Chapter 5

5.0 Case Studies for Existing Installations

5.1 Background

This chapter will present few case studies of existing building electrical installations on how above methodologies can be used to save operational and maintenance costs. At the time of proposal they did not have any issue over the unbalance. Hence the whole idea of the research could be achieved by suggesting changes to the existing system to save the losses and possible future unexpected maintenance costs.

5.2 Data collection from various facilities

Data was collected from varying large LV installations. The purpose was to analyze how different consumers face the problem of phase unbalance and how different solutions will be implemented. The following different types of facilities were included for the study.

- Apparel facility – Located in the Kaluthara area producing children's wear for export to US & Europe. The maximum demand is 260 kVA and the facility is mostly 450W single phase sewing machines of 350 numbers and fluorescent lighting with magnetic ballasts.

- Hospital facility – Located in Malaysia a 225 bed hospital equipped with modern theatres and laboratories. The maximum demand is 4MVA. Central air conditioning and fluorescent lighting with magnetic ballasts are the largest power consumers. Bio medical equipment such as scanners, x-ray machines is used widely.

- Mobile base station – a GSM base station of a leading mobile operator in Sri Lanka, located in the Rathmalana area. The maximum demand is 15kVA. A GSM BTS station is present with split type air conditioning to keep the temperature inside the room.

- Data Centre – a data processing facility with over 3000 computers serving for an international bank. The maximum demand is 1.2 MVA. Computers are provided with large screen monitors of both CRT and LCD. Lighting is provided via T5 fluorescent fittings. Air conditioning is central air cooled chiller system.

5.3 Equipment used

The study required several meters to be used to collect data and to be recorded at the installation. The following equipment was used for the data recording and harmonics analysis of the above locations.

Detail of Equipment		
Name and model	**Description**	**Serial No.**
Fluke 1735 Power Logger	3 phase power analyzer with logger	S082701051B6

Table 4 : Equipment used for testing

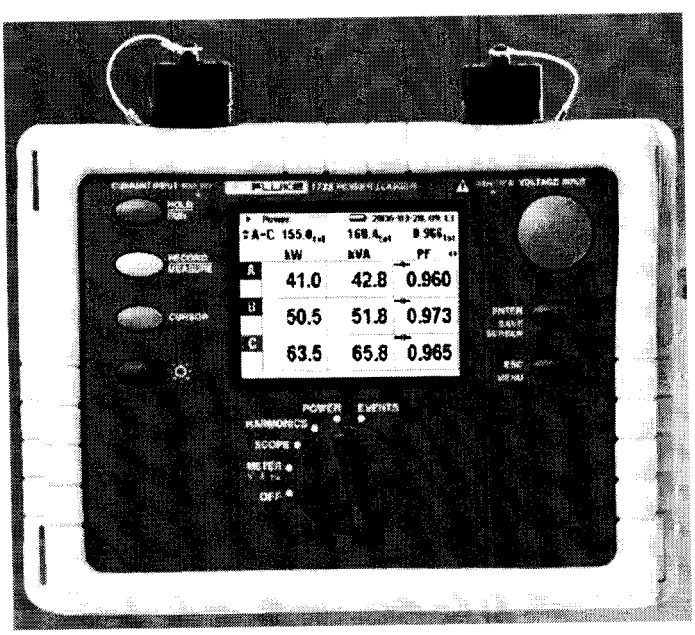

Figure 17 : Power analyzer used for data collection

5.4 Study results

Study results with problem definition are presented below as cases. Possible solutions are suggested with estimated savings and investment required to justify an economic solution.

5.4.1 Case 1 – Apparel facility

Analysis

- Phase Currents during peak – 322A, 321A, 378A
- Average current – 340A
- Maximum Unbalance – 11%
- Phase voltages during peak – 233V, 231V, 226V
- Average voltage – 230V
- Voltage unbalance – 1.7%
- Neutral current – 60A
- Neutral cable – 2runs of 120mm^2, 55m
- Inappropriate single phase load distribution

