I K Gujral Punjab Technical University Jalandhar, Kapurthala (Punjab)

Policy Document On Environment and Energy Usage

The Environment and Energy Usage Policy of IK Gujral Punjab Technical University, Kapurthala, Punjab is to manage energy in such a systematic way so as to minimize its impact on the environment. The policy implies to explore the renewable energy resources to reduce the burden of the government and to find out substitute natural resources as solutions to the energy crisis. This environment and energy policy is binding for all the components of the institution and applies to all its stakeholders and to the various activities undertaken by the institution. It will help us to embed efficiency and environmental awareness into our everyday activities, thus helping us to realize our responsibilities and commitment to conservation of natural resources and to limit its usage.

Policies:

- To assess our energy usage and measure its impact on the environment.
- To count CO2 emissions generated by our means of transportations- vehicles.
- To reduce local air pollution emissions using environment-friendly vehicles, including bicycles, public transportation and use of pedestrian-friendly roads.
- To install photovoltaic solar panels for the generation of alternate energy.
- To install LED bulbs in the complete campus to save energy.
- To develop systematic waste management mechanism.
- To develop rain water harvesting unit.
- To undertake tree plantation drives.
- To take additional measures to continuously improve our energy consumption.
- To ensure the availability of necessary resources to achieve our objectives.
- To encourage use of advanced technology to minimize energy consumption, atmospheric emissions and noise, particularly from our DG sets, AC units, vehicle fleets etc.
- To engage in dialogue with the government agencies, municipal corporation and the affiliating university and actively work with the local organizations in the areas of environment, energy efficiency and sustainable development.
- To monitor and respond to emerging environmental and energy issues.

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

- To strengthen our employees' and students' environmental knowledge and skills in order to improve our own environmental performance.
- To provide information and training opportunities on energy saving measures.
- To offer opportunities for employees and students to engage in initiatives those contribute to environmental protection.
- To motivate our employees and students and partners to plant trees each year.

This policy will be communicated to the students and employees via internal communication channels, and will be made available to all the stakeholders on the institutional website. The Environment and Energy Policy, objectives and targets will be reviewed on a regular basis under the guidance of Vice Chancellor of the University.

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JALANDHAR

(27)

ਆਈ. ਕੇ. ਗੁਜਰਾਲ ਪੰਜਾਬ ਟੈਕਨੀਕਲ ਯੂਨੀਵਰਸਿਟੀ ਜਲੰਧਰ

I. K. GUJRAL PUNJAB TECHNICAL UNIVERSITY JALANDHAR

Estd. Under Punjab Technical University Act, 1996
(Punjab Act No. 1 of 1997)

Dr. S.S. Walia
Registrar

Ref. No. IKGPTU/REG/XEN/ 1647

Dated 09/02/19

Work Order

M/s Pramod K.Sharma and Co.
SCO-9,First Floor,Mobile Market
Street 6A, Central Town, Jalandhar.

Subject: Conducting Green Audit of IKGPTU Main Campus, Kapurthala.
Ref: Your quotation dated 23-07-2019

This is to inform that your above referred quotation has been accepted and order of conducting Green Audit for IKGPTU main Campus, Kapurthala is hereby placed you as under:

Sr. No.	Description	Rate	Total Amount (In Rs.)
1	Professional Charges for conducting Green Audit of IKGPTU Main Campus, Kapurthala.	3,75,000.00/-	4,42,500.00/-
	GST@18%		**67500.00/-**
	Total		**4,42,500.00/-**

(Rupees Four Lakh Forty Two Thousand and Five Hundred Only)

Terms & Conditions:

1. The work will be executed as per enclosed terms and conditions, scope of work.
2. Payment on completion of work and on satisfaction of IKGPTU officials.

Registrar

Cc to:

1. I/C Secretariat, O/o Vice Chancellor: For information of Vice Chancellor
2. Deputy Controller (F&A), IKGPTU
3. XEN, IKGPTU

H.P.SINGH
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A REPORT ON GREEN AUDITOF I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY, JALANDHAR, DISTT. KAPURTHALA, PANJAB

Submitted by

PRAMOD K. SHARMA AND CO.

REGISTERED OFFICE: SCO- 9, FIRST FLOOR, MOBILE MARKET, STREET – 6A CENTRAL TOWN JALANDHAR – 144001(PUNJAB)

OFFICE II: 11-12, SARNATH COMMERCIAL COMPLEX, OPP. MP BOARD OFFICE BHOPAL – 461011(MADHYA PRADESH)

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Prepared by

Dr. PANKAJ SINGH

Ph.D. (Architecture and Planning)

B. Tech (Civil), M. Tech (Energy), MBA(Production), M.A.(Economics), AD Construction Management, PGD Environment & Sustainable Development,C-Environmental Impact Assessment (EIA)

Certified Energy Auditor and Manager, GRIHA Certified Trainer & Evaluator (Plumbing Expert and Public Health Engineering Expert), IGBC Accreted Professional, Chartered Engineer, **Chartered Environmentalist,**Licensed Engineer Bhopal Municipal Corporation L.M.I.B.C., M.I.V, Approved Valuer(Institution of Valuers, New Delhi)

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H.P.SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

Contents

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

INTRODUCTION: GREEN AUDIT

BACKGROUND

Criterion 7.1.2 under Criterion 7 i.e. **"INSTITUTIONAL VALUES AND BEST PRACTICES"**Of Guidelines for National Assessment and Accreditation Council (NAAC) Accreditation checks Environmental Consciousness and Sustainability/Alternate initiative taken by the institute. Green audit is a tool which not only checks Environmental Consciousness and Sustainability/Alternate Energy initiatives but also suggests the improvement practices can be adopted

GREEN AUDIT

The last century observed increased use chemical and petroleum product lead to degradation of environment. Restoration of degraded environment and sustaining it for future generation is global challenge. Now it is time for academic leaders to take initiative setup an example for society to follow.

The academic activity of delivering and grasping knowledge through an education system need infrastructure. The infrastructure consists of building, teachers and other facility like library and laboratory. These as a whole creates conducive environment for academic activity.

The term "Green" generally misunderstood with natural greenery, eco-friendly or not damaging the environment. Whereas "Green" here green refers to sustainability i.e. using all the resources without comprising on the right to uses these resources by generation to come.

The campus Green audit has been introduced NAAC accreditation in recent years. In adherence to this requirement the University management intended to go for Green audit of the campus. A campus Green audit is both a summary and a report card for a campus and a way to evaluate where and how resources are being used. A Green audit is also the first step in being able to quantify whether or not current and/or future green efforts are actually making a difference. As such, a green audit is the beginning of the sustainability planning process. The results can be used

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

to quantify what kinds of impacts the campus community has on the environment and what steps the University can take to reduce these impacts.

By this exercise it is anticipated that this will serve as a guide for educating people on the current practices and resource use as well as provide direction to the user to attain sustainability.

A comprehensive Green audit will ensure planned, efficient application of capital and operational budgets for University buildings, to ensure:-

- Maximized useful life of each facility
- Protection of assets
- Cost savings over the long term
- Enhanced Public safety
- Reduced disruption of services and greater efficiencies

The process of "Green Audit" is systematic observation of system under study, identifying the gaps in system, quantifying them for recording and analysis. There is no true standard for conducting "Green Audit" each consultant differs in content as well as process.

The overall objective of Green Audit has five fold:

- To introduce management to real concerns of environment and its sustainability
- To analyze the pattern and extent of resource use on the Campus
- To establish a baseline data to assess future sustainability plans
- To make the University management a more environmentally sustainable institution of higher learning
- To bring out a status report on environmental compliance

It is hoped that the results presented in this audit will serve as a guide for educating people on the current practices and resource use at University force all the stack holders for new initiatives.

COMPONENT OF GREEN AUDIT

A Green audit involves examining a facility on many different levels and results in specific recommendations. A Greene valuation carried out to determine status of the following:

The property and Maintenance Practices

- Water management

208

- Energy use and its management
- Solid waste management
- Heat island impact
- Carbon accounting
- Occupational health and general safety of users

THE GENERAL CONDITION OF AN EXISTING PROPERTY

Building deteriorates with time good maintenance practices upkeep the property in its original form. A general assessment of existing properties is obtained for commercial real estate projects to determine current conditions, immediate improvement needs, and replacement reserve recommendations. The property condition analysis determines the structural and operational integrity of real estate collateral and estimates the repair, replacement and reserve requirements that impact cash flow for operating expenses and debt service coverage

TO IMPLEMENT HOUSEKEEPING AND MAINTENANCE PRACTICES AS PER GREEN BUILDING NORMS

It might be possible that the constructed property is not a Green rated property. But implementing Green practices in Housekeeping and Maintenance can enhance occupant health, happiness and well-being.

ENERGY AUDIT & ENERGY MANAGEMENT

Energy Audit will help your business in following ways

- Use less Energy
- Deferred Maintenance and Increased system Reliability
- Improve Comfort and Productivity of Staff

WATER MANAGEMENT

Water resource management is the activity of planning, developing, distributing and managing the optimum use of water resources. It is a sub-set of water cycle management. Ideally, water resource management planning has regard to all the competing demands for water and seeks to

H.P. SINGH
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JALANDHAR

allocate water on an equitable basis to satisfy all uses and demands. As with other resource management, this is rarely possible in practice

PURPOSE OF WORK

This work is a systematic, independent system verification process of objectively obtaining and evaluating audit evidence to determine whether institute is meeting Criterion 7.1.2 of Guidelines for National Assessment and Accreditation Council (NAAC) Accreditation, which checks Environmental Consciousness and Sustainability/Alternate initiative taken by the institute

SCOPE OF WORK

Walk-through condition study of the property to evaluate structural integrity, capacity, condition and life expectancy, and efficiency of major systems (including but not limited to: mechanical, electrical, plumbing and roof components).

