Report on Power Quality Analysis

And

Energy Audit

Audit Conducted at

Leading IT Company
Hinjewadi Pune

Date of Audit
12th to 20th June 2013.

INDEX

Note: Detail recorded data is arranged in separate appendix

Objective and the details of the equipment

Objective:

1) Study and understand electrical single line diagram of distribution network inside the premises.
2) Check and record electrical power quality pattern at all major feeders.
3) Study current harmonic contents starting from maximum upstream point / points on the single line diagram as per compliance requirements of IEEE 519 1992 standard
4) Measure and calculate working efficiency of all UPS systems and comment on possible savings.
5) Study historical energy consumption and tariff and comment on possible savings from cost of energy purchase point of view. (If applicable and possible)
6) Study and comment on reactive power compensation
7) Suggest remedies for harmonic mitigation and maintaining unity power factor
8) Undertake IR thermography to know thermal health of electrical distribution system.
9) Earthing audit to know health of electrical earthing throughout premises.
10) Demand Analysis of HVAC requirements, measurement of actual energy consumption by various HVAC systems, performance assessment of installed HVAC systems and recommendations to improve energy performance of these HVAC systems along with payback.
11) Recording energy consumption for illumination and survey of available illumination. Recommending energy saving options along with payback.
12) Present report on above data and analysis.

Details of Equipment Used:

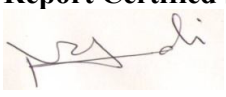
No	Name of the equipment	SR. No Model	Make	Use	Calibration Validity
1	Power Analyzer	1212 5:8 ALM 35	KRYKARD	Electrical Parameter Measurement	27/2/2014
2	Power Analyzer	1212 5:8 ALM 35	KRYKARD	Electrical Parameter Measurement	27/2/2014
3	Infrared Camera	Testo 875-2	TESTO	Thermography	18/8/2013
4	Earth Tester	DECT-3	MOTWANE	Earth Tester	30/8/2013

Audit team

-------: Mr. Narendra Duvedi, (Certified energy auditor)
Mr. Vijay Sonawane, Mr. Mandar Kolhatkar
Mr. Ranjit Deshmukh, Mr. Sunil Gogate (Certified energy auditor)
Mr. Ajit Gowande.

ABC : Mr Mohan Mulay and his team.

Certification:
Report Certified by:



Narendra R. Duvedi. (CEO -------)
B.E. Electrical and Certified Energy Auditor Reg No: EA 10859)

Executive Summary:

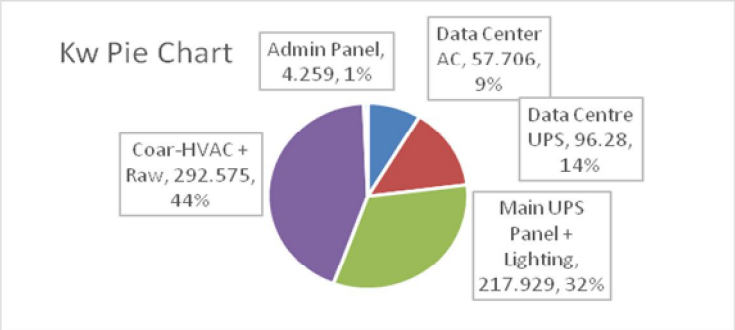
1) XYZ is IT setup working in owned premises. The present occupied area is about 204000 sq ft. Major source of energy at present is electricity available from MSEDCL. Average monthly consumption is about 350000Kwh. Setup avails all possible incentives in electricity bill and present per kWh rate is at its lowest and is around Rs. 6.5.

2) During audit, work area occupancy was around 1050. (Not considering auditorium) The energy consumption actually measured was 11530 Kwh in 22 hrs and 50 mins.

3) Current harmonic distortion compliance limit is 15% as per IEEE 519 1992, however present maximum distortion level is 12%, which is well within limit. Any time you decide to replace APFC capacitors here, you should replace them with detuned filters to avoid harmonic amplification.

4) Electrical power quality parameters for the power available to all critical loads are well within acceptable limits and the redundancy is also reasonably sufficient. Admin floor voltage harmonic distortion is slightly above 5%, which should be investigated.

5) Following Pie Chart shows contribution by different loads.



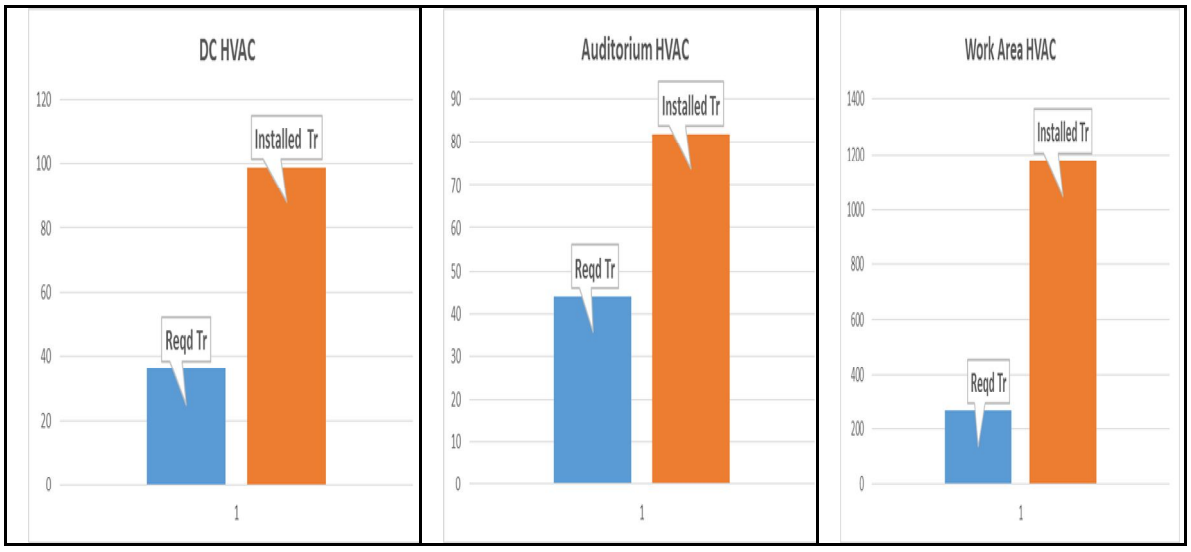
As can be seen from above 53% load is HVAC load and 46% load is UPS load.

