ENERGY AUDIT REPORT OF
AMRUTVAHINI COLLEGE OF ENGINNERING

Near Pune Nashik Highway, Ahmadnagar,
Sangamner, Maharashtra 422608

PREPARED BY

DR. B. E. KUSHARE AND ASSOCIATES
PROF. DR. B. E. KUSHARE
POWER QUALITY & ELECTRICAL CONSULTANT,
CERTIFIED ENERGY AUDITOR,
CHARTERED ELECTRICAL ENGINEER (IEE UK)
FLAT NO.G1 AND G2,
SHREE B.D.WAGH CO.OPP.HOUSING SOCIETY,
SWAMI NARAYAN NAGAR,
OPP.APPOLO HOSPITAL,
PANCHAVATI, NASHIK 422003

January-2021

"A Mission made programme can be created for energy conservation. We have to set yearly target of saving twenty five billion units per year from the present 3.2 billion units, so that we can wipe out the existing shortage within the next four years"

Dr APJ Abdul Kalam
Ex. Hon. President of India
Address at National Energy Awards Function,
Dec.15, 2005

ACKNOWLEDGEMENT

Power quality, Harmonic audit, Resonance Test Electrical Consultancy cell of DR. B.E. Kushare and Associates, Nashik, places sincere gratitude to all management , CEO , Principal and HODs for providing necessary support and data during Energy Audit

Our sincere thanks to Maintenance In charge, all Electrician of Maintenance cell, for excellent co-ordination during field measurements and providing accurate data required the said work and preparation of Energy Audit report.

(DR.) B. E. KUSHARE
Certified Energy Auditor
Power Quality Consultant

ABBREVIATION

Symbol	Abbreviation
A	Ampere
V	Volts
KV	Kilo volts
KVA	Kilo volt ampere
KVAR	Kilo volt ampere reactive
KW	Kilo watts
MD	Maximum demand
%THD	Percentage Total harmonic distortion
% THDv	Percentage voltage Total harmonic distortion
% THDi	Percentage current Total harmonic distortion
% TIHDv	Percentage voltage Total inter harmonic distortion
% TIHDi	Percentage current Total inter harmonic distortion
Voltage sag	Reduction in RMS voltage from 90% to 10% for the time period from 10 msec. to 1 min.
Voltage swell	Increase in RMS voltage from 110% to 180% for the time period from 10 msec. to 1 min.
Transient	Sudden non-power frequency change in the voltage or current from steady state.
%Vunb	Percentage voltage unbalance factor
%Iunb	Percentage current unbalance factor
KF	Crest factor
%U2, U3,…….,U50	Percentage individual voltage harmonics from 2 orders to 50 orders
%I2,I3,…….,I50	Percentage individual current harmonics from 2 orders to 50 orders
Max.val.	Maximum value of the parameter over the measurement period
Avg. val.	Average value of the parameter over the measurement period
Min.val.	Minimum value of the parameter over the measurement period

EXECUTIVE SUMMARY :

Energy audit round of lighting system, Air conditioning system, Water pumping system, and other office load, reactive power management was carried. After conducting of detailed Audit of various Utilities and analysis of performance of various Equipments, various Energy conservation opportunities are identified and Energy conservation measures are recommended for each ECO with economic analysis. The various finding of Energy audit with suggested Energy conservation measures and Pay back analysis for each type of load in summarised in following sections.

Summary of various Energy conservation initiatives implemented :

Energy efficiency improvement :

- Use of LED light fixtures in areas of higher hours of use .
- Use of 3 star Air conditioners
- Water distribution system by gravity

Energy substitution :

Use of day light for indoor illumination

Use of solar water heaters in Hostels

Renewable Energy Resources :

Installed 400 KWp roof top solar PV grid interactive system with net banking

Awards received for Energy Conservation Initiatives :

12th state level MEDA Award in Educational Institute Category

Energy efficient unit award of CII during this year

Fuel substitution /reuse : Biogas plant

Summary of total Energy saving in lighting:

Sr. No.	Energy conservation measures	Energy saving per Year In KVAH	Energy cost Saving per Year in Rs	Investment Rs.	Payback period Year	%ROI
1	Replacement of 100W Halogen Lamp by 30W LED Flood	5219.5	69314.96	54600	0.787	127.06%
2	Replacement of 28W CFL LIGHT by 9W LED Bulb	820.80	10900.224	1995	0.183	546.448%
3	Replacement of 2X18W PL by 15W LED DL	9240	122707.20	124740	1.0165	98.37%
4	Replacement of 36W FTL by 18W LED TL	30624	406686.72	324800	0.798	126.742%
5	Replacement of 4X18W PL by 36W LED Panel Light	258.72	3435.80	4900	1.426	70.126%
6	Replacement of 40W FTL by 18W LED TL	3065.04	40703.73	12040	0.295	338.983%
	Total	49228.06	653748.6	5,23,075	0.800 Year or 9.601 Months	125%

Reduction in connected lighting load after replacement of conventional Light fixtures by LED Light fixtures:

Sr. No.	Recommended Energy Conservation Measures	Reduction in load in KW
1	Replacement of 100W Halogen Lamp by 30W LED Flood	1.43
2	Replacement of 28W CFL LIGHT by 9W LED Bulb	0.456
3	Replacement of 2X18W PL by 15W LED DL	3.3
4	Replacement of 36W FTL by 18W LED TL	23.20
5	Replacement of 4X18W PL by 36W LED Panel Light	0.098
6	Replacement of 40W FTL by 18W LED TL	1.161
Total reduction in load (KW):		29.645

Sr. No.	Parameter	Value
1	Total lighting connected load in KW considered for replacement with LED lamp	54.302 KW
2	Revised connected load with LED light fixtures	24.657 KW
3	%Reduction of lighting load	54.592 %

Recommended LED Light fixture makes:

1) SYSKA
2) PHIPLIPS
3) WIPRO
4) OSRAM
5) BAJAJ

Recommended warranty period: 12 Month

Energy cost reduction potential by adequate reactive power compensation

Difference between KVAH and KWH units pre COVID 19 period per month on average of three months =262.33KVAH

Annual difference between KVAH and KWH based on three months pre COVID average = 262.33X12 = 3148.00 KVAH

Total Energy cost reduction potential by adequate reactive power compensation per year = Rs13.28x3148.00 = Rs 41805.44

Recommended to connect 7.5KVAR capacitor with MCB before APFC CT for transformer reactive power compensation and program APFC in auto mode and disconnect other fixed capacitors .

Investment : Rs 6000.00

Payback period = 0.143 Years or 1.722 Months

%ROI = 699.300

Revision of sanctioned contract Demand under COVID 19 :

During COVID 19 MSEDCL is allowing to revise sanctioned contract demand three times in one month by online application .Presently during COVID period Maximum demand charges are being paid as per 55% of sanctioned contract demand as per Minimum MD billing

Recommended to revise sanction contract from 415KVA from 200KVA .

Energy cost reduction by revision by sanctioned contract demand 400KVA from 200KVA during COVID period for next 4 months = 118x411x4 = Rs 193992.00

Investment :NIL

Provision of separate energy meter for residential energy consumption

Scheduling of water pumps during night 10 PM to 6 AM to avail advantage of off peak TOD tariff benefits

Summary of Energy Saving potential in Air conditioning :

S.No	Suggested Energy conservation measure	Energy saving potential in KWH per Year	Energy cost Saving potential in Rs per Year	Investment Rs	Payback period	% ROI
1	Installation of auto saturation detection units on Window /Split Air conditioners	20680.96	274643	340000.00	1.237 Years or 14.855 Months	80.84
Total		20680.96	274643	340000.00	1.237 Years or 14.855 Months	80.84

SUMMARY OF OUTCOME

Sr. No	Energy conservation Measures	Energy saving per year KWH	Amount saved/year Rs.	Investment required (Rs.)	Payback period.	% ROI
1	Replacement of 100W Halogen Lamp by 30W LED Flood	5219.5	69314.96	54600	0.787	127.06%
2	Replacement of 28W CFL LIGHT by 9W LED Bulb	820.80	10900.224	1995	0.183	546.448%
3	Replacement of 2X18W PL by 15W LED DL	9240	122707.20	124740	1.0165	98.37%
4	Replacement of 36W FTL by 18W LED TL	30624	406686.72	324800	0.798	126.742%
5	Replacement of 4X18W PL by 36W LED Panel Light	258.72	3435.80	4900	1.426	70.126%
6	Replacement of 40W FTL by 18W LED TL	3065.04	40703.73	12040	0.295	338.983%
7	Adequate Reactive power compensation	3148	41805	6000	0.143	699.30
8	Revision of sanctioned contract demand during COVID period from 415 KVA to 200KVA	-	193992.00	-	-	-
9	Installation of auto saturation detection units on Window /Split Air conditioners	20680.96	274643	340000.00	1.237 Years or 14.855 Months	
Total		73057.02	1164189	869075	0.746 years or 8.958 months	134.048

-

SUMMARY OF NO INVESTMENT SAVINGS

Sr. No	Energy conservation Measures	Energy saving per year KWH	Amount saved/year Rs.
1	Revision of sanctioned contract demand during COVID period from 415 KVA to 200KVA	-	193992.00
Total			193992.00

CHAPTER–1
INTRODUCTION

CHAPTER – 1

1.0 GENERAL:

Amrutvahini College of Engineering is located at Sangamner, Maharashtra. With increasing Energy cost and social, environmental responsibility management of the organization decided to identify energy conservation opportunities. Energy Audit was carried out with following scope to identify various Energy conservation opportunities and suggest cost effective Energy conservation measures without and with investment.

SCOPE OF ENERGY AUDIT:

To study the energy consumption analysis of the building such as lighting, water pumping, motor, reactive power management, HVAC and other areas.

1.1 ELECTRICAL ENERGY

1. To study electrical energy metering, monitoring and control systems are existing in the both units and to recommend the suitable system for future monitoring.
2. To study the monthly power factor, maximum demand, working hours, load factors etc. for reference period along with monthly electricity consumption and to establish scope for optimization of load factor through detailed load management study.
3. To recommend a specific rationalization/optimization programmed based on measurement of power factors at various PCC points, existing capacitor systems and its maintenance, automatic/manual control required etc.
4. To undertake the detail motor load assessment on all the motors above 5HP to study the loading patterns of the motors to identify the oversized and undersized motors.
5. To study water pumping system.
6. To undertake Illumination audit of all the section including lux measurement with the help of lux meter to recommend the specific plan for energy conservation.
7. Comparison of actual level of illumination with recommended level of illumination for various activities.
8. Study of efficiency of existing lamps and ballast used.
9. Study of voltage profile of all feeders.
10. Identification of energy conservation opportunities of lighting systems.
11. Performance evaluation of Window, split, Ducted and Packaged Air conditioners.
12. Performance Evaluation by FAD, Leak test on Air Compressors, optimization of compressor pressure setting.
13. Performance Evaluation of Water pumps,
14. Recommend immediate low cost / no cost energy conservation measures.
15. Recommend medium term energy conservation measures.
16. Recommend long-term energy conservation measures.
17. Evaluation, Implementation and monitoring: To identify, evaluate and prioritize energy saving opportunities through above into short, mid and long-term time basis depending upon investments, quantum of savings, skills and time required for implementation etc. To recommend a time bound action plan for implementation of accepted measures.

1.2 METHODOLOGY:

Following Methodology was followed during Energy Audit:

1. Held preliminary discussion with Production and maintenance in charge and his team to understand electric supply distribution network feeding power to various Section and energy consumption pattern of various utilities, energy accounting system and various energy management systems employed for energy conservation.
2. Gathered all relevant data related to conduction of detailed energy audit pertaining to electrical system, connected load, monthly energy bills, single line diagram of distribution system, HVAC system, Water distribution system.
3. Detailed Measurement was conducted with the help of various instruments and expert staff. The various equipment's used during measurements are advanced power quality analyzer HIOKI-3198, lux meter and clamp on meter.
4. On the basis of measurement result and data collected performance of room wise lighting system, motor driven system and street Light are calculated.
5. Recommendations are given based on techno economic analysis to reduce energy consumption.
6. Cost benefits analysis on account of improved efficiency is done.

The various equipment's used during measurements are listed in table 1.0

TABLE 1.0: INSTRUMENTION USED DURING ENERGY AUDIT

Sr. No	Instrument	Specifications
1.	Advanced Power Quality Analyzer	HIOKI 3198, Japan, 8 channels, four for voltage and 4 for currents, facility of measurement of 180 electrical parameters and different wiring configuration. Sampling frequency 6M samples per second. Facility of voltage sag, swell, flicker, harmonics, inter-harmonics, transients and all other electrical parameters.
2.	Advanced Power Quality Analyzer	HIOKI 3360, Japan, 8 channels, four for voltage and 4 for currents, facility of measurement of 180 electrical parameters and different wiring configuration. Sampling frequency 6M samples per second.
3.	Clamp on meter	0-1200KW 0-600V AC 0-800V DC 0-2000A, Current AC/DC
4.	Lux meter	0-10,000 lux level, non-contact type
5.	Digital Clamp on Earth tester	Make: MOTWANI, Range: 1500Ω
6.	Digital Clamp-on leakage meter	Rishabh
7.	Anemometer	Make: FLIR
8.	IR camera	Make: TESTO
9.	IR thermometer	Make: HIOKI

1.3 ENERGY SCENCE

1.4 ENERGY: SOURCES AND UTILIZATION

ELECTRICAL ENERGY: The main source of power for the plant is through HT 11KV Supply of incoming supply through sub-station and Energy metering is carried out at 11KV side with TOD meter

CHAPTER-2
ENERGY CONSERVATION OPPORTUNITIES IN LIGHTING AREA
(OBSERVATIONS, FIELD TRIALS, ANALYSIS AND KEY RESULT AREAS)

2.0 ENERGY SAVING OPPORTUNITIES IN LIGHTING AREA:

Plant General lighting is provided by use of 24W LED WALL LIGHTS, 28W CFL LIGHT, 12W LED PANEL LIGHT, 18W LED DOWN LIGHT, 2X18W PL LAMP, 36W, 40W FTL EB, 18W LED TL, 24W LED TL, 36W LED PANEL LIGHT, 36WX4 PL LAMP, 30W, 40W, 60W, 80W LED STREET LIGHT etc.

Lights are controlled by switched and there is no timer based as well as occupancy sensor-based control. Energy audit of lighting was carried out by measurement of illumination level with lux meter and Lighting load assessment was carried out to identify the areas for Energy saving in lighting area.

