Energy Audit Report

FOR

A LEADING PAHRMACEUTICAL MNC

By

SAS Powertech Pvt Ltd.

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Behind Opulent Car Care Center Baner, Pune 411045

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Audit Period Site work: 8th to 15th March 2016

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Audit Team

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Audit Methodology:

1) Study energy bills for last 12 months and understand the trend.
2) Record electrical energy parameters for 24 hours at major feeders and for strategic time for other feeders to know consumption of various utilities and processes.
3) Pie chart above measurements and decide significant use of energy.
4) Understand operation of various utilities.
5) Undertake demand analysis of various utilities wherever possible.
6) Compare operating parameters of these utilities with demand and estimate the difference.
7) Inspect utility equipment while they are working, collect measurements of various parameters, asses working of these equipments for energy performance.
8) Recommend energy saving measures, required investments and estimated paybacks based on above study.
9) Prepare a report based on above and present.

Major utilities at plant:

1) HVAC – chilled water / hot water based systems for various processes.
2) Furnace oil fired Boilers for steam generation.
3) Compressed air system.
4) Lighting system.
5) Water handling.
6) Electrical distribution system.

Summary of proposed energy savings

Sr	Area of savings	Possible saving INR million / year	Required investment INR million	Category	Payback Months
1	HVAC system redesign and modifications to suit assessed demand and avoid present losses.	9.5	4.5	High cost	6
2	Increasing Chiller delta T after above modifications	0.45			0
3	Using heat pumps for Hot water Generation	1.24	1.84	High cost	18
4	Using heat pumps for FBE	0.83	5.0	High cost	72
5	Illumination	1	3	High cost	36
	Total	**13.02**	**14.34**		**14**
6	Electrical demand does not touch 75% of 2800KVA contract demand. Plant has to pay for 75% demand as per rules. This results into payment of around Rs. 1 Lac extra every month.				
Recommended HVAC modifications will bring down CT makeup water need to 28 KL per day from present level of 64 KL per day.					
	Modifications in existing systems for energy saving *(Not relevant if use of boiler is discontinued and CT requirement is reduced)*				
1	Increasing boiler feed water temperature by steam purging	0.48	Negligible	Low cost	Immediate
2	Cooling tower fan temperature control	0.1	Negligible	Low cost	Immediate
	Total	**0.55**	**Negligible**		**Immediate**
Present cost of average annual energy consumption is around INR 66 million. **This indicates that the savings proposed by this audit are around 19% of present consumption, with overall payback of about 14 months.** These payback calculations do not consider cost of rental equipment required if any during the modifications suggested to continue the production.					

1) While undertaking demand analysis we have considered data from DQs made available to us, we advise that **** should reconfirm the HVAC demand side before implementation.
2) Once the demand is confirmed, **** can think about modifying existing HVAC system or shifting HVAC equipment near to point of use and have simple independent redundant systems for each block.
3) If recommendations 1 through 4 are implemented, **** can reassess use of boilers.
4) Such implementation will theoretically release some Chiller equipment. The financial impact of this is not considered in above summary.
5) Continuous electrical consumption recording shows requirement of reactive power, which means power factor is not maintained at unity. This may be achieved if the APFC panels work in auto mode. We will be able to throw more light on commercial gains if we know the PF incentive scheme offered by ELECTRICITY BOARD.
6) Detail justification of modifications and demand analysis of HVAC systems is enclosed in a separate report.
7) Assessment of other utilities is also enclosed in this report. As of now there are limited saving potentials in this area.

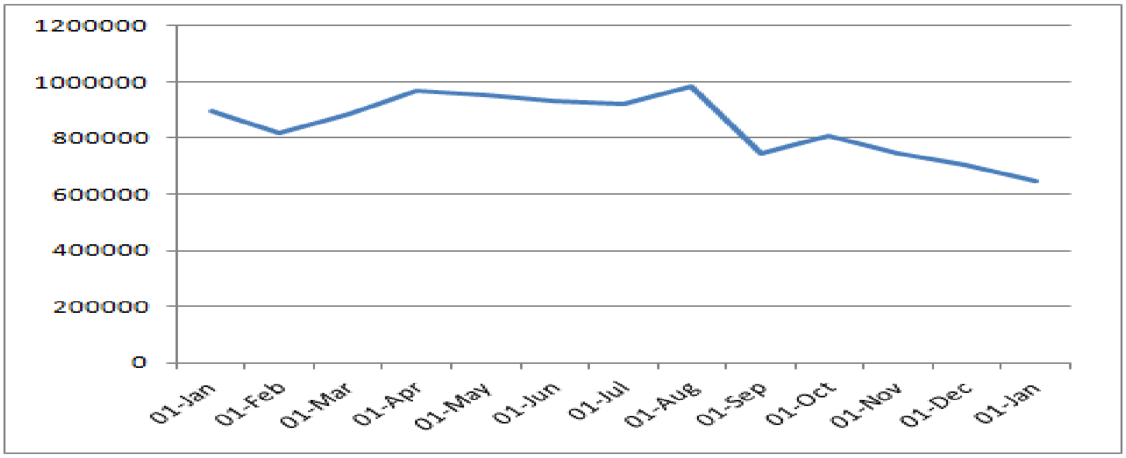
Description of energy infrastructure at **** ****.

This is a typical pharmaceutical manufacturing setup using following forms of energy:

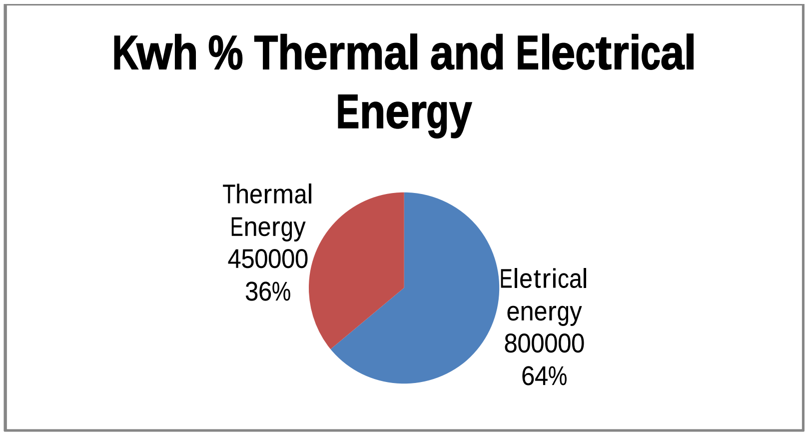
Sr	Form of Energy	Monthly consumption	Use
1	Electrical	800000Kwh	Plant operations and utility
2	Furnace Oil	40000Kg / 450000Kwh	Steam generation

Thermal energy in the form of furnace oil / briquettes is used with boilers for generating steam. This steam is used in hot water generation and dryers.

