POWER QUALITY STUDY

MOULDED CASED CIRCUIT BREAKER (MCCB) TRIPPING AT COMPUTER LABORATORY SUB-SWITCHBOARD

Politeknik Seberang Perai P.Pinang

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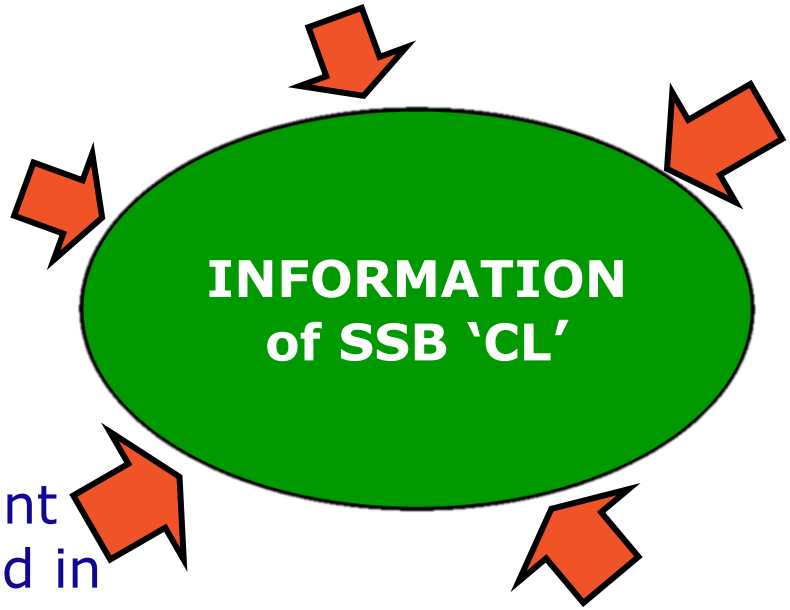
INTRODUCTION

Moulded Case Circuit Breaker (MCCB) tripping at the Sub-Switchboard (SSB 'CL') for Computer Laboratory Block

INTRODUCTION



The wirings was done since 1998

Incoming supply: from **MSB 1**

The Definite Time Lag (DTL) **Earth Fault Relay (EFR) setting** at incoming 500A MCCB was **0.5A/0.1sec**.

Load: Power point quantity designed in each outgoing DBs were between **46 and 52 nos**.

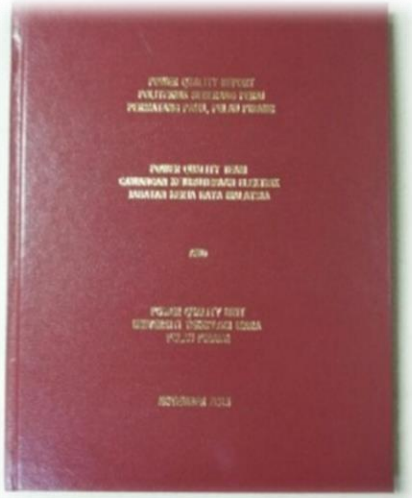
Residual Current Circuit Breakers **(RCCBs)** at each DBs was rated at **100mA**

OBJECTIVE

To identify the causes of the MCCB tripping at the Sub-Switchboard (SSB 'CL')

WORKFLOW PROCESS

a. Briefing
b. Site Investigation
c. Power Quality Monitoring
d. Data Analysis
e. Joint Venture Report
f. Presentation to PSP



a | b | c | d | e | f

INVESTIGATION PROCEDURE

- **Visual inspection** of installation as per wiring regulation requirements.

- A measurement was done using power quality **monitoring equipment Fluke 1750** at the incoming of MCCB at SSB 'CL'.

- The power monitoring was recorded from **21st until 31st October 2013** (with a sampling rate of 10ms).

A simplified single line diagram for the SSB'CL'

Point of Measurement at P2

Incoming from MSB '1'

P2

DTL

E/F

500A TPN MCCB

- DB 'GA' (Lighting & socket)
- DB'CL' → Compound Lighting
- CP-4 → A/C Panel
- DB 'GPA' (Socket)
- DB 'GD'
- Spare
- DB 'GE'
- DB 'GB' → Lighting+Socket+A/C
- DB 'GC' → Lighting+Socket+A/C
- CP-6 → A/C Panel
- DB 'GF' (Lighting & socket)

FINDINGS

During the measurement period, there was **no tripping incident** but there were **events on voltage swells** (overvoltages) which recorded 5,337 times.