6) About 200 KW load during night

7) The work station UPS configuration was earlier 5 x 200 KVA. Now the same is replaced with 3 x 200 KVA and the setup works at average efficiency of 85%. Data center load is supported by 2 x 200 KVA and also works at 85% efficiency. We recommend that these UPS systems could be replaced with modular systems and vertical redundancy to get flat 95% efficiency. This will save about 24KW running load and around Rs. 13.5 Lacs annually through energy saving alone.

8) Illumination Load is 44 KW and presently supported from workstation UPS output. This load may be transferred to Raw power to save another 8 KW. This translates to saving of Rs.4.5 Lacs annually. You may arrange different UPS / inverter for emergency light requirement.

9) HVAC demand analysis for against installed HVAC system shows that the total peak demand is 348 TR and installed capacity is 1360 TR at peak summer load. Following bar charts show area wise capacities. *(These calculations are done against actual occupancy during dates of audit. Separate calculations are available in the report which show demand against occupancy as per layout)*



10) Above charts show that installed capacities are very high compared to required capacities. Theoretically it is possible to switch off 2 out of every 3 VRV units. However practically one has to check the end results by assessing comfort levels while doing this. If this is done, there is possibility of saving around 300000 Kwh or Rs.20 Lacs at current tariff. This would also release VRV HVAC equipment of capacity around 800 Tr, which can be used elsewhere. Floor redesign using various ducting options is also feasible to achieve this saving and to release extra capacity.

11) If you can provide around 5000 sq ft roof top space, it is possible to install 40KW roof top grid connected PV solar generation, which will run in sync with transformer secondary in load sharing mode. The setup can generate about 200Kwh per day average throughout the year. This would yield net savings of about Rs. 4.75 Lacs per year for 1st five years.

Savings and payback at a glance

Sr	Area	Investment Required in INR	Possible energy and other cost saving in INR per year	Payback in Years
1	UPS efficiency increase	8500000.00	3000000.00 *	2.8
2	VRV reconfiguration	NIL	20,00,000.00 **	0
3	Using Raw power for Lighting	NIL	4,50,000.00	0
	Total	**8500000.00**	**5450000.00**	**18 Months.**

- *** Payback will reduce drastically if OLD UPS are auctioned rather than scrapped. Other costs include AMC, Scrap, Harmonic Filters etc.**
- **** VRV reconfiguration will release 800 TR VRV equipment, which can be used elsewhere.**
- **Solar PV related figures are not presented above as the payback in this case also depends upon subsidies and Income tax rebates, which are not related to reduction in energy consumption.**

----------END OF SUMMARY----------

Description of energy distribution system

ABC Hinjewadi is a software development company located in large premises at Hinjewadi Pune, which is owned by them. ABC receives MSEDCL supply from a receiving station located just across the road. The HT supply is 22KV. The HT supply is received in ABB make RMU and distributed to two transformers. Transformers are rated at 1600KVA and work in either one working one standby or two working mode through suitable bus - coupler arrangement. The LT – AC thus available is further distributed to various utilities through distribution panels named MLTP 1 and MLTP 2. Critical IT load is divided into workstation – floor area load and DC load and is supported using separate UPS configurations. UPS configurations are as follows

1) 200KVA UPS X 5 of Chloride make (12pulse rectifier based), for Workstation area Load working in parallel redundant mode. (Installed in basement)
2) 200 KVA X 2 of Chloride make (12pulse rectifier based), working independently as dual power supply for Datacenter Load. (Installed on DC floor)

UPS output and floor area raw power is distributed using duplicated bus raisers for redundancy and tapped on each floor. Floor level redundancy is achieved through static switches located at strategic locations.

UPS output is distributed on floor as well as Server rooms through dedicated DBs. VRV ODU and TFA distribution is arranged on each floor through DBS in Galleries provided on respective floors.
Reactive power compensation is provided using capacitor panels in respective MLTP rooms with a provision to get them connected under any mode of bus coupler arrangement.
Entire illumination load at present works on UPS output.

Electrical installation appears to be well maintained and in proper working condition.
The buildings are not yet fully occupied and total electrical load is likely to increase beyond present level.

Procedure followed during the recording.

The company has work schedule of 12-15hours a day and 5 days a week
.The electrical parameter recording was done for 24 hours duration with High end Power Analyzer to know pattern of consumption throughout the day at strategic locations. Loads in further distribution were recorded for 10 min or for one full load cycle as applicable. After confirming the feeder wise consumption with total incomer consumption, the data was used to prepare energy Pie chart. This data was then analyzed during preparation of this report. Feeder wise Graphical representation of all recorded parameters is attached to this report as annexure, which can remain with you as record.
Simultaneous survey of panel wise earthing arrangement was carried out to know status of earthing.
Detail illumination audit was conducted at all work areas to know illumination levels.
IR Thermography was done for Main incomers, Sub -feeders and for UPS system to further sub-distribution. Loose Terminations were pointed out and suggestions about re-termination were given to concerned persons.

The facility is equipped with VRV HVAC systems for work area. PAC HVAC systems for DC area and ductable splits for UPS rooms and few isolated areas. A detail demand analysis was carried out for all these areas based on

1) Area drawings, known building parameters,
2) Measured occupancy
3) Measured equipment load.
4) Known usage schedules.