2.1 Area Wise Light Fixture Details and Measured Illumination Level:

Table 2.0: Area Wise Light Fixture Details and Measured Illumination Level:

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
Electrical department						
PSED LAB	150, 136, 20, 100, 135, 136, 102, 138, 150, 148, 15, 134	113.67	36W FTL EB	6	-	8
Power Electronics	95, 136, 124, 97, 129, 138, 99, 113, 108, 109, 102	113.64	36W FTL EB	6	-	8
Project lab	69, 76, 82, 83, 86, 91	81.17	36W FTL EB	1	-	8
Cap production lab	160, 171, 153, 127, 143, 149, 152	150.71	36W FTL EB	3	-	8
Faculty room	148, 151, 96, 81,95, 62, 63, 71, 146, 143	105.60	36W FTL EB	3	-	8
Electrical HOD Office (S27)	173, 215, 163, 123, 101, 65, 64, 98	125.25	36W FTL EB	3	-	8
Electrical Seminar Hall	134, 133, 121, 129, 117, 116, 128, 122, 133, 138, 125, 115	125.92	36W FTL EB	9	-	8
			18W LED TL	0	1	8
EMS Lab Electrical department	118, 153, 143, 228	160.50	36W FTL EB	4	0	8
Electrical machine (Lab 1& 2)	149, 156, 143, 131, 180, 124,	131.15	36W FTL EB	8	0	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
	141, 145, 190, 106, 59, 74, 107					
Library	105, 70, 67, 69, 87, 121, 110, 86, 88	89.22	18W LED TL	2	0	8
Software lab	177, 1766, 171, 163, 161, 176, 172	398.00	36W FTL EB	4	0	8
Basic electrical lab	129, 130, 167, 165, 198, 194, 102, 140, 157	153.56	36W FTL EB	5	0	8
T-11 Classroom	105, 97, 70, 69, 75, 87, 120, 139	95.25	36W FTL EB	5	0	8
T-12 Classroom			36W FTL EB	5	0	8
T-13 Classroom			36W FTL EB	5	0	8
T-14 Classroom			36W FTL EB	5	0	8
T-15 Classroom			36W FTL EB	5	0	8
T-16 Classroom			36W FTL EB	5	0	8
T-17 Classroom			36W FTL EB	5	0	8
T-18 Classroom			36W FTL EB	5	0	8
T-19 Classroom			36W FTL EB	5	0	8
FE department						
FE Coordinator	170, 175, 250, 299, 327, 510	288.50	36W FTL EB	2	-	8
HOD (Eng. Science)	229, 238, 213, 216, 261, 237, 186, 211	223.88	18W LED TL	1	-	8
			36W FTL EB	2	-	8
T7	166, 155, 191, 212, 159, 206, 187, 149, 155, 288, 450, 457	231.25	36W FTL EB	9	-	8
T8			36W FTL EB	9	-	8
T9			36W FTL EB	9	-	8
T10(Drawing Hall/ Seminar)			36W FTL EB	9	-	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
T-21 (F.E.1) Classroom	105, 97, 70, 69, 75, 87, 120, 139	95.25	36W FTL EB	5	0	8
T-15 (F.E.G) Classroom			36W FTL EB	5	0	8
T-13 Classroom (F.E. Dept.)			36W FTL EB	5	0	8
T-12 Classroom (F.E. Dept.)			36W FTL EB	5	0	8
T-11 Classroom (F.E. Dept.)			36W FTL EB	5	0	8
T-4 Classroom (F.E. Dept.)			36W FTL EB	5	0	8
T-3 Classroom (F.E. Dept.)			36W FTL EB	5	0	8
T-1 Classroom (F.E. Dept.)			36W FTL EB	5	0	8
S-19 Classroom (F.E. Dept.)			36W FTL EB	5	0	8
E&TC department						
Digital HP Lab	279, 282, 290, 239, 247, 279, 276, 301	274.13	36W FTL EB	4	-	8
Project lab	223, 231, 245, 221, 229, 231, 358, 362,252	261.33	36W FTL EB	4	-	8
Digital Communication lab	278, 274, 281, 273, 261	273.40	36W FTL EB	4	-	8
Faculty room	124, 118, 84, 83, 86,89, 93, 83, 109, 118	98.70	36W FTL EB	3	-	8
			40W FTL EB	3	-	
PG research lab	97, 95, 56, 81, 83, 72, 78, 81, 111, 103	85.70	40W FTL EB	3	3	8
			36W FTL EB	3	0	8
PG Computer lab	55, 58, 88, 50, 54, 51, 72, 92, 75, 93, 86, 97, 109	75.38	36W FTL EB	4	2	8
OFC lab	43, 37, 51, 63, 93, 76, 71, 86, 74, 290, 185	97.18	40W FTL EB	1	-	8
			36W FTL EB	2	2	

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
MPMC lab	87, 144, 138, 102, 79, 101, 104	107.86	36W FTL EB	4	-	8
Computer lab (S-52)	142, 140, 137, 132, 153, 158, 163, 167	149.00	40W FTL EB	1	-	8
			36W FTL EB	1		
Faculty room (S49)	228, 231, 158, 152, 189, 169, 287, 292, 141, 153	200.00	40W FTL EB	2	-	8
			36W FTL EB	2	-	
Digital Electronics (S-40)	115, 146, 128, 149, 127, 99, 75, 84, 108	114.56	40W FTL EB	4	-	8
Electronics Network (S-39)	132, 153, 177, 108, 172, 160, 142	149.14	40W FTL EB	2	1	8
			36W FTL EB	1	-	
HOD (Electronics)	227, 231, 209, 205, 177, 158, 208	202.14	36W FTL EB	2	-	8
S-20 Tutorial-2 PG (ETC Dept)	105, 97, 70, 69, 75, 87, 120, 139	95.25	36W FTL EB	5	0	8
S-21 Seminar hall (ETC Dept.)	318, 280, 360, 352, 344, 323, 280, 274	316.38	18W LED TL	11	1	8
S-58 PC Lab (ETC Dept)	177, 159, 112, 92, 142, 124, 90	128.00	36W FTL EB	6	0	8
S1B-Communication lab	68, 94, 106, 143	102.75	36W FTL EB	2	2	8
S1A-Audio & video lab	85, 151, 130, 153, 146, 131, 143, 137	134.50	36W FTL EB	3	0	8
			40W FTL EB	2	0	8
G-39 Digital Library	224, 222, 205, 61, 58, 102, 109, 85	133.25	36W FTL EB	2	0	8
			28W CFL LIGHT	3	0	8
G-39B Periodical section	89, 169, 167, 153, 159	147.4	36W FTL EB	2	0	8
			28W CFL LIGHT	1	0	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
G-39C Section	41, 65, 68, 84, 64, 24, 21	52.43	36W FTL EB	1	1	8
			28W CFL LIGHT	1	0	8
			18W LED TL	1	0	8
Library area	107, 111, 159, 51, 71, 72, 28, 146, 121, 109, 141, 234, 46, 36, 132	104.27	28W CFL LIGHT	12	2	8
			36W FTL EB	9	0	8
			9W LED TL	1	0	8
G-42 Library area top (reading room)	145, 261, 263, 176, 253, 274, 205, 192, 155, 287, 210, 179, 240, 166, 252	217.20	36W FTL EB	38	4	8
Periodical section	204, 150, 159, 145	164.50	36W FTL EB	4	0	8
S31- High voltage engineering lab	82, 83, 137, 106, 123, 60	98.50	36W FTL EB	4	0	8
S55- DPDP PG Lab	120, 98, 135, 112, 81, 98, 126	110.00	36W FTL EB	4	0	8
S-35 Embedded system lab	140, 125, 98, 99, 115, 150, 81, 134	117.75	36W FTL EB	4	0	8
S-23 Class room	121, 83, 55, 58, 63, 64	74.00	36W FTL EB	4	1	8
T-14-Eng., physics lab	88, 128, 121, 180, 158, 130	134.17	36W FTL EB	6	0	8
			18W LED TL	1	0	8
Dark room	58, 64, 118, 101, 92, 94	87.83	36W FTL EB	2	0	8
T-5 Faculty room (Eng. Science dept.)	183, 106, 121, 98, 136, 140	130.67	36W FTL EB	4	0	8
T-10 Drawing hall	150, 139, 120, 158, 183, 163, 215, 190	164.75	36W FTL EB	7	1	8
S-07 Microwave lab	92, 75, 65, 161, 77, 98, 63, 84, 88	89.22	36W FTL EB	7	1	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
S-6 HOD Cabin (E&TC Department)	116, 92, 71, 66, 80, 88, 128, 96	92.13	36W FTL EB	4	0	8
S-05 Library	121, 71, 94, 101, 79, 108	95.67	36W FTL EB	2	0	8
S-4 VISI Lab	94, 102, 96, 178, 138, 89, 91, 104	111.50	36W FTL EB	7	0	8
S-3 DSP Lab	91, 98, 104, 121, 108, 120, 87, 96, 88	101.44	36W FTL EB	6	0	8
S-02 Tutorial lab-UG ETC	121, 71, 94, 101, 79, 108	95.67	36W FTL EB	2	0	8
S-59 Instrumentation lab	58, 41, 54, 68, 75, 79, 80, 70, 69	66.00	36W FTL EB	8	1	8
S-47 Electronics communication lab	128, 106, 140, 158, 109, 111	125.33	36W FTL EB	3	0	8
S-46 Basic electronics lab	128, 106, 140, 158, 109, 111	125.33	36W FTL EB	3	0	8
S-45 Driver & control lab	104, 151, 146, 130, 121, 140	132.00	36W FTL EB	2	2	8
S-43 Power electronics lab	95, 160, 124, 141, 139, 118, 108, 139, 141, 129, 118, 130	128.50	36W FTL EB	5	0	8
F-06 HOD Cabin	61, 88, 102, 175, 95, 119	106.67	36W FTL EB	3	0	8
F-05 Hardware lab	77, 107, 114, 116, 90, 95, 81	97.14	36W FTL EB	6	0	8
F-4 Meeting room	96, 98, 62, 87, 89, 59	81.83	36W FTL EB	2	0	8
F-03 Programming lab-4	99, 60, 85, 89, 91, 102, 138, 69, 88	91.22	36W FTL EB	6	2	8
F-02 Faculty room-1	82, 43, 64, 43, 78, 81	65.17	36W FTL EB	2	1	8
F-01 Central computing facility	114, 90, 121, 85, 70, 75	92.50	36W FTL EB	2	0	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
F-01B Programming lab-2	114, 90, 121, 85, 70, 75	92.50	36W FTL EB	2	0	8
F-01C Programming lab-3	114, 90, 121, 85, 70, 75	92.50	36W FTL EB	3	0	8
IT department						
Software Lab (F17)	261, 264, 285, 223, 228, 225	247.67	36W FTL EB	4	-	8
PG Lab -2 (F16)	209, 204, 170, 146, 102,107	156.33	36W FTL EB	4		8
Tutorial Lab (F17)	55, 63, 128, 136, 138, 141, 148	115.57	36W FTL EB	1	1	8
Software Lab (F13)	58, 60, 85, 88, 89, 84, 86, 95, 69, 124, 103, 110	87.58	40W FTL EB	3	-	8
			36W FTL EB	2		
Software Lab-3 (F12)	114, 117, 108, 105, 187, 157, 199, 171	144.75	36W FTL EB	6	-	8
Software Lab-2 (F11)	113, 106, 104, 117, 132, 110, 136, 153, 131, 137, 129	124.36	40W FTL EB	3	-	8
			36W FTL EB	3		
Software Lab-1 (F10)	130, 147, 96, 112, 123, 113, 193, 69, 74, 101	115.80	36W FTL EB	4	2	8
PG IT Lab (F07)	103, 114, 185, 152, 131, 106	131.83	36W FTL EB	6	-	8
HOD IT (F06)	74, 71, 145, 129, 169, 155	123.83	36W FTL EB	3	-	8
			18W LED TL	1	-	
Seminar Hall IT (F54)	54, 48, 144, 256, 528, 328, 428, 440, 480, 271, 315, 415	308.92	2X18W PL LAMP	18	-	8
			2X18W PL LAMP	11		
Computer Department						

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
Design Lab (F56)	121, 112, 76, 82, 109, 122, 131, 93, 97, 115, 113, 118, 103, 122	108.1428571	36W FTL EB	4		8
			40W FTL EB	1		
Meeting Hall	130, 113, 123, 118, 137, 134, 151, 156	132.75	36W FTL EB	1		8
			40W FTL EB	-	1	
Faculty room(F49)	243, 240, 237, 162, 176, 173, 181, 189	200.125	40W FTL EB	2		8
			36W FTL EB	1		
HOD Office (F48)	286, 245, 476, 122, 164, 420, 426, 389	316	40W FTL EB	1		8
			36W FTL EB	1		
Computer Graphics (F47)	138, 147, 136, 158, 173, 153, 151, 249	163.125	40W FTL EB	2		8
			36W FTL EB	2	1	
Internet Lab (F46)	104, 134, 116, 209, 207	154	40W FTL EB	1		8
			36W FTL EB		1	
Software Lab (F44)	90, 92, 123, 127, 203, 186, 173, 181	146.875	40W FTL EB	2	-	8
			36W FTL EB	1	1	
Software Lab 2 (F43)	127, 124, 120, 95, 60, 190	119.3333333	36W FTL EB	3	-	8
Tutorial U.G.-2 (F42)	149, 241, 260, 237, 213	220	40W FTL EB	1		8
Class Room 1 (F39)	160, 211, 183, 226, 231, 237, 213	208.7142857	36W FTL EB	7		8
			40W FTL EB	1		8
Class Room 1 (F40)	160, 211, 183, 226, 231, 237, 213	208.7142857	36W FTL EB	7		8
			40W FTL EB	1		8
Class Room 1 (F41)	160, 211, 183, 226, 231, 237, 213	208.7142857	36W FTL EB	7		8
			40W FTL EB	1		8
Civil Engineering						

