

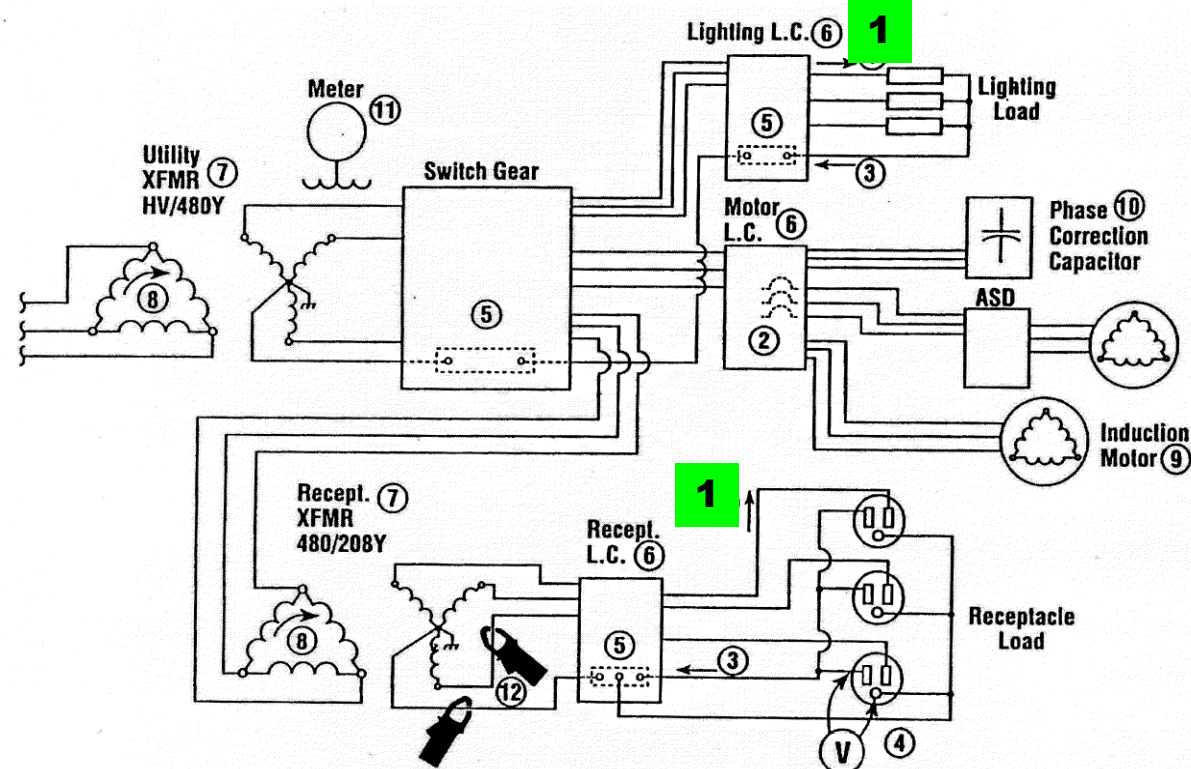
# Power Factor Improvement By RTPFC system using detuned capacitors

Presented by :

Energetic Consulting Pvt. Ltd

A-88, Wagle Industrial Estate, Thane (West)