- Identification of recent or on-going improvements at the property (e.g. face lifts, new windows and doors, etc.) that is completed, underway, or anticipated.
- Assessment of site conditions: maintenance, paving, curbs, sidewalks, drainage, landscaping, Fire shifty, universal design etc.
- Compliance with applicable codes, ordinances and regulatory requirements; confirmation of status of building, occupancy and applicable operating permits and licenses necessary for the intended use of the property.
- General conformance to IS 4563:1987 Recommendations for Building and Facility for physically handicapped.
- General conformance to NBC Part-4 (Vol.-1) Recommendations for Fire and lift safety.
- Identification of possible environmental concerns (e.g., the existence of asbestos in the building and plans of abatement).
- Suggestions for additional investigations or comprehensive analyses of possible concealed conditions as external observation warrants.
- Study of the existing system of Housekeeping and Maintenance practices and identification of possible improvement.
- Suggest and alter the existing system of Housekeeping and Maintenance practices with green house keeping system.
- Site Visit to understand existing energy system, process and review of facility equipment and systems with staff, collect energy usage and equipment data. The systems studied and assessed as part of the Energy Audit and Management Strategy devising process included the following:

- HVAC Systems: Split ACs, Cassette ACs
- Lighting Systems: TFL Lights and CFL Bulbs.
- Equipment like computers etc.
- Architectural Features: Glazing, Doors
- Develop inventory of all energy use equipment grouped by process

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

206

- Use a portable power meter, data loggers and available with us to verify energy use.
- Comparison of energy use data with annual energy bills to verify data.
- Development of energy conservation strategies.
- Developing system of energy accounting and implementing the same.
- Site Visit to understand existing water supply drainage and sewage system with end use.
- Develop inventory of all water consuming areas. Grouped them according to use and disposal of water.
- Use a portable meter and other measuring system to verify water end use.
- Comparison of water use with standards.
- Development of water conservation strategies.

Developing system of water accounting and implementing the same. **Client's input**

The client will provide the following information:

- Facility O&M manuals & site drawings.
- Specification data for all major equipment (i.e. pumps curves, performance data).
- Copy of recent 12 months energy bills (electric, natural gas and fuel oil) and monthly energy bill for accounting.
- List of all major equipment with specification
- Copy of recent energy bills (electric, natural gas,water and fuel oil) and monthly energy bill for accounting.
- Insure hindrance free accessibility for site

LIMITATIONS

We rely on the accuracy of any information provided by Client in the performance of our services, and will not be held responsible for errors or inaccuracies contained in information provided to us.

Detailed building energy simulations and audit will not be performed. The study will employ techniques that rely on historical information compiled over the years from similar facilities. Individual building performance will not be modeled in great detail. Rather, building type, size and occupancy will be used to form a rough calculation model of the building (or specific equipment) energy usage for use in determining the estimated results of energy conservation measures. Likewise, costs of addition and alteration required due to this service will also be based on historic data compiled from similar installations, and engineering opinion

METHODOLOGY

The work is executed in two phase

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

Phase I -General introduction and Data collection

- A walk through audit was conducted to familiarize with property and its use.
- Interview of management to understand system in use.
- Bills of water and Fuel used in University along with site plan property are collected
- Photography of property was done to collect evidence of existing system.
- Portable equipment are used to check quality of electricity, status of light, ventilation, noise, Earthing and heat island effect.

Phase II - Data analysis and Recommendation

The collected data correlated with with standard regulation and/or best practices io industry. Stagy and recommendations were framed to improve and enhance the existing system with relevant IS code, standard regulation and/or best practices ionindustry.

REPORT ORGANIZATION

Submit report after each audit. This report contain

- Introduction
- Overview of Current Systems in Place
- Data analysis and findings
- Recommendations recommendations were framed to improve and enhance the existing system.

H.P. SINGH
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JALANDHAR

204

PROJECT DETAIL

I. K. Gujral Punjab Technical University (IKGPTU), previously known as **Punjab Technical University (PTU)** is a Co-ed institute situated at, Kapurthala highway, Jalandhar (Punjab), India. **IKGPTU** was Established by an Act of State Legislature on 16th January, 1997, to promote technical, management and pharmaceutical education in the state at degree level and above.The University has undertaken the task of training students to help in the development of skilled manpower in technical education in the country in general and in the state in particular. With this goal in mind, the university is promoting a number of courses in different streams in regular as well as distance education programmes. At present University have 121 AICTE and 65 UGC institutes affiliated with it.

This is a government institution and comes under the department of Technical education, govt. of Punjab. It provides an innovative, state-of-the art approach to higher education with a view to aid the growth of its students into well balanced, value oriented, socially sensitive and responsible members of the society. Housed in their own campus and the financial assistance is provided by University Grants Commission and State Government.

University started its journey with 09 Engineering & 05 Management Universitys. IKGPTU has its own learning centers under Distance Education Programme.Presently the University administrates 280 Universitys, out of which 102 are engineering, 134 are management, 30 are pharmacy, 07 are architecture and 07 are Hotel Management & Catering Technology (HMCT) with 33 regional centers.The reach of this University is not only restricted to Indian citizen but it has 1,500+ international students from 30+ countries.

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

The University is situated on Jalandhar Kapurthala Highway. All the basic facilities like Bus Stop, Dispensary, shopping Centers, Post Office, Bank are all located in and around the University. This makes the Universityan ideally located one.

INFRASTRUCTURE AND LEARNING RESOURCES

The University is housed in buildings comprised of 16 different blocks, spread over an area of 78.16 acres. Total constructed till date is 93000 sqm., whose details are as follows:

S.No.	Name of building	Area in sq.meter	no. of floors	Year of construction
1	Main Administrative Building	24130	B+G+7&3	2008
2	University Building 1	12956	G+5	30/11/2016
3	University building 2	12729	G+5	31/03/2017
4	University building 3	6635	G+2	30/06/2016
5	Library	5904	G+2	31/03/2017
6	Seminar hall (1) (140 seats)	340	Ground Floor	30/11/2016
7	Seminar Hall (2) ground floor G3 building (100 seats)	401	Ground Floor	2008
8	Hostel girl (2 No.s) PIT	4876	G+I	30/06/2016
9	Director office	258	G+I	30/06/2016
10	Staff quarter	2090	G+I	2010
11	Bank and Post office	1675	Ground Floor	31/03/2017
12	Auditorium (800 seats)	3663	G+I	Ongoing
13	Hostel Boys (1) (Kapurthala side)	10522	G+8	31/03/2019
14	Hostel Boys (2) (Kapurthala side)	6753	G+8	31/03/2019

Auditorium and a Girls Hostelisunderconstruction in the campus TheUniversityhasits own works department to cater day-to-day maintenance problems of various departments.

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

202

COURSES OFFERED

S.No.	Department	Course	Duration of course in years	Intake in first year	Total no of students	Total no of Faculty
1	Civil Engineering	B. Tech. – Civil Engg.	4	60	240	41
		M. Tech. – Civil Engg.	2	20	40	
		(Specialization in Structural Engineering)				
2	Computer Science & Engineering	B. Tech. – Computer Engineering	4	60	240	
		B. Tech. – Computer Science &Engg.	4	60	240	
		M.Tech. – Computer Science &Engg.	2	25	50	
		B.Tech Software Engineering in collaboration with Thompson Rivers University, CANADA (course details)	4	30	120	
		BCA (Bachelors of Computer Applications)	3	40	120	
		MCA (Masters of Computer Applications)	3	25	75	
3	Electrical Engineering	B. Tech. – Electrical Engg.	4	60	240	
		M.Tech. – Electrical Engg. (Power Systems)	2	25	50	
4	Electronics & Communication Engineering	B. Tech. – Electronics & Communication Engg.	4	60	240	
		M.Tech. – ECE (Wireless Communication Engg.)	2	25	50	
5	Mechanical Engineering	B. Tech. – Mechanical Engg.	4	60	240	
		M. Tech. – Mechanical Engg.	2	25	50	

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

2-01

S.No.	Department	Course	Duration of course in years	Intake in first year	Total no of students	Total no of Faculty
6	Food Science & Technology	MSc Food Technology	2	25	50	
		MSc Clinical Research	2	10	20	
		M.Tech. Food Technology	2	18	36	
7	Chemical Sciences	B.Sc (Honors) Chemistry	3	45	135	
		M. Sc. – Chemistry	2	25	50	
8	Physical Sciences	B.Sc (Honors) Physics	3	30	90	
		M. Sc. – Physics	2	25	50	19
9	Mathematical Science	B.Sc (Honors) Mathematics	3	30	90	
		M. Sc. – Mathematics	2	25	50	
10	Journalism and Mass Communication	B.A. – Journalism and Mass Communication	3	25	75	
		M.A. – Journalism and Mass Communication	2	25	50	5
		M. Phil – Journalism and Mass Communication	1	10	10	
11	Management	MBA	2	60	120	9
		BBA	3	45	135	
12	Hotel Management	Bachelor of Hotel Management & Catering Technology (BHMCT) – 4 Years	4	60	240	
		Diploma in Food and Beverage Service	3	30	90	
13	Humanities, Languages and Cultural Studies	M.Phil. – English	1	4	4	3
		M.Phil. – Punjabi	1	4	4	
		M.Phil. – Political Science	1	4	4	
		Total		1075	3300	77

Data Source:-https://www.ptu.ac.in

H.P. SINGH
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JALANDHAR

STRENGTH OF UNIVERSITY

S.No.	Description	Numbers
1	Student	3300
2	Teaching staff/ Non Teaching staff/ Outsource staff	1000
3	Total	4300

PARKING FACILITIES

There are two covered parking rest of the commuter's park their vehicle under tree or in open space near respective buildings. The Buses owned by the University parks at the back side road.