These requirements were compared with installed capacities of equipment and their present energy consumption.
Detail HVAC measurements along with thermography was carried out on all installed HVAC equipment to know their present status.

A report based on above data on HVAC system was prepared to know their energy performance and recommendations related to energy saving.

Harmonic Mitigation requirements.

IEEE519 1992 is an international standard followed worldwide for Harmonic mitigation between utility and consumer. Here the utility supply is available from MSEDCL. MSEDCL supply code 2005 will be applicable document for compliance. The clauses to be referred are 12.1 and 12.2. This standard requires that we should calculate a ratio Isc / IL, where Isc is short circuit current of utility supply transformer and IL is consumer's average load current for last 12 months. Once this ratio is known, a table in standard has to be referred to for deciding compliance limit.

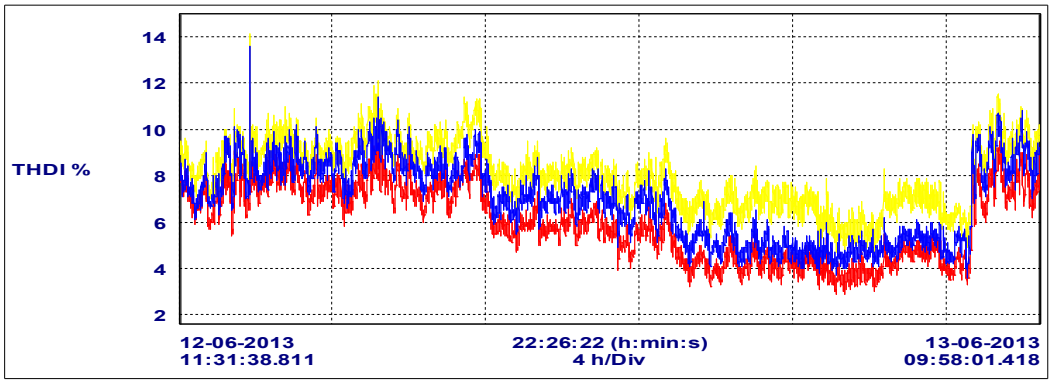
Client: ABC Hinjewadi	
Parameter	**Value**
MSEDCL Transformer Capacity MVA	50.00
MSEDCL Transformer % Impedance	14.93
Contract Demand KVA	1500.00
Max current as per contract demand on LT Side AMPS	2000.12
Max Load Current IL Amps on LT Side AMPS	1257.00
HT System Voltage K Volts	22.00
LT System Voltage	433.00
Full Load current of MSEDCL Transformer Amps	1312.20
Short Circuit current of MSEDCL Transformer IscAmps	**8789.00**
Plant current as per contract demand on HT side	**39.37**
Plant Average load current on HT side	24.74
Isc / IL Ratio as per contract demand	**223.26**
Isc / IL Ratio as per Average Plant Current	355.25

Table showing **Current harmonics level compliance limits as per IEEE 519 – 1992**

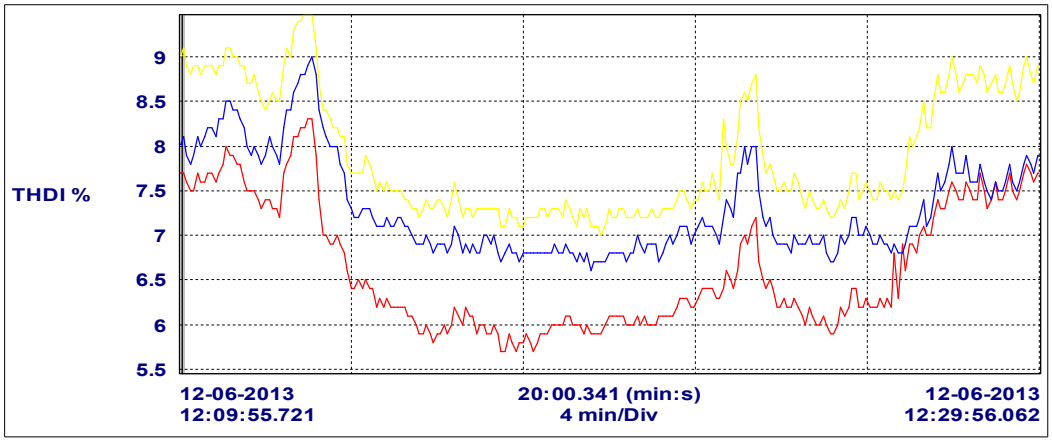
Maximum harmonic current distortion in percentage of IL for voltages less than 22KV.						
Individual harmonic order (odd harmonics)						
Isc/IL	**<11h**	**11=h< 17**	**17=h<23**	**23=h< 35**	**35=h< 49**	**TDD**
<20*	4.00	2.0	1.5	0.6	0.3	5.00
20<50	7.00	3.5	2.5	1.0	0.5	8.00
50<100	10.00	4.5	4.0	1.5	0.7	12.00
100<1000	12.00	5.5	5.00	2.0	1.0	15.00
>1000	15.00	7.00	6.00	3.5	1.4	20.00
Even harmonics are limited to 25% of odd harmonic limits above.						

As per above current harmonics compliance limit is 15% as the ratio is 223 or 355.
The current harmonic distortion observed at main incomer is 12% max with capacitors ON. The same reduces to 7% when capacitors are OFF. This indicates amplification of harmonics due to resonance. The annual electricity bills show that Power factor is unity in every month and full P.F. Incentive is available. This situation needs to be checked whenever load increases. Further whenever these capacitors are to be replaced, they should be replaced with detuned harmonic filters to avoid current harmonic amplification.

