.5	Within Limits
VFD-2	1.20	0.90	0.82	2.5	Within Limits
Softstarter	0.90	0.92	0.85	2.5	Within Limits

2.7.3.3 Current unbalance compliance

Results are shown in Table 2.15 with note that the current unbalance should not exceed 10%.

Table 2.15: Power quality -Current unbalance

Current unbalance	Minimum	Average	Maximum	Limits (%)	Remarks
MAIN (Load Side)	3.74	5.84	2.01	$\leq 10\%$	Within Limits
VFD-1	6.27	6.11	5.99	$\leq 10\%$	Within Limits
VFD-2	3.63	3.46	3.61	$\leq 10\%$	Within Limits
Softstarter	5.96	5.96	1.17	$\leq 10\%$	Within Limits

2.7.3.4 Harmonic - THD compliance

Results are shown in Table 2.16 with the following notes:

- Harmonics shall be defined as sinusoidal voltage and currents having frequencies that are integral multiples of the fundamental frequency;
- The total harmonic distortion (THD) shall be defined as the ratio of the RMS value of the harmonic content to the RMS value of the fundamental quantity, expressed in percent;
- PHILIPPINE DISTRIBUTION CODE sets the THD of the voltage at any user system to not exceed five percent (5%) during normal operating conditions.

Table 2.16: Power quality -Harmonic THD compliance

THD compliance	Phase	Minimum	Average	Maximum	Limits (%)	Remarks
Main (Load side)	AB	0.57	0.88	2.39	$\leq 5\%$	Within Limits
	BC	0.62	0.91	2.32		
	CA	0.57	0.88	2.39		
VFD-1	AB	0.45	0.89	2.39	$\leq 5\%$	Within Limits
	BC	0.51	0.93	2.33		
	CA	0.45	0.89	2.39		
VFD-2	AB	0.57	0.88	1.02	$\leq 5\%$	Within Limits
	BC	0.61	0.96	2.27		
	CA	0.57	0.60	2.30		
Softstarter	AB	0.59	0.92	2.30	$\leq 5\%$	Within Limits
	BC	0.69	0.95	2.24		
	CA	0.59	0.92	2.30		

2.7.3.5 Harmonic - TDD compliance

Results are shown in Table 2.17 with the following notes:

- The Total Demand Distortion (TDD) shall be defined as the ratio of the RMS value of the harmonic content to the RMS value of the rated or maximum fundamental quantity, expressed in percent;
- PHILIPPINE DISTRIBUTION CODE sets the TDD of the current at any user of the system to not exceed five percent (5%) during normal operating conditions.

It is important to note that the values obtained for the THD (refer to previous sections) might declare the parameter values within the limits. However, the overall conclusion shall be derived together with the TDD compliance as the values of the TDD coming from the asset while the THD values coming normally from the sources.

In this situation, results of TDD are significant higher than the limit of 5%, indicating a certain degree of probability that there is an existing issue.

Table 2.17: Power quality -Harmonic TDD compliance

TDD compliance	Phase	Minimum	Average	Maximum	Limits (%)	Remarks
Main	AB	1.28	4.89	26.82	$\leq 5\%$	Outside limits
	BC	1.28	4.73	25.67		
	CA	1.37	4.71	25.98		
VFD-1	AB	25.74	27.00	61.62	$\leq 5\%$	Outside limits
	BC	24.90	25.90	55.23		
	CA	25.67	26.87	57.07		
VFD-2	AB	24.24	25.01	37.14	$\leq 5\%$	Outside limits
	BC	23.59	24.42	52.61		
	CA	23.78	24.62	72.75		
Soft starter	AB	0.48	0.49	55.46	$\leq 5\%$	Outside limits
	BC	0.40	0.46	134.49		
	CA	0.44	0.48	52.65		

2.7.3.6 100% Power frequency (HZ) compliance

Results are shown in Table 2.18 with the following notes:

- A nominal fundamental frequency of 60HZ, PHILIPPINE DISTRIBUTION COCE set an acceptable limit of 59.7 HZ. for low frequency and 60.3 hz for high frequency.

Table 2.18: Power quality -Harmonic TDD compliance

Frequency	Minimum HZ	Average HZ	Maximum HZ	Limits HZ	Remarks
Main	59.68	60.17	60.48	59.7-60.3	Outside limits
VFD-1	59.74	60.07	60.34	59.7-60.3	Within limits
VFD-2	59.66	60.12	60.36	59.7-60.3	Outside limits
Softstarter	59.59	60.22	60.44	59.7-60.3	Outside limits

2.7.3.7 Power factor

Results are shown in Table 2.19 with the following notes:

- The ideal situation is a cos phi or DPF equal or close to 1. Utilities may charge additional cost (penalty when var readings are high because they need to provide apparent power (VA, kVA) that does not include both var and W).

Table 2.19: Power quality -powerfactor

Power factor	Minimum	Average	Maximum	Limits	Remarks
Main	0.79	0.87	0.87	>0.85	Within Limits
VFD-1	0.92	0.92	0.92	>0.85	Outside limits
VFD-2	0.93	0.93	0.93	>0.85	Within Limits
Softstarter	0.88	0.89	0.90	>0.85	Within Limits

2.7.3.8 Flicker

Results are shown in Table 2.20 with the following notes:

- A measuring period of 2 hours (Plt) is useful when there may be more than one interference source with irregular working cycles and for equipment such as welding machines. Plt ≤ 1.0 is the limit used in standards like EN15160;
- The 10 min (Pst) uses a longer measuring period to eliminate the influence of random voltage variations.

Table 2.20: Power quality -powerfactor

Flicker	Parameter	Minimum	Average	Maximum	Limits	Remarks
Main	Plt	0.31	0.34	0.29	<=0.80	Within Limits
	Pst	0.59	0.71	0.55	<=1.0	Within Limits
VFD-1	Plt	0.35	0.25	0.24	<=0.80	Within Limits
	Pst	0.76	0.51	0.52	<=1.0	Within Limits
VFD-2	Plt	0.49	0.71	0.24	<=0.80	Within Limits
	Pst	0.97	1.36	0.51	<=1.0	Within Limits
Soft starter	Plt	0.48	0.38	0.29	<=0.80	Within Limits
	Pst	1.06	0.84	0.49	<=1.0	Outside Limits

2.7.4 Conclusion and Recommendations

- In general the most efficient way to troubleshoot electrical systems, is to begin at the load and work towards the building's service entrance. Measurements are taken along the way to isolate faulty components or loads;
- Monitoring up to a period of one week is recommended to perform a quality check That allows you to obtain a good impression of power quality;
- According to IEEE 519. "Most motor loads are relatively tolerant of harmonics". However, IEEE 519-1992 states further that, "Even in the case of the least susceptible equipment, harmonics can be harmful. Harmonics, can cause dielectric thermal or voltage stress, which causes premature aging of electrical insulation. A major effect of harmonic voltages and currents in rotating machinery (induction and synchronous) is increased heating due to iron and copper losses at the harmonic frequencies. The harmonic components thus affect the machine efficiency, and can also affect the torque developed";
- In the case of this station, the total demand distortion is outside the limits set in the Philippine Distribution Code. From the application perspective, we're most concerned with the maximum harmonic current levels, and the impact they have on the distribution system. This makes TDD a much more useful metric for power inverter distortion;
- the current unbalance occurred in the absence of voltage unbalance, hence it is recommended to look for the cause of current unbalance which could be faulty insulation or a phase shorted to ground. Correcting the current unbalance helps prevent overheating and deterioration of motor-winding insulation and other equipment. Thermal scanning of motor is recommended;
- The measured power factor is low for Main ATS 1250A. Consider addressing first the issues on harmonics if any before improving the power factor;
- Crest Factor – A high crest factor value for current was recorded to signify a distorted current waveform. A CF of 1.8 or higher means high waveform distortion. This can be attributed on the current drawn by the variable frequency drive;

Main Phase	VOLTAGE		CURRENT	
	MIN	MAX	MIN	MAX
A	1.41	1.45	1.36	2.14
B	1.41	1.46	1.36	2.08
C	1.42	1.47	1.38	2.08

VFD-1 phase	VOLTAGE		CURRENT	
	MIN	MAX	MIN	MAX
A	1.41	1.46	1.53	5.18
B	1.41	1.62	1.62	6.29
C	1.42	1.47	1.55	6.07

VFD-2 phase	VOLTAGE		CURRENT	
	MIN	MAX	MIN	MAX
A	1.42	1.46	1.45	11.08
B	1.41	1.45	1.51	8.39
C	1.42	1.46	1.43	11.95



Figure 2.13: Visual inspection on electrical safety and grounding

Soft starter	VOLTAGE		CURRENT	
	MIN	MAX	MIN	MAX
A	1.41	1.48	1.37	5.15
B	1.41	1.44	1.06	70.51
C	1.42	1.48	1.27	4.73

- Investigate TDD again on the low-voltage side of the transformer serving each motor, and at the meter where utility service is being received, to get a better sense of how the distortion has perpetuated throughout the system. If distortion is high at the meter, investigate further by installing harmonic filtration equipment. An active filter (cancellation of all harmonics) can be considered altogether.

2.8 Grounding system study

The study has been conducted in accordance with the ITP. Figure 2.13 shows the grounding points and activities conducted during the test.

Results of the study are shown in Table 2.21 with the following note:

- The resistance between the main grounding electrode and ground should be no greater than five ohms for large commercial or industrial systems and 1.0 ohm or less for generating or transmission station grounds unless otherwise specified by the owner (Reference ANSI/IEEE Standard 142).

Table 2.21: Ground system measurement results

Locations	Asset/Room	Resistance	Findings	Recommendations	Effects	Risks
LIGHTNING ARRESTER	TEST POINT 1 BARE COPPER WIRE	2.99Ω	(1) Within the 5 ohms limit as per NFPA and IEE standards; (2) However, values are already within the marginal level of acceptability	(1) Checking and retightening of loose grounding terminal connections; (2) Replacement of corroded copper wires improper lugs for grounding terminations	Overheating on conductors and possible nuisance tripping of ground fault protection or relays	Damage to equipment or accessories
LIGHTNING ARRESTER	TEST POINT 1 GROUND ROD	2.97Ω	(1) Within the 5 ohms limit as per NFPA and IEE standards; (2) However, values are already within the marginal level of acceptability	(1) Checking and retightening of loose grounding terminal connections (2) Replacement of corroded copper wires improper lugs for grounding terminations	(1) Overheating on conductors and possible nuisance tripping of ground fault protection or relays (2) Replacement of corroded copper wires improper lugs for grounding terminations	Damage to equipment or accessories
NEAR LVSG/MOTOR CONTROL CENTER	TEST POINT 2 COPPER WIRE	0.31Ω	Within the 5 ohms limit as per NFPA and IEE standards	None	None	None
NEAR LVSG/MOTOR CONTROL CENTER	TEST POINT 1 GROUND ROD	0.31Ω	Within the 5 ohms limit as per NFPA and IEE standards	None	None	None

2.9 Electrical system design and analysis

2.9.1 Basics

In accordance with Article 1.3 Electrical Plans and specifications of the Philippine Electrical Code 2017 Edition, Electrical design analysis shall be included and submitted separately together with the electrical plans. These includes the followings:

1. Branch circuits, sub-feeders, feeders, busways, and service entrance;
2. Types, ratings, and trip settings of overload protective device;
3. Calculation of voltage drops;
4. Calculation of short circuit current for determining the interrupting capacity of overcurrent protective device for residential, commercial and industrial establishment;
5. Protection coordination of overcurrent protective devices;
6. ARC-flash Hazard Analysis to determine the required personal protective equipment (PPE).

ARC flash Hazard Analysis is required and is intended for concerned parties to be informed and made aware of the importance of personal protective equipment (PPE) and its type for the flash hazard risk category determined by the analysis (refer to Table 2.22).

Table 2.22: ARC flash hazard risk categories and PPE ratings (Appendix H, PEC 2017)

Risk CAT.	Range of calculated incident energy [cal/cm ²]	Minimum Ppe Rating [Cal/Cm ²]	Clothing Required
0	0 < E ≤ 1.2	N/A	4.5-14.0 Oz/Yd ² Untreated Cotton
1	1.2 < E ≤ 4	4	Flame Retardant (Fr) Shirt And Pants
2	4 < E ≤ 8	8	Cotton Underclothing Plus Fr Shirt And Pants
3	8 < E ≤ 25	25	Cotton Underclothing Plus Fr Shirt, Pants, Overalls Or Equivalent
4	25 < E ≤ 40	40	Cotton Underclothing Plus Fr Shirt, Pants, Plus Double Layer Switching Coat And Pants Or Equivalent
5	40 < E ≤ 100	100	Cotton Underclothing Plus Fr Shirt, Pants, Plus Multi-Layer Switching Suit Or Equivalent

Table 2.23: Short circuit Summary

1/2 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus	ID	kV	3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
			Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
Bus1		34.500	1.394	-16.693	16.751	1.044	-12.514	12.557	14.456	1.208	14.507	14.039	6.212	15.352
Bus2		0.480	3.367	-13.211	13.633	3.253	-12.805	13.212	11.441	2.916	11.807	9.868	9.128	13.442
Bus3		0.480	3.428	-12.673	13.129	3.405	-11.931	12.407	10.975	2.969	11.370	-12.658	2.664	12.936
Bus5		0.480	3.428	-12.673	13.129	3.405	-11.931	12.407	10.975	2.969	11.370	-12.658	2.664	12.936
Bus6		0.480	3.432	-12.637	13.094	3.413	-11.873	12.353	10.944	2.972	11.340	-12.632	2.624	12.902
Bus7		0.460	0.341	-0.739	0.814	0.491	-0.218	0.537	0.640	0.296	0.705	-0.810	-0.272	0.854
Bus8		0.460	0.341	-0.739	0.814	0.488	-0.216	0.534	0.640	0.295	0.705	-0.808	-0.272	0.853
Bus9		0.460	5.072	-5.061	7.165	4.124	-2.646	4.900	4.383	4.392	6.205	-6.020	-3.577	7.003
Bus10		0.460	2.034	-0.434	2.080	1.223	-0.167	1.234	0.376	1.761	1.801	-0.812	-1.716	1.898
Bus11		0.460	1.776	-0.347	1.810	1.060	-0.132	1.069	0.300	1.538	1.567	-0.677	-1.503	1.648
Bus13		0.460	1.576	-0.287	1.602	0.936	-0.108	0.942	0.248	1.365	1.388	-0.580	-1.336	1.457
Bus14		0.480	5.586	-3.399	6.539	4.038	-1.643	4.360	2.943	4.838	5.663	-4.487	-4.348	6.248
Bus15		0.240	0.396	-0.357	0.533	0.395	-0.353	0.530	0.309	0.343	0.461	-0.506	-0.168	0.533
Bus16		0.460	0.380	-0.720	0.814	0.505	-0.219	0.550	0.624	0.329	0.705	-0.802	-0.306	0.858
Bus17		0.460	0.385	-0.717	0.814	0.504	-0.217	0.549	0.621	0.334	0.705	-0.799	-0.310	0.857
Bus19		0.460	4.283	-10.213	11.074	4.548	-8.577	9.708	8.844	3.709	9.590	-11.119	-0.063	11.119

All fault currents are symmetrical (1/2 Cycle network) values in rms kA.

* LLG fault current is the larger of the two faulted line currents.

2.9.2 Results

Results are briefly presented in the following subsections. Details reports generated by the software are enclosed as part of the Appendix of this report (can also be an electronic files)

2.9.2.1 Types, ratings, and trip settings of overload protective device

Types, ratings, and trip settings of overload protective devices are shown in Table 2.8 of subsection 2.5

2.9.2.2 Calculation of voltage drops

Basic for analysis is per IEC 2017 ARTICLE 2.15.1.2(A)(1)(b)FPN NO.2, which states "Conductors for feeders, as defined in Article1.1, sized to prevent a voltage drop exceeding three (3) percent at the farthest outlet of power, heating and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed five (5) percent , will provide reasonable efficiency."

Results of voltage drop are summarized in Table 2.3 of subsection 2.3

2.9.2.3 Calculation of short circuit current 3-PHASE

Table 2.23 show summaries of results on short circuit.

2.9.2.4 Protection coordination of overcurrent protective devices

Results of study on protection coordination are presented in subsection 2.5. With reference to the coordination plot shown in Figure 2.9, it is noted that partial coordination only for CB2 Normal breaker of Automatic Transfer Switch and Main of MCC panel. TCC of Main MCC crosses the TCC of circuit breaker upstream. It is recommended to have a higher trip unit (Micrologic 6) which will be placed upstream for better coordination.

2.9.2.5 Arc-flash Hazard Analysis

2.9.3 Recommendations

According to the results of the Arc Flash Analysis, Flame retardant shirt and pants should be worn when opening the cover of the MCC Panel respecting the Arc flash Boundary (AFB) . Contributors to the arc flash are the motor loads and the VFD's.

An Arc flash label (refer to Figure 2.15) should be placed on the MCC as per requirement of the Philippine Electrical code.

2.10 Electrical Integrity

2.10.1 Basic for testing

Integrity test was conducted based on the following basics:

- Insulation resistance values should be in accordance with the manufacturers published data. Values less than the insulation resistance less than the manufacturer's recommendations should be investigated. In the absence of the manufacturer's data, NETA (National Electrical Testing Association) values for IR were used to determine suitability of existing apparatus to remain in service.
- If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the over-potential test, the test specimen is considered to have passed the test.
- The acceptable insulation resistance value for electrical apparatus and systems for a nominal rating of 600 Volts is minimum 100Megohms at a test voltage of 1000 volts DC.
- Insulation test may be used to establish a trending pattern. Deviations from the baseline information permit evaluation of the insulation.

2.10.2 Results

Results of the test are presented in Table 2.24

Table 2.24: Insulation resistance test- results

No.	Description	Voltage	Connectivity ($M\Omega$)						Remarks
			L1-L2	L2-L3	L3-L1	L1-G	L2-G	L3-G	
1	Normal Side Incoming power cable from ECB 1250AT outdoor to noraml ACB from ECB 1250AT outdoor to noraml ACB	1kV	>2000	>2000	>2000	1423	1358	1179	Within limits
2	Emergency side incoming power cable from genset breaker to ATS emergency ACB	1kV	868	930	1044	518	530	531	Within limits
3	Common load busbar of ATS 1250AT to lineside of sub-main MCCB 1250AT	1kV	>2000	>2000	>2000	>2000	>2000	>2000	Within limits
4	Common main busbar of MCC	1kV	>2000	>2000	>2000	>2000	>2000	>2000	Within limits

It can be confirmed from the data/results of the insulation test that values at the time of the test were within the limits.

AYALA ALABANG R1P ARC FLASH ANALYSIS

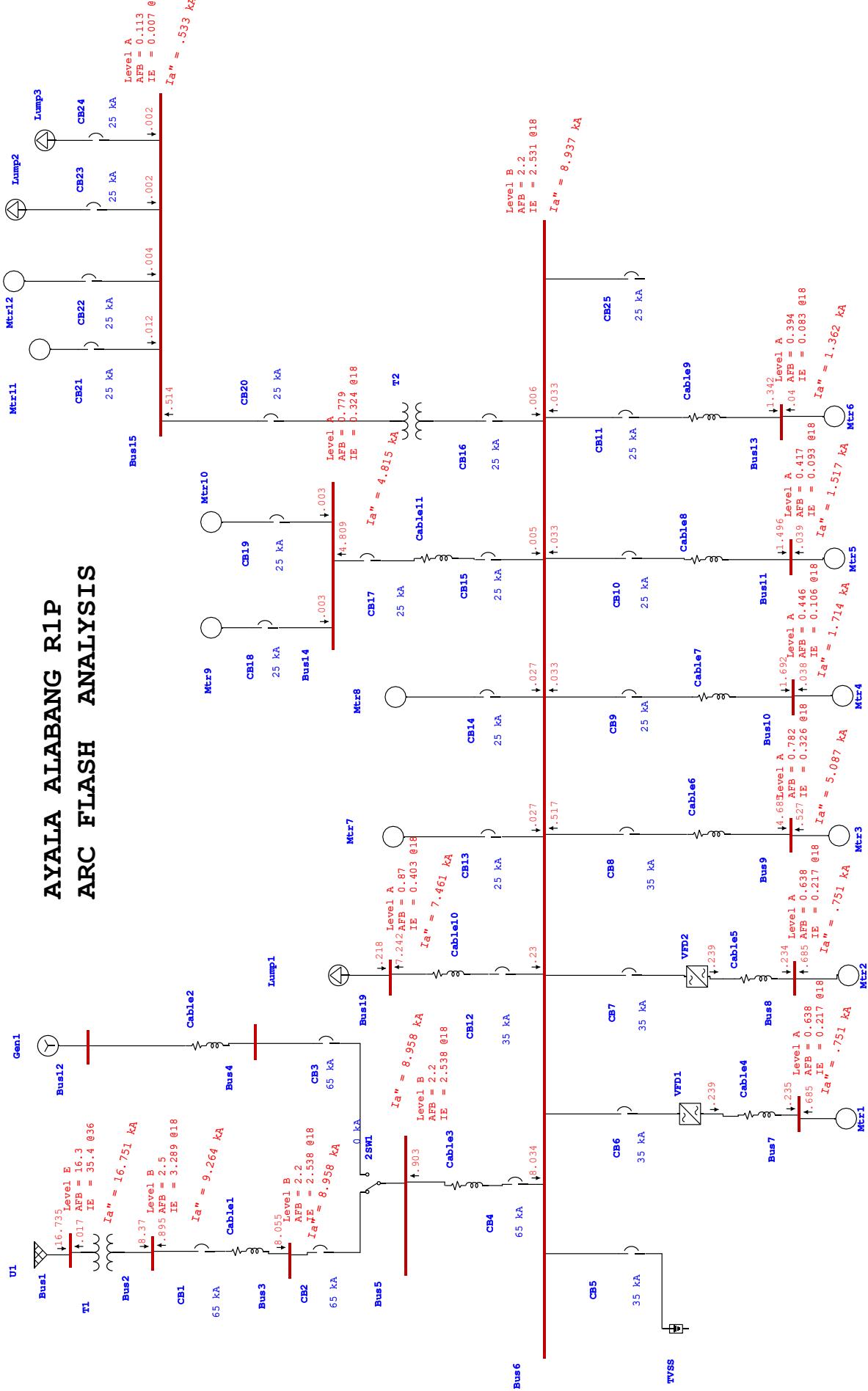


Figure 2.14: ARC flash analysis



Figure 2.15: Arc flash labels

2.11 Fire protection and safety (FDAS) audit

2.11.1 Fire alarm and detection system

2.11.1.1 Data and analysis

Summary of data and information from FDAS audit is presented in Table 2.25 with visual images on as-found devices and panels (Figure 2.16 and Figure 2.17).

Table 2.25: FDAS data highlights 01.

No.	Assets	Status	Remarks
A.	VISUAL CHECK OF FIRE ALARM CONTROL PANEL		
1	Panel Status, installed and location area	1	INSTALLED, LOCATED AT ENTRANCE
2	Power indicator lamp operational	1	
3	Devices properly indicated and marked	1	
4	Panel clear from trouble indicators	1	
5	Lamp test indicator operational	1	
6	Zones properly indicated and marked	1	
7	Check if it's connected to sprinkler system	0	NO SPRINKLER INSTALLED AT SITE
B.	CHECKING OF INSTALLED DEVICES		
1	Check floor plan lay-out and location of the device if accessible/easy to access	0	No floor Plan presented during inspection
2	Heat detectors and / or smoke detectors locations acceptable	1	
3	Heat detectors and / or smoke detectors indicator lamp functioning	1	
4	Pull station locations acceptable	1	
5	Bells and buzzers operated correctly	1	FOR VERIFICATION
6	Bells and buzzers audibility	1	FOR VERIFICATION
7	Strobe lights locations are acceptable	0	NO STROBE LIGHT DEVICE
8	Strobe light operated correctly	0	NO DEVICE
9	Are Fire alarm zones (areas) clearly marked	1	
10	Is there a maintenance and service contract for the fire alarm system	1	INFORMATION SUPPLIED BY OPERATOR AT SITE
11	Does the Fire Alarm System smoke detector, heat detector, manual call point, horn and strobe light working and have a current inspection tag	0	NO INSPECTION TAG
12	Is the fire alarm system in full working order		FOR VERIFICATION

On the inspection date, it was established that there is Fire Alarm Control with PYGARD brand and the devices are SMOKE DETECTOR "PYGARD" brand.

It is a conventional fire alarm system which is an early warning system design that detects a fire, that tells the zone / area of the fire but not the exact location of the fire. The existing design plan did not consider where a specific fire alarm can signal exactly where the fire is occurring.

The existing Fire Detection and Alarm system consists of: 20 pcs of smoke detector, 4 zone indicators, 5 sets manual call point and buzzers, and 4 sets of bells.

On the testing date, the activity was witnessed by the operator on duty for this pump station. Highlights of the testing are:

- 16 out of 20 smoke detector devices were tested, activated after spraying of smoke tester. Location of functioning SD are:
 - the lobby
 - hallway
 - conference room
 - file room
 - back room
 - pantry
 - customer care
 - utility room



Figure 2.16: As-found devices and panels

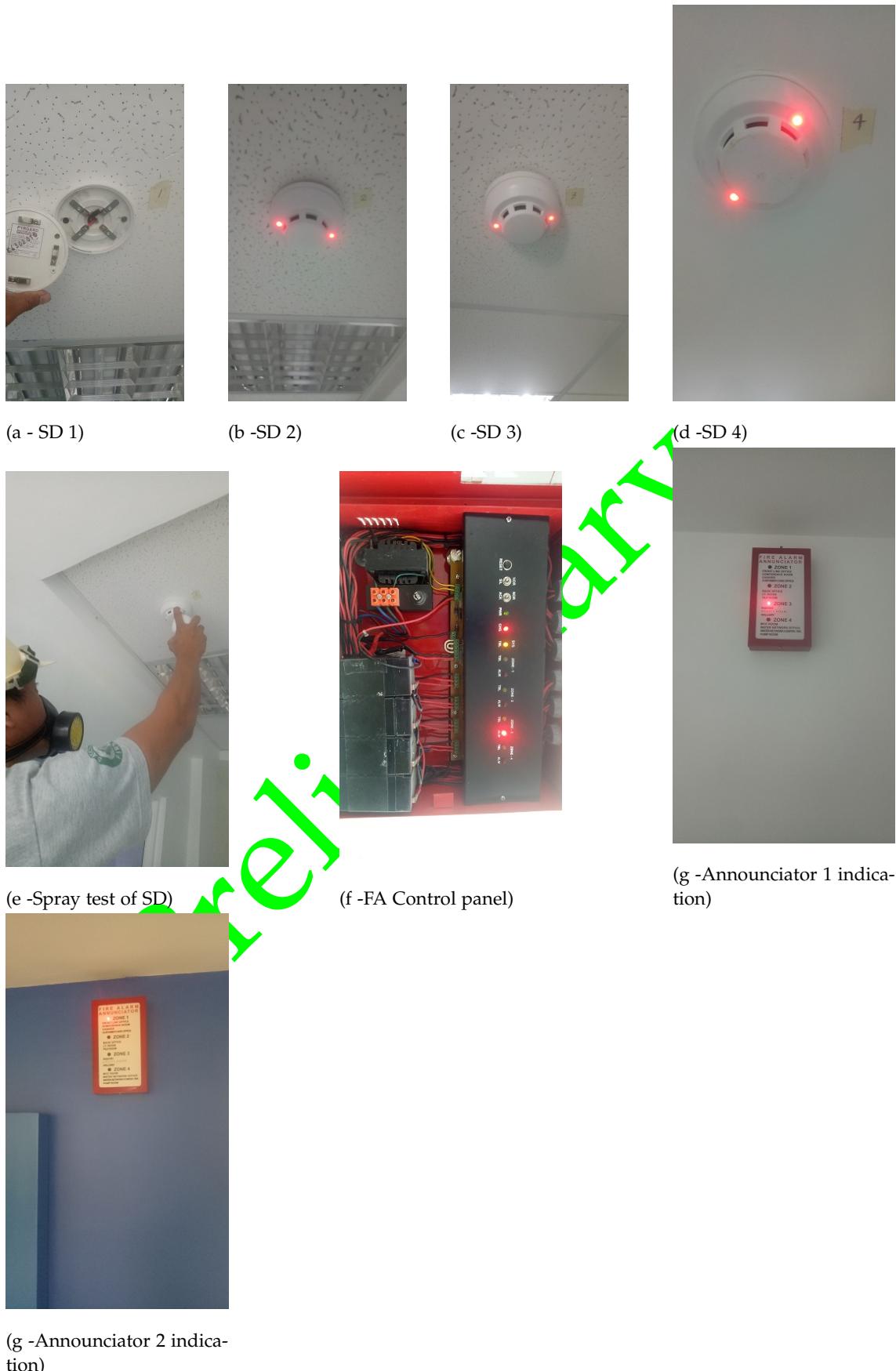


Figure 2.17: Testing of smoke detectors

- Motor control center room
- Water network room
- Water network conference room
- Remaining 4 devices not tested due to unavailability of keys in the IT room, cashier room, and need scaffolding in the pump room;
- All manual call point in good condition;
- Three (3) bells were activated every time the smoke detectors and manual call point were activated;
- One (1) bell device did not function (not activated-no sound) during testing located at the MCC room;
- There are no smoke detectors at the chlorine tank house and genset room.

Recommendations

- Troubleshoot non-functioning bell at the MCC room. Check wiring specially on the termination.

System Testing

FDAS shall be subjected to the following tests conforming to the Philippine Electronics Code of 2014 and Philippine Electrical Code of 2017

- ✓ Testing of insulation resistance and continuity of wires;
- ✓ Verification of installed devices;
- ✓ Operation and response of FDAS;
- ✓ Testing the operation of initiating devices;
- ✓ Measuring sound pressure level generated by notification devices;

Records

Every FDAS system shall keep the following documentations

- ✓ A complete set of operation and maintenance manuals of the manufacturer covering all equipment used in the system;
- ✓ A complete set of as-built drawings;
- ✓ A written sequence of operation;
- ✓ Record of completion and results of every inspection, testing and maintenance;
- ✓ Record of components within the database.

2.11.2 Lighting protection system

2.11.2.1 Data and testing

There is a lightning protection system installed for this in pump station. The strike counter has registered previous strikes (Figure 2.18).

Testing the connection of the continuity of bare copper wire connecting the lightning arrester indicated acceptable values but already on the marginal side.

2.11.2.2 Recommendations

Short term Recommendations

It is advisable to continue monitoring the lighting system with future tests possible to detect the statistical trend that the system will fail to provide adequate level of services.



(a - Bare copper wire) (b -Lighting arrester rod) (c -Strike counter)

Figure 2.18: Lightning devicesLong term Recommendations

- ✓ According to the standard, an inspection should be undertaken during the construction of the structure, after the installation, after alterations or repairs, and when it is known that the structure has been struck by lightning;
- ✓ It is also recommended that inspections take place “periodically at such intervals as determined with regard to the nature of the structure to be protected”, taking into account the local environment, such as corrosive soils and corrosive atmospheric conditions and the type of protection measures employed;
- ✓ The inspection comprises checking the technical documentation, visual inspections and test measurements;
- ✓ Prepare an inspection guide to facilitate the inspection process containing sufficient information on the installation and its components, tests methods and previous inspection/test data;
- ✓ During the visual inspection, the following should be checked;
 - the deterioration and corrosion of air-termination elements, conductors and connections
 - the corrosion of earth electrodes
 - the earthing resistance value for the earth-termination system
 - the condition of connections, equipotential bonding and fixings.
- ✓ For those parts of an earthing system and bonding network not visible for inspection, tests of electrical continuity should be performed;
- ✓ An inspection report should be prepared detailing the status of the system, any deviations from the technical documentation and the results of any measurements undertaken. Any obvious faults should also be reported.

No lightning protection system is 100% effective. A system designed in compliance with the standard does not guarantee immunity from damage. Lightning protection is an issue of statistical probabilities and risk management. A system designed in compliance with the standard should statistically reduce the risk to below a pre-determined threshold. The IEC 62305-2 risk management process provides a framework for this analysis. An effective lightning protection system needs to control a variety of risks. While the current of the lightning flash creates a number of electrical hazards, thermal and mechanical hazards also need to be addressed.

Risk to persons (and animals) include:

- Direct flash;
- Step potential ;
- Touch potential ;
- Side flash ;
- Secondary effects
 - asphyxiation from smoke or injury due to fire
 - structural dangers such as falling masonry from point of strike
 - unsafe conditions such as water ingress from roof penetrations causing electrical or other hazards, failure or malfunction of processes, equipment and safety systems

Risk to structures & internal equipment include:

- Fire and/or explosion triggered by heat of lightning flash, its attachment point or electrical arcing of lightning current within structures ;
- Fire and/or explosion triggered by ohmic heating of conductors or arcing due to melted conductors;
- Punctures of structure roofing due to plasma heat at lightning point of strike ;
- Failure of internal electrical and electronic systems ;
- Mechanical damage including dislodged materials at point of strike.

2.11.3 Ground-Fault circuit interrupter (GFCI) or electric leakage circuit breaker (ELCB) or Residual circuit devices (RCD)

2.11.3.1 Data and analysis

No ground fault circuit interrupter (GFCI) or earth leakage Circuit breaker (ELCB) protection was installed in the panel for FDAS for this PS.

2.11.4 Electrical safety and protective devices

2.11.4.1 Data and analysis

The pump station in general is well maintained and the area station where the operator stays is free from all obstructions. There were some marginal findings of safety issues but otherwise the station is well managed. The station has observed good housekeeping and cleanliness of the pump station.

Some highlights on fire protection are with the Table 2.26 and figure 2.19

Table 2.26: Highlights on Fire protection data

Items	Visual inspection on	Status	Remarks
1	Evacuation Plan	1	Posted
2	Fire Extinguishers	1	Green FEX(HCFC) and Red FEX dry chemical
3	Fire Exits	1	All doors have exit signages
4	Fire Hose Cabinet	0	Not found
5	Fire Sprinkler System	0	No sprinkler system
6	Emergency Exit Signages	1	Found in every door
7	Emergency Lights	1	Emergency lights are functioning (Aglow) Mosy has no inspection tag
8	Ppe Cabinet	0	Not found



(i -No signal manhole) (j -No warning signale) (k -No checklist)

Figure 2.19: Safety

Appendix A

Load Flow Analysis

Preliminary

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Bus Loading Summary Report

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic		MVA	% PF	Amp	Percent Loading
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MVA					
Bus1		34.500								0.570	78.8		9.5	
Bus2		0.480								0.546	80.9		685.6	
Bus3		0.480								0.544	81.0		685.6	
Bus5		0.480								0.544	81.0		685.6	
Bus6		0.480	0.236	0.214						0.544	81.0		685.6	
Bus7		0.460	0.109	0.048						0.119	91.5		144.7	
Bus8		0.460	0.109	0.048						0.119	91.5		145.0	
Bus9		0.460	0.109	0.048						0.119	91.5		152.3	
Bus10		0.460	0.010	0.006						0.011	86.5		14.1	
Bus11		0.460	0.010	0.006						0.011	86.5		14.2	
Bus13		0.460	0.010	0.006						0.011	86.5		14.2	
Bus14		0.480	0.002	0.002						0.003	81.0		3.3	
Bus15		0.240	0.002	0.002						0.003	81.5		7.6	
Bus16		0.460								0.120	91.6		144.7	
Bus17		0.460								0.121	91.6		145.0	
Bus19		0.460	0.048	0.029	0.012	0.007				0.070	85.0		88.1	

* Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating).

Indicates operating load of a bus exceeds the bus margin limit (90.0% of the Continuous Ampere rating).

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Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer			
ID	Type	Ampacity (Amp)	Loading Amp	%	Capability (MVA)	Loading (input) MVA	Loading (output) MVA	
Cable1	Cable	1003.37	685.58	68.33				
Cable3	Cable	1003.37	685.58	68.33				
* Cable10	Cable	76.20	88.15	115.68				
T1	Transformer				0.750	0.0	76.0	
T2	Transformer				0.025	0.003	60.1	
							0.546	
							72.7	
							0.003	
							59.2	

* Indicates a branch with operating load exceeding the branch capability.

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Branch Losses Summary Report

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	kW	kvar	From	To	
T1	0.449	0.351	-0.441	-0.321	7.7	30.4	100.0	95.7	4.29
Cable1	0.441	0.321	-0.441	-0.319	0.9	2.2	95.5	95.5	0.24
Cable3	0.441	0.319	-0.440	-0.319	0.1	0.1	95.5	95.4	0.02
Cable6	0.111	0.048	-0.109	-0.048	1.7	0.1	95.4	98.2	1.33
Cable7	0.010	0.006	-0.010	-0.006	0.1	0.0	95.4	99.0	0.55
Cable8	0.010	0.006	-0.010	-0.006	0.1	0.0	95.4	98.9	0.64
Cable9	0.010	0.006	-0.010	-0.006	0.0	0.0	95.4	98.8	0.73
Cable10	0.059	0.037	-0.059	-0.037	0.1	0.0	95.4	99.5	0.14
Cable11	0.002	0.002	-0.002	-0.002	0.0	0.0	95.4	95.4	0.03
T2	0.002	0.002	-0.002	-0.002	0.0	0.0	95.4	94.0	1.44
Cable4	-0.109	-0.048	0.110	0.048	1.2	0.2	103.4	104.3	0.99
Cable5	-0.109	-0.048	0.110	0.048	1.3	0.3	103.2	104.3	1.16
					13.2	32.6			

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Alert Summary Report

% Alert Settings		
	<u>Critical</u>	<u>Marginal</u>
<u>Loading</u>		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Inverter/Charger	100.0	95.0
<u>Bus Voltage</u>		
OverVoltage	105.0	102.0
UnderVoltage	95.0	98.0
<u>Generator Excitation</u>		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus15	Bus	Under Voltage	0.240	kV	0.226	94.0	3-Phase
Cable10	Cable	Overload	76.202	Amp	88.15	115.7	3-Phase
VFD1	VFD	Overload	180.422	Amp	189.37	105.0	3-Phase
VFD2	VFD	Overload	180.422	Amp	189.71	105.1	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus14	Bus	Under Voltage	0.480	kV	0.458	95.4	3-Phase
Bus2	Bus	Under Voltage	0.480	kV	0.46	95.7	3-Phase
Bus3	Bus	Under Voltage	0.480	kV	0.46	95.5	3-Phase
Bus5	Bus	Under Voltage	0.480	kV	0.46	95.5	3-Phase
Bus6	Bus	Under Voltage	0.480	kV	0.46	95.4	3-Phase

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SUMMARY OF TOTAL GENERATION , LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	0.449	0.351	0.520	78.79 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	0.449	0.351	0.570	78.79 Lagging
Total Motor Load:	0.424	0.030	0.470	90.18 Lagging
Total Static Load:	0.012	0.007	0.014	85.00 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.013	0.140		
System Mismatch:	0.000	0.000		

Number of Iterations: 2

Preliminary

Appendix B

Harmonic Analysis

Preliminary

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VIHD (Individual Harmonic Distortion) Report

Bus	Voltage Distortion				
	ID	kV	Fund.	VIHD	
		%	%	Order	
Bus2		0.480	95.71	10.56	3.00
Bus3		0.480	95.46	10.53	3.00
Bus5		0.480	95.46	10.53	3.00
Bus6		0.480	95.44	10.53	3.00
Bus9		0.460	98.20	10.68	3.00
Bus10		0.460	99.02	10.59	3.00
Bus11		0.460	98.41	10.61	3.00
Bus13		0.460	98.84	10.61	3.00
Bus14		0.480	95.41	10.53	3.00
Bus15		0.480	94.60	2.59	3.00
Bus19		0.460	99.45	10.50	3.00
Bus2		0.480	95.71	4.11	7.00
Bus3		0.480	95.46	4.21	7.00
Bus5		0.480	95.46	4.21	7.00
Bus6		0.480	95.44	4.21	7.00
Bus9		0.460	98.20	4.22	7.00
Bus10		0.460	99.02	4.23	7.00
Bus11		0.460	98.93	4.24	7.00
Bus13		0.460	98.84	4.24	7.00
Bus14		0.480	95.41	4.21	7.00
Bus15		0.240	94.00	4.41	7.00
Bus19		0.460	99.45	4.21	7.00
Bus2		0.480	95.71	1.64	9.00
Bus3		0.480	95.46	1.63	9.00
Bus5		0.480	95.46	1.63	9.00
Bus6		0.480	95.44	1.63	9.00
Bus9		0.460	98.20	1.66	9.00
Bus10		0.460	99.02	1.64	9.00
Bus11		0.460	98.93	1.65	9.00
Bus13		0.460	98.84	1.65	9.00
Bus14		0.480	95.41	1.64	9.00
Bus19		0.460	99.45	1.63	9.00
Bus2		0.480	95.71	3.08	11.00
Bus3		0.480	95.46	3.17	11.00
Bus5		0.480	95.46	3.17	11.00
Bus6		0.480	95.44	3.18	11.00
Bus9		0.460	98.20	3.18	11.00
Bus10		0.460	99.02	3.19	11.00
Bus11		0.460	98.93	3.20	11.00
Bus13		0.460	98.84	3.20	11.00

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Bus	Voltage Distortion			
	ID	Fund.	VIHD	Order
	kV	%	%	
Bus14	0.480	95.41	3.18	11.00
Bus15	0.240	94.00	3.04	11.00
Bus19	0.460	99.45	3.18	11.00
Bus2	0.480	95.71	3.19	13.00
Bus3	0.480	95.46	3.28	13.00
Bus5	0.480	95.46	3.28	13.00
Bus6	0.480	95.44	3.28	13.00
Bus9	0.460	98.20	3.29	13.00
Bus10	0.460	99.02	3.30	13.00
Bus11	0.460	97.41	3.32	13.00
Bus13	0.460	98.84	3.30	13.00
Bus14	0.480	95.41	3.28	13.00
Bus15	0.240	94.00	3.11	13.00
Bus19	0.460	99.45	3.28	13.00
Bus2	0.480	95.71	3.33	17.00
Bus3	0.480	95.46	3.41	17.00
Bus5	0.480	95.46	3.41	17.00
Bus6	0.480	95.44	3.41	17.00
Bus9	0.460	98.20	3.42	17.00
Bus10	0.460	99.02	3.43	17.00
Bus11	0.460	98.93	3.43	17.00
Bus13	0.460	98.84	3.44	17.00
Bus14	0.480	95.41	3.41	17.00
Bus15	0.240	94.00	3.17	17.00
Bus19	0.460	99.45	3.41	17.00
Bus2	0.480	95.71	3.45	19.00
Bus3	0.480	95.46	3.52	19.00
Bus5	0.480	95.46	3.52	19.00
Bus6	0.480	95.44	3.53	19.00
Bus9	0.460	98.20	3.53	19.00
Bus10	0.460	99.02	3.54	19.00
Bus11	0.460	98.93	3.55	19.00
Bus13	0.460	98.84	3.55	19.00
Bus14	0.480	95.41	3.53	19.00
Bus15	0.240	94.00	3.23	19.00
Bus19	0.460	99.45	3.53	19.00
Bus2	0.480	95.71	3.68	23.00
Bus3	0.480	95.46	3.74	23.00
Bus5	0.480	95.46	3.74	23.00
Bus6	0.480	95.44	3.75	23.00
Bus9	0.460	98.20	3.76	23.00
Bus10	0.460	99.02	3.77	23.00
Bus11	0.460	98.93	3.77	23.00

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Bus	Voltage Distortion			
	ID	Fund.	VIHD	Order
	kV	%	%	
Bus13	0.460	98.84	3.77	23.00
Bus14	0.480	95.41	3.75	23.00
Bus15	0.240	94.00	3.34	23.00
Bus19	0.460	99.45	3.75	23.00
Bus2	0.480	95.71	3.81	23.00
Bus3	0.480	95.46	3.87	25.00
Bus5	0.480	95.46	3.87	25.00
Bus6	0.480	95.44	3.87	25.00
Bus9	0.460	98.20	3.88	25.00
Bus10	0.460	99.45	3.87	25.00
Bus11	0.460	98.93	3.90	25.00
Bus13	0.460	98.84	3.90	25.00
Bus14	0.480	95.41	3.87	25.00
Bus15	0.240	94.00	3.40	25.00
Bus19	0.460	99.45	3.87	25.00
Bus2	0.480	95.71	3.88	29.00
Bus3	0.480	95.46	3.94	29.00
Bus5	0.480	95.46	3.94	29.00
Bus6	0.480	95.44	3.94	29.00
Bus9	0.460	98.20	3.95	29.00
Bus11	0.460	99.02	3.96	29.00
Bus13	0.460	98.93	3.97	29.00
Bus14	0.460	98.84	3.97	29.00
Bus15	0.240	94.00	3.94	29.00
Bus19	0.460	99.45	3.94	29.00
Bus2	0.480	95.71	4.00	31.00
Bus3	0.480	95.46	4.05	31.00
Bus5	0.480	95.46	4.05	31.00
Bus6	0.480	95.44	4.05	31.00
Bus9	0.460	98.20	4.06	31.00
Bus10	0.460	99.02	4.07	31.00
Bus11	0.460	98.93	4.08	31.00
Bus13	0.460	98.84	4.08	31.00
Bus14	0.480	95.41	4.05	31.00
Bus15	0.240	94.00	3.38	31.00
Bus19	0.460	99.45	4.05	31.00
Bus2	0.480	95.71	4.06	35.00
Bus3	0.480	95.46	4.11	35.00
Bus5	0.480	95.46	4.11	35.00
Bus6	0.480	95.44	4.11	35.00
Bus9	0.460	98.20	4.12	35.00
Bus10	0.460	99.02	4.13	35.00

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Bus	Voltage Distortion			
	ID	Fund.	VIHD	Order
	kV	%	%	
Bus11	0.460	98.93	4.13	35.00
Bus13	0.460	98.84	4.14	35.00
Bus14	0.480	95.41	4.11	35.00
Bus15	0.240	94.00	3.30	35.00
Bus19	0.460	99.45	4.11	35.00
Bus2	0.480	95.71	4.19	37.00
Bus3	0.480	95.46	4.23	37.00
Bus5	0.480	95.46	4.23	37.00
Bus6	0.480	95.44	4.23	37.00
Bus9	0.460	97.93	4.21	37.00
Bus10	0.460	99.02	4.26	37.00
Bus11	0.460	98.93	4.26	37.00
Bus13	0.460	98.84	4.26	37.00
Bus14	0.480	95.41	4.24	37.00
Bus15	0.240	94.00	3.33	37.00
Bus19	0.460	99.45	4.23	37.00
Bus2	0.480	95.71	4.27	41.00
Bus3	0.480	95.46	4.31	41.00
Bus5	0.480	95.46	4.31	41.00
Bus6	0.480	95.44	4.31	41.00
Bus9	0.460	98.20	4.33	41.00
Bus10	0.460	99.02	4.34	41.00
Bus11	0.460	98.93	4.34	41.00
Bus13	0.460	98.84	4.34	41.00
Bus14	0.480	95.41	4.32	41.00
Bus15	0.240	94.00	3.26	41.00
Bus19	0.460	99.45	4.31	41.00
Bus2	0.480	95.71	4.33	43.00
Bus3	0.480	95.46	4.36	43.00
Bus5	0.480	95.46	4.36	43.00
Bus6	0.480	95.44	4.37	43.00
Bus9	0.460	98.20	4.38	43.00
Bus10	0.460	99.02	4.39	43.00
Bus11	0.460	98.93	4.39	43.00
Bus13	0.460	98.84	4.40	43.00
Bus14	0.480	95.41	4.37	43.00
Bus15	0.240	94.00	3.23	43.00
Bus19	0.460	99.45	4.37	43.00
Bus2	0.480	95.71	4.30	47.00
Bus3	0.480	95.46	4.34	47.00
Bus5	0.480	95.46	4.34	47.00
Bus6	0.480	95.44	4.34	47.00
Bus9	0.460	98.20	4.35	47.00

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Bus	Voltage Distortion			
	ID	Fund.	VIHD	Order
Bus10	0.460	99.02	4.36	47.00
Bus11	0.460	98.93	4.36	47.00
Bus13	0.460	98.84	4.37	47.00
Bus14	0.480	95.41	4.34	47.00
Bus15	0.240	94.00	3.06	47.00
Bus19	0.460	99.45	4.34	47.00
Bus2	0.480	95.71	4.29	49.00
Bus3	0.480	95.46	4.32	49.00
Bus5	0.480	95.46	4.32	49.00
Bus6	0.480	95.84	4.32	49.00
Bus9	0.460	98.20	4.34	49.00
Bus10	0.460	97.92	4.35	49.00
Bus11	0.460	98.93	4.35	49.00
Bus13	0.460	98.84	4.36	49.00
Bus14	0.480	95.41	4.33	49.00
Bus15	0.240	94.00	2.98	49.00
Bus19	0.460	99.45	4.32	49.00

Indicates buses with VIHD (Individual Harmonic Distortion) exceeding the limit.