Electrical energy is received at 33 KV from ELECTRICITY BOARD in 2 x 2500 KVA step down transformers. The Maximum demand is about 1800KVA. The KWh pattern for last 12 months is as follows

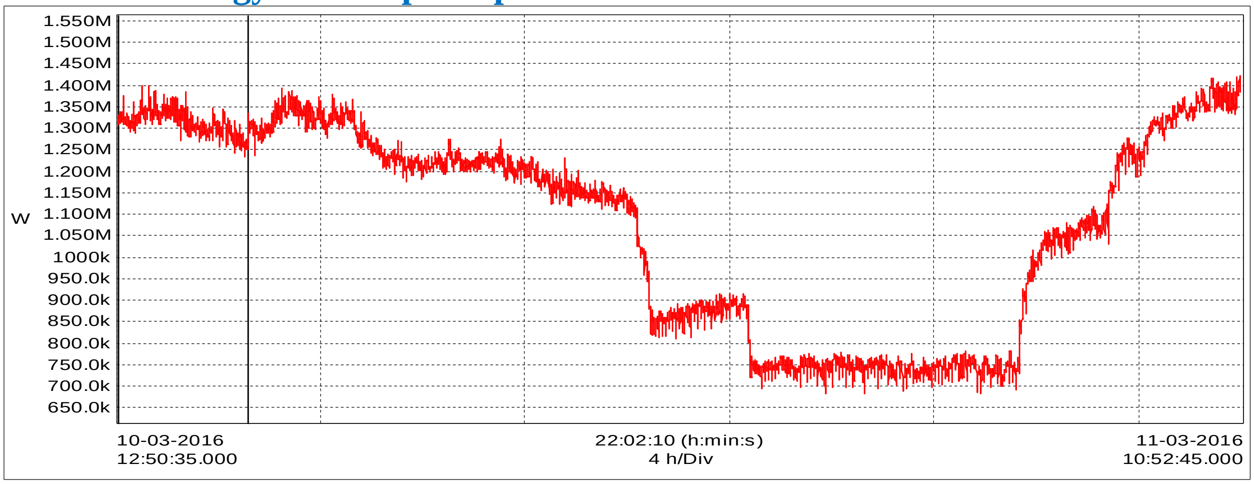


Month	15-Jan	15-Feb	15-Mar	15-Apr	15-May	15-Jun	15-Jul	15-Aug	15-Sep	15-Oct	15-Nov	15-Dec	16-Jan
KWH	894240	817380	887280	968580	954300	932580	921720	982920	744240	809100	746880	704940	647760

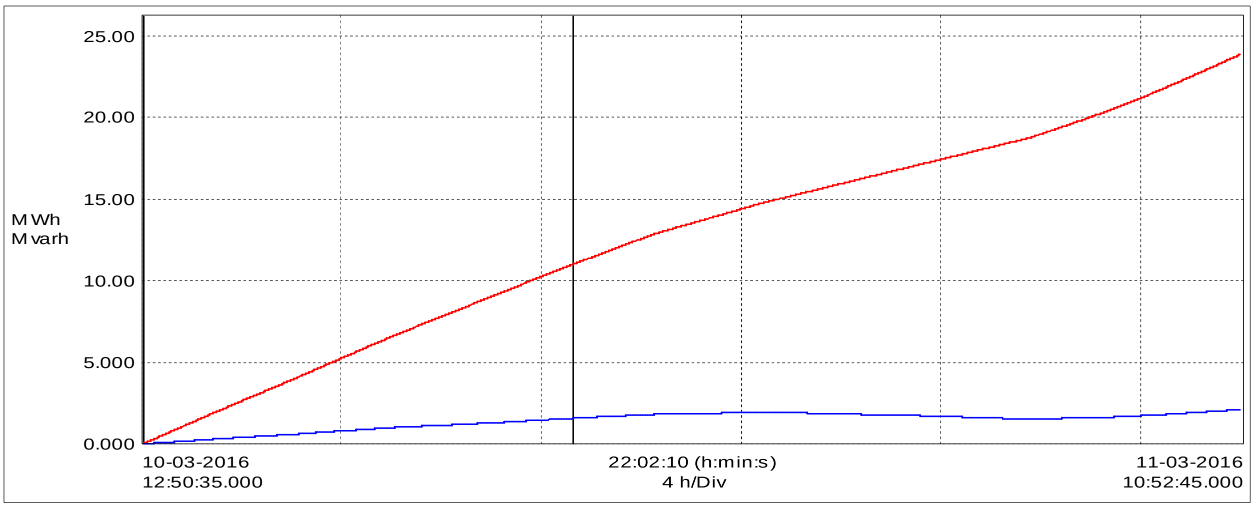


This indicates that thermal energy is 36% and Electrical energy is 64%.

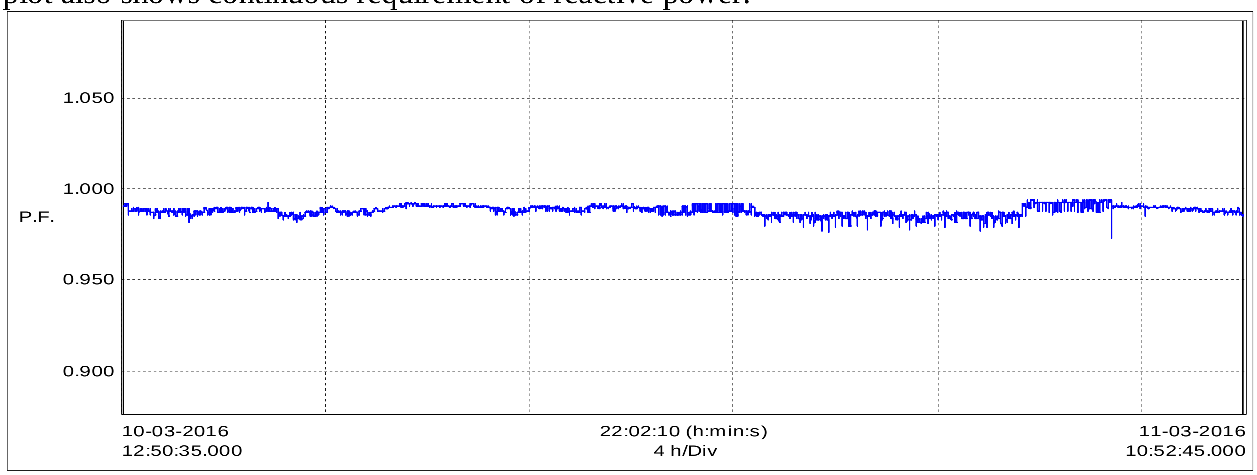
Electrical energy consumption pattern for 24 hours



As shown above, the peak load of 1300KW prevails from 11AM to 6PM. During 1AM to 6 AM the load is around 750KW.