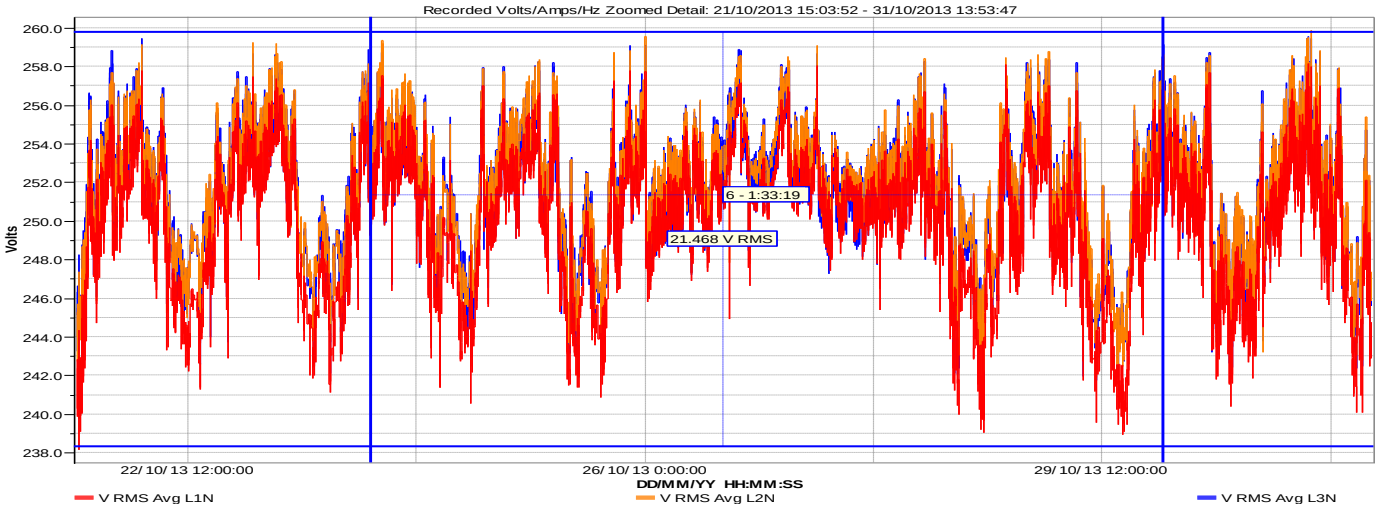
FINDINGS

- **Voltage Summary**

	10 minutes trend data average RMS			*Detail view data average RMS*		
Phase	V_{L1N}	V_{L2N}	V_{L3N}	V_{L1N}	V_{L2N}	V_{L3N}
Voltage	256.50V	257.95V	257.83V	258.14V	259.91V	259.55V
	*(+11.52%)**	*(+12.15%)**	*(+12.10%)**	*(+12.23%)**	*(+13.00%)**	*(+12.85%) **

These average RMS voltages are exceed +10% limit of the nominal voltage.