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VTHD (Total Harmonic Distortion) Report

Bus	Voltage Distortion			
	ID	kV	Fund. %	VTHD %
Bus2		0.480	95.71	18.47
Bus3		0.480	95.46	18.64
Bus5		0.480	95.46	18.64
Bus6		0.480	95.44	18.66
Bus9		0.460	98.20	18.77
Bus10		0.460	99.02	18.75
Bus11		0.460	99.23	18.77
Bus13		0.460	98.82	18.79
Bus14		0.480	95.41	18.66
Bus15		0.240	94.00	13.16
Bus19		0.60	99.45	18.63

Indicates buses with VTHD (Total Harmonic Distortion) exceeding the limit.

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Alert Summary Report

% Alert Settings

	<u>Critical</u>	<u>Marginal</u>
Bus		

Individual Bus VTHD / VIHD values are used.

Transformer

Total I	100.0	95.0
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Filter

Capacitor kV	100.0	95.0
Inductor Amp	100.0	95.0

Capacitor

Max kV	100.0	95.0
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Cable

Ampacity	100.0	95.0
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Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Harmonic
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	10.59	706.1	3.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	4.23	282.2	7.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	1.64	109.6	9.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	3.19	212.9	11.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	3.30	219.9	13.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	3.43	228.7	17.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	3.54	236.3	19.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	3.77	251.0	23.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	3.89	259.5	25.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	3.96	264.2	29.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	4.07	271.5	31.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	4.13	275.3	35.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	4.26	283.7	37.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	4.34	289.1	41.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	4.39	292.6	43.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	4.36	290.7	47.00
Bus10	Bus	Exceeds Limit	1.50	Bus IHD	4.35	289.9	49.00
Bus10	Bus	Exceeds Limit	2.50	Bus THD	18.75	750.2	Total
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	10.60	706.8	3.00

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Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Harmonic
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	4.24	282.4	7.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	1.65	109.7	9.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	3.20	213.0	11.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	3.25	220.0	13.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	3.43	228.9	17.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	3.55	236.5	19.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	3.77	251.2	23.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	3.90	259.7	25.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	3.97	264.4	29.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	4.08	271.7	31.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	4.13	275.5	35.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	4.26	283.9	37.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	4.34	289.3	41.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	4.39	292.9	43.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	4.36	291.0	47.00
Bus11	Bus	Exceeds Limit	1.50	Bus IHD	4.35	290.1	49.00
Bus11	Bus	Exceeds Limit	2.50	Bus THD	18.77	750.8	Total
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	10.61	707.4	3.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	4.24	282.7	7.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	1.65	109.8	9.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	3.20	213.2	11.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	3.30	220.2	13.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	3.44	229.1	17.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	3.55	236.7	19.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	3.77	251.4	23.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	3.90	260.0	25.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	3.97	264.6	29.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	4.08	272.0	31.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	4.14	275.8	35.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	4.26	284.2	37.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	4.34	289.6	41.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	4.40	293.1	43.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	4.37	291.2	47.00
Bus13	Bus	Exceeds Limit	1.50	Bus IHD	4.36	290.4	49.00
Bus13	Bus	Exceeds Limit	2.50	Bus THD	18.79	751.5	Total
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	10.53	702.3	3.00

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Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Harmonic
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	4.21	280.9	7.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	1.64	109.0	9.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	3.18	211.9	11.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	3.22	218.8	13.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	3.41	227.6	17.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	3.53	235.2	19.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	3.75	249.8	23.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	3.87	258.3	25.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	3.94	262.9	29.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	4.05	270.2	31.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	4.11	274.0	35.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	4.24	282.3	37.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	4.32	287.7	41.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	4.37	291.2	43.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	4.34	289.3	47.00
Bus14	Bus	Exceeds Limit	1.50	Bus IHD	4.33	288.5	49.00
Bus14	Bus	Exceeds Limit	2.50	Bus THD	18.66	746.4	Total
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	2.59	172.6	3.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	4.41	294.3	7.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	3.04	202.4	11.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	3.11	207.3	13.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	3.17	211.3	17.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	3.23	215.6	19.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	3.34	222.9	23.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	3.40	227.0	25.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	3.35	223.5	29.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	3.38	225.6	31.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	3.30	220.1	35.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	3.33	222.3	37.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	3.26	217.2	41.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	3.23	215.1	43.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	3.06	204.2	47.00
Bus15	Bus	Exceeds Limit	1.50	Bus IHD	2.98	199.0	49.00
Bus15	Bus	Exceeds Limit	2.50	Bus THD	13.16	526.5	Total
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	10.50	699.9	3.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	4.21	280.8	7.00

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Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Harmonic
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	1.63	108.6	9.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	3.18	211.8	11.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	3.28	218.7	13.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	3.37	227.5	17.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	3.53	235.0	19.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	3.75	249.7	23.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	3.87	258.1	25.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	3.94	262.7	29.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	4.05	270.0	31.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	4.11	273.8	35.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	4.23	282.1	37.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	4.31	287.5	41.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	4.37	291.0	43.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	4.34	289.1	47.00
Bus19	Bus	Exceeds Limit	1.50	Bus IHD	4.32	288.3	49.00
Bus19	Bus	Exceeds Limit	2.50	Bus THD	18.63	745.3	Total
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	10.56	703.7	3.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	4.11	273.8	7.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	1.64	109.2	9.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	3.08	205.1	11.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	3.19	212.5	13.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	3.33	221.9	17.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	3.45	229.7	19.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	3.68	245.0	23.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	3.81	253.7	25.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	3.88	259.0	29.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	4.00	266.5	31.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	4.06	270.5	35.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	4.19	279.0	37.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	4.27	284.8	41.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	4.33	288.4	43.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	4.30	286.8	47.00
Bus2	Bus	Exceeds Limit	1.50	Bus IHD	4.29	286.1	49.00
Bus2	Bus	Exceeds Limit	2.50	Bus THD	18.47	739.0	Total
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	10.53	702.2	3.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	4.21	280.4	7.00

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Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Harmonic
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	1.63	109.0	9.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	3.17	211.4	11.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	3.28	218.3	13.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	3.37	227.2	17.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	3.52	234.7	19.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	3.74	249.5	23.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	3.87	257.9	25.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	3.94	262.6	29.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	4.05	269.9	31.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	4.11	273.7	35.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	4.23	282.0	37.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	4.31	287.4	41.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	4.36	291.0	43.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	4.34	289.1	47.00
Bus3	Bus	Exceeds Limit	1.50	Bus IHD	4.32	288.3	49.00
Bus3	Bus	Exceeds Limit	2.50	Bus THD	18.64	745.7	Total
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	10.53	702.2	3.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	4.21	280.4	7.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	1.63	109.0	9.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	3.17	211.4	11.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	3.28	218.3	13.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	3.41	227.2	17.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	3.52	234.7	19.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	3.74	249.5	23.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	3.87	257.9	25.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	3.94	262.6	29.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	4.05	269.9	31.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	4.11	273.7	35.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	4.23	282.0	37.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	4.31	287.4	41.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	4.36	291.0	43.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	4.34	289.1	47.00
Bus5	Bus	Exceeds Limit	1.50	Bus IHD	4.32	288.3	49.00
Bus5	Bus	Exceeds Limit	2.50	Bus THD	18.64	745.7	Total
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	10.53	702.0	3.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	4.21	280.9	7.00

Preliminary

Project:	Maynilad- Ayala Alabang R1P	ETAP	Page:	12
Location:	Ayala Alabang Muntinlupa	16.2.0C	Date:	04-12-2019
Contract:			SN:	APSI-PH001
Engineer:		Study Case: HA	Revision:	Base
Filename:	Alabang R1P		Config.:	Normal

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Harmonic
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	1.63	109.0	9.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	3.18	211.8	11.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	3.28	218.8	13.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	3.37	227.6	17.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	3.53	235.1	19.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	3.75	249.8	23.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	3.87	258.2	25.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	3.94	262.8	29.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	4.05	270.1	31.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	4.11	273.9	35.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	4.23	282.3	37.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	4.31	287.6	41.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	4.37	291.1	43.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	4.34	289.3	47.00
Bus6	Bus	Exceeds Limit	1.50	Bus IHD	4.33	288.4	49.00
Bus6	Bus	Exceeds Limit	2.50	Bus THD	18.66	746.2	Total
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	10.68	712.0	3.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	4.22	281.3	7.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	1.66	110.5	9.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	3.18	212.2	11.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	3.29	219.2	13.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	3.42	228.1	17.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	3.53	235.6	19.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	3.76	250.4	23.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	3.88	258.9	25.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	3.95	263.5	29.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	4.06	270.8	31.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	4.12	274.6	35.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	4.25	283.0	37.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	4.33	288.4	41.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	4.38	291.9	43.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	4.35	290.1	47.00
Bus9	Bus	Exceeds Limit	1.50	Bus IHD	4.34	289.2	49.00
Bus9	Bus	Exceeds Limit	2.50	Bus THD	18.77	750.9	Total
Cable10	Cable	Overload	76.20	Amp	89.24	117.1	Total

Preliminary

Preliminary

Appendix C

Power Quality Study

Preliminary



Instrument Information

Model Number	435-II
Serial Number	41183106
Firmware Revision	V05.04

Software Information

Power Log Version	5.4
FLUKE 430-II DLL Version	1.2.0.13

General Information

Recording location	MAIN ATS, 1250A
Client	MAYNILAD AYALA ALABANG R1P
Notes	

Preliminary

Measurement Summary

Measurement topology	3-element delta mode
Application mode	Logger
First recording	2/1/2019 11:47:08 PM 6msec
Last recording	2/2/2019 11:37:08 PM 6msec
Recording interval	0h 10m 0s 0msec
Nominal Voltage	480 V
Nominal Current	1250 A
Nominal Frequency	60 Hz
File start time	2/1/2019 11:37:08 PM 6msec
File end time	2/2/2019 11:37:08 PM 6msec
Duration	1d 0h 0m 0s 0msec
Number of events	Normal: 0 Detailed: 0
Events downloaded	No
Number of screens	0
Screens downloaded	Yes
Power measurement method	Unified
Cable type	Copper
Harmonic scale	%H1
THD mode	THD 40
CosPhi / DPF mode	DPF

Scaling

Phase:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	1250 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1
Neutral:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	1250 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1

Recording Summary

RMS recordings	144
DC recordings	0
Frequency recordings	144
Unbalance recordings	144
Harmonic recordings	144
Power harmonic recordings	144
Power recordings	144
Power unbalance recordings	0
Energy recordings	144
Energy losses recordings	0
Flicker recordings	144
Mains signaling recordings	144

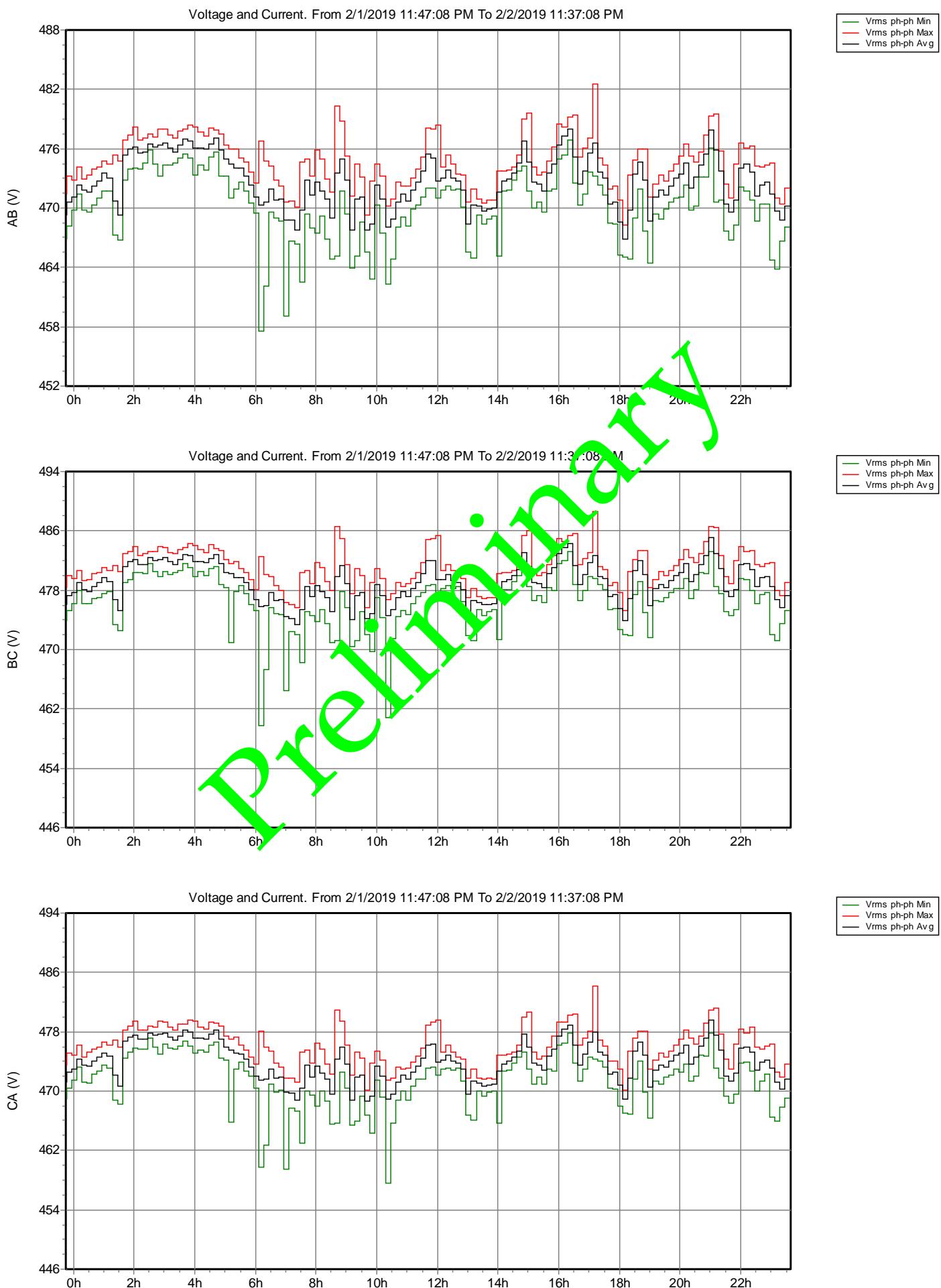
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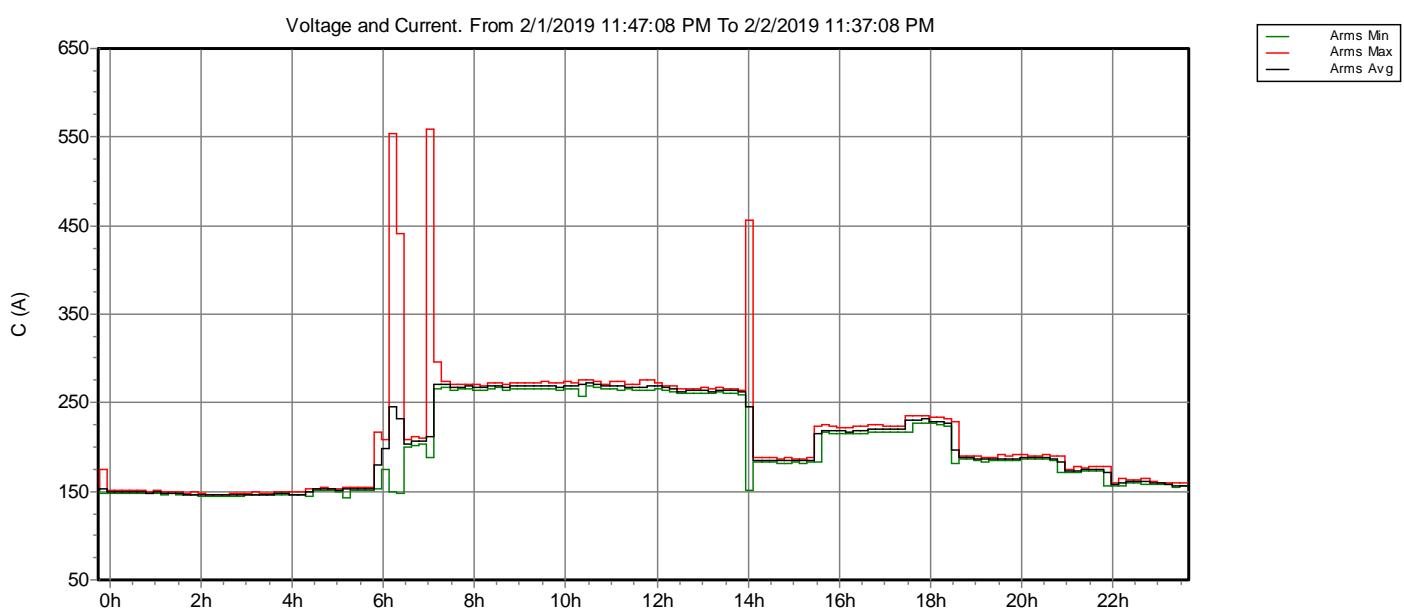
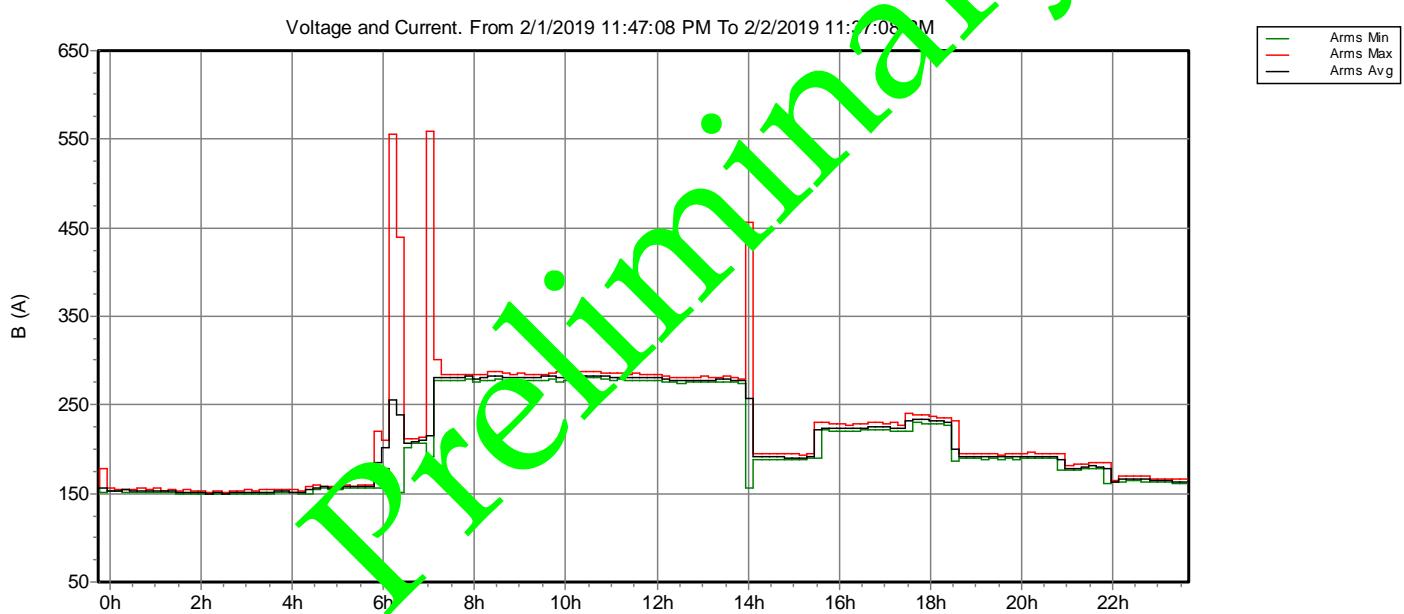
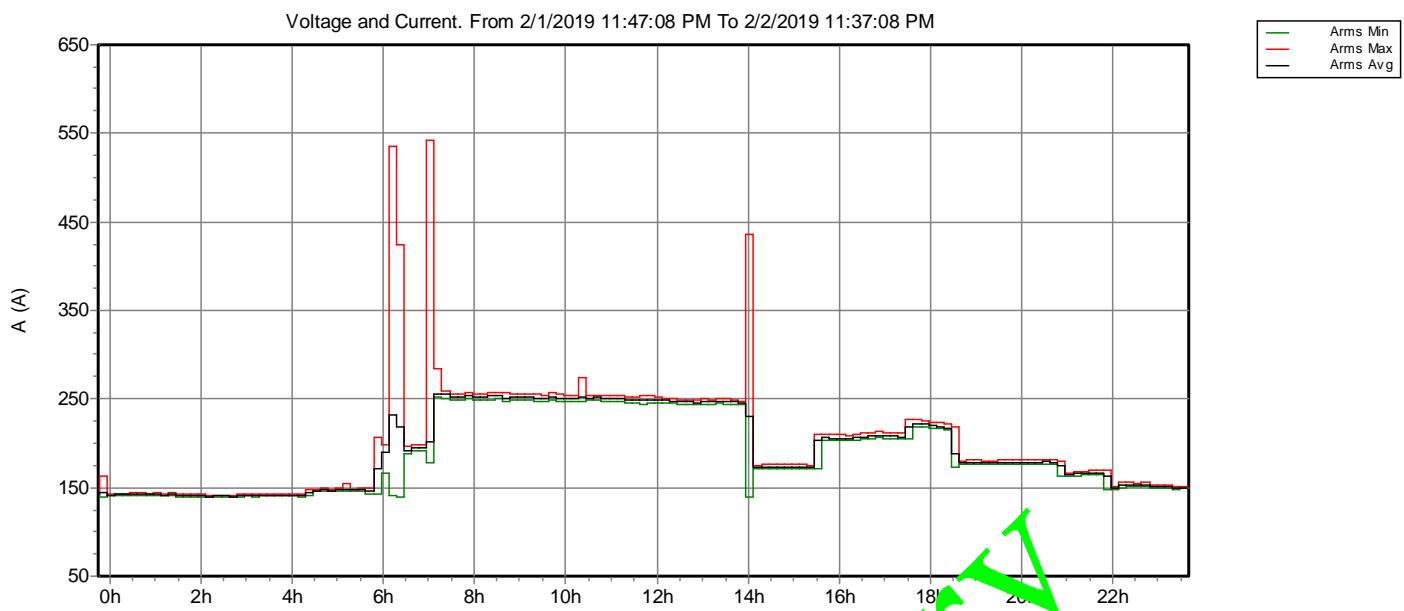


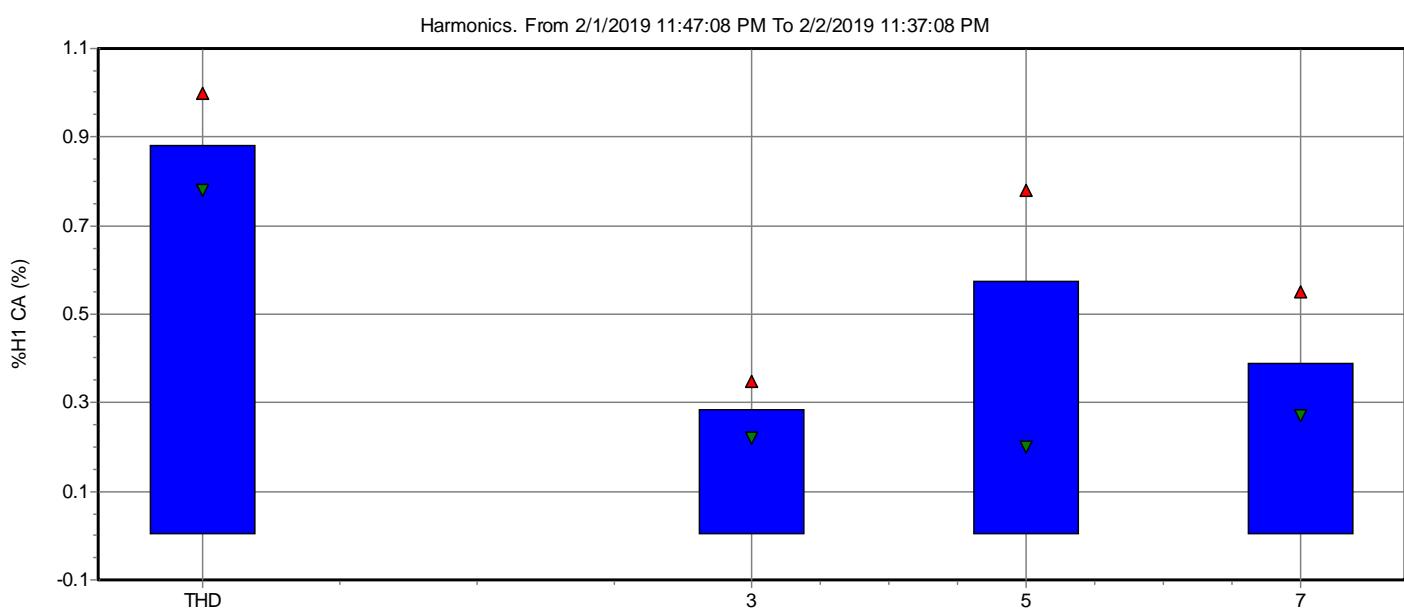
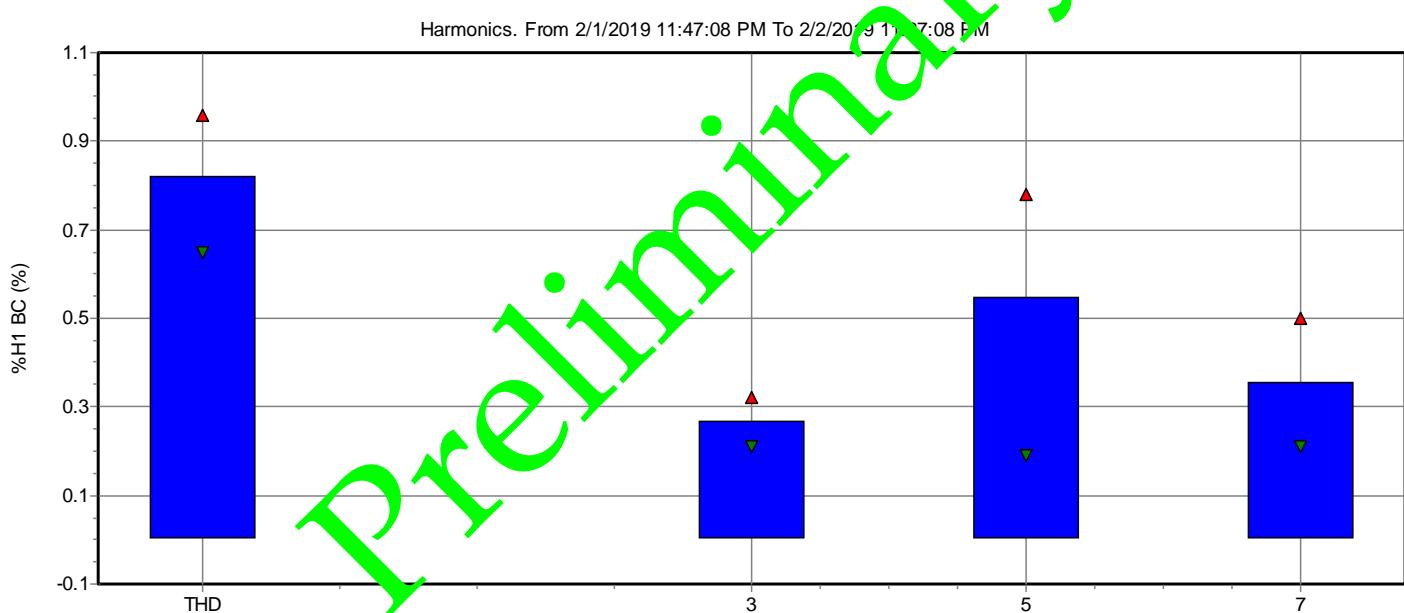
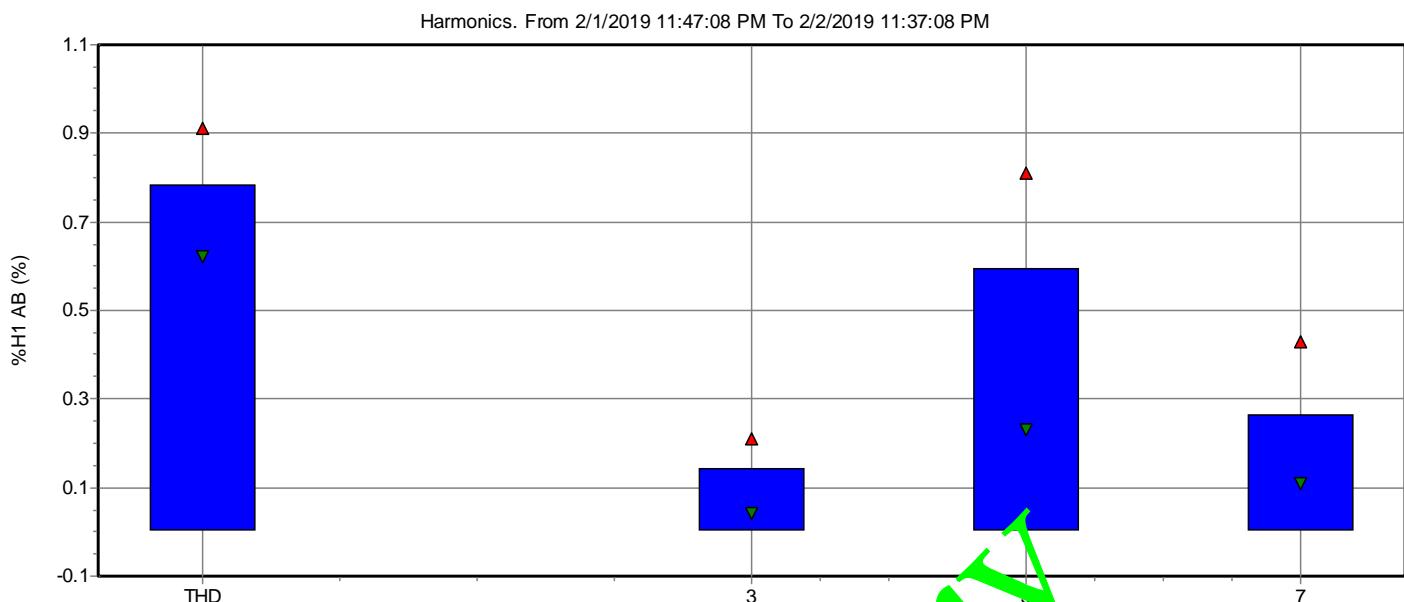
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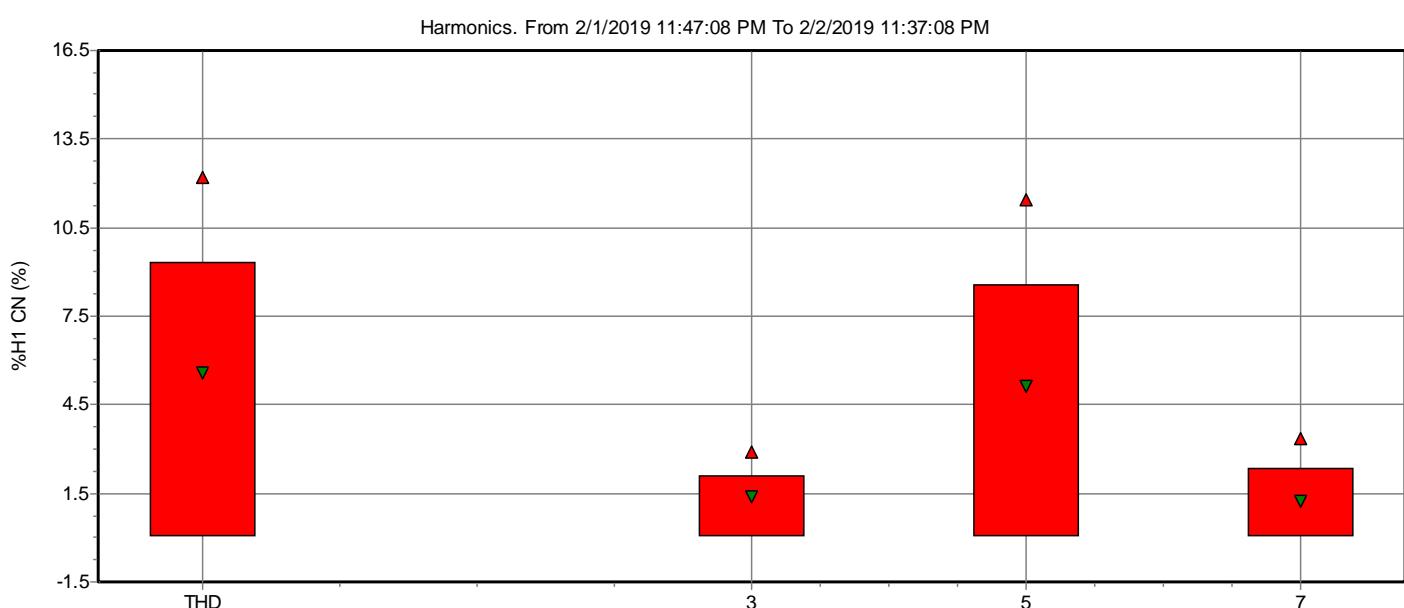
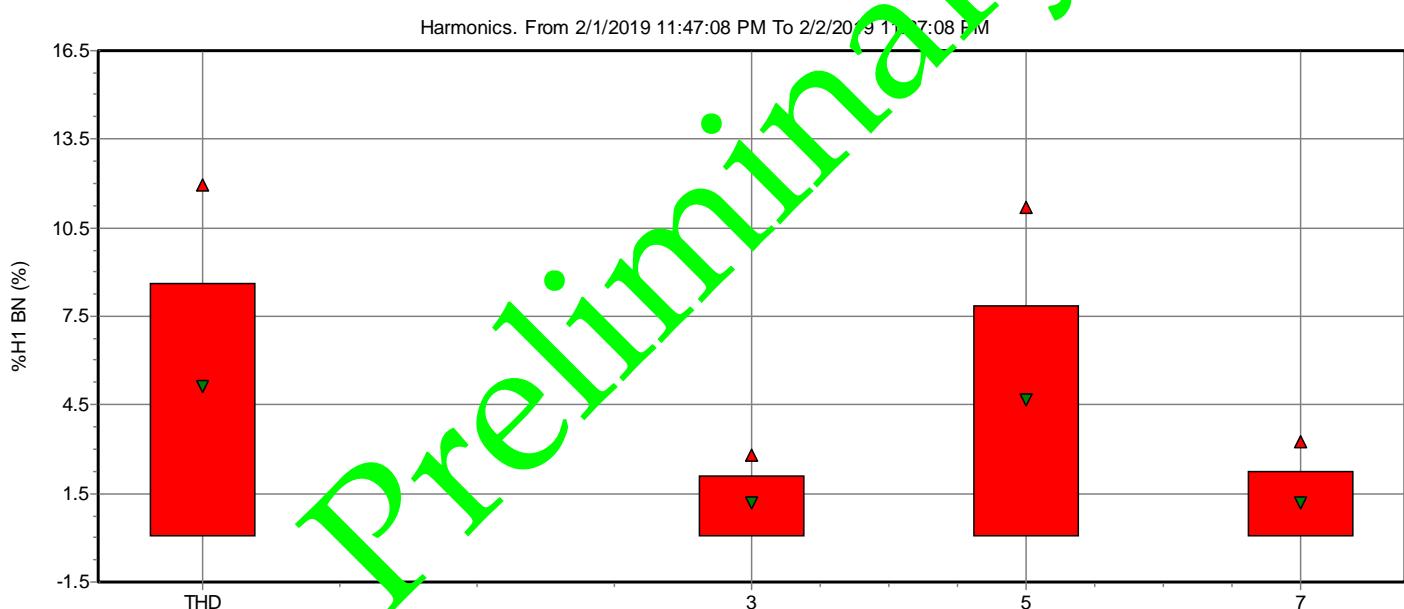
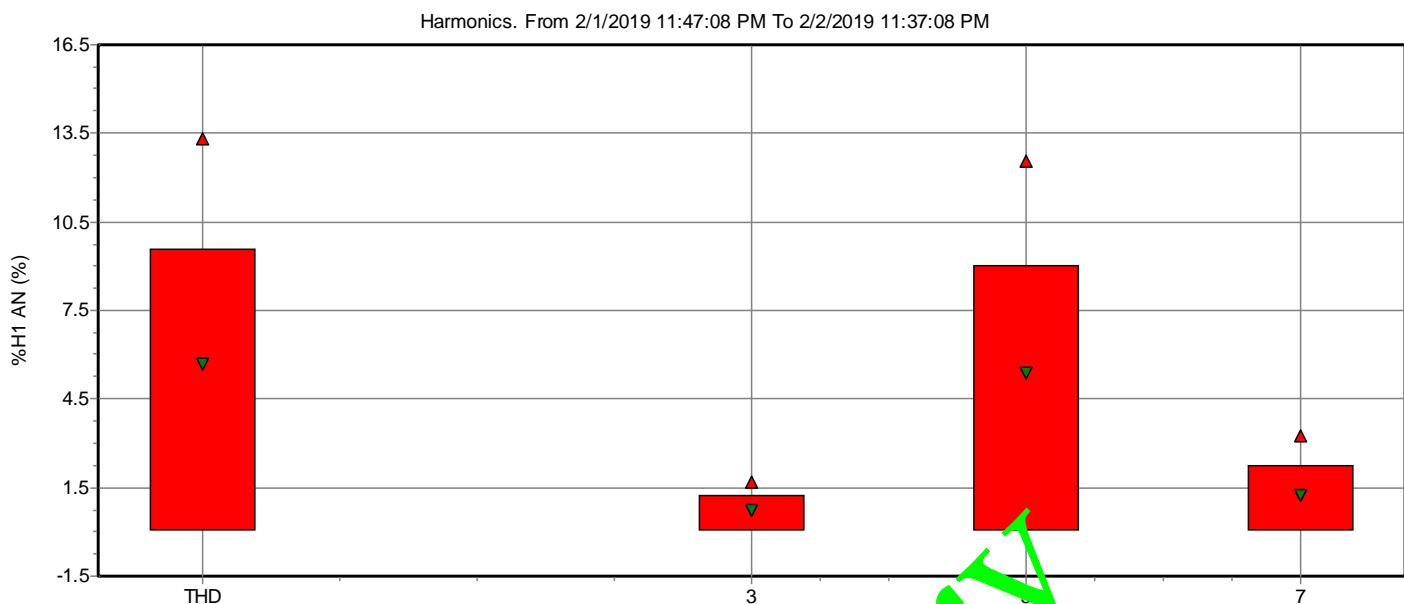
Dips	0
Swells	0
Transients	0
Interruptions	0
Voltage profiles	0
Rapid voltage changes	0
Screens	0
Waveforms	0
Intervals without measurements	0
Inrush current graphics	0
Wave events	0
RMS events	0