Current Harmonics with capacitors ON

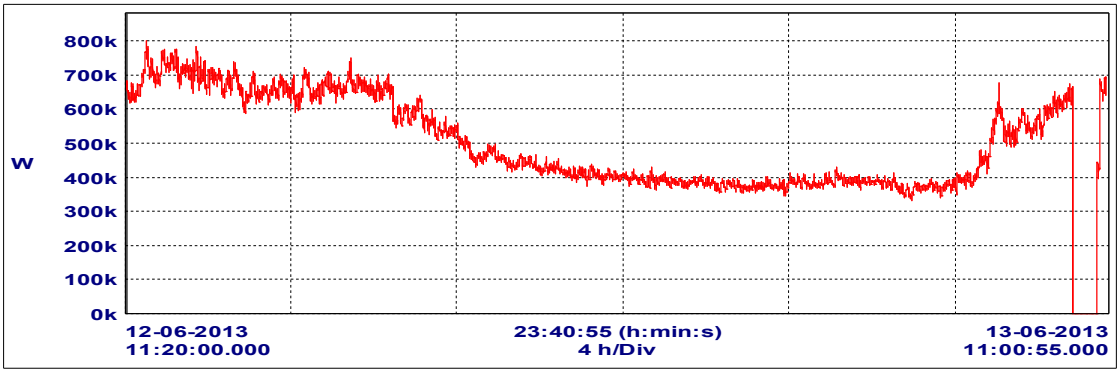


Current Harmonics with capacitors OFF



Above graphs indicate harmonic amplification, which will increase if more capacitors are added to correct power factor after increase in Load.

Summary of recorded running electrical load



Being a typical IT setup, computer load and requirement of conditioned power is almost stable during working hours. In this case distributed air conditioning is implemented using VRV – HVAC systems. At feeder / floor level these HVAC systems act as variable loads, however at PCC, their combined vector addition is a KW load which varies only 15%. So day time average is around 700KW, while night time average is 400KW.

KW Load at main LT incomer

KW at Main feeders	**Avg**	**Peak**
Data Centre AC	57.706	
Data Centre UPS	96.28	149.65
Main UPS Panel + Lighting	217.929	237.913
Core-HVAC + Raw	292.575	340.572
Admin Panel	4.259	8.273
	611.043	736.408

KWH Consumption during day of audit

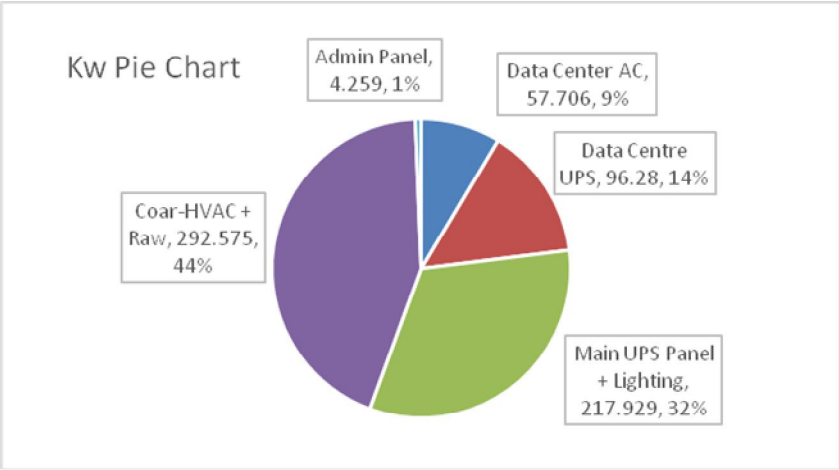
	Duration - 22:50 (h:min)		
Date		Time	Kwh
12/6/2013	Start	11:20 AM	1.13533
13/6/2013	End	10:11 AM	11531.54
	Total		11530.41

Constant consumption day time Kwh	1st slope KWh		
Time	kwh	Time	kwh
11:20 AM	1.13533	5:47 PM	4369.026
5:47 PM	4369.026	10:00 PM	6440.426
KWh (6hrs 27Mins)	4367.891		2071.4

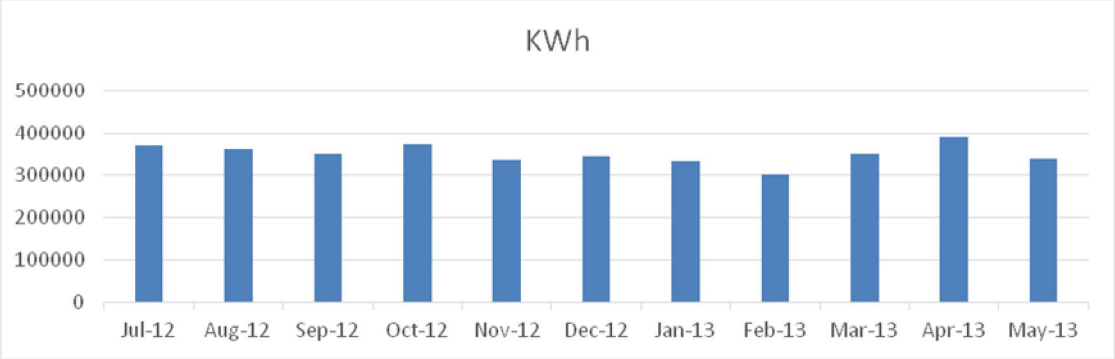
Constant consumption night time Kwh	2nd slope Kwh		
Time	kwh	Time	kwh
10:00 PM	6440.427	7:20 AM	10038.25
7:20 AM	10038.247	10:11 AM	11531.54
KWh (9hrs 20 Mins)	3597.8207		1493.294

This matches to monthly consumption within +/- 10%. Out of 400KW working load during night, 150KW correspond to Data Center AC and Data center UPS, which will be ON as required by process. However it may be worthwhile to investigate remaining 250KW through various SOPs established for the process.