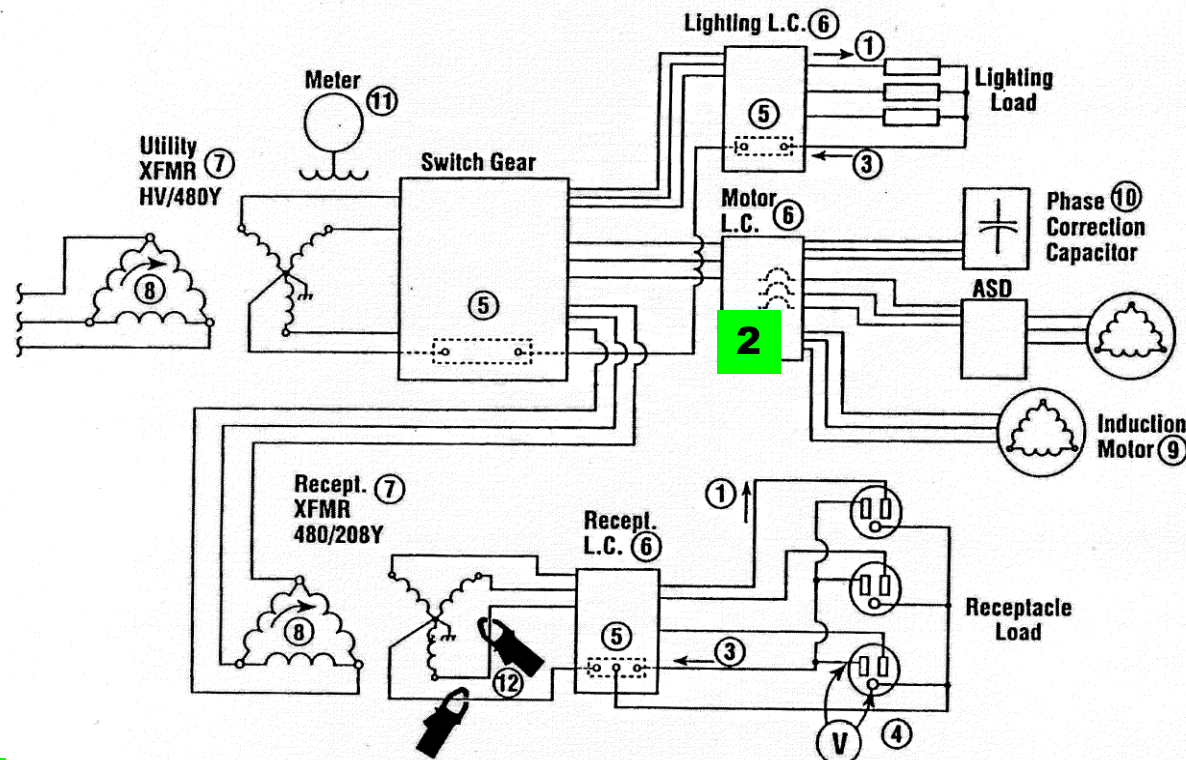
# Power Quality Issues In Distribution System



**1** Phase Conductors – Heating from Skin Effect

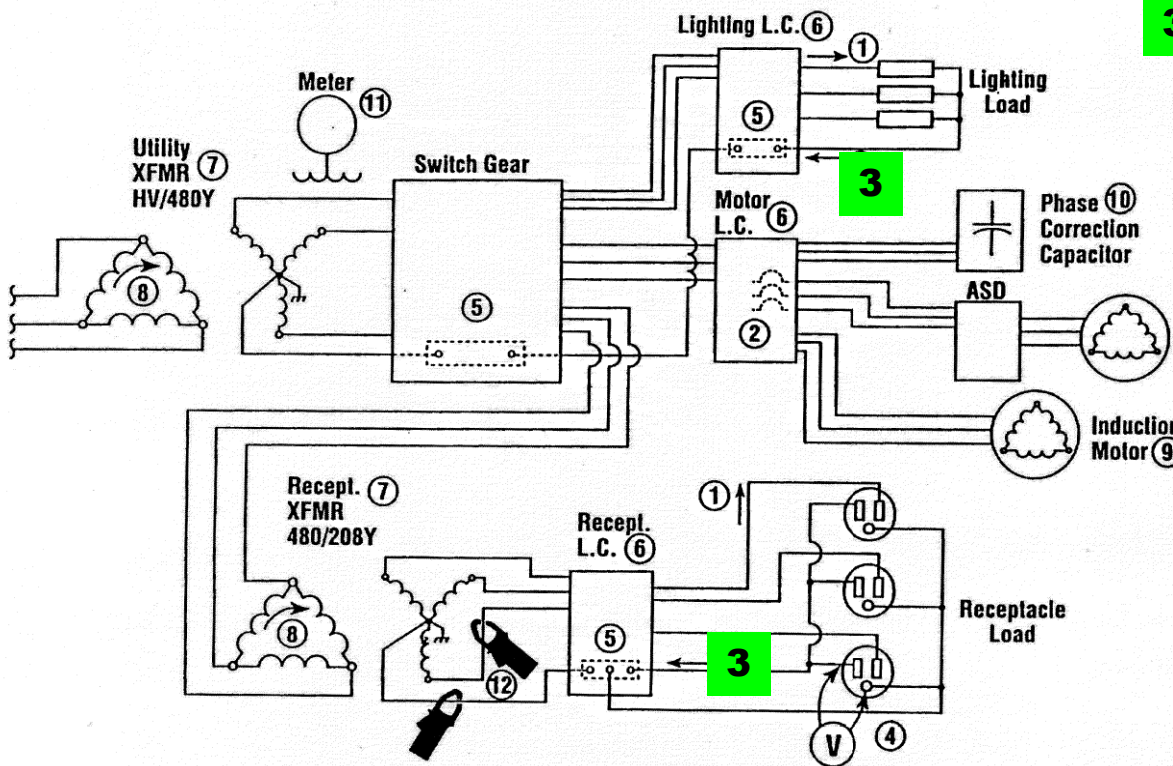
Conduits – Heating from Skin Effect and eddy currents