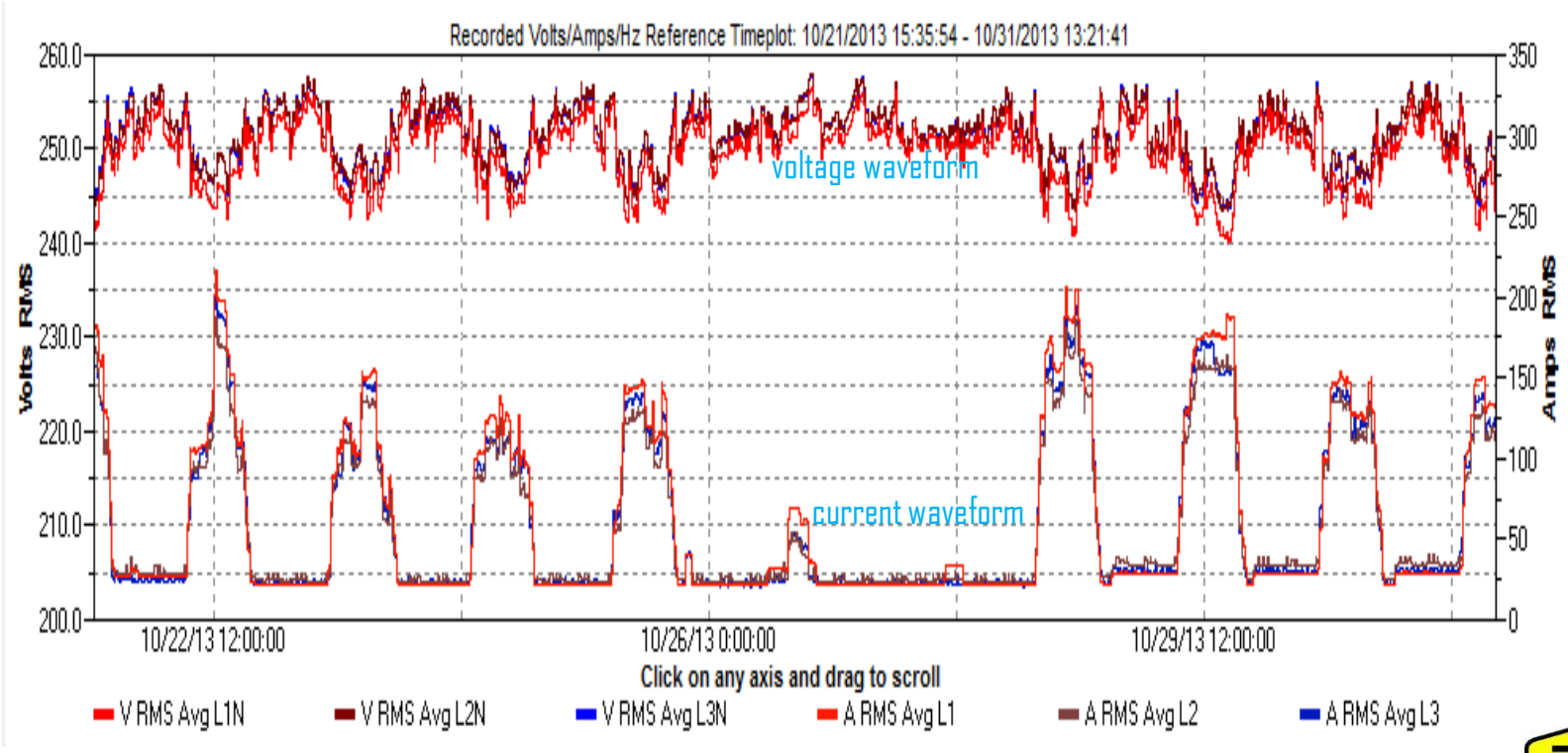
Figure below shows the voltage fluctuation is 21V (9.3%) are considered high (above 6% of nominal voltage, i.e.>13.8V)