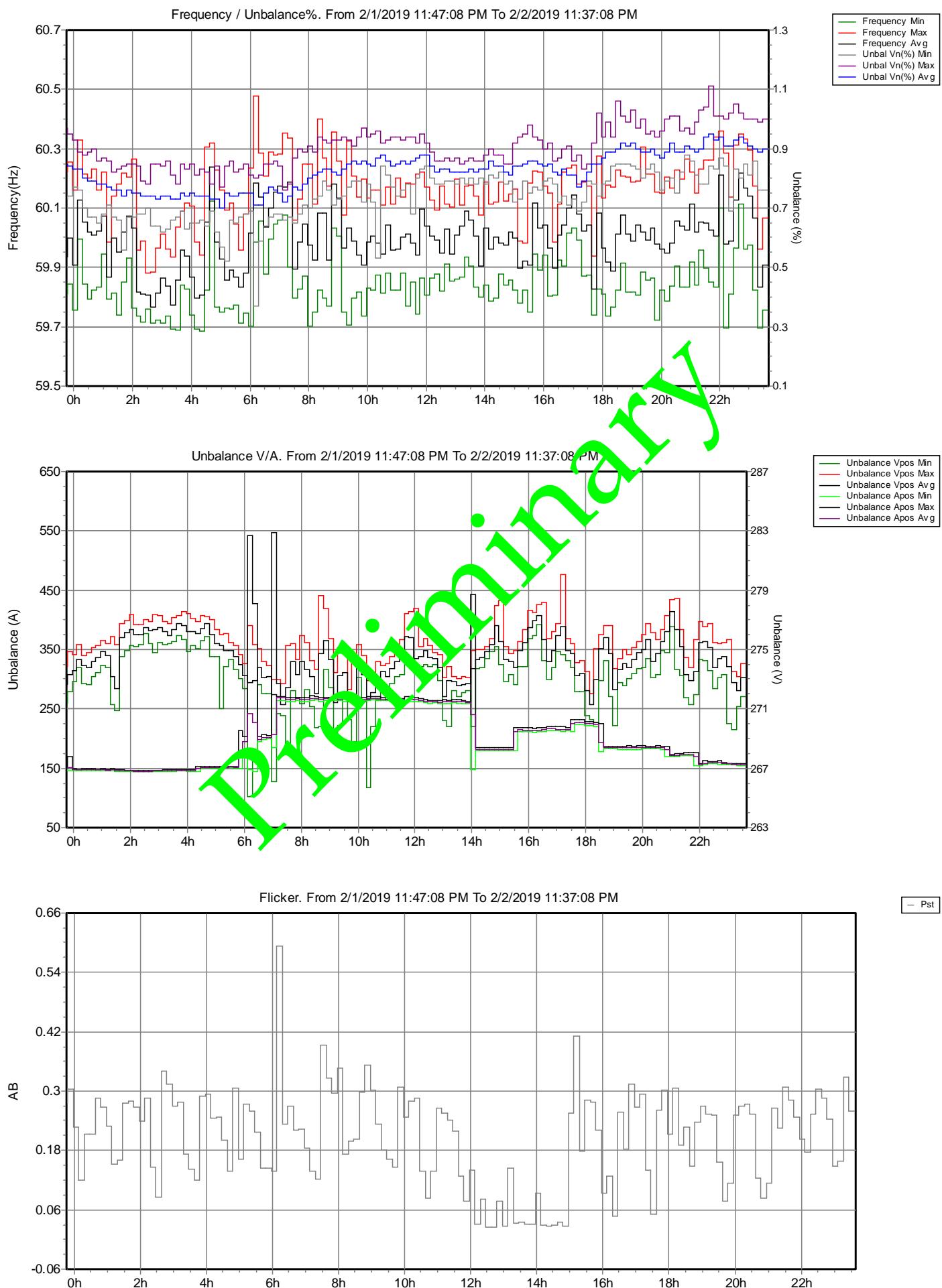
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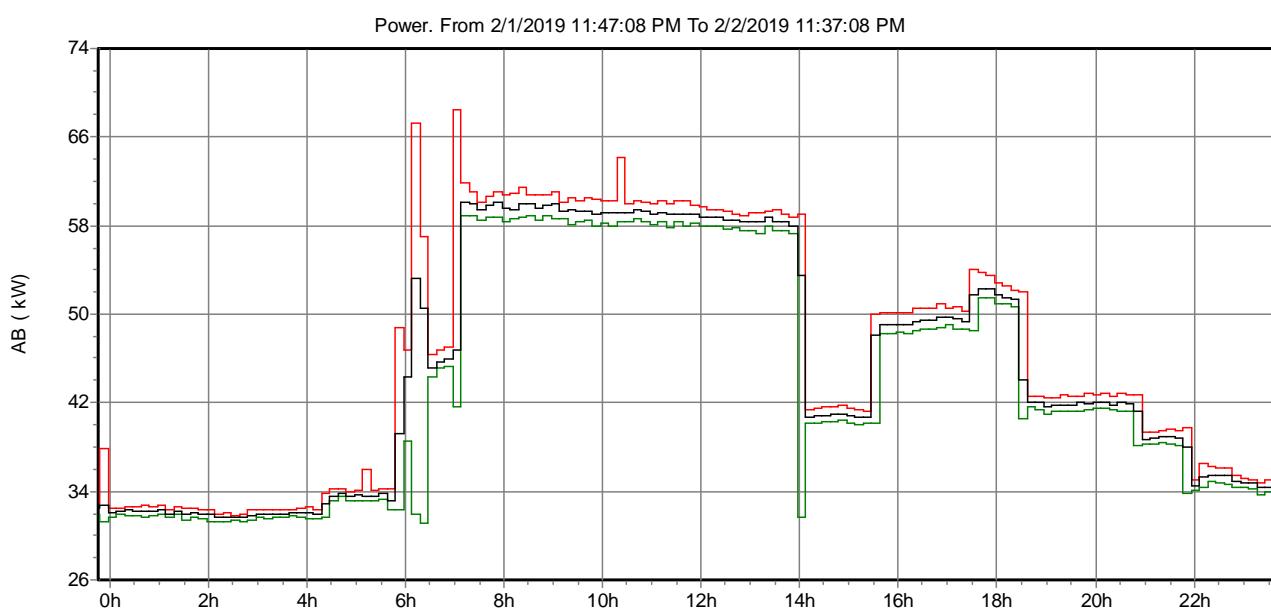
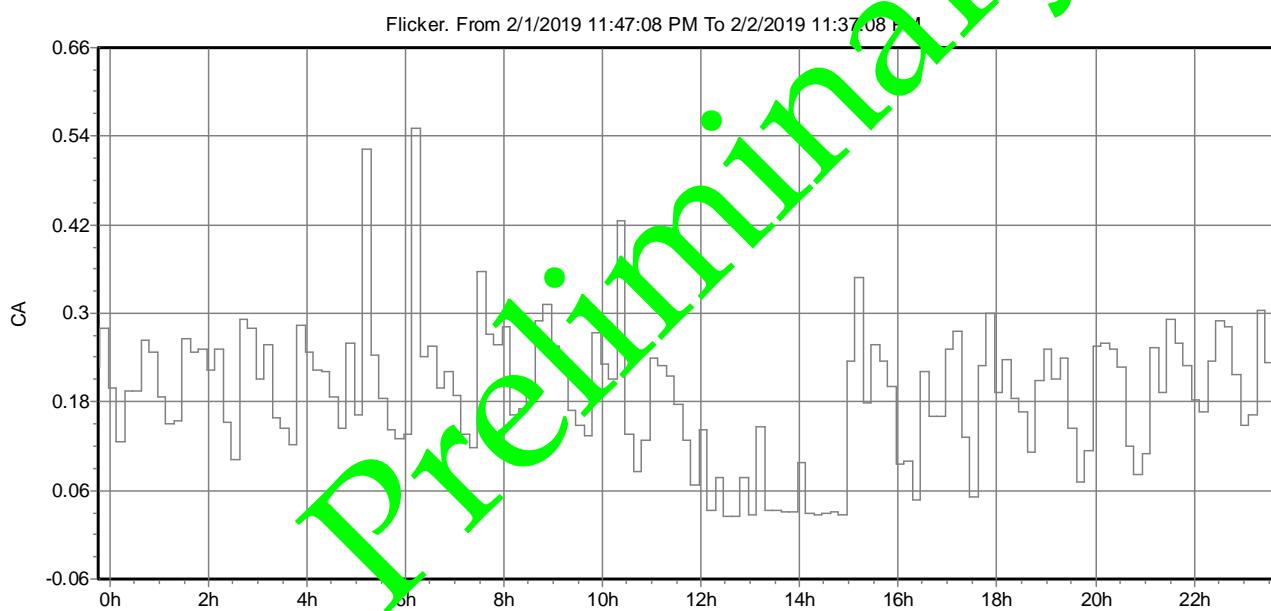
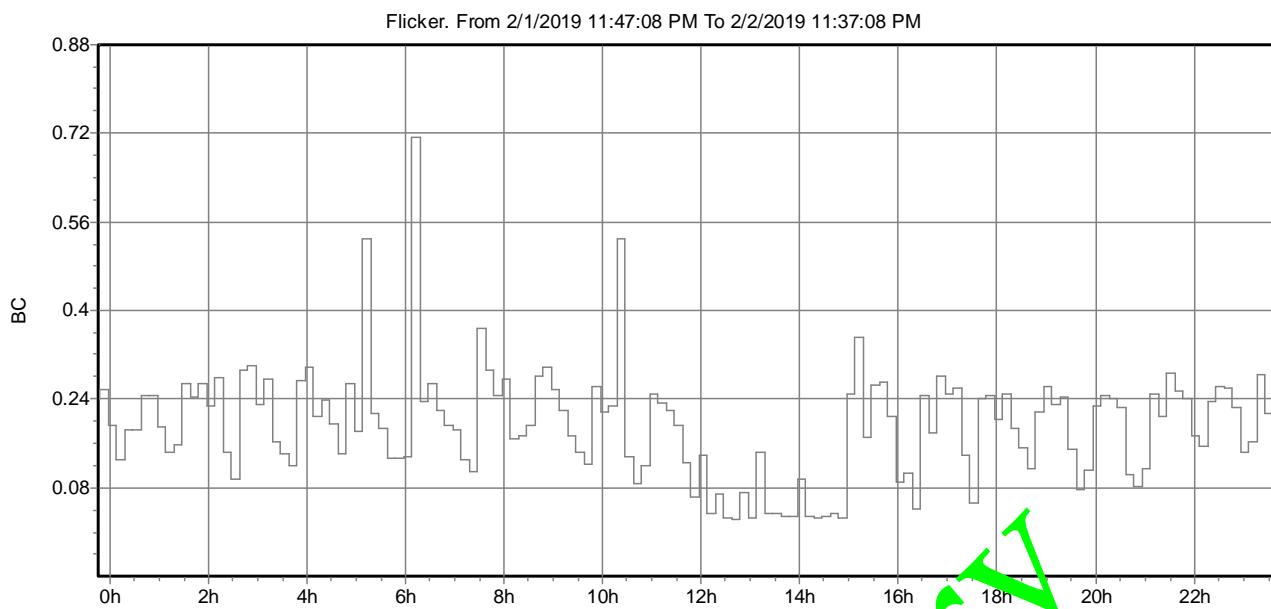


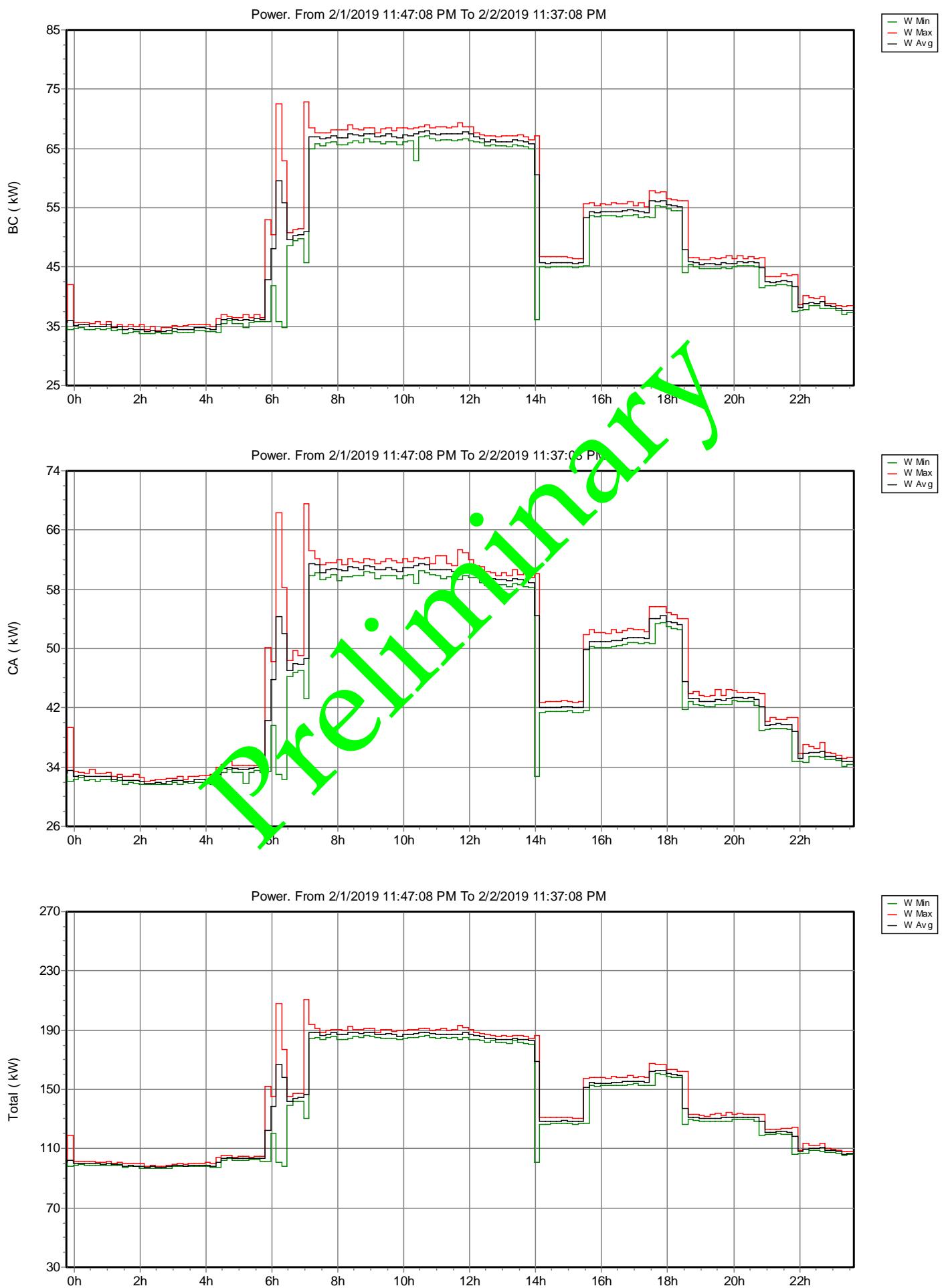


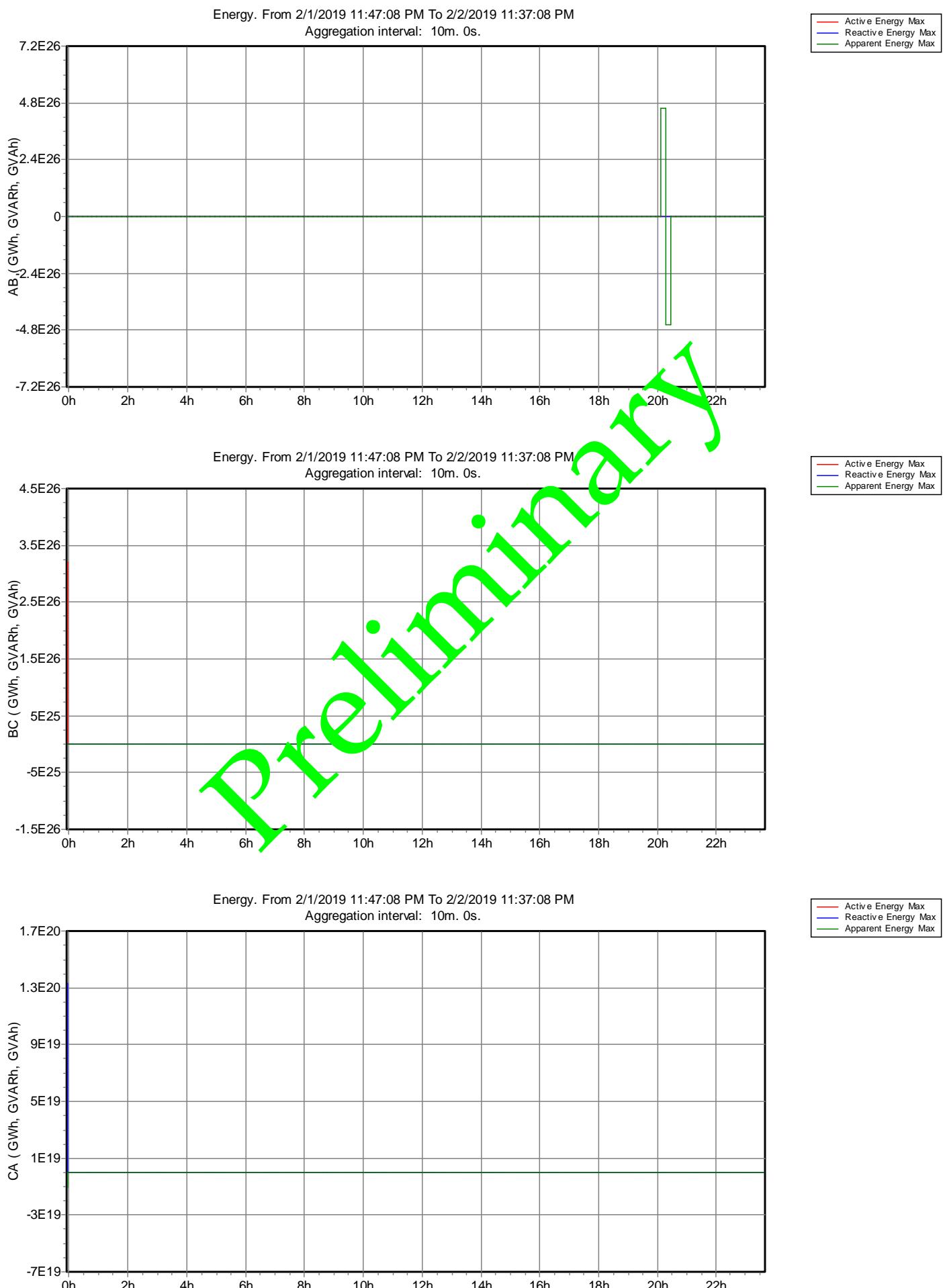


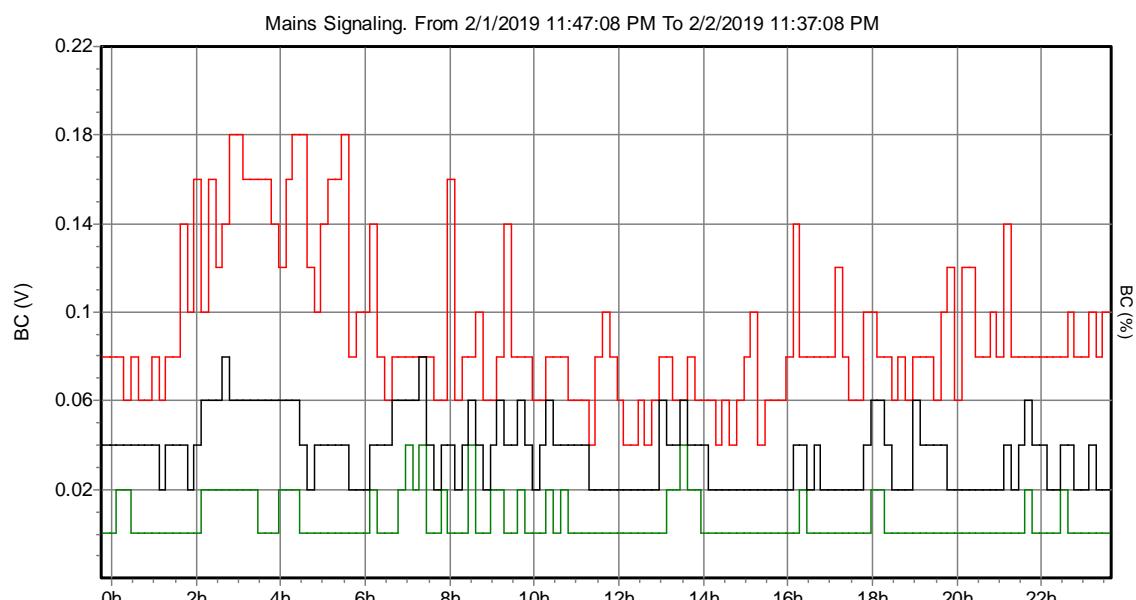
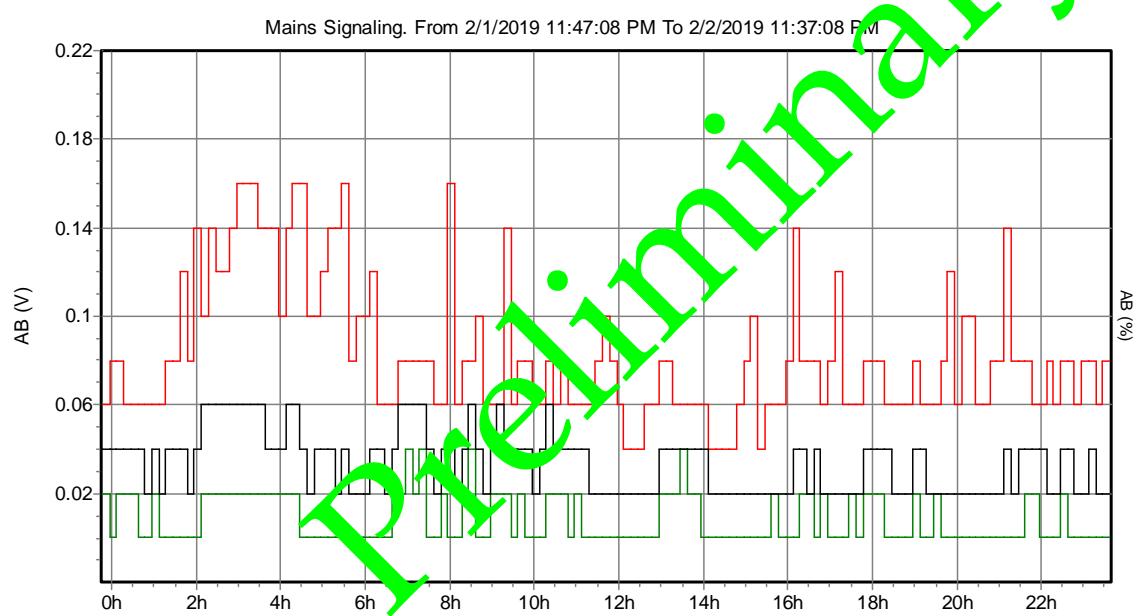
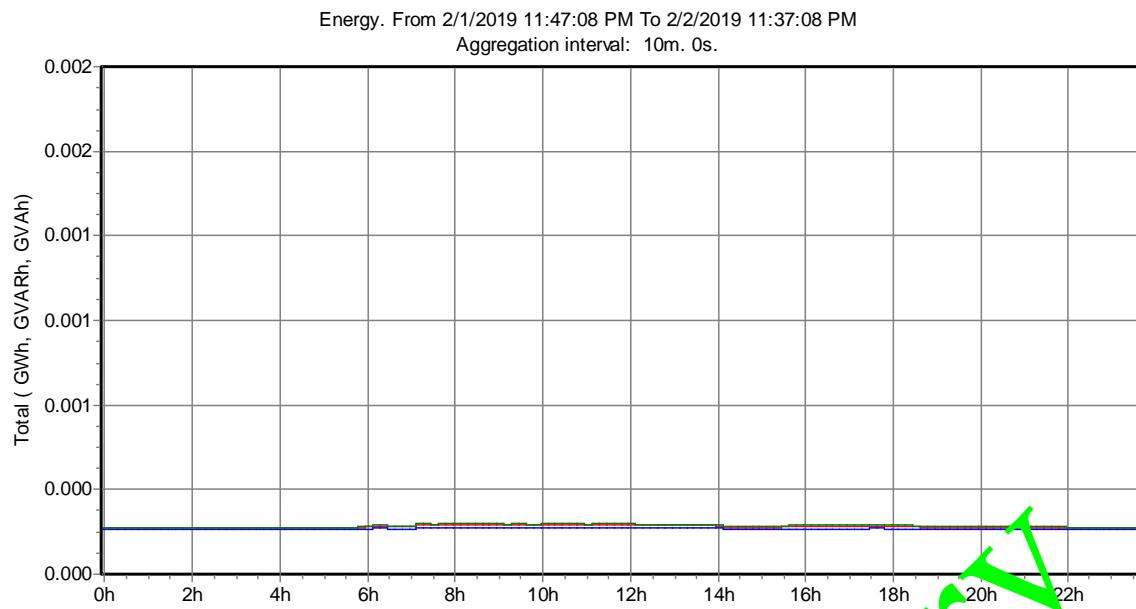


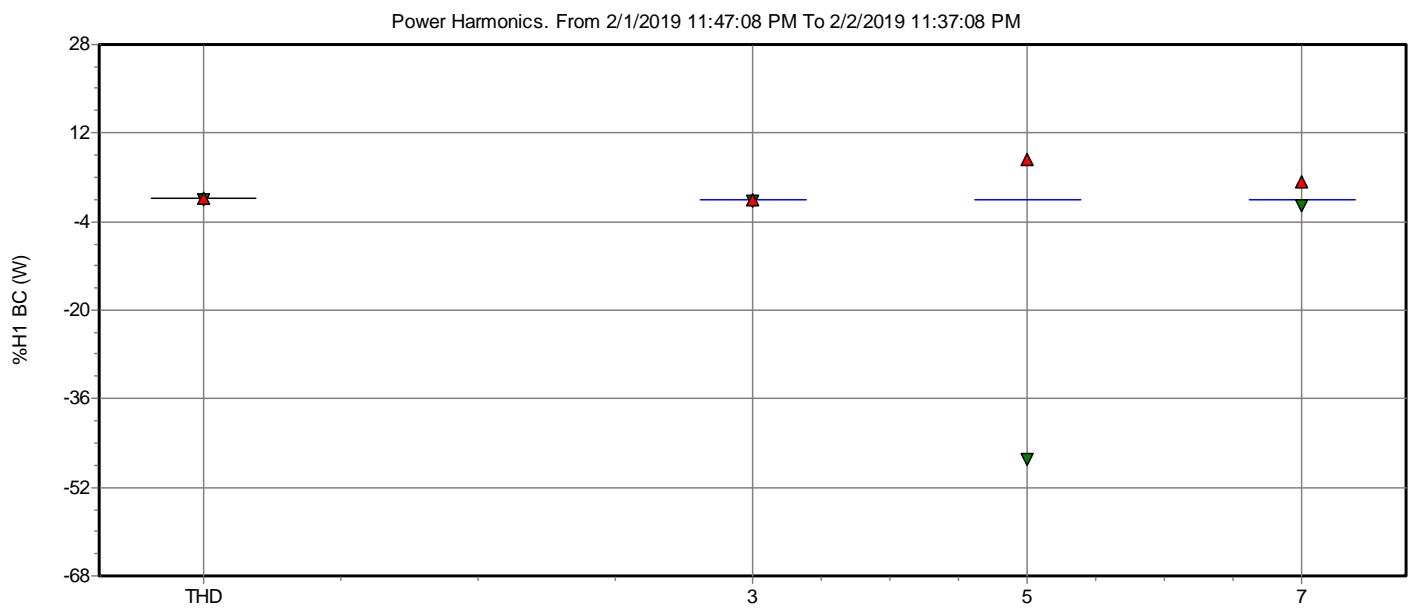
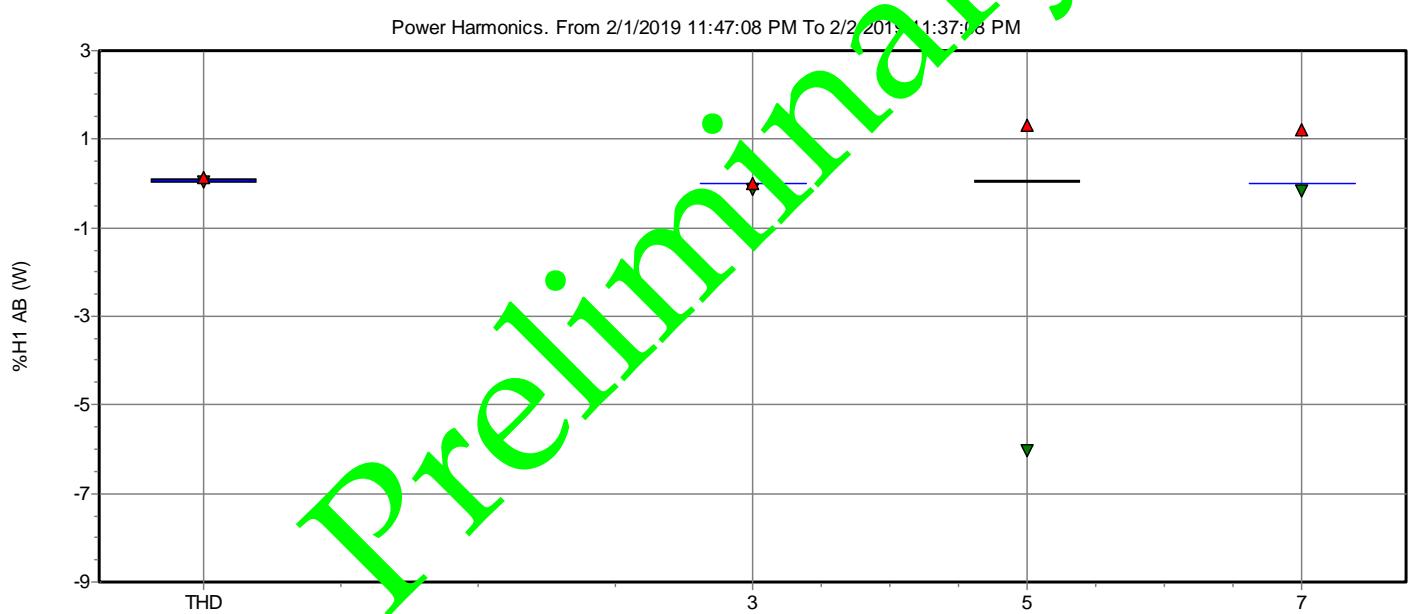
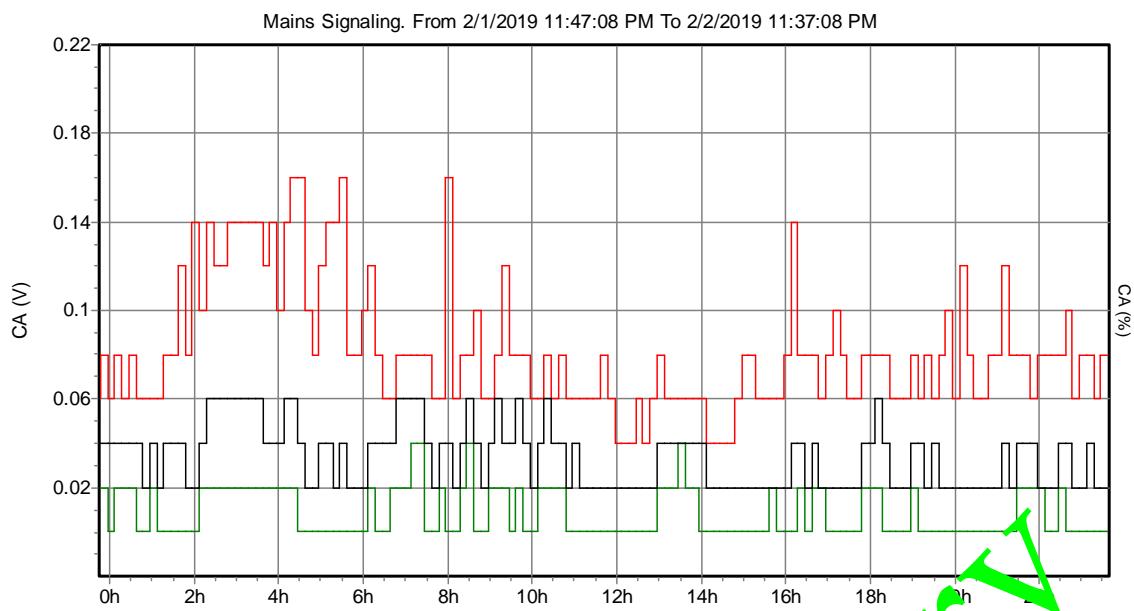


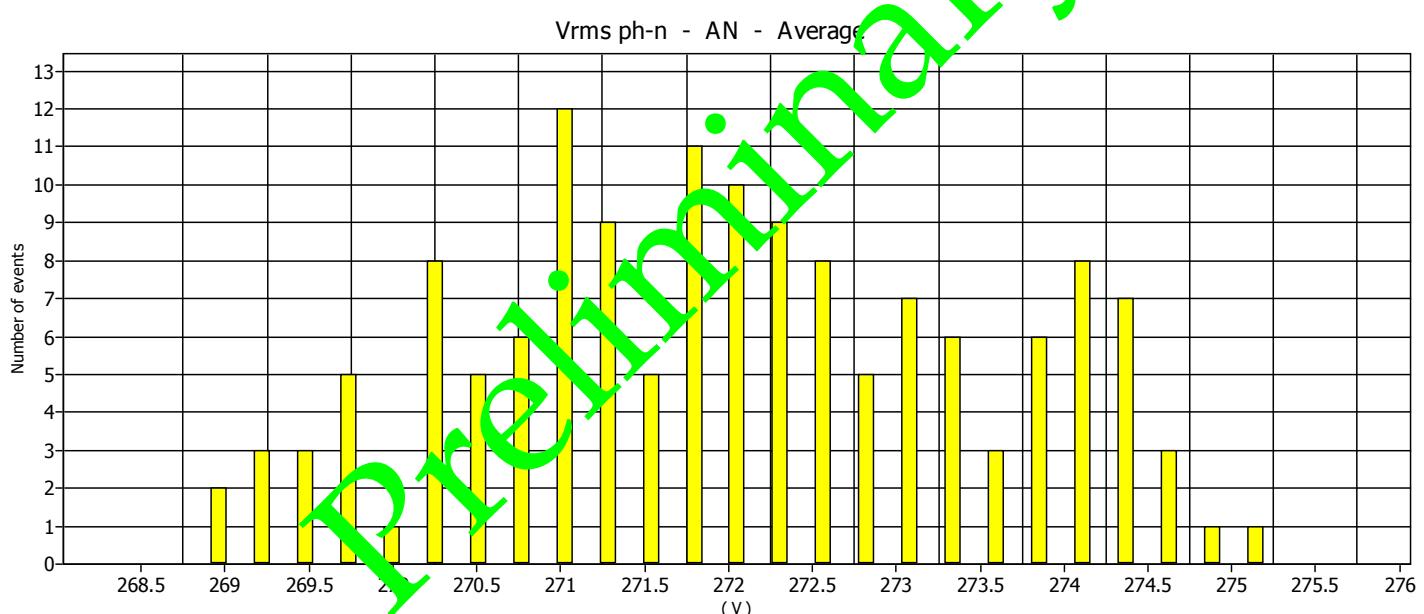
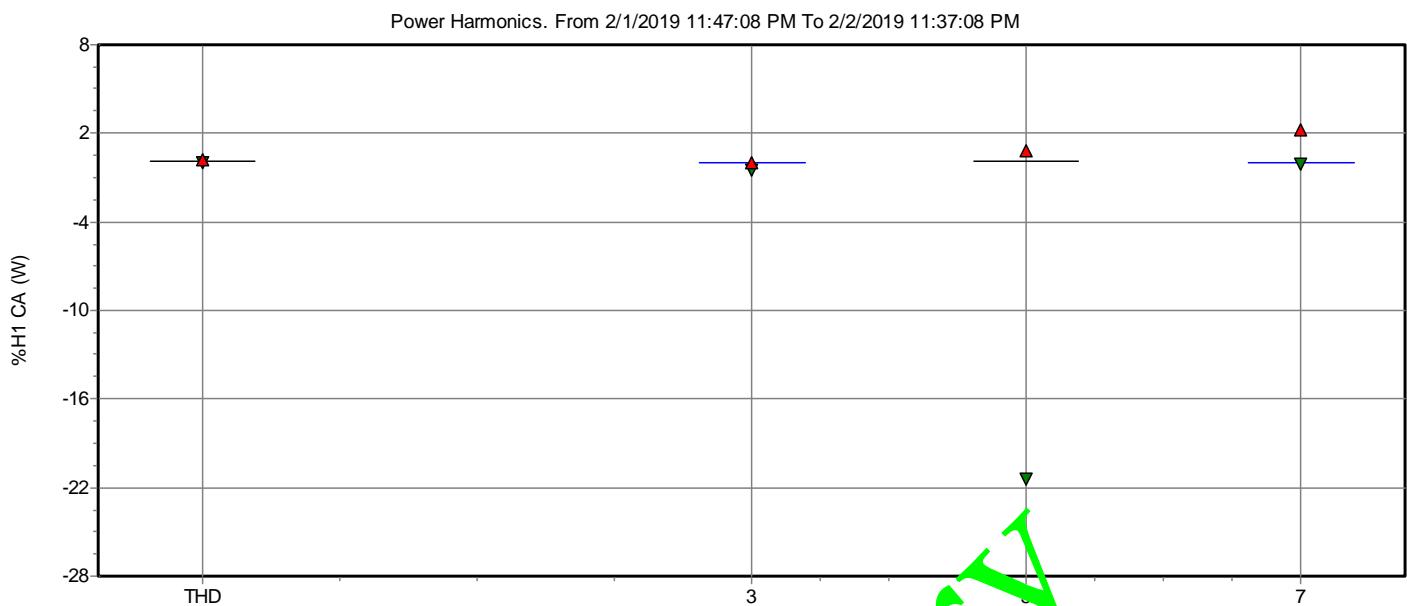












**Instrument Information**

Model Number	435-II
Serial Number	41183106
Firmware Revision	V05.04

Software Information

Power Log Version	5.4
FLUKE 430-II DLL Version	1.2.0.13

General Information

Recording location	VFD1 MOTOR1 MCCB 250A
Client	MAYNILAD AYALA ALABANG R1P
Notes	

Preliminary

Measurement Summary

Measurement topology	3-element delta mode
Application mode	Logger
First recording	12/12/2018 11:09:36 PM 239msec
Last recording	12/13/2018 10:59:36 PM 239msec
Recording interval	0h 10m 0s 0msec
Nominal Voltage	480 V
Nominal Current	250 A
Nominal Frequency	60 Hz
File start time	12/12/2018 10:59:36 PM 239msec
File end time	12/13/2018 10:59:36 PM 239msec
Duration	1d 0h 0m 0s 0msec
Number of events	Normal: 1 Detailed: 0
Events downloaded	No
Number of screens	1
Screens downloaded	Yes
Power measurement method	Unified
Cable type	Copper
Harmonic scale	%H1
THD mode	THD 40
CosPhi / DPF mode	DPF

Scaling

Phase:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	250 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1
Neutral:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	250 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1

Recording Summary

RMS recordings	144
DC recordings	0
Frequency recordings	144
Unbalance recordings	144
Harmonic recordings	144
Power harmonic recordings	144
Power recordings	144
Power unbalance recordings	0
Energy recordings	144
Energy losses recordings	0
Flicker recordings	144
Mains signaling recordings	144

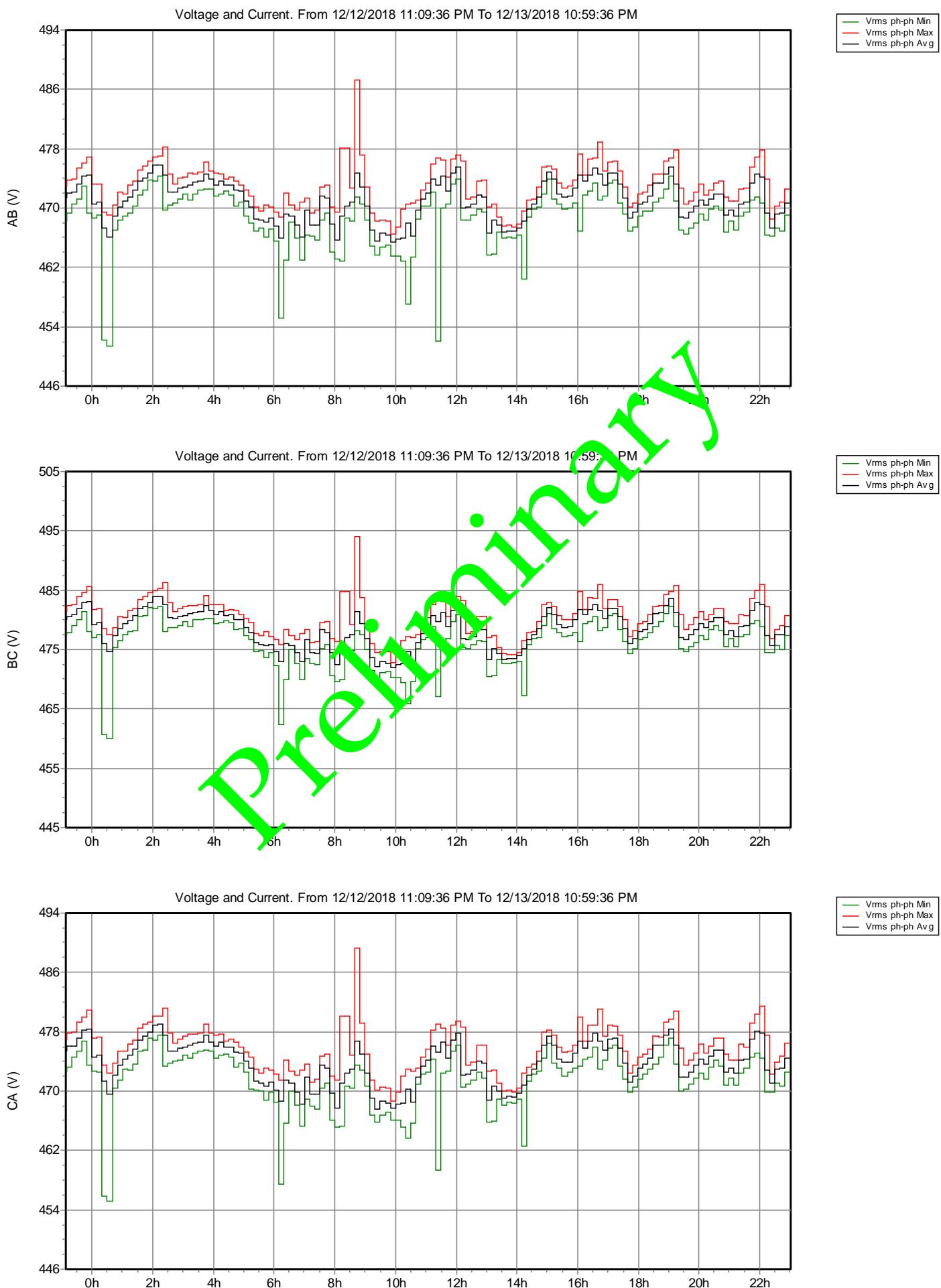
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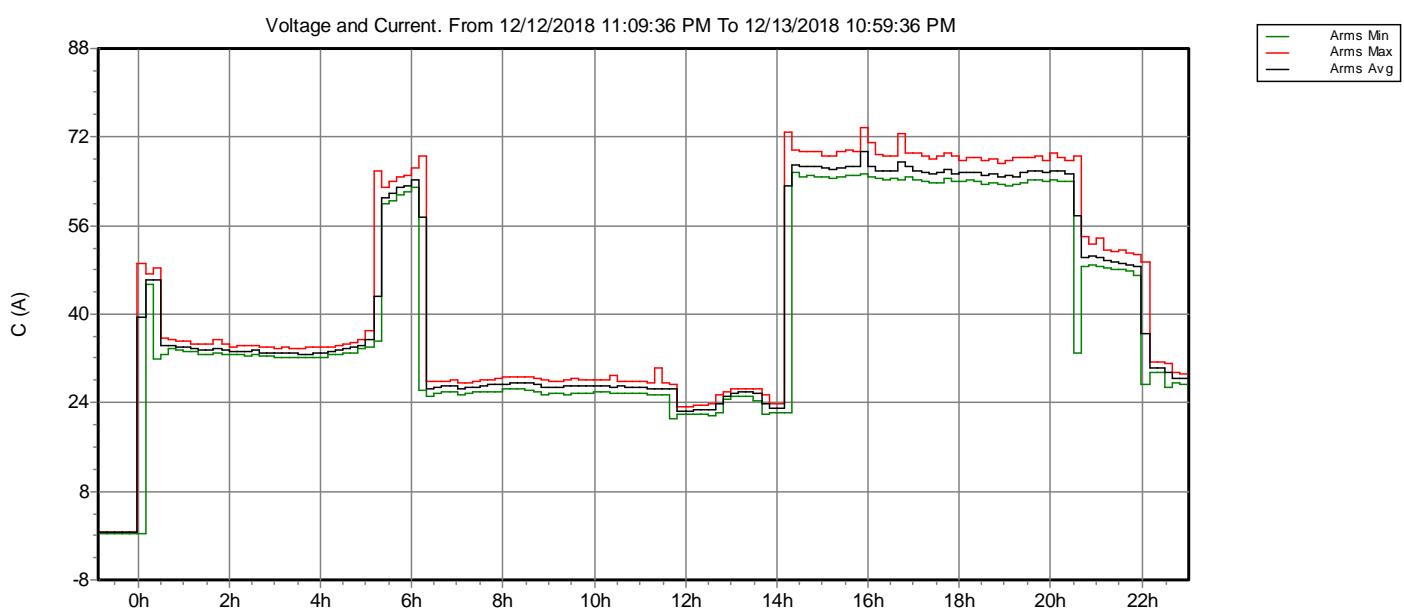
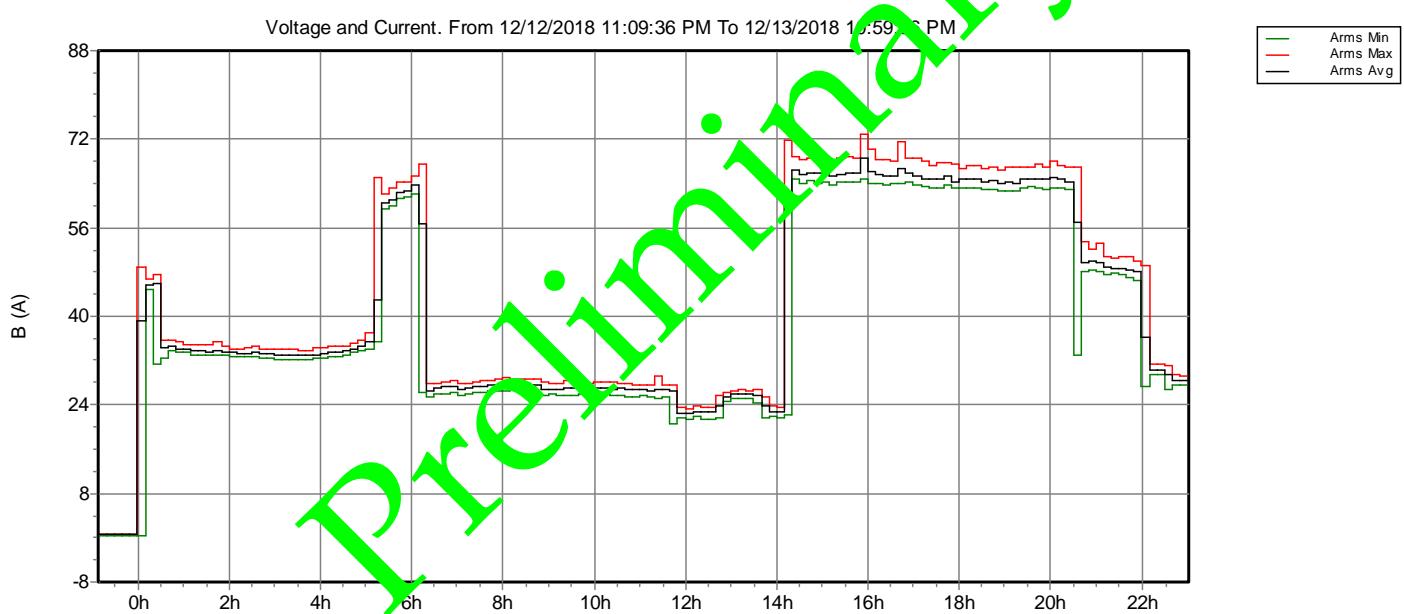
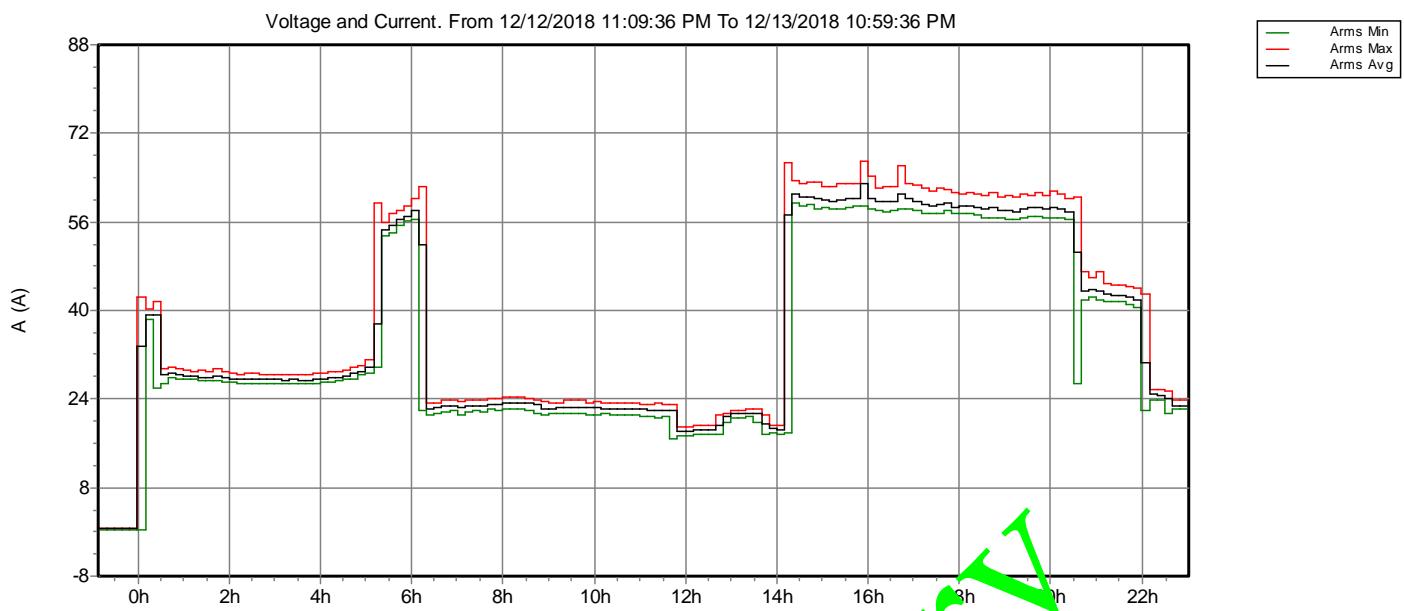