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
Cad Lab UG Civil (F30)	109, 115, 118, 100, 106, 110, 117	110.71	36W FTL EB	5	-	8
TOM Lab (G32)	95, 84, 108, 128, 124, 105, 113, 126, 98, 110	109.10	36W FTL EB	10	-	8
Research Lab (G31) PG Civil	78, 83, 85, 87, 89, 93, 96	87.29	36W FTL EB	3		
Tutorial Lab 1 (G29)	76, 101, 48, 54, 96, 103, 107	83.57	36W FTL EB	4	1	8
Tutorial Lab 1 (G30)			36W FTL EB	4	-	
Geotechnical & Geology lab (G27, G28)	115, 136, 142, 105, 76, 65, 69, 60, 67, 135, 139	100.82	36W FTL EB	8	1	8
Civil HOD Office (G24)	85, 98, 43, 81, 75, 78, 109, 175	93.00	36W FTL EB	4	1	8
Civil Computer Lab	84, 87, 113, 116, 99, 87	97.67	18W LED TL	2	-	8
Transport Lab (G22)	85, 89, 93, 101, 131, 149, 112, 152	114.00	36W FTL EB	6	6	8
Environment Lab (G21)	101, 105, 193, 112, 98, 123, 97	118.43	36W FTL EB	6	-	8
Chemistry Lab (G16)	155, 152, 146, 122, 113, 111, 144, 170, 138, 187, 161	145.36	36W FTL EB	7	1	8
Class Room 1 (G14)	153, 132, 128, 147, 161, 106, 76, 86, 90	119.89	36W FTL EB	4	-	8
Class Room 2			18W LED TL	1	-	
Faculty Room (Civil)	53, 83, 81, 110, 117, 115, 123, 129	101.38	36W FTL EB	2	-	8
			18W LED TL	1	-	
F-19 Class room-2 IT	210, 160, 172, 154, 128, 244,	180.44	36W FTL EB	6	0	8
F-20 Class room-3			36W FTL EB	6	0	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
F-21 Class room-7 F.E.	190, 162, 204		36W FTL EB	6	0	8
F-22 Class room F.E.-4 Civil			36W FTL EB	6	0	8
F-24 Class room F.E.-5 Civil			36W FTL EB	6	0	8
F-25 Class room F.E.-6 Civil			36W FTL EB	6	0	8
F-26 Class room F.E.-7 Civil			36W FTL EB	6	0	8
F-27 Class room F.E.-8 Civil			36W FTL EB	6	0	8
F-52 Hardware lab	123, 115, 148, 145, 132, 112, 119, 126, 121	126.78	36W FTL EB	4	0	8
F-53 Microprocessor lab			36W FTL EB	4	0	8
F-33 Software lab-3			36W FTL EB	4	0	8
F-37 Advanced computing lab			36W FTL EB	4	0	8
F-32 Software lab-4			36W FTL EB	4	0	8
F-31 Class room-4			36W FTL EB	4	0	8
F-36 Fundamental programming lab			36W FTL EB	4	0	8
F-35A Faculty room	76, 78, 89, 102, 82, 104, 68, 91, 101	87.89	36W FTL EB	4	0	8
Faculty room-2 Civil	102, 104, 98, 94, 138, 184	120.00	36W FTL EB	2	0	8
			18W LED TL	2	0	8
G-33 Survey lab	53, 84, 98, 100, 120, 96, 83, 82, 110	91.78	36W FTL EB	5	0	8
G-34 Mechanics lab	123, 128, 144, 102, 106, 112, 124, 105	118.00	36W FTL EB	6	0	8
Innovative lab	137, 121, 101, 84, 107, 94	107.33	36W FTL EB	5	0	8
G-17, G-16 Fluid machinery lab	185, 159, 132, 155, 174, 151, 118, 172, 92,	147.83	36W FTL EB	16	0	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
	164, 109, 163					
G-15 Class room-3 Civil	106, 74, 82, 76, 86, 90	85.67	36W FTL EB	4	1	8
Other areas						
Canteen	163, 117, 137, 118, 134, 137	134	18W LED TL	8	0	8
G4a Board room	554, 454, 513, 540, 460, 589, 435	506.4285714	18W LED TL	6	0	8
			36W LED PANEL LIGHT	1	0	8
G2 Admin office 1 (CEO)	293, 301, 326, 150	267.5	36W LED PANEL LIGHT	3	0	8
Admin office 2	258, 340, 396, 377, 110, 137	269.6666667	2X18W PL LAMP	9	0	8
CEO office	471, 207, 227, 225, 101	246.2	36W LED PANEL LIGHT	3	0	8
Trusty cabin 1	344, 340, 136, 178, 321	263.8	36W LED PANEL LIGHT	2	0	8
Trusty cabin 2	100, 110, 121, 98,	85.8	2X18W PL LAMP	6	0	8
R&D dept. head	80, 98, 102, 88, 96, 84	91.33	36W FTL EB	2	0	8
			18W LED TL	1	0	8
Student section	158, 159, 139, 232, 226, 218, 168, 188, 165	183.67	18W LED TL	9	0	8
G-7 Central computing faculty	280, 225, 185, 310, 341, 322	277.17	36W FTL EB	20	2	8
Principal office	520, 642, 818, 580, 576, 499, 580	602.14	36W LED PANEL LIGHT	6	0	8
Vice principal cabin	672, 645, 578, 653, 496, 758, 510, 635, 764, 635	634.60	36W LED PANEL LIGHT	2	0	8
			12W LED PANEL LIGHT	3	0	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
Sakura Japanese learning section	150, 99, 206, 182, 155, 182, 281, 175	178.75	24W LED WALL LIGHTS	10	0	8
Language room	123, 137, 143, 78, 73	110.80	36W FTL EB	8	0	8
Purchase dept.	129, 133, 140, 267, 163, 149	163.50	18W LED TL	1	0	8
			24W LED TL	2	0	8
Training & placement	192, 393, 422, 365, 303, 422, 460	365.29	36W LED PANEL LIGHT	9	0	8
			18W LED TL	12	0	8
Workshop	177, 134, 169, 146, 130,152, 148, 143, 104	144.78	36W FTL EB	52	13	8
Cabin CNC Lab	102, 97, 72, 75	86.50	36W FTL EB	10	0	8
Gayatri mess	123, 139, 31.3, 79	93.08	18W LED TL	9	0	8
Boys Hostel- 1 (Sinhagad)						
Ground Floor (Total Room 38)	201, 140, 192, 122	163.75	18W LED TL	76	-	8
Hostel Office	96, 88, 136, 159, 73	110.4	18W LED TL	2	-	8
First Floor (Total Room 38)	119, 123, 180, 186, 181, 177	161	18W LED TL	76	-	8
Second Floor (Total Room 38)	226, 235, 278, 249, 227, 120	222.5	18W LED TL	76	-	8
Third Floor (Total Room 38)	235, 248, 246, 278, 271	255.6	18W LED TL	76	-	8
Fourth Floor (Total Room 38)	235, 271, 243, 219, 220	237.6	18W LED TL	76	-	8
Passage	30, 28, 36, 60	38.5	18W LED TL	6	-	8
Boys Hostel- 2 (Sajjangad)						
Ground Floor (Total Room 30)	299, 328, 243, 141, 322, 278	268.5	18W LED TL	60	-	8
Passage	64, 112, 109, 44, 34, 53	69.33333333	9W LED TL	7	-	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
First Floor (Total Room 31)	289, 228, 201, 218, 227	232.6	18W LED TL	62	-	8
Second Floor (Total Room 31)	256, 230, 239, 240, 265	246	18W LED TL	62	-	8
Third Floor (Total Room 31)	295, 301, 290, 236, 254	275.2	18W LED TL	62	-	8
Girls Hostel- 1 (Krushna Mati)						
Ground Floor (Total Room 15)	122, 116, 65, 56, 63, 79, 70	81.57142857	36W FTL EB	30	-	24
First Floor (Total Room 19)	122, 128, 134, 98, 96	115.6	36W FTL EB	38	-	24
Second Floor (Total Room 19)	102, 99, 100, 95, 118	102.8	36W FTL EB	38	-	24
Third Floor (Total Room 19)	134, 112, 124, 89, 91	110	36W FTL EB	38	-	24
Hostel Office (Ground Floor)	134, 89, 55, 65, 118	92.2	36W FTL EB	1	-	24
Passage (Ground Floor)	15, 18, 34, 45, 10	24.4	36W FTL EB	4	-	24
Girls Hostel- 1 (Kalsubai)						
Ground Floor (Total Room 13)	135, 156, 194, 191, 172, 185	172.1666667	18W LED TL	26	-	24
Ground Floor (Total Room 9)	120, 67, 108, 88, 92, 85, 89	92.71428571	9W LED TL	18	-	24
Ground Floor (Passage)	55, 91, 35, 84, 86	70.2	18W LED TL	4	-	24
First Floor (Total Room 35)	135, 188, 184, 161	167	18W LED TL	70	-	24
Second Floor (Total Room 35)	188, 167, 145, 154	163.5	18W LED TL	40	-	24
First Floor (Passage)	53, 48, 19, 25	36.25	9W LED TL	4	-	24
			18W LED TL	2	-	24
Second Floor (Passage)	18, 17, 36, 22	23.25	36W FTL EB	4	-	24
Hostel Office	157, 188, 146, 143	158.5	36W FTL EB	1	-	24
Outside area						
Outside front area	20.1, 17.2, 16.3, 22.5, 19, 18, 15, 14, 17, 8.5,	15.51	100W LED FLOOD LIGHTS	2	0	12

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
	6, 9, 14, 16, 20					
Security cabin (Outdoor)	240, 94, 137, 123, 207, 63, 261	160.71	18W LED TL	4	0	12
Security cabin (Indoor)	147, 110, 246, 240, 238	196.20	36W FTL EB	1	0	12
DG Set area	4, 5, 3, 7, 5, 21, 1, 11, 16, 54, 36	14.82	36W FTL EB	2	1	12
Washroom	100, 46, 75, 103, 49, 48	70.17	36W FTL EB	1	0	12
			18W LED TL	1	0	12
DG Set (old) outdoor	49, 58, 18, 25, 38	37.60	36W FTL EB	1	0	12
Transformer area	37, 35, 42, 21, 11, 16, 12	24.86	4X18W PL LAMP	2	2TL	12
Gate no.2 passage	42, 57, 61, 59, 41, 34, 30	46.29	80W LED STREET LIGHT	1	0	12
Inner passage from gate	50, 57, 43, 42, 34, 33	43.17	36W FTL EB	1	0	12
Workstation gate side	35, 45, 28, 22, 16, 14	26.67	80W LED STREET LIGHT	1	0	12
Account side	33, 34, 24, 10, 4, 3	18.00	80W LED STREET LIGHT	1	0	12
Near canteen	33, 34, 24, 10, 4, 4	18.17	80W LED STREET LIGHT	1	0	12
Canteen	55, 67, 80, 120, 73, 118, 134, 110, 113	96.67	18W LED TL	5	0	12
Dr. sarvapalli radhakrishnan Garden	10, 12, 19, 9, 8, 5, 4, 3, 5, 9, 16, 6, 14, 10, 15	9.67	120W LED STREET LIGHT	4	3	12
Power house (Old office)	228, 236, 231, 240	233.75	18W LED TL	2	0	12
Panel room	124, 162, 125, 129, 137, 144, 118, 140, 144	135.89	24W LED TL	3	0	12
			36W FTL EB	1	0	12

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
New office	242, 233, 270, 261, 263, 228	249.50	24W LED TL	2	0	12
College gate no.1	36, 42, 58, 54, 61, 48, 100, 96, 104, 112	71.10	9W LED DOWN LIGHT	4	5	12
			2X18W PL LAMP	3	3	12
Gate no.1 passage inside	53, 58, 66, 71, 79, 165, 230, 353, 430, 443, 450	218.00	2X18W PL LAMP	3	5	12
Store dept. to language lab passage	167, 121, 34, 31, 37, 84, 72, 16, 127, 86, 10, 11, 6, 103, 39, 41	61.56	2X18W PL LAMP	2	0	12
Event hall	33, 36, 21, 19, 14, 12, 9, 7, 8, 6, 5, 20, 23, 28	17.21	100W LED FLOOD LIGHTS	1	1	12
Event stage	945, 600, 573, 344, 597, 820, 1047, 484, 504	657.11	60W LED FLOOD LIGHT	5	0	12
			250W LED FLOOD LIGHT	2	0	12
			400W LED FLOOD LIGHT	2	0	12
Devi temple area	16, 18, 23, 22, 32, 33	24.00	40W LED FLOOD LIGHT	1	0	12
			100W LED FLOOD LIGHTS	2	0	12
Road to vasantdada Smarak	14, 27, 6, 1, 4, 22, 10, 12, 16, 11	12.30	30W LED STREET LIGHT	13	0	12
			40W LED STREET LIGHT	2	0	12
Gate area	13, 34, 38, 106, 8, 21, 5, 3	28.50	40W LED STREET LIGHT	2	0	12
			60W LED STREET LIGHT	1	0	12

