Liberty Grove
Power Quality Report

Prepared for

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Service & Installations Manager

City Electrical Services (Aust) Pty Ltd

1/23 Aylesbury Street, Botany NSW 2019

28 April 2014

by

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1. With regards to the monitoring of the Main Switchboard (MSB) fed from substation No. 1, there are no significant Power Quality (PQ) issues at Liberty Grove.

2. The averaged phase voltages are marginally higher than the nominal 240V. This is not unexpected and within tolerances. Voltage peaks that exceed stated tolerances only marginally exceed tolerances and are infrequent. No recommendations suggested here.

3. The three-phase loads are unbalanced. The maximum load for each phase together with the spare capacity is summarised in the table below.

Parameter	IA	IB	IC
Max (A)	572	608	677
Spare load (A)	628	592	523

Note: MSB is rated at 1200A.

4. To obtain better utilisation of the substation transformer's available capacity it is recommended that loads be brought into balance.

5. Following any further equipment installations, Power Quality monitoring may be necessary to ensure loads are balanced.

Introduction

The MSB rated at 1200A feeds somewhere between 80-100 houses and provides power to the common area (lighting and lifts). Recently, the MSB was upgraded because about one third of the households have installed air-conditioning systems and heaters which caused breakers to trip. The main purpose for monitoring was to monitor loads over a thirty (30) day period and assess the spare load capacity of the upgraded MSB.

The MSB is located near the corner of Settlers Boulevard and Charlton Drive, Liberty Grove (postcode 2138).

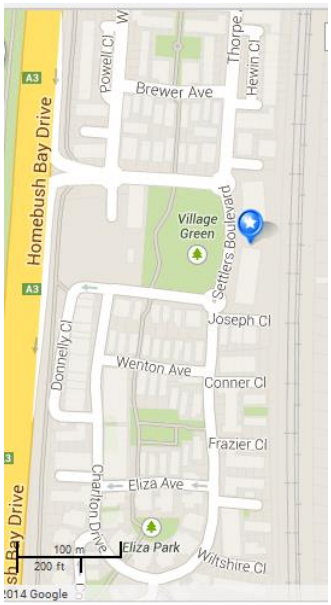

Figure 1: Location of Monitoring Installation

PQ data was recorded using a PowerMonic PM30 Power Quality Analyser leased from TechRentals. The PM30 was installed at the MSB at 8:18 on Thursday 20 March 2014, and was removed at 2:46 on Sunday 20 April 2014; a logging period of 30 days, 18 hours and 27 minutes. A photo of the installation is shown below.

Figure 2: Monitoring Installation

Power quality data was downloaded from the PM30 into the “DUMP01.PMS” file, which was then emailed to CHK GridSense for analysis.

PQ Data Recording

A PM30 (Serial No 04045032) was installed at the MSB. The three phase voltages were monitored using a star connection, with all voltages measured with respect to the neutral. Three (3) 3000 Amp Current Transformers (CTs) were used to monitor the currents. The neutral current was not monitored.

A printout of the configuration is provided in Appendix A.

The log interval was set to 60 seconds, and Root Mean Square (RMS) voltage and current data was recorded at this interval. In addition, Min/Max voltages and currents, Power Factor (True – TPF and Displacement – DPF) and Total harmonic Distortion (THD) were recorded for both voltage and current. Frequency was recorded. No harmonic data was recorded.

This configuration did not record neutral current.

Sag/Swell data (called Table Capture in a PM30) was recorded. These events are triggered from the RMS voltage readings. The upper threshold was set to 254.4V or 106% of the nominal RMS voltage (240V). The lower threshold was set at 225.6V, or 94% of the nominal RMS voltage. These are the standard supply tolerances. No hysteresis was applied.

RMS events provide a snapshot of the mains voltage and current envelopes, and are triggered from the RMS voltage readings via a low pass filter. The output of the filter is nominally 100%, and the trigger thresholds were set at +5% (upper threshold) and -5% (lower threshold).

Waveform events were recorded using the same rolling thresholds as the RMS events.

Waveform events are also triggered by transient events, with the threshold set to 350 V/ms. The maximum slope (at the zero crossing) of a 240 V 50 Hz sine wave is 106 V/ms, so any transient whose rate of change is 3.5 times greater than this will be captured.

PQ Data Analysis

Volt/Amps Data

The Volt/Amp graph shown in Figure 3 below displays the voltage and current data aggregated within the 60 second logging interval. The top graph is voltage and the bottom graph is current.