Typical Running KW load under different heads and their % to total running load. (Reference: above data recording)



Monthly KWH consumption during last year



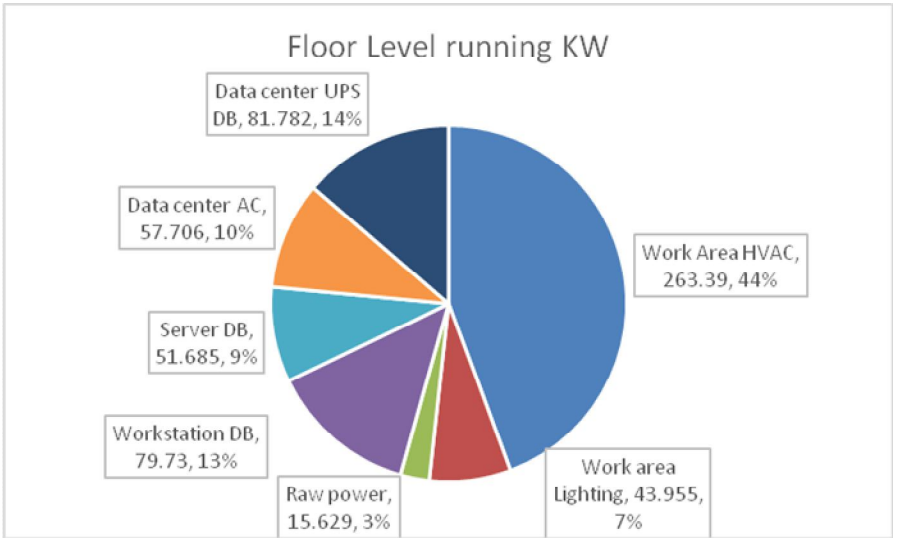
Tariff Analysis:

Month	Total bill paid	KWH recorded	Billed Demand KVA	Billed Power Factor	A	B	C	D	Net TOD	Demand Charges	Energy Charges	FAC	Max PF Incentive	P.F. Incentives	Final Rate Rs./Kwh
May-13	2103334	339106	1018	1	-173445	0	45046.4	54107.9	-74290.7	193420	2146541	-32927.2	156292	156292	6.202586
Apr-13	2439764	387780	990	1	-253800	0	44640	72534	-136626	188100	2454647	84187.04	181322	181322	6.291618
Mar-13	2255718	351160	834	1	-244400	0	40960	64416	-139024	158460	2222843	153281.3	167689	167689	6.42362
Feb-13	1976661	301360	758	1	-217350	0	34144	57354	-125852	144020	1907609	174005.3	146985	146985	6.559134
Jan-13	2150179	334060	758	1	-242400	0	37104	63228	-142068	144020	2114599	166996.6	159848	159848	6.436506
Dec-12	2396600	344860	758	1	-99780	0	38464	64900	3584	144020	2182964	217020.4	178331	178331	6.949488
Nov-12	2529046	335660	792	1	-97740	0	37200	62392	1852	150480	2124728	413734.5	188356	188356	7.534547
Oct-12	2695274	372060	826	1	-105060	0	42032	68508	5480	156940	2355140	348843.5	200648	2000648	7.244193
Sep-12	2880724	349000	732	1	-101780	0	39056	64108	1384	144020	2209170	379223.4	191366	191366	8.254222
Aug-12	2328670	360520	800	1	-87159	0	40096	65714	18651	120000	1979976	354571.4	173124	173124	6.459198
Jul-12	2392468	369240	826	1	-88757	0	42512	66286	20041	123900	2027866	369240	177873	177873	6.479438
Jun-12	2472767	378780	990	1	-87057	0	43152	68618	24713	148500	2080260	372833.2	183841	183841	6.52824
Jun-12	1178139	181140	980	1	-38573	0	20656	33088	15171	63210	994820.9	178296.1	87605	87605	6.504024
May-12	2393834	390880	990	1	-86003	0	45648	71126	30771	148500	2146713	214671.3	177846	177846	6.124218

Except for September 12, the tariff is optimized. During Sept bill "Debit bill adjustment" of Rs. 310617.27 is added to bill which has increased rate / kwh. Apart from seasonal changes, monthly Kwh show steady trend.

Floor Level Loading

Floor Level running KW	
Work Area HVAC	263.39
Raw power	15.629
Work area Lighting	43.955
Workstation DB	79.73
Server DB	51.685
Data center AC	57.706
Data center UPS DB	81.782
Total	**593.877**



It can be noticed from above that work area lighting load is approximately 44/0.85 = 51.76KW. Entire lighting works on UPS output and average UPS efficiency is 85%. Actual lighting load is

44KW, whereas at UPS input it becomes 52KW. Day and night lighting load is almost same. This means 8KW x 24 hours x 300 days = 57600 KWh are spent extra costing you almost Rs.3.5 Lacs annually due to lights working on UPS.

Yet another data collection shows that workstation area UPS are loaded at 185KW during day and 129 KW during night. 44KW lighting load and 52KW server load may be ON during night which works on these UPS. Rest of the 33KW load must be contributed by workstations. In terms of workstations, this is load of around 400 workstations. It will be worth verifying this server and workstation load and it's utility during night. These servers contribute to 292000Kwh and Workstations contribute 185000Kwh during night. Present contribution of this load is Rs.31 Lacs annually.

Summary of Electrical Power Quality Parameters at Critical IT feeders

Combination of 5 x 200KVA UPS						
UPS Tag	Voltage (V)	Frequency (Hz)	% Voltage Distortion	% Current Distortion	Current (A)	KW
UPS-1	231.7	49.89	0.92	39.43	62.25	36.24
UPS-2	230.9	49.89	0.95	39.33	61.91	35.63
UPS-3	231.7	49.89	0.98	41.22	71.83	41.56
UPS-4	231.68	49.89	1.05	72.95	73.03	39.24
UPS-5	231.71	49.89	1.17	60.83	85.77	42.15
Combination of 2 x 200KVA UPS - server						
UPS Tag	Voltage (V)	Frequency (Hz)	% Voltage Distortion	% Current Distortion	Current (A)	KW
UPS-A	232.21	50.04	0.86	13.56	61.36	38.47
UPS-B	229.47	50.04	0.74	15.07	74.93	45

This setup is equipped with 7 numbers of 200 KVA UPS systems. They are arranged in two groups.