# Power Quality Issues In Distribution System



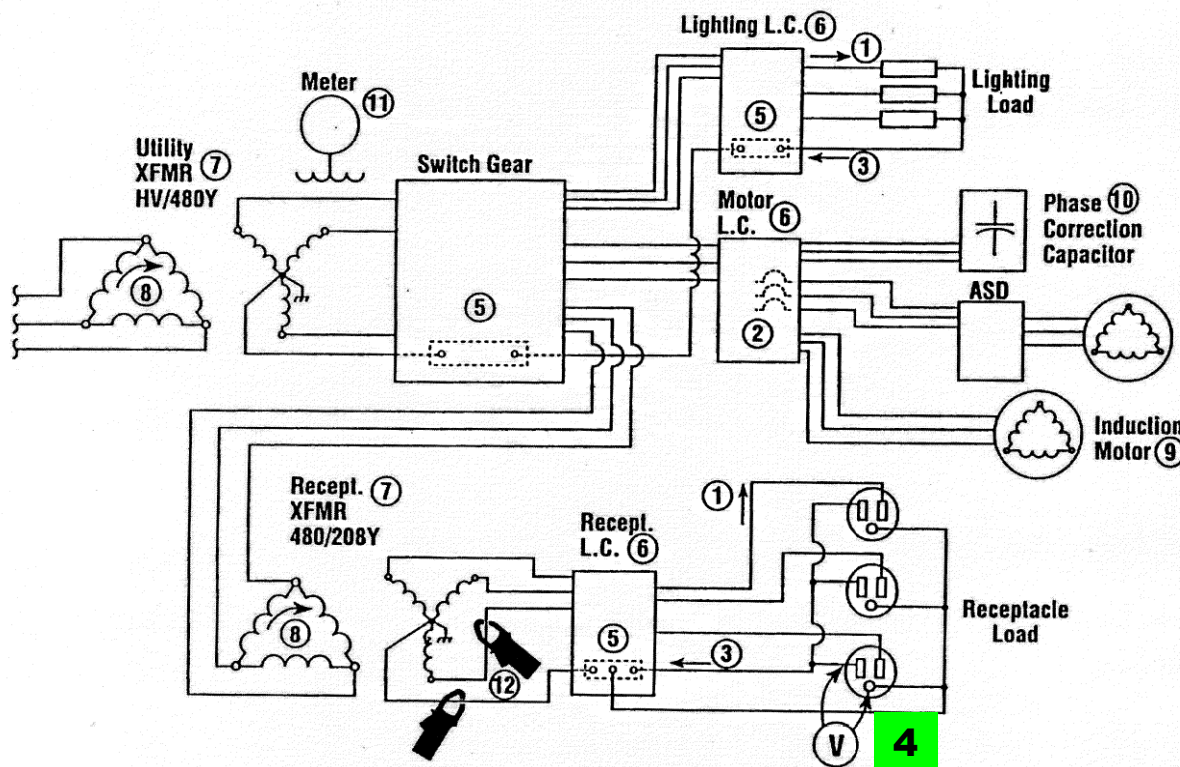
- 2** Circuit breakers – False tripping due to high heat and higher frequencies caused by harmonics. Peak sensing CB's may trip because of higher peaks