As shown above Energy consumption plot shows consumption of 23878 Kwh in 22 hours. The plot also shows continuous requirement of reactive power.



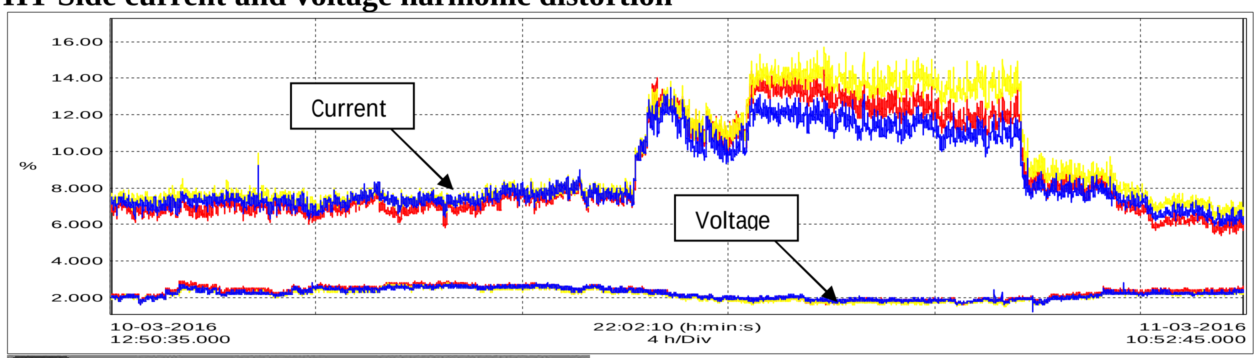
As shown above power factor is continuously bellow unity.

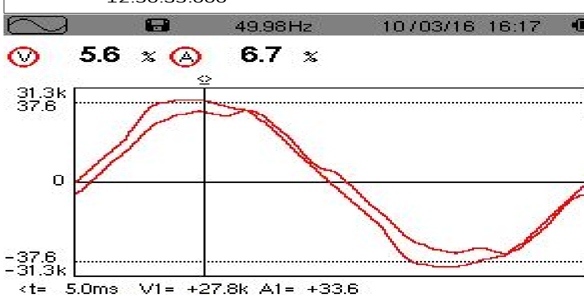
Assessment of demand utilization and transformer loading

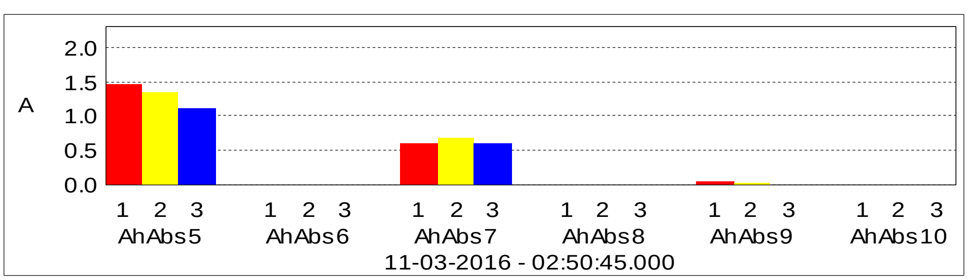
Point in distribution	Rating/ contract demand KVA	KVA			PF	Distortion		% Loading
		AVG	MIN	MAX		I Thd%	V Thd%	
HT	2800	1096	698	1442	0.988	5.4 - 15.7%	1.2 – 2.9%	52%
Tr1 sec	2500	653	533	812	0.985	12 – 21%	2.7 – 4.6%	32%
Tr2 Sec	2500	440	153	646	0.953	2.9 – 15.3%	1.1 – 2.6%	26%

1) As shown above contract demand is utilized for 52%. ELECTRICITY BOARD charges for minimum 75% of contract demand and due to this plant is paying around Rs.100000 extra every month as fixed charge. **** may think about reducing contract demand based on decision regarding implementation of energy saving majors.
2) Transformer 1 and 2 can be loaded for another 25%. We advice correction of power factor for both the transformers in auto mode and use of thyristor switched detuned filters for both to help reduce current harmonics during night time. Tr 1 and 2 efficiency may be marginally low due to underloading.

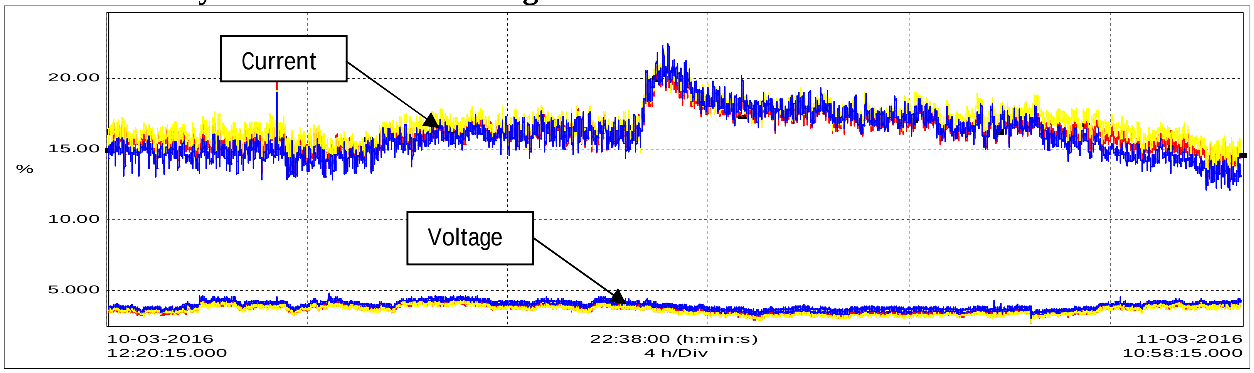
HT Side current and voltage harmonic distortion