1) 5 x 200 KVA work in parallel redundant mode and supply to floor level workstations, floor level servers and work area lighting.
2) 2 x 200 KVA work independently and work as duel source for data center.

Above data is recorded at UPS output terminals while supplying normal load. All UPS systems appear to deliver acceptable power quality to all critical loads.

Power Quality at Floor Level Server DBs							
Floor	Location	Voltage (V)	Frequency (Hz)	% Voltage Distortion	% Current Distortion	Current (A)	KW
A1	DB-1	229.99	49.88	1.59	93.66	2.11	0.769
	DB-2	230.00	49.88	1.59	41.31	14.07	3.61
A2	DB-1	230.12	49.88	1.89	65.69	8.01	2.88
	DB-2	230.27	49.88	1.87	21.32	1.3	0.192
A3	DB-1	229.71	49.89	2.46	26.7	7.32	1.51
	DB-2	229.39	49.88	2.14	19.16	1.46	0.258
A4	DB-1	229.95	49.88	2.3	45.04	2.65	0.477
A5	DB-1	229.98	49.88	1.83	82.91	2.59	0.732
	DB-2	229.57	49.88	1.8	17.77	1.08	0.166
A6	DB-1	229.69	49.88	2.27	60.26	23.16	12.43
	DB-2	229.69	49.88	2.32	60.59	6.22	2.11
Admin	DB-1	231.17	49.88	5.18	17.29	0.371	0.043
	DB-2	230.36	49.88	5.23	50.02	1.08	0.252

Above table shows that power quality parameters for output power available at respective floor DBs is well within limit and clean power is available for the critical loads. As shown voltage distortion for Admin DBs is on higher side and needs investigation.

Power Quality at Floor Level Server DBs							
Floor	Location	Voltage (V)	Frequency (Hz)	% Voltage Distortion	% Current Distortion	Current (A)	KW
B0	DB-1	230.19	49.88	1.56	16.33	1.46	0.404
	DB-2	229.17	49.88	1.54	14.93	0.84	0.184
B2	DB-1	229.99	49.89	2.3	16.61	3.03	0.813
	DB-2	229.82	49.88	2.3	60.45	6.17	1.78
B3	DB-1	229.98	49.88	2.73	12.73	0.797	0.173
	DB-2	229.57	49.88	2.74	12.96	0.705	0.152
B4	DB-1	230.12	49.88	2.6	17.99	21.77	9.61
	DB-2	230.27	49.88	2.63	14.19	0.91	0.176
B5	DB-1	230.21	49.88	2.26	21.74	12.2	3.12
	DB-2	229.96	49.89	2.27	41.94	0.78	0.266
B6	DB-1	229.86	49.88	2.44	92.63	1.23	0.251
	DB-2	230.05	49.88	2.19	53.46	11.04	3.13

Above table shows that power quality parameters for output power available at respective floor DBs is well within limit and clean power is available for the critical loads.

Power Quality at Floor Level Server DBs							
Floor	Location	Voltage (V)	Frequency (Hz)	% Voltage Distortion	% Current Distortion	Current (A)	KW
D0	DB-1	230.21	49.88	1.8	41.84	0.97	0.276
	DB-2	229.96	49.88	1.71	36.31	1.15	0.411
D1	DB-1	229.93	49.88	5.24	36.57	0.95	0.405
D2	DB-1	231.17	49.88	2.79	19.99	1.24	0.23
	DB-2	230.36	49.88	2.81	21.96	0.9	0.143
D3	DB-1	229.96	49.89	0.94	37.12	2.2	0.853
	DB-2	229.84	49.88	0.964	43.62	2.01	0.755
D4	DB-1	229.73	49.89	2.63	19.9	2.32	0.508
	DB-2	230.15	49.88	2.63	4.37	23.06	0.241
E0	DB-1	230.87	49.88	0.9	35.67	1.15	0.413

Above table shows that power quality parameters for output power available at respective floor DBs is well within limit and clean power is available for the critical loads.

Power Quality at Floor Level workstation DBs							
Floor	Location	Voltage (V)	Frequency (Hz)	% Voltage Distortion	% Current Distortion	Current (A)	KW
A1	DB-1	230.01	49.89	1.61	101.66	5.71	2.42
	DB-2	230.36	49.88	1.59	106.28	2.23	0.94
A2	DB-1	229.96	49.88	1.9	78.85	4.85	2.21
	DB-2	230.27	49.88	1.89	79.64	5.28	2.87
A3	DB-1	229.71	49.88	2.13	80.75	6.36	2.85
	DB-2	230.37	49.88	2.13	61.06	6.63	2.47
A4	DB-1	229.82	49.88	2.29	95.83	9.09	3.22
	DB-2	229.39	49.88	2.29	87.42	8.51	3.99
A5	DB-1	230.36	49.88	1.84	78.81	5.39	2.16
	DB-2	229.86	49.88	1.81	79.26	4.22	0.98
A6	DB-1	230.05	49.88	2.2	72.99	6.57	2.95
	DB-2	229.42	49.88	2.24	76.49	7.28	2.55
Admin	DB-1	230.53	49.88	5.15	91.45	2.22	0.911
	DB-2	230.36	49.88	5.15	96.45	1.98	0.669

Above table shows that power quality parameters for output power available at respective floor DBs is well within limit and clean power is available for the critical loads. As shown voltage distortion for Admin DBs is on higher side and needs investigation.