FINDINGS

- **Voltage Summary**

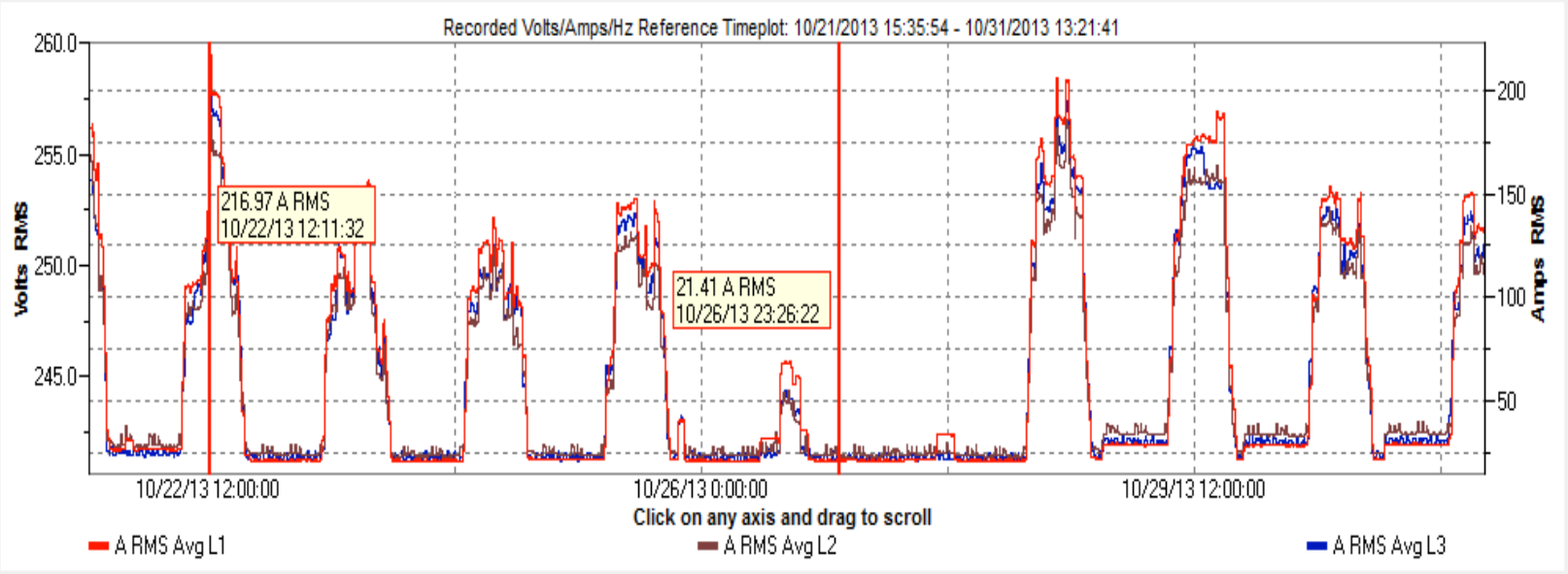
Recorded data shows that, when the current increase and the voltage drop significantly (or vice versa) shows that the electrical distribution system for SSB'CL' has high system impedance.



FINDINGS

- **Current Summary**

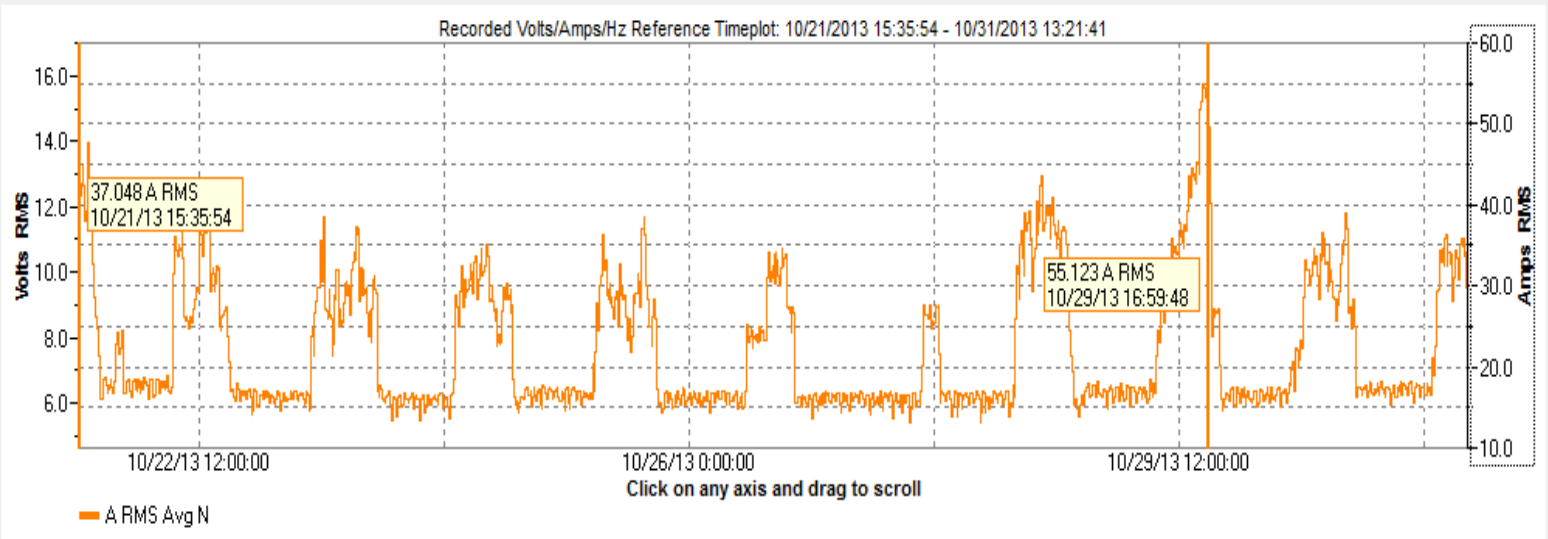
	10 minutes trend data average RMS			*Detail view data average RMS*		
Phase	L1	L2	L3	L1	L2	L3
Current	216.97A	188.08A	205.09A	259.13A	220.55A	239.77A