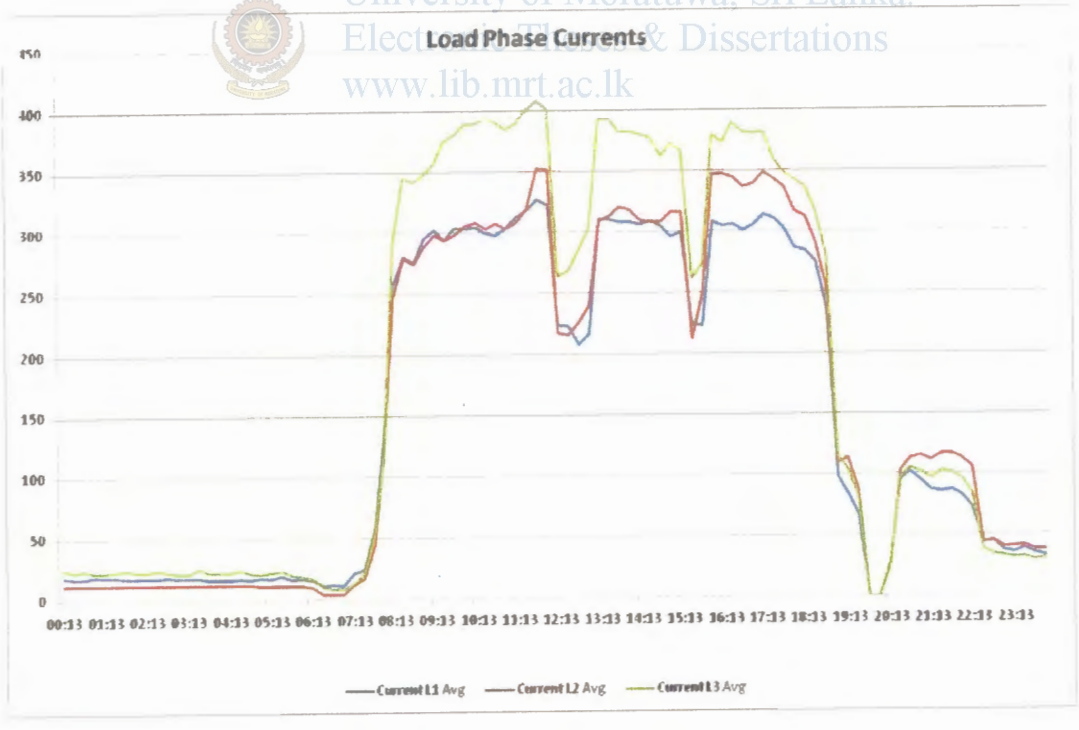

Figure 18 : Logged data of the facility

Suggestion for improvements

Almost all the loads of the facility were single phase loads and the load distribution was bad. This is a classic example of a bad design. The design was by a designer who doesn't have an idea of simultaneity of loads at this type of facility. The problem remains permanent to a certain extend making it difficult to solve as a proper load balancing will cost an entire rewiring. I did a feeder rearrangement of the facility to reduce neutral current by about 60%. This facility is an ideal place where a half neutral cable could be used. There are no major harmonic distortions in the network. It is in vain to use a cable that can carry over 500A when the actual is only 20A.

Benefits to the facility

- Load balancing – Neutral current reduced to 20A
- Cable loss reduction – 1,634 kWh/annum
- Saving – 16,000 LKR/annum
- Investment – negligible (phase swapping at breakers by technicians)
- If ½ neutral cable used – 150,000 LKR saving
- Change over switch heating rectified