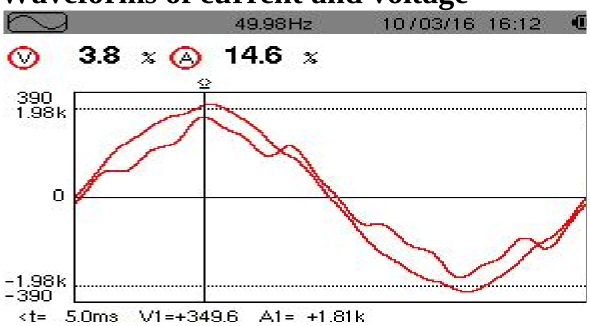




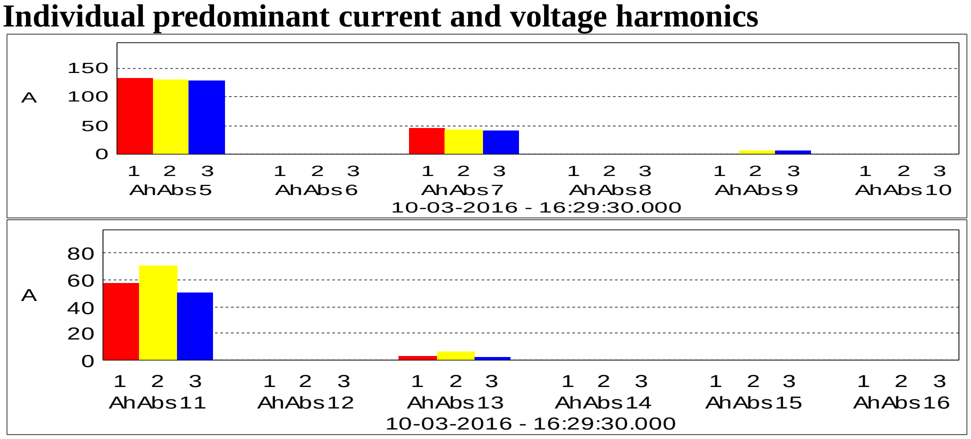
TR 1 secondary side current and voltage harmonic distortion



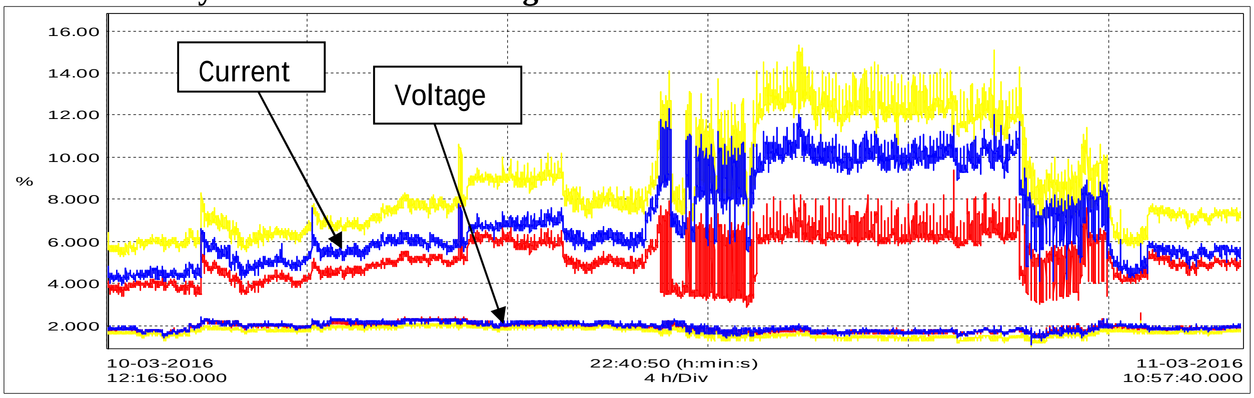
Waveforms of current and voltage



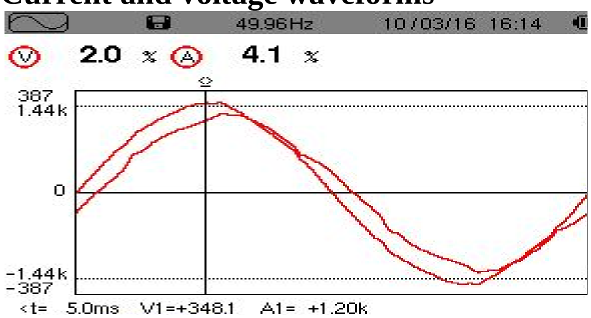
Individual predominant current and voltage harmonics



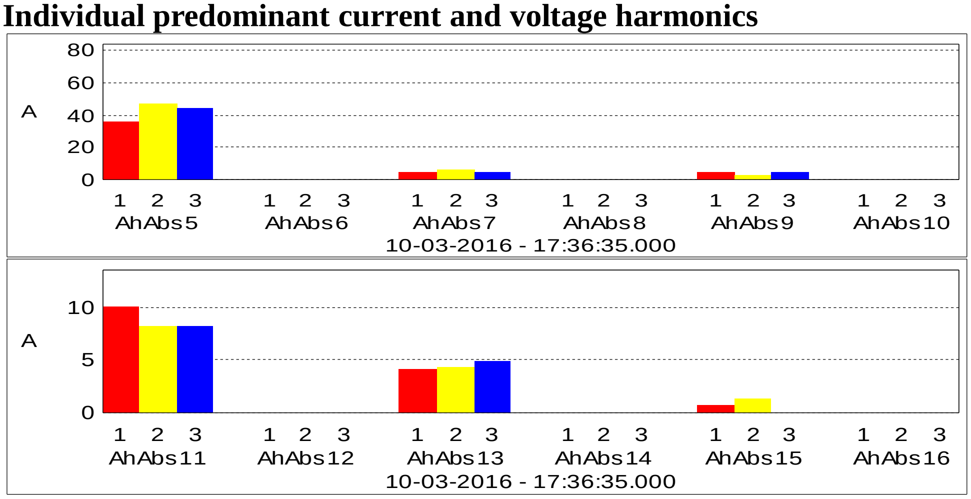
TR 2 secondary side current and voltage harmonic distortion



Current and voltage waveforms



Individual predominant current and voltage harmonics



The graphs above show current and voltage harmonics trends on 24 hours basis on HT side, at Tr1 secondary and Tr2 secondary. It is clear from above that there is harmonic amplification due to only capacitive correction offered to one of the transformers. Further in case of both the transformers the reactive power correction is manual and as such the same is on leading side during night.

This makes both the transformers handle increased harmonics. In case of transformer 1, occasionally voltage distortion is reaching the value of 5%, which is limit prescribed by various standards. Such distorted voltage can cause damage to complex electronic circuits like VFDs. Electrical noise generated can cause malfunction of digital circuits. Distorted voltage forces distorted currents through normal linear loads causing increased electrical losses.