# Power Quality Issues In Distribution System



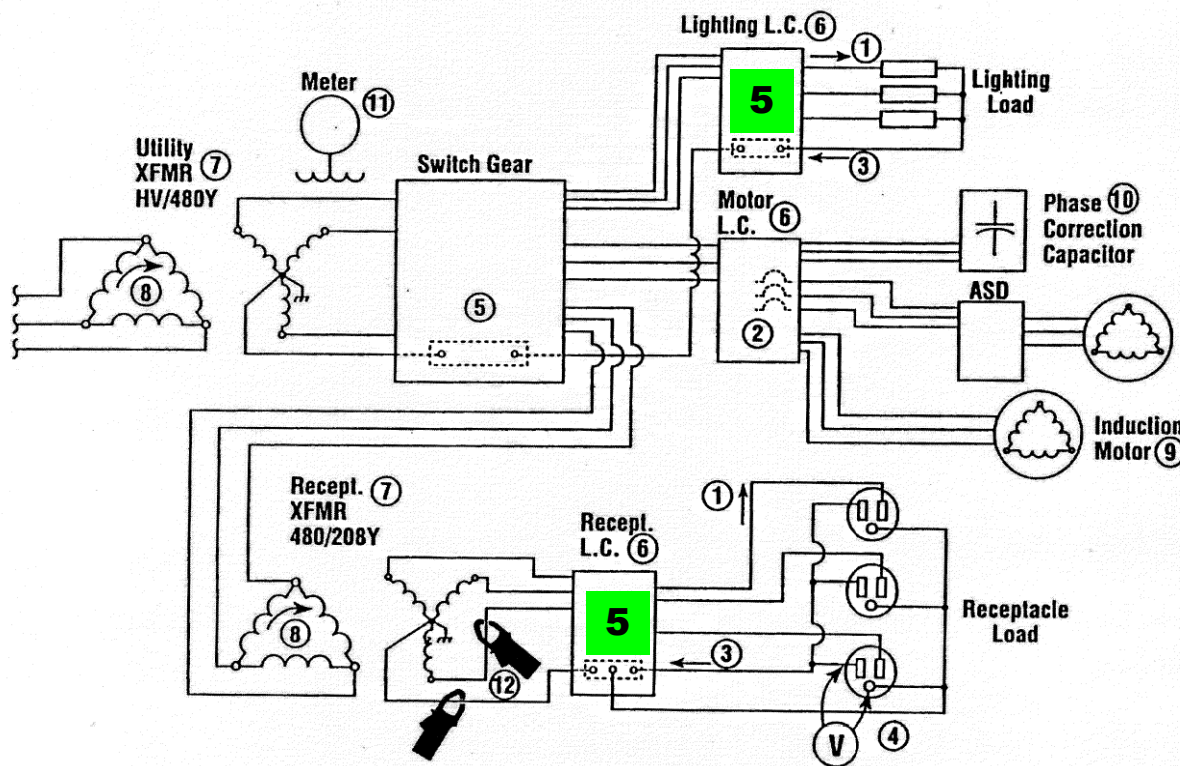
**3** Neutral conductors – high current from zero sequence triplen harmonics (3<sup>rd</sup> & 9<sup>th</sup>) can add as much as 30% to neutral current even if phases are balanced. Shared neutrals or reduced size neutral can be hazardous (no CB to protect from over current!)

# Power Quality Issues In Distribution System



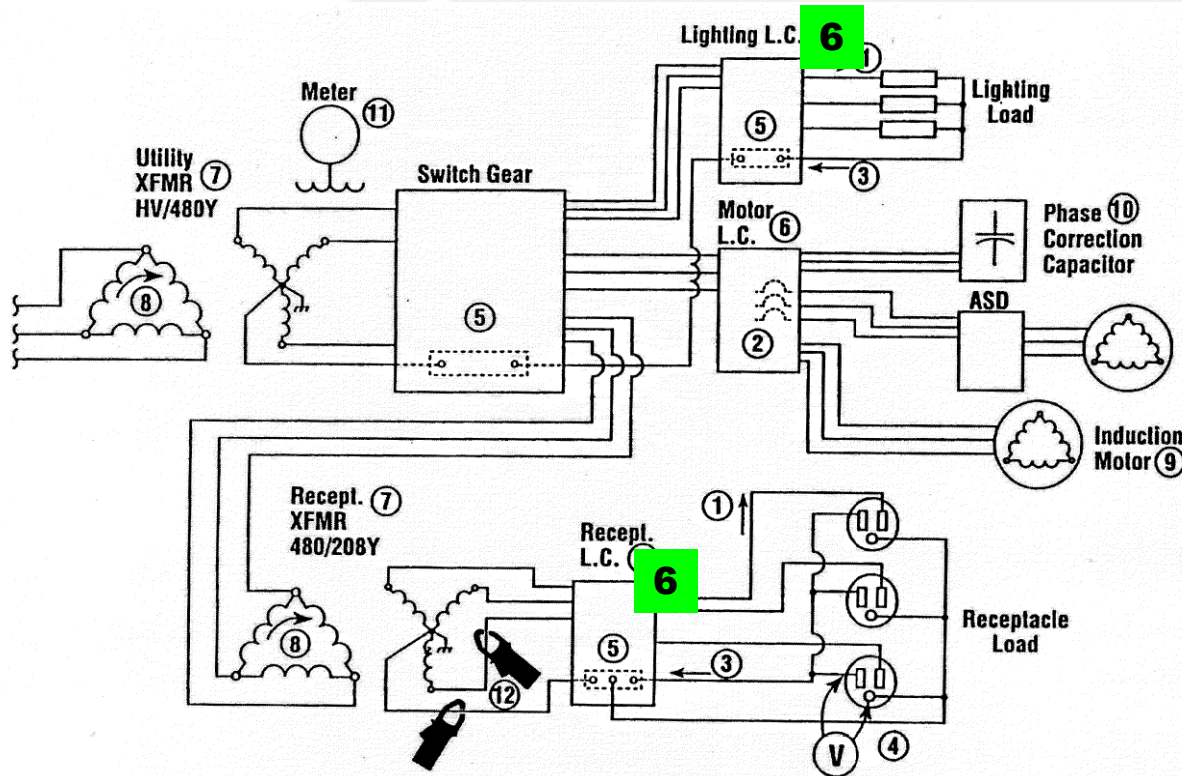
- 4** Neutral to ground voltage at receptacle – Excessive neutral current results in high voltage drops between neutral and ground at the outlet