OTHER FACILITIES

S.No.	Description	Numbers / capacity
1	Underground water storage tank 2 Nos.	250 KLD 100 KID
2	STP 3 Nos	2 nos 30kld each 1 no. 50 KLD
	Solar panel system	
1	G+7/3	74 S8 KW
2	AB1	26.40 KW
3	AB2	23.75 KW
4	AB3	75.34 KW
5	LIBRARY	100.32 KW
4	Substation	
1	G+7	G+7&3 auditorium stp 30 KLD
2	BAY HOSTEL	BAY HOSTEL, MARRIAGE HOSTEL, GIRLS HOSTEL
3	AB1	AB1,AB2, LIBRARY, SEMINAR HALL,PART OFFICE & BANK
4	Ap3	Ap3,girls hostel-2 no., quarters , stp (50 KLD)(30 KLD)

H.P. SINGH
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JALANDHAR

199

OBSERVATIONS

THE GENERAL CONDITION OF EXISTING PROPERTY

University is operational in this campus from 2008. The development of infrastructure is in process. The buildings are designed as per modern Architectural practice. The buildingsare RCC framed structure with cement plastered brick partition wall. The building is having corridor with adjoining class room or other rooms. Exterior of the buildings are combination of exterior paint, stone cladding with glazing. Inside it is painted with light colour distemper on the walls.

Administrative building

EARTHQUAKE IMPACT ON BUILDING

The Indian sub-continent has a history of devastating earthquakes. Depending upon the intensity of earthquake India is divided into four seismic zone. Jalandhar lies in the **Zone** IV of the **seismic** zoning map of India as per IS:1893 (2002) Part 1.Zone IV is called the

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

High Damage Risk Zone in which magnitude of earthquake is between 5 to 5.9 on Richter scale. Visually building infrastructure look like it can sustain intensity of earthquake occurring in Zone Four.

Physical status of building

The buildings are new and robust to sustain fire and earthquakes. There is no visual distortion or seepage observed.

EVACUATION PROCESS

Although the buildings are new and robust enough to sustain fire and earthquakes butIt is observed that there is hindrance at entry and exit in the buildings. Drawings and details are not provided hence difficult to comment on emergency exit situation Details not provided

CONNECTIVITY WITH CITY

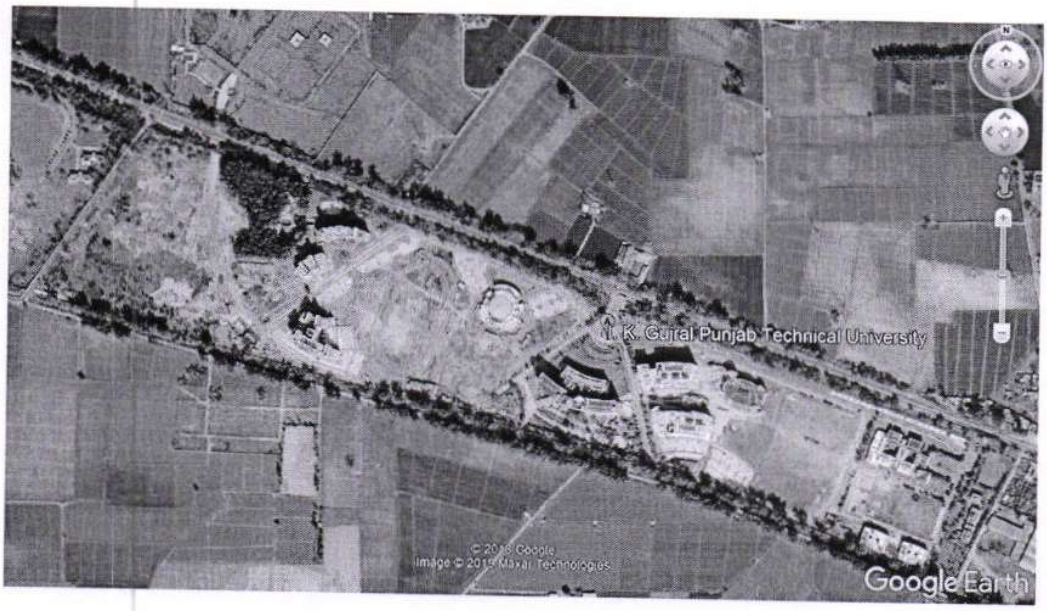
The University at located at Kapurthala highway, Jalandhar. The nearest railway station and bus stand is Jalandhar City which is 15 Km from campus. All type of public conveyance are available from main gate of the campus.

PLANTATION AND GREENERY IN CAMPUS

It is a lush green campus trees planted along the building, boundary and dedicated 4 acre land inside the campus. Ample numbers of trees are planted every year by staff and students. Details are as follows:

Lawn Area (Approx) :- 22,430 SQM. + 23,000 SQM. = 45,430 SQM.

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR



Shrubs	1800 Nos. (Approx)
Flower Pots	1200 Nos.
Hedge Area	1693 Raft.
Shrubbery Border	1691 SQM.
Flower beds	1200 SQM.
Trees	3000 Nos.

Name of Trees: - Avenue trees 'shady tree with flowers, Silver oak, Casuarinas, Krajla Magnolia, Pagoda Champa, Plumeria, Bottle brush, Sukhchain, TunKachnar, Kusham, Ficus Panda, Green ficus, Bottle Palm, Chukrassis, Moulserry, Jammon, Chinnas, Gulmohar, Amaltas, Bismarckia Palm, Jacaranda, Acutifolia, SilsAshook, Ashooka Tree, Juniperus golden, Juniperus green etc.
Shrubs: - Chandni , VecigatedChandni, Acacia, Biflora, HaemaliaPottens, LogistoniaIndica, Cassia Gulaka, FicusVacigated, Ficus green, Ficus Block, Kalandra, Golden Bottle Palm, Phonex Palm, Gardnia etc.

H.P. SINGH
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PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

FIRE SAFETY

Fire equipment are installed in the campus, whose details are as below:

Observation on Fire fighting system	
Type Fire hydrant/ Sprinkler / Mix Description	Pressurised Hydrant System wet pipe types sprinkler System

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

Observation on Fire fighting system	
Location	Pressurised Hydrant System in ALL Building - AB-1,2,3 KRC ANG , G+7 , G+3sprinkler System in library and ground floor of G+7 , G+3 building
Size of pipe in stack	size Dia - 4 inches
No. and size of fire tank Under ground	1x1.5 lakhLitres storage at G+7 , G+3 building
Overhead	25 X 5000 lakhLitres storage
Make up water requirement Frequency of cleaning of tank	500 LTR EACH

No comprehensive fire safety system is placed in the Institute. Although some fire extinguisher are observed at some places but no evacuation plans was observed. there is no caution boards on main electrical panel board. No records was provided regarding annual maintenance of these fire extinguishers. Material are placed at the passage which may obstruct smooth movement at the time of emergency.

The building is robust enough to take heat load of moderate capacity for more than two hours. The building has been analysed for need of evacuation. There are adequate entry points at ground floor, whereas staircase and ramps connecting upper floors can be easily approached in case of disaster. The corridors are

H.P. SINGH
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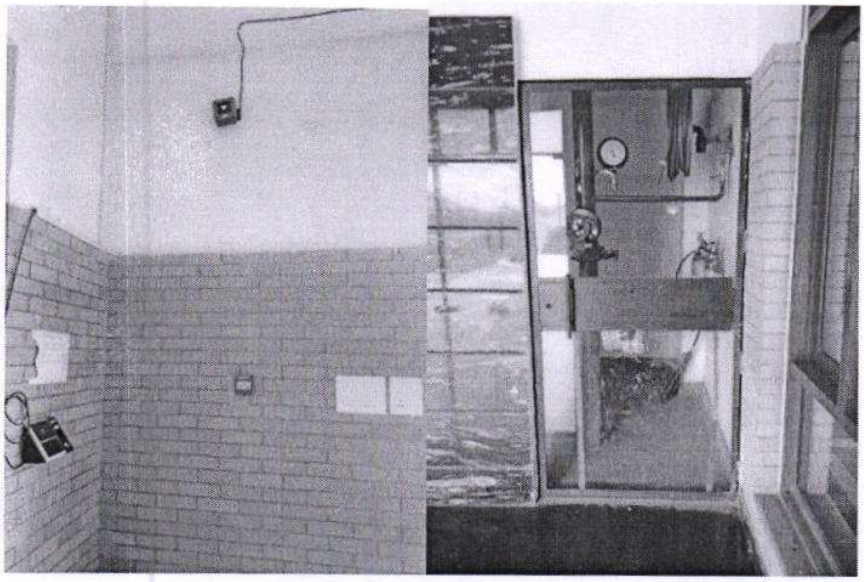
JALANDHAR

194

opening directly to outside. The ground floor height is only 10 feats from outside. Hence evacuation through windows is possible without causing heavy injury.



H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR

Staircases are naturally ventilated to avoid suffocation in case of fire. Ramps provided in buildings will help in evacuation of injured and disabled persons.

The electrical wiring is either loose or there is web of wire lead to major accident.

There is no lift or staircase shaft system in the campus.

There is thick plantation with falling leafs .There are chances of fire in dry leaves, for this is no preparedness.

Record of fire system maintenance was not provided.

UNIVERSAL ACCESSIBILITY AND USE

Various, disabilities which have been considered while preparing the guidelines for barrier free built environment are broadly classified under four categories

Non-Ambulatory : Impairments that, regardless of cause ormanifestation, for all practical purposes, confine individuals to wheel & chairs.