FINDINGS

- **Current Summary**

Data	Unbalance Neutral Current, I_N	Indicator	Effect to the system
10 minutes trend data average RMS	55.12 A	> the earth fault relay pick up current (i.e 50 A)	nuisance tripping to the MCCB
Maximum current unbalance (%)	23.41%		



FINDINGS

- **Harmonic Summary**

The value of Voltage Total Harmonic Distortion (V_{THD}) and Current Total Harmonic Distortion (I_{THD}) for SSB 'CL' :

Phase	L1N	L2N	L3N	Indicator
Average V_{THD} (Max)	1.22%	1.55%	1.20%	The values of V_{THD} are acceptable and within the limit (< 8 % based on IEC 61000-2-2)
Phase	**L1**	**L2**	**L3**	**Indicator**
Average I_{THD} (Min)	3.45%	5.29%	2.39%	The values of I_{THD} are low and do not contribute to the distortion of the supply voltage waveform

The low V_{THD} and I_{THD} that are generated by the loads connected to distribution boards are not related to the tripping of MCCB.

FINDINGS

- **Neutral to Ground Voltage, V_{NG}**

Data	V_{NG}	Indicator	Caused by	Effect to the system
10 minutes trend data average RMS	16.65V	*high levels of V_{NG}*	1. indicates a loose/corrode connection at the ground electrode 2. the volt drop along the resistance of the neutral	1. contributes to the power quality problem 2. some of the sensitive loads are disrupted or damaged
Detail view data average RMS	87.47V (impulse)	*The magnitude of V_{NG} is high* ***(values above 4.3% (> 10V) of the nominal voltage)***	Neutral to ground impulses indicate that there are wiring errors in the electrical wiring installation (intermittent single line-to-ground fault)	Neutral to ground impulses can result in equipment damage over time and also can cause nuisance tripping of Residual Current Circuit Breaker (RCCB)

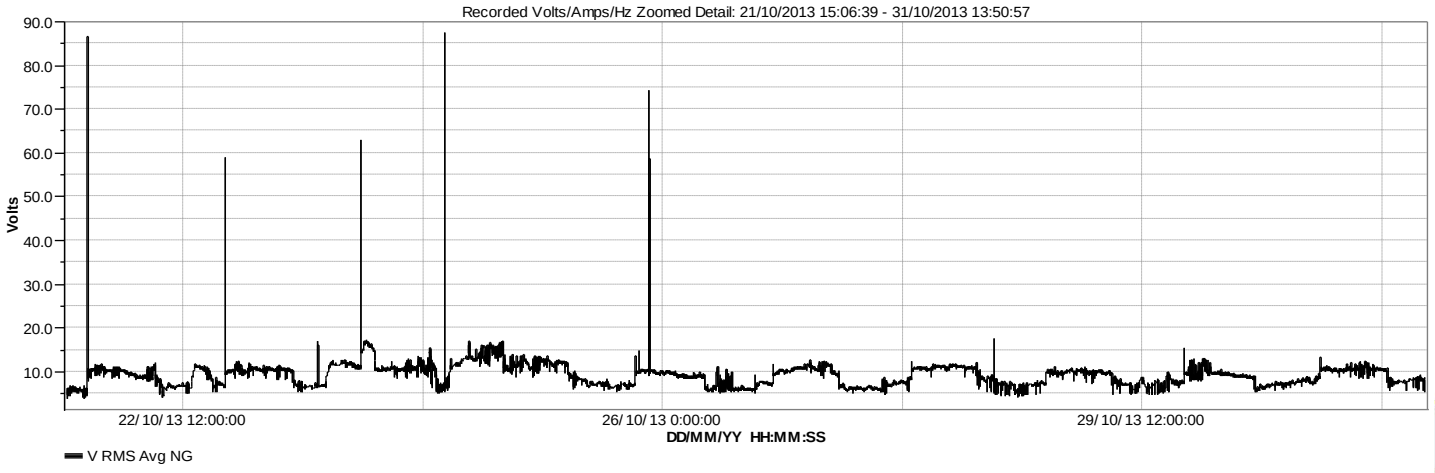
FINDINGS

- **Neutral to Ground Voltage**

The neutral to ground event recorded :