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
Passage	91, 110, 75, 116, 122, 15, 13, 38, 166, 110, 17, 6, 4, 9, 24, 130, 126, 59, 57, 16	65.20	24W LED TL	6	0	12
Civil engg. Office	28, 30, 57, 20, 16, 22, 58, 54, 12	33.00	36W FTL EB	5	0	12
Environment lab to HOD Cabin civil	65, 52, 21, 45, 27, 1, 2, 23	29.50	36W FTL EB	3	0	12
Geotech lab to TOM Lab	30, 36, 54, 29, 53,57, 25	40.57	36W FTL EB	3	1	12
Near staircase	26, 36, 79, 57, 41, 32, 21	41.71428571	36W FTL EB	1	1	12
			40W FTL EB	0	1	12
Annapurna canteen girls hostel	253, 248, 156, 533, 632, 245, 176, 123,	262.8888889	2X18W PL LAMP	8	0	8
			36W FTL EB	5	10	8
Kitchen 1	143, 125, 563, 324 ,123, 653,	275.8571429	36W FTL EB	4	0	8
Kitchen 2	464, 537, 336, 125, 214	335.2	36W FTL EB	6	0	8
					0	8
Amarkuti room no 1	492, 522, 408, 409, 305	427.2	18W LED DOWN LIGHT	4	0	8
			9W LED TL	1	0	8
Amarkuti room no 2	782,125, 478, 596, 658,	439.8333333	18W LED DOWN LIGHT	4	0	8
			9W LED TL	1	0	8
Amarkuti room no 3	546, 623, 408, 409, 307	458.6	18W LED DOWN LIGHT	4	0	8
			9W LED TL	1	0	8
Corridor area	123, 565,124,	203	18W LED TL		0	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
meeting room	406, 441, 690, 803	585	18W LED DOWN LIGHT	10	1	8
Guest house kitchen	427, 421, 321, 325, 331,	304.1666667	18W LED DOWN LIGHT	4	0	8
			9W LED TL	1	0	8
			9W LED FOCUS LIGHT	1	0	8
Production department						
05 Robotics lab	308, 135, 143, 223, 173, 221	200.5	36W FTL EB	10	0	8
			36W FTL EB	1	0	8
Production class room 119	236, 246, 241, 255, 250, 275, 157	237.1428571	36W FTL EB	2	0	8
			2X18W PL LAMP	4	2	8
			18W LED TL	2	0	8
Production class room 109	236, 246, 241, 255, 250, 275, 157	237.1428571	36W FTL EB	2	0	8
			2X18W PL LAMP	4	0	8
			18W LED TL	2	0	8
S218 QC lab	146, 156, 173, 168, 226	173.8	36W FTL EB	4	0	8
Cabin 1	192, 230, 220, 257	224.75	36W FTL EB	5	0	8
S209A Project lab	114, 101, 162, 113, 154	128.8	36W FTL EB	3	0	8
213 HOD Office	90, 64, 69, 77	75	36W FTL EB	2	0	8
S215 Staff room	90, 125, 122, 80	104.25	36W FTL EB	1	1	8
S212 P Cad cam	240, 136, 235, 122, 112, 123	161.3333333	36W FTL EB	2	0	8
Cad Lab production (sun light)	155, 183, 146, 321, 332,	189.5	36W FTL EB	5	0	8
Production boys' common room	182, 127, 131, 157, 173	154	18W LED TL	1	1	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
S209B MCTD Lab	123, 136, 74, 105, 107,	35.88888889	36W FTL EB	8	0	8
S210 Material forming	123, 136, 74, 105, 107,	90.83333333	36W FTL EB	1	0	8
			18W LED TL	1	0	8
Automation lab (sun light)	411, 148, 163, 393 ,381,	249.3333333	36W FTL EB	1	1	8
Ladies common room	411, 483, 387, 333,	322.8	36W FTL EB	2	0	8
PG Tutorial S221	117, 119, 273, 350	214.75	36W FTL EB	2	1	8
PG Tutorial S222	117, 119, 273, 351	215	36W FTL EB	2	1	8
Library (206)	223, 130, 109, 91, 151, 167,	124.4285714	18W LED TL	2		8
			36W FTL EB	4	0	8
Reading room	140, 144, 166, 172, 111	146.6	36W FTL EB	2	0	8
MBA						
224 HOD Cabin	183, 160 ,136, 142	155.25	36W FTL EB	2	0	8
225 staff Room	248, 175, 128, 172, 149,	145.3333333	18W LED TL	3	0	8
Staff room passage	40, 42, 47, 37, 35	40.2	18W LED TL	0	1	8
201 MBA class room	125, 113, 105, 114, 97, 108,	94.57142857	36W FTL EB	4	0	8
204 computer labs	142, 147, 258, 252, 345, 387,	218.7142857	36W FTL EB	6	0	8
202 tutorial labs	243, 241, 247, 187,	229.5	36W FTL EB	1	0	8
203 seminar halls	97, 105, 65, 56, 51	74.8	36W FTL EB	1	1	8
205 MBA CR2	109, 113, 144, 133, 111	122	36W FTL EB	4	2	8
Mechanical department						
Heat engine lab 1) ET	164, 124, 91, 89, 304, 98, 48, 242,	128.8888889	18W LED TL	2	0	8
			36W FTL EB	14	0	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
2) Steam lab	304, 201, 115, 97, 415, 176, 121	204.1428571	36W FTL EB	12	0	8
cabin 1	102, 80, 78, 91,	70.2	36W FTL EB	1	0	8
Cabin 2	105, 82, 83, 195	116.25	36W FTL EB	2	0	8
Mechanical ground floor passage	163, 220, 241, 237, 150, 128, 107, 128, 138,	151.2	18W LED DOWN LIGHT	27	1	8
HOD mech department	254, 164, 181, 162	190.25	36W FTL EB	4	0	8
inside chamber	171, 124, 132, 107	133.5	36W FTL EB	1	0	8
			18W LED TL	1	0	8
Department office	147, 163, 207, 203, 193	182.6	18W LED TL	2	0	8
108 PG lab	196, 152, 211, 263, 253	215	18W LED TL	3	1	
			36W FTL EB	4	2	
Reff & A/c lab	576, 876,534,536, 714	647.2	36W FTL EB	2		
			36W FTL EB	6	0	8
Dynamics of machinery lab	527, 598, 703, 567, 906	660.2	18W LED TL	4	0	8
			36W FTL EB	9	0	8
			36W FTL EB	2	0	8
Cabin 1	160, 165, 164, 144	7.125	18W LED TL	2	0	8
Cabin 2	160, 165, 164, 145	158.5	18W LED TL	2	0	8
Theory of machines Lab 1 & 2	155, 268, 140, 287, 291, 144	214.1666667	18W LED TL	6	0	8
			2X18W PL LAMP	8	1	
			36W FTL EB	1	1	
Cabin 1	126, 132, 138, 143, 153	138.4	18W LED TL	2	0	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
Cabin 2	126, 132, 138, 143, 154	138.6	18W LED TL	2	0	8
BME lab	128, 149, 272, 491, 312, 252	267.3333333	36W FTL EB	4	0	8
			2X18W PL LAMP	6	0	8
Cabin 1	126, 132, 138, 143, 153	138.4	18W LED TL	2	0	8
Cabin 2	126, 132, 138, 143, 154	138.6	18W LED TL	2	0	8
Stair case	1480, 1400, 1200, 1250,	1066	36W LED PANEL LIGHT	2	0	8
2nd floor passage	304, 201, 115, 97, 415, 176, 121	204.1428571	36W LED PANEL LIGHT	12	0	8
116Mechatronics & ifp lab	180, 261, 362, 480, 573, 567,	346.1428571	18W LED TL		2	
			2X18W PL LAMP	4	0	8
class room	182, 187, 161, 158, 165, 160, 178	170.1428571	36W FTL EB	2	0	8
			18W LED TL	3	0	8
			2X18W PL LAMP	3	0	8
Cabin 1	160, 165, 164, 144	158.25	18W LED TL	2	0	8
Cabin 2	160, 165, 164, 145	158.5	18W LED TL	2	0	8
114PG CAD/CAM LAB +113 UG CAD/CAM LAB	145, 139, 124, 148, 86, 71, 56, 58,	91.88888889	18W LED TL	4	2	
			2X18W PL LAMP	9	0	8
Cabin 1	74, 76, 60, 64, 46, 44,	18.85714286	18W LED TL	1	0	8
111) Heat transfer lab	705, 345, 249, 213,	302.4	2X18W PL LAMP	3	1	8
			18W LED TL		2	8
Class room	296, 321, 210, 211, 128, 134, 101, 75, 144	180	18W LED TL	3	1	8
			2X18W PL LAMP	3	0	8
Cabin 1	160, 165, 164, 144	158.25	18W LED TL	2	0	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
Cabin 2	160, 165, 164, 145	158.5	18W LED TL	2	0	8
PG Room	207, 185, 237, 153, 127	181.8	36W FTL EB	1	1	8
			2X18W PL LAMP	1	1	8
Boys common room	250, 263, 222, 210	236.25	18W LED DOWN LIGHT	1		8
			18W LED TL	1	0	8
163 Faculty room	86, 123, 113, 119, 121	112.4	2X18W PL LAMP	1	1	8
118 Faculty room (sun light)	643, 85, 653, 122, 166, 202	311.8333333	18W LED TL	1	1	8
			2X18W PL LAMP		1	8
Project lab (Mechanical) (s.l)	180, 425, 670, 623, 384, 357	439.8333333	2X18W PL LAMP	1	0	8
			18W LED TL	2	0	8
107 mechanical class room	226, 343, 292, 190, 315, 733	349.8333333	18W LED TL	3	0	8
			2X18W PL LAMP	2	0	8
			36W FTL EB	2	0	8
106 mechanical class room	226, 343, 292, 190, 315, 733	349.8333333	18W LED TL	3	0	8
			2X18W PL LAMP	2	0	8
			36W FTL EB	2	0	8
104 mechanical class room	226, 343, 292, 190, 315, 733	381.8	18W LED TL	3	0	8
			2X18W PL LAMP	2	0	8
			36W FTL EB	2	0	8
Faculty room (M13)	163, 167, 154, 103, 190, 147	154	18W LED TL	2	0	8
Faculty room (M14)	163, 167, 154, 103, 190, 147	154	18W LED TL	2	0	8
Control room Exam control	204, 207, 192, 193, 186, 273,	179.2857143	18W LED TL	1	0	8
			2X18W PL LAMP	1	0	8

Location	Illumination Level	Average Illumination	Light Fixture	Working	Not Working	Hours of use
101 Class room	253, 260, 304, 165, 355, 369	284.3333333	18W LED TL	3	0	8
			2X18W PL LAMP	3	0	8
			36W FTL EB	2	0	8
Seminar hall (Mechanical)	420, 357, 497, 18, 222, 531,	292.1428571	100W LED FLOOD LIGHTS	2	0	8
			36W FTL EB	7	0	8
			100W HALOGEN LIGHT	22	4	8
			36W LED PANEL LIGHT	5	0	8
Varanda mechanical	123, 143, 166, 108,	108	18W LED DOWN LIGHT	6	0	8
Engineering store (sajjangarh hostel)	206, 156, 169, 251, 277, 253	218.6666667	18W LED TL	3	0	8
			36W FTL EB	1	0	8
Canteen	437, 182, 183, 80, 104, 137,	160.4285714	18W LED TL	18	0	8

Table 2.1: Recommended Illumination levels as per National Building Code (NBC)

Activity	Recommended Illumination level
General lighting: Illuminated tables	200-300-500
Proof press	300-500-750
Proof reading	500-750-1000
sheet Inspection	750-1000-1500
Ware house/Go down	50-100-150
Gangway	20
General office	300-500-750
Pump room	200-300-500
Toilet	50-100-150
Library	200-300-500
Reading rooms	200-300-500
Entrance lobbies	150-200-300
Entrance desk	300-500-750
Gate houses	150-200-300
Lift	50-100-150
Corridors, passages, staircases	50-100-150
Changing /locker rooms	50-100-150
Canteen	150-200-300
Food preparation	300-500-750
Food store	100-150-200
Electrical power supply and distribution room	100-150-200
Mechanical plant room	100-150-200
Covered car parks floor	5-20

2.2 Energy Conservation Opportunity in Lighting Area:

Table No. 2.2: Conventional Light Fixtures considered for replacement by LED Light Fixture:

Light Fixture Type	Working	Not Working	Total Light Fixture	Hours of Use
100W HALOGEN LIGHT	22	4	26	8
28W CFL LIGHT	17	2	19	8
2X18W PL LAMP	117	15	132	9
36W FTL EB	1084	76	1160	9
4X18W PL LAMP	2	0	2	12
40W FTL EB	37	6	43	8

2.3: ENERGY CONSERVATION IN LIGHT FIXTURES:

Table 2.3: Energy conservation by Replacement of 100W Halogen Lamp by 30W LED Flood

Sr. No	Description	
1	Total power consumption of 100W Halogen Lamp Fixtures for quantity of 26 lamps.	2.21 KW
2	Total power consumption of 30W LED Flood Fixtures for quantity of 26 lamps.	0.78 KW
3	Power consumption reduction by replacement of 100W Halogen Lamp by 30W LED Flood	1.43 KW
4	Energy saving per year considering 10 hours operation per day and 365 days in year	5219.50
5	Total energy cost saving/year considering demand charges and Electricity Duty, Energy Cost of 13.28 Rs/KVAH	Rs69314.96
6	Total cost of 26 Nos of 30W LED Flood (Approx. Rs. 2100 per unit)	Rs54600.0
7	Payback period	0.787 Years
		9.452 Months
8	% Return on investment	127.06%

2.3: ENERGY CONSERVATION IN LIGHT FIXTURES:

Table 2.4: Energy conservation by Replacement of 28W CFL LIGHT by 9W LED Bulb

Sr. No	Description	
1	Total power consumption of 28W CFL LIGHT Fixtures for quantity of 19 lamps.	0.627 KW
2	Total power consumption of 9W LED Bulb Fixtures for quantity of 19 lamps.	0.171 KW
3	Power consumption reduction by replacement of 28W CFL LIGHT by 9W LED Bulb	0.456 KW
4	Energy saving per year considering 6 hours operation per day and 300 days in year	820.80
5	Total energy cost saving/year considering demand charges and Electricity Duty, Energy Cost of 13.28 Rs/KVAH	Rs10900.224
6	Total cost of 19 Nos of 9W LED Bulb (Approx. Rs. 105 per unit)	Rs1995.00
7	Payback period	0.183 Years
		2.196 Months
8	% Return on investment	546.448%

2.3: ENERGY CONSERVATION LIGHT FIXTURES

Table 2.5: Energy conservation by Replacement of 2X18W PL by 15W LED DL

Sr. No	Description	
1	Total power consumption of 2X18W PL Fixtures for quantity of 132 lamps.	5.28 KW
2	Total power consumption of 15W LED DL Fixtures for quantity of 132 lamps.	1.98 KW
3	Power consumption reduction by replacement of 2X18W PL by 15W LED DL	3.3 KW
4	Energy saving per year considering 8 hours operation per day and 350 days in year	9240
5	Total energy cost saving/year considering demand charges and Electricity Duty, Energy Cost of 13.28 Rs/KVAH	Rs 122707.20
6	Total cost of 132 Nos of 15W LED DL (Approx. Rs. 945 per unit)	Rs 124740
7	Payback period	1.0165 Years
		12.198 Months
8	% Return on investment	98.37%

2.3: ENERGY CONSERVATION LIGHT FIXTURES

Table 2.6: Energy conservation by Replacement of 36W FTL EB by 18W LED TL

Sr. No	Description	
1	Total power consumption of 36W FTL Fixtures for quantity of 1160 lamps.	44.080 KW
2	Total power consumption of 18W LED TL Fixtures for quantity of 1160 lamps.	20.88 KW
3	Power consumption reduction by replacement of 36W FTL by 18W LED TL	23.20 KW
4	Energy saving per year considering 6 hours operation per day and 220 days in year	30624
5	Total energy cost saving/year considering demand charges and Electricity Duty, Energy Cost of 13.28 Rs/KVAH	Rs 406686.72
6	Total cost of 1160 Nos of 18W LED TL (Approx. Rs. 280 per unit)	Rs324800
7	Payback period	0.798 Years
		9.583 Months
8	% Return on investment	126.742%

2.3: ENERGY CONSERVATION LIGHT FIXTURES

Table 2.7: Energy conservation by Replacement of 4X18W PL by 36W LED Panel Light

Sr. No	Description	
1	Total power consumption of 4X18W PL Fixtures for quantity of 2 lamps.	0.17 KW
2	Total power consumption of 36W LED Panel Light Fixtures for quantity of 2 lamps.	0.072 KW
3	Power consumption reduction by replacement of 4X18W PL by 36W LED Panel Light	0.098 KW
4	Energy saving per year considering 8 hours operation per day and 330 days in year	258.72
5	Total energy cost saving/year considering demand charges and Electricity Duty, Energy Cost of 13.28 Rs/KVAH	Rs3435.80
6	Total cost of 2 Nos of 36W LED Panel Light (Approx. Rs. 2450 per unit)	Rs 4900
7	Payback period	1.426 Years
		17.1139 Months
8	% Return on investment	70.126%

2.3: ENERGY CONSERVATION LIGHT FIXTURES

Table 2.8: Energy conservation by Replacement of 40W FTL by 18W LED TL

Sr. No	Description	
1	Total power consumption of 40W FTL Fixtures for quantity of 43 lamps.	1.935 KW
2	Total power consumption of 18W LED TL Fixtures for quantity of 43 lamps.	0.774 KW
3	Power consumption reduction by replacement of 40W FTL by 18W LED TL	1.161 KW
4	Energy saving per year considering 8 hours operation per day and 330 days in year	3065.04
5	Total energy cost saving/year considering demand charges and Electricity Duty, Energy Cost of 13.28 Rs/KVAH	Rs 40703.73
6	Total cost of 43 Nos of 18W LED TL (Approx. Rs. 280 per unit)	Rs 12040
7	Payback period	0.295 Years
		3.549 Months
8	% Return on investment	338.983%

Table 2.9: Summary of total Energy saving in lighting:

Sr. No.	Energy conservation measures	Energy saving per Year In KVAH	Energy cost Saving per Year in Rs	Investment Rs.	Payback period Year	%ROI
1	Replacement of 100W Halogen Lamp by 30W LED Flood	5219.5	69314.96	54600	0.787	127.06%
2	Replacement of 28W CFL LIGHT by 9W LED Bulb	820.80	10900.224	1995	0.183	546.448%
3	Replacement of 2X18W PL by 15W LED DL	9240	122707.20	124740	1.0165	98.37%
4	Replacement of 36W FTL by 18W LED TL	30624	406686.72	324800	0.798	126.742%
5	Replacement of 4X18W PL by 36W LED Panel Light	258.72	3435.80	4900	1.426	70.126%
6	Replacement of 40W FTL by 18W LED TL	3065.04	40703.73	12040	0.295	338.983%
	Total	49228.06	653748.6	5,23,075	0.800 Year or 9.601 Months	125%

Reduction in connected lighting load after replacement of conventional Light fixtures by LED Light fixtures:

Sr. No.	Recommended Energy Conservation Measures	Reduction in load in KW
1	Replacement of 100W Halogen Lamp by 30W LED Flood	1.43
2	Replacement of 28W CFL LIGHT by 9W LED Bulb	0.456
3	Replacement of 2X18W PL by 15W LED DL	3.3
4	Replacement of 36W FTL by 18W LED TL	23.20
5	Replacement of 4X18W PL by 36W LED Panel Light	0.098
6	Replacement of 40W FTL by 18W LED TL	1.161
Total reduction in load (KW):		29.645

Sr. No.	Parameter	Value
1	Total lighting connected load in KW considered for replacement with LED lamp	54.302 KW
2	Revised connected load with LED light fixtures	24.657 KW
3	%Reduction of lighting load	54.592 %

Recommended LED Light fixture makes:

1)SYSKA
2)PHIPLIPS
3)WIPRO
4)OSRAM
5)BAJAJ

Recommended warranty period: 12 Month

CHAPTER-3
POWER QUALITY AUDIT FINDINGS AND RECOMMENDATIONS

CHAPTER-3
POWER QUALITY AUDIT FINDINGS AND RECOMMENDATIONS

3.0 NEED OF POWER QUALITY AUDIT

There are several important reasons to conduct power quality audit. The various reasons are: To avoid financial loss due to process disruption: - The various cost of disruption is

a) Lost work: The product or service is not generated for a period of time until the recovery is complete. The various cost related to lost work are idled labour, lost production hence lost profits, overtime labour and premium charges, overtime operating cost, late delivery fees.

b) Cost of repair of the damaged equipment: - The various costs involved in repairing of damaged equipment due to power quality problem are repair, cost of labour, cost of replaced spare parts, cost of replacement part availability.

c) Cost of recovery: - Cost involved in recovery of secondary equipment failures, recovery of labour inefficiency.

d) Cost of scrap and product quality: - The various cost involved are replacement value of scrap (BOM value + labour value, product lost profit margin and rework costs.

e) Miscellaneous cost: - The various miscellaneous costs are customer's dissatisfaction, lost business, avoided customers due to longer lead time, fines and penalties etc.