# Power Quality Issues In Distribution System



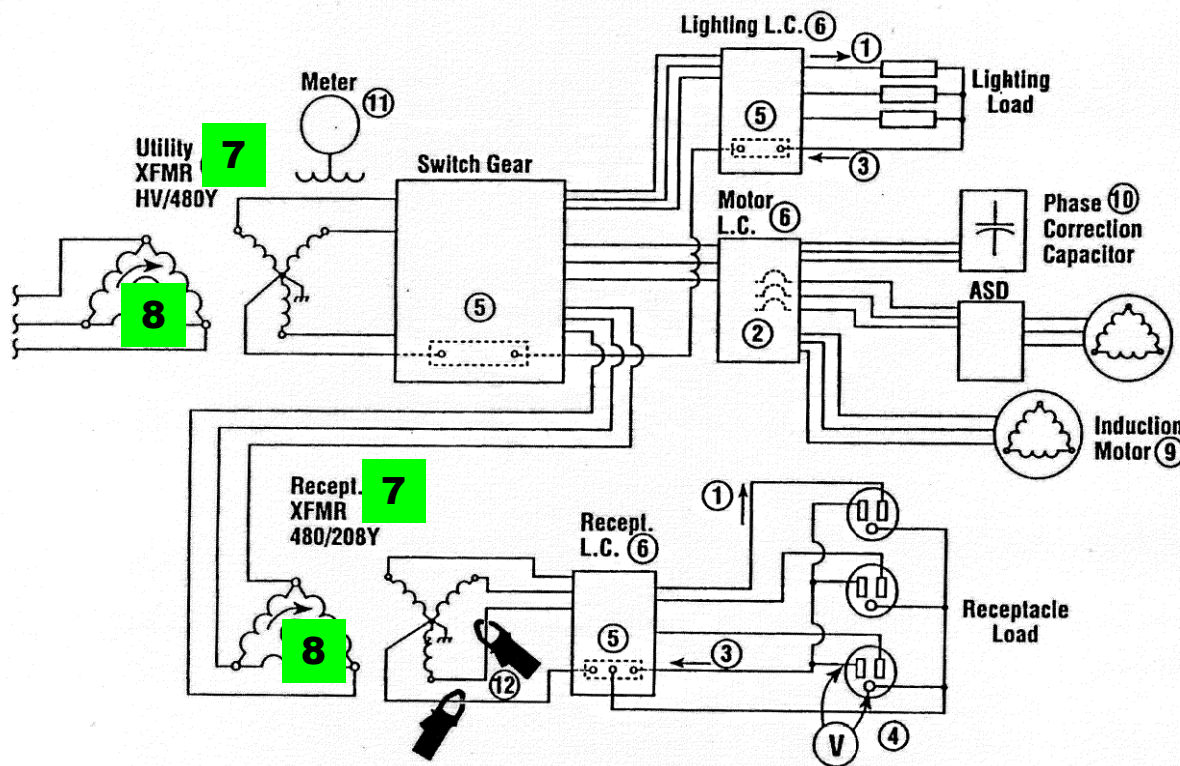
- 5** Neutral bus bar – overloading and heat from zero sequence harmonics (3<sup>rd</sup> and 9<sup>th</sup>)