All this can be avoided by having automatic power factor control using thyristor switched detuned filters in place of ordinary capacitors, or contactor switched filters. These are investments to improve power quality within the plant and have nontangible returns.

Power Quality parameters at various locations in electrical distribution

Sr no	HT	Voltage L-L Avg V	Voltage L-L Max V	THD V % Avg	THD V % Max	Currant Avg A	Currant Max A	THD I % Avg	THD I % Max	KW Avg	KW Max	KVAR Avg	KVAR Max	P F Avg	P F Max
1	HT	32.6	34.3	2.25	3	19.55	27.1	9.55	15.9	1081.5	1425	94.4	420.1	0.99	0.99

Sr no	LT	Voltage L-L Avg V	Voltage L-L Max V	THD V % Avg	THD V % Max	Currant Avg A	Currant Max A	THD I % Avg	THD I % Max	KW Avg	KW Max	KVAR Avg	KVAR Max	P F Avg	P F Max
1	Transformer 1	415.0	425.6	3.7	4.6	915	1184	16.4	22.5	642.85	803.6	111.6	213.7	0.98	0.99
2	Transformer 2	417.25	429.7	1.95	3.8	631.5	932	7.5	19.8	426.65	639.3	47.55	316.6	0.96	1.00

Sr no	DG	Voltage L-L Avg V	Voltage L-L Max V	THD V % Avg	THD V % Max	Currant Avg A	Currant Max A	THD I % Avg	THD I % Max	KW Avg	KW Max	KVAR Avg	KVAR Max	P F Avg	P F Max
1	DG Main Incomer	412	416.5	2.3	2.6	1966	2052	4.9	5.4	1225	1288	636.6	660.4	0.89	0.89

Sr no	TR-1 - HVAC	Voltage L-L Avg V	Voltage L-L Max V	THD V % Avg	THD V % Max	Currant Avg A	Currant Max A	THD I % Avg	THD I % Max	KW Avg	KW Max	KVAR Avg	KVAR Max	P F Avg	P F Max
1	Chiller NO -2	417.9	422	4.5	4.8	267.9	281.1	8.7	9.3	149.5	160.2	113.4	117.5	0.8	0.81
2	Cond.W.pump-1	405.2	407.6	4.8	5.1	51.6	52.1	43.8	45.2	31.4	31.6	5.1	5.3	0.9	0.91
3	Cond.W.pump-3	405.2	406.1	4.8	5.1	25.7	26.1	69.5	71.7	13.7	13.8	9.2	10.1	0.81	0.82
4	Cooling Tower -1	416.1	417	4.3	4.5	8.6	8.7	5.2	5.8	3.1	3.2	5.2	5.3	0.51	0.52
5	Cooling Tower -2	416	417	4.4	4.5	12	12.1	3.3	3.5	4.9	5	6.9	6.9	0.58	0.58
6	primary Chill-W-Pump-2	410.7	412	4.6	4.8	25.4	25.6	8.7	9.6	12.2	12.4	12.2	12.3	0.71	0.71
7	Secondary Chilld-1-pump-1	412	414	4.5	4.7	98.7	99.2	6.2	6.4	60.8	61.2	32	32.5	0.88	0.89

Sr no	Chiller (24 Hour)	Voltage L-L Avg V	Voltage L-L Max V	THD V % Avg	THD V % Max	Currant Avg A	Currant Max A	THD I % Avg	THD I % Max	KW Avg	KW Max	KVAR Avg	KVAR Max	P F Avg	P F Max
1	Chiller No-1	413.25	422.2	4.2	4.9	236.95	298.2	9.75	34.2	138.15	178.6	89.9	114	0.835	0.87
2	Chiller No-2	411	421.7	4.4	5.2	254	303.6	7.8	9.2	160.3	172.4	108.1	120.8	0.83	0.85

Sr no	UPS	Voltage L-L Avg V	Voltage L-L Max V	THD V % Avg	THD V % Max	Currant Avg A	Currant Max A	THD I % Avg	THD I % Max	KW Avg	KW Max	KVAR Avg	KVAR Max	P F Avg	P F Max
1	60KVA UPS output (Manufacturing PDB) (Block -2)	396.6	396.7	0.5	0.7	52	55.4	44.3	47.5	22.8	23.9	10	10.4	0.92	0.92
2	60KVA UPS-1 Input	409.8	413.5	5.5	5.8	28.8	30.9	68.5	70	13.4	14.5	14.1	15.3	0.69	0.7
3	60KVA UPS-1 output	396.6	396.6	0.5	0.6	25.8	26.5	45.2	46.8	11.5	12.5	4.8	4.8	0.92	0.94
4	60KVA UPS-2 Input	406.8	408.5	5.8	6.1	33.3	39.1	57.4	65.3	16.3	19.4	15	17	0.73	0.75
5	60KVA UPS-2 Output	396.3	396.6	0.5	0.7	29.1	33.2	35.7	45.7	14.3	17.3	5	5.4	0.94	0.96
6	160KVA UPS output (R&D PDB)(Block-1)	397.9	398.4	0.4	0.5	163.7	181.8	20.3	25	102.8	114	-6.7	8	0.98	0.98
7	160KVA UPS-1 input	408.1	410.8	5.6	5.9	110	117.8	48.5	52.2	58	62.8	49.6	53	0.76	0.78
8	160KVA UPS-1 output	397.8	398.1	0.4	0.5	80.3	94.7	17	21.1	52.7	57.8	-3.2	-3.7	0.99	0.98
9	160KVA UPS-2 input	407.3	408.4	5.5	5.8	118.9	127.8	42.7	44.7	63.6	69.2	49.6	53.1	0.79	0.8
10	160KVA UPS-2 output	397.8	398	0.4	0.5	95	102.7	22.7	27.9	58.2	64	-5.1	-5.7	0.98	0.97

Sr no	UPS output	Voltage L-L Avg V	Voltage L-L Max V	THD V % Avg	THD V % Max	Currant Avg A	Currant Max A	THD I % Avg	THD I % Max	KW Avg	KW Max	KVAR Avg	KVAR Max	P F Avg	P F Max
1	60KVA UPS output (Manufacturing PDB)(Block-2)	396.7	397.1	0.6	1	52.4	71	39.1	52.6	25.8	39.4	8.9	13.2	0.93	0.95
2	160 KVA UPS output R & D	398	398.5	0.4	0.6	149	238.2	18.7	27.8	101.1	139.5	-0.045	7.1	0.98	0.99

Above table gives recorded power quality parameters at all major electrical feeders within electrical distribution. The voltage distortion appears to be on higher side for feeders emerging from transformer 1 secondary.
At rest of the feeders, all power quality parameters appear to be within limit.