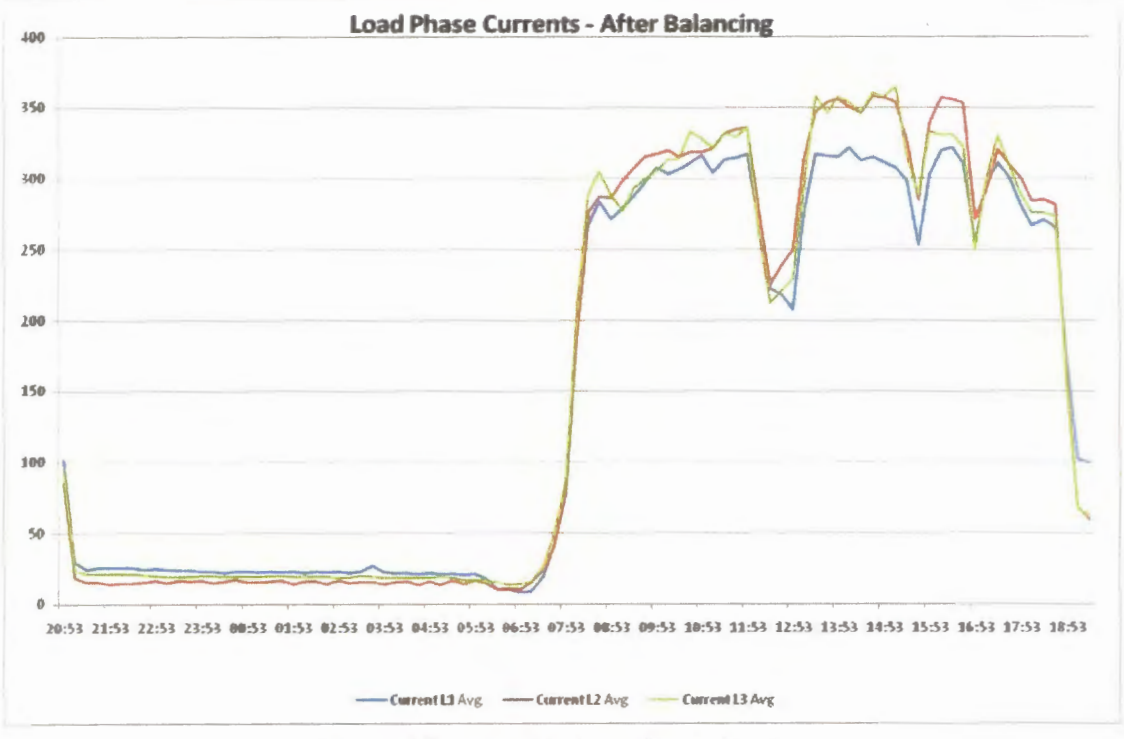

Figure 19 : Logged data after balancing

5.4.2 Case 2 – Hospital facility

Analysis

- Currents balanced – but, high neutral current
- Unbalance – <10%, Neutral current – 20% of phase current
- Non-linear loads not segregated
- Feeder for bio medical equipment with high neutral current and harmonics level.
- Poor quality electronic ballast not conforming IEC