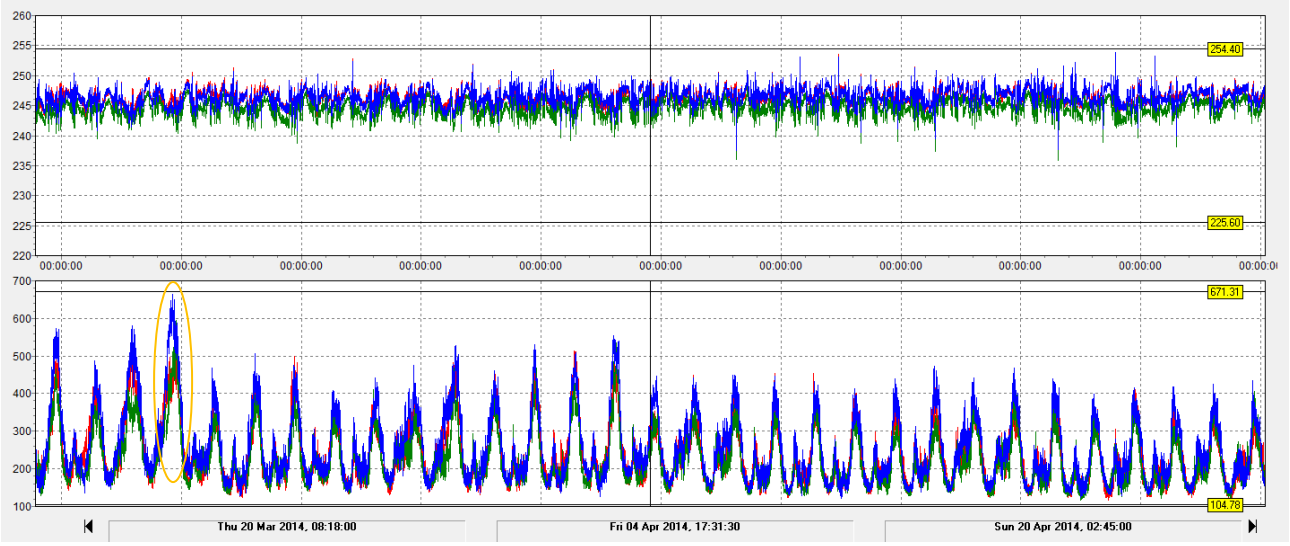

Figure 3: Main Volt/Amps Graph

Voltage Graph

The horizontal cursors on the voltage graph are set to tolerances between 94% and 106% of the nominal voltage. From inspection all three phase voltages appear well balanced and are within the tolerances, although near the upper tolerance.

The table below summarises voltage information.

Parameter	Trace	Min. RMS (V)	Max. RMS (V)	Average RMS (V)
VA	RED	238.02	253.67	246.44
VB	GREEN	235.92	251.47	244.60
VC	BLUE	237.50	253.84	246.43
Vav				245.82

The maximum deviation from the nominal voltage is 253.84V (105.8%) and occurs on phase C.

The three phase voltages averaged over the logging period is 245.82V which is 2.43% above the nominal voltage.

Current Graph

As expected, for each phase the current (load) profile varies considerably throughout the day, and depending upon the day of the week.

On Saturday and Sunday the load profile exhibits a single peak. The minimum load occurs at approximately 5am whilst the maximum load occurs at approximately 6pm with the peak usage occurring on Sunday.

During weekdays the load profile exhibits two peaks, one in the morning at approximately 7:30am and a higher peak at approximately 7:30pm. This is expected for working families.

The current graph is expanded in time to highlight the peaks and troughs during weekends and weekdays and shown in Figure 4 below.

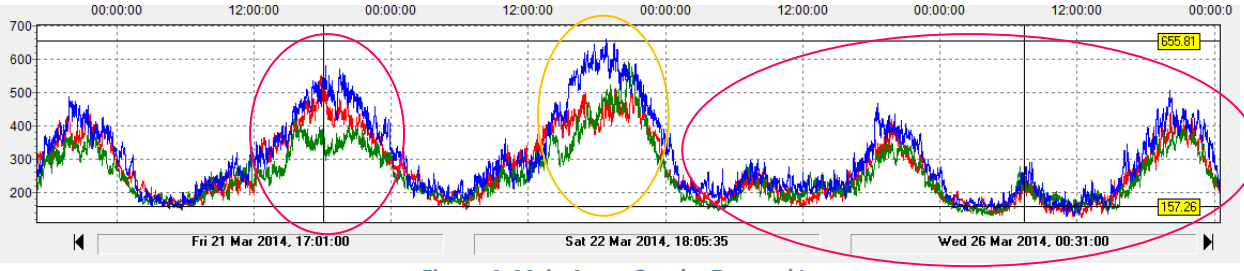

Figure 4: Main Amps Graph - Zoomed In

In Figure 4 the leftmost ellipse shows the peak on Saturday whilst the rightmost ellipse shows the double peaks occurring on Monday and Tuesday.

The three phase loads are not so well balanced. This is normal where there are many single phase loads as found in residential areas.

The table below summarises load information.

Parameter	Trace	Min. RMS (A)	Max. RMS (A)	Average RMS (A)
IA	RED	117.90	550.75	236.08
IB	GREEN	116.90	595.02	222.72
IC	BLUE	122.15	663.40	254.17
Iav				237.66

The load on all three phases averaged over the logging period is approximately 237.66A.