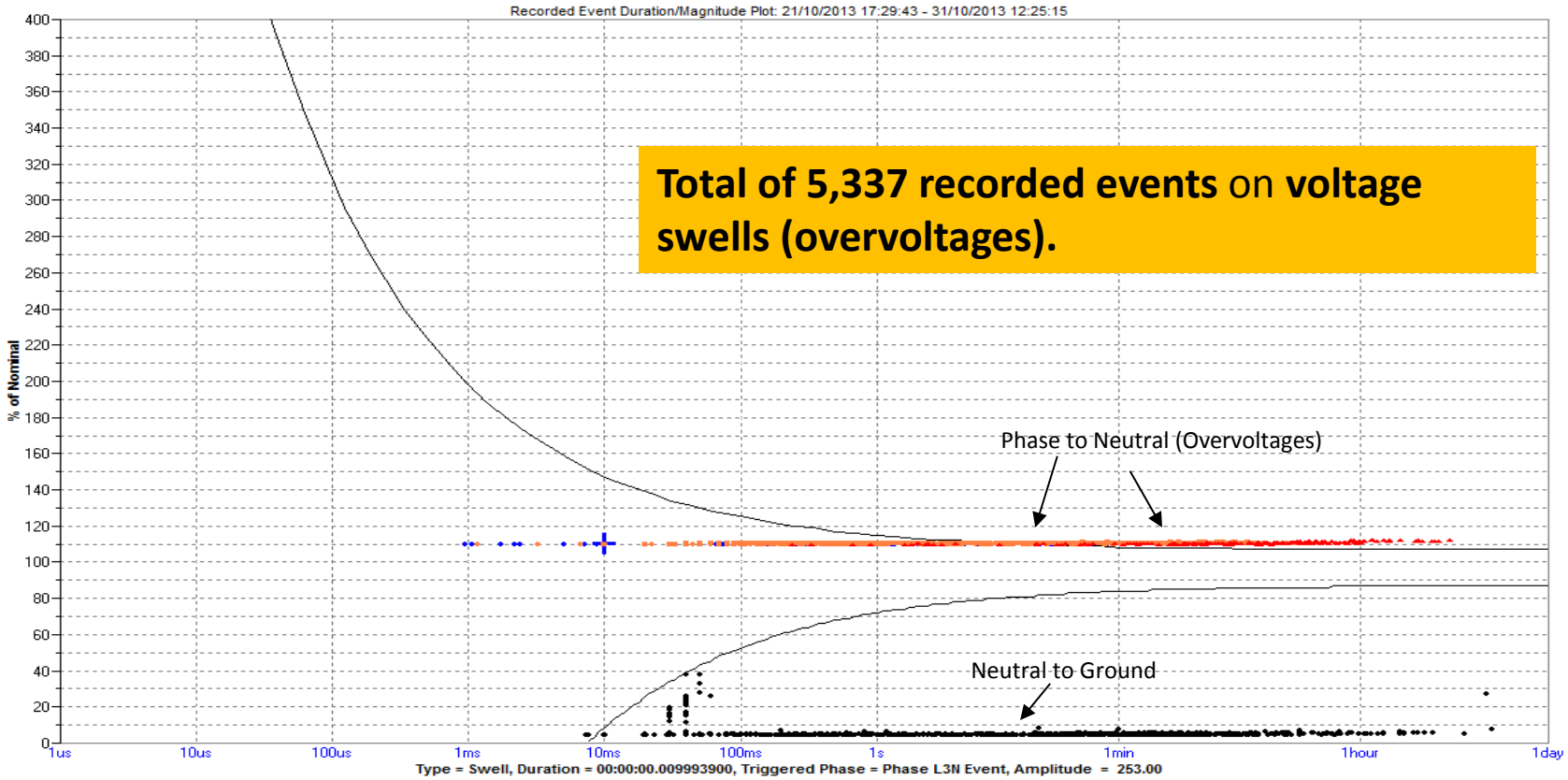
#	Date/Time	Type	Duration (Days - Hrs:Min:Sec)	% of Nominal	Absolute	Triggered Phase
1,707	24/10/2013 09:44:13.183.227	Swell	0 - 00:00:00.039945700	37.94%	87.267 V	NG
30	21/10/2013 19:06:43.393.282	Swell	0 - 00:00:00.050085300	37.71%	86.738 V	NG
2,199	25/10/2013 21:27:36.636.293	Swell	0 - 00:00:00.049950100	33.09%	76.098 V	NG
28	21/10/2013 19:06:42.772.153	Swell	0 - 00:00:00.050091000	27.90%	64.174 V	NG
1,294	23/10/2013 13:20:03.005.678	Swell	0 - 08:31:49.181644700	27.30%	62.779 V	NG
2,244	25/10/2013 21:36:32.656.549	Swell	0 - 00:00:00.059933600	26.05%	59.916 V	NG
2,196	25/10/2013 21:27:01.410.350	Swell	0 - 00:00:00.039888400	25.89%	59.558 V	NG
812	22/10/2013 19:13:07.753.516	Swell	0 - 00:00:00.040034300	25.49%	58.636 V	NG
2,194	25/10/2013 21:26:56.834.019	Swell	0 - 00:00:00.039966300	24.43%	56.187 V	NG
2,235	25/10/2013 21:34:06.588.812	Swell	0 - 00:00:00.040027100	23.03%	52.975 V	NG
2,195	25/10/2013 21:26:58.962.196	Swell	0 - 00:00:00.039959800	22.87%	52.594 V	NG
2,198	25/10/2013 21:27:15.579.415	Swell	0 - 00:00:00.039965800	22.69%	52.191 V	NG
2,207	25/10/2013 21:28:48.591.284	Swell	0 - 00:00:00.039974100	21.65%	49.798 V	NG
2,242	25/10/2013 21:35:52.533.829	Swell	0 - 00:00:00.039952400	21.61%	49.696 V	NG
2,239	25/10/2013 21:34:45.050.995	Swell	0 - 00:00:00.039946400	21.03%	48.369 V	NG