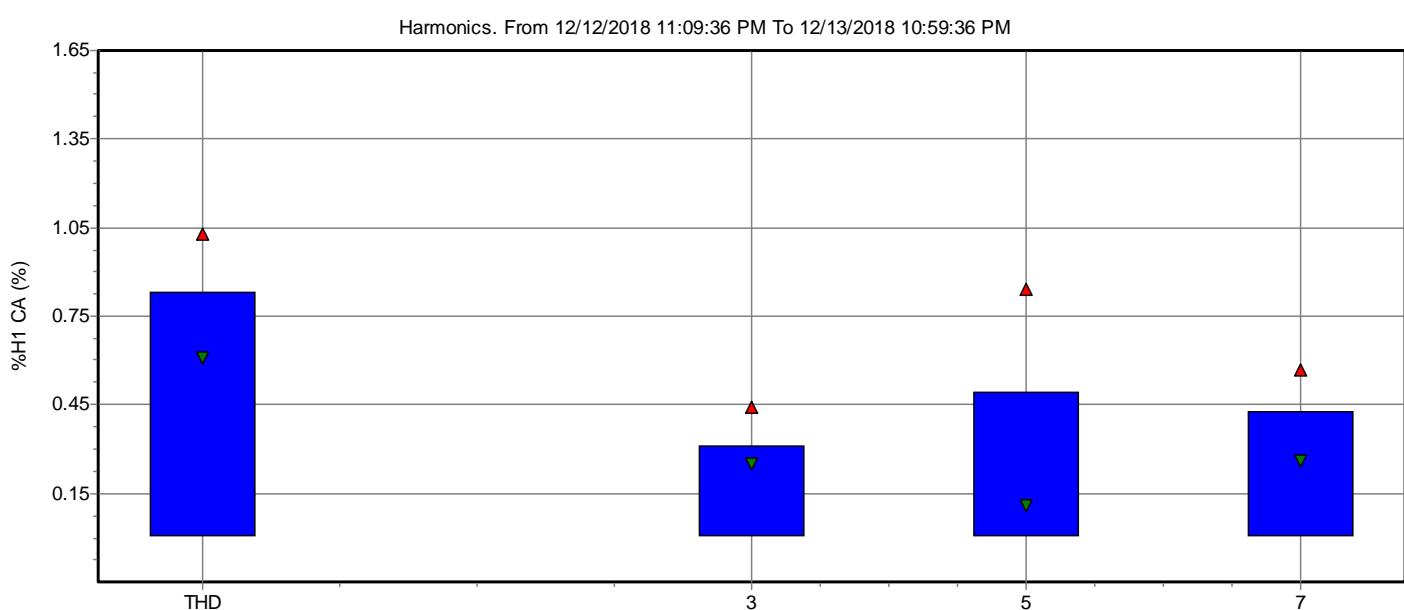
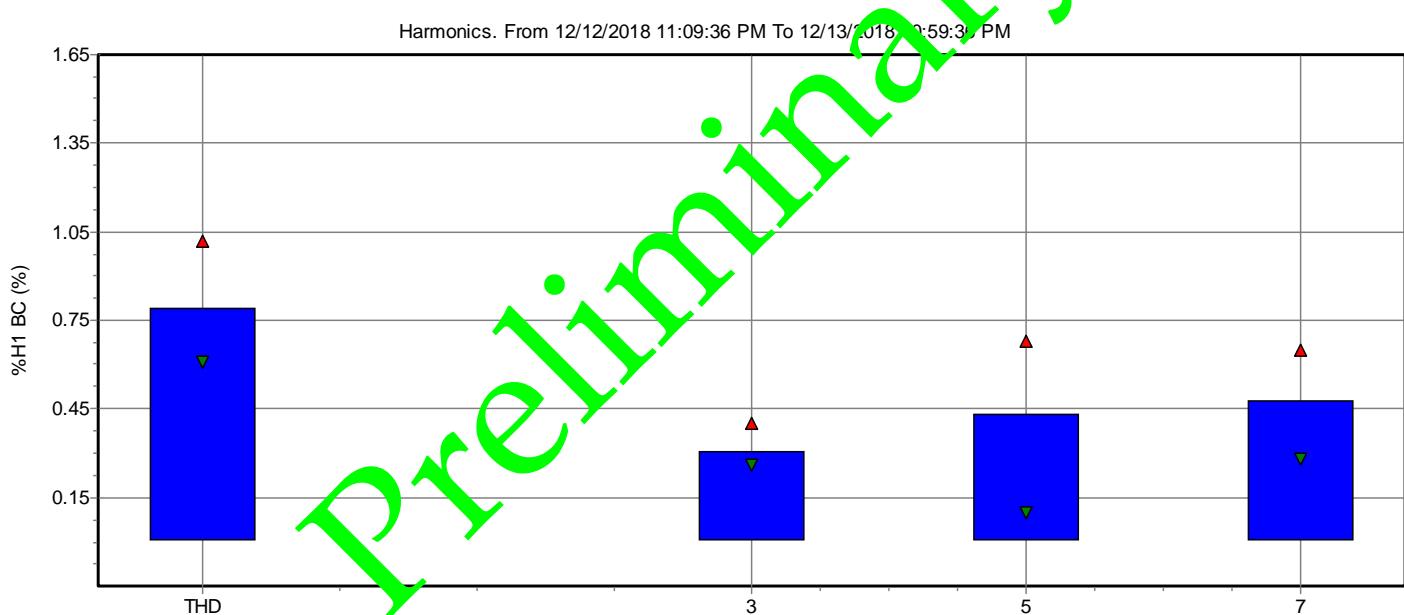
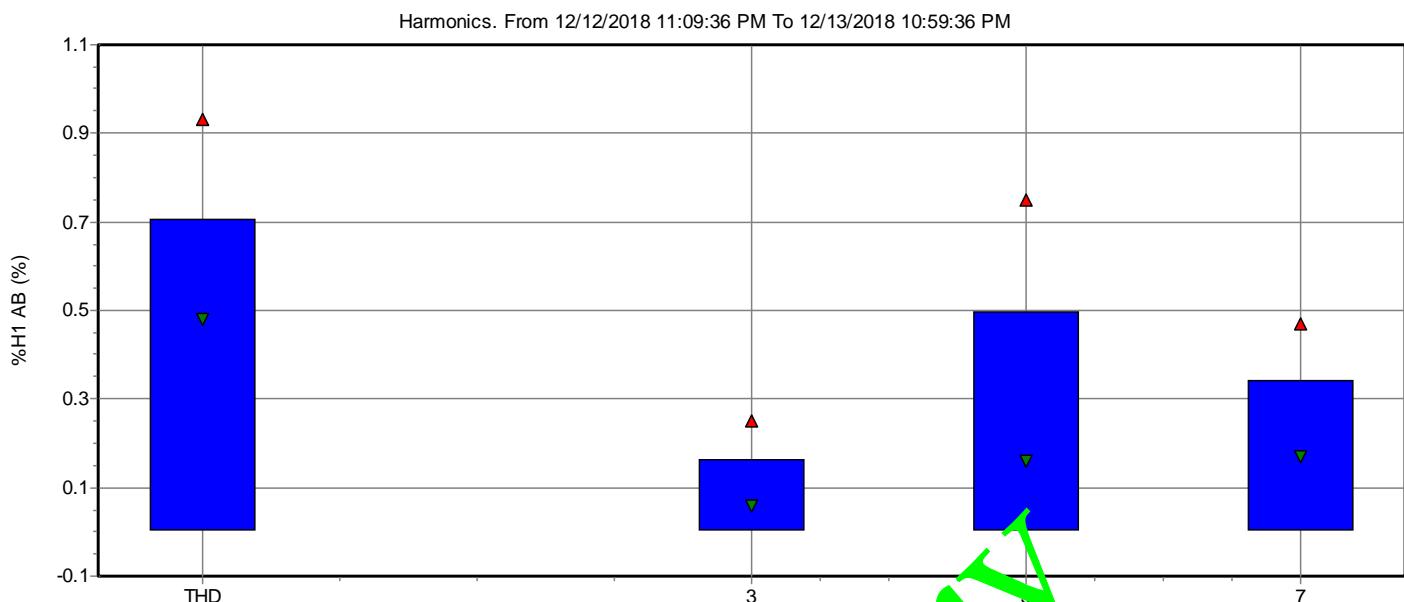
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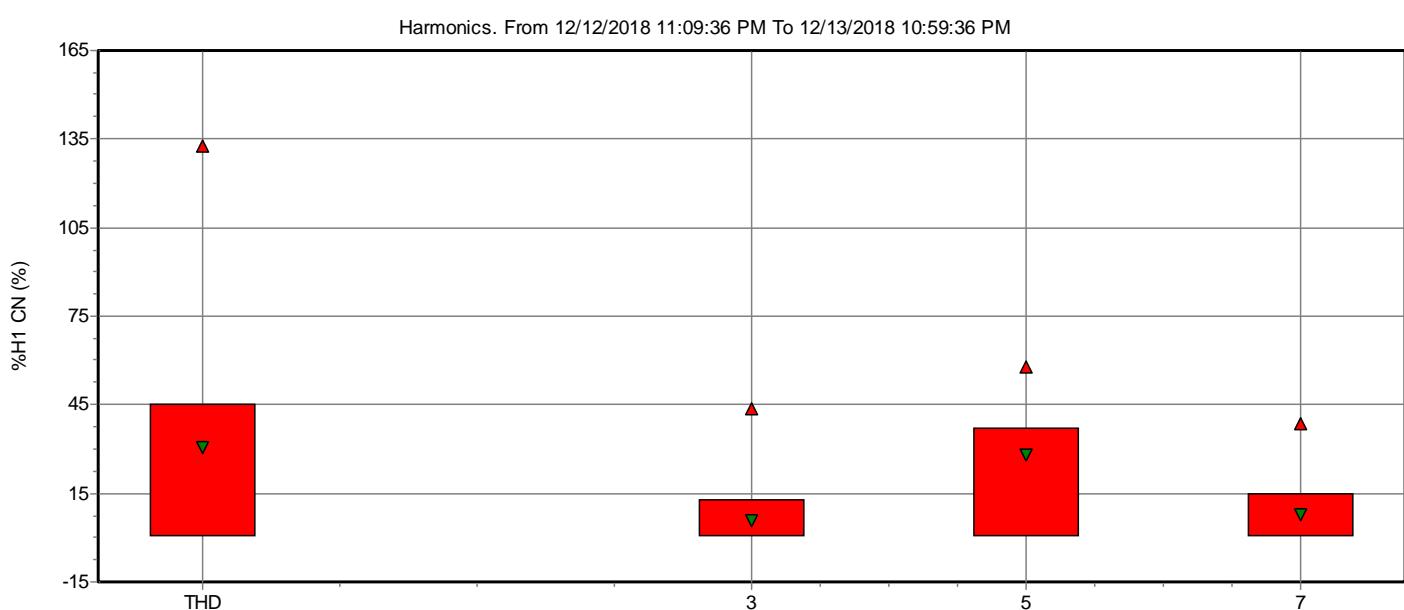
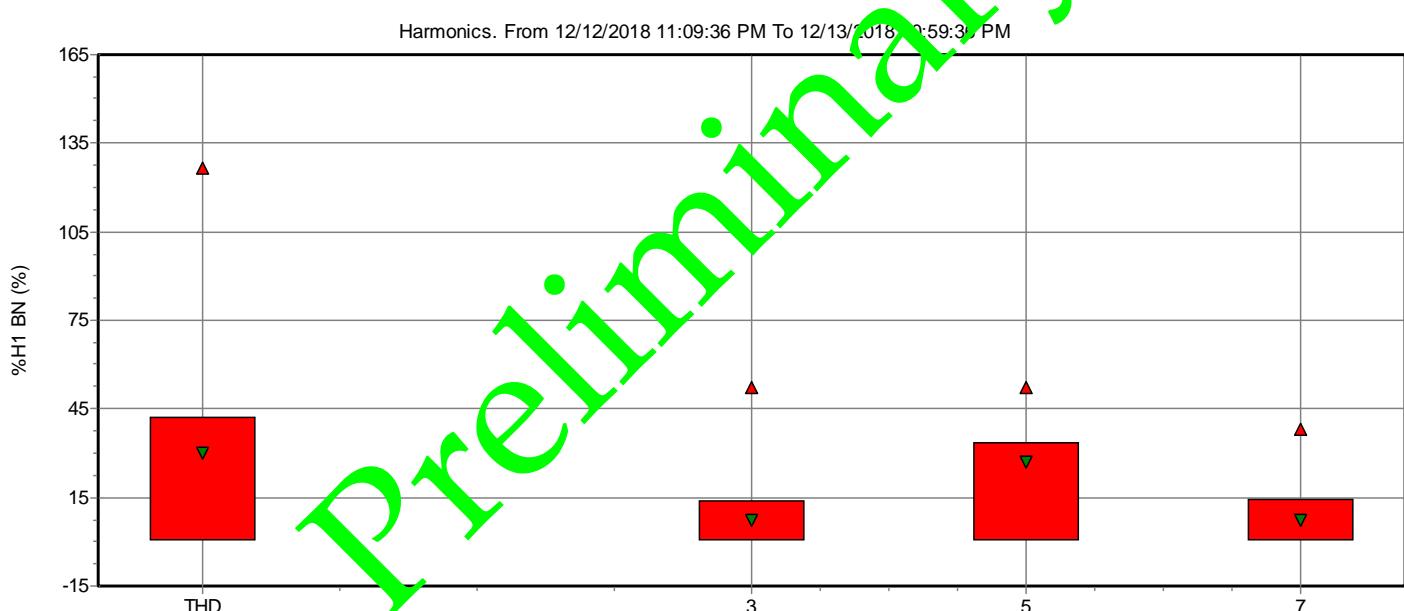
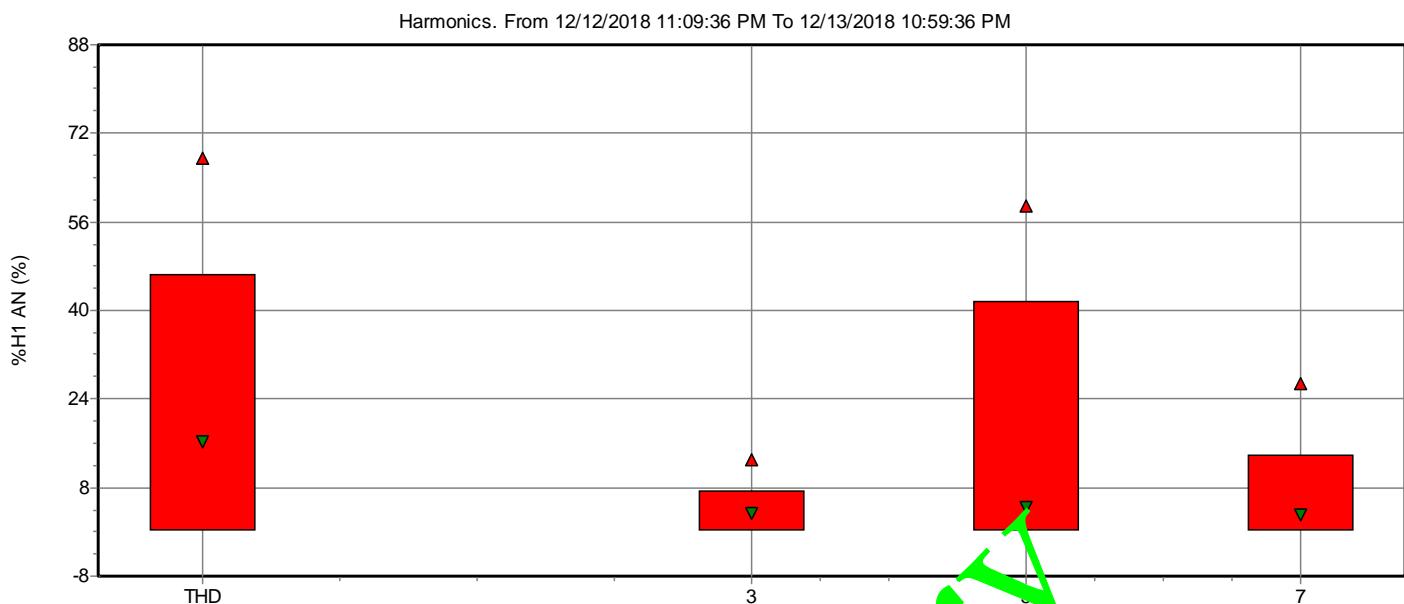
Dips	0
Swells	0
Transients	0
Interruptions	0
Voltage profiles	0
Rapid voltage changes	0
Screens	1
Waveforms	0
Intervals without measurements	0
Inrush current graphics	0
Wave events	0
RMS events	0

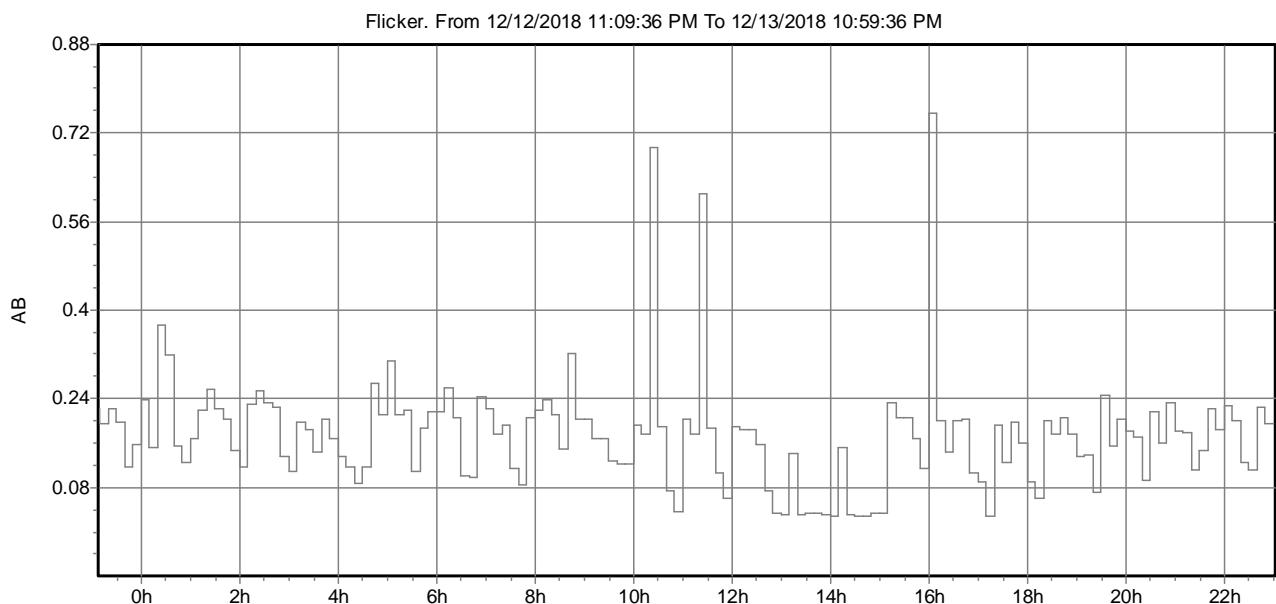
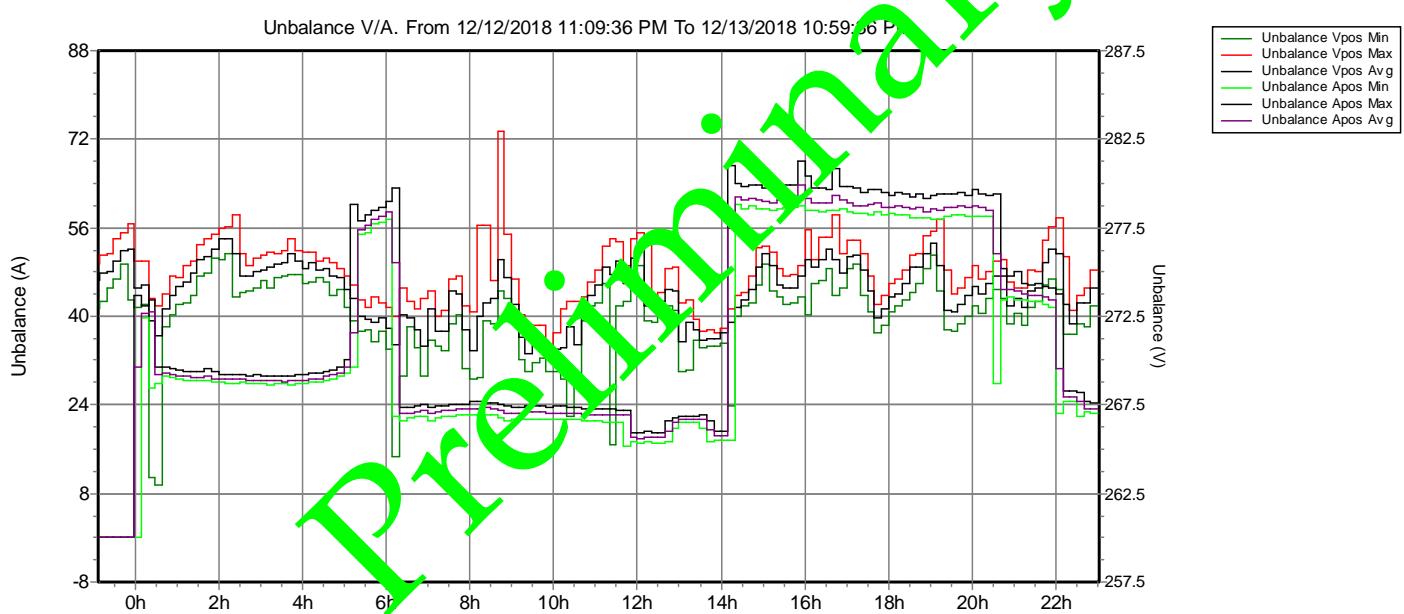
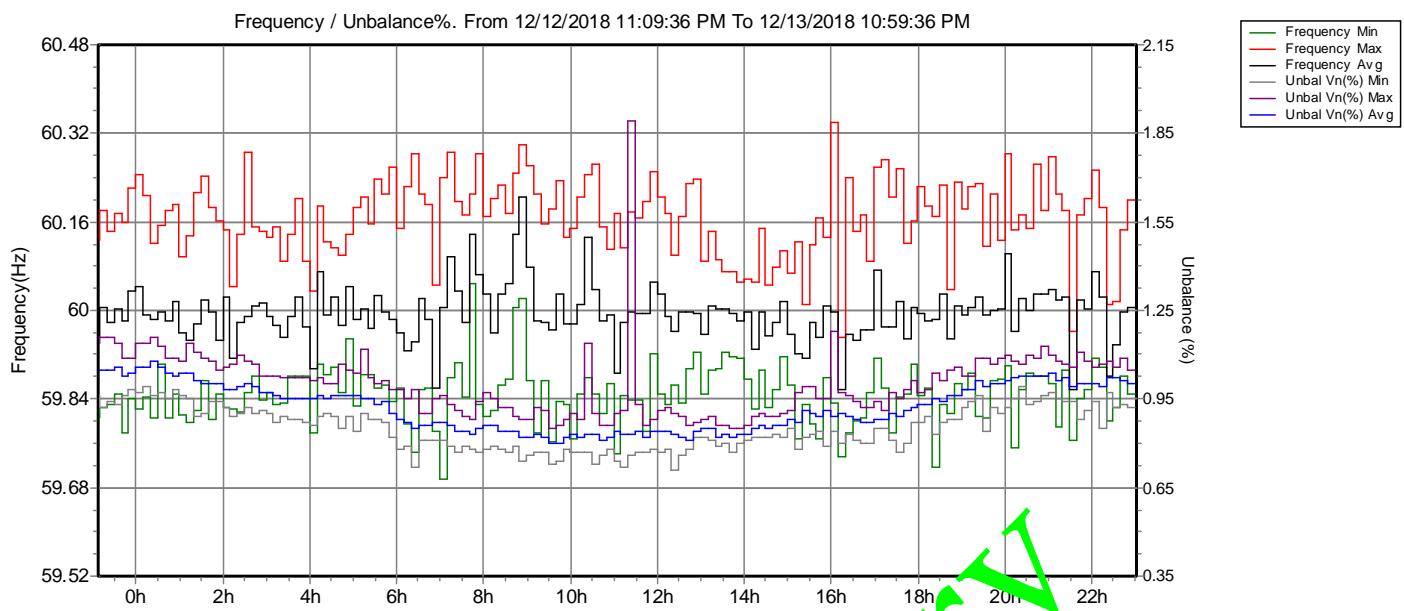
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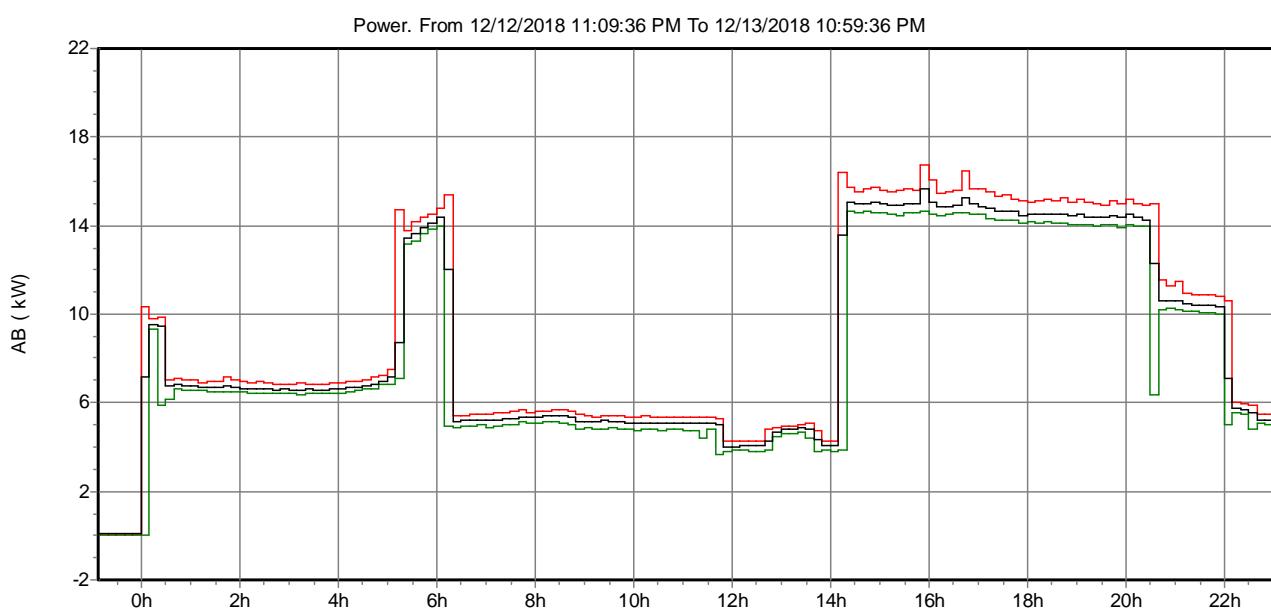
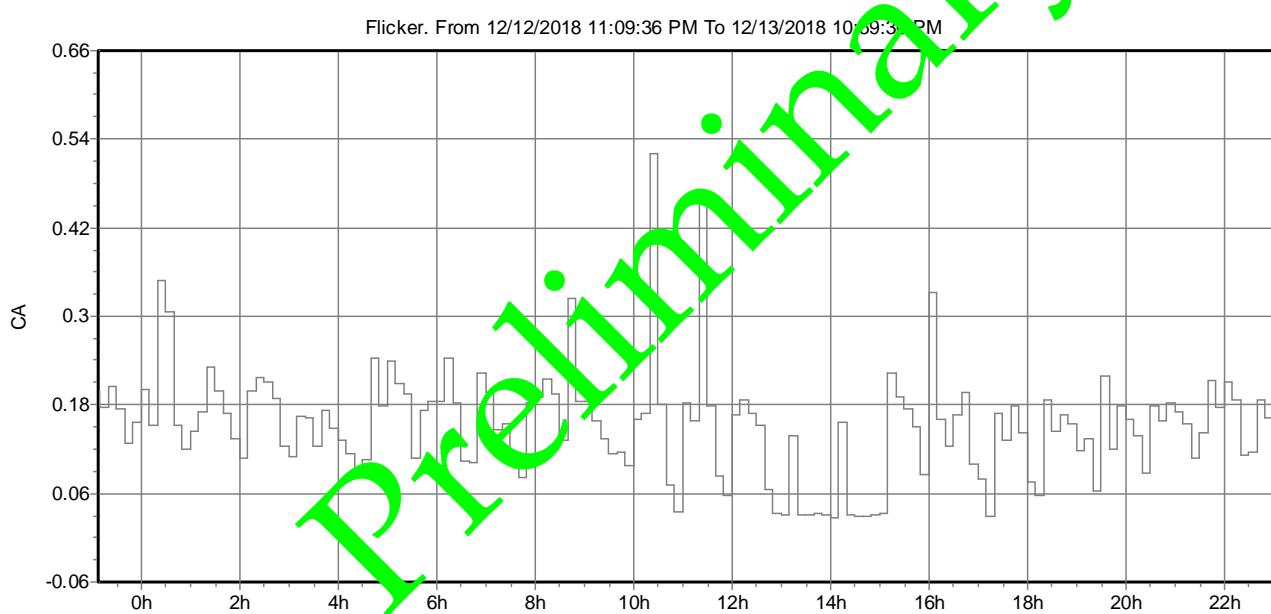
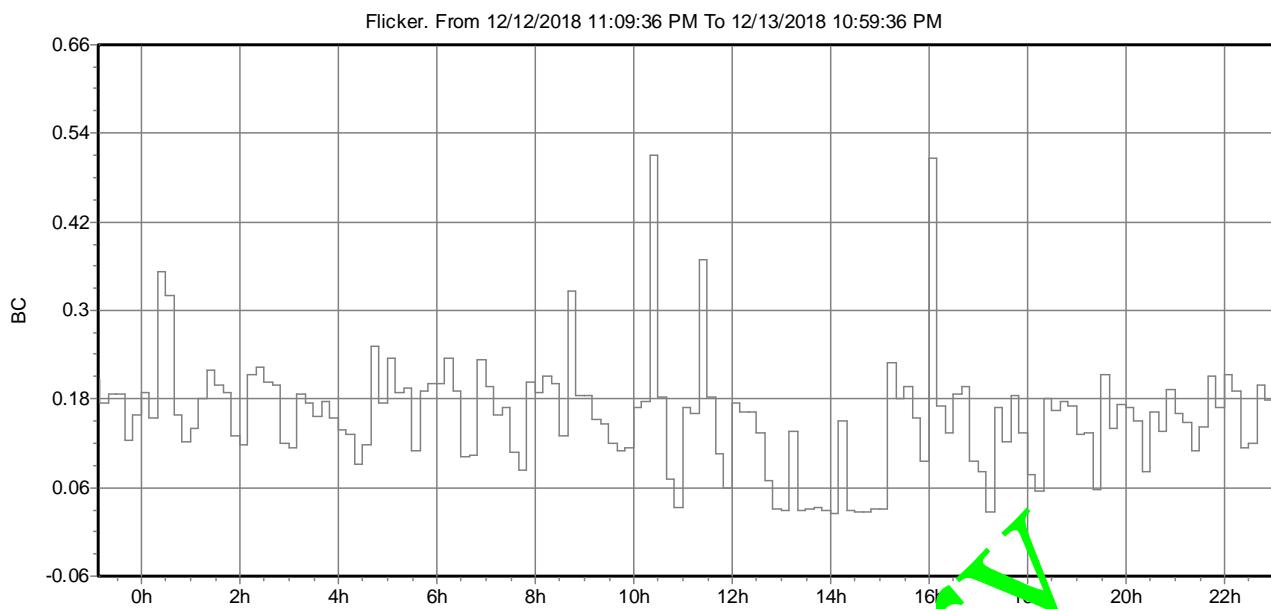


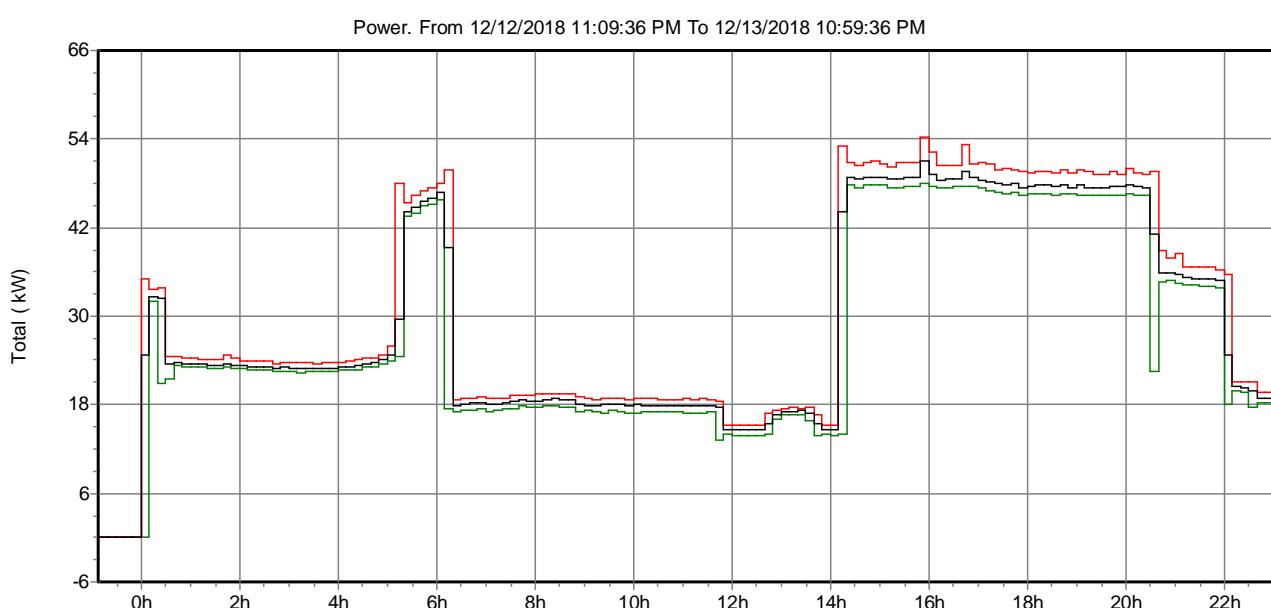
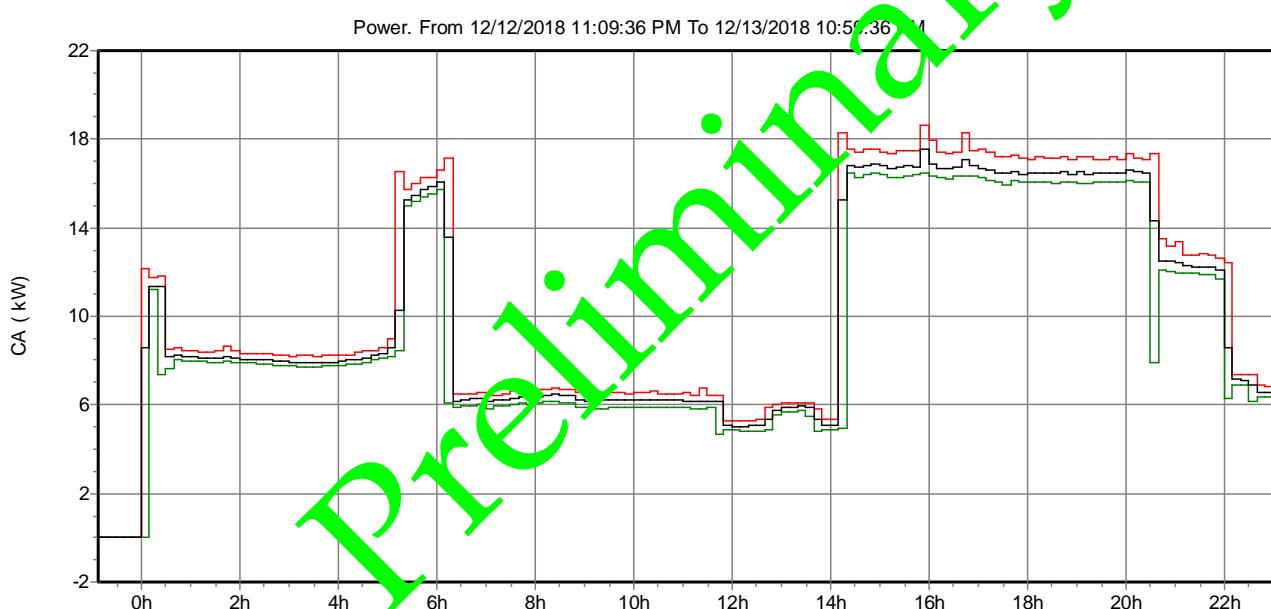
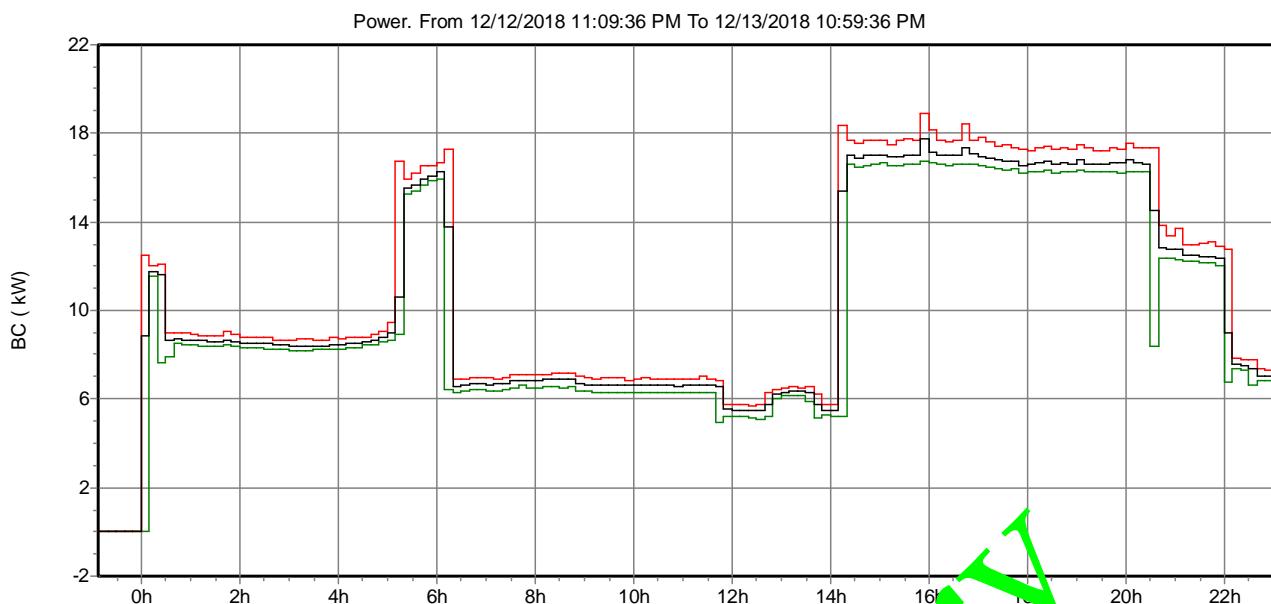