192

Semi-Ambulatory : Impairments that cause individuals to walkwith difficulty or insecurity. Individual using braces or crutches, amputees, arthritics, spastics &those with pulmonary & cardiac ills may be semi-ambulatory

Sight: Total blindness or impairments affectingsight to the extent that the individual functioning in public areas is insecure or exposed to danger

Hearing: Deafness or hearing handicaps that might make an individual insecure in public areas because he is unable to communicate or hear warning signals.

FACILITY AUDIT FOR NON-AMBULATORY AND SEMI-AMBULATORY

Corridors and doors are wide enough to provide adequate space for persons using mobility devices, e.g. wheelchairs, crutches and walkers. The floors are firm and leveled. Lifts and ramps are there in almost all the buildings to provide acerbity. Details of lifts and ramps are as follows:

Building name	Floors	No of Ramps	No of Lift
BuildingG+7&3	G+7&3	2	4
AB1	G+5	1	2
AB2	G+6	1	4
AmbikaPoul AB3	G+2	1	2
Liabrary	B+G+1	0	0
Seminaar hall 1	GF ONLY	0	0
Girls Hostel B1	G+2	0	0
Girls Hostel B2	G+2	0	0
DIRECTOR OFFICE	G+1	0	0
Staff Quarter B1	G+1	0	0
Staff Quarter B2	G+1	0	0
Staff Quarter B3	G+1	0	0
BANK & POST OFFICE	GF ONLY	0	0
Auditotirm	GF ONLY	1	0
Boys Hostel(1)	G+8	1	2
Boys Hostel(2)	G+8	0	2

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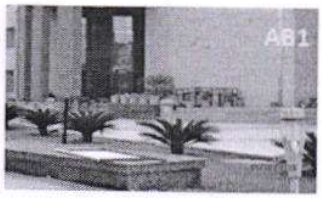
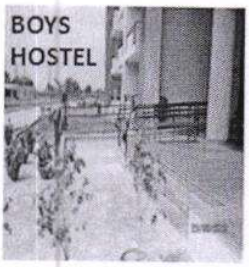
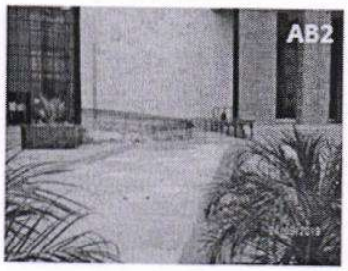
191

Ramp Details







Lift doors are wide enough to provide actability to a person with wheel chair. There are grab bars in lift for support.

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190

There is no provision of handicap toilet for disabled persons nether there is any grab bars in toilets.

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189

FACILITY AUDIT FOR BLIND PERSON:

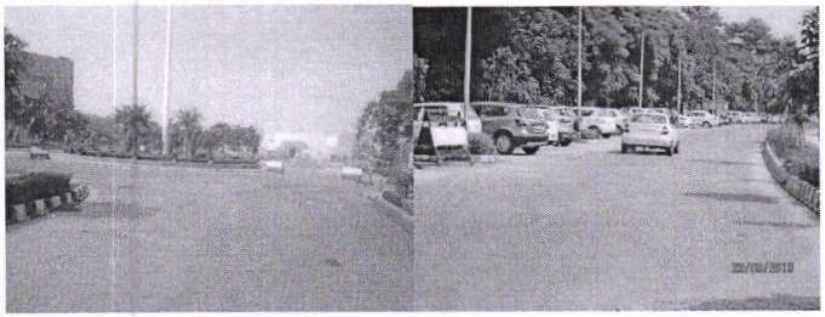
- Sounder in lift was not in operation.
- Sign board in Braille- not located
- Guidance block for blinds - no provision

FACILITY AUDIT FOR IMPAIRED HEARING

- Sign boards are the in local language
- **Facility audit for** General facility for differently abled person
- There is no dedicated parking. Floors are slippery.

PUBLIC HEALTH

Public health aims to improve the quality of life through human activity and prevention. The pathways are open to sky. There is no physical division between motorized traffic and pedestrian. This makes campus unfriendly for pedestrians. It has been observed that people use their vehicle for short distance movement.



Sign boards showing tobacco or smoking prohibition are not visible.

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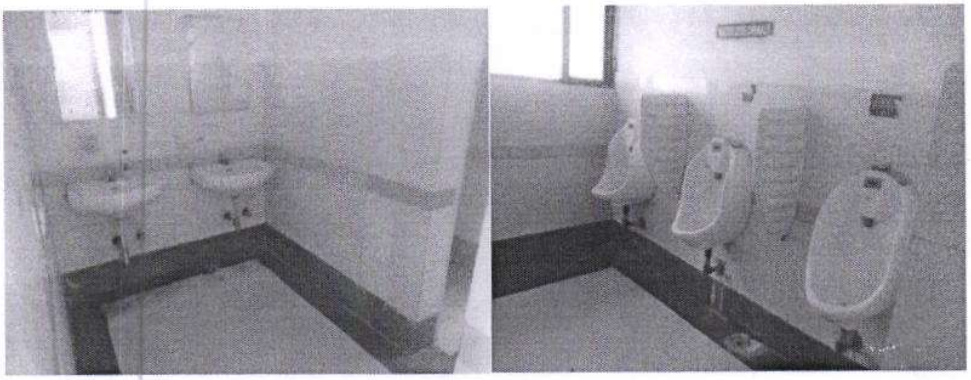
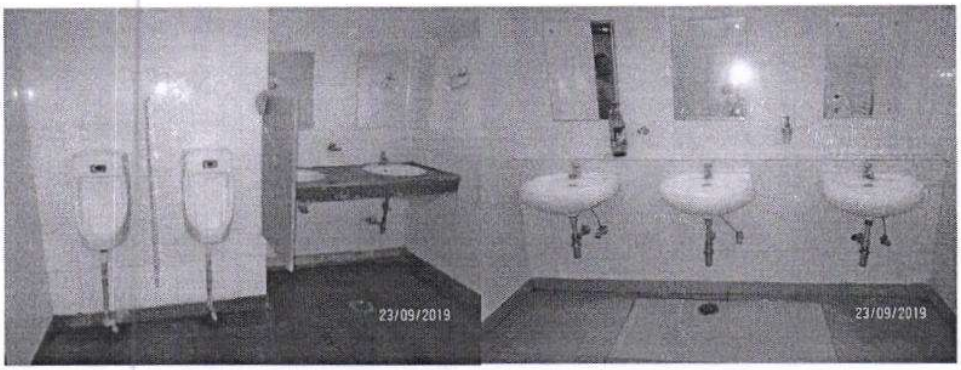
HOUSE KEEPING

General cleanliness of the campus is good with clean toilets. But There is no protocol for dust suspension.





NOISE CONDITION

Studies reveal that noise effect learning ability and concentration, hence it is necessary to examine noise level in educational institute. The observation of Noise level taken in between 12 noon to 3 pm on working day with window closed. The observed noise level is in between 40 to 65 db. Details are as below:

S.No.	Location	Sound in db
	Ambika school	
	Director main office	
1	Room = 013C	53.1
2	Room = 013B	50.8
3	Room = 013A	53.1

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S.No.	Location	Sound in db
4	Room = 002B	50.8
5	Room = 002A	53.5
6	Room = 002	41.3
7	Room = 003 B	56.3
8	Room = 003 G	56.3
9	Room = 003 E	51.7
10	Room = 004	51.7
11	Room = 005	57.4
12	Room = 006 (physics lab - I)	52.8
13	physics lab - II	41.3
14	physics lab - III	41.1
15	Room = 009	54.8
16	Room = 010 (Hall)	54.8
	(G+7) - Canteen	
17	Lunch Area	53.5
18	Kitchen Area	53.4
	(G+7) - First Floor	
19	Account Section	60.9
20	room	57.3
21	Legal cell	60.3
22	Room	53.1
23	office	61.5
	AB-I (Ground floor)	
24	Depart of Civil (office)	61.3
25	senior assistant room	61.3
26	Assistant Register	55.2
27	canter	55.3
28	class room - A007	56.4
	4th floor AB-I	
29	Management department (office)	51.6
30	common room	50.5
	5th floor	
31	class room -A511	56.3
32	class room -A509	49.1
	Library	
33	I floor	48.3
34	II nd floor	48.3
	Ground floor	48.3
35	Seminar Hall	44.7

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186

PEST CONTROL TREAATMENT

Pest is a destructive insect or other animal that attacks crops, food, live stock and other things in the building. Basically it is harmful for humans and their health.

- Problems resulting from pests in a building can include:
- Deterioration of the building (e.g. rodents making holes, termites destroying wood).
- People developing allergies (allergies to animals such as possums and rats, or dust mites, are common).
- Pests can bring & spread diseases (e.g. flies, rodents).
- Bites (from spiders, fleas, mosquitos, etc.).

PSYCHOLOGICAL AFFECTS.

TYPES OF PESTS

Types of pests include:

- insects, such as roaches, termites, mosquitoes, aphids, beetles, fleas, and caterpillars.
- insect-like organisms, such as mites, ticks, and spiders,
- microbial organisms, such as bacteria, fungi, nematodes, viruses, and mycoplasmas,
- weeds, which are any plants growing where they arc not wanted,
- mollusks, such as snails, slugs, and shipworms, and
- vertebrates, such as rats, mice, other rodents, birds, fish, and snakes

Pest control is the regulation or management of a species defined as a pest, a member of the animal kingdom that impacts adversely on human activities especially in buildings.