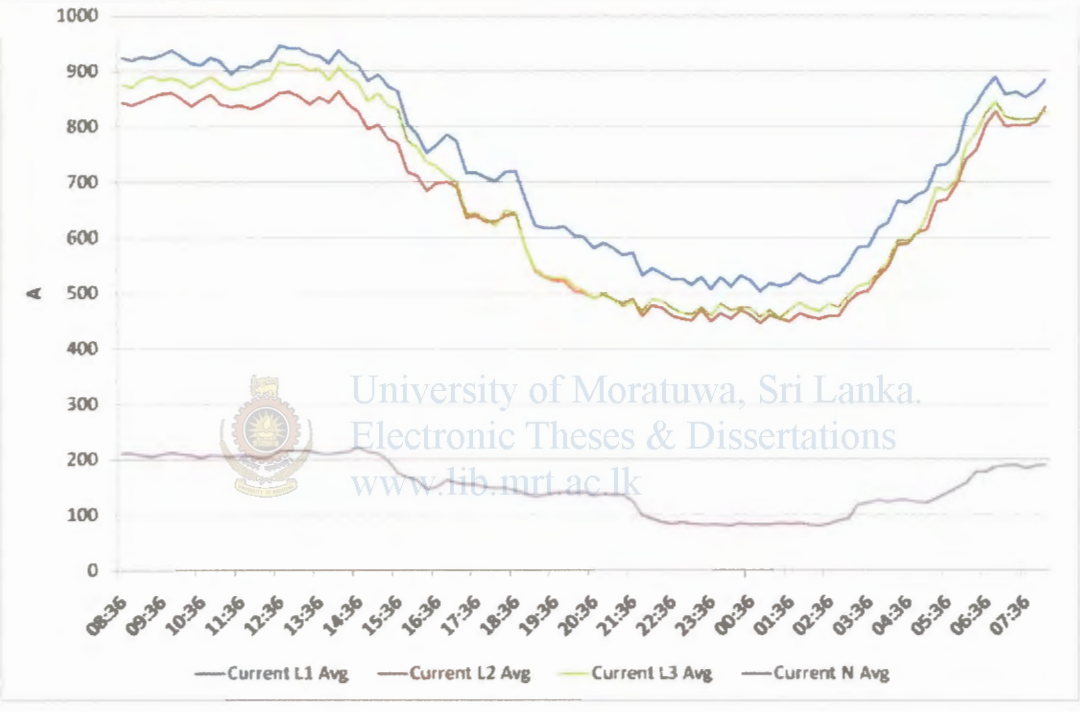

Figure 20 : Logged data of the facility

Suggestion for improvement

This is a bad design due to non-segregation of possible harmonic producing equipment to a single feeder. Then filtration of harmonics is much easier. No filtration was used at this facility and transformer overloading was experienced by operational staff.

Benefits

- Harmonic filtering – Neutral current reduced to 20A
- Cable loss reduction – 10,100 kWh/annum

- Saving – 100,000 LKR/annum
- If ½ neutral cable used – 1,300,000 LKR saving
- Transformer overloading solved
- Investment – 2,500,000 LKR

5.4.3 Case 3 – Mobile base station

Analysis

- Currents unbalanced – different phases carrying different loads, heavy neutral current
- Unbalance – >25%, Neutral current – 90% of average phase current
- Non-linear loads such as switches and switch mode power supplies used
- No filtration of harmonics

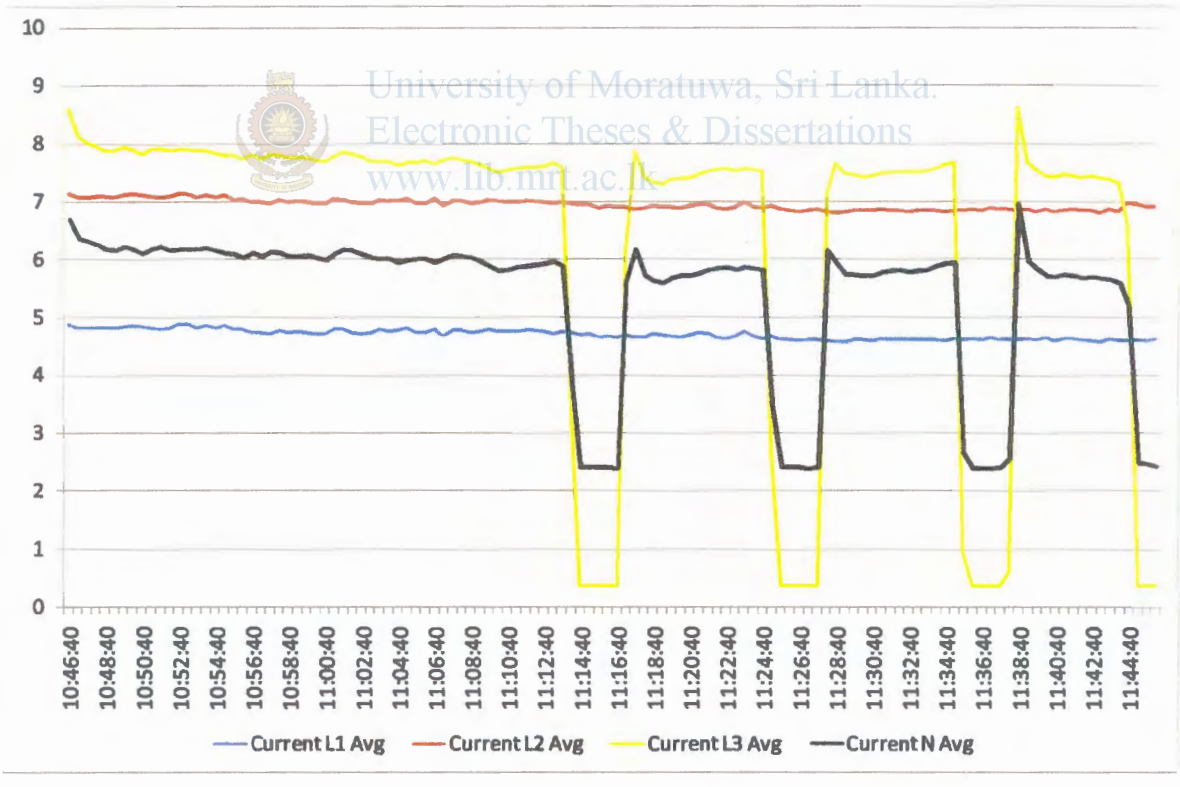

Figure 21: Logged data of a mobile base station

Suggestion for improvement

This is a typical carelessness of the consultants. Most will think this is a very low load, but these range in thousands for each operator. They absorb power from the national grid u dand inject harmonics into the system. No filtration was used at this facility which can be easily incorporated at the inception.