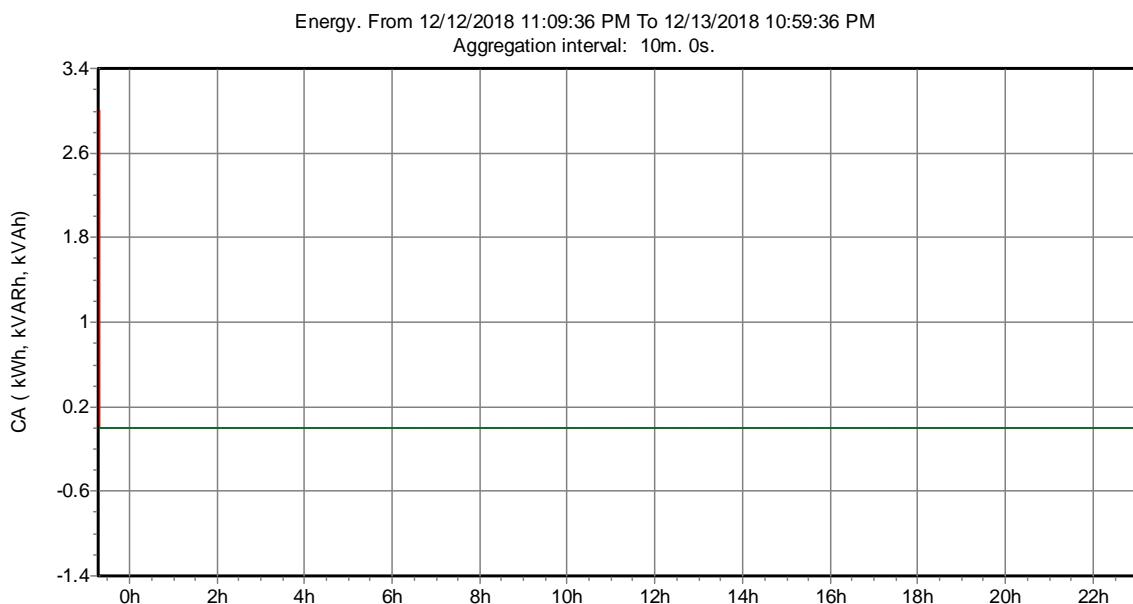
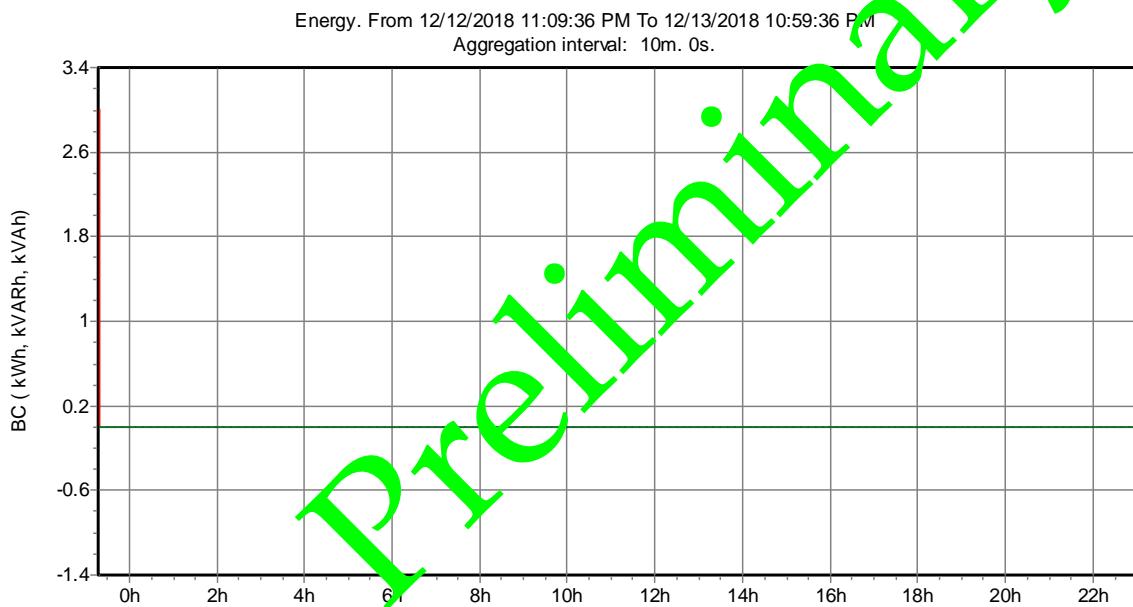
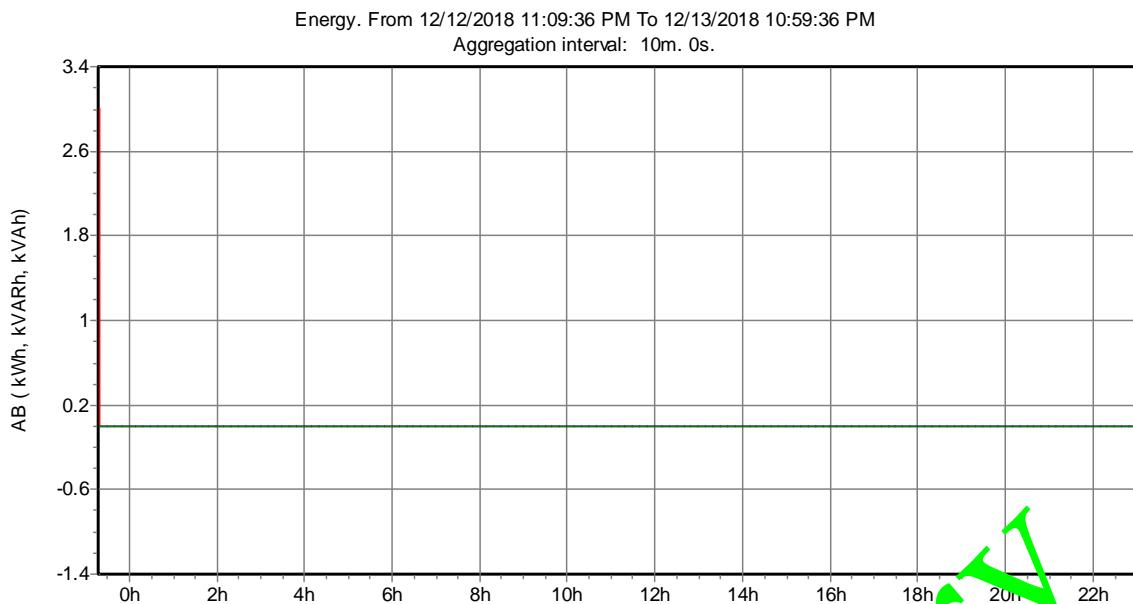


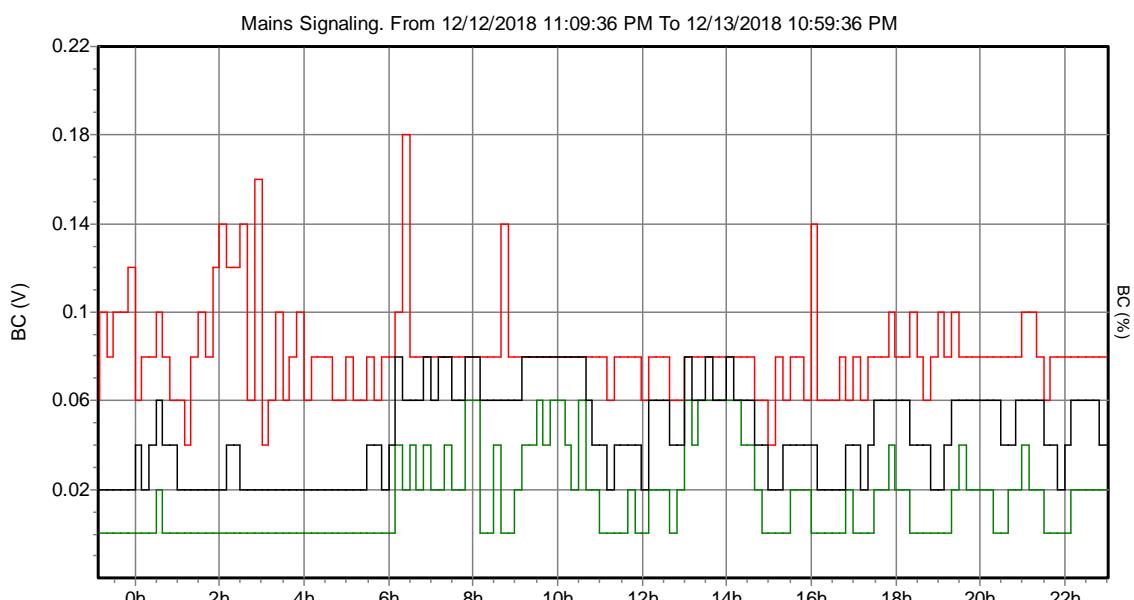
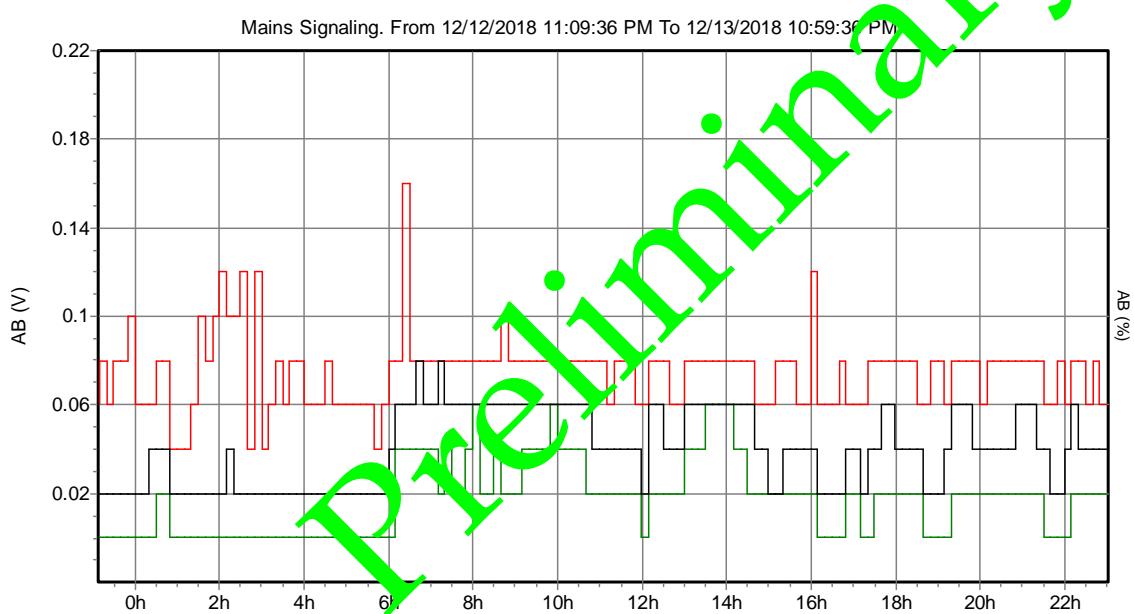
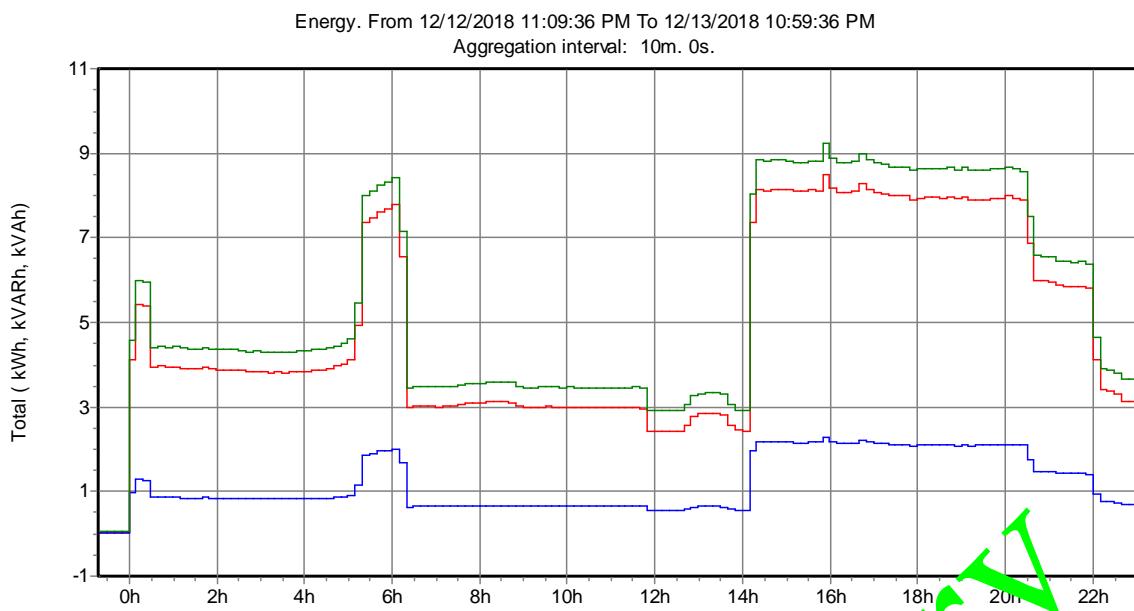


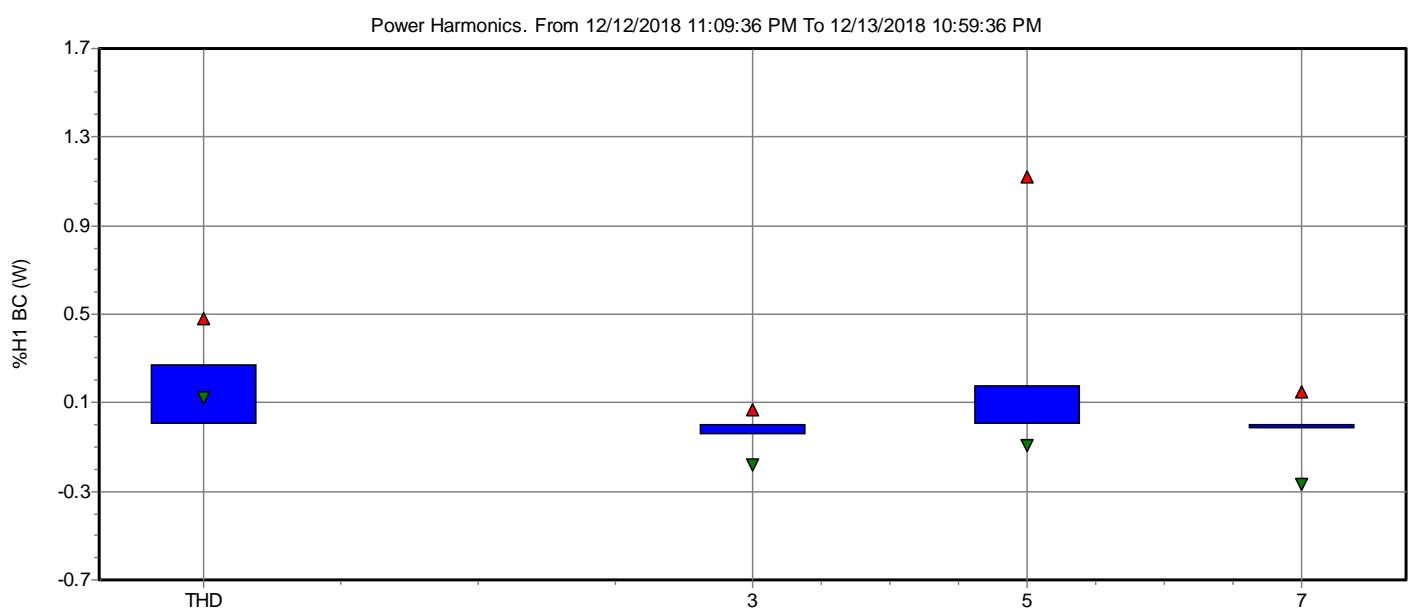
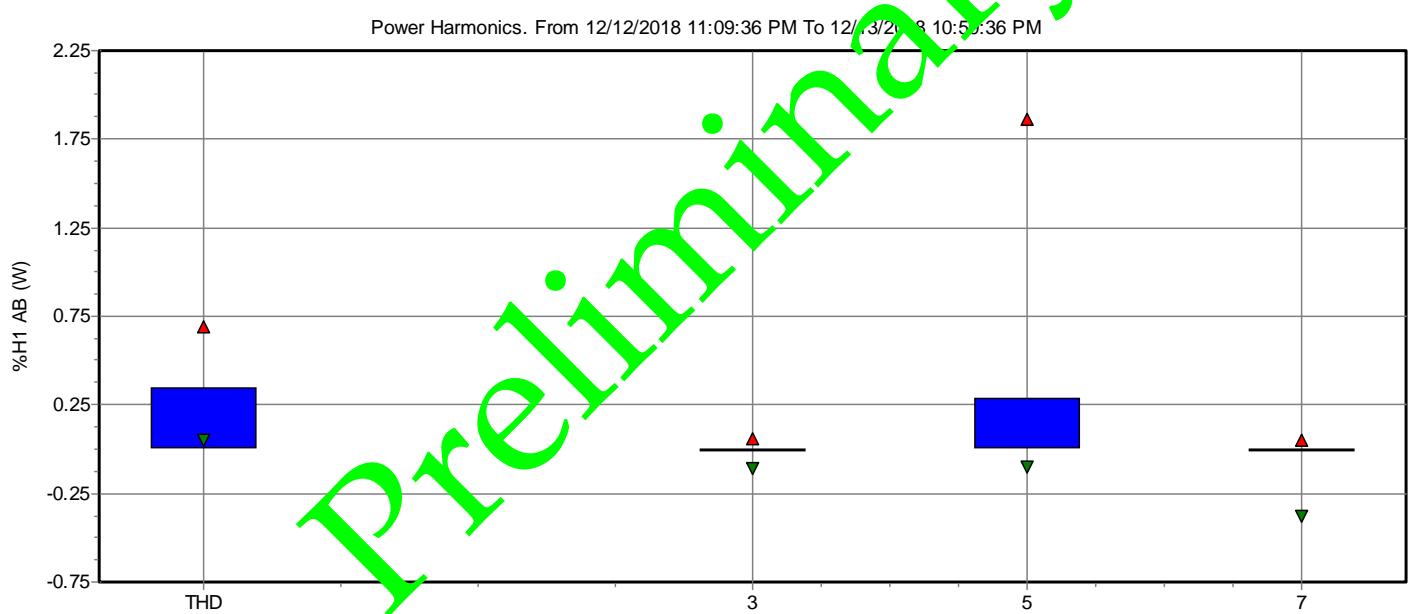
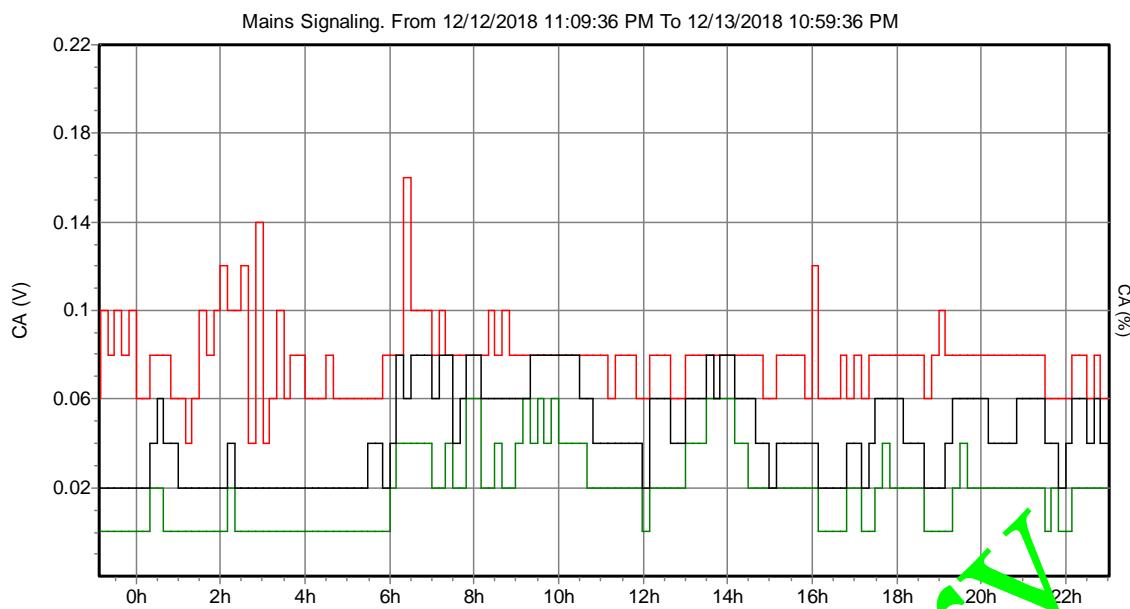


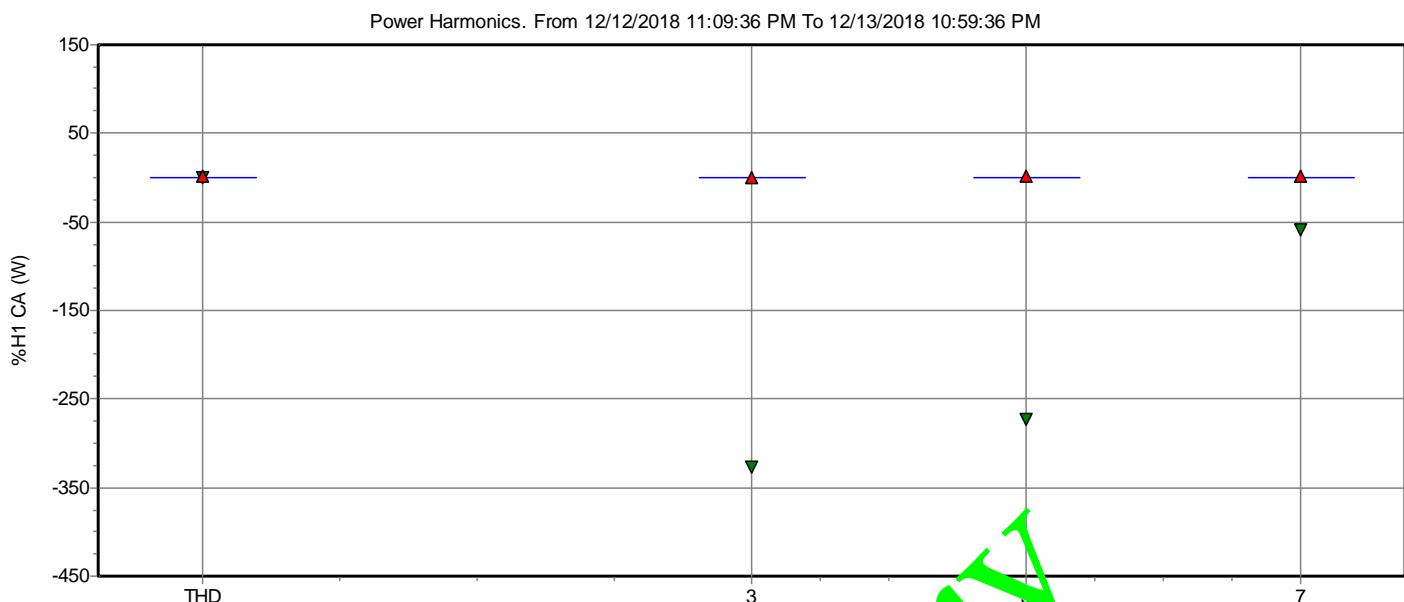














Instrument Information

Model Number	435-II
Serial Number	41183106
Firmware Revision	V05.04

Software Information

Power Log Version	5.4
FLUKE 430-II DLL Version	1.2.0.13

General Information

Recording location	VFD2 MOTOR2 MCCB 250A
Client	MAYNILAD AYALA ALABANG R1
Notes	

Preliminary



Instrument Information

Model Number	435-II
Serial Number	41183106
Firmware Revision	V05.04

Software Information

Power Log Version	5.4
FLUKE 430-II DLL Version	1.2.0.13

General Information

Recording location	SOFTSTARTER MOTOR 3 MCCB 250A
Client	MAYNILAD AYALA ALABNG R1
Notes	

Preliminary

Measurement Summary

Measurement topology	3-element delta mode
Application mode	Logger
First recording	2/1/2019 4:00:57 AM 531msec
Last recording	2/1/2019 10:30:57 PM 531msec
Recording interval	0h 10m 0s 0msec
Nominal Voltage	480 V
Nominal Current	250 A
Nominal Frequency	60 Hz
File start time	2/1/2019 3:50:57 AM 531msec
File end time	2/1/2019 10:30:57 PM 531msec
Duration	0d 18h 40m 0s 0msec
Number of events	Normal: 0 Detailed: 0
Events downloaded	No
Number of screens	0
Screens downloaded	Yes
Power measurement method	Unified
Cable type	Copper
Harmonic scale	%H1
THD mode	THD 40
CosPhi / DPF mode	DPF

Scaling

Phase:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	250 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1
Neutral:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	250 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1

Recording Summary

RMS recordings	112
DC recordings	0
Frequency recordings	112
Unbalance recordings	112
Harmonic recordings	112
Power harmonic recordings	112
Power recordings	112
Power unbalance recordings	0
Energy recordings	112
Energy losses recordings	0
Flicker recordings	112
Mains signaling recordings	112

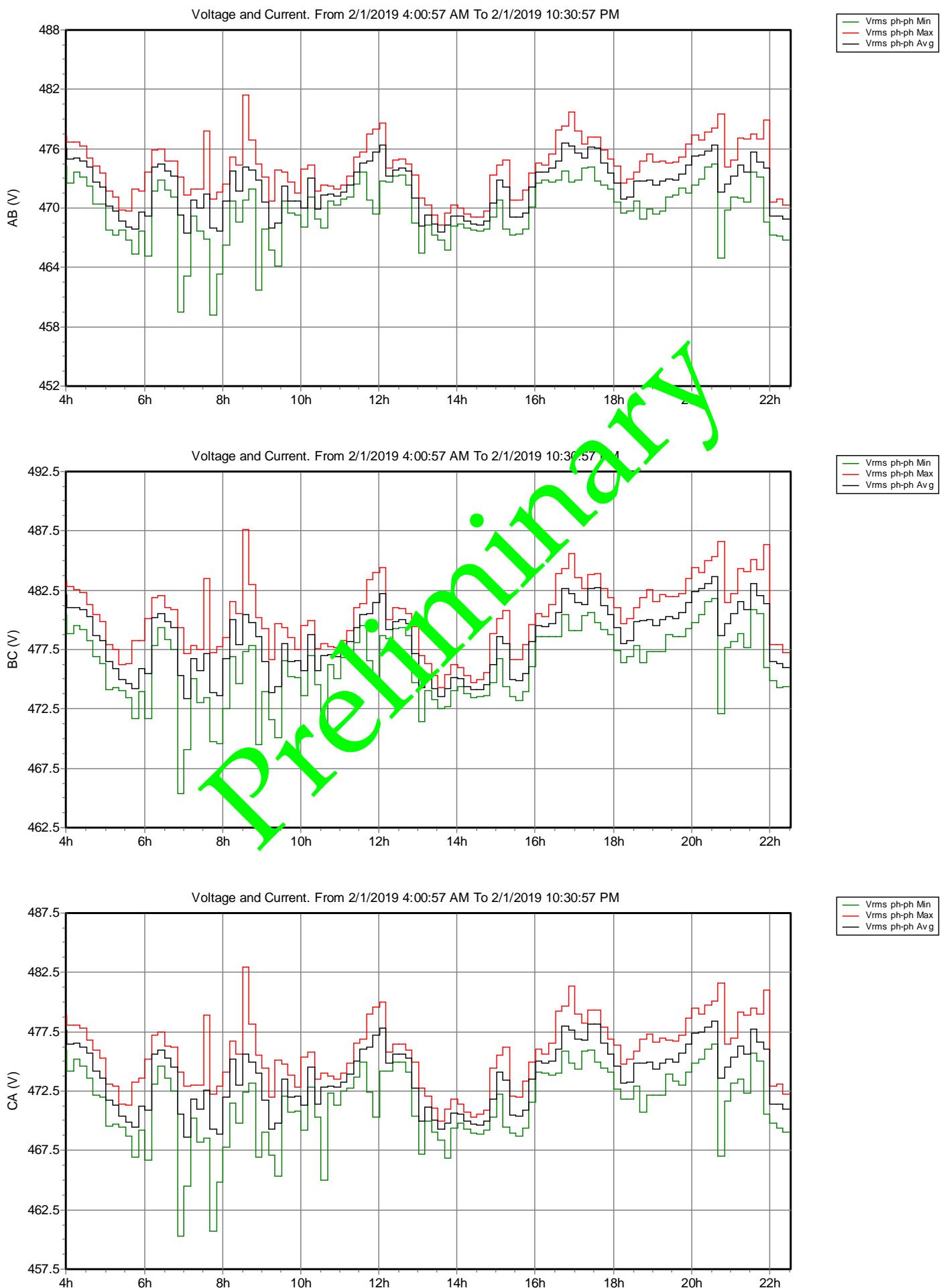
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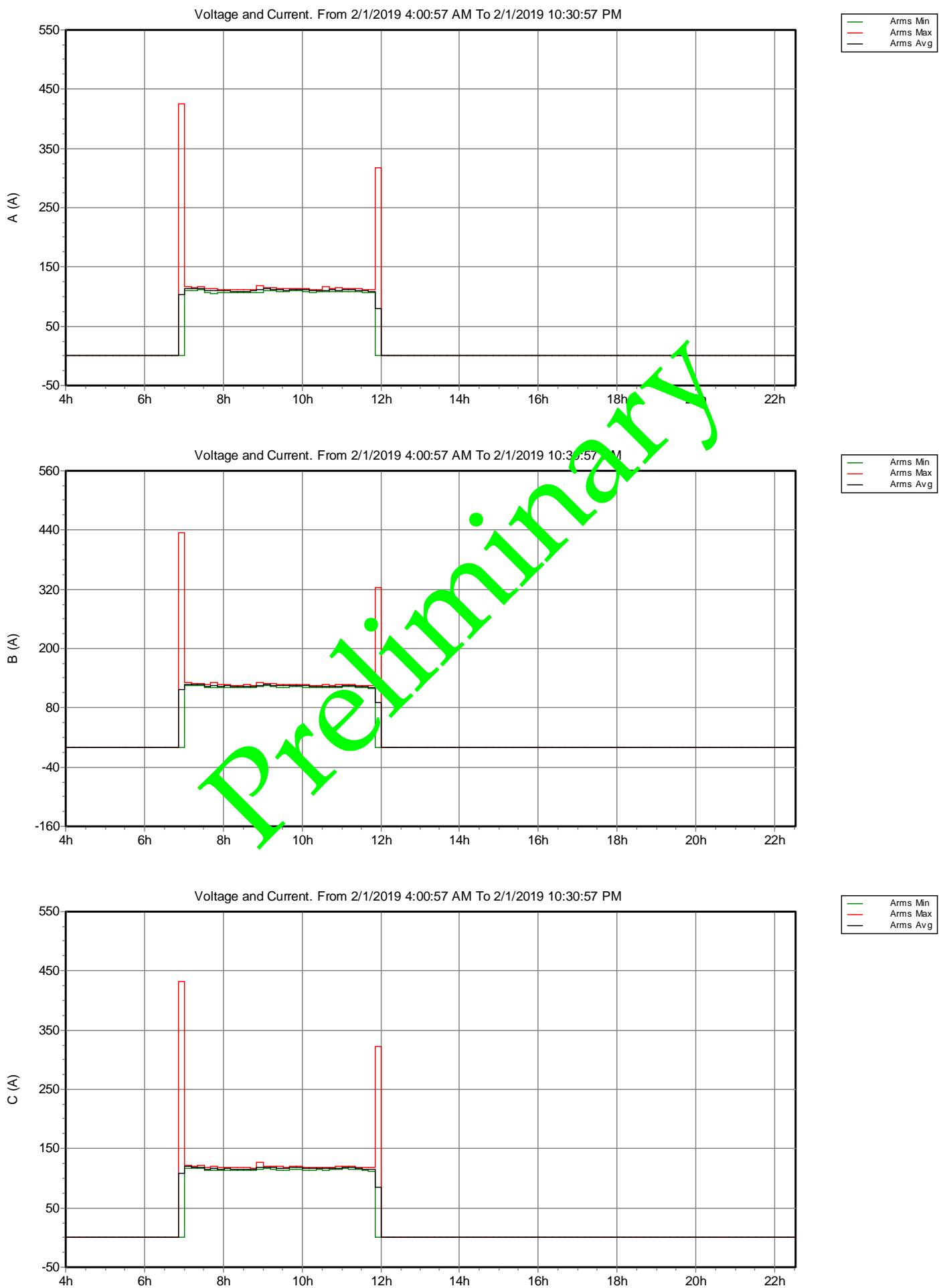


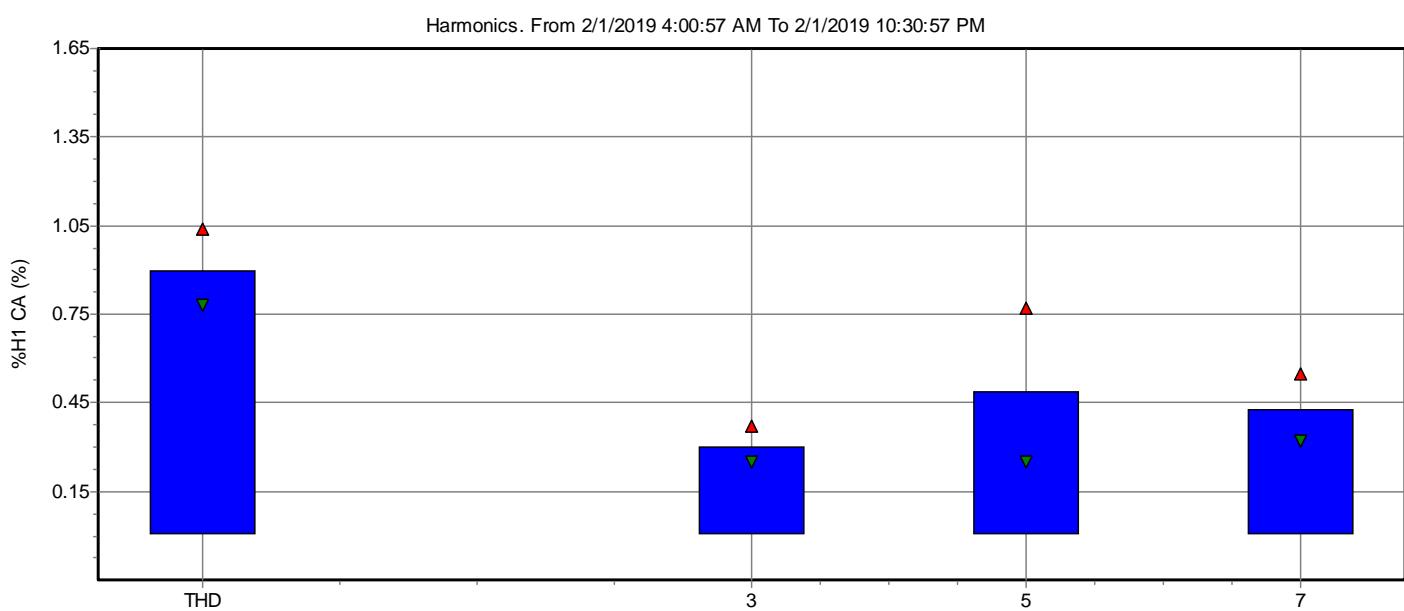
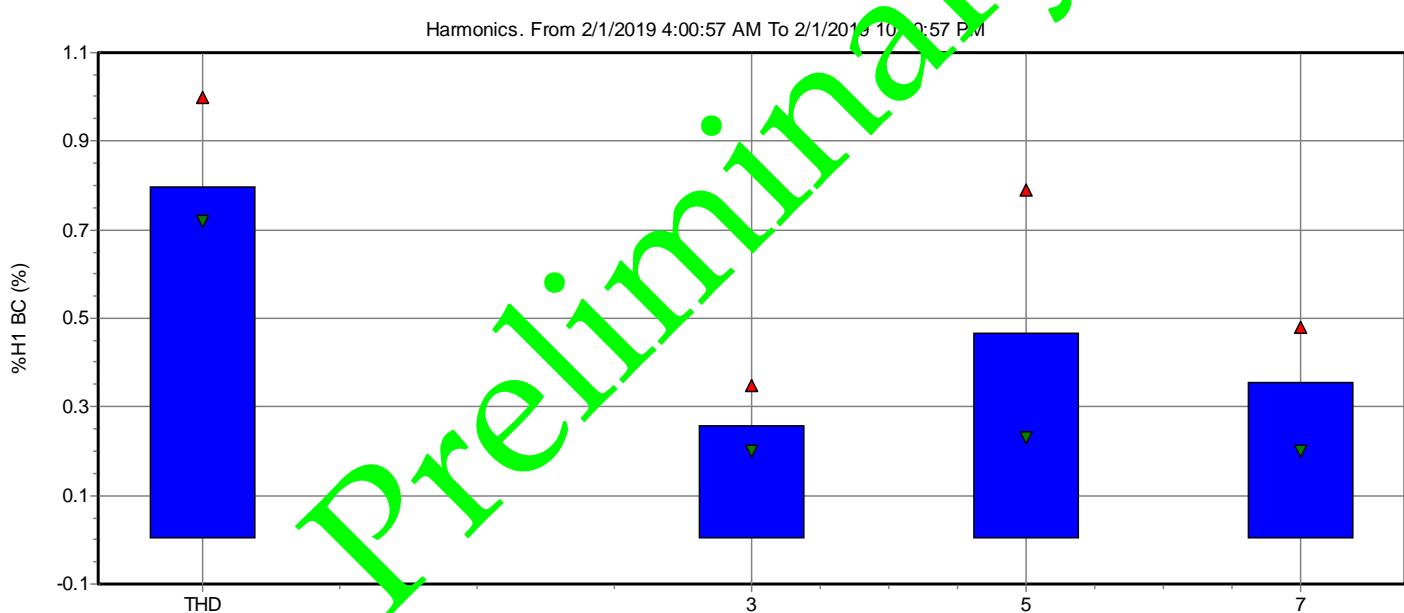
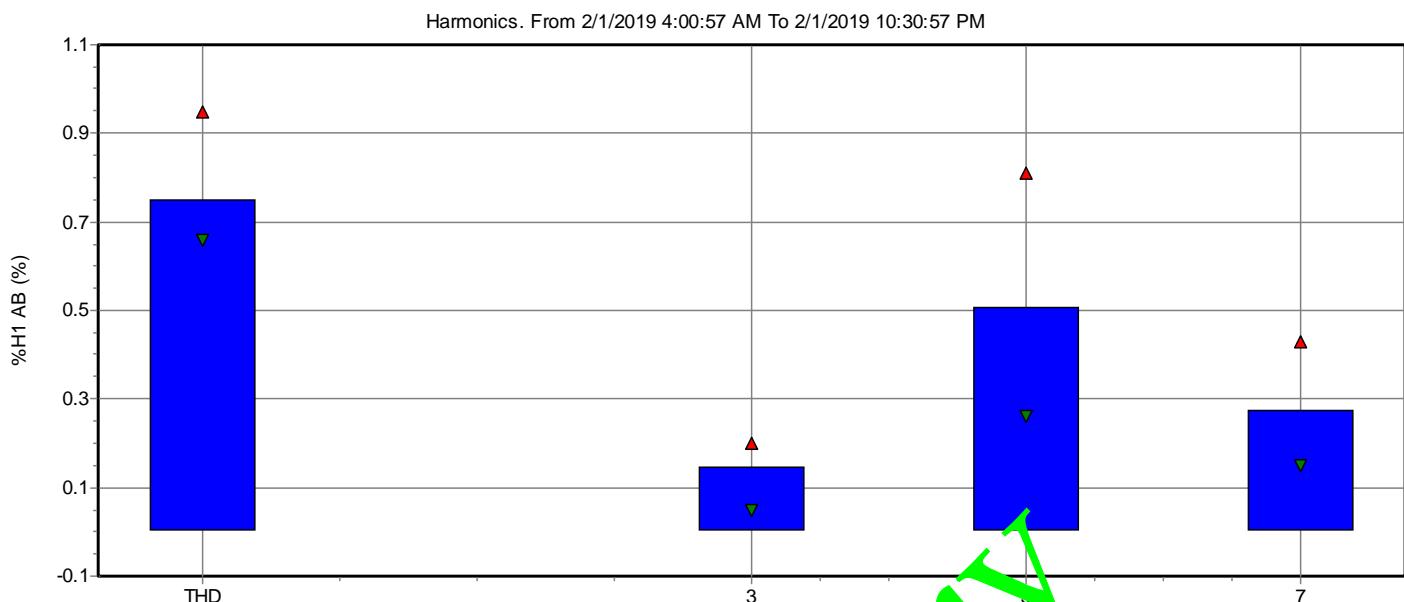
Events Summary