On average, load on phase A is close to the average load (-0.66%), load on phase B is lower than the average load (by approximately 6.28%) and load on phase C is higher than the average load (by approximately 6.95%).

The maximum phase current is approximately 663A and occurs on Sunday 23 March at 6:49pm. This is highlighted by the peaks enclosed within the orange ellipses in Figures 3 and 4. Figure 5 below shows that the hottest day during the logging period occurred on Saturday 22 March (30°C), followed by Sunday 23 March (29°C) and would suggest the highest usage of air-conditioning systems on these days.

The usage on phase C is highest on Sunday and not Saturday. One explanation for this observation is that it is likely that most residents would be indoors Sunday nights and therefore more usage of air-conditioning systems.

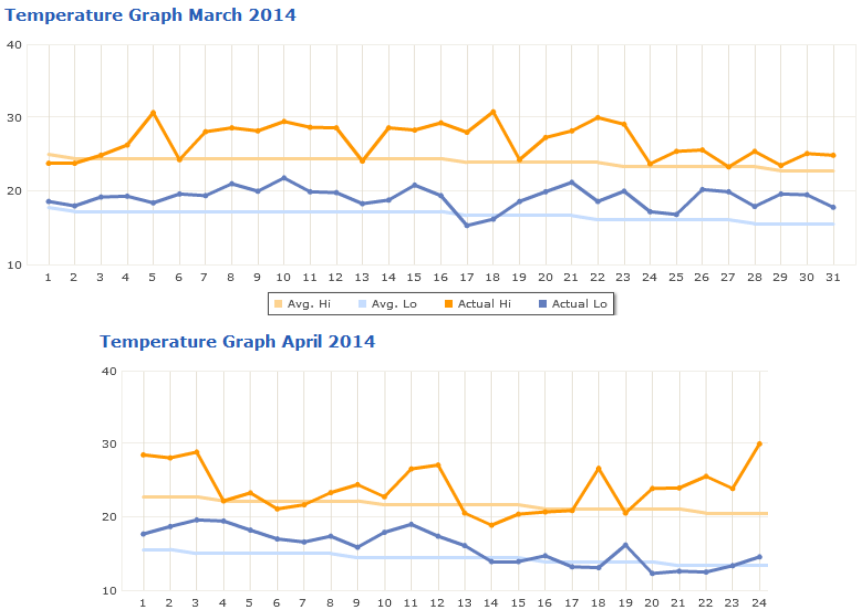

Figure 5: Temperature Graphs for March-April 2014

http://www.accuweather.com/en/au/sydney/22889/month/22889?monyr=3/01/2014

Min/Max Voltage

The Min/Max phase voltage graph in Figure 6 below displays the average, the minimum and maximum values of the aggregated voltage within the 60 second logging interval; nine (9) traces in total, with results summarised in the table below.

Parameter	VA	VB	VC
Average	246.44	244.60	246.43
Min	237.18	234.98	236.46
Max	256.12	253.79	256.25

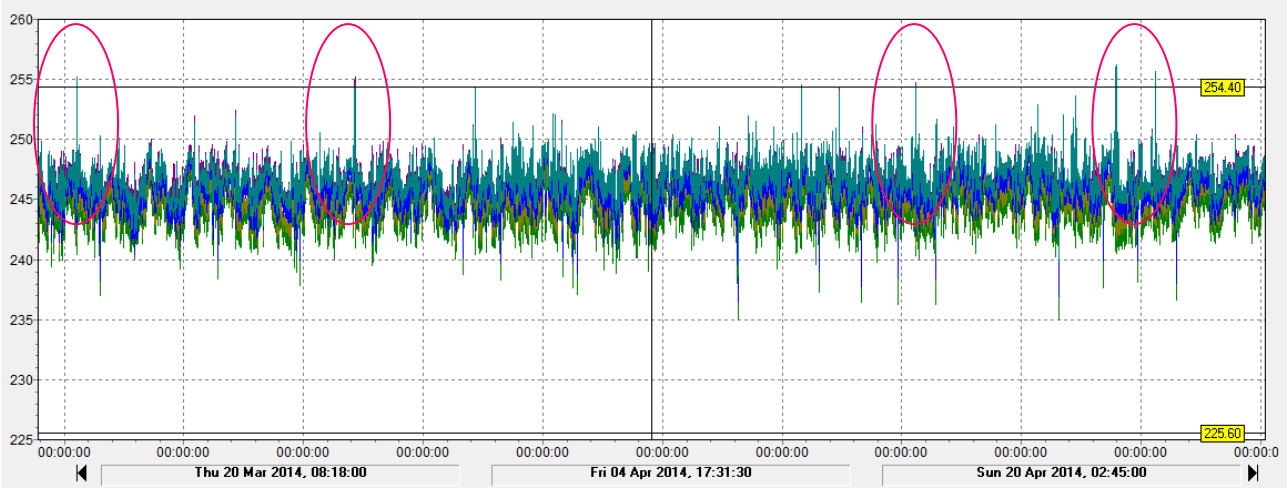

Figure 6: Voltage Min/Max Graph

The horizontal cursors are set to tolerances between 94% and 106% of the nominal voltage. From inspection, all three phase voltages appear well above the lower limit. Voltage spikes on phases A and C only marginally exceed the upper limit cursor with maximum deviations of 6.72% and 6.77% respectively.