Considering the huge financial losses related to a power quality event causing process disruption to industry, it is necessary to monitor power quality to provide cost effective solution to avoid financial losses. The various effects of power quality event on equipment and process operation include miss-operation, damage, process disruption, and other anomalies.

3.1 IMPACT OF POWER QUALITY PROBLEMS ON THE OPERATIONS OF VARIOUS EQUIPMENTS

The growing percentage of sensitive equipments and process downtime due to power quality problems has pointed out an incompatibility between the tolerances of electronics appliances to power disturbances and the expected electric environment. Power quality audit helps to study various power quality problems present in electric supply distribution system and to take appropriate remedial actions. With a better understanding of the electrical environment, end users can request improvements in the tolerance of electrical appliances to power quality disturbances to ensure electrical power system compatibility. In order to mitigate these power quality anomalies a statistical knowledge base of frequency, voltage profiles as a function of time of the day is required. The harmonics present in the electrical distribution are undesirable for the operation of various equipments. They cause frequent failure of equipment's due to excessive heating, over loading of transformers and cables, malfunctioning of electronic equipment and increase in line loss etc.

Some symptoms caused by power quality include:

- Malfunction of equipment.
- Frequent system reboots becoming necessary.
- High failure rate of electronic systems.
- Overheating of transformers, cables, motors and capacitor banks.
- A.C coil contactor disengagement and tripping of ASD's.
- Inaccuracy of testing and measuring equipment.
- Light dimming or blinking.

The level of power quality required is that level which will result in proper operation of equipment at a particular facility. It is the susceptibility of end use equipment that defines the necessary level of power quality. The various power quality problems with their characteristics are tabulated in tables below.

3.2 RESULTS OF POWER QUALTIY ANALYSIS:

Power quality analysis was conducted at various feeders. The result of power quality analysis conducted for various positions of tap of the distribution transformer is presented below.

3.3 Power Quality Analysis of Main LT Incomer-1 (Commercial):

Table No: 3.0 Power Quality Analysis of Main LT Incomer-1 (Commercial):

Parameter	CH1			CH2			CH3		
	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.
RMS VOLTAGE (V)	427.6	408.86	395.6	431.5	413.68	401	433	413.83	401.2
RMS CURRENT (A)	112.07	55.85	35.87	114.09	52.93	37.61	115.11	51.32	31.64
RMS VOLTAGE AVG.(V)	430.7	412.12	399.3	---	---	---	---	---	---
RMS CURRENT AVG.(A)	113.75	53.36	35.19	---	---	---	---	---	---
ACTIVE POWER (KW)	54	28.97	14.5	---	---	---	---	---	---
REACTIVE POWER (KVAR)	17.5 Cap.	23.91 Cap.	67.9 Cap.	---	---	---	---	---	---
APPARENT POWER (KVA)	80	38.05	24.7	---	---	---	---	---	---
POWER FACTOR	0.519 Lead	0.749 Lead	0.946 Lead	---	---	---	---	---	---
K.F.	5.86	3.46	2.02	6.19	3.9	2.18	6.22	3.78	2.21
%Vunb	1.02	0.802	0.58	---	---	---	---	---	---
%Iunb	12.69	6.979	0.86	---	---	---	---	---	---
%VTHD	2.32	1.66	1.04	1.85	1.39	0.92	1.78	1.3	0.78
%ITHD	29.26	23.34	17.91	34.63	28.23	16.84	32.21	26.2	17.66

3.3 Power Quality Analysis of Main LT Incomer-1 (Commercial):

Table No: 3.1: Individual Voltage Harmonic Distortion in volts at Main LT Incomer-1 (Commercial):

Harmonic Order	CH1			CH2			CH3		
	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.
2	0.08	0.04	0.02	0.11	0.05	0.02	0.12	0.06	0.03
3	1.46	0.44	0.08	1.61	0.87	0.45	1.27	0.44	0.07
5	5.14	2.84	0.66	3.86	2.11	0.66	3.6	1.88	0.6
7	3.99	1.98	0.39	3.18	1.78	0.32	3.28	1.68	0.28
9	0.42	0.2	0.07	0.3	0.14	0.04	0.44	0.21	0.07
11	2.54	1.11	0.46	1.74	0.91	0.35	2.59	1.13	0.46
13	0.76	0.4	0.12	1	0.54	0.28	1.24	0.64	0.33
15	0.3	0.14	0.04	0.36	0.12	0.03	0.32	0.15	0.04
17	0.3	0.17	0.03	0.53	0.3	0.06	0.51	0.28	0.11
19	0.29	0.11	0.03	0.24	0.1	0.03	0.23	0.11	0.03
21	0.11	0.05	0.02	0.16	0.07	0.02	0.14	0.06	0.02
23	0.11	0.06	0.02	0.13	0.06	0.02	0.13	0.07	0.02
25	0.13	0.06	0.01	0.18	0.07	0.01	0.09	0.06	0.02
27	0.06	0.02	0.01	0.11	0.05	0.02	0.07	0.03	0.01
29	0.07	0.04	0.01	0.09	0.05	0.01	0.12	0.04	0.01
31	0.06	0.03	0.01	0.08	0.04	0.01	0.05	0.02	0.01
33	0.04	0.02	0.01	0.05	0.03	0.01	0.04	0.02	0.01
35	0.06	0.03	0.01	0.04	0.02	0.01	0.07	0.03	0.01
37	0.04	0.02	0.01	0.06	0.02	0.01	0.07	0.03	0.01
39	0.03	0.02	0.01	0.05	0.03	0.01	0.04	0.02	0.01
41	0.04	0.02	0.01	0.04	0.02	0.01	0.03	0.01	0.01
43	0.05	0.02	0.01	0.05	0.02	0.01	0.05	0.01	0
45	0.02	0.01	0.01	0.03	0.01	0.01	0.03	0.01	0.01
47	0.04	0.02	0.01	0.04	0.01	0	0.04	0.02	0
49	0.04	0.01	0.01	0.04	0.02	0.01	0.03	0.01	0

3.3: Power Quality Analysis of Main LT Incomer-1 (Commercial):

Table No: 3.2 Individual Current Harmonic Distortions in Ampere at Main LT Incomer-1 (Commercial):

Harmonic Order	CH1			CH2			CH3		
	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.
2	1.14	0.35	0.2	1.8	1.14	0.78	1.68	0.37	0.17
3	15.38	8.33	5.23	16.71	9.95	6.62	14.89	8.82	5.2
5	6.81	3.06	0.53	10.66	5.42	2.07	9.53	4.78	1.36
7	16.97	6.42	2.81	12.62	6.08	2.78	15.9	5.87	1.47
9	4.1	3.32	2.62	4.8	3.39	2.27	4.03	2.75	1.96
11	6.42	3.58	1.49	5.17	3.31	1.76	6.62	3.52	1.64
13	3.48	1.71	0.47	3.08	1.8	0.92	3.84	2.14	0.93
15	2.3	1.08	0.26	1.88	1.03	0.37	2.39	0.99	0.2
17	1.05	0.52	0.11	1.51	0.92	0.18	1.25	0.6	0.17
19	1.35	0.53	0.1	1.1	0.46	0.11	1.58	0.61	0.12
21	0.52	0.31	0.13	0.49	0.26	0.08	0.74	0.33	0.13
23	0.41	0.21	0.08	0.54	0.26	0.11	0.37	0.15	0.05
25	0.48	0.18	0.05	0.57	0.22	0.05	0.57	0.33	0.1
27	0.24	0.08	0.03	0.2	0.1	0.03	0.28	0.11	0.03
29	0.28	0.11	0.03	0.29	0.13	0.05	0.28	0.13	0.05
31	0.32	0.12	0.03	0.43	0.19	0.06	0.35	0.13	0.06
33	0.1	0.05	0.03	0.16	0.08	0.03	0.16	0.08	0.03
35	0.29	0.11	0.03	0.37	0.11	0.06	0.3	0.12	0.07
37	0.28	0.08	0.03	0.27	0.1	0.05	0.33	0.11	0.04
39	0.15	0.05	0.01	0.11	0.06	0.03	0.15	0.05	0.02
41	0.21	0.06	0.01	0.19	0.06	0.03	0.13	0.06	0.03
43	0.25	0.07	0.02	0.27	0.08	0.02	0.35	0.09	0.02
45	0.1	0.04	0.01	0.09	0.04	0.02	0.14	0.05	0.02
47	0.22	0.07	0.01	0.21	0.06	0.02	0.12	0.04	0.02
49	0.21	0.05	0.01	0.19	0.05	0.01	0.28	0.09	0.02

3.4: Conclusion of power quality analysis at Main LT Incomer-1 (Commercial):

- RMS voltage variation is between 395.6V to 433V. RMS voltage variation is slightly higher than recommended limit .Recommended to revise lower and raise setting of AVR of RTCC panel to maintain RMS voltage between 395 to 415V
- Reactive power variation is between -67.9KVAR to -17.5KVAR. Reactive power compensation is not adequate and overcompensation in the range of 17.5 KVAR 67.9KVAR. Inadequate reactive power compensation results into increase in MD, transformer loading and branch circuit losses. Recommended to maintain adequate reactive power compensation.
- % Voltage unbalance factor is 1.02% and is upto 1% recommended limit as per NEMA MG standard.
- **%** Current unbalance factor is 12.69 % and it is within recommended limit.
- % Total voltage harmonic distortion is 2.32% which is more than 8% recommended limit as per IEEE 519-2014 standard for rated system voltage below 1KV.
- % Individual voltage harmonic distortion of 2^{nd} order to 50^{th}order is within recommended limit of 5% as per IEEE 519-2014 standard for rated system voltage of 1KV.
- % Total current harmonic distortion is 34.63% which is higher than 5% limit for ISC/IL ratio less than 20 for rated system voltage of 110V upto 69 KV
- % Individual current harmonic distortion of 3^{rd} , 5^{th} , 7^{th} , 11^{th} and 13^{th} order harmonics is higher than recommended limit for ISC/IL ratio less than 20 for rated system voltage between 110V to 69 KV as per IEEE 519-2014 standard.

3.5 Power Quality Analysis of Main LT Incomer-2 (Residential):

Table No: 3.3 Power Quality Analysis of Main LT Incomer-2 (Residential):

Parameter	CH1			CH2			CH3		
	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.
RMS VOLTAGE (V)	432.93	408.08	393.84	436.85	412.96	399.46	440.55	414.57	401.08
RMS CURRENT (A)	91.57	45.31	14.43	83.85	42.12	22.33	108.62	53.86	15.46
RMS VOLTAGE AVG.(V)	436.78	411.87	398.13	---	---	---	---	---	---
RMS CURRENT AVG.(A)	94.68	47.1	17.41	---	---	---	---	---	---
ACTIVE POWER (KW)	63.75	32.5	12.94	---	---	---	---	---	---
REACTIVE POWER (KVAR)	22.56	7.97	2.91 Cap.	---	---	---	---	---	---
APPARENT POWER (KVA)	64.94	33.63	13.74	---	---	---	---	---	---
POWER FACTOR	1	0.96	0.99 Lead	---	---	---	---	---	---

3.5: Conclusion of power quality analysis at Main LT Incomer-2 (Residential):

- RMS voltage variation is between 393.84V to 440.55V. RMS voltage variation is more than recommended limit of 380-420V. Higher RMS voltage results into increase in power loss and decrease in life of Electrical and electronic equipment's due to higher Electrical voltage stress. RMS voltage variation is slightly higher than recommended limit .Recommended to revise lower and raise setting of AVR of RTCC panel to maintain RMS voltage between 395 to 415V
- Reactive power variation is within -2.91KVAR to 22.56KVAR. Reactive power compensation is not adequate and there is under compensation by 22.56KVAR and overcompensation during peak off period by 2.91KVAR. Inadequate reactive power compensation results into increase in MD, transformer loading and branch circuit losses. Recommended to maintain adequate reactive power compensation.

CHAPTER-4
REACTIVE POWER MANAGEMENT

4.0 REACTIVE POWER MANAGEMENT

An improvement of power factor can provide both economic and system advantages. The various operational benefits are improved system efficiency, release of system capacity, reduction of power losses and voltage improvement. The energy saving is dependent on

- The percentage reduction in ampere due to additional KVAR
- Motor design, conductor size and conductor length.
- Capacitor watt loss.

Table No. 4.0: Energy Bill Analysis:

Sanctioned contract demand – 415KVA, 55% OF sanctioned contract demand: 228.25KVA

Month	Recorded MD in KVA	Recorded Avg. P.F.	Billed MD in KVA	Calculated actual Demand in KVA considering P.F. As One	Difference in billed MD and actual MD at unity Power factor	KVA @Rs XXXX From Bill Data	Reduction in MD charges in Rs	Monthly KWH consumption	Monthly KVAH consumption	KVAH-KWH	RKVAH (LAG)	RKVAH (LEAD)	Total Bill Amount
Nov-19	179	0.994	208	177.93	30.07	391	11758.93	69058	69350	292	2432	5012	9,13,136.97
Dec-19	220	0.990	221	217.80	3.20	391	1251.20	71575	71755	180	1140	9022	9,83,632.80
Jan-20	219	0.986	219	215.93	3.07	391	1198.81	66925	67240	315	1792	9372	8,73,502.55
Feb-20	207	0.980	208	202.86	5.14	391	2009.74	63682	63750	68	410	12545	8,44,913.03
Apr-20	94	0.999	228	93.91	134.09	411	55112.63	7607	7615	8	25	9043	2,17,495.05
May-20	96	0.978	228	93.89	134.11	411	55120.03	8087	10878	2791	208	5715	2,46,220.68
Jun-20	105	0.916	228	96.18	131.82	411	54178.02	6837	7464	627	20	11130	2,21,525.32
Jul-20	89	0.921	228	81.97	146.03	411	60018.74	6946	7542	596	83	10898	2,16,391.18
Aug-20	88	0.908	228	79.90	148.10	411	60867.46	7004	7714	710	30	12000	2,18,720.83
Sep-20	101	0.922	228	93.12	134.88	411	55434.86	7845	8509	664	45	11620	2,29,597.95
Oct-20	95	0.939	228	89.21	138.80	411	57044.75	8422	8969	547	43	10923	2,35,909.23
Nov-20	92	0.893	228	82.16	145.84	411	59941.88	7600	8511	911	8	12520	2,29,580.84
				Total				**3,31,588**	**3,39,297**	**7,709**	**6,236**	**1,19,800**	**54,30,626.43**

Electricity Average per unit Charge Rs/KVAH during pre COVID-19 period =	13.286

Recommendations :

A) Energy cost reduction potential by adequate reactive power compensation

Difference between KVAH and KWH units pre COVID 19 period per month on average of three months =262.33KVAH

Annual difference between KVAH and KWH based on three months pre COVID average = 262.33X12 = 3148.00 KVAH

Total Energy cost reduction potential by adequate reactive power compensation per year = Rs13.28x3148.00 = Rs 41805.44

Recommended to connect 7.5KVAR capacitor with MCB before APFC CT for transformer reactive power compensation and program APFC in auto mode and disconnect other fixed capacitors .