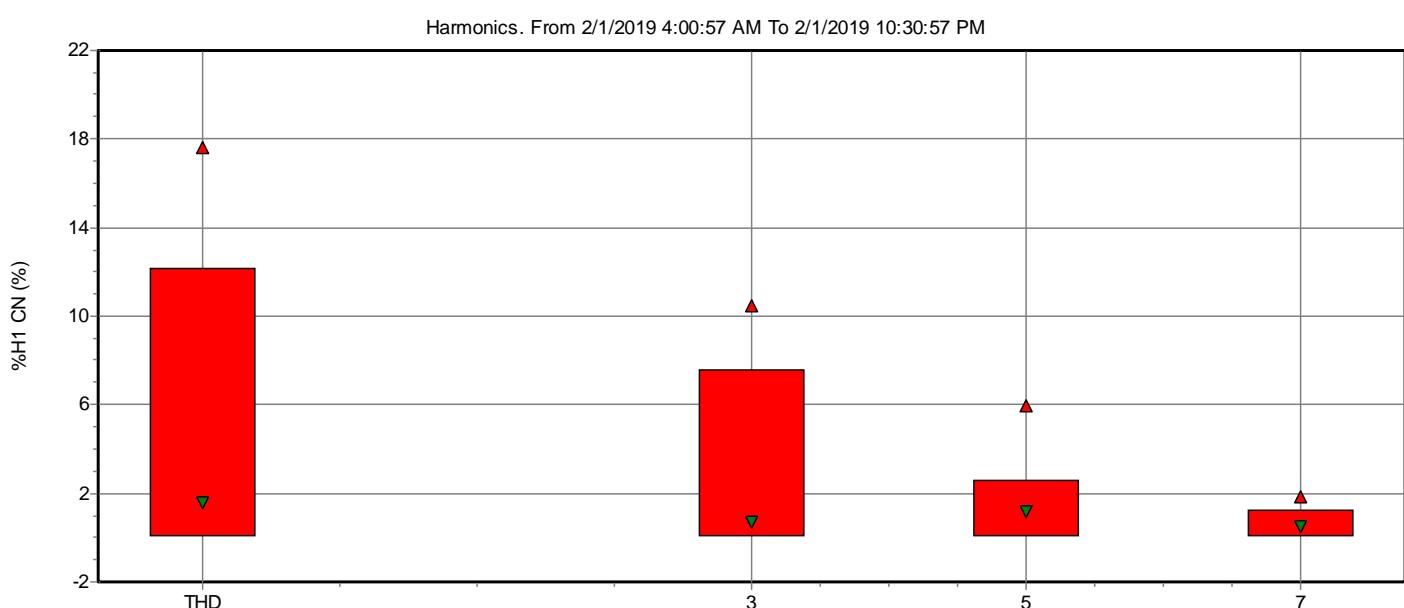
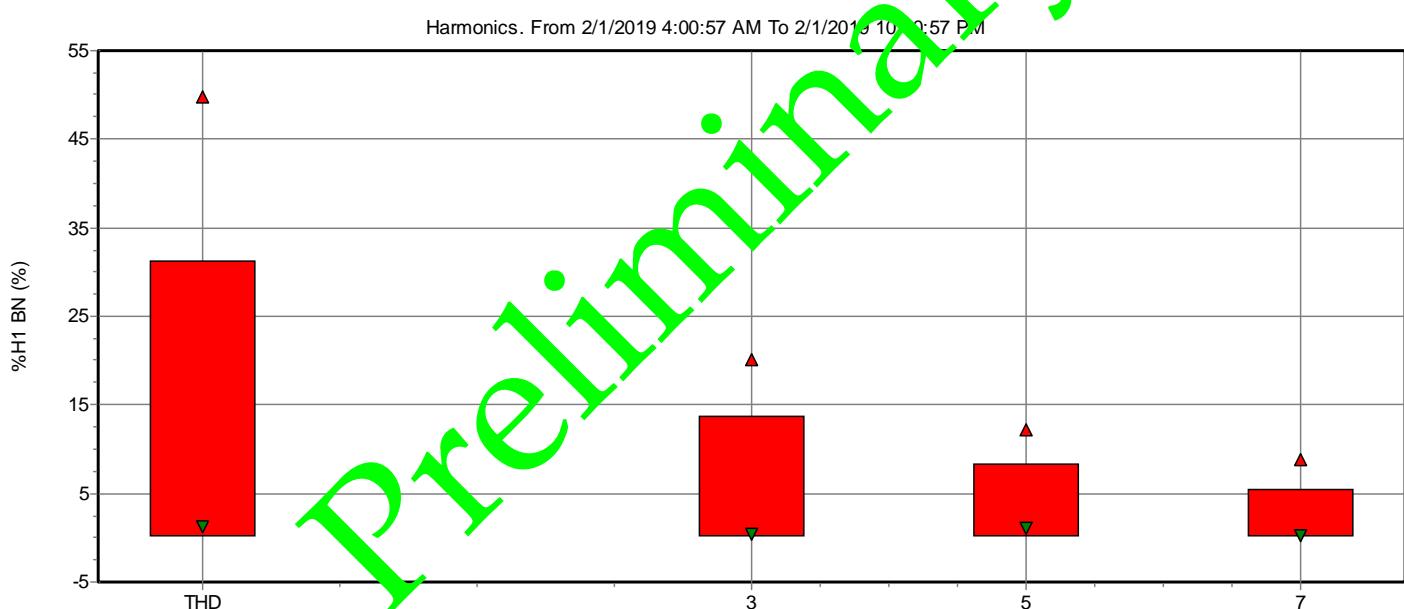
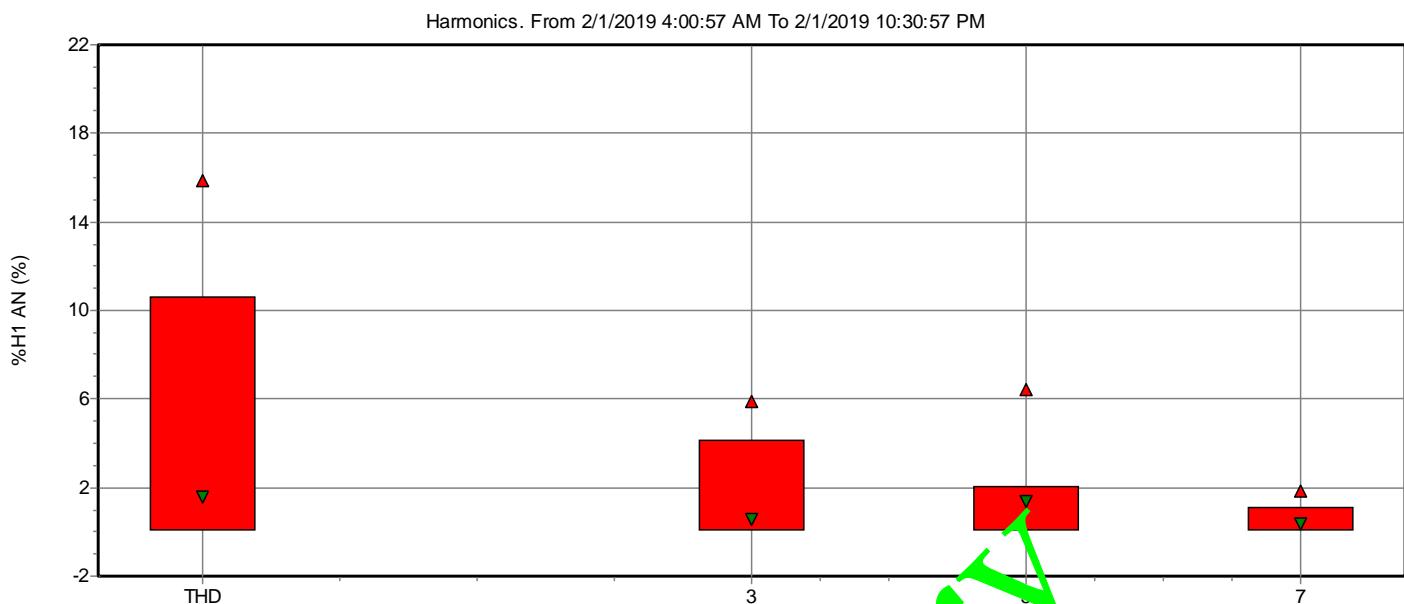
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Swells	0
Transients	0
Interruptions	0
Voltage profiles	0
Rapid voltage changes	0
Screens	0
Waveforms	0
Intervals without measurements	0
Inrush current graphics	0
Wave events	0
RMS events	0

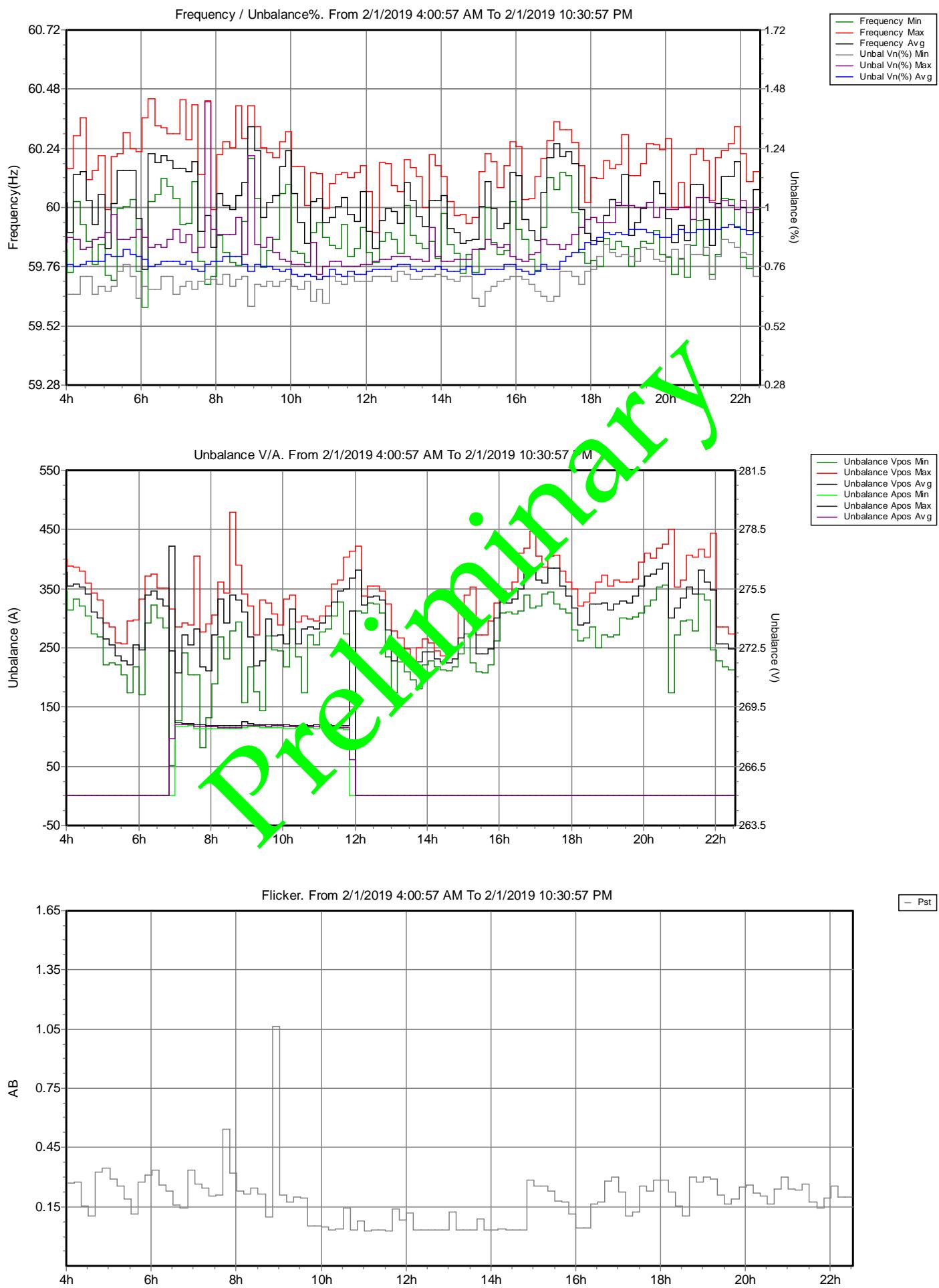
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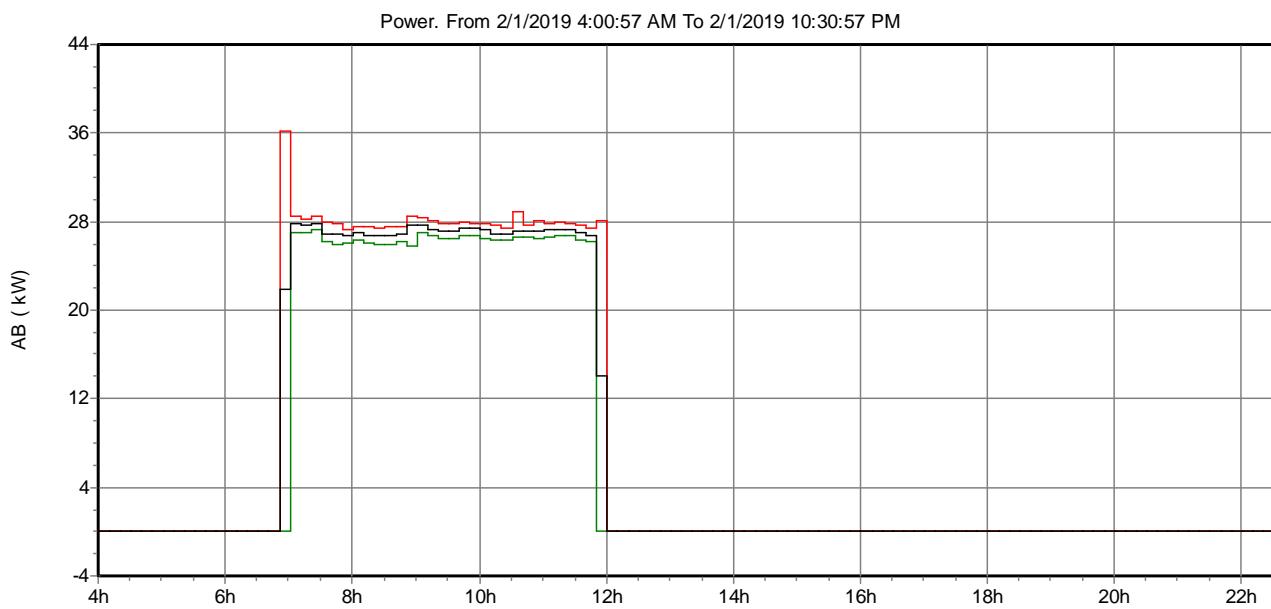
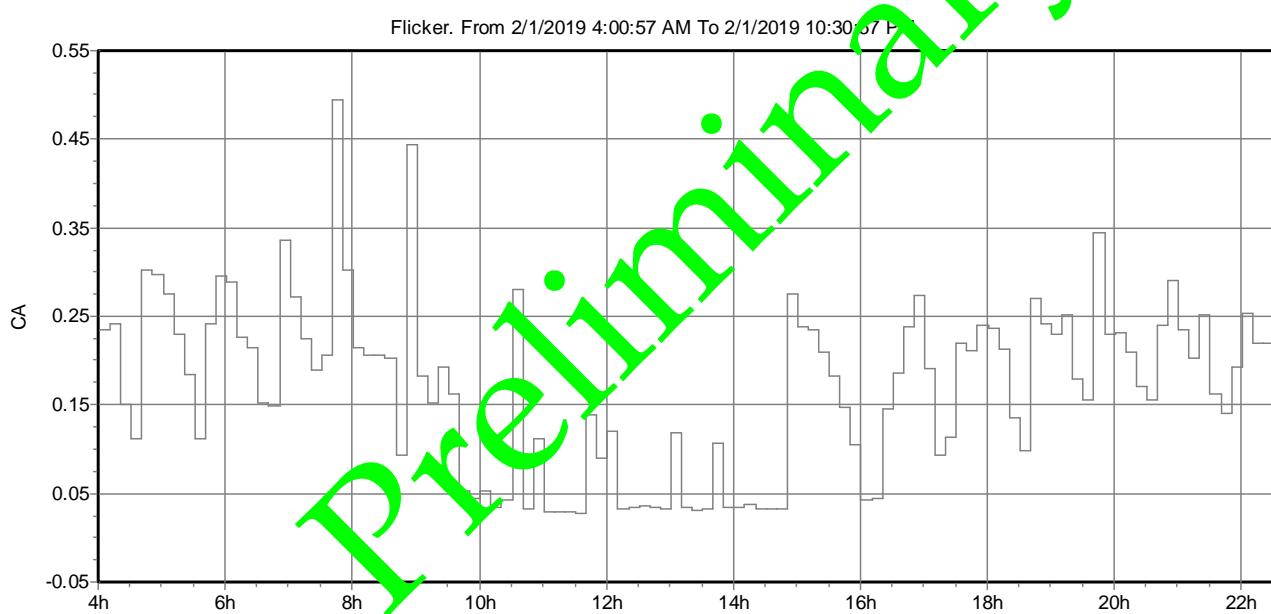
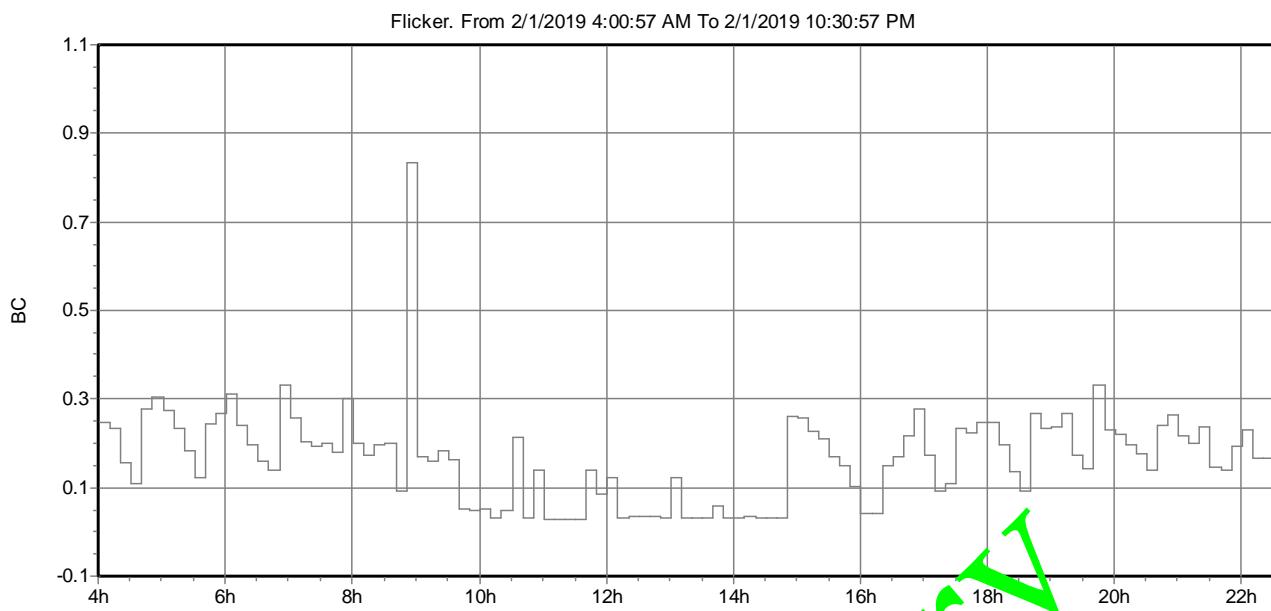


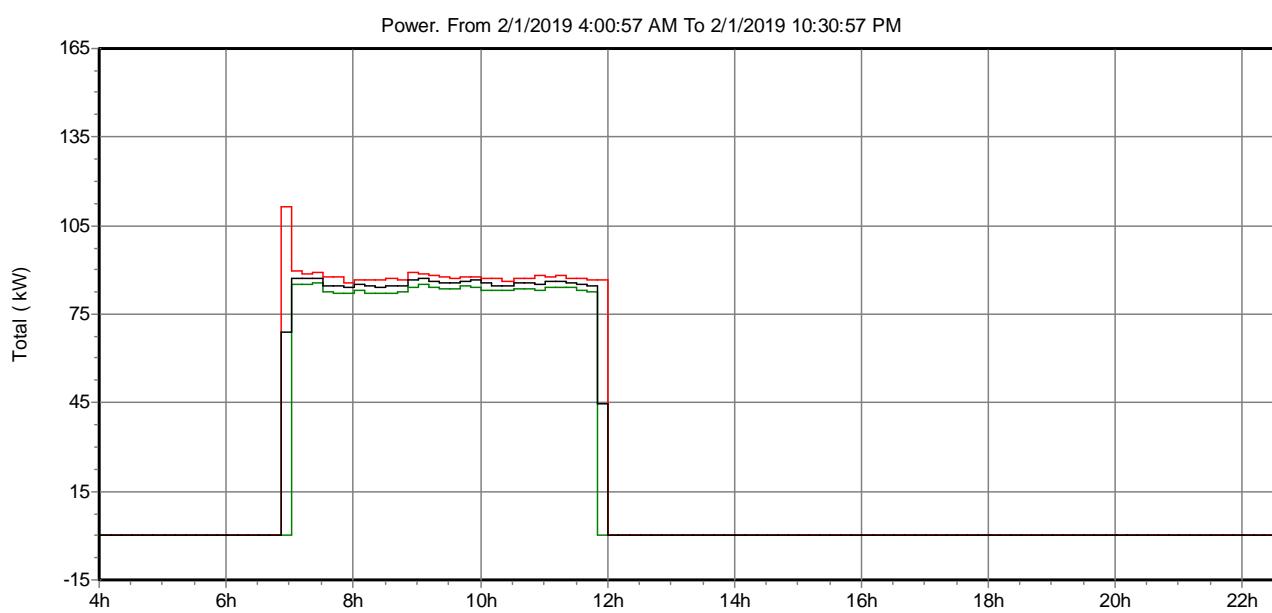
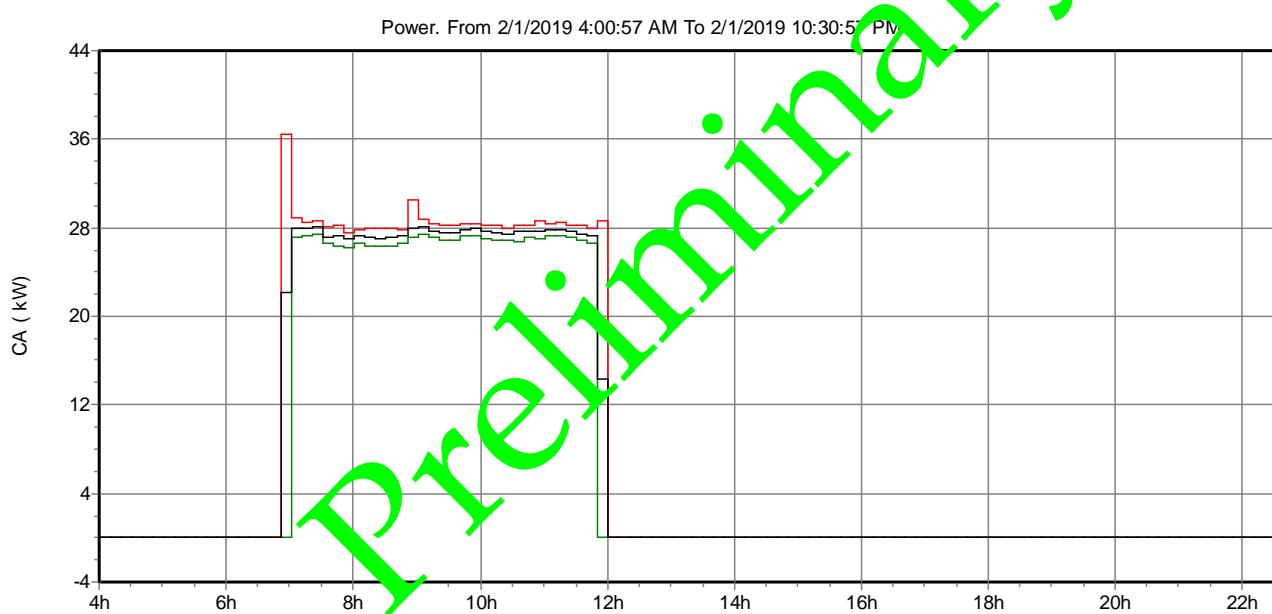
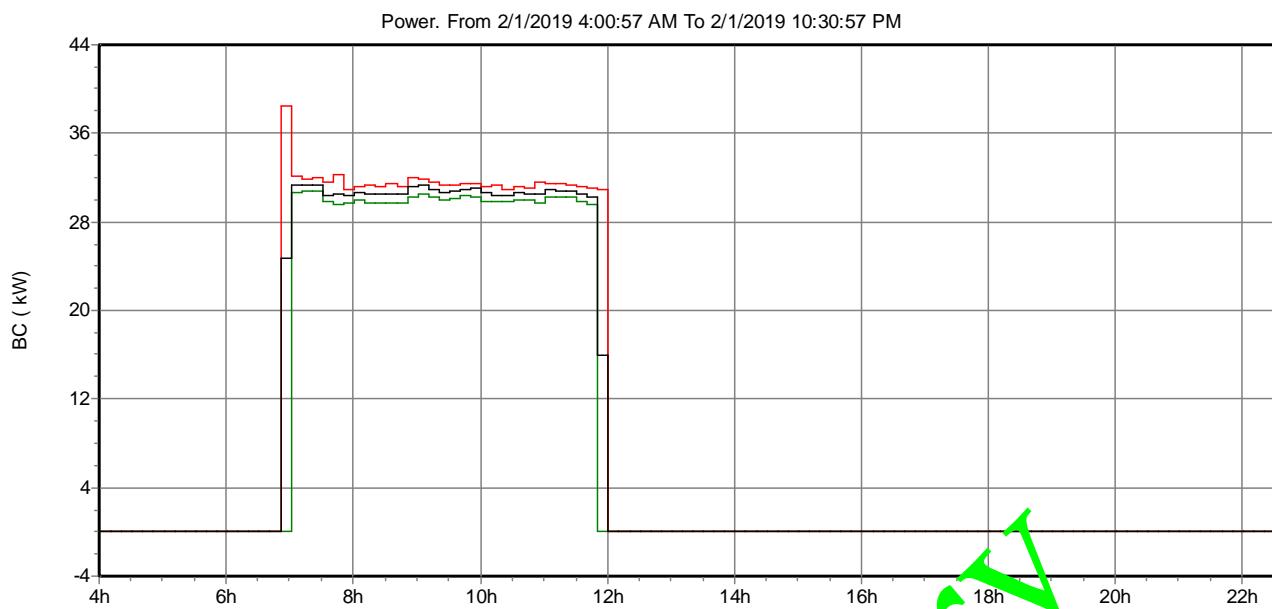


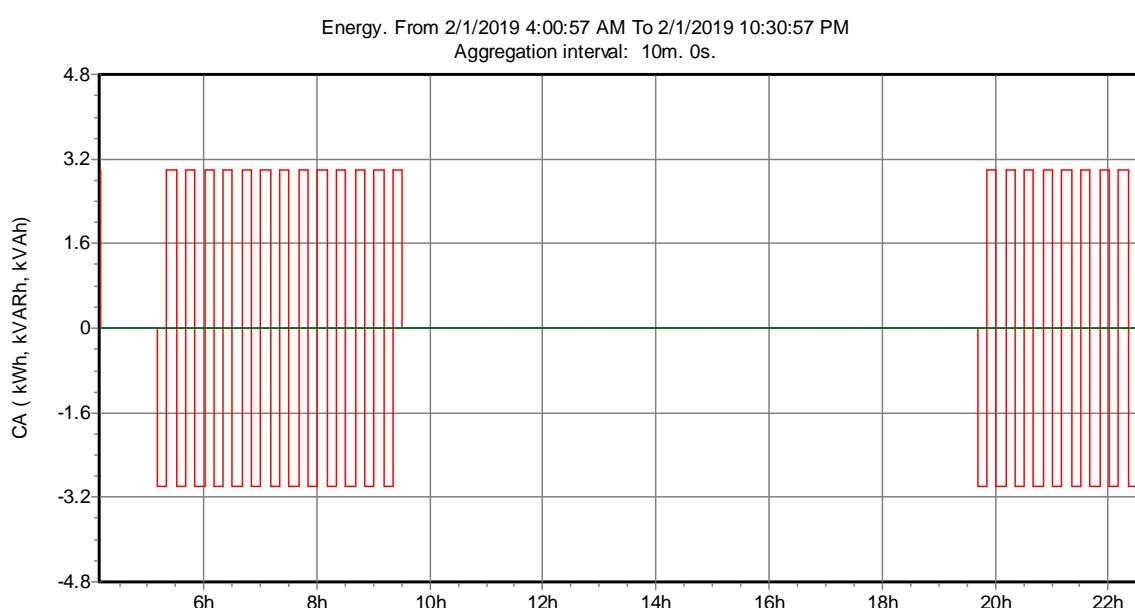
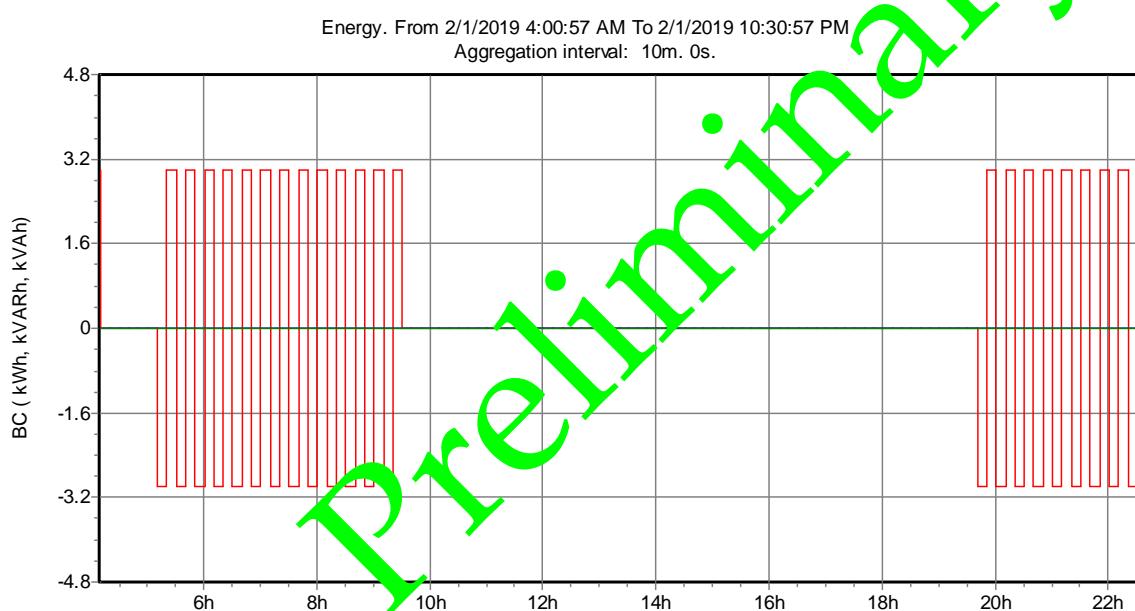
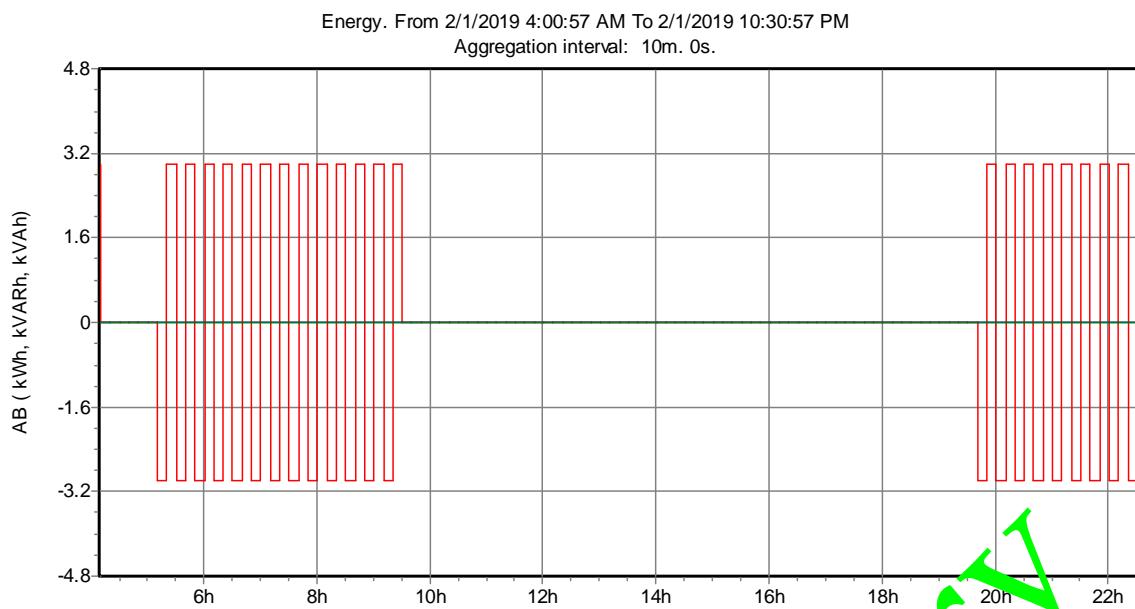


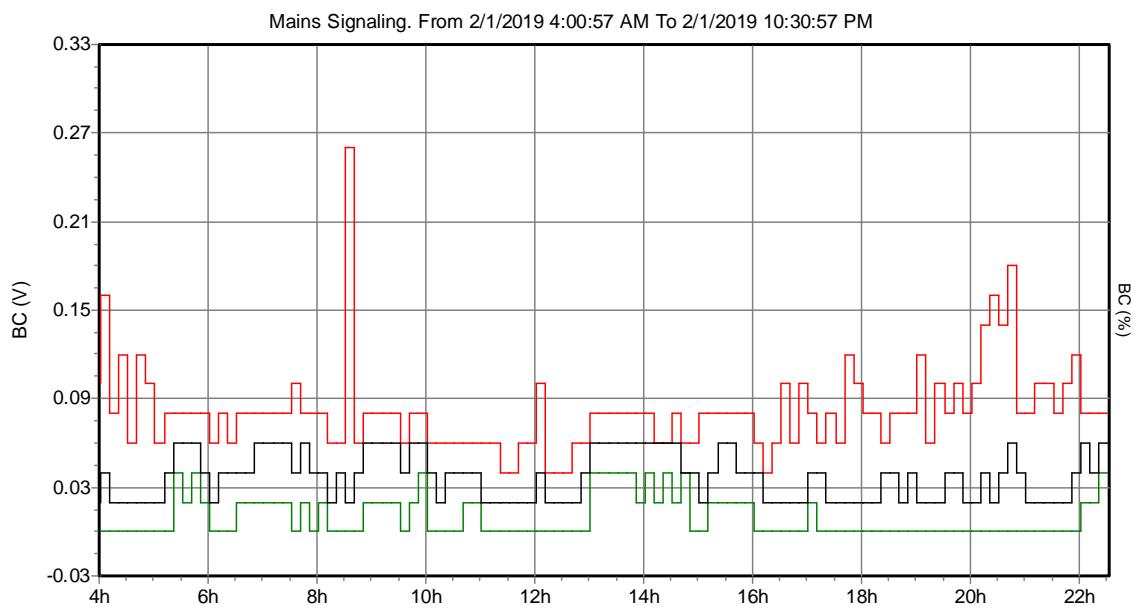
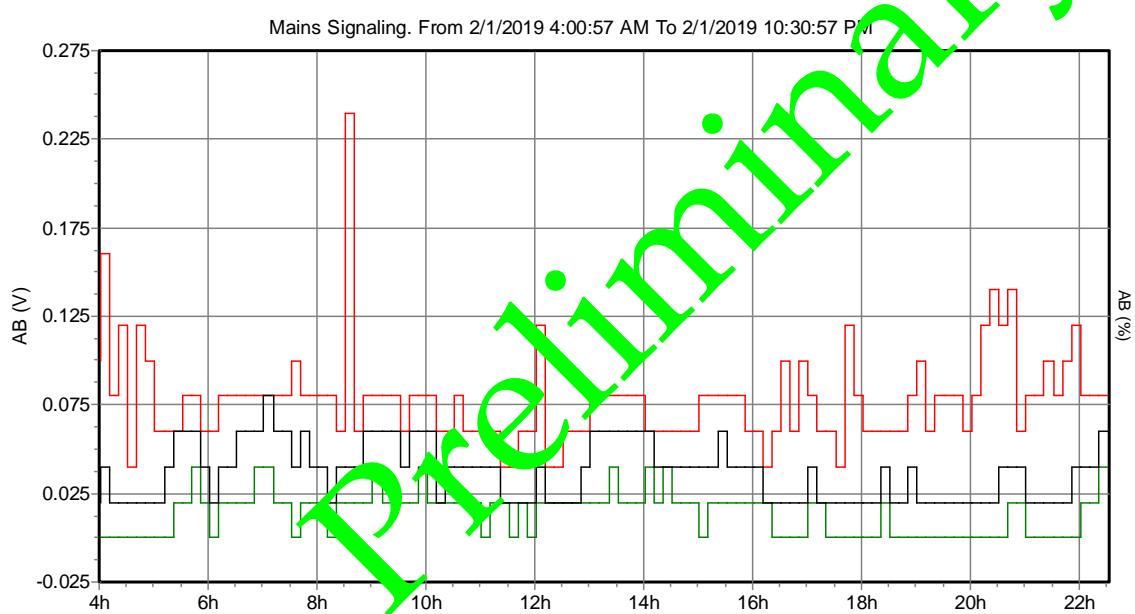
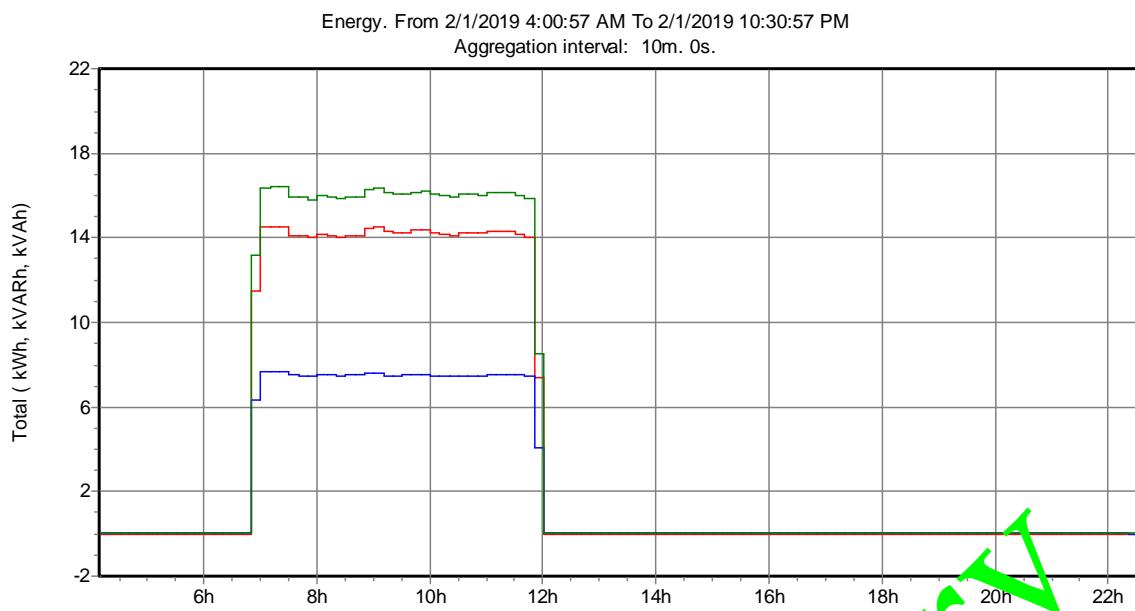


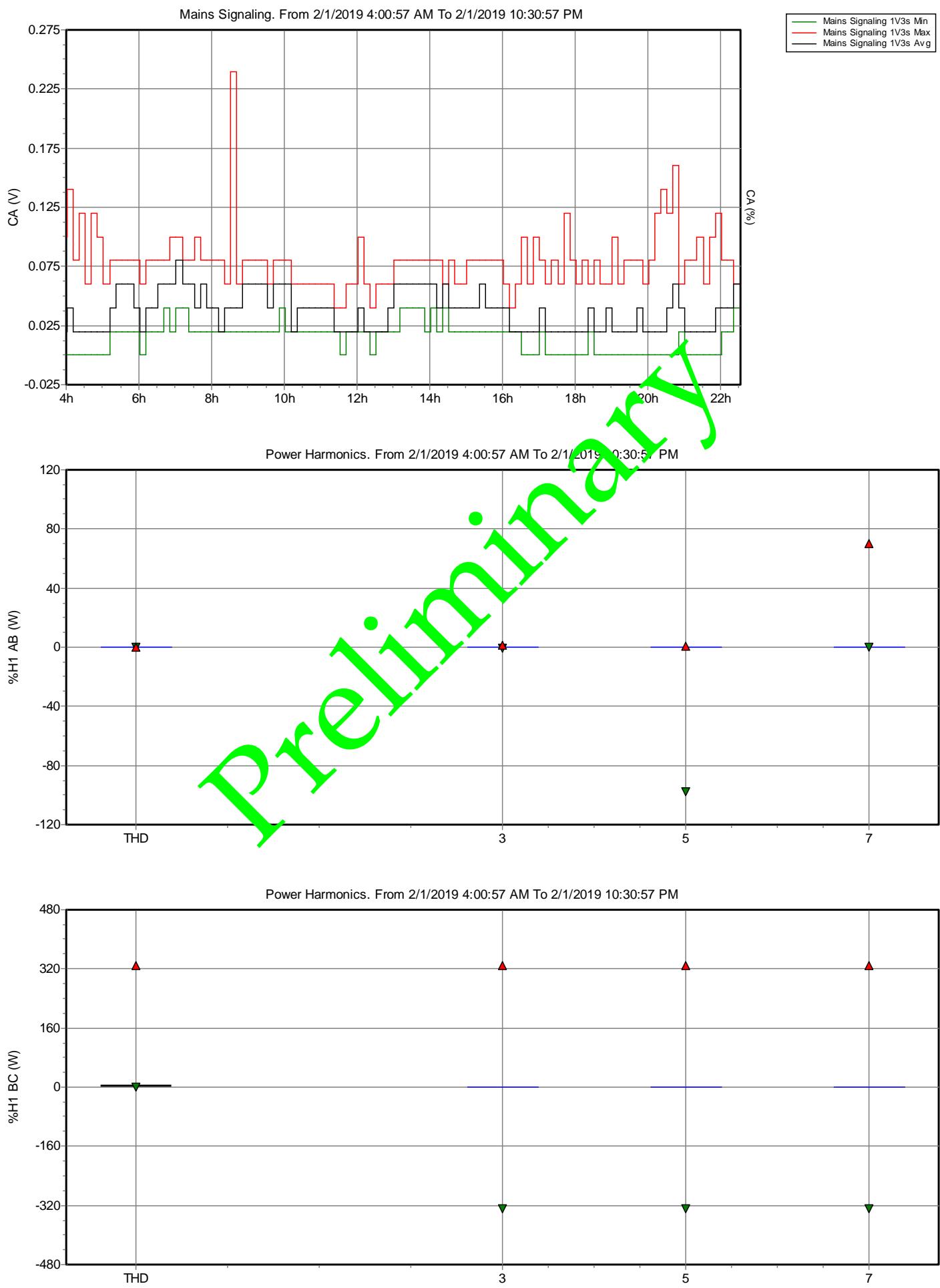


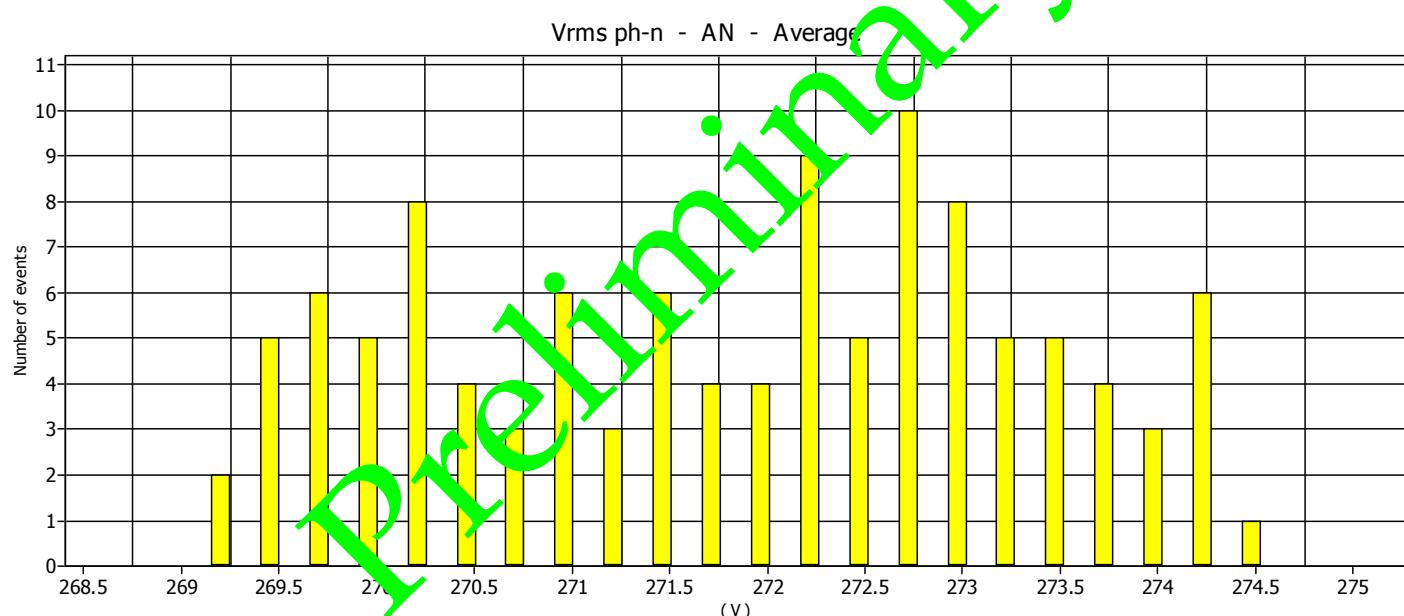
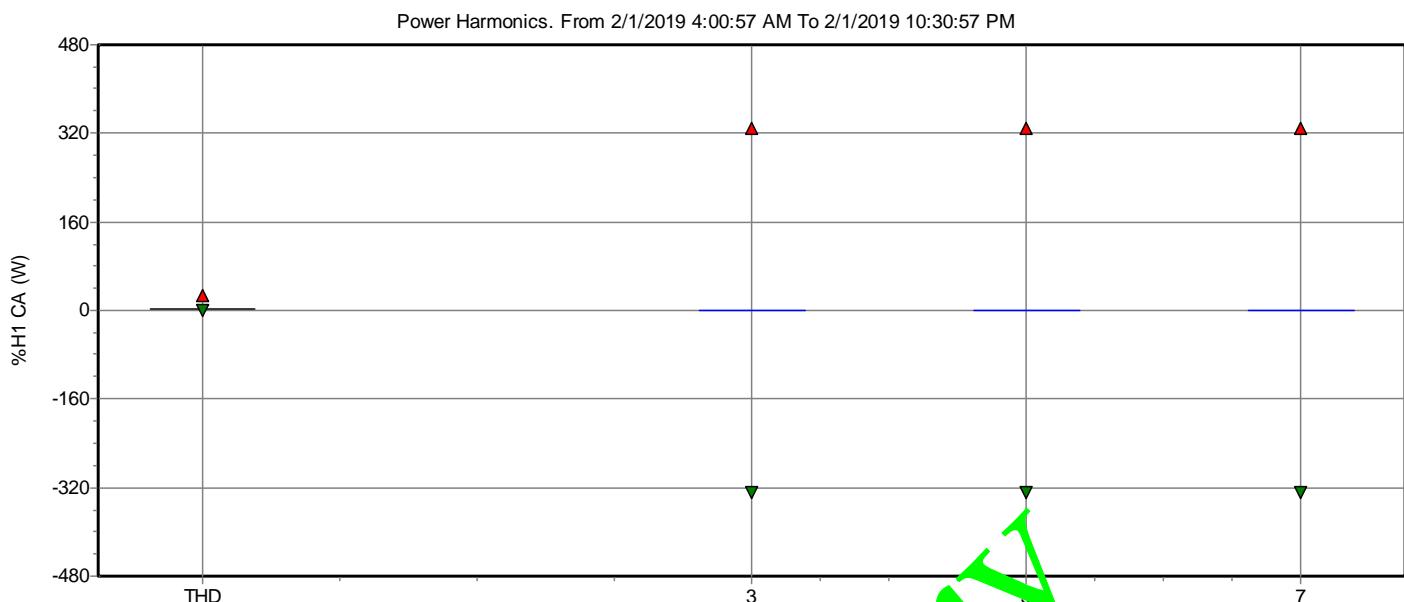