Separating the phases into the three graphs in Figures 7, 8 and 9 can provide further insights into identifying the possible causes of the voltage spikes. Each graph displays the maximum values.

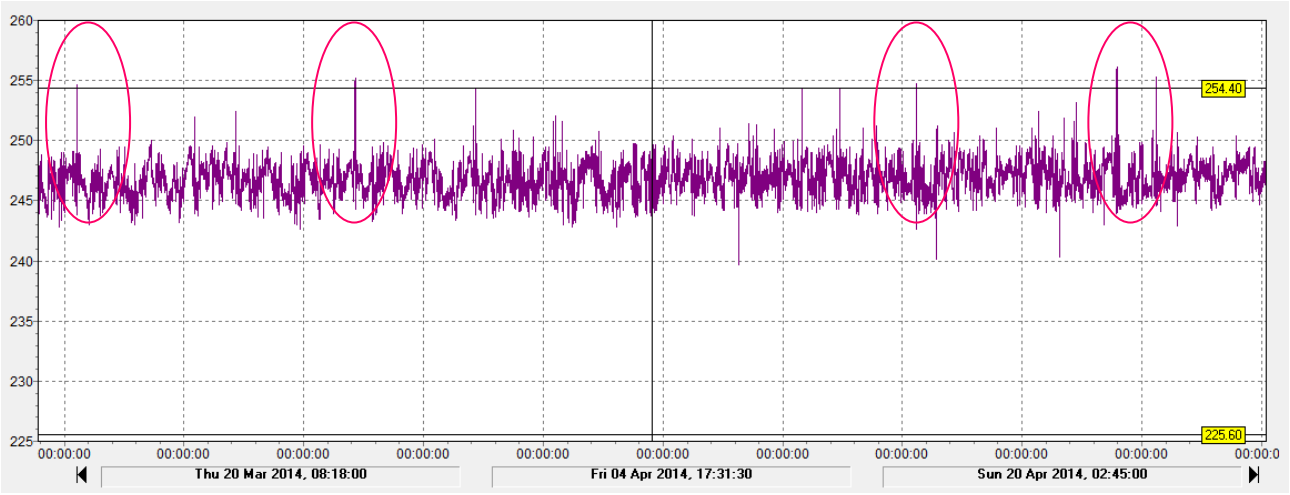

Figure 7: Voltage (phase A) Max Graph

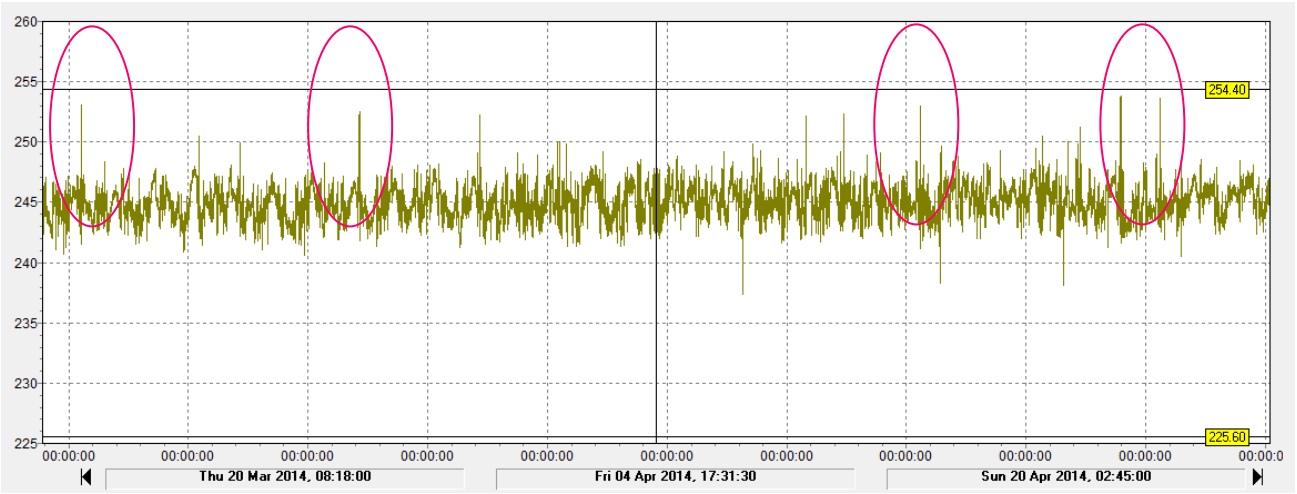

Figure 8: Voltage (phase B) Max Graph

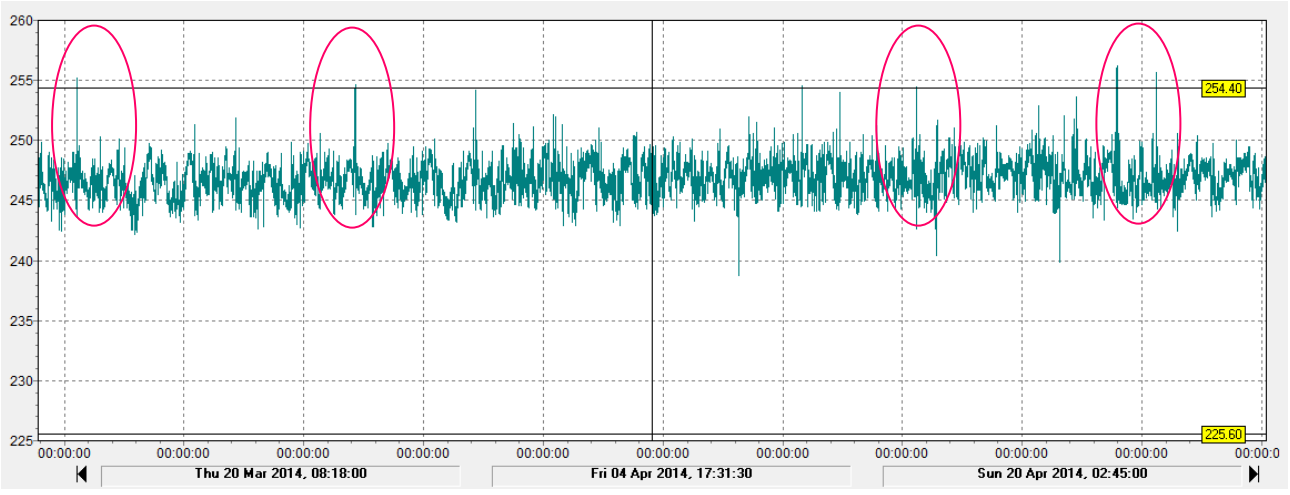

Figure 9: Voltage (phase C) Max Graph

All three maximum voltage traces look similar and spikes enclosed within the ellipses all occur at the same time, with those on phases A and C similar in magnitude. Those on phase B are lower in magnitude.

It is likely that the spikes are caused by simultaneous switching on the supply lines by an external device or switching of three-phase loads.

Min/Max Current

The Min/Max phase current graphs in Figures 10, 11 and 12 below displays the average, the minimum and maximum values of the aggregated current within the 60 second logging interval. Each graph consists of three traces, the average values (in RED), the minimum values (in GREEN) and the maximum values (in BLUE).