There are traces of termite, mosquito and other rodent on the building. There is protocol for pest control in the University. Tanks lid was found open

INDOOR AIR QUALITY

Exposure to poor indoor air quality can cause short-term eye, nose and throat irritation as well as headaches, dizziness and fatigue. This effect concentration and has direct impact on learning ability. In this background air quality was checked for four parameter i.e. $PM_{2.5}$, volatile organic compounds (VOCs). Carbon Dioxide and Formaldehyde. Results are as follows

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S.No.	Location	Air Quality			
		PM 2.5	VoC	Co2	HCHO
	Ambika school				
	Director main office				
1	Room = 013C	19.1	0.09	1109	0.01
2	Room = 013B	47.6	0.01	0400	0.01
3	Room = 013A	67.2	0.08	0921	0.01
4	Room = 002B	82.1	0.07	0400	0.01
5	Room = 002A	61.1	0.09	0400	0.01
6	Room = 002	68.7	0.07	0400	0.01
7	Room = 003 B	59.7	0.07	0400	0.01
8	Room = 003 G	74.5	0.07	0400	0.01
9	Room = 003 E	78.5	0.08	0400	0.01
10	Room = 004	52.1	0.09	0400	0.01
11	Room = 005	64.2	0.09	0901	0.01
12	Room = 006 (physics lab - I)	72.1	0.09	0791	0.01
13	physics lab - II	74.1	0.08	0400	0.01
14	physics lab - III	68.9	0.09	0400	0.01
15	Room = 009	82.1	0.09	620	0.01
16	Room = 010 (Hall)	7.85	0.01	0400	0.01
	(G+7) - Canteen				
17	Lunch Area	2.27	0.01	0400	0.01
18	Kitchen Area	7.66	0.01	0400	0.01
	(G+7) - First Floor				
19	Account Section	52.1	0.09	0400	0.01
20	room	64.2	0.09	0901	0.01
21	Legal cell	68.7	0.07	0400	0.01
22	Room	59.7	0.07	0400	0.01
	G+3 (First floor)				
23	office	82.1	0.09	620	0.01
	AB-I (Ground floor)				
24	Depart of Civil (office)	82.1	0.07	0400	0.01
25	senior assistant room	61.1	0.09	0400	0.01
26	Assistant Register	68.7	0.07	0400	0.01
27	canter	59.7	0.07	0400	0.01
28	class room - A007	47.6	0.01	0400	0.01
29	4th floor AB-I				
	Management department (office)	19.1	0.09	1109	0.01
30	common room	47.6	0.01	0400	0.01
	5th floor				
31	class room -A511	67.2	0.08	0921	0.01
32	class room -A509	59.7	0.07	0400	0.01
	Library				
33	I floor	74.1	0.08	0400	0.01

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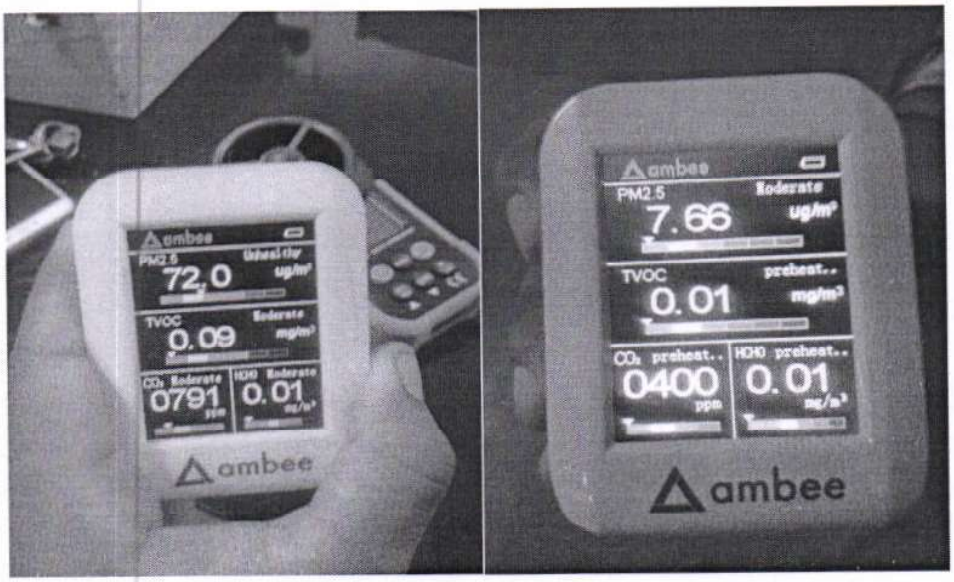
S.No.	Location	Air Quality			
		PM 2.5	VoC	Co2	HCHO
34	II nd floor	82.1	0.09	620	0.01
	Ground floor	7.85	0.01	0400	0.01
35	Seminar Hall	68.7	0.07	0400	0.01

From the above it is clear that the level of $PM_{2.5}$, volatile organic compounds (VOCs) and Formaldehyde is moderate .But level of Carbon Dioxide is high .



MAINTENANCE PRACTICES

Maintenance is a practice to upkeep building in its original shape. The damages observed are attended to make the facility functional. The minor defects and maintenance issues are addressed by the University itself. Buildings are new, no major defect is observed.

PARKING

At the time of visit i.e. 24.09.2019 about 700 vehicles are found parked in the campus. Maximum vehicles are parked near G+7&3 Building and AB3. Details are as follows:

Building name	Parked 2 wheel at visit time	Parked 4wheel at visit time	Covered Parking
Building G+7&3	200	140	1
AB1	4	0	0

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Building name	Parked 2 wheel at visit time	Parked 4wheel at visit time	Covered Parking
AB2	0	0	0
AB3	150	120	0
Liabrary	50	40	0
Seminaar hall 1	0	0	0
Girls Hostel B1	0	0	0
Girls Hostel B2	0	0	0
DIRECTOR OFFICE	0	0	0
Staff Quarter B1	0	1	1
Staff Quarter B2	0	1	1
Staff Quarter B3	0	1	1
BANK & POST OFFICE	0	0	0
Auditotirm	0	0	0
Boys Hostel(1)	10	4	0
Boys Hostel(2)	0	0	0
Total	414	307	4

Facility of covered parking is available at G+7&3 Building, AB3 and Staff quarters. Maximum places vehicles are parked on open parking or at road side. Even University owned Buses are parked roadside behind G+7 building.

Parking at G+7&3 building

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ENERGY AUDIT & ENERGY MANAGEMENT

OBJECTIVE OF ENERGY AUDIT EXERCISE

The objective of Energy Audit is to identify area of energy consumption and promote Energy sustainability in the Campus

- The purpose of the energy audit is to identify, quantify, describe and prioritize cost saving measures relating to energy
- Identification of areas of energy wastage and estimation of energy saving potential • Suggesting cost-effective measures to improve the efficiency of energy use.
- Identification of possible usages of co-generation and renewable sources of energy
- Rectification of energy bills and negotiation with energy supply company to reduce fix rate.

THE CAMPUS

This is a day use campus, using electricity for Lighting, HVAC system, Operation of computers and other equipment. Source of Energy is as followes:

- Electricity is supplied by **Punjab State Power Corporation Limited** through 11 KV feeder.
- High Speed Diesel (HSD) is used as a fuel for Diesel Generator which operates whenever power supply from PSPCL is not available (equipment and operational details of DG set not provided by the client).
- Solar PV plant is installed on site (Details needed)
- LPG is used for cooking in Canteen and Hostel (Details needed)

Note:-Record keeping of energy consumption need improvement.

ELECTRICITY CONSUMPTION PATTERN

GRID SUPPLIED ELECTRICAL POWER

There is only one 11 KV electrical meter installed in the campus (location need verification).
Observation from electricity bill is as follows:

Months	2015	2016	2017	2018	2019
January		134238	164064	213330	235852
February	-	90102	139915	151318	186272

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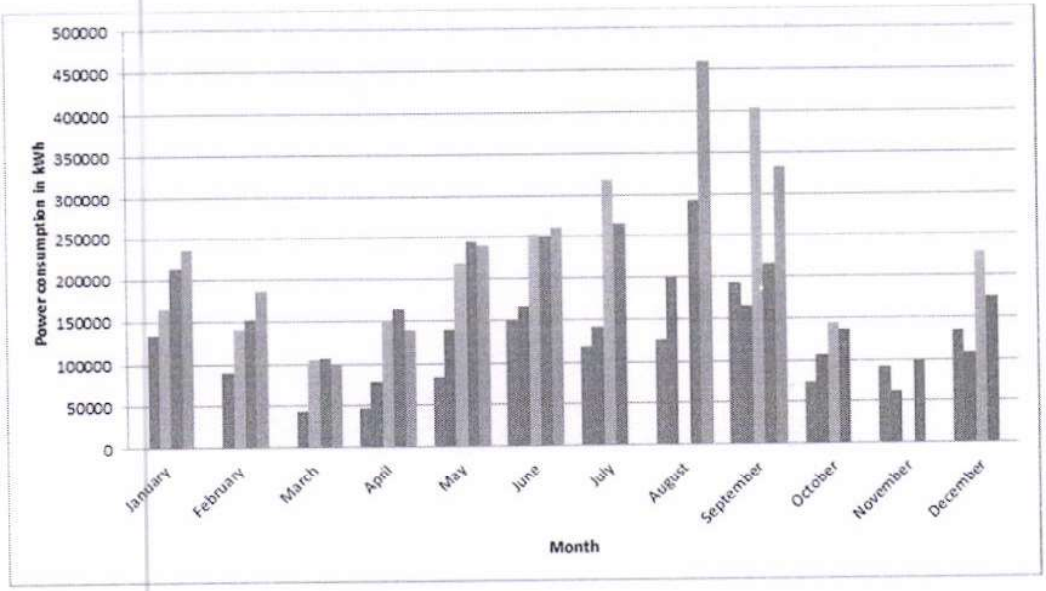
178

Months	2015	2016	2017	2018	2019
March	-	42563	104912	106854	100066
April	45940	78768	149885	163470	138808
May	84520	138630	218533	243638	239392
June	148620	165717	252295	249802	260418
July	118320	140935	318844	265010	-
August	125220	199593	-	293294	459931
September	192689	164686	404210	214670	332708
October	74477	106792	144300	136126	-
November	91765	63431	-	99900	-
December	134238	108339	227960	174178	-

From June 2015 till August 2017 sanctioned load and contract demand was 2000 KW and 2000 KVA respectively. But from September 2017 sanctioned load and contract demand was revised to 3056.84 KW and 3396 KVA respectively.