Sr no	TR-2 - HVAC (Utility MCC)	Voltage L-L Avg V	Voltage L-L Max V	THD V % Avg	THD V % Max	Currant Avg A	Currant Max A	THD I % Avg	THD I % Max	KW Avg	KW Max	KVAR Avg	KVAR Max	P F Avg	P F Max
1	Air Com -No-2	408.2	413.7	1.7	1.9	83.7	87.9	4.4	9.9	43.8	46.7	26.6	27.9	0.85	0.87
2	Boiler No - G-253	411.3	422.6	1.4	4.3	12.4	165.7	0.95	15.3	6.5	72.6	5.2	92.3	0.8	0.89
3	Boiler No. G-140	410.5	418.6	4	4.5	18	75	6.9	18.3	11.1	37.2	6.2	38.7	0.84	1
4	Borewell-1	410.1	411.8	1.7	1.9	6.5	6.5	2.8	3.1	2.2	2.3	3.8	3.8	0.51	0.51
5	Borewell-2	407.7	408.4	1.7	1.8	3.1	3.2	2.7	4.7	1.5	1.6	1.5	1.5	0.7	0.72
6	Borewell-3	408.8	410.7	1.7	1.9	6.7	6.8	4	4.3	2.7	2.9	3.6	3.6	0.6	0.63
7	Borewell-4	412.2	413.1	1.6	1.8	7.3	7.3	2.7	3	3.8	3.8	3.2	3.3	0.76	0.76
8	Chiller No-3	414.4	421.7	1.8	2	218.3	227	3.1	3.6	117.7	124.9	86.2	91.2	0.8	0.83
9	Chiller No-4	414.2	421.7	1.8	2.1	224.8	243	2.8	3.3	131.7	145.2	84.1	89.7	0.84	0.87
10	Cooling Tower -5	414.4	417.5	1.7	1.8	30.6	31	2.4	2.7	16.3	16.5	13.5	13.7	0.77	0.78

Sr no	TR-2 - HAVAC Panel - Block -2 Panel	Voltage L-L Avg V	Voltage L-L Max V	THD V % Avg	THD V % Max	Currant Avg A	Currant Max A	THD I % Avg	THD I % Max	KW Avg	KW Max	KVAR Avg	KVAR Max	P F Avg	P F Max
1	CDS.W.Pump-1	416.8	420	1.5	1.6	36.2	36.5	1.6	1.9	19.6	19.8	15	15.2	0.79	0.8
2	CDS.W.Pump-3	412.9	414.4	1.6	1.7	36.3	36.4	1.9	2.1	20	20.2	14.6	14.7	0.81	0.81
3	Cooling Tower -4	415	420.2	1.5	1.7	14.6	14.8	0.98	1.2	7	7.1	7.4	7.6	0.69	0.69
4	Cooling Tower-3	418.1	421.2	1.5	1.6	16.1	16.2	0.89	1	7.3	7.3	8.8	8.9	0.64	0.65
5	PRI.CHW pump-1	416.4	419.5	1.5	1.6	20.1	20.3	1.6	2.1	11.4	11.5	7.6	7.7	0.83	0.83
6	PRI.CHW pump-2	412.5	414.1	1.6	1.7	19.7	19.9	1.7	2	11.1	11.3	7.5	7.5	0.83	0.83
7	Sec.CHW-Pump-3	411.6	414.3	1.7	1.8	34.7	35	2.6	2.9	19	19.2	13.4	13.7	0.82	0.82
8	Sec-CHW-Pump-2	413.7	415	1.7	1.8	28.2	28.6	3.8	4	15.8	16.1	9.5	9.6	0.86	0.86

Sr no	Chiller (24 Hour)	Voltage L-L Avg V	Voltage L-L Max V	THD V % Avg	THD V % Max	Currant Avg A	Currant Max A	THD I % Avg	THD I % Max	KW Avg	KW Max	KVAR Avg	KVAR Max	P F Avg	P F Max
1	Chiller No.04..	413.3	425.2	1.75	7.2	170.8	254.2	5.3	18.5	99.6	147	64.1	89.7	0.825	0.88
2	Chiller No-3	411.8	425.4	1.8	6.1	169.53	240	4.7	13.9	93.667	136.9	60	90.7	0.79	0.86

Sr no	ETP	Voltage L-L Avg V	Voltage L-L Max V	THD V % Avg	THD V % Max	Currant Avg A	Currant Max A	THD I % Avg	THD I % Max	KW Avg	KW Max	KVAR Avg	KVAR Max	P F Avg	P F Max
1	ETP	416.5	418.5	4.1	4.3	24.4	28.2	23.8	24.7	13.9	14.9	7.6	7.8	0.87	0.88

Power quality parameters at all feeders except for ETP feeder are within limit. The voltage distortion at ETP feeders appears to be on higher side.

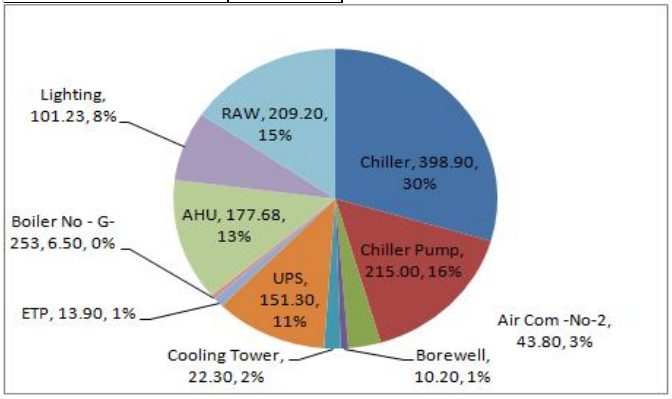
Earthing Measurements:

Earthing resistance is measured using loop method at all possible points in electrical distribution and the same was found in order.

Division of electrical energy used in the plant

Load	AVG
Chiller	398.90
Chiller Pump	215.00
Air Com -No-2	43.80
Borewell	10.20
Cooling Tower	22.30
UPS	151.30
ETP	13.90
Boiler No - G-253	6.50
AHU	177.68
Lighting	101.23
RAW	209.20
	1350.00

For detail recorded measurements and trends, please refer separately attached annexure " Recorded Electrical Data".