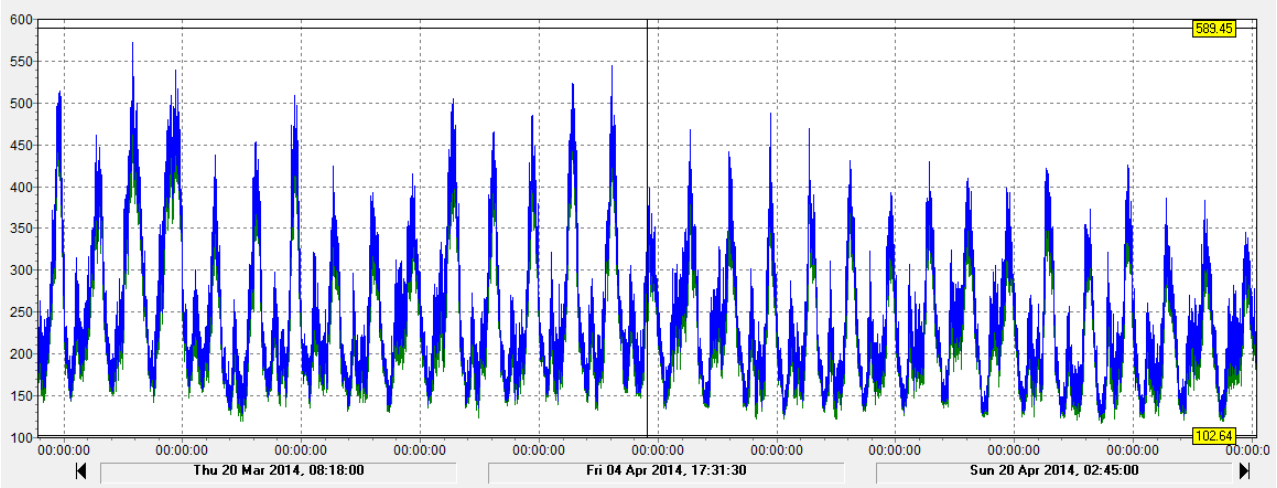

Figure 10: Current (phase A) Min/Max Graph

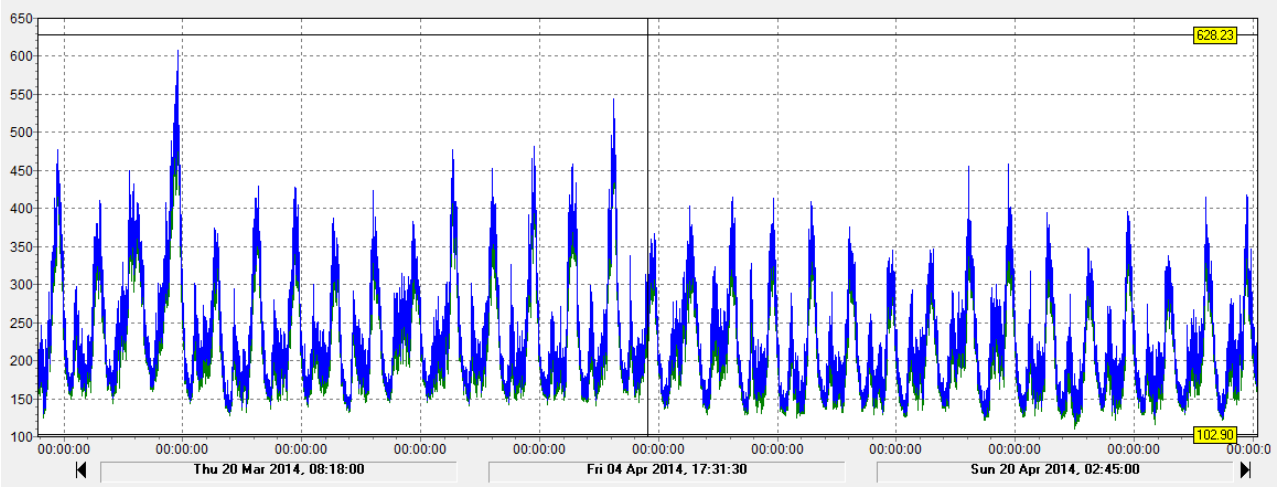

Figure 11: Current (phase B) Min/Max Graph

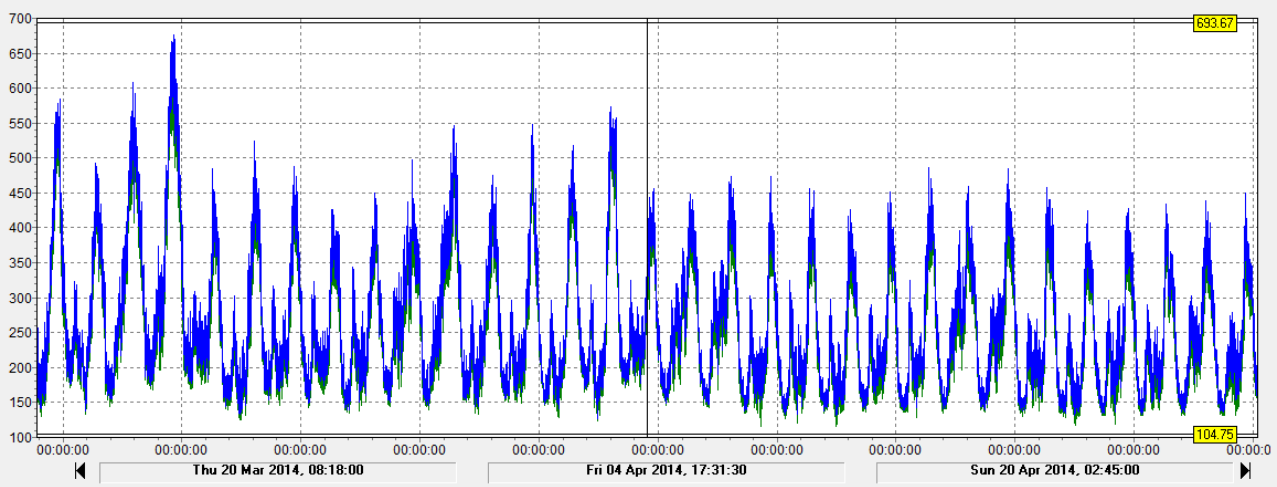

Figure 12: Current (phase C) Min/Max Graph

The table below summarises Min/Max load information.

Parameter	Trace	IA	IB	IC
Average	RED	236.08	222.72	254.17
Min	GREEN	117.19	109.81	115.34
Max	BLUE	572.17	608.21	677.02
Max/Average		2.42	2.73	2.66
Max/Min		4.88	5.54	5.87

The red trace on each of three graphs is swamped by the overlaying minima and maxima traces and therefore not visible.