Measurement Summary

Measurement topology	3-element delta mode
Application mode	Logger
First recording	2/3/2019 12:53:24 AM 751msec
Last recording	2/4/2019 10:23:24 PM 751msec
Recording interval	0h 10m 0s 0msec
Nominal Voltage	480 V
Nominal Current	250 A
Nominal Frequency	60 Hz
File start time	2/3/2019 12:43:24 AM 751msec
File end time	2/4/2019 10:23:24 PM 751msec
Duration	1d 21h 40m 0s 0msec
Number of events	Normal: 2 Detailed: 8
Events downloaded	No
Number of screens	0
Screens downloaded	Yes
Power measurement method	Unified
Cable type	Copper
Harmonic scale	%H1
THD mode	THD 40
CosPhi / DPF mode	DPF

Scaling

Phase:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	250 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1
Neutral:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	250 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1

Recording Summary

RMS recordings	274
DC recordings	0
Frequency recordings	274
Unbalance recordings	274
Harmonic recordings	274
Power harmonic recordings	274
Power recordings	274
Power unbalance recordings	0
Energy recordings	274
Energy losses recordings	0
Flicker recordings	274
Mains signaling recordings	274

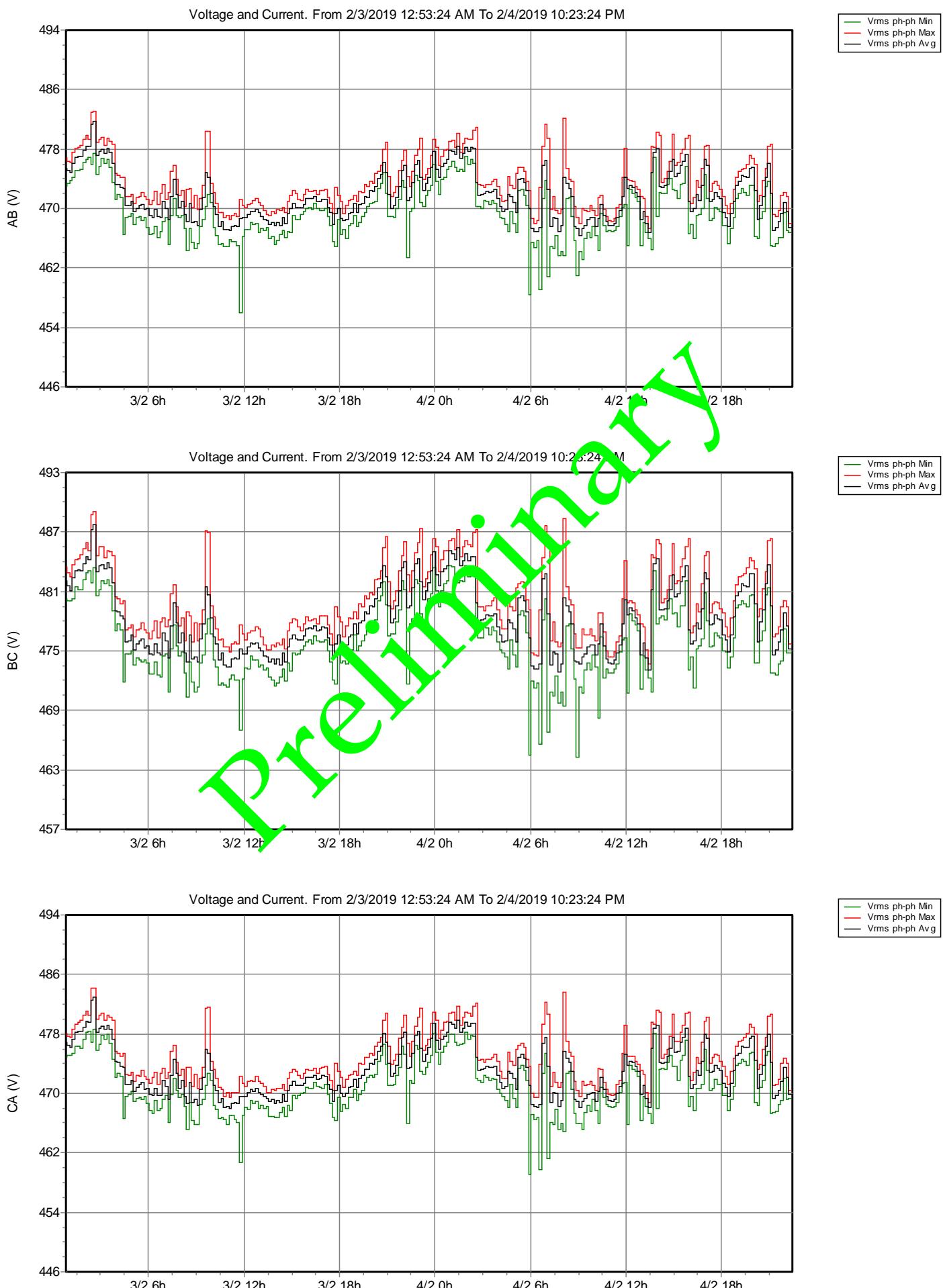
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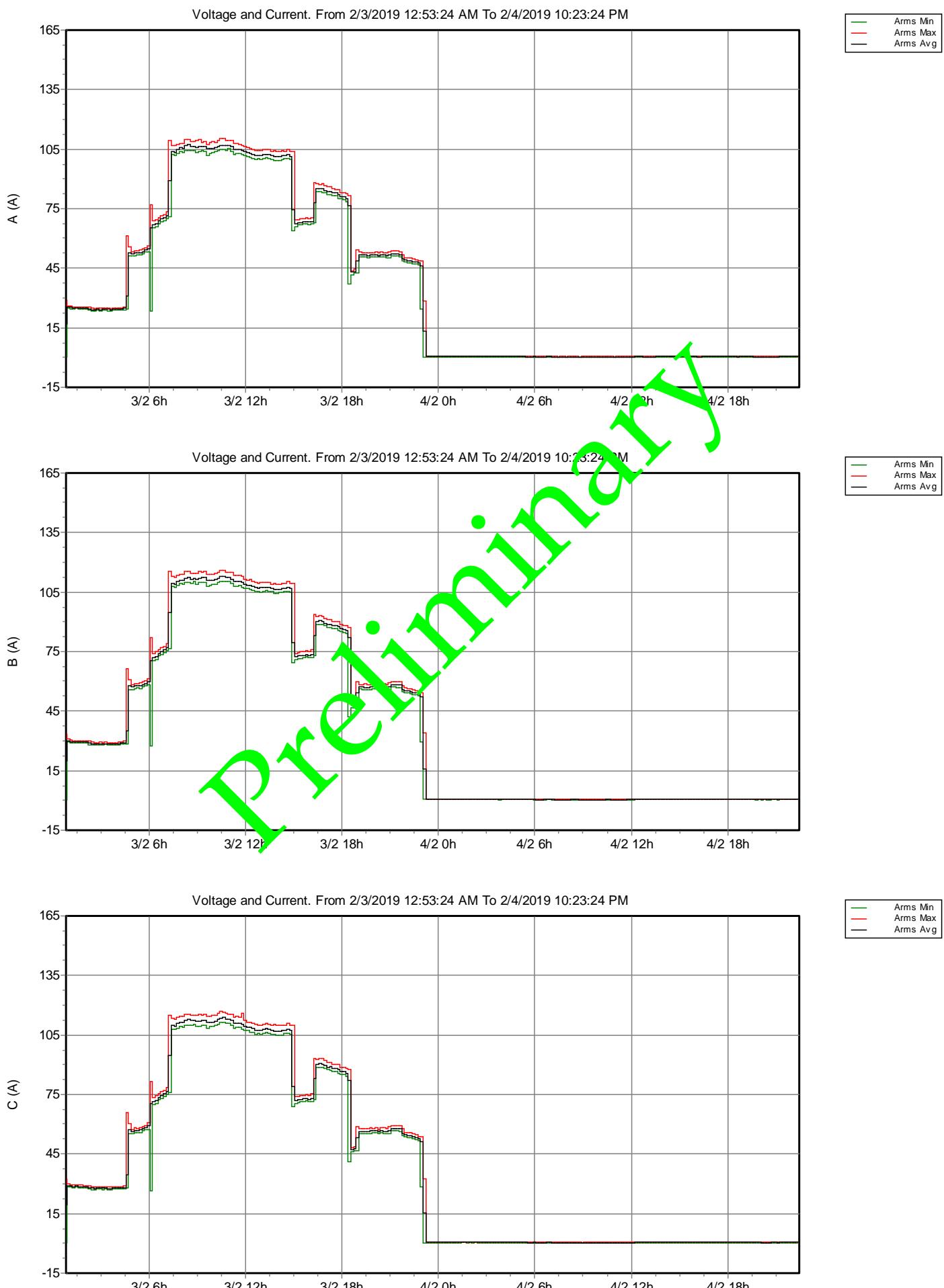


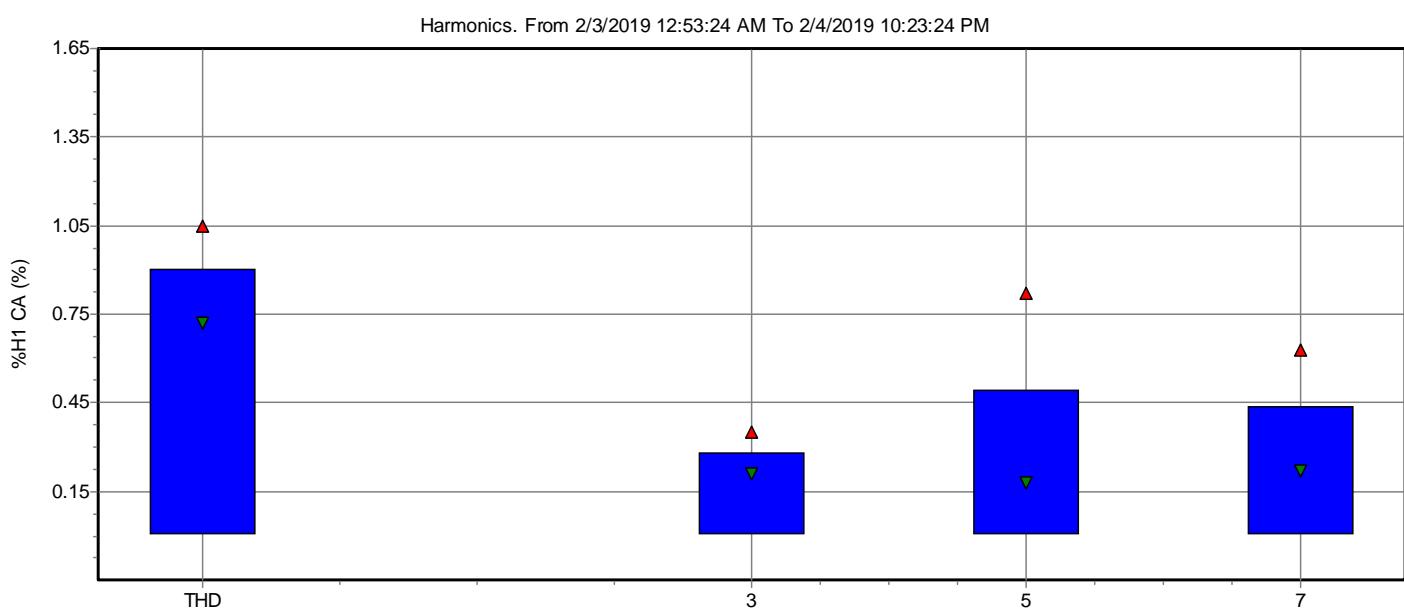
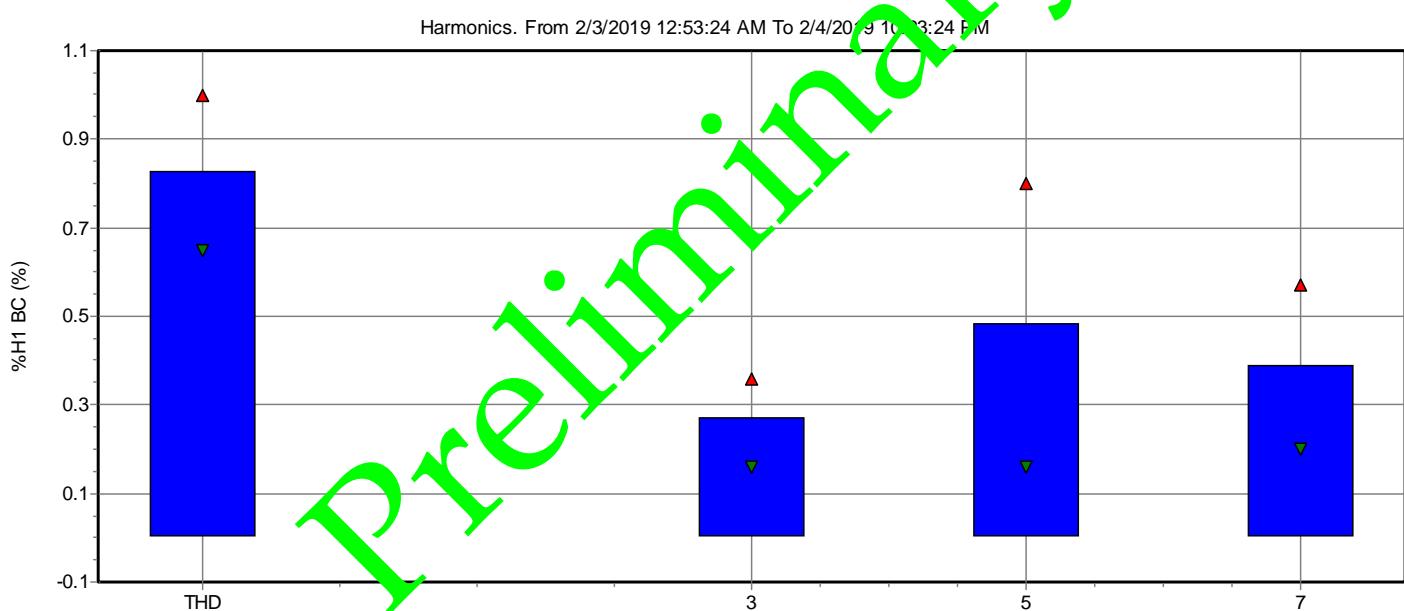
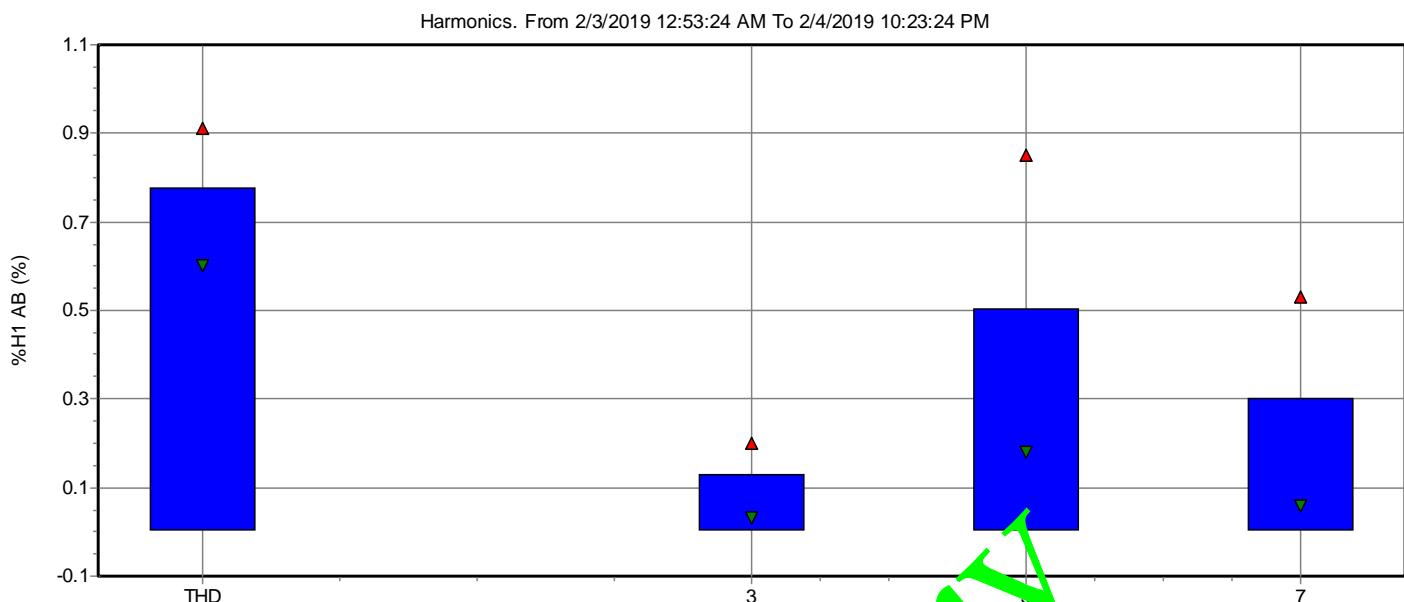
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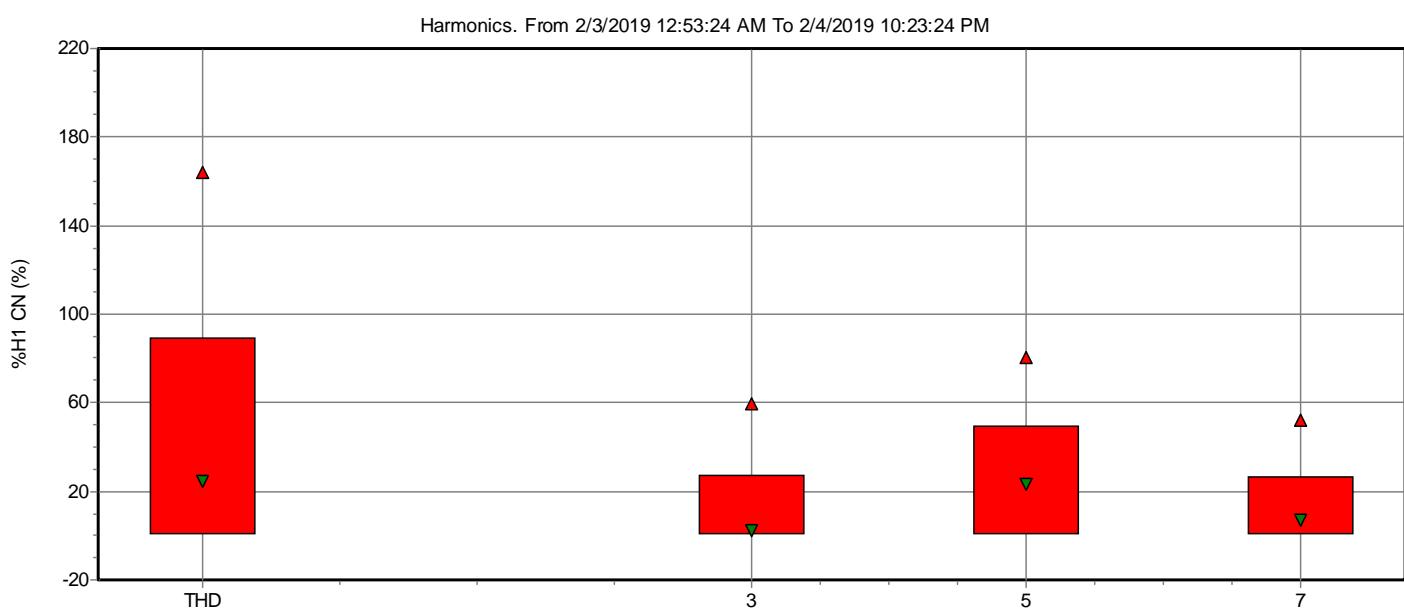
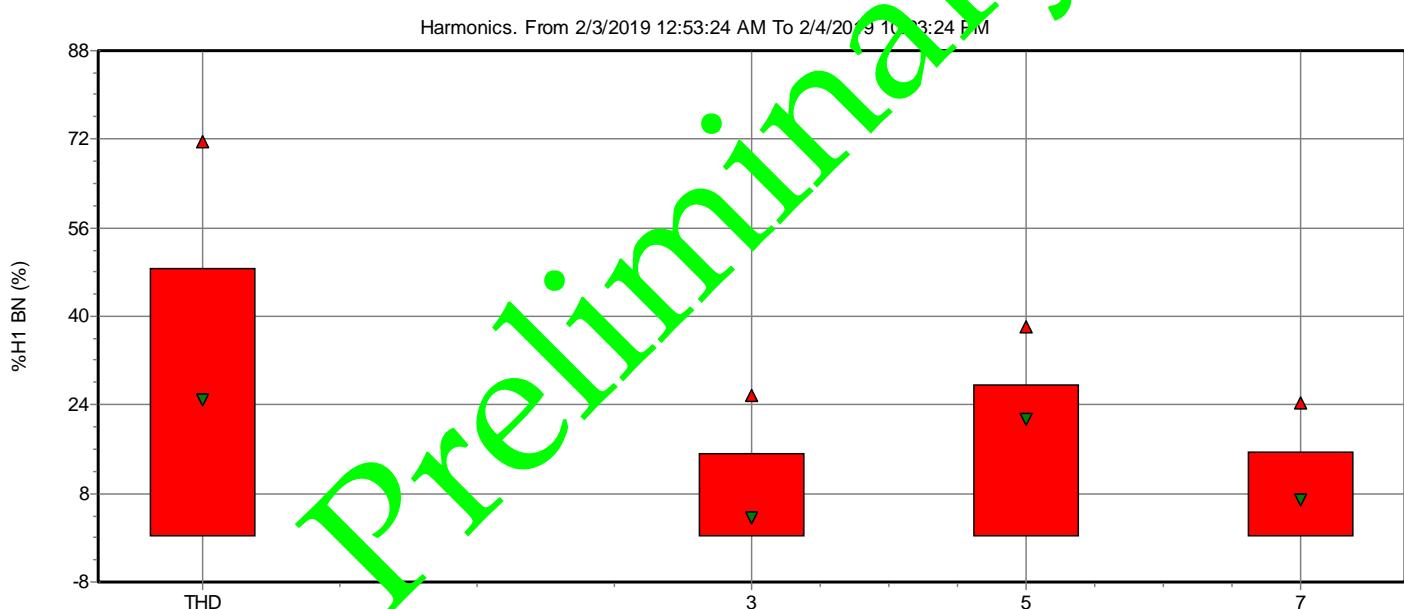
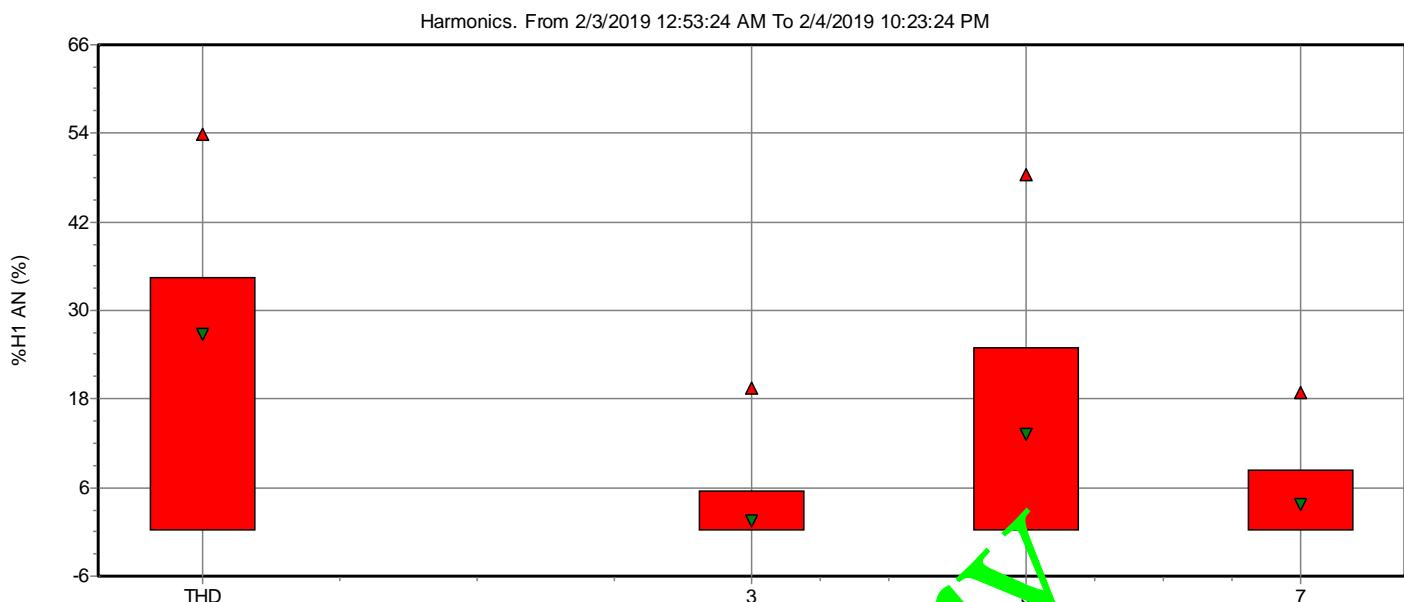
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Swells	0
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Interruptions	0
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Waveforms	0
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Wave events	0
RMS events	0

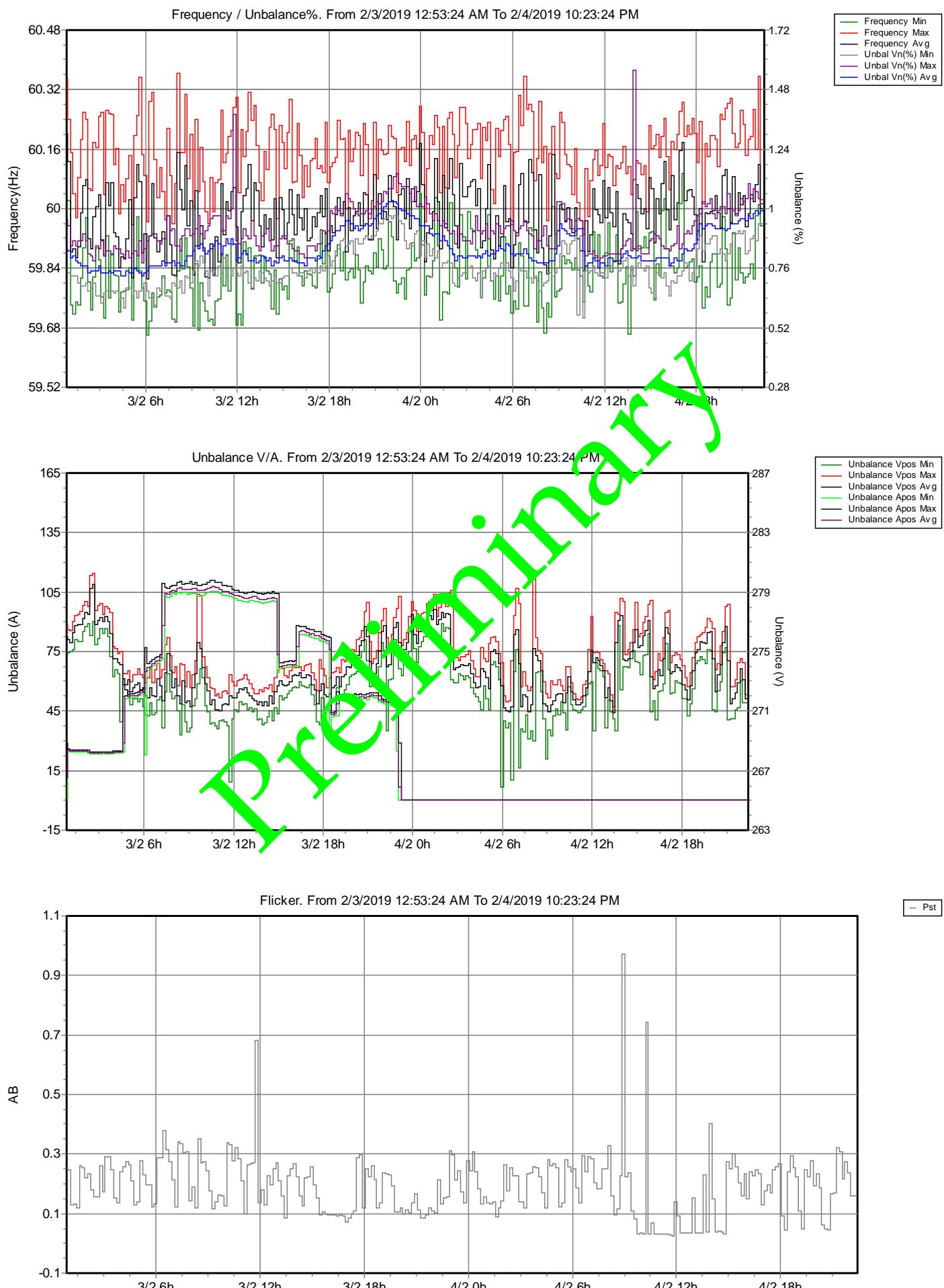
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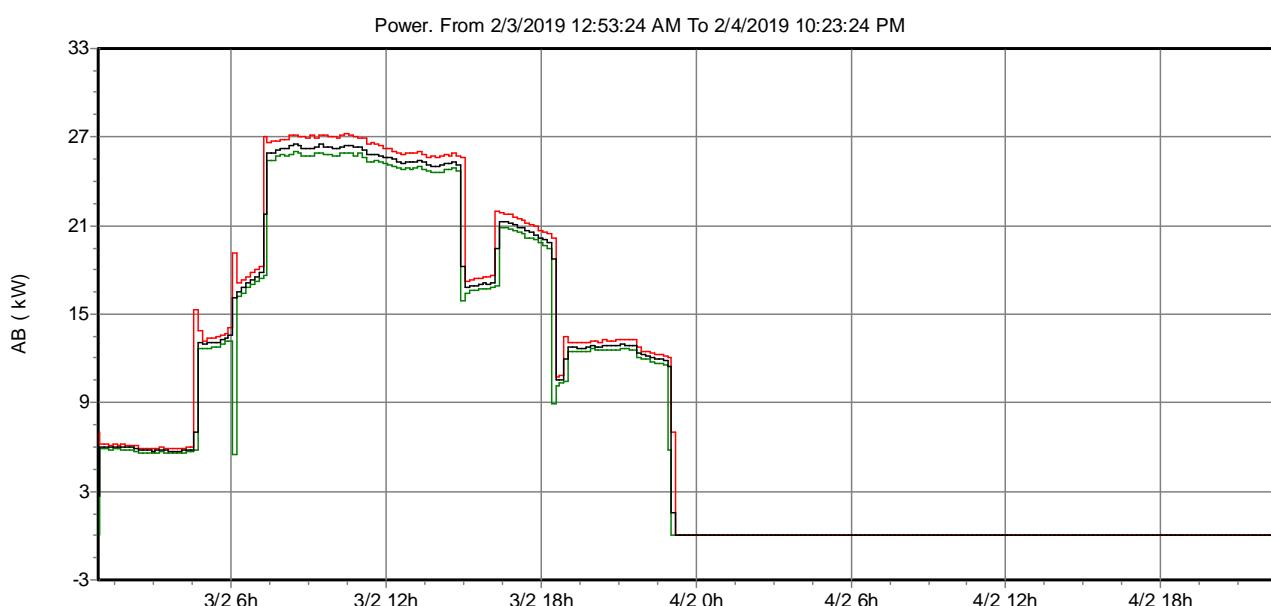
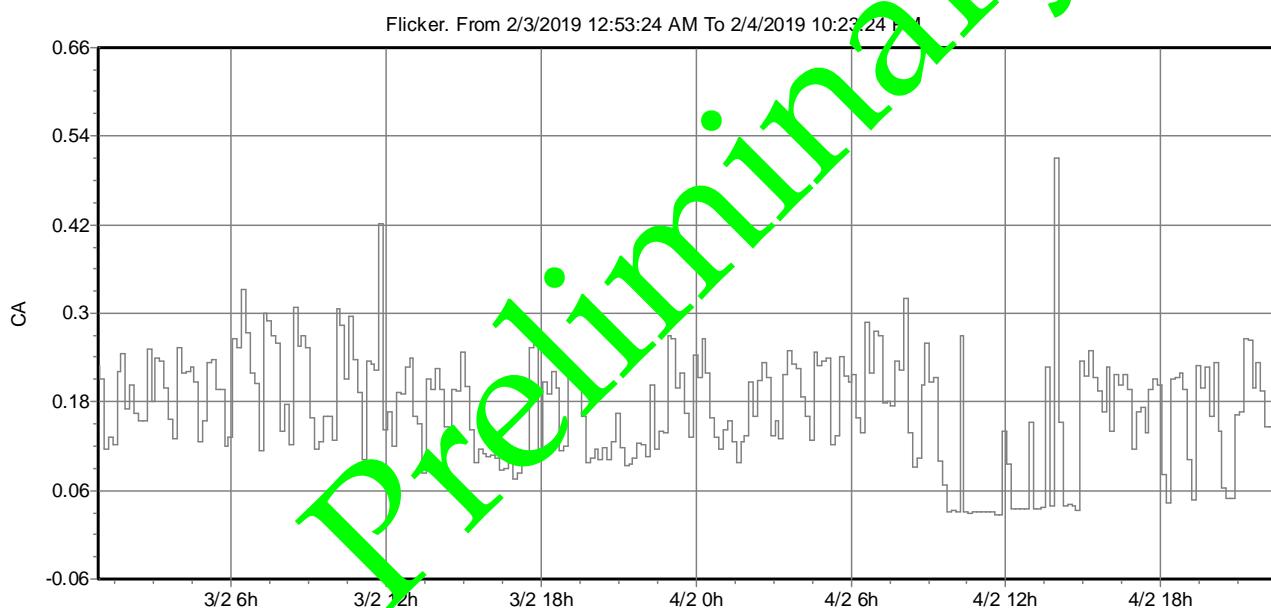
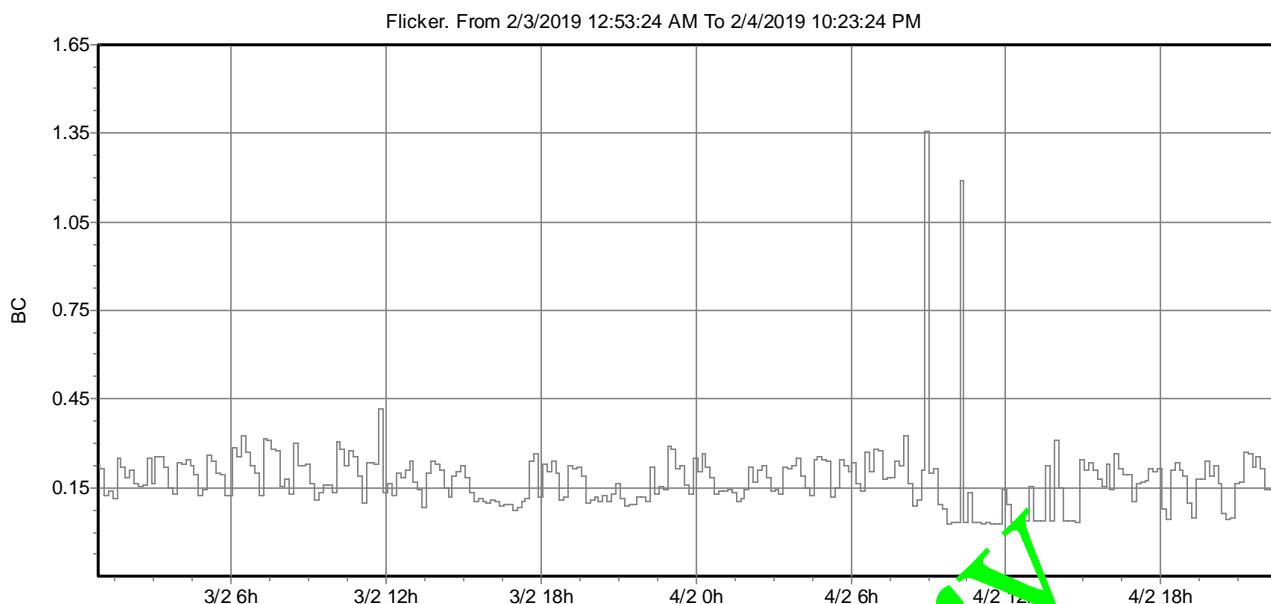


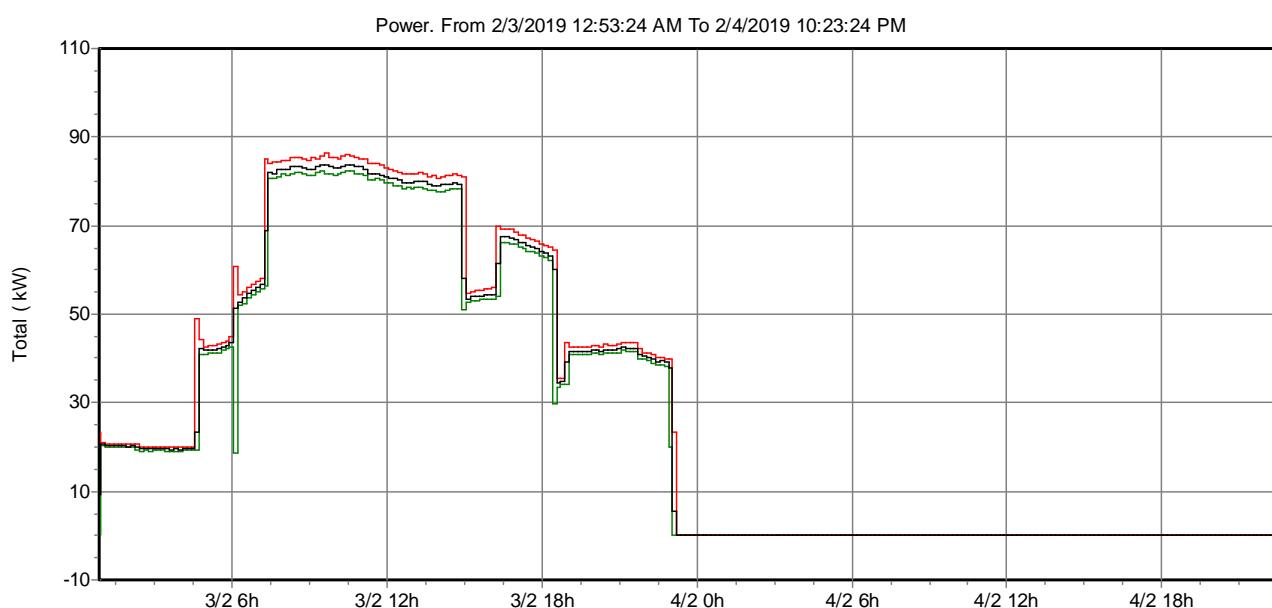
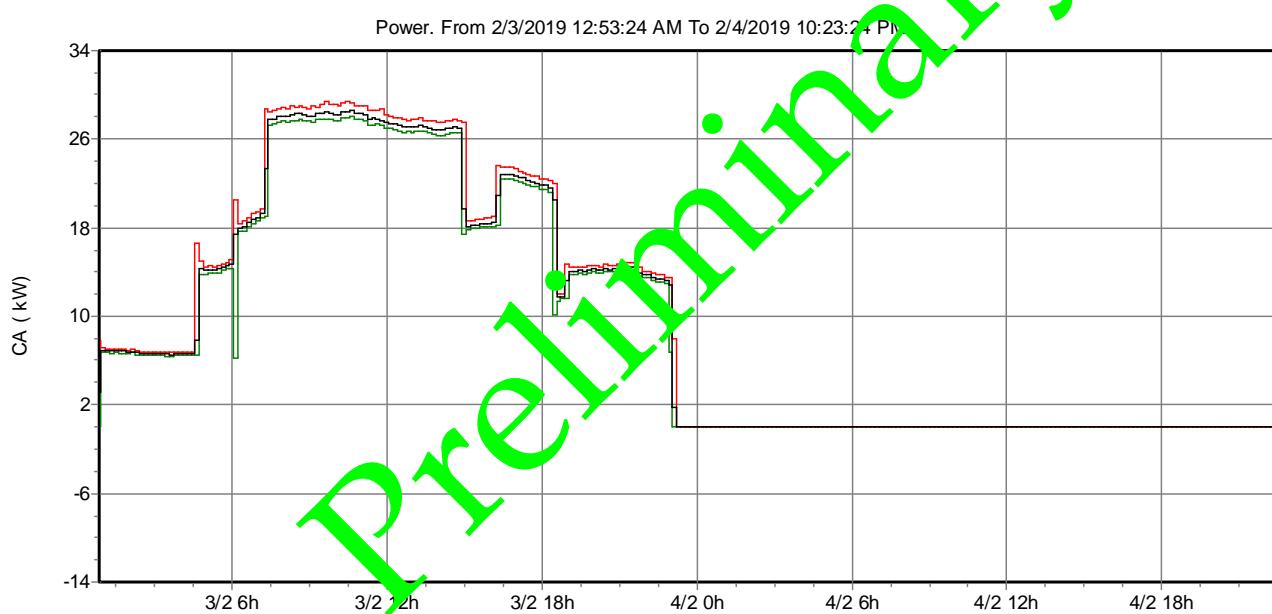
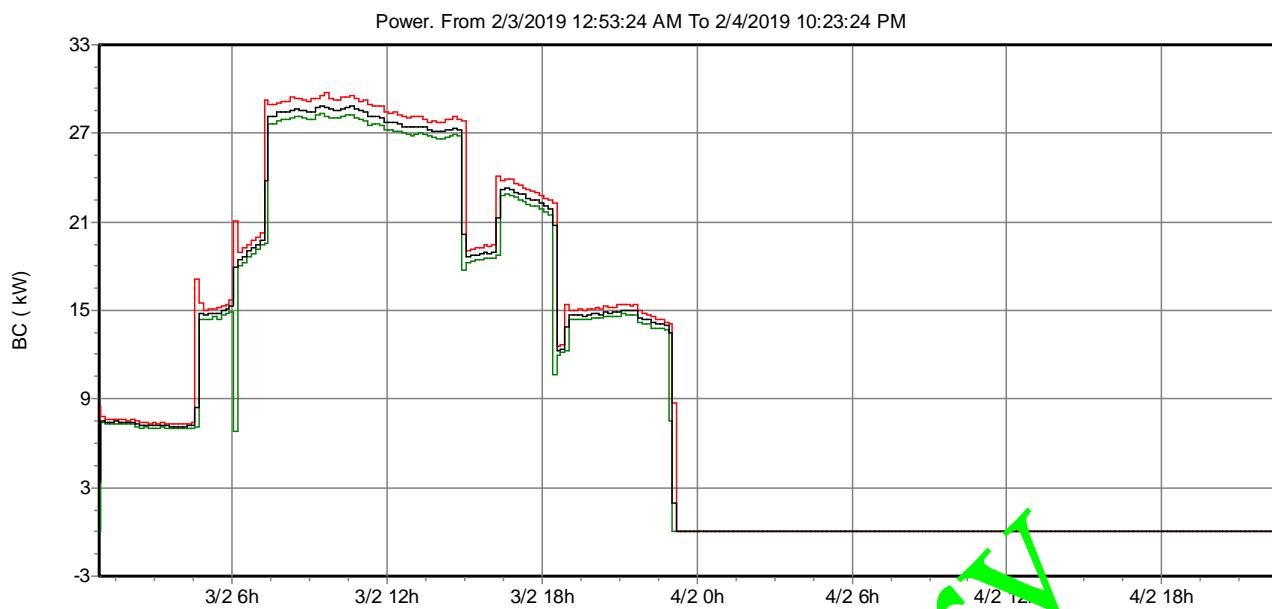