# Power Quality Issues In Distribution System



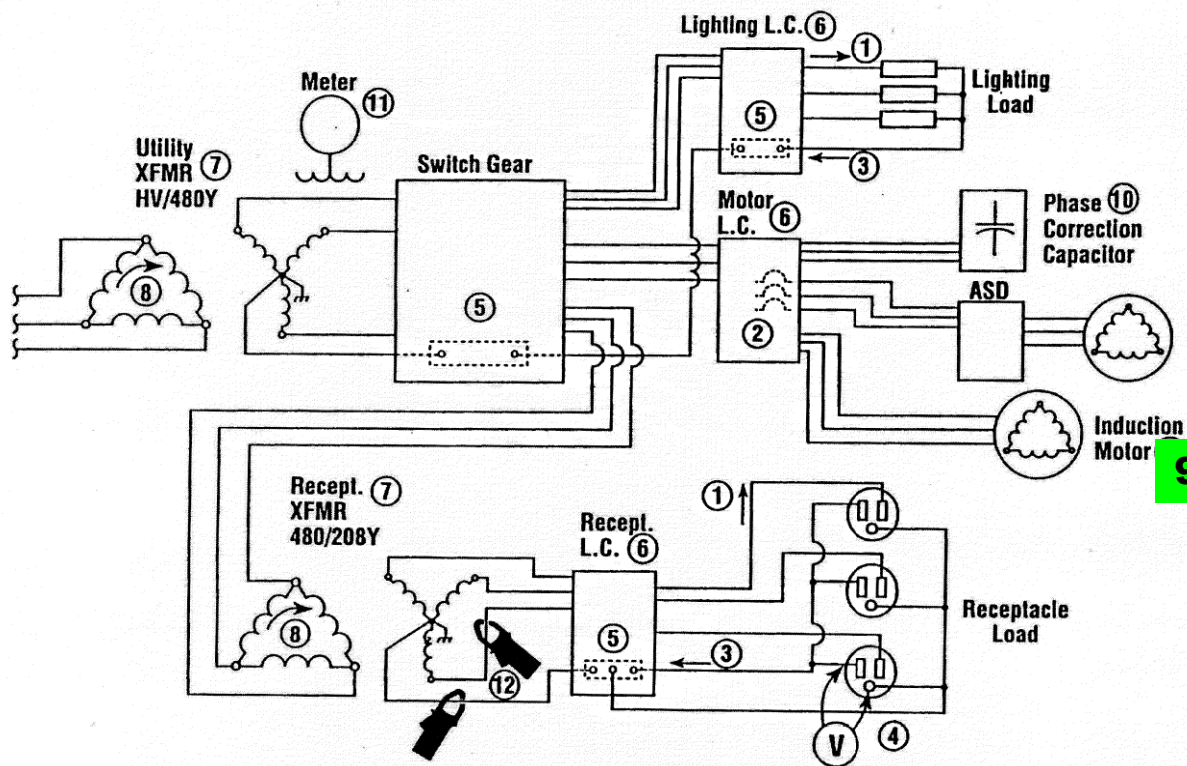
- 6** Panelboard enclosure – heating from eddy currents (induced currents caused by magnetic fluxes), as well as vibration (“buzzing” sound).