Each phase is reasonably balanced during times of minimum load. The maximum load on any phase exceeds twice the average load. The load on phase C not only has the highest load but also exhibits the largest load variation with a Max/Min ratio of 5.87. Phase B has the highest variation from its average load with Max/Average of 2.73.

True Power Factor

The True PF graph below displays True Power Factor (TPF) for all three phases, with phase A in RED, phase B in GREEN, and phase C in BLUE.

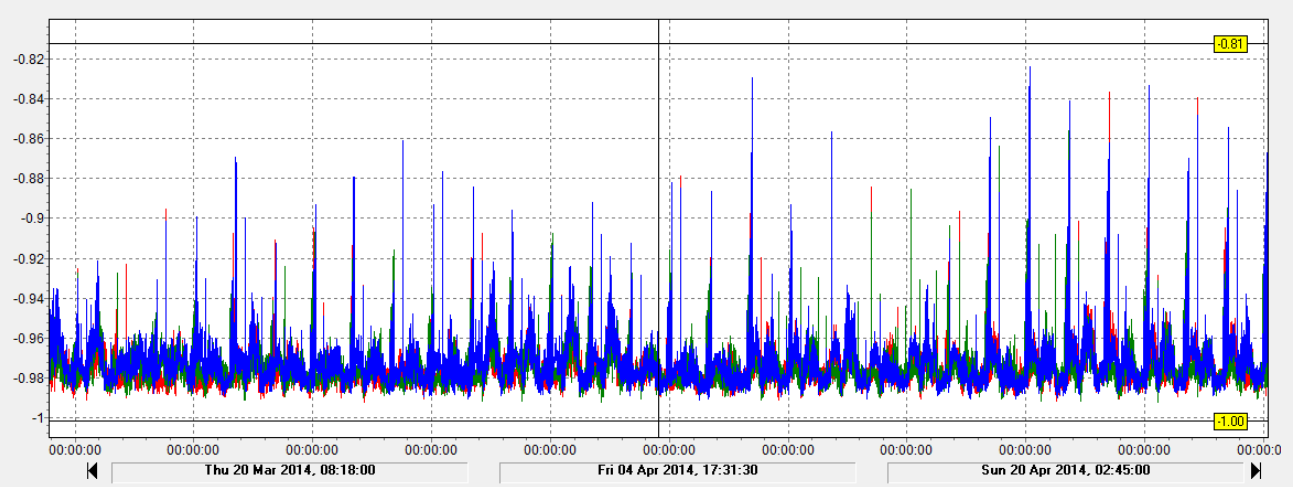

Figure 13: True PF Graph

We note that the TPF readings are negative; they should be positive. This suggests that the CTs were installed in the opposite sense. The magnitudes of the readings are however as expected.

Conclusions and Recommendations

With regards to the monitoring of the Main Switchboard (MSB) fed from substation No. 1, there are no significant power quality issues at Liberty Grove.

The averaged phase voltages are marginally higher than the nominal 240V. This is not unexpected and within tolerances. Voltage peaks that exceed stated tolerances only marginally exceed tolerances and are infrequent. No recommendations suggested here.

The three-phase loads are unbalanced. The maximum load for each phase together with the spare capacity is summarised in the table below.

Parameter	IA	IB	IC
Max (A)	572	608	677
Spare load (A)	628	592	523

Note: MSB is rated at 1200A.

To obtain better utilisation of the substation transformer's available capacity it is recommended that loads be brought into balance.

Increase the average loads on phases A and B to match the average load of phase C. This requires an increase in phase current of approximately 18A (7.12%) for phase A and approximately 31.5A (12.37%) for phase B.

Following any further equipment installations, Power Quality monitoring may be necessary to ensure loads are balanced.

Dr Angelo De Francesco BE (Hons), BSc, PhD
General Manager and Power Quality Consultant
CHK GRIDSENSE PTY LTD

Appendix A – PM30 Configuration

PowerView 4.6.5 **- File Information - DUMP01.PM3**

CHK GridSense

Report prepared by: Angelo De Francesco
Dept.:
Supervisor:

Phone: Fax:
E-mail:

START LOG: Thu 20 Mar 2014, 08:18:00 END LOG: Sun 20 Apr 2014, 02:46:00

LOG NOTES

POWERmonic DETAILS

Serial number: 04045032 Model: PM30 Memory size: 4 MB Version: 3.13

SCALING

Voltage Ratio: 1.00:1 Current Ratio: 1.00:1 Full scale for uncoded CTs (e.g. CK1/CK5): 3000.00 Amps

ACTIVE CONFIGURATION

Not listed as predefined configuration

LOG TYPE	LOG CAPACITY	LOG USED	PERCENT	MEMORY ALLOCATION
Log Data	30 days 18h 28min	30 days 18h 27min	100.0%	2752 KB [Rolling disabled]
Table Capture	4681 events	36	0.8%	64 KB
RMS Capture	34 events	5	12.4%	640 KB
Waveform Capture	34 events	4	9.2%	640 KB