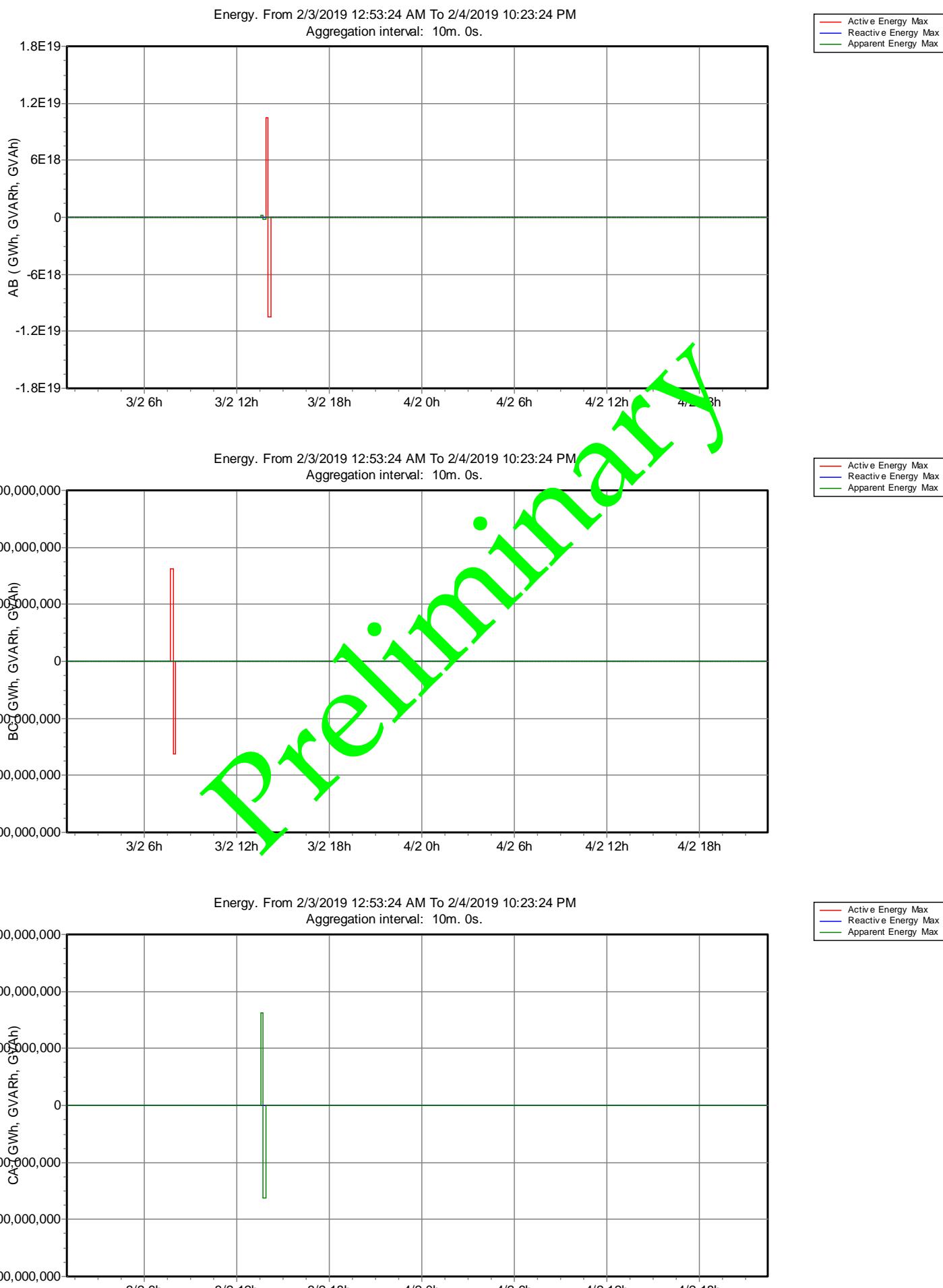


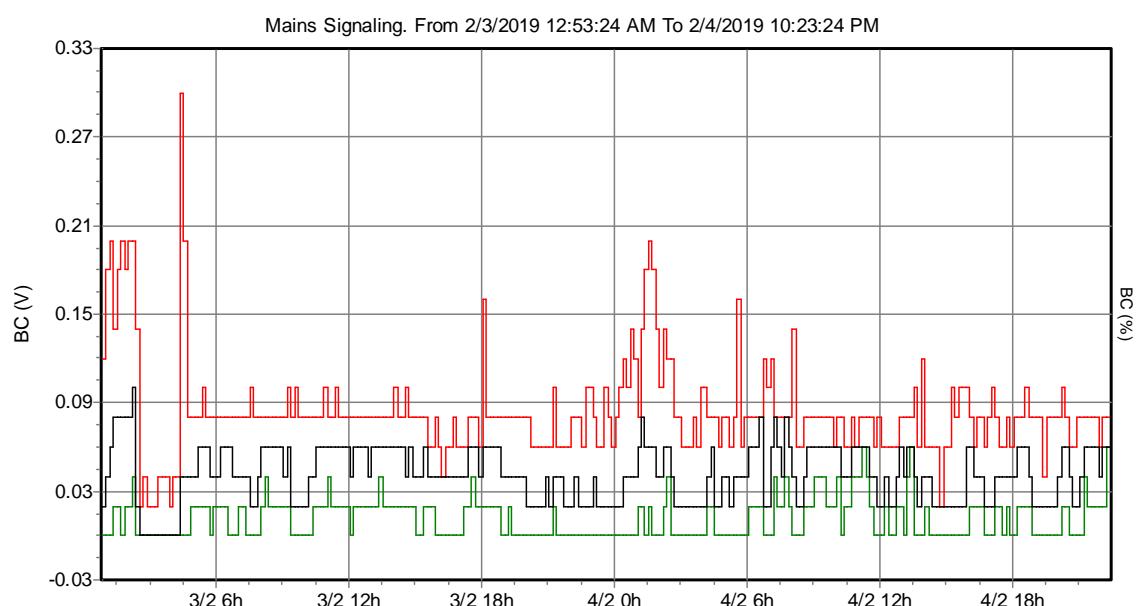
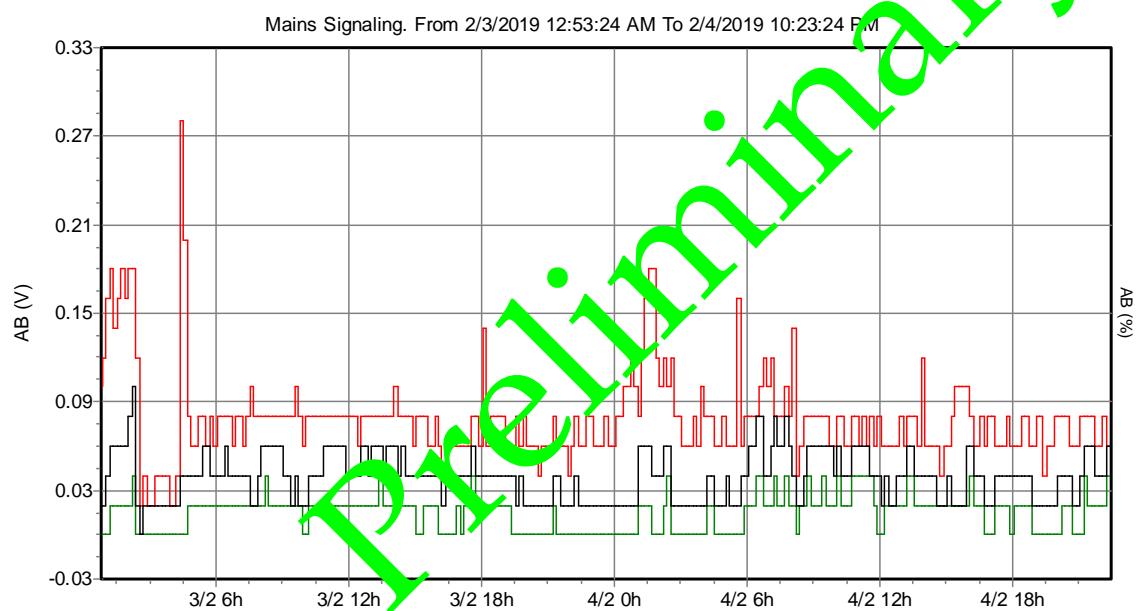
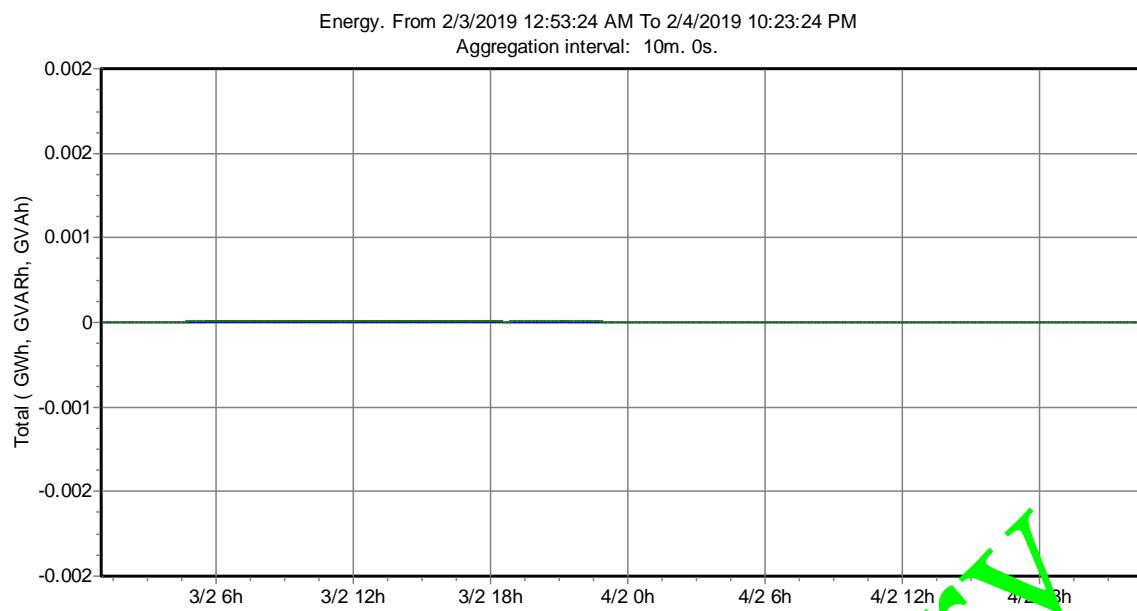


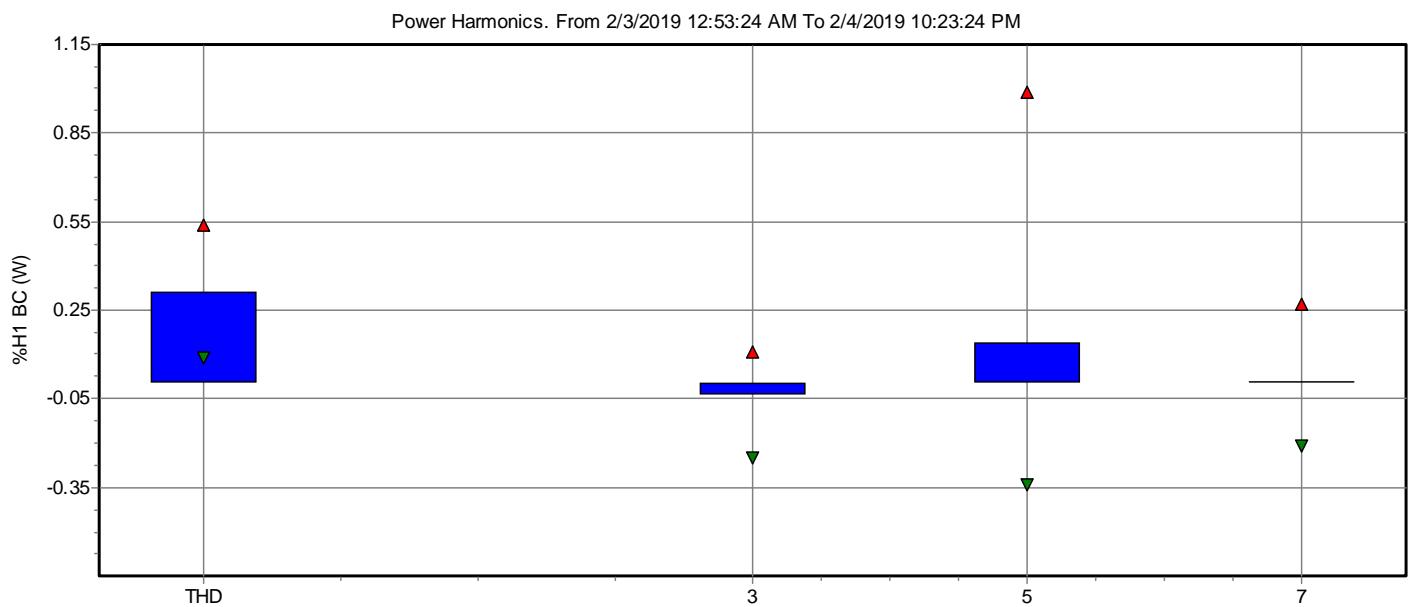
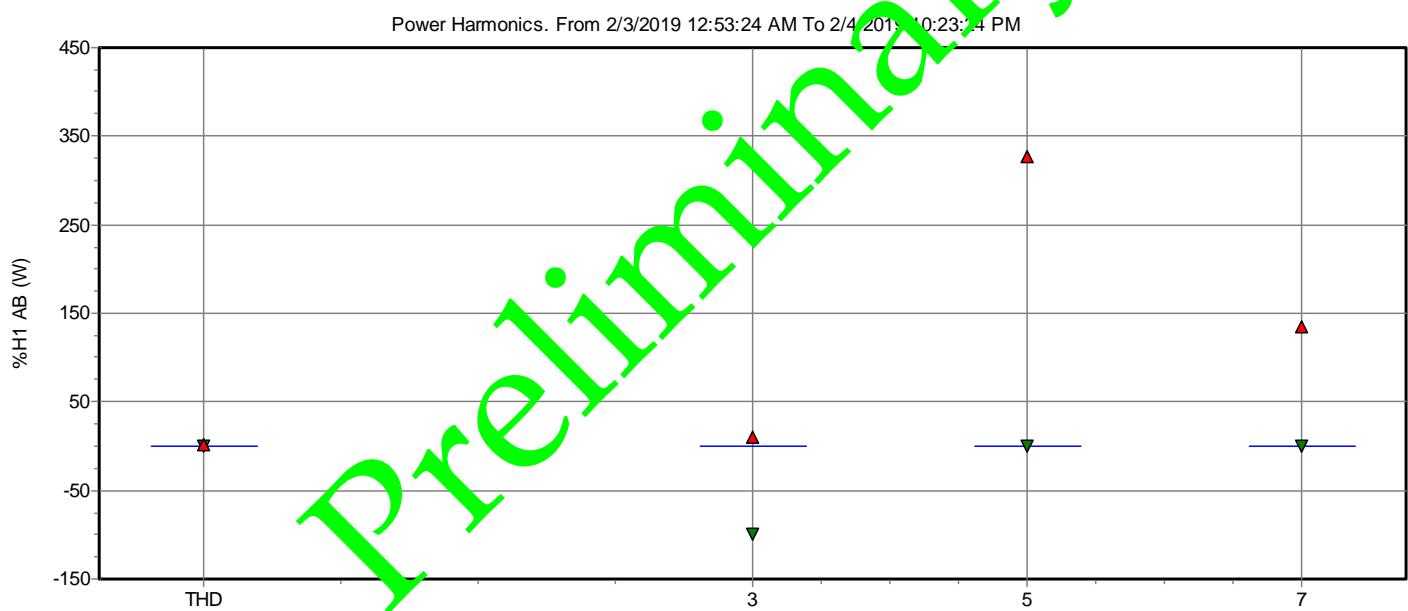
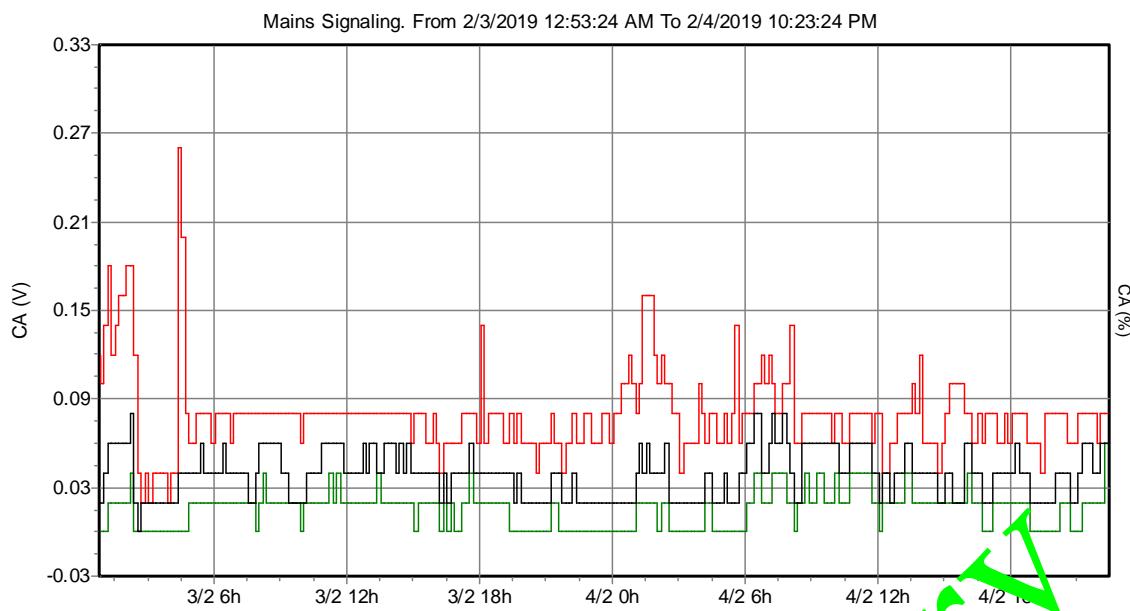


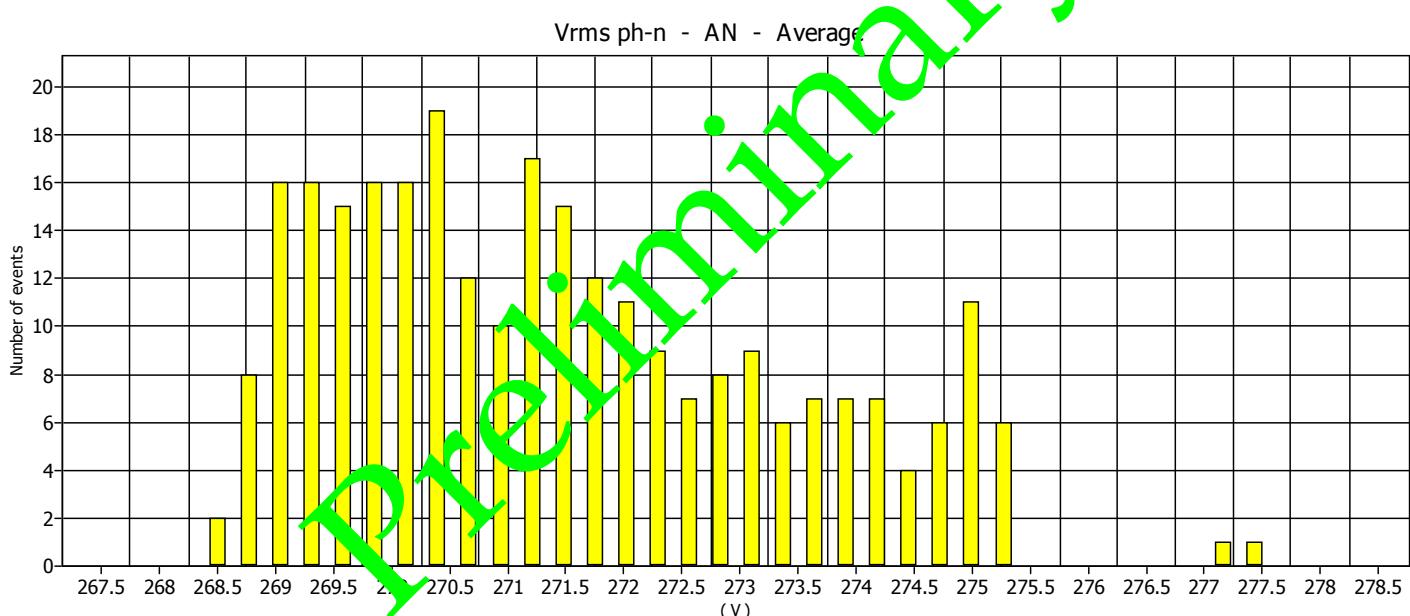
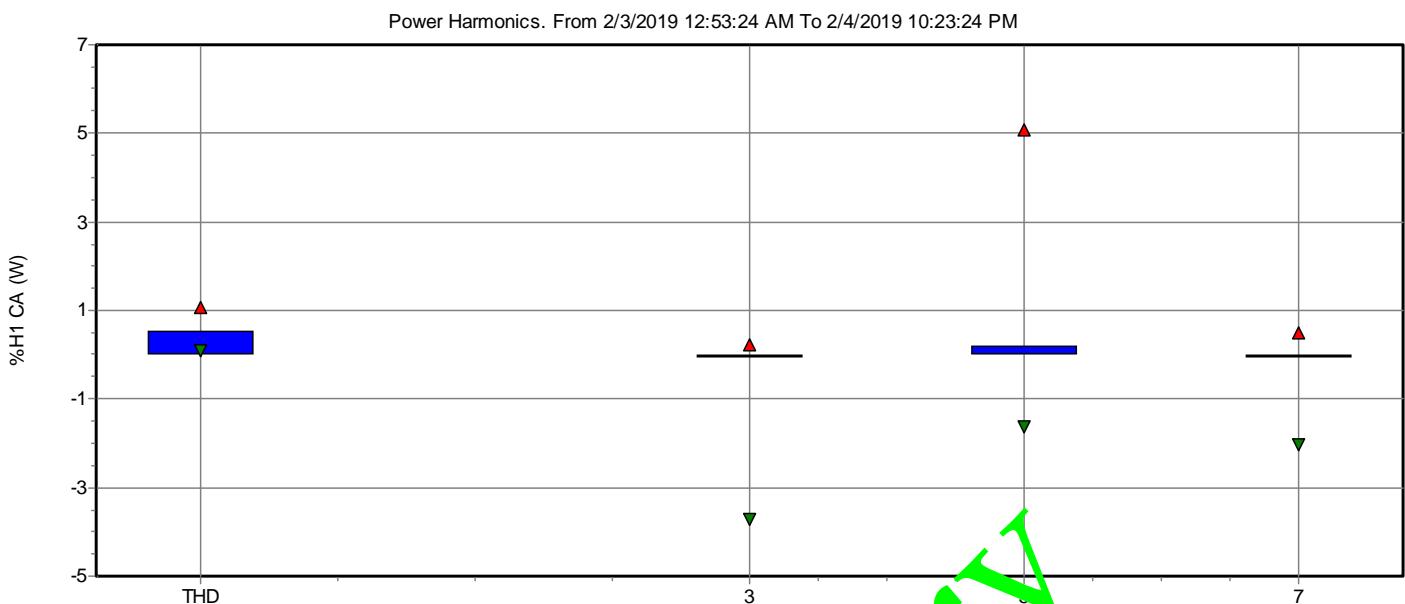










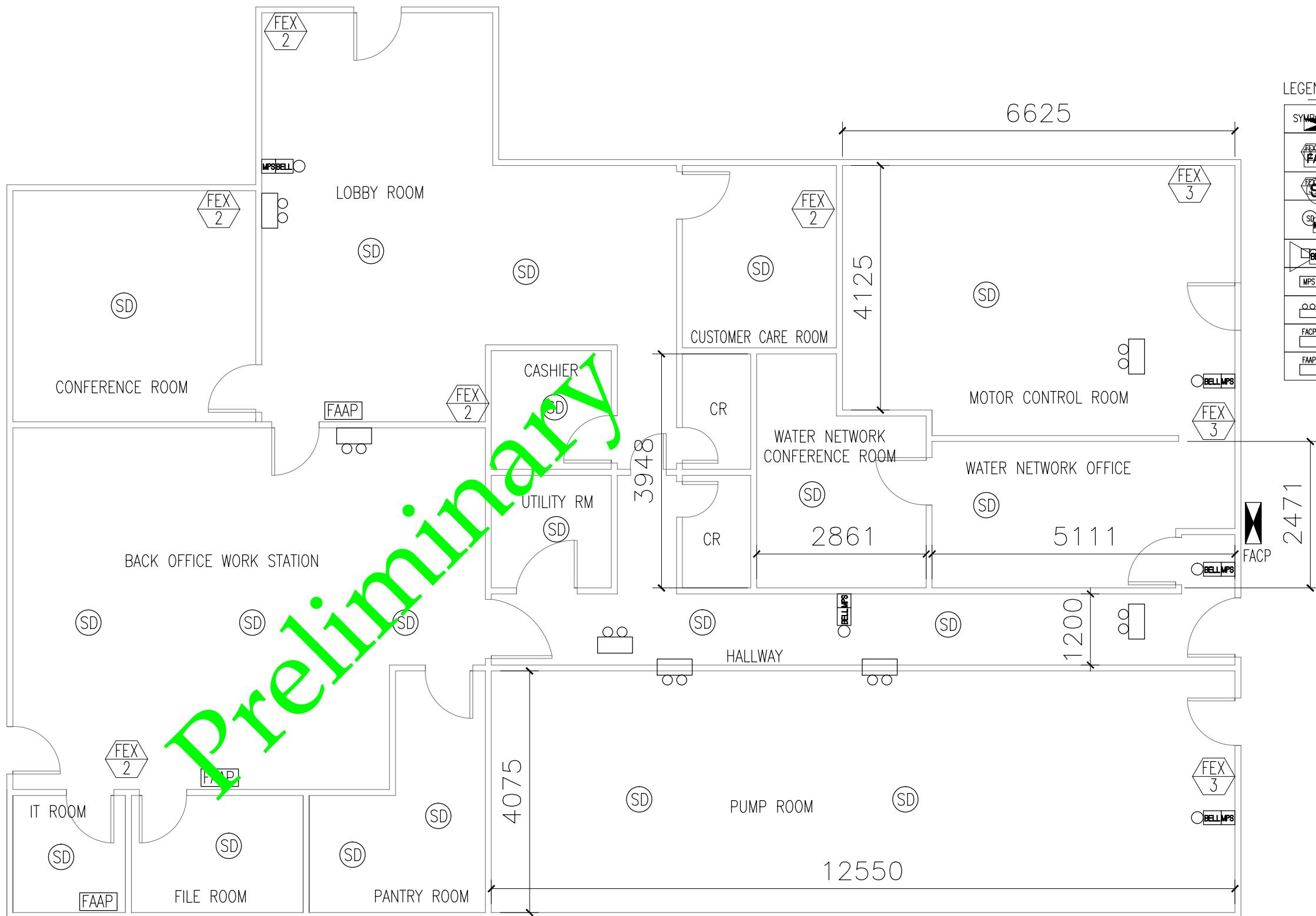


Preliminary

Appendix D

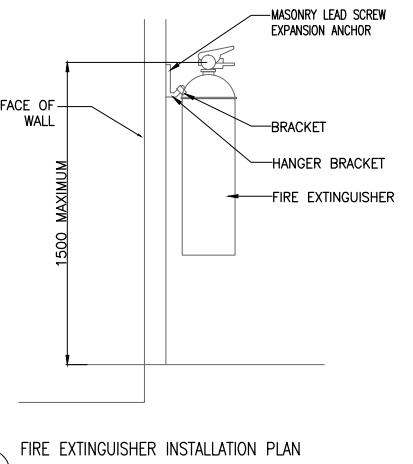
Drawings

Preliminary



LEGEND: LE

SYMBOL	QTY	DESCRIPTION
FEX	5 UNITS	FIRE EXTINGUISHER (RED)
FAAP	3 UNITS	MULTI-PURPOSE DRY CHEMICAL W/ 2A MIN. FIRE ALARM (RED)
SD	20 UNITS	CLEAN EXTINGUISHER AGENT SMOKE
SD MPS	4 UNITS	SMOKE DETECTOR BATTERY MANUAL
BELL	4 UNITS	ALARM BELL 6" DIAMETER, 220V
MPS	4 UNITS	MANUAL PULL STATION
OO	7 UNITS	EMERGENCY LIGHT
FACP	1 UNIT	FIRE ALARM CONTROL SYSTEM
FAAP	3 UNIT	FIRE ALARM ANNUNCIATOR PANEL



Maynilad	Maynilad		
CONFORME:	CONFORME:		
HEAD, Division (End User)	HEAD, Department (End User)		
DRAWN	SURVEYED	DESIGNED	CHECKED
REVISION			
REV	DATE	BY	APPROVED BY

1
EE-01

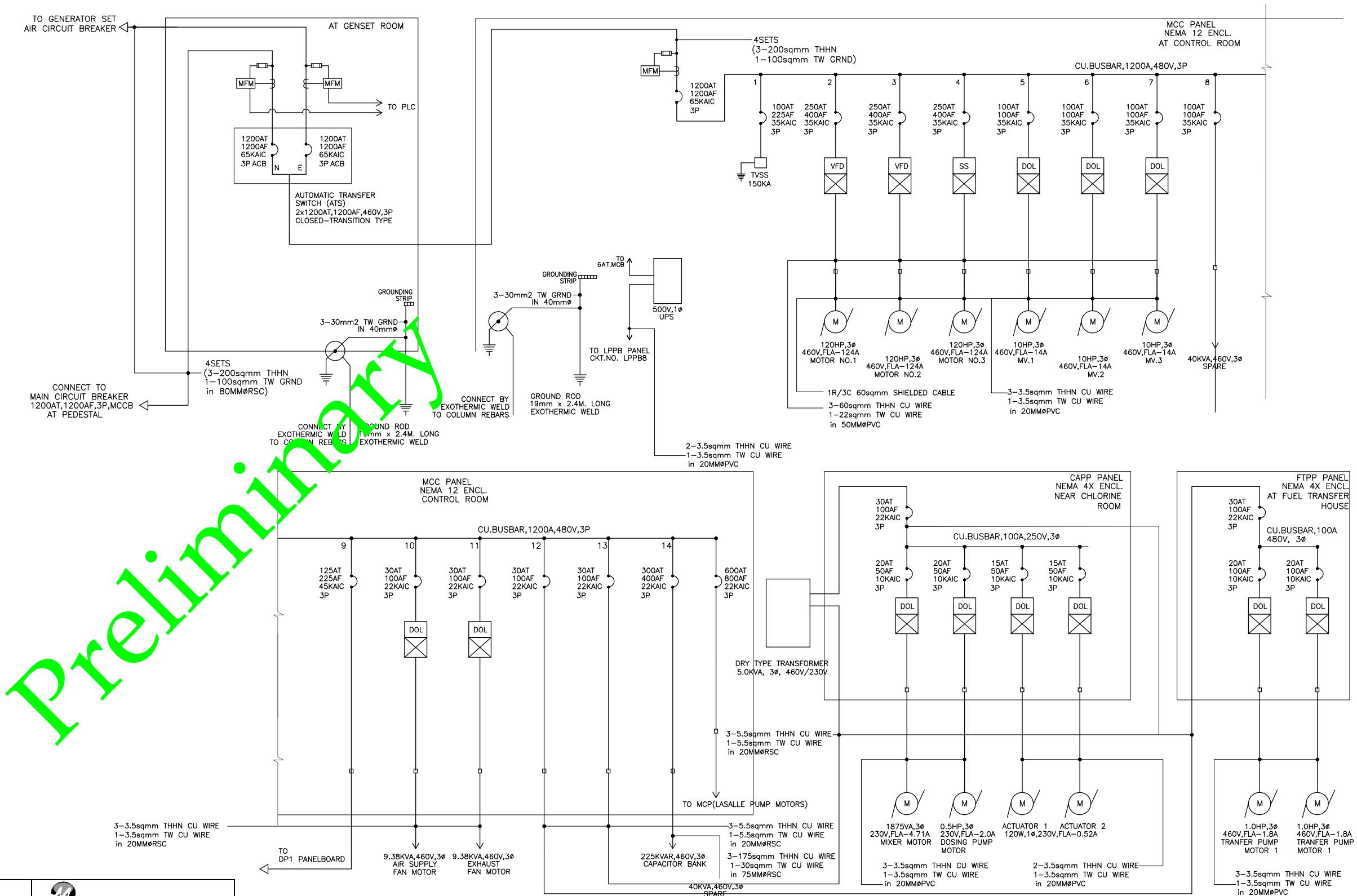
(FDAS, FEX, AND EL LOCATION PLAN)

Checked & Certified :
GHD 11/F Alphaland Southgate Tower 2258 Chino Roces Ave corner
 ENGR. MARITES R. PANGILINAN
 Professional Electrical Engineer
 EDSA Makati City 1232 Philippines
 T 63 2 479 5600 F 63 2 479 5601
 E mnlmail@ghd.com W www.ghd.com

**ALTERNATIVE POWER
SOLUTIONS, INC.**
 124 UBRADA AVELINO STREET PANDACAN MANILA
 TEL (65) 420201 TEL (65) 420202

AS-BUILT DRAWING

PROJECT TITLE:	CONSULTANCY SERVICES FOR THE ENGINEERING, PROCUREMENT AND CONSTRUCTION MANAGEMENT FOR THE LA MESA TREATMENT PLANT 2 PROCESS IMPROVEMENT WORKS		
LOCATION:	MAYNILAD, AYALA ALABANG R1		
SHEET CONTENT:	FDAS, FEX, AND EL LOCATION PLAN		
SCALE:	CONTRACT NO. OP18REFCS03-RIP-EE01-FDAS	SHEET NO. 01 OF 01	REV. 00
Approved :	DESIGN UNIT	ENGR. MARITES R. PANGILINAN	VP-OPERATIONS
PROFESSION : PTR :			
REGISTRATION NO. : DATE ISSUED :			
TIN : PLACE ISSUED :	Project Manager	DESIGN SECTION	



1
EE-02
SINGLE LINE DIAGRAM

Maynilad	Maynilad		
CONFORME:	CONFORME:		
HEAD, Division (End User)	HEAD, Department (End User)		
DRAWN	SURVEYED		
DESIGNED	CHECKED		
REVISION			
REV	DATE	BY	APPROVED BY

Checked & Certified :
ENGR. MARITES R. PANGILINAN
Professional Electrical Engineer

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1401 LIBRAZIA AVENUE STREET, PANDACON, MANILA
TEL. 63 2 479 5601

AS-BUILT DRAWING

PROJECT TITLE: CONSULTANCY SERVICES FOR THE ENGINEERING, PROCUREMENT AND CONSTRUCTION MANAGEMENT FOR THE LA MESA TREATMENT PLANT 2 PROCESS IMPROVEMENT WORKS

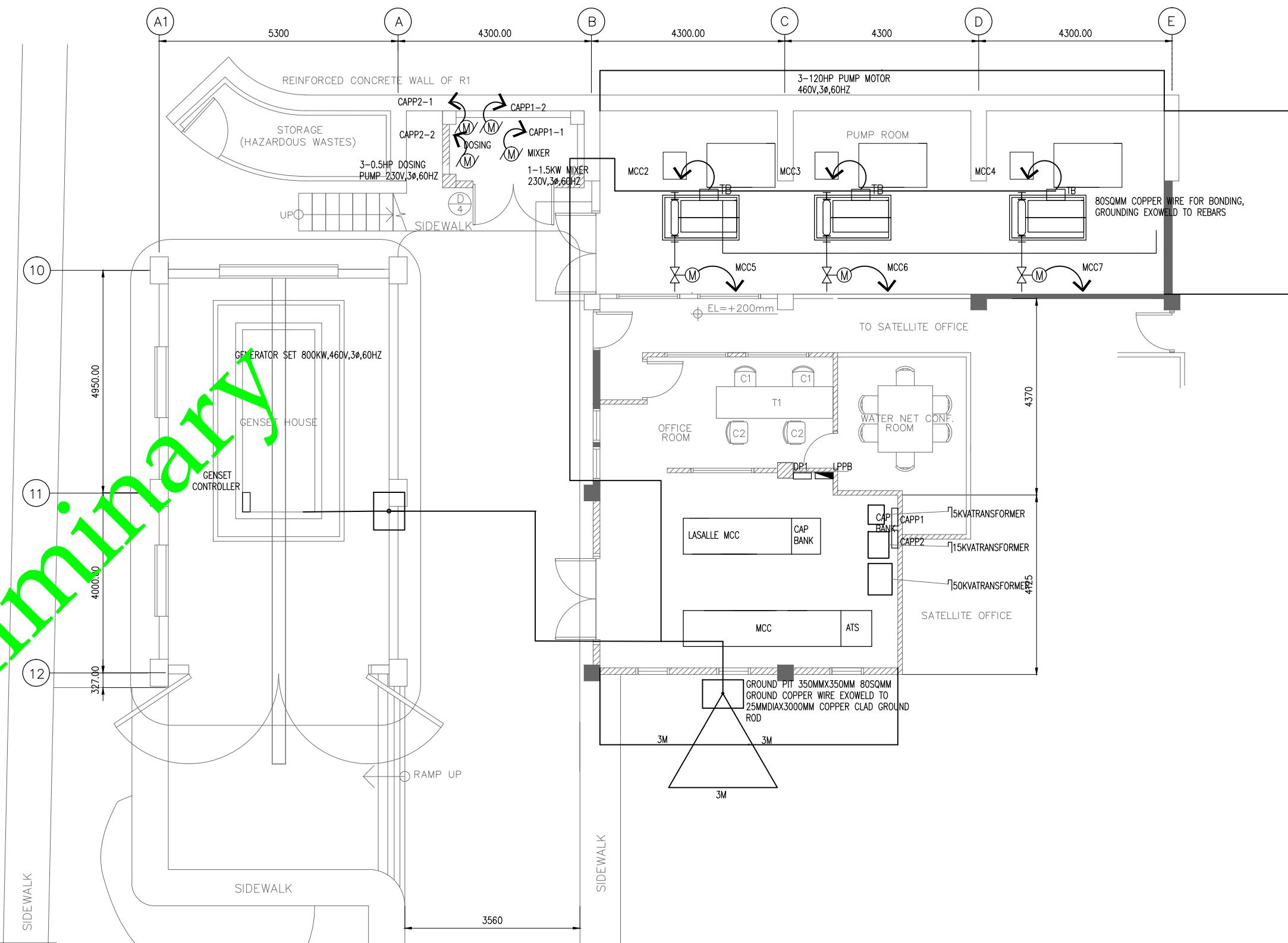
PROFESSION : PTR :
REGISTRATION NO. : DATE ISSUED :
TIN : PLACE ISSUED :

Approved :
Project Manager

DESIGN UNIT
ENGR. MARITES R. PANGILINAN
DESIGN SECTION
VP-OPERATIONS

LOCATION: MAYNILAD, AYALA ALABANG R1
SHEET CONTENT: RESERVOIR 1 PUMPING STATION POWER SYSTEM LINE DIAGRAM
SCALE: CONTRACT NO. OP18REFCS03-RIP-EE02-SD SHEET NO. 01 OF 01 REV. 00

Preliminary



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CONFORME:	CONFORME:		
HEAD, Division (End User)	HEAD, Department (End User)		
DRAWN	SURVEYED		
DESIGNED	CHECKED		
REVISION			
REV	DATE	BY	APPROVED BY

1
EE-01

R1 PUMP STATION GROUNDING LAYOUT

Checked & Certified :
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 Professional Electrical Engineer



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AS-BUILT DRAWING

PROJECT TITLE: CONSULTANCY SERVICES FOR THE ENGINEERING, PROCUREMENT AND CONSTRUCTION MANAGEMENT FOR THE LA MESA TREATMENT PLANT 2 PROCESS IMPROVEMENT WORKS

LOCATION: MAYNILAD, AYALA ALABANG R1

SHEET CONTENT: R1 PUMP STATION GROUNDING LAYOUT

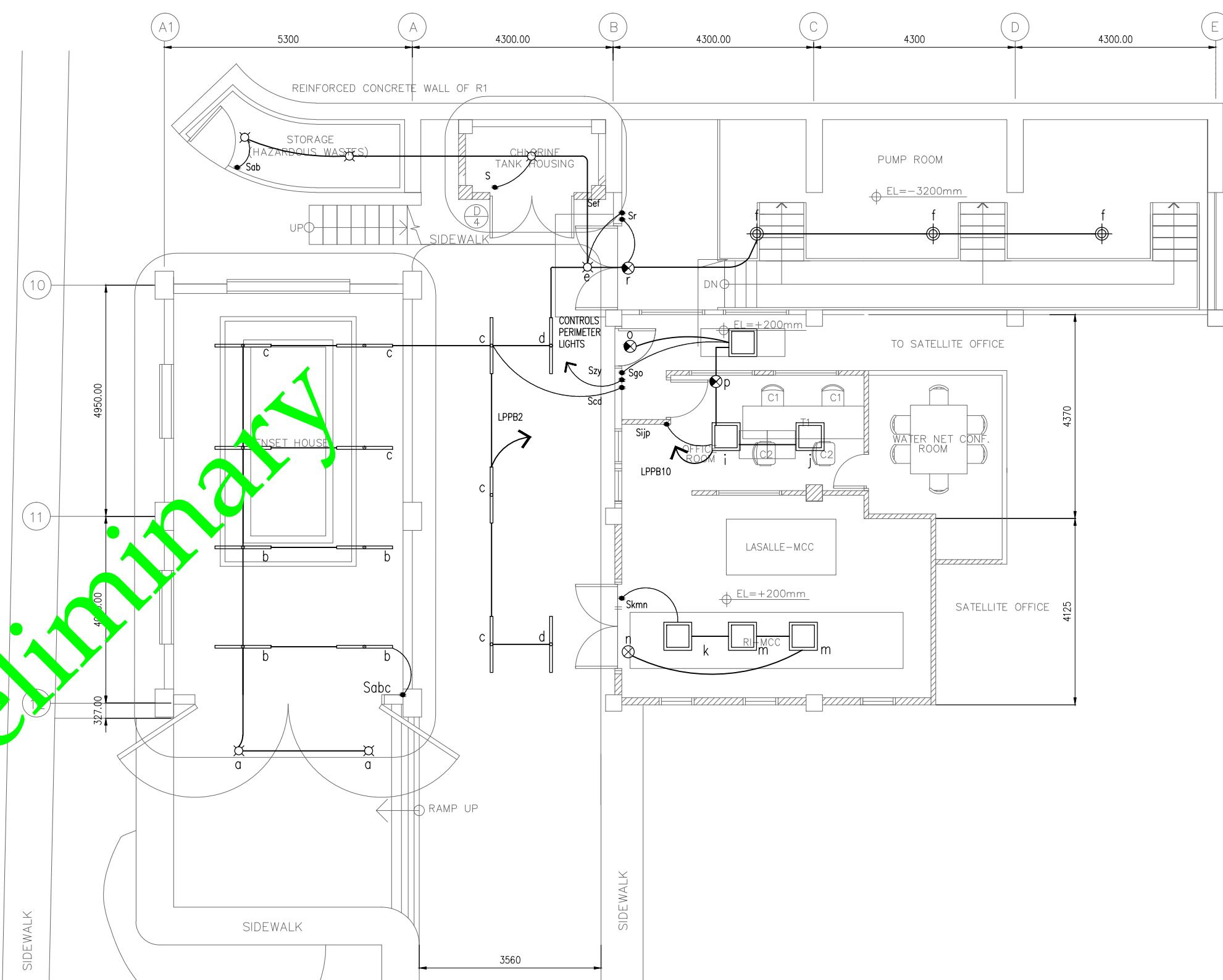
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Approved :

DESIGN UNIT	DESIGN SECTION
ENGR. MARITES R. PANGILINAN	VP-OPERATIONS

Project Manager

Preliminary



Maynilad	Maynilad		
CONFORME:	CONFORME:		
HEAD, Division (End User)	HEAD, Department (End User)		
DRAWN	SURVEYED		
DESIGNED	CHECKED		
REVISION			
REV	DATE	BY	APPROVED BY

1
EE-01

R1 PUMP STATION LIGHTING SYSTEM LAYOUT

Checked & Certified :
ENGR. MARITES R. PANGILINAN
 Professional Electrical Engineer

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 EDSA Makati City 1232 Philippines
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AS-BUILT DRAWING

PROJECT TITLE:	CONSULTANCY SERVICES FOR THE ENGINEERING, PROCUREMENT AND CONSTRUCTION MANAGEMENT FOR THE LA MESA TREATMENT PLANT 2 PROCESS IMPROVEMENT WORKS		
LOCATION:	MAYNILAD, AYALA ALABANG R1		
SHEET CONTENT:	R1 PUMP STATION LIGHTING SYSTEM LAYOUT		
SCALE:	CONTRACT NO.	OP18REFCS03-RIP-EE01-LIGHTING	Sheet No. 01 OF 01