Power Quality at Floor Level workstation DBs							
Floor		Voltage (V)	Frequency (Hz)	% Voltage Distortion	% Current Distortion	Current (A)	KW
B0	DB-1	230.21	49.89	1.54	70.61	3.82	1.46
	DB-2	229.86	49.88	1.54	77.98	3.6	1.4
B2	DB-1	229.82	49.88	2.28	78.4	7.55	3.3
	DB-2	230.14	49.88	2.28	78.6	5.63	2.83
B3	DB-1	229.34	49.88	2.73	68.7	7.43	3.38
B4	DB-1	230.36	49.88	2.55	74.04	6.72	2.85
	DB-2	229.96	49.88	2.58	73.23	4.32	1.97
B5	DB-1	231.17	49.89	2.26	74.96	4.53	1.8
	DB-2	230.36	49.88	2.27	61.75	2.93	1.43
B6	DB-1	230.27	49.88	1.53	82.24	6.78	3.51
	DB-2	229.71	49.88	1.63	75.17	7.53	3.55

Above table shows that power quality parameters for output power available at respective floor DBs is well within limit and clean power is available for the critical loads.

Power Quality at Floor Level workstation DBs							
Floor	Location	Voltage (V)	Frequency (Hz)	% Voltage Distortion	% Current Distortion	Current (A)	KW
D0	DB-1	230.45	49.88	1.24	110.83	3.76	1.26
	DB-2	229.82	49.88	1.79	92.9	3.34	1.01
D1	DB-1	229.53	49.88	4.42	70.12	5.4	2.41
	DB-2	230.12	49.88	4.52	79.14	6.39	2.71
D2	DB-1	229.64	49.88	2.83	75.59	2.64	0.604
	DB-2	229.86	49.88	2.83	90.91	3.94	1.03
D3	DB-1	230.05	49.88	0.96	75.76	5.14	2.16
	DB-2	230.21	49.89	0.97	73.48	2.83	1.28
D4	DB-1	230.27	49.88	2.66	74.9	1.21	0.393
	DB-2	229.71	49.88	4.37	90.26	4.73	1.38

Above table shows that power quality parameters for output power available at respective floor DBs is well within limit and clean power is available for the critical loads. As shown voltage distortion for D4 DB - 2 is on higher side and needs investigation.

UPS performance and efficiency analysis.

UPS arrangement and loading

UPS Group 1
At present only 3 systems are working.
5 x 200 KVA UPS are located in basement UPS room. Batteries are arranged in a separate room near UPS room. **At present loading, this room receives almost 25KW heat load (Input – Output as above) released by these UPS systems.**
5 x 200 KVA UPS Parallel combination receives input from either of the transformers. The output is taken to respective floors through bus raisers A,B and D,E.
Each level has a HVAC/Electrical Gallery, which selects the source from these raisers through automatic switch and further distributes it for Lighting, Floor Server and workstations.

UPS Group 2
At present both the systems are working.
2 x 200 KVA UPS are located on Datacenter floor and serve as dual power source for data center equipment. The load on these UPS is 83KW. **At this loading, the UPS room receives almost 13 KW heat load released by these UPS systems.**

Day / Night UPS loading on UPS and corresponding loss as per recorded data.

Total UPS power required – Day time			
	Input	Output	Loss
Total	306.48	268.97	37.51
Total UPS power required - Night time			
Total	251.47	212.75	38.72

This indicates that about 3Lacs Kwh or Rs.20 Lacs are spent annually on generating clean / uninterrupted electrical power for IT load.

UPS Performance Analysis

Location	**Data Center Load 2 x 200KVA**					
	UPS Input	UPS Output	efficiency			
A1	44.83	38	0.85			
B1	51.45	45	0.87			
Total	96.28	83				
	Total Loss for 24 hours	13.28				
As shown above data center UPS work with 85% efficiency and total loss is about 13KW. With higher efficiency UPS configuration there is possibility of saving 9KW. On yearly basis this amounts to savings of Rs. 5 Lacs at present tariff.						

Location	Combination of 3 UPS 3 x 200KVA Parallel					
UPS	Day			Night		
	Input	Output	Efficiency	Input	Output	Efficiency
1	67.33	59.44	0.88	50.065	42	0.84
4	72.57	63.68	0.88	53	45.15	0.85
5	70.3	62.85	0.89	52.12	42.6	0.82
Total	210.2	185.97	0.88	155.19	129.75	0.84
	Total Loss during day		24.23			
	Total Loss during night		25.435			

As shown above work station UPS work with 85% (average) efficiency and total loss is about 25KW. With higher efficiency UPS configuration there is possibility of saving 15 KW. On yearly basis this amounts to savings of Rs. 8.5 Lacs at present tariff.

1st Year savings in energy cost	1350000.00
2nd year savings in energy cost	1485000.00
1 year AMC cost of old UPS systems	700000.00
Cost of harmonic filters	1000000.00
Scrap Value of Old UPS	2000000.00
Total Savings Possible in 2 years	**5535000.00**

Salvage value of OLD UPS can be almost double if they are auctioned.

EARTHLING TEST RESULTS

All electrical distribution panels were tested for proper earthing. More than 180 locations were tested for earth resistance. Following results were not satisfactory. At some places earth strip accessibility was not suitable for tester in use.

Location	Earth Resistance in Ohms
Data Center PDU B2	OPEN
E0 -VRV Panel	OPEN
D4 -Main UPS DB	OPEN
D4- VRV Panel	OPEN
core 3 stilt panel room all Panels	OPEN
C Building Main UPS DB	OPEN
B1 VRV DB	OPEN
B4 UPS DB	OPEN
A1 VRV DB	OPEN
A4 VRV DB	OPEN
APFC Panel MLTP-2	OPEN
E0- LDB	Not Accessible
E0- UPS DB	Not Accessible
C BUILDING VRV DB	Not Accessible
A6 Main common DB	Not Accessible

It is advised that above situations should be rectified. At rest of the places the earthing resistance was satisfactory.