LOG DATA OPTIONS

Log interval:	1 min			
RMS Voltage:	☑ A	☑ B	☑ C	
RMS Current:	☑ A	☑ B	☑ C	☐ Neutral
Min/Max RMS:	☑			
True Power Factor:	☑ A	☑ B	☑ C	
Displacement Power Factor:	☑ A	☑ B	☑ C	
THD Voltage:	☑ A	☑ B	☑ C	
THD Current:	☑ A	☑ B	☑ C	☐ Neutral
Frequency:	☑			

HARMONIC SELECTION:

VA		VB		VC		IA		IB		IC		IN	
01	25	01	25	01	25	01	25	01	25	01	25	01	25
02	26	02	26	02	26	02	26	02	26	02	26	02	26
03	27	03	27	03	27	03	27	03	27	03	27	03	27
04	28	04	28	04	28	04	28	04	28	04	28	04	28
05	29	05	29	05	29	05	29	05	29	05	29	05	29
06	30	06	30	06	30	06	30	06	30	06	30	06	30
07	31	07	31	07	31	07	31	07	31	07	31	07	31
08	32	08	32	08	32	08	32	08	32	08	32	08	32
09	33	09	33	09	33	09	33	09	33	09	33	09	33
10	34	10	34	10	34	10	34	10	34	10	34	10	34
11	35	11	35	11	35	11	35	11	35	11	35	11	35
12	36	12	36	12	36	12	36	12	36	12	36	12	36
13	37	13	37	13	37	13	37	13	37	13	37	13	37
14	38	14	38	14	38	14	38	14	38	14	38	14	38
15	39	15	39	15	39	15	39	15	39	15	39	15	39
16	40	16	40	16	40	16	40	16	40	16	40	16	40
17	41	17	41	17	41	17	41	17	41	17	41	17	41
18	42	18	42	18	42	18	42	18	42	18	42	18	42
19	43	19	43	19	43	19	43	19	43	19	43	19	43
20	44	20	44	20	44	20	44	20	44	20	44	20	44
21	45	21	45	21	45	21	45	21	45	21	45	21	45
22	46	22	46	22	46	22	46	22	46	22	46	22	46
23	47	23	47	23	47	23	47	23	47	23	47	23	47
24	48	24	48	24	48	24	48	24	48	24	48	24	48

✓ Harmonic Selection * Harmonic Phase Angle Selection

EVENT CAPTURE OPTIONS - GENERAL SETTINGS

Nominal RMS voltage:	240 V
Nominal frequency:	50 Hz
Beep at exceedances:	☑

TABLE CAPTURE SETTINGS (EXTENDED)

Voltage threshold:

	☑ VA	☑ VB	☑ VC
Upper Limit: (Volts)	254.4	254.4	254.4
Lower Limit: (Volts)	225.6	225.6	225.6

Table Capture Tolerance (%): 0.00

RMS CAPTURE SETTINGS (EXTENDED)

Capture mode: Rolling voltage

	☑ VA	☑ VB	☑ VC
(+ %):	5.0	5.0	5.0
(- %):	5.0	5.0	5.0

Capture mode: Current threshold

	☐ IA	☐ IB	☐ IC	☐ I Neutral
Upper Limit: (Amps)	100.0	100.0	100.0	100.0
Lower Limit: (Amps)	0.0	0.0	0.0	0.0

Phase Imbalance:
☑ VA, VB, VC — % of voltage deviation: 10.0 %

RMS Capture trigger point: Pre-trigger: 2.000 sec Post-trigger: 11.600 sec

WAVEFORM CAPTURE SETTINGS (EXTENDED)

Capture mode: Rolling voltage

	☑ VA	☑ VB	☑ VC
(+ %):	5.0	5.0	5.0
(- %):	5.0	5.0	5.0

Capture mode: Current threshold

	☐ IA	☐ IB	☐ IC	☐ I Neutral
Upper Limit: (Amps)	100.0	100.0	100.0	100.0
Lower Limit: (Amps)	0.0	0.0	0.0	0.0

Phase Imbalance:
☑ VA, VB, VC — % of voltage deviation: 10.0 %

Transient (V/ms):

	☑ VA	☑ VB	☑ VC
dV/dt Setting:	350	350	350

Waveform Capture trigger point: Pre-trigger: 2.0 cycles Post-trigger: 4.0 cycles

DISPLAY OPTIONS

Voltage / Current / True Power Factor:	☑ A	☑ B	☑ C	
Current / THD Current:				☐ Neutral
THD Voltage / THD Current:	☐ A	☐ B	☐ C	
Frequency/Phase Imbalance:	☐			
Log status:	☑			

Display update time: 2 sec
Date/Time display mode: dd/mm/yyyy, 24 hour
Enable PowerMonic Monitor: ☑