Investment : Rs 6000.00

Payback period = 0.143 Years or 1.722 Months

%ROI = 699.300

B) Revision of sanctioned contract Demand under COVID 19 :

During COVID 19 MSEDCL is allowing to revise sanctioned contract demand three times in one month by online application .Presently during COVID period Maximum demand charges are being paid as per 55% of sanctioned contract demand as per Minimum MD billing

Recommended to revise sanction contract from 415KVA from 200KVA .

Energy cost reduction by revision by sanctioned contract demand 400KVA from 200KVA during COVID period for next 4 months = 118x411x4 = Rs 193992.00

Investment :NIL

C) Provision of separate energy meter for residential energy consumption

4.1: APFC Panel Details:

Table No. 4.1: 10 KVAR Capacitor Details:

Make	L&T
Type	Standard duty Power Capacitor
KVAR	10
Voltage	440V
Current	13.1A
Frequency	50HZ
Connection	Delta
Phases	3

Table No. 4.2: 12.50 KVAR Capacitor Details:

Make	L&T
Type	Heavy duty gas filled power capacitor
KVAR	12.50
Voltage	440V
Current	16.4A
Frequency	50HZ
Connection	Delta
Phases	3

Table No. 4.3: 20 KVAR Capacitor Details:

Make	EPCOS
Type	Standard duty Power Capacitor
KVAR	20
Voltage	440V
Current	26.2A
Frequency	50HZ
Connection	Delta
Phases	3

Table No. 4.4: 20.8 KVAR Capacitor Details:

Make	EPCOS
KVAR	20.8
Voltage	440V
Current	27.3A
Frequency	50HZ
Connection	Delta
Phases	3

Table No. 4.5: Capacitor current Details:

Step No.	**KVAR**	**IR (A)**	**IY (A)**	**IB (A)**
1	20	21.52	21.37	21.33
2	20	25.32	19.56	19.75
3	20	25.50	25.05	25.20
4	20	16.73	23.62	23.89
5	20.8	24.02	NA	12.37
6	20.8	24.13	23.73	23.67
7	20.8	24.94	24.69	25.22
8	20.8	24.56	24.15	24.36
9	10	12.71	12.17	12.28
10	-	-	-	-
11	-	-	-	-
12	12.50	10.45	13.87	13.92

CHAPTER-5
ENERGY CONSERVATION OPPORTUNITIES
AIR CONDITIONING
(OBSERVATION, FIELD TRIALS, ANALYSIS AND KEY RESULT AREAS)

5.0: FACTORS GOVERNING ENERGY EFFICIENCY OF AIR CONDITIONING SYSTEM

In any commercial buildings power consumption of air conditioning system is major component. Proper design of building, use of energy efficient air-conditioning systems and regular maintenance leads to substantial saving in energy cost

The various factors governing energy consumption of air-conditioning systems are;

a. **Building design**: Orientation of building plays a key role in the air-conditioning requirement. Excessive use of glass especially on the western side adds high air-conditioning heat loads. Use of materials such as foam concrete, double wall glazing, hollow concrete blocks or foam insulated roofing will help to improve the insulation of building and save energy.

b. **Energy efficient air-conditioning equipment's:** It is recommended to use the air-conditioning equipment's with the best energy efficiency ratio (EER). Window ACs using rotary compressors are more energy efficient than those with reciprocating compressors. Packaged air-conditioners/ducted splits are available with reciprocating compressor as well as scroll compressors. Scroll compressors are capable of higher EER which leads to saving in energy for higher tonnages Screw and centrifugal equipment are most preferred because of low operating costs. Where heat source such as steam or hot water is available as a byproduct or economically, absorption type units are a good energy saving choice. Though the initial cost of energy efficient air conditioning unit is high but the energy consumption is less. Considering the life cycle cost, it is always recommended to use energy efficient air conditioning equipment's.

c. **Regular Maintenance:** Periodical maintenance helps to ensure efficient operation of air-conditioning equipment. During periodical maintenance, it is necessary to carry out cleaning of filters, de-scaling of heat exchangers, lubricating friction point, such as fans, motors and shafts. Setting of indoor temperatures at the highest point acceptable to the largest segment of occupants, and shutting off the system when not in use will lead to energy saving.

The performance of given system depends upon the performance of equipment used. The parameters needed to be looked into are:

- Inside and outside design conditions.
- Measured flows and capacities of all the equipment used in the system.
- Comparison of the measured and design capacities.
- Comparison of energy consumption with design values.

Key factors in evaluating and better utilization of the HVAC system are as follows

a. Are there obstructions in the ventilation system?
   i. Do filters, radiator fins or coils need cleaning?
   ii. Are ducts, dampers or passages and screens clogged?
b. Is the wrong amount of air being supplied at various times?
   i. Are dampers stuck?
   ii. Is exhaust or intake volume is too high or too low?
   iii. Are all dampers functioning in the most efficient manners?
c. Can the system exhaust only the area needing ventilation?
d. Can the system intake only the amount required?
e. Can air be recycled rather than exhausted?
f. Can the system be turned OFF at night?
g. Is the temperature being right for the area of use?
h. Can temperature setback be used effectively?
i. Can heat be redirected?

j. Is the proper system is being used?
k. Is there too much or too little ventilation?
l. Can the natural environment be used more effectively?
m. Are doors, windows or other openings letting out valuable heat?
n. Can weather strip, caulking or other leaks be repaired?
o. Can additional insulation be justified/

5.1 EXISTING AIR CONDITIONING SYSTEM DESCRIPTION

Performance analysis of each ducted, RAC and Precision air conditioner was carried out and detailed measurements and analysis with recommendations are listed in performance evaluation of particular section.

5.2: Performance assessment of Room Air conditioners:

Table 5.0: Performance assessment of Room Air conditioners**:**

Sr. No.	Location	Type	Specifications	Set temp. (˚C)	Grill temp. (˚C)	Room Temp. (˚C)	Grill Size (cm)		Velocity (m/s)	Average Velocity (m/s)	CFM (m/s)	Actual current (A)	Filter
							W	H					
1	Power house AC-1	SP	Make: Videocon Model: USG63 Star:3 Capacity:6650W Power: 2135W EER:	16	13.7, 13.2, 12.9	23.5, 24.1	98	10	4.23, 3.93, 2.35	3.50	**727.47**	9.98 A	Dusty
2	Power house AC-2	SP	Make: Samsung	**AC is in off condition.**									
3	Bank AC	SP	Make: Voltas (TATA) Model: Star: 3 Capacity:1.5 T Power: 5050W EER:2.71	16	27.1, 27.3, 27	27, 27.1	80	10	3.66, 4, 4.01	3.89	**659.40**	-	Dusty
4	Vice principal cabin	SP	Make: Voltas Model: voltas123CZTT Star: 3 Capacity: 3550W Power: 1130W EER: 3.80	22	12.6, 12.3, 12.2	22.8, 22.3, 22.6	72	10	3.38, 3.46, 3.56	3.47	**528.87**	-	Dusty

Sr. No.	Location	Type	Specifications	Set temp. (˚C)	Grill temp. (˚C)	Room Temp. (˚C)	Grill Size (cm)		Velocity (m/s)	Average Velocity (m/s)	CFM (m/s)	Actual current (A)	Filter
							W	H					
5	Sakura centre AC-1	SP	Make: Voltas Model: Voltas 743ZZv Star: 3 Capacity: 7000W Power: 1994W EER: 3.51	24	23.1, 22.9, 23.5	23.1, 23.2, 23.5	110	10	2.56, 3.01, 3.20	2.92	**681.36**	-	Clean
6	Sakura centre AC - 2	SP	Make: Voltas Model: voltas243ZZV Star: 3 Capacity: 7000W Power (kw): 1994W EER: 3.51	24	23.2, 23.1, 22.8	23.2, 23.4, 23.5	110	10	2.49, 2.36, 3.10	2.65	**617.65**	-	Clean
7	TPO office	SP	Make: LG Model: JSq18PUXA Star: 3 Capacity: 5000W Power: 1838W EER:3.68	22	12.8, 12.1, 11.9	23.1, 22.6, 22.1	80	10	2.53,2.10,1.83	2.15	**365.01**	-	Partially dusted

Sr. No.	Location	Type	Specifications	Set temp. (˚C)	Grill temp. (˚C)	Room Temp. (˚C)	Grill Size (cm)		Velocity (m/s)	Average Velocity (m/s)	CFM (m/s)	Actual current (A)	Filter
							W	H					
8	TPO hall	SP	Make: Voltas Model: 2.00TVOLTAS Star: 1 Capacity: 6125W Power: 2565W EER:2.39	25	22.6, 22.3, 22.1	22.8, 22.9, 23.1	88	10	4.63, 2.10, 1.83	2.85	**532.04**	11.8 A	Partially dusted
9	Register office	SP	Make: Blue star Model: KHWE101YP Capacity: 2200kcal/hr	20	22.8, 22.7, 22.6	22.7, 22.9, 23	80	10	2.77, 2.8, 2.82	2.80	**474.06**	-	Partially dusted
10	Board room	SP	Make: Voltas Model: 4502362/2018 Star: 3 Capacity: 5120 Power: 1454W EER:3.52	22	22.1, 22.3, 22.2	23, 22.8, 22.7	88	10	3.36, 3.16, 3.26	3.26	**607.86**	-	Dusty
11	CCF lab 1 AC-1	SP	Make: Blue star Model: 3104181YB	23	22.8, 22.7, 22.9	23.4, 23.6, 23.9	88	10	2.53, 1.82, 1.73	2.03	**377.90**	-	Dusty
12	CCF lab 1 AC-2	SP	Make: Blue star Model: KHWE241RB	22	21.8, 21.3, 21.6	22.6, 22.7, 22.3	110	10	4.22, 3.72, 4.12	4.02	**936.97**	-	Dusty

Sr. No.	Location	Type	Specifications	Set temp. (˚C)	Grill temp. (˚C)	Room Temp. (˚C)	Grill Size (cm)		Velocity (m/s)	Average Velocity (m/s)	CFM (m/s)	Actual current (A)	Filter
							W	H					
			Capacity: 6000kcal/hr										
13	CCF lab 1 AC-3	SP	**Not working**										
14	CCF lab 1 AC-4	SP	Make: Blue star Model: KHWE241RB Capacity:6000kcal/hr	22	22.8, 22.7, 22.6	22.9, 22.8, 22.8	110	10	4.19, 3.93, 3.83	3.98	**928.42**	-	Dusty
15	CCF lab 2 AC -1	SP	Make: Voltas Model: 4502601/2019 Star:3 Capacity: 7000W Power: 1994W EER: 3.51	22	22.6, 22.7, 22.6	23.3, 23.2, 23	110	10	2.38, 2.34, 2.64, 2.75,	2.11	**492.26**	-	Dusty
16	CCF lab 2 AC -2	SP	Make: Voltas Model: 4502601/2019 Star:3 Capacity: 7000W Power: 1994W EER: 3.51	22	22.8, 22.7, 22.1	23.4, 23.3, 23.1	110	10	2.88, 2.93, 2.99, 2.89	2.92	**681.17**	-	Dusty

Sr. No.	Location	Type	Specifications	Set temp. (˚C)	Grill temp. (˚C)	Room Temp. (˚C)	Grill Size (cm)		Velocity (m/s)	Average Velocity (m/s)	CFM (m/s)	Actual current (A)	Filter
							W	H					
17	CCF lab 2 AC -3	SP	Make: Voltas Model: 4502601/2019 Star:3 Capacity: 7000W Power: 1994W EER: 3.51	22	22.8, 22.7, 22.6,	23.5, 23.4, 23.1	110	10	2.98, 2.88, 3.01	2.96	**689.13**	-	Dusty
18	CEO cabin AC 1	SP	Make: Voltas Model: Voltas243CYS Capacity: 6300W Power: 2025W	22	10.4, 10.1, 9.5	23.2, 23.1, 23.4	100	10	2.98, 2.88, 3.01	2.96	**626.48**	-	Dusty
19	CEO cabin AC 2	SP	Make: Blue star Model: ID0241YC	22	10.1, 11.9, 11.5	23.2, 23.1, 23.4	88	10	4.25, 4.63, 4.52	4.47	**832.86**	-	Dusty
20	Trustee Room	SP	Make: Voltas	22	22.7, 22.9, 22.8	23.5, 23.2, 23.1	88	10	4.25, 3.66, 4.11	4.01	**747.09**	-	Dusty

Sr. No.	Location	Type	Specifications	Set temp. (˚C)	Grill temp. (˚C)	Room Temp. (˚C)	Grill Size (cm)		Velocity (m/s)	Average Velocity (m/s)	CFM (m/s)	Actual current (A)	Filter
							W	H					
21	Manager cabin	SP	Make: LG Model: JSQ12PWXA/201 Star: 3 Capacity: 34502 Power: 1725W EER: 3.86	**Not Working**									
22	Principle cabin	SP	Make: Voltas Model: 4502601/2019 Star:3 Capacity: 7000W Power: 1994W EER:3.51	22	22.9, 22.8, 22.7	23.5, 23.1, 23.5	110	10	3.1, 3.22, 3.15	3.16	**735.75**	-	Dusty
23	Tata hall AC-1	SP	Make: Blue star Model: MHW361RCIDU Capacity:9000Kcal/hr	22	9.6, 8.6, 8.1	24.8, 23.7, 22.4	110	10	5.87, 5.1, 2.81	4.59	**1070.60**	-	Dusty
24	Tata hall AC-2	SP	Make: Blue star	22	8, 8.3, 8.2	24.8, 23.7, 22.5	110	10	3.96, 4.21, 4.86	4.34	**1012.33**	-	Dusty
25	Tata hall AC-3	SP	Make: Blue star	22	17.1, 18, 18.1	24.8, 23.7, 22.6	110	10	3.32, 2.71, 4.42	3.48	**811.88**	-	Dusty

Sr. No.	Location	Type	Specifications	Set temp. (˚C)	Grill temp. (˚C)	Room Temp. (˚C)	Grill Size (cm)		Velocity (m/s)	Average Velocity (m/s)	CFM (m/s)	Actual current (A)	Filter
							W	H					
26	Tata hall AC-4	SP	Make: Blue star	22	19.4, 18.2, 19.3	24.8, 23.7, 22.7	110	10	5.82, 5.2, 3.7	4.91	**1143.63**	-	Dusty
27	Tata hall AC-5	SP	Make: Blue star	22	14.4, 13.2, 12.1	24.8, 23.7, 22.8	110	10	4.2, 4.4, 4.3	4.30	**1002.23**	-	Dusty
28	Workshop superintendent AC-1	W	Make: Voltas	-	19.3, 18.5, 18.7	23.1, 23.2, 21.1	15	28	1.86, 1.19, 1.39	1.48	**131.71**	-	Dusty
29	Workshop superintendent AC-2	W	Make: Voltas	-	10.8, 8.1, 3.6	22.7, 22.3, 22.6	16	26	2.34, 2.27, 2.03	2.21	**195.10**	-	Dusty
32	Server room	SP	Make: Voltas Model: 123VCZTT(R32) Star:3 Capacity:3550W	21	18.4, 17.6, 17.4	21.1, 20.8, 20.9	110	10	1.83, 1.80, 1.78	1.80	**420.32**	-	Partially dusted
33	Seminar hall mechanical (Dronagiri)	Duct	No name plate	-	26.8, 27.1, 27	22.8, 23.4, 23.3	-	-	6.36, 6.07, 2.97	5.13	-	-	
34	Amrutkuti Class Room No. 1	SP	Make: Daikin, Model: FTKD50FVM	17	16.6, 15.1, 15.5	26.4, 26.6, 26.4	110	10	2.58, 3.10, 2.81	2.83	**659.61**	-	Clean