This shows that total HVAC load is 59%, which is measured and appears fixed for day time and reduces during night.
The pump energy appears to be on higher side compared to energy consumption by chillers.

As suggested by this Pie chart significant energy is used by HVAC systems. This is most important utility in any Pharma setup as it has direct impact on quality of product manufactured. We have taken maximum efforts in estimating / simulating the HVAC demand and have compared the same with present consumption. A detail report regarding the same is attached as a separate annexure to this report.

Illumination

We have carried out Lux measurements and have counted various light fittings to estimate total load. Area wise Lux measurement report is included in annexure "Recorded Electrical Data". However about 61KW of lighting load can be brought down to 37KWby replacing these conventional fittings by energy efficient fittings. Plant management has already undertaken this in phased manner as per the allocated budgets. The lux measurements may be used to check required compliance.

Block	Conventional KW	LED KW
1	40	11
2	21	19
Total	61	30

Boiler assessment

1) If temperature of feed water is increased from 40 °c to 85°c ,then reduction in FO consumption per hr would be 3.02Kg. The possible annual saving would be Rs. 4.78 L
2) Condensate recovery should be improved to reduce water consumption.

Details of Boilers

Steam Generator no.1,
**** Registration no. G / 172, Capacity 3 TPH, Furnace oil fired, Working pressure 10.54 Kg/cm2 (g),
status during audit -standby mode.

Steam Generator no.2,
**** Registration no. G / 140, Capacity 2 TPH, Furnace oil fired, Working pressure 10.54 Kg/cm2 (g),
Status during audit - running condition.

Steam Generator no.3
**** Registration no. G / 253, Capacity 4 TPH, Briquette fired, Working pressure 10.54 Kg/cm2 (g),
Status during audit -standby mode.

This set up works as 1 working 2 standby. Briquette fired boiler was installed when it's fuel cost was less compared to FO. At present this boiler is not in use as FO rates are very low.

Steam Generator G 140 Assessment:

Sr.no.	Description	Steam Generator G 140
1	**Boiler**	
	Make	M/s J N Marshall
	Capacity in Kcals/hr.	2TPH
2	**Burner**	
	Make	M/s JNM.
	Sr.no.	JNM-594
	Mfg.year	2006
	Elec.supply	400V-3Ph-50Hz
	Fuel	Furnace oil
3	**Observations**	
	Heating media	Steam
	Fuel utilized	Furnace oil
	GCV of Furnace oil	10100 kcal/kg
	NCV of Furnace oil	9650 kcal/kg
	Furnace oil sp.gravity	0.89
	Steam generation (boiler) cut off pressure kg/cm2(g)	9.5 kg/cm2(g)
	Steam generation (boiler) cut on pressure kg/cm2(g)	8.0 kg/cm2(g)
	Steam operating pressure kg/cm2(g)	3.5 kg/cm2
	FO temp inlet to burner, °C	118 °C
	Stack Temp°C	237 °C
4	**Feed water details**	
	Feed water Temperature,°C	40 °C
	Feed water Hardness, ppm	2 ppm
	Feed water TDS,ppm	93 ppm
	Feed water pH	9.5
5	**Blow down water details**	
	Boiler drum water TDS,ppm	476 ppm
	Blow down water pH	10.5
	Blowdown time,sec	Ist shift-40 sec
		II nd shift-35 sec
		III rd shift-54 sec
	Blow down line size,mm	25 mm
	Blow down valve	Manual operated

Sr.no.	Description	Steam Generator G 140
	Boiler drum TDS,ppm	Ist shift-476 ppm
		II nd shift-480 ppm
		III rd shift-490 ppm
	Percentage blow down, %	3.68 %
	Online trial carried out ,	
	FO storage tank volume, Kilo liters	4.5 Kl
	FO storage tank volume per cm	25.28 lit
	Feed water storage tank volume, Kilo liters	20 Kl
6	**Trial Duration, Hrs**	**2 Hrs from 05:30 pm to 07:30 pm**
	Initial FO tank dip taken, cm	134.5 cm
	Final FO tank dip taken, cm	130.07 cm
	FO consumption, Lit per Hr	**4.43 cm x 25.28 lit = 55.99 Lit (49.83 Kg)**
	Initial Feed water meter reading, Cu.mtr	028742.204 Cu.mtr
	Final Feed water meter reading, Cu.mtr	028743.500 Cu.mtr
	Feed water consumption, Lit per Hr	**0.648 Cu.mtr**
	Steam to Fuel ratio, Kg steam / Kg of Fuel.	13.00 Kg of steam / Kg of Fuel.
	If temp of feed water increases from 40 °c to 85°c ,then reduction in FO consumption per hr	(648 x 45 x 1)/ 9650 =3.02 kg of FO.
	Improved Steam to Fuel ratio, Kg steam / Kg of Fuel.	13.84 Kg of steam / Kg of Fuel
	% increase in S/F ratio,	6.47 %
	Reduction in FO consumption per day	72.48 Kg/day
	Rs.saving per Annum due to reduction in FO consumption,	Rs.4.76 Lacs per Annum.
	Thermal Efficiency by Direct method	
	Mass of steam produced Kg	648 kg
	Fuel net calorific value, kCal/kg	9650 kCal/kg
	Steam Working pressure, Kg/cm2(g)	9.0 Kg/cm2(g)
	Feed water temp, °c	40 °c
	Fuel consumption, Kg per hr	49.83 Kg/hr
	Enthalpy of steam at 9.0 Kg/cm2(g)	2776.2 KJ/kg (663.08 kCal/kg)
	Thermal Efficiency %	83.95 %

Flue Gas Analysis:

Sr.no.	Description	Steam Generator G 140
1	**At high firing mode**	
	Oxygen %	6.4 %
	Carbon dioxide %	10.80 %
	Carbon monoxide %	0.004 %
	Excess air percentage	41.60 %
	Heat loss in unburnt fuel %	0.00 %
	Heat loss in dry flue gas %	8.94 %
	Heat loss due to H2 in fuel %	6.44 %
	Heat loss in water vapour in combustion air %	0.45 %
	Total Heat loss %	15.83 %
	Overall Efficiency %	84.17 %
2	**At low firing mode**	
	Oxygen %	2.7 %
	Carbon dioxide %	13.53 %
	Carbon monoxide %	0.008 %
	Excess air percentage	14.31 %
	Heat loss in unburnt fuel %	0.00 %
	Heat loss in dry flue gas %	5.24 %
	Heat loss due to H2 in fuel %	6.20 %
	Heat loss in water vapour in combustion air %	0.28 %
	Total Heat loss %	11.73 %
	Overall Efficiency %	88.27 %

Observations and Recommendations:

1) Observed feed water temperature at 40°c. Following are the reasons for the same

a) Boiler feed water tank capacity is 20 Kiloliters. This is very huge storage capacity for this size of boilers. It was observed that feed water tank was filled up for 79 % of total capacity with makeup water at ambient temperature.

b) Boiler feed water tank level maintained in between 57 % to 79 % throughout the day.

c) Steam purging system is in off condition.

d) Indicative photograph of existing boiler feed water tank.