Average area wise Lux Measurement.

In following areas the illumination level was found to be extremely Low. We are not aware of any standard being followed at ABC regarding illumination levels. In general the illumination levels are on lower side throughout the work areas. However following is a list of areas with identifiers, where the same was found to be extremely low. Detail area wise measurement is included elsewhere in this report.

LUX LEVEL REPORT						
Cubicle No	**1**	**2**	**3**	**4**	**Avg.**	**Remark**
A Building 1st Floor Workstation Area						
6	57				57	Low
10	68				68	Low
13	63				63	Low
24	95				95	Low
Cabin 2	57				57	Low
A Building 2nd Floor Workstation Area						
1	90				90	Low
30	95				95	Low
TL2	92				92	Low
A Building 3rd Floor Workstation Area						
2	97				97	Low
24	75				75	Low
25		99			99	Low
Cabin 2	93				93	Low
A Building 4th Floor Workstation Area						
Cabin 1	68				68	Low
Cabin 2	73				73	Low
A Building 5th Floor Workstation Area						
12			77		77	Low
16		95			95	Low
21	82				82	Low
25	95				95	Low
Cabin 2	56				56	Low
Disc 2		87			87	Low
Small Conff 1		80			80	Low
B Building 0th Floor Workstation Area						
9	80				80	Low
12	93				93	Low
14	98				98	Low
Cabin 1	93				93	Low
B Building 1st Floor Workstation Area						
7	48				48	Low
11	98				98	Low

LUX LEVEL REPORT						
Cubicle No	**1**	**2**	**3**	**4**	**Avg.**	**Remark**
B Building 2nd Floor Workstation Area						
29	92				92	Low
B Building 3rd Floor Workstation Area						
1	87				87	Low
B Building 4th Floor Workstation Area						
8	98				98	Low
21	52				52	Low
28	84				84	Low
Cabin 2	95				95	Low
B Building 5th Floor Workstation Area						
10	75	98			86	Low
27		93			93	Low
TL5		81			81	Low
Cabin 2	77				77	Low
B Building 6th Floor Workstation Area						
25	74				74	Low
D Building 1st Floor Workstation Area						
3		89			89	Low
4	73				73	Low
25	98				98	Low
Small Conff 1	99				99	Low
D Building 2nd Floor Workstation Area						
15	97				97	Low
25	97				97	Low
Cabin 1	97				97	Low
Small Conff 1	89				89	Low
D Building 3rd Floor Workstation Area						
9	55				55	Low
TL6	97				97	Low
Small Conff 2		84			84	Low
D Building 4th Floor Workstation Area						
9		87			87	Low
14	97				97	Low
Big Conff 1	97				97	Low
C0	**LUX**	**Remark**				
Garnet	89	Low				
Admin office	81	Low				

The work area illumination power requirement is about 44KW or 7% of total consumption. At present you are spending 15% extra over this by connecting this load to UPS output. You can spend this 15% extra on illumination without increasing total energy requirement and generate more illumination by connecting this load directly to utility supply.

Infrared Thermography test results

Infrared thermography was carried out on all working electrical LT side feeders while they were carrying normal current. Following are few alarming observations. Audit team had identified these and other thermographed feeders where some corrective action was required by sticking stickers.

MLTP - 1 - APFC Panel		
Tag	**Nature of Fault - hot spot**	**Required action**
5F3 50 KVAR - Y phase	Cable loose - 58.4 C	Needs tightening
5F2 50 KVAR - B phase	Cable loose - 58.8 C	Needs tightening
APFC Feeder - Y & B phase	Cable loose in lug - 52.3 C	Needs tightening
MLTP - 2 - APFC Panel		
Tag	**Nature of Fault - hot spot**	**Required action**
Main incomer - R & Y phase	Cable loose in lug - 93.5 C	Needs tightening
Main incomer - load side - R phase	Busbar loose in bolt-65.5C	Needs tightening
F-8 Contactor - all cables	Cable loose - 46.4 C	Needs tightening
F-6 contactor - Y & B phase	Cable loose - 93.7 C	Needs tightening
3rd floor - Data center		
Tag	**Nature of Fault - hot spot**	**Required action**
PDU - B1 - Cable no. R4 & R10	Cable loose - 53.4 C	Needs tightening
Server UPS Room - AC Panel - 2		
Tag	**Nature of Fault - hot spot**	**Required action**
3F5 - MCCB - R phase	Cable loose in lug - 63.3 C	Needs tightening
3F5 - MCCB - bus R phase	Cable loose in lug - 70.4 C	Needs tightening
D - 0th floor		
Tag	**Nature of Fault - hot spot**	**Required action**
Server DB -2 - MCB R phase	Cable loose - 50.9 C	Needs tightening
A - 0th floor		
Tag	**Nature of Fault - hot spot**	**Required action**
UPS DB -2 - MCB Neutral	Cable loose - 214.7 C	Needs tightening
B - 2th floor		
Tag	**Nature of Fault - hot spot**	**Required action**
UPS DB -2 - MCB Y phase	Cable loose - 72 C	Needs tightening
A - 4th floor		
Tag	**Nature of Fault - hot spot**	**Required action**
VRV Panel - MCCB - R phase	Cable loose in lug - 50.3 C	Needs tightening
B - 5th floor		
Tag	**Nature of Fault - hot spot**	**Required action**
VRV DB - B phase	Cable loose - 44 C	Needs tightening

A - 5th floor		
Tag	**Nature of Fault - hot spot**	**Required action**
UPS DB -1 MCB - B phase	Cable loose - 45.4 C	Needs tightening
Auditorium		
Tag	**Nature of Fault - hot spot**	**Required action**
AHU Panel - MCCB - Y phase	Busbar loose in bolt-42.5 C	Needs tightening

----------END OF ENERGY AUDIT REPORT----------