Sr. No.	Location	Type	Specifications	Set temp. (˚C)	Grill temp. (˚C)	Room Temp. (˚C)	Grill Size (cm)		Velocity (m/s)	Average Velocity (m/s)	CFM (m/s)	Actual current (A)	Filter
							W	H					
35	Amrutkuti Class Room No. 2	SP	Make: Voltas, Model: NSE18CRQC2, Power: 1720W	19	21.2, 20.9, 19.9	26.9, 25.9, 26.1	110	10	1.21, 1.32, 2.1	1.54	**359.72**	-	Clean
36	Amrutkuti Class Room No. 3	SP	Make: Voltas, Model: NSE18CRQC2, Power: 1720W	19	21.1, 20.3, 20.6	25.3, 26.1, 26.4	110	10	1.32, 1.13, 1.68	1.38	**320.87**	-	Clean
37	Meeting hall AC-1	SP	Make: Voltas, Model: EUGA024KXX1VC, Capacity: 2 Ton	-	12.6, 12.1, 11.3	25.4, 26.1, 26.2	110	10	4.4, 4.46, 4.95	4.60	**1072.93**	-	partially dusted
38	Meating hall AC-2	SP	**Standby**										

5.3: Observations and recommendations related with room Air conditioners:

Table No. 5.1: Observations and recommendations related with room Air conditioners

Sr. No.	Recommended Energy conservation measures (ECM)
1	Increase in temperature set point of Air conditioners 24 present setting to 26 Degree centigrade of return air
2	Switching off ACs 30 minutes before conclusion off office hours.
3	During winter when Ambient temperature is below 24 degrees centigrade, it is recommended to run only blowers of AC unit.
4	Regular cleaning of AC filters. During Energy Audit, it has been observed that split and ducted AC filters were clogged. Clogging of Filters results into decrease in CFM and cooling and running of AC compressor for more hours leading to increase in Energy consumption. Recommended to carry out regular cleaning of AC filters.
5	Recommended to carry out regular cleaning of condenser fins for better heat transfer

5.4:Energy Saving potential by installation of saturation check and Temperature set point password protected system on Air conditioners up to 3 ton :

Save up to 30% of the running cost on split, window, duct able and tower air conditioners

:Air Conditioning accounts for 70 to 80% of any energy bill. It works on an advanced sensor driven software algorithm based on the principle of Thermal Saturation. It is not a time based unit that merely switches the machine on and off periodically thus compromising comfort and temperature levels. Every air conditioner should be fitted with one.

Air conditioners are designed and manufactured to cope with the extreme cooling demands of the few hottest days of the year plus a safety margin. However, in most cases this maximum output is not required. The system is thus oversized. Running the AC continuously until the thermostat switches it off, means that the system operates at excess capacity most of the time, wastes energy and adds to the electricity bill.

• Auto saturation detection unit is an intelligent control device which ads state of the art intelligence to air conditioning systems and improves their energy efficiency.

• Achieves average energy savings of between 20% to 30% resulting in a short payback period.

• Is a retrofit product to upgrade existing ACs

A typical cooling cycle with excess capacity works like this:

1. When the AC starts, the Compressor charges cooling energy into the evaporator coil where it is stored. At this stage, the system works at high efficiency because compressors operate most efficiently when fully loaded.

2. Even after the evaporator coil is fully charged and saturated, the compressor continues to run and delivers more gas to the coil than the coil can absorb.

Thermodynamic saturation takes place. Running the compressor beyond this stage does not increase the cooling any more.

Working Principle of Auto Saturation Detection Unit :

Unit is sensor driven software algorithms are designed to detect thermodynamic saturation and to optimize compressor running. When thermal saturation is detected, Unit switches into “Saving Mode” and turns the compressor off. Units prevents inefficient overcooling and saves power.

After the compressor is switched off, the fan keeps running, cool air continues to be delivered and the system makes maximum use of the cooling energy stored in the coil. Once the stored energy is depleted, Unit switches the compressor back on and it can work efficiently once again. The room temperature set on the thermostat is reached without the wasteful and inefficient part of the cooling cycle. Significant savings

are achieved without compromising cooling comfort.
Weather conditions, Unit incorporates dynamic software to constantly adapt its settings to ensure efficient operation of Air Conditioning system at all times.

5.5:Energy saving potential by installation of Auto saturation detection unit on Split Air conditioners:

Total Energy consumption of Split Air conditioners = 64.628 KW

Energy saving potential by installation of auto saturation detection system for Air conditioners per Year = (0.20x 64.628 x8x200) = 20680.96KWH

Energy cost saving potential considering Energy cost of Rs 13.28 per KWH per Year = 20680.96 xRs13.28= Rs 274643.00

Investment: Cost of Auto saturation detection System = Rs 10000.00 X34= Rs 340000.00

Payback Period = 1.237 Years or 14.855 Months

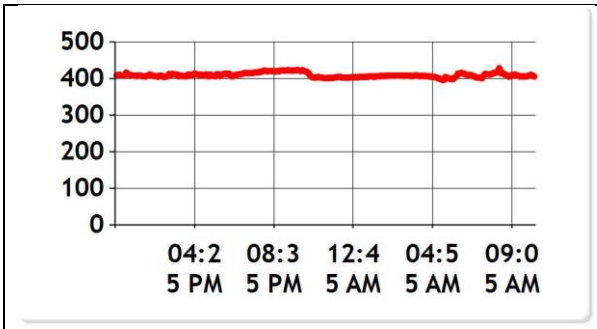
% ROI = 80.84

Table 5.2: Summary of Energy Saving potential in Air conditioning

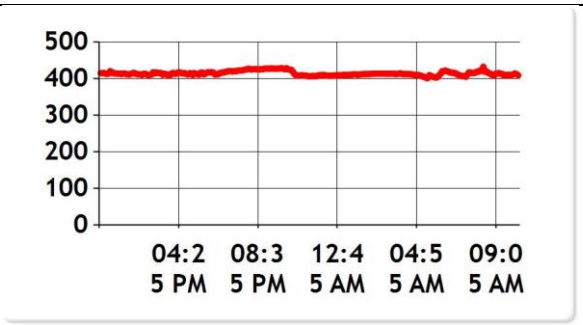
S.No	Suggested Energy conservation measure	Energy saving potential in KWH per Year	Energy cost Saving potential in Rs per Year	Investment Rs	Payback period	% ROI
1	Installation of auto saturation detection units on Window /Split Air conditioners	20680.96	274643	340000.00	1.237 Years or 14.855 Months	80.84
Total		20680.96	274643	340000.00	1.237 Years or 14.855 Months	80.84

ANNEXURE-I
POWER QUALITY TIMEPLOTS

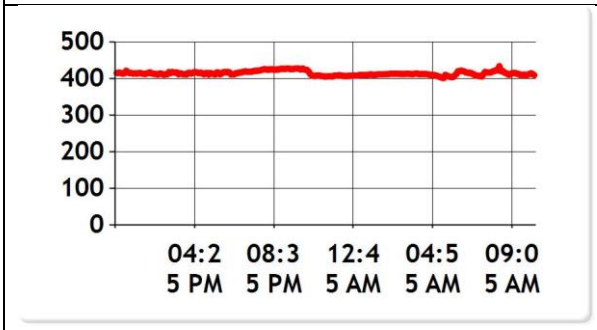
1. MAIN LT INCOMER (COMMERCIAL):



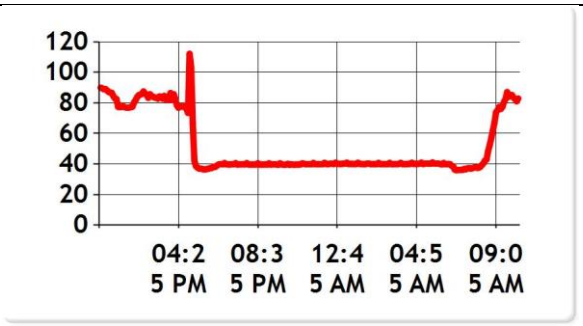
RMS VOLTAGE VARIATION TIME PLOT OF CH1
Max Val. : 427.6 V
Avg. Val. : 408.86 V
Min Val. : 395.6 V



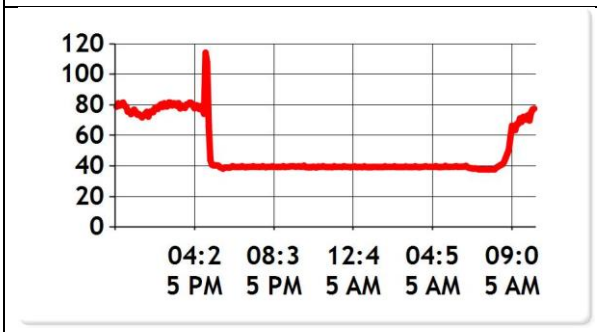
RMS VOLTAGE VARIATION TIME PLOT OF CH2
Max Val. : 431.5 V
Avg. Val. : 413.68 V
Min Val. : 401 V



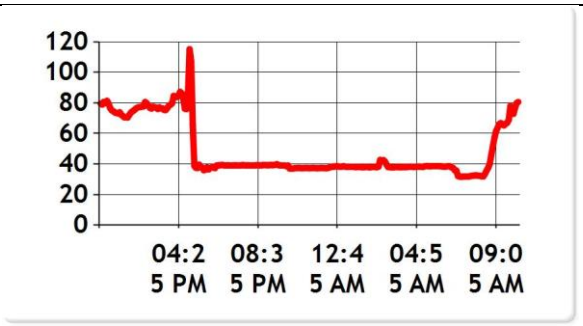
RMS VOLTAGE VARIATION TIME PLOT OF CH3
Max Val. : 433 V
Avg. Val. : 413.83 V
Min Val. : 401.2 V



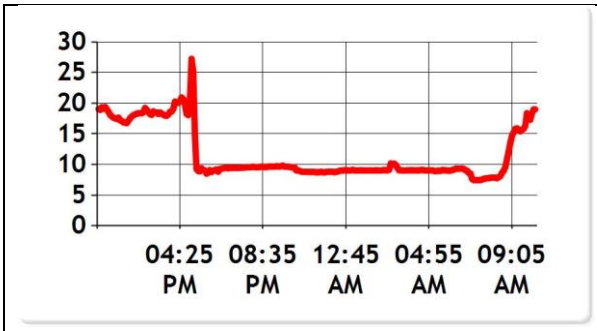
RMS CURRENT VARIATION TIME PLOT OF CH1
Max Val. : 112.07 A
Avg. Val. : 55.85 A
Min Val. : 35.87 A



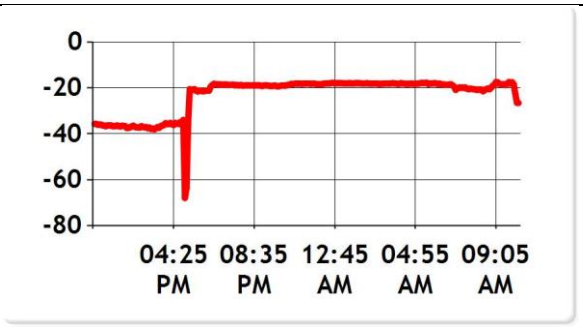
RMS CURRENT VARIATION TIME PLOT OF CH2
Max Val. : 114.09 A
Avg. Val. : 52.93 A
Min Val. : 37.61 A



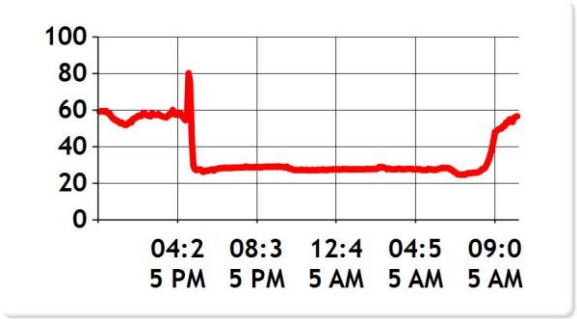
RMS CURRENT VARIATION TIME PLOT OF CH3
Max Val. : 115.11 A
Avg. Val. : 51.32 A
Min Val. : 31.64 A



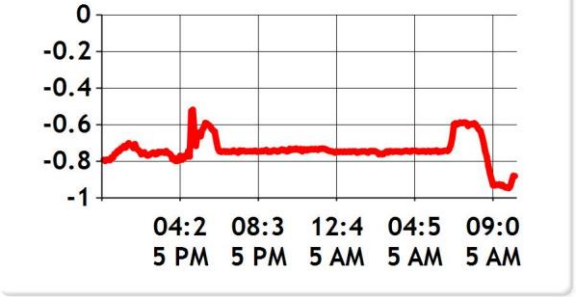
TOTAL ACTIVE POWER VARIATION TIME PLOT
Max Val. : 54 KW
Avg. Val. : 28.97 KW
Min Val. : 14.5 KW



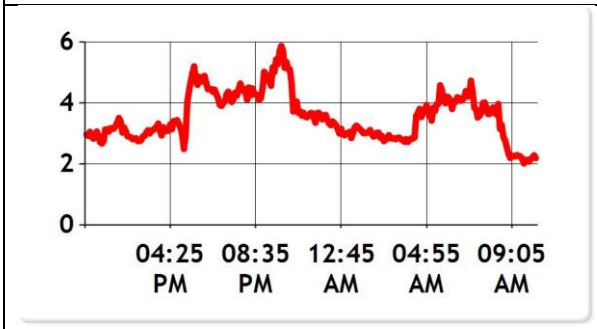
TOTAL REACTIVE POWER VARIATION TIME PLOT
Max Val. : -17.5 KVAR
Avg. Val. : -23.91 KVAR
Min Val. : -67.9 KVAR



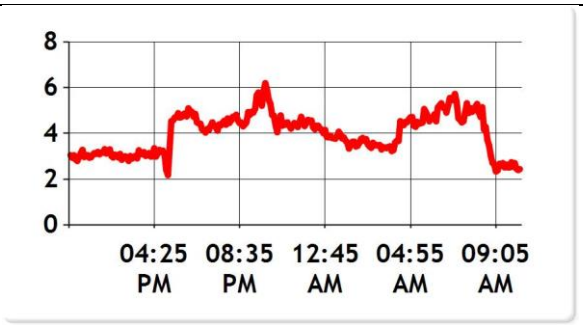
TOTAL APPARENT POWER VARIATION TIME PLOT
Max Val. : 80 KVA
Avg. Val. : 38.05 KVA
Min Val. : 24.7 KVA