# Power Quality Issues In Distribution System



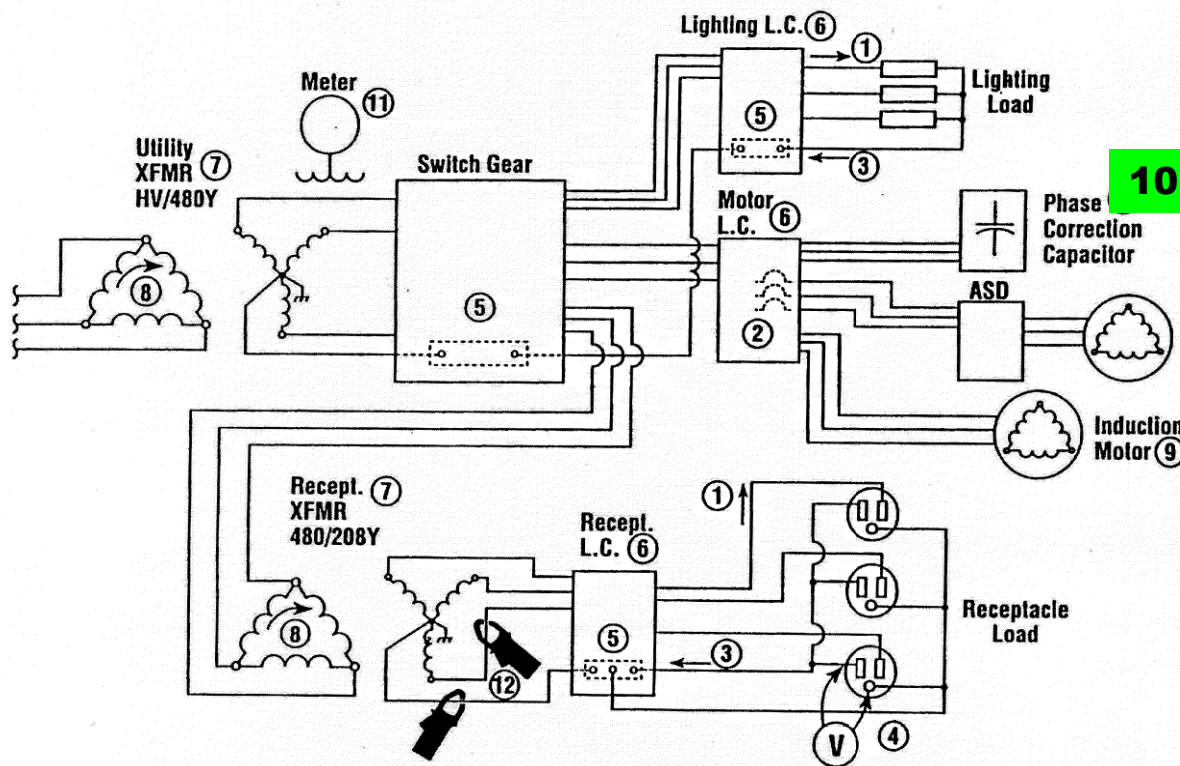
- 7** Transformers – heating from
- 8** eddy currents reduces the life of a transformer insulation system, and lowers efficiency.

# Power Quality Issues In Distribution System



- 9** Induction Motor Leads – Heating from eddy currents and negative sequence harmonics (5<sup>th</sup>, 11<sup>th</sup>, 17<sup>th</sup>, etc.)  
Note – Negative sequence harmonics work AGAINST a motor's natural rotation, making it work harder!

# Power Quality Issues In Distribution System



**10** Power factor (kVAR) Capacitors – since they are lowest impedance, resultant high harmonic current can overheat capacitors and/or blow fuses.

# Case Study – Real Time Power Factor Control System

Client : L.M Fitness, Khar – Bandra Linking Road , Mumbai

Type of Billing	:	LT – 4.
Contract Demand	:	60kVA.
Energy Charges	:	Rs. 3.90 per kWh (electrical unit).
Peak hour additional rate	:	Rs. 0.60 per kWh (6PM to 10PM).
Demand Charges	:	Rs. 300/- per kVA. (Upto contract demand)
Penalty Demand Charges	:	Rs. 450/- per kVA (Exceeding contract demand)
Present Average Bill	:	Rs. 150,000 per month

# Case Study – Real Time Power Factor Control System

Client : L.M Fitness, Khar – Bandra Linking Road , Mumbai

## Major Connected Loads:

Air conditioning : 41 TR distributed in  
(8.5 ton X 2nos., 5.5 ton X 2nos., 3 ton X 2nos., 2 ton X 2nos., 1 ton X 3nos.)

Steam Generation System : 9kW X 2nos. 3-phase connection.

Hot water generation system : 4.5kW X 2nos. 3-phase connection.