Benefits

- Harmonic filtering – Neutral current can be reduced to 2A
- Cable loss reduction – 3,000 kWh/annum
- Saving – 45,000 LKR/annum
- Investment – 50,000 LKR

5.4.4 Case 4 – Data centre

Analysis

- Currents unbalanced – different phases carrying different loads, heavy neutral current
- Unbalance – <5%, Neutral current – 10% of average phase current
- Non-linear loads such as computers, data servers, UPS, emergency power systems and network switches used extensively.
- Some amount of filtration of harmonics from central UPS.

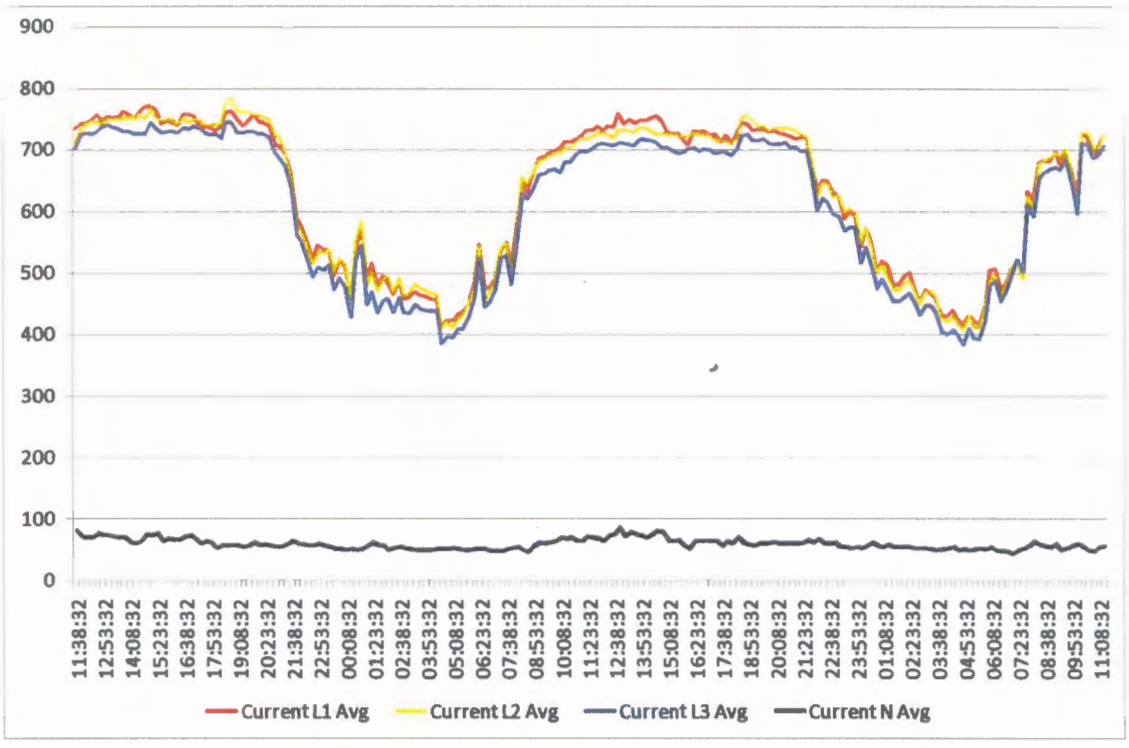

Figure 22: Logged data of a computer data centre

Suggestion for improvement

This is a somewhat better designed facility. Consultants have acted early for the heavy non linear loads that will be added to the system. This has led them to a lot of saving from the distribution network. However further reduction can be recommended to keep the network losses low. Main requirement is to analyze existing harmonic filtrations and to recommend improvements to the existing system.

Benefits

- Harmonic filtering – Neutral current can be reduced to 20A
- Cable loss reduction – 26,000 kWh/annum
- Saving – 260,000 LKR/annum
- Investment – 300,000 LKR