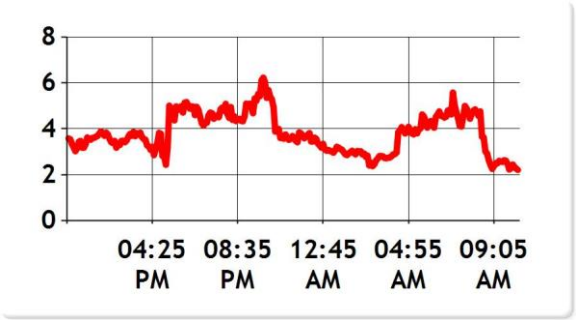
POWER FACTOR VARIATION TIME PLOT
Max Val. : -0.52
Avg. Val. : -0.75
Min Val. : -0.95



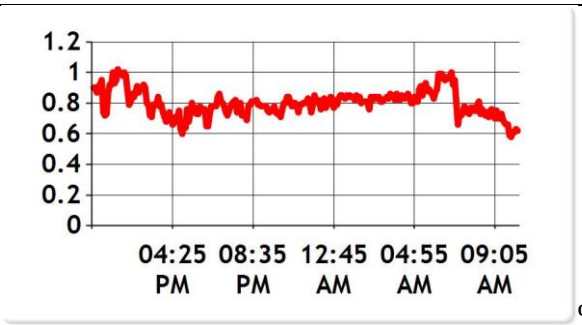
KF FACTOR VARIATION TIME PLOT OF CH1
Max Val. : 5.86
Avg. Val. : 3.46
Min Val. : 2.02



KF FACTOR VARIATION TIME PLOT OF CH2
Max Val. : 6.19
Avg. Val. : 3.9
Min Val. : 2.18

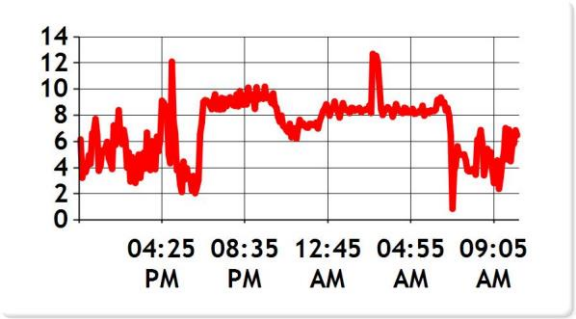


KF FACTOR VARIATION TIME PLOT OF CH3
Max Val. : 6.22
Avg. Val. : 3.78
Min Val. : 2.21



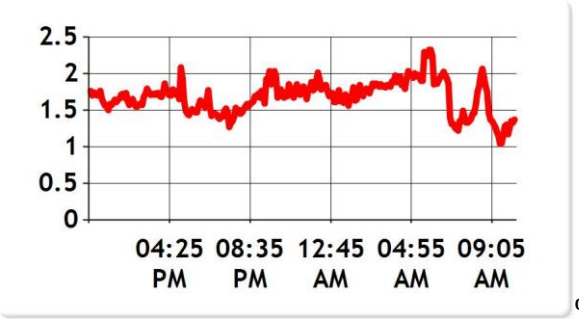
%

VOLTAGE UNBALANCE FACTOR VARIATION TIME PLOT
Max Val. : 1.02
Avg. Val. : 0.8
Min Val. : 0.58



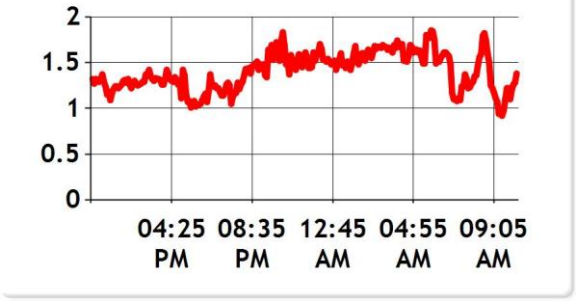
%

CURRENT UNBALANCE FACTOR VARIATION TIME PLOT
Max Val. : 12.69
Avg. Val. : 6.98
Min Val. : 0.86



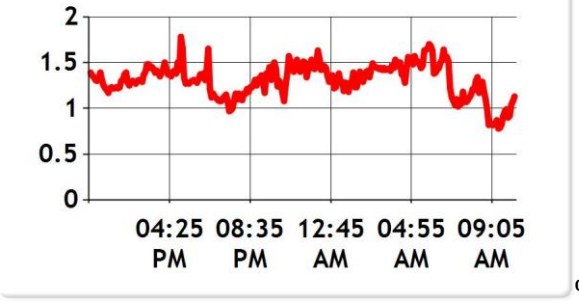
%

TOTAL VOLTAGE HARMONIC DISTORTION VARIATION TIME PLOT OF CH1
Max Val. : 2.32
Avg. Val. : 1.66
Min Val. : 1.04



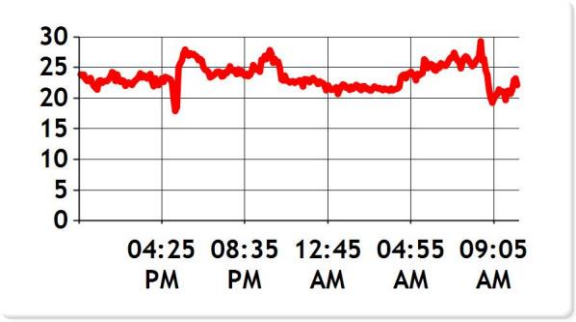
%

TOTAL VOLTAGE HARMONIC DISTORTION VARIATION TIME PLOT OF CH2
Max Val. : 1.85
Avg. Val. : 1.39
Min Val. : 0.92

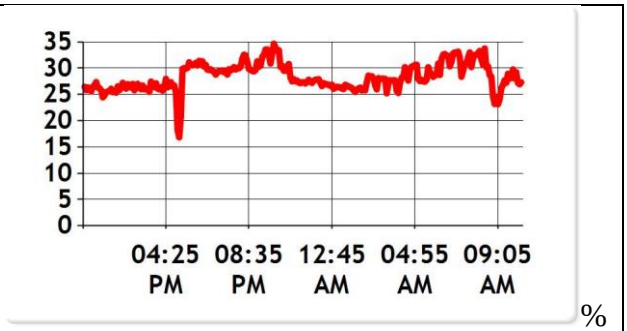


%

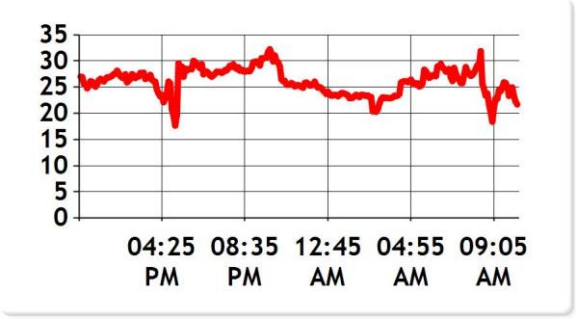
TOTAL VOLTAGE HARMONIC DISTORTION VARIATION TIME PLOT OF CH3
Max Val. : 1.78
Avg. Val. : 1.302
Min Val. : 0.78



TOTAL CURRENT HARMONIC DISTORTION VARIATION TIME PLOT OF CH1
Max Val. : 29.26
Avg. Val. : 23.34
Min Val. : 17.91

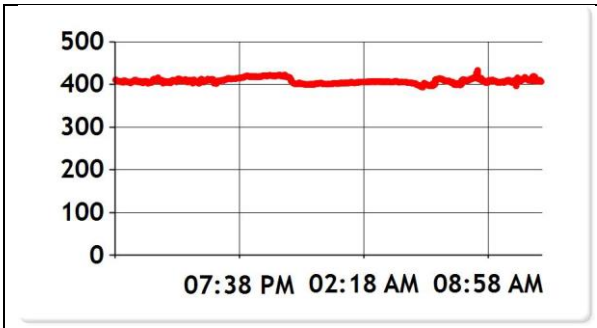


TOTAL CURRENT HARMONIC DISTORTION VARIATION TIME PLOT OF CH2
Max Val. : 34.63
Avg. Val. : 28.227
Min Val. : 16.84

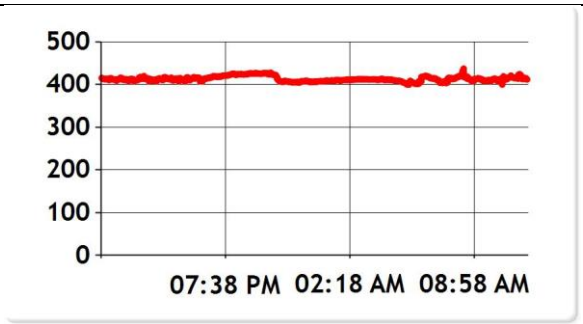


TOTAL CURRENT HARMONIC DISTORTION VARIATION TIME PLOT OF CH1
Max Val. : 32.21
Avg. Val. : 26.2
Min Val. : 17.66

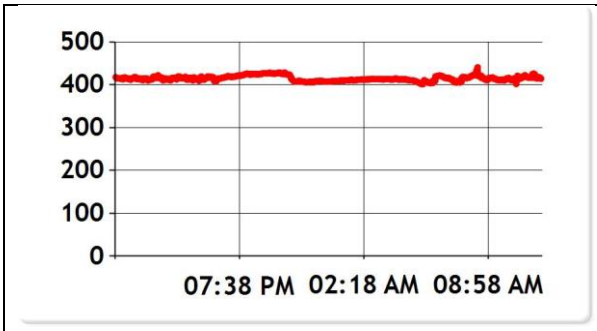
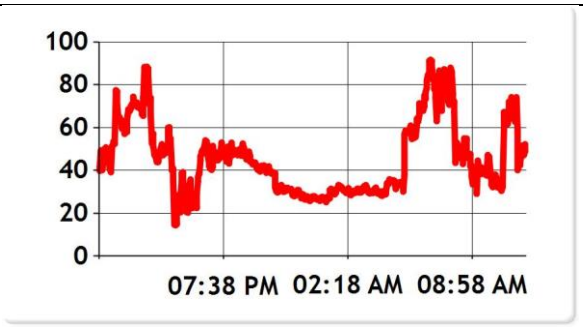
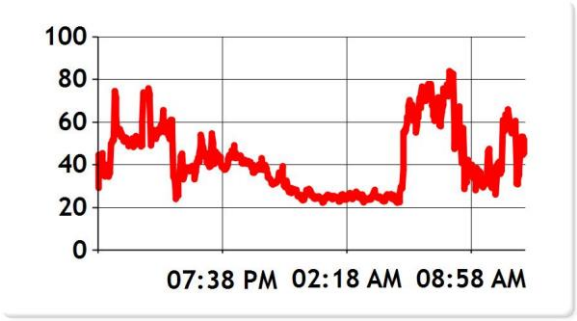
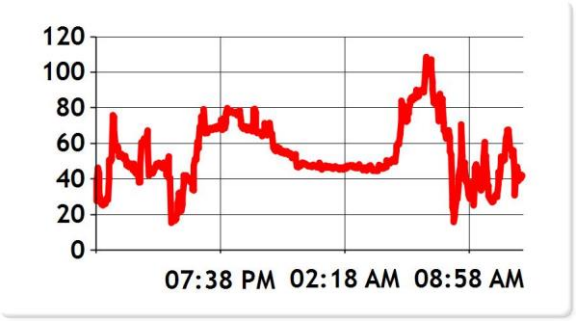
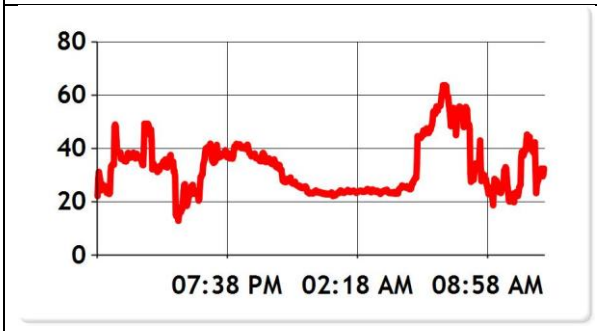
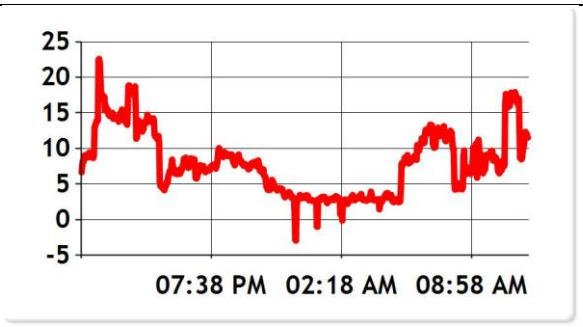
2. MAIN LT INCOMER (RESIDENTIAL):

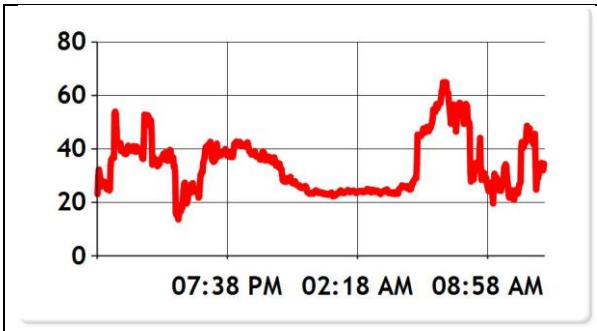
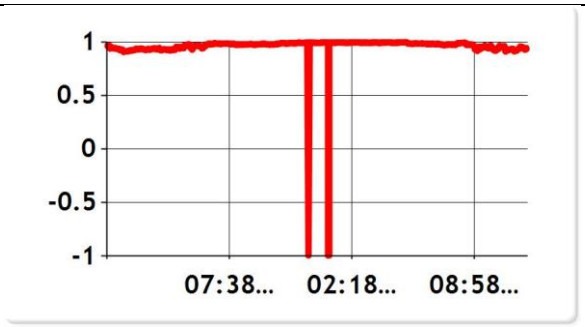


RMS VOLTAGE VARIATION TIME PLOT OF CH1
Max Val. : 432.93 V
Avg. Val. : 408.08 V
Min Val. : 393.84 V



RMS VOLTAGE VARIATION TIME PLOT OF CH2
Max Val. : 436.85 V
Avg. Val. : 412.96 V
Min Val. : 399.46 V

 RMS VOLTAGE VARIATION TIME PLOT OF CH3 Max Val. : 440.55 V Avg. Val. : 414.57 V Min Val. : 401.08 V	 RMS CURRENT VARIATION TIME PLOT OF CH1 Max Val. : 91.57 A Avg. Val. : 45.31 A Min Val. : 14.43 A
 RMS CURRENT VARIATION TIME PLOT OF CH2 Max Val. : 83.85 A Avg. Val. : 42.12 A Min Val. : 22.33 A	 RMS CURRENT VARIATION TIME PLOT OF CH3 Max Val. : 108.62 A Avg. Val. : 53.86 A Min Val. : 15.46 A
 TOTAL ACTIVE POWER VARIATION TIME PLOT Max Val. : 63.75 KW Avg. Val. : 32.5 KW Min Val. : 12.94 KW	 TOTAL REACTIVE POWER VARIATION TIME PLOT Max Val. : 22.56 KVAR Avg. Val. : 7.97 KVAR Min Val. : -2.91 KVAR

	
TOTAL APPARENT POWER VARIATION TIME PLOT Max Val. : 64.94 KVA Avg. Val. : 33.63 KVA Min Val. : 13.74 KVA	POWER FACTOR VARIATION TIME PLOT Max Val. : 1 Avg. Val. : 0.96 Min Val. : -0.99