The neutral to ground impulses :



FINDINGS

- **Event Summary**



Total of 5,337 recorded events on **voltage swells (overvoltages).**

Plot of events on a CBEMA voltage tolerance curve

CONCLUSION

- The summary of events at SSB ‘CL’:

	Event recorded	Caused by	Effect to the system
1	**Voltage fluctuation** > 6% (i.e >13.8V) of nominal voltage	High system impedance and exaggerates the effect of current increases	Voltage swells
2	**Significant Voltage drop & Current increase** (or vice versa)	Loose or defective wiring, such as insufficiently tightened screws connection on power conductors or corroded connections	Electrical distribution system SSB‘CL’ has high system impedance
3	**Unbalance Neutral Current, I_N**	I_N > the earth fault relay pick up current i.e 50 A (for this SSB ‘CL’)	Nuisance tripping to the MCCB

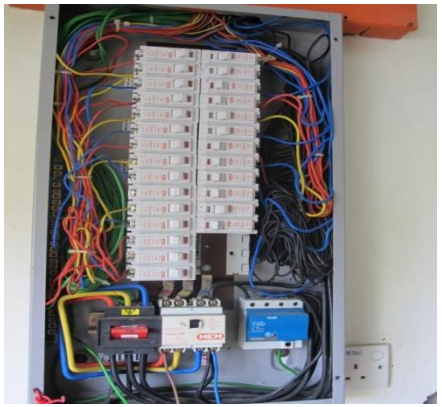
CONCLUSION

	Event recorded	Caused by	Effect to the system
4	**High Neutral to Ground Voltage**, V_{NG} *(> 10V of the nominal voltage)*	1. indicates a loose/corrode connection at the ground electrode 2. caused by the volt drop along the resistance of the neutral	1. contributes to the power quality problem 2. some of the sensitive loads are disrupted or damaged
5	**Neutral to ground impulse**	Neutral to ground impulses indicate that there are wiring errors in the electrical wiring installation (intermittent single line-to-ground fault)	Neutral to ground impulses can result in equipment damage over time and also can cause nuisance tripping of Residual Current Circuit Breaker (RCCB)
6	**Overvoltages**	the insulation of the equipment	shorten the lifespan of the equipment

Recommendation

- **Improvement of Electrical Wiring Installation**

1. Check the wiring installation of the electrical system and correct all the wiring errors such as improper neutral-to-ground bond, intermittent single line-to-ground fault and improper cable joint.