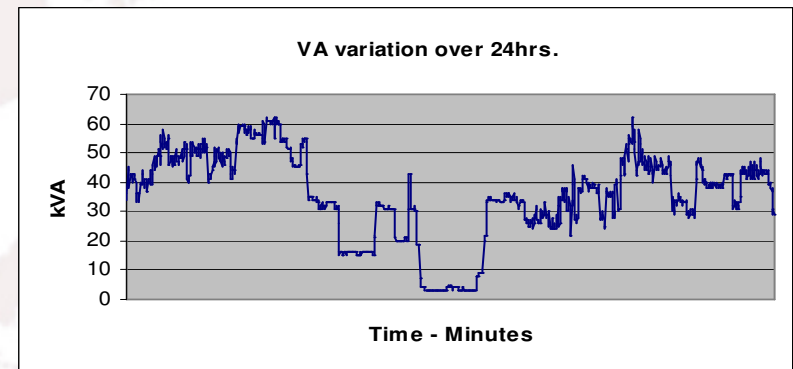
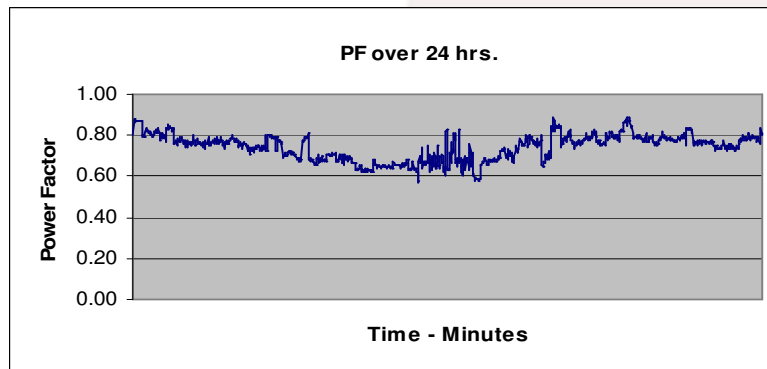
Treadmills : 3.2kW X 10nos. – Single phase machines.  
Max loading 32kW.

Lighting : Maximum up to 2.0kW.

# Case Study – Real Time Power Factor Control System

Client : L.M Fitness, Khar – Bandra Linking Road , Mumbai

	KVAR	KW	KVA	V_av	I_av	PF
<b>Maximum Value:</b>	<b>40.00</b>	<b>53.00</b>	<b>62.00</b>	<b>438.00</b>	<b>86.40</b>	<b>0.89</b>
<b>Average Value:</b>	<b>22.87</b>	<b>26.66</b>	<b>35.45</b>	<b>422.94</b>	<b>49.61</b>	<b>0.74</b>
<b>Minimum Value:</b>	<b>2.00</b>	<b>2.00</b>	<b>3.00</b>	<b>412.00</b>	<b>5.30</b>	<b>0.57</b>



Conclusion from Power Analysis:

- Maximum Demand is exceeding contract demand
- Average Power factor is 0.74

# Case Study – Real Time Power Factor Control System

Client : L.M Fitness, Khar – Bandra Linking Road , Mumbai

Harmonic Analysis	Vry-THD	Vyb-THD	Vbr-THD	Ir_THD	Iy_THD	Ib_THD	In_THD
<b>Maximum Value:</b>	<b>3.20</b>	<b>2.80</b>	<b>2.60</b>	<b>11.10</b>	<b>32.50</b>	<b>21.30</b>	<b>73.30</b>
<b>Average Value:</b>	<b>2.61</b>	<b>2.27</b>	<b>1.89</b>	<b>4.45</b>	<b>10.95</b>	<b>7.33</b>	<b>5.60</b>
<b>Minimum Value:</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>

Conclusion from Harmonic Analysis:

- VTHD is exceeding limits prescribed by IEC and IEEE
- VTHD is exceeding limits prescribed by IEC and IEEE
- Harmonics on supply system being of transient nature (i.e. appearing when only the prominent load is of tread-mills), a permanent solution against this at this stage is not considered. But can be considered sometimes at later stage. This is in view of present electricity bill does not ask for improvement in the THD.

# Case Study – Real Time Power Factor Control System

Client : L.M Fitness, Khar – Bandra Linking Road , Mumbai

## Suggestion:

It's recommended to put a Real Time Power Factor Control System (RTPFC)

Total kVAr rating	:	40kVAr at 415Vac line-line voltage.
Configuration	:	5kVAr fixed, 35kVAr variable.
Switching configuration	:	Steps of 5 + 10 + 20kVAr.
Switching method	:	Thyristorised switching.
Usage of detuned reactors	:	7% rating for all the capacitor banks.

# Power Quality Issues In Distribution System

## Implementation:

Implementation date : 4<sup>th</sup> October 2008.

Implementation results:

Measuring Parameter	Before	After
Maximum Demand (kVA)	62	51.32
Bill Amount (Rs.)	150000	115000
Power factor	0.74	0.9992

Investment : Rs. 145,000

Saving : Rs. 35,000 ( Exclusive of demand charges as it was suppose to be reflected after 6 months. Approx. saving Rs. 3000)

Payback : 4 Months