It is recommend to install new feed water tank of capacity 8 cu.mtr with steam purging system in it to heat feed water upto 85 – 100°c.and use existing tank as soft water storage tank.

It is better to use steam oil pre heater in place of electrical oil preheating unit.

It was observed that blow down time in each shift is different i.e 40 ,35 and 54 seconds. To avoid water loss through blow down, give fixed time blow down in each shift.

If Plant continues with boilers, it is recommended that condensate recovery should be improved by taking appropriate measures.

Cooling Tower assessment

Details of equipment

Type: Induced draft, FRP Cooling tower

No.of cooling towers: 4 nos.,

Capacity : 250 TR x 4
: 600 TR x 1 – 300TR x 2 Cells

Location: Installed on utility block terrace.

Purpose: Cooling return water from plant HVAC systems.

Study of Existing Cooling Towers

Cooling Tower	CT 1 ,2,3,4,5
Make	Advance cooling towers
Model	Induced draught type
Capacity	250 TR-4 nos. and 600 TR-01 no.
Cooling water inlet temp Deg.cen.	33°C
Cooling water outlet temp Deg.cen.	28.5 °C
Range	4.5 °C
Observations	
No.of Cooling towers	Five, All are parallel in working condition for Utility chillers.
Working cooling towers	CT 1 & 2 -250 TR each is in standby mode , CT3-250 TR , CT4-250 TR and CT 5 – 600 TR are running in parallel condition.
Wet Bulb Temp of Atm. air	27°C
Dry Bulb Temp of Atm. air	29°C
Present Approach	1.5°C
Cooling tower effectiveness	75 %
Recirculating water TDS	1000 ppm
Make up water TDS	136 ppm
Cycle of concentration	7.35
Total flow rate Cu.mtr/hr	610.02 cu.mtr/hr
Total Rated Cooling capacity, kCal/hr	33,26,400 kCal/hr
% Percentage utilization of existing cooling tower	82.52 %.
Total no. of chillers in working condition	03 nos.
Present Plant load %	More than 75%

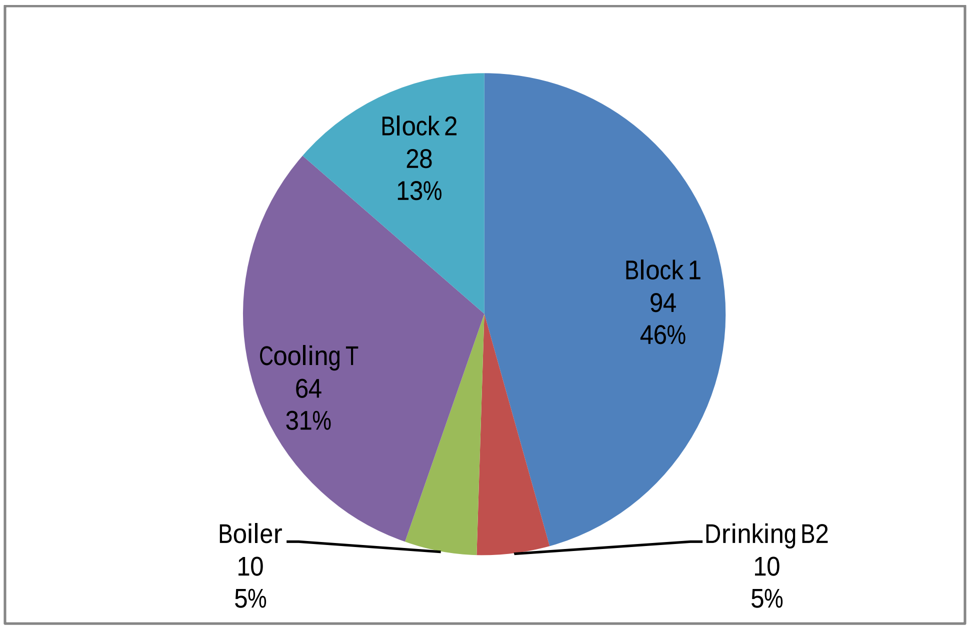
Observations and Recommendations:

- During every preventive maintenance of cooling tower, check fan blade pitch angle.
- Observed power consumption for each cooling tower fan are 3.14 kW, 4.92 kW, 7.3 kW, 6.98 kW and 16.28 kW respectively for CT 1,2,3,4 and CT 5.
- Although FAN power is different for different fans due to individual blade angles, the total fan power being very less compared to other energy guzzlers, we do not recommend very close monitoring of the same. You may undertake this once in six months.
- CT fans may be controlled with sensing cold well cooling water temperature. This may lead to some saving.
- Condenser pressure drop for chiller no.3 and 4 for cooling water is 0.9 Kg/cm2(g) and the same for chiller no.1,is 2.4 Kg/cm2(g) .
- For better performance of chilling system, we recommend de scalling from cooling water side.
- The cooling towers are performing well for present duty and are well maintained. There life expectancy is about 4 / 5 years more. Further for **** weather, we do not recommend fan less or natural draft cooling towers for performance issues.
- These cooling towers are part of HVAC system and reject heat collected from process areas to atmosphere by evaporating water. The makeup water added at present is around 80 KL per day. After confirming demand, if recommended HVAC modifications are implemented, this water consumption will reduce up to 28KL per day. This will contribute in reducing plant water consumption and expenses on water softening systems.

Water consumption:

A typical water consumption pattern for a day is as follows

Area	Water in KL
Block 1	94
Drinking B2	10
Boiler	10
Cooling T	64
Block 2	28
Total	**206**



We have conducted detail HVAC system study (Refer attached annexure) and have recommended revamping of HVAC system to suit actual requirement and save energy. These calculations have suggested that the water consumption on account of CT makeup water will reduce to 28KL from present average of 64KL per day.

Other areas for water conservation are

1) Reduction in boiler consumption by increase in condensate recovery.
2) Reduction in steam requirement if heat pumps are adopted for HW systems.
3) Savings from "Man Use" may be achieved by timer based water taps.

---------------------------------END OF REPORT-------------------------------