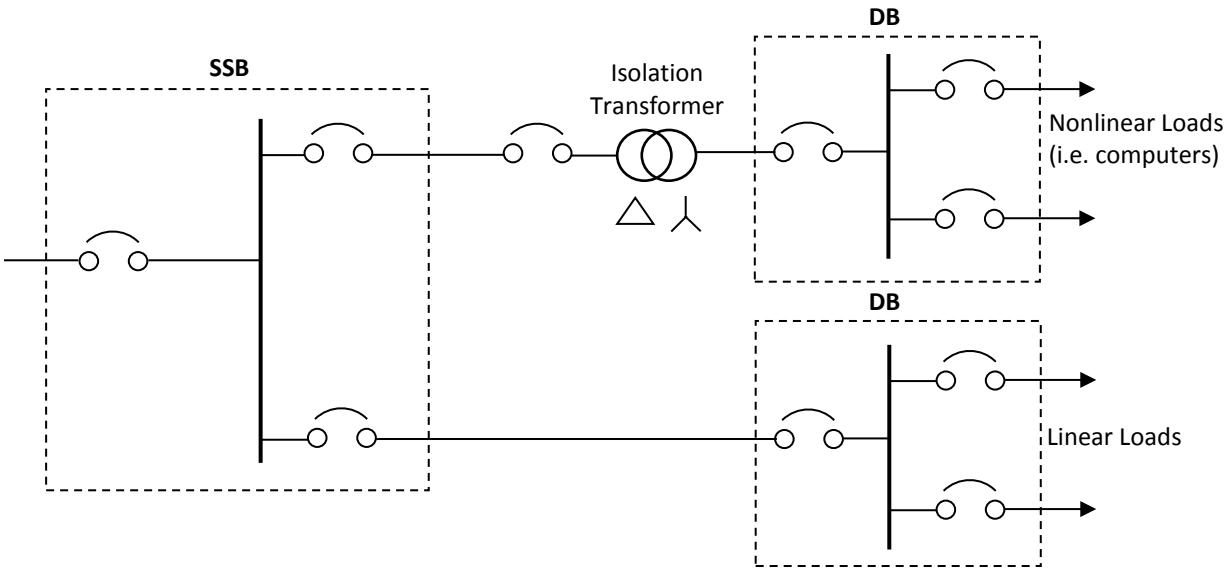


2. Check for loose neutral connections.

3. Inspect the wiring for other equipment, light fittings etc. for loose joints and terminations.

Recommendation

4. To mitigate high neutral-to-ground voltage, it is recommended to install an isolation transformer connected as separately derived system. The transformer should be placed near to the load.



To separate dedicated nonlinear loads, linear loads and an isolation transformer is used for sensitive equipment

Recommendation

- **Improvement of Grounding System**

1. Connection between grounding conductor to the ground electrode at the transformer and main switchboard (MSB) should be by exothermic weld, not clamps that can loosen over time.

Recommendation

2. Only one ground electrode system at the MSB should be implemented. A separate ground electrode should never be used to ground any piece of electrical equipment. Separate ground electrodes always create two ground references at different potentials, which in turn cause a “ground loop” current to circulate in an attempt to equalize those potentials. In the case of lightning strikes, surge currents travelling to ground at different earth potentials will create hazardous potential differences.

Recommendation

- **Immediate Action to be taken**

1. Redistribute final circuit loads to improve balance of the three phases. The maximum unbalance current should be below the earth fault relay pick up current.

2. Reduce the supply voltage to the nominal value by changing the position of the tap-changer of the transformer.

Impact to Politeknik Administration

- **The report will be send to the polytechnic for their action:**

- Inform maintenance department to identify repair work to carried out

- Get estimation for the maintenance allocation

…THANK YOU