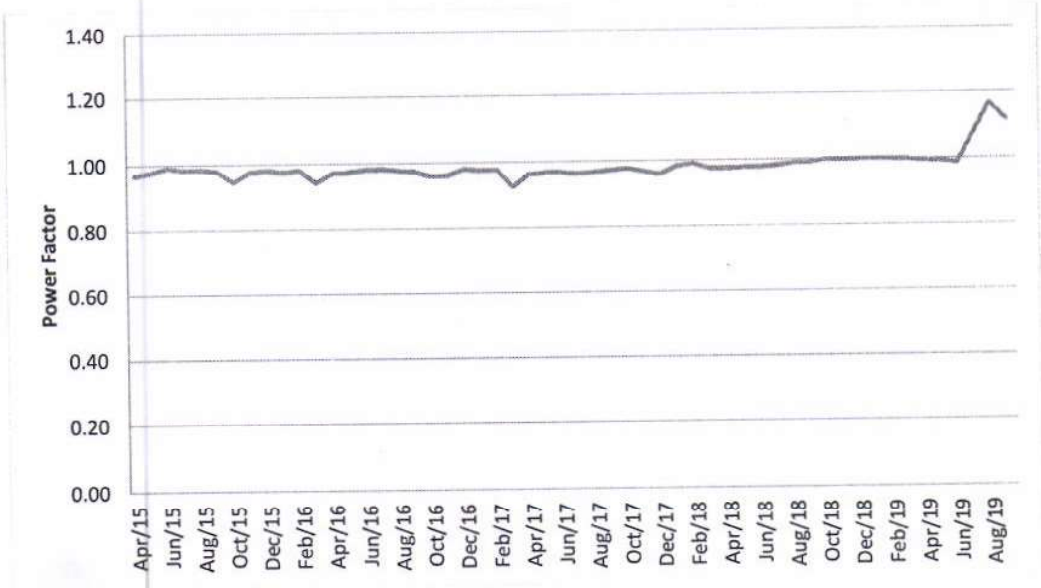
ENERGY CONSUMPTION PATTERN

From Energy consumption pattern it is clear that energy consumption is more in monsoon months i.e. august and September. Energy consumption in spring and autumn is least in all season. Electricity consumption of winters is less than summer.



POWER FACTOR PATTERN

From Bills of April 2015 till September 2019 it is observed that PF roam around 0.96 with minimum of 0.92 and maximum more than 1 in this period. Incentive against maintaining high power factor was never claimed nor surcharged was attracted.



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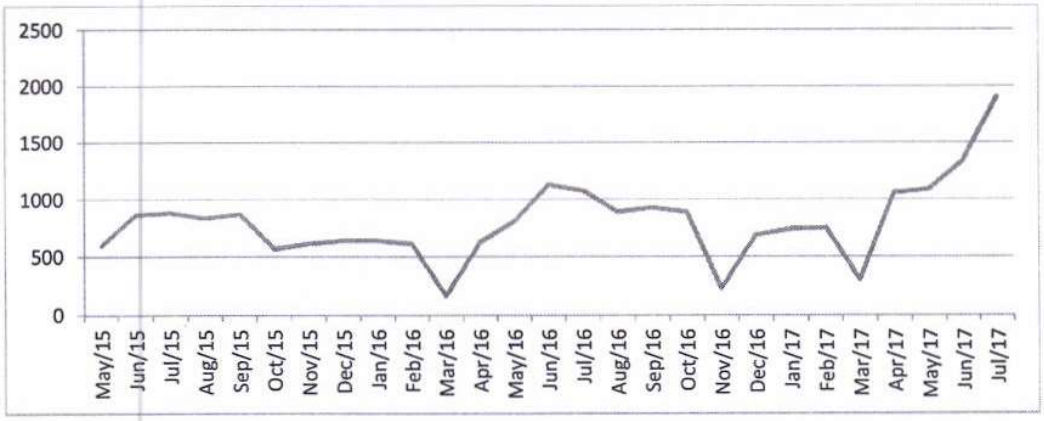
MAXIMUM DEMAND

Maximum demand is the highest level of electrical demand monitored in a particular period. Once the value is higher than the contracted power, the customer will pay a penalty on the electricity bill.



EFFECT OF SANCTIONED LOAD AND CONTRACT DEMAND

From June 2015 till August 2017 sanctioned load and contract demand was 2000 KW and 2000 KVA respectively. But from September 2017 sanctioned load and contract demand was revised to 3056.84 KW and 3396 KVA respectively. But the maximum demand never crossed 2000KW from June 2015. The high sanctioned load and contract demand is attracting high fixed charges. April 2019 the fixed charges was higher than energy charges.

CONDITION OF EXISTING ELECTRICAL INSTALLATION

WIRING

The campus is new and the electrical system is well planned. Concealed conduit wiring is adopted for internal distribution. Care was taken at the time of planning to adhere the functional need of

175

the spaces. Even after diligent planning electrical power extension through open wiring has been observed at few places.

It has been learnt that there is no protocol of checking insulation of wiring

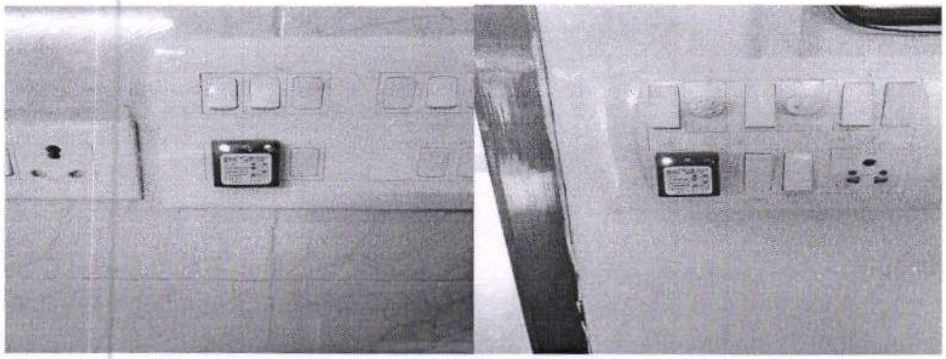
ELECTRICAL EARTHING SYSTEM

The process of transferring the immediate discharge of the electrical energy directly to the earth by the help of the low resistance wire is known as the electrical earthing. This system provide shifty to human being and electrical equipment and installation.

Electrical earthing has been observed at substation as well as individual buildings. Using portable equipment random checking for continuity and insulation of wiring was conducted in the campus. The observations are as below

S.No.	Building	Observation
1	G+7	Earthing faulty
2	G+3	Earthing faulty
3	AB-1	ALL OK
4	CANTEEN	ALL OK
5	AB-2	ALL OK
6	LIBRARY	ALL OK
7	AB-3	Earthing faulty
8	Post office & Bank	L&D reversed
9	boys hostel	Earthing faulty

Over all wiring condition is good but earthing system need attention. At the time of inspection the earth pits were found dry. There was no record of watering earthing pit.



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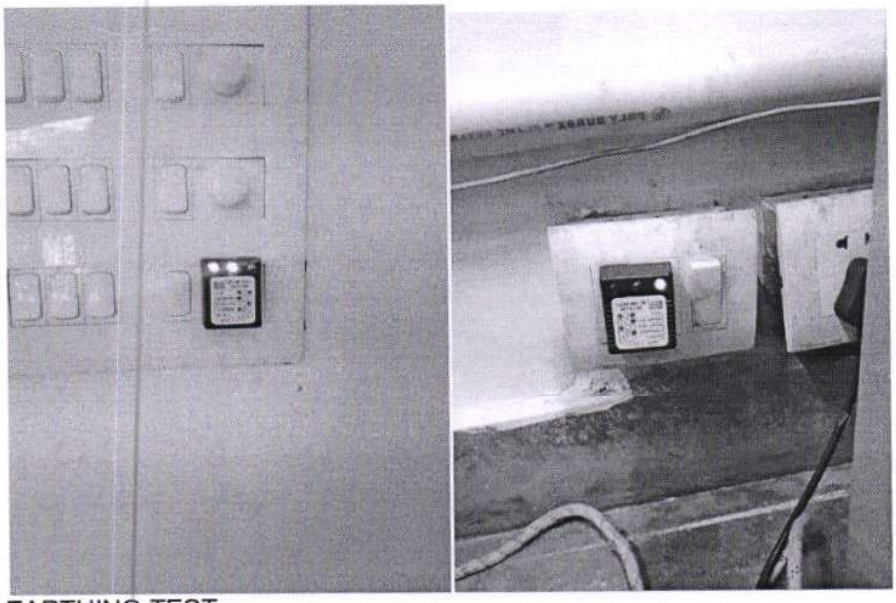
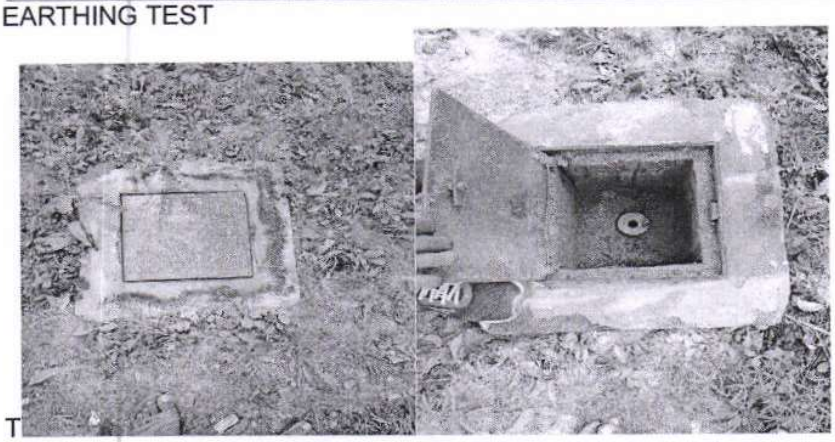
174



EARTHING TEST



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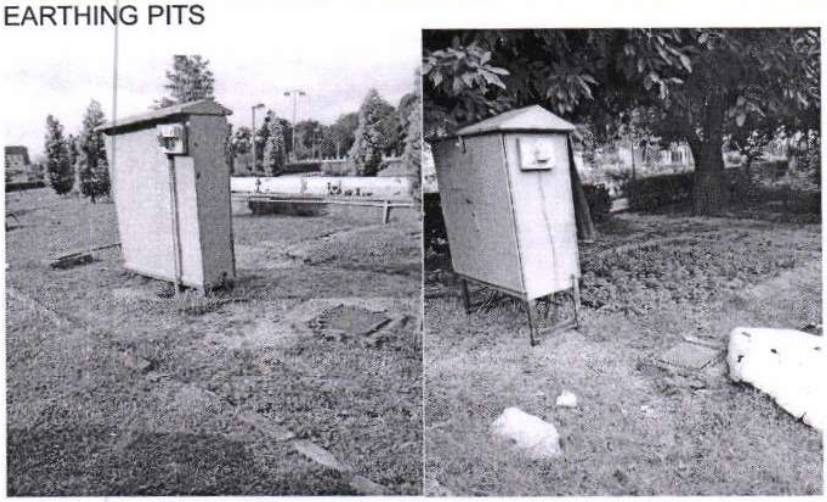
EARTHING PITS



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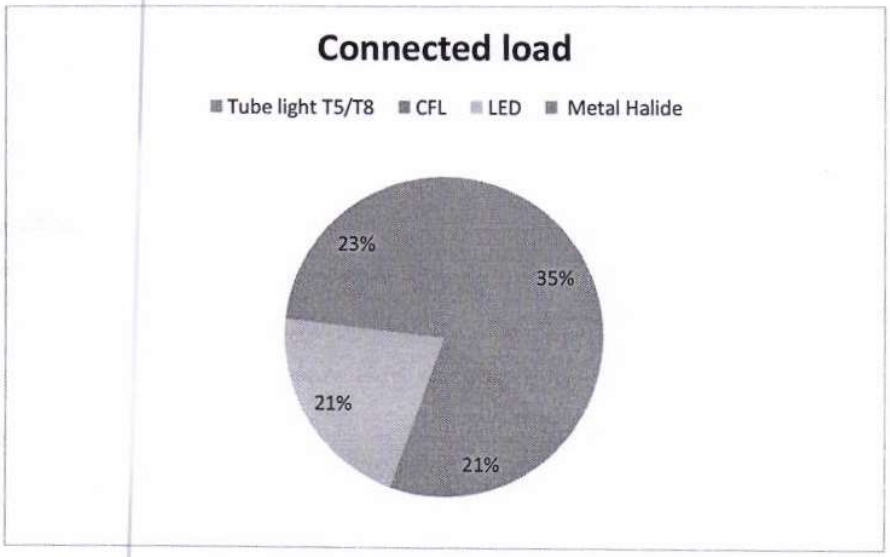
EARTHING PITS

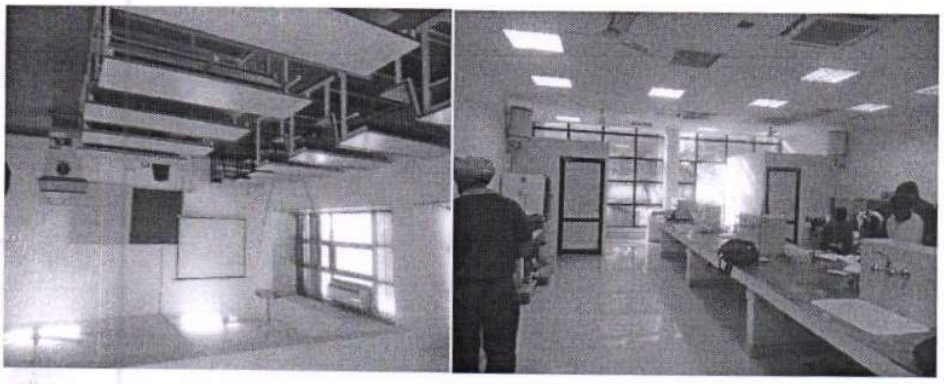
LUMINARY

It is observed that there is no uniformity in luminary. Details of luminary are as follows:

LUMINAIRES	Connected load in KW	Connected load in %
Tube light T5/T8	139	35%
CFL	80.6	20%
LED	84.1	21%
Metal Halide	92	23%

Although Institute is in the process of phasing out system of CFL and bulb with LED bulbs.





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172

Light and fans

DAY LIGHT CONDITION

Each and every rooms are having adequate windows. The observation of day light taken in between 12 noon to 3 pm on bright sunny day of April is more than 150 lux on lux meter.

It is observed that the window light is obstructed by putting curtains.

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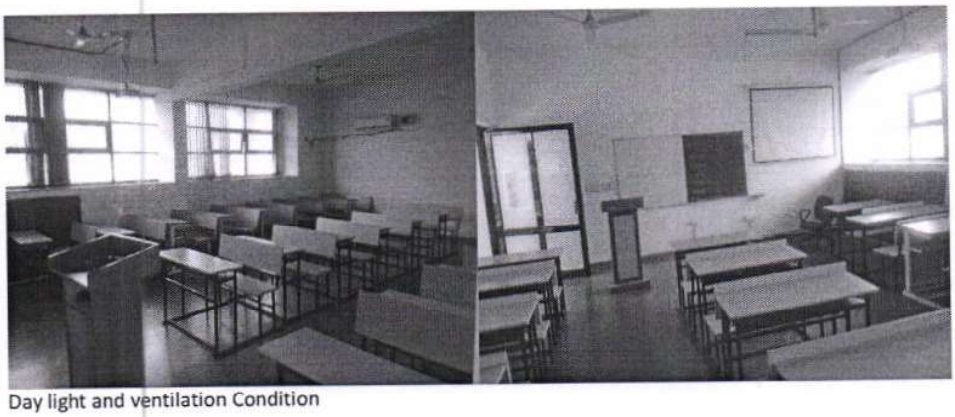

Day light and ventilation Condition

VENTILATION CONDITION

NATURAL VENTILATION

The buildings are fully air conditioned but fornatural ventilation there are adequate amount of open able panes in windows, opening on outer side of the rooms on outer face of the building. There is no obstruction in front of windows. Doors and windows are provided on the opposite wall of the room. Doors are opening incorridor to provide proper cross ventilation. There is about 5°C temperature difference is observed in ambient air outside and inside the building with avarage airflow of 0.4m/s.

It is observed that windows and ventilators are permanently closed obstructing cross ventilation.

MECHANICAL VENTILATION

Fans and blowers are provided to move air inside the building to remove order, provide fresh air and to maintain thermal comfort in relatively cooler days. Fans are placed at every nick and corner of the campus to adhere respective function of the space. Details are as follows:

Type of Fan	Numbers
CEILING FAN 1400 MM	534
WALL BRACKET FAN	10
CEILING FAN 1200 MM	1161
EXHAUST FAN 300 MM	247
EXHAUST FAN 450 MM	16

Thermal Comfort condition

HVAC system is provided to maintain thermal comfort in the buildings. Details of HVAC are as follows:

HVAC EQUIPMENT DETAIL-						
S.no	Description	Make	Model	Manufacturing year	Rated capacity in TR	Use
A	Building - AB-I , AB-2 , SH-2 , KRC					
	VRF AC System	Voltas			1422 TR	Feeding AB-1 , AB-2 , SH-2 , KRC
B	Building - G+3 , G+7					
	Air Cooled				3X 200 TR	Feeding G+3 , G+7
					1X 55TR	
C	Split A.C In G+3 , G+7					
	Split A.C				2TR-24	Feeding G+3 , G+7
					1TR-02	
					1.5TR-14	
D	Split A.C In AB-3					
	Split A.C				2TR-84	Feeding AB-3
					1TR-07	
					1.5TR-50	
	Cassette A.C				2TR-16	

Comfort condition of campus was checked using portable anemometer cum thermometer. Details are as follows:

S. No	Room No.	Temperature/ humidity	Air Velocity in m/s
	Ambika school		
	Director main office		

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167

S. No	Room No.	Temperature/ humidity	Air Velocity in m/s
1	Room = 013C	28.6 .C 40.5% rh	0.93
2	Room = 013B	27.6 .C 45.0% rh	0.13
3	Room = 013A	20.8.C 61.0% rh	0.00
4	Room = 002B	20.0.C 59.5 % rh	0.40
5	Room = 002A	28.5 .c 64.5 % rh	0.73
7	Room = 003 B	28.7 .c 52.0 % rh	0.06
8	Room = 003 G	28.2 .c 61.5 % rh	0.06
10	Room = 004	28.7 .c 57.2 % rh	0.33
11	Room = 005	28. 0 c 49.5 % rh	0.20
12	Room = 006 (physics lab - I)	27.3 c 46.7 % rh	0.13
13	physics lab - II	26.8 c 53.7 % rh	0.73
14	physics lab - III	26.5 c 48.5 % rh	0.53
	AB-I (Ground floor)		
24	Depart of Civil (office)	29.2 c 67 % rh	0.26
25	senior assistant room	29.2 c 68.5 % rh	0.73
26	Assistant Register	28.6 c 53.0 % rh	0.33
29	4th floor AB-I		
	Management department (office)	29.0 c 52.5 % rh	0.26
30	common room	28.6 c 54.2 % rh	0.33
	5th floor		
31	class room -A511	29.3 c 45.0 % rh	0.20
32	class room -A509	29.3 c 53.5 % rh	0.53
	Library		
33	I floor	30.2 c 56.2 % rh	0.13
	Ground floor	29.1 c 55.3 % rh	0.26
35	Seminar Hall	29.3 c 57.0 % rh	0.06

Ambient weather condition between 23.09.2019 to 27.09.2019 is

Day	T	TM	Tm	H
23	27.8	33.8	22.8	72
24	28.3	33.4	23.41	73
25	28.7	33.3	24.6	75
26	28.6	34	24.6	76
27	26.4	33.7	24.8	77
Monthly average				
	28.0	33.6	24.0	74.6
T	Daily Average temperature			
TM	Daily maximum temperature			
Tm	Daily minimum temperature			

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Day	T	TM	Tm	H
H	Average Humidity			

For above ambient weather conditions the internal thermal comfort maintained using HVAC system is good. The HVAC system is used for reducing humidity by maintaining high temperature which is a good practice.

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PUMPS AND MOTORS

Pumps are used to deliver water at different tanks placed at different terrace. Details of pumps are as follows:

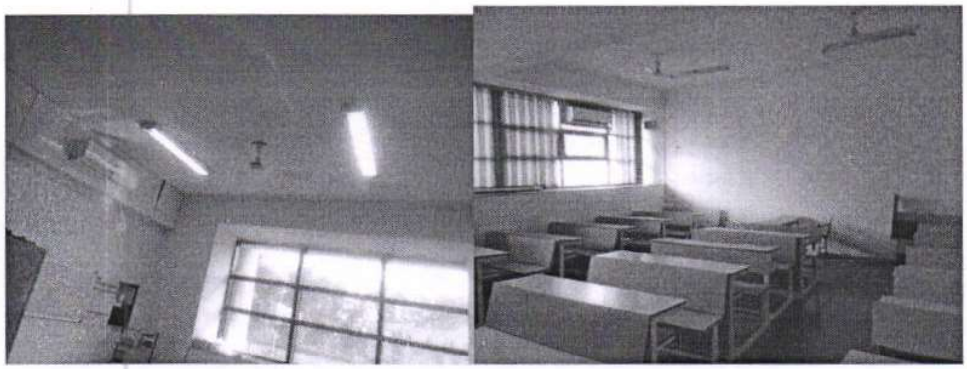
S.No	Storage of water location	Pump installed fozr transferring of water if yes then type and capacity
1	Administrative G+7 , G+3	3x11 HP Kirloskar
2	AB-1 , AB-2 , KRC HALL	3x11 HP Kirloskar
3	AB-3 , Girls Hostel	2x11 HP kirloskar
4	Boys Hostel	1x50 Amer sine motor

There is no meter installed at pumping station to monitor regular energy performance of water supply pumps. Similarly no record is maintained for operating hours as well as quantity of water pumped.

IDENTIFICATION OF WASTAGE

Electricity is used to maintain visual and thermal condition in the buildings. It is observed that light are operational at places where day light condition was good and there were no occupants.

Similarly fans and AC were on in empty spaces or class rooms.



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166

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WATER AUDIT AND MANAGEMENT

FRESH WATER

WATER REQUIREMENT

Water is required for drinking, flushing of toilets, Lab works and watering of plants of Botanical garden. The anticipated water requirement is as follows:

S.No.	Description	Consumption in liters
Fresh water requirement		
1.	Domestic water for staff and student (day scholar) @25 per head considering 80% of 2733 (total enrolled students) i.e 2200 (approx.)	55000l
1.	Domestic water student (Hostel)@90 per headconsidering 565 students	50850 l
1.	Domestic water for visitors @5 per head considering 50 visitors per day	250 l
	Fire tank make up	400 l
	Sub total (Domestic water)	**110000 l**
Raw / Recycled water requirement		
2.	**Flushing water for staff and student (day scholar) @20 per head considering 80% of 2733 (total enrolled students) i.e 2200 (approx.)**	**44000 l**
	Flushing water student (Hostel) @45 per head 565 students	25425 l
2.	**Flushing water for visitors @0 per headconsidering 50 visitors per day**	**250 l**
3	Watering of plants Trees (3000 no.)	Not required plants are too old
	Shrubs & Flower Pots 3000 (Approx.) @ 1l per plant	3000 l
3	Hedge Area, Shrubbery Border, Flower beds 3000 SQM. (Approx.) @ 5l per SQM	15000 l
	Lawn 45000 SQM@ 5l per SQM	225000 l
	Sub total (Flushing water)	**273000 l**
	Total anticipated water requirement	**383000 l**

Source:-NBC 2016 table 1 part 9 page 12

SOURCE AND DISTRIBUTION

There are 2 tube wells and a no municipal water connection. The water is collected in under ground sump. Details are as below:

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SOURCE OF WATER

S.No	Source of water	Quantity received	Storage facility
1	Tube well in Administrative Building		2.5 lakh ltr RCC UGT (1.5 lack liter is reserved for fire)
2	Tube well in AB-3 (PIT) Building		01 lakh ltr RCC UGT

The water is then transferred to individual tank placed on terrace. The water is distributed through pipe network to individual point of use.Details of terrace tanks are as below:

S.No	Storage of water location	Tank type PVC/RCC/steel/other	Quantity stored in liters	Pump installed fozr transferring of water if yes then type and capacity
1	Administrative G+7 , G+3	pvc	12x5000 ltr	3x11 HP Kirloskar
2	AB-1 , AB-2 , KRC HALL	pvc	24x5000 ltr	3x11 HPKirloskar
3	AB-3 , Girls Hostel	pvc	12x25000 ltr	2x11 HPkirloskar
4	Boys Hostel	pvc	5x10000 ltr	1x50 Amer sine motor

The terrace tanks are cleaned once in a year. Details are as below:

S.No	Location	Nos. of PVC tank	Frequency	Last date of cleaning
1	Building G+7 , G+3	12	one year	Dec-18
2	AB-1 , AB-2 , KRE , HALL	24	one year	Dec-18
3	AB-3 , Girls Hostel	12	one year	Dec-18
4	Boys Hostel	6	one year	Dec-18

Note:-There is no meter in supply line or distribution line.

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DRINKING WATER FACILITY

There are 50 drinking water point having a set of water cooler with purifier are installed. These cooler get cleaned every month. Purifiers are maintained . Details are as follows:

S.no	Storage type	Nos	Fitter with local filter or common filter	Last date of cleaning
1	water cooler	50	Branded filters	cleaning in monthly last cleaning done on 19 sep 2019

Drinking water facility

FLUSHING WATER REQUIREMENT

Waterless urinals are installed int the campus where as to flush water closets fress water is used.

FLOOR CLEANING AND VEHICLE CLEANING

Non treated fresh water is used for floor cleaning and Vehicle cleaning as and when required. Record not maintained.

FIXTURE AND FITTING

Regular Fixture and fitting are installed in the campus.

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WASTE WATER MANAGEMENT

Waste water is generated from Drinking water point, Basin and WC of toilets. The sewage so generated is conveyed to the STP whose capacity and location are as follows:

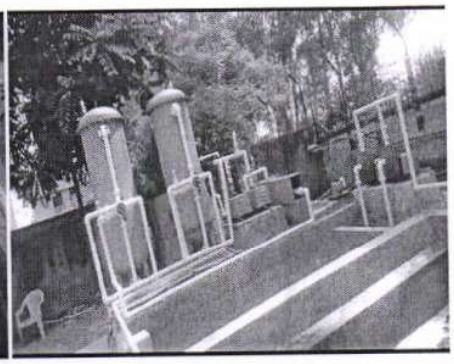
Waste water treatment system

S. no	Source of waste water Location	Quantity Generated sewage in litres	Only water or mixing of chemicals(soap/ detergent/ phenol/other)	Treat ment syste m	Pump installed if yes then type and capacity
1	STP - 30 KLD X 2	There is no meter to measure	yes	STP	Details not provided
2	STP - 50 KLD X 1		yes	STP	

The waste water generated in chemical lab is also conveyed to the STP for respective building.

IRRIGATION OF GARDEN

The average lives of plants in 4.5 acre green cluster are 15 to 20 year of the plant needs almost no water. At other area irrigation is done by flooding method using mixture of fresh and recycled water. There is no meter in irrigation water supply or recycl3ed water supply.



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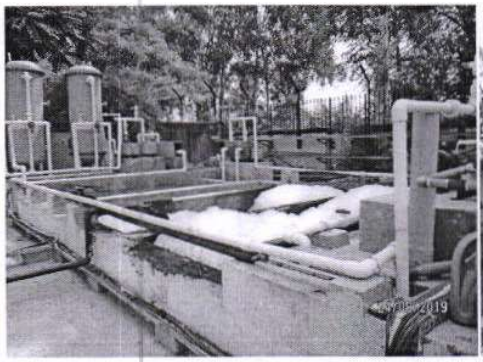

RAIN WATER MANAGEMENT

Water from roof and other area follow natural path of contour and flow conveyed to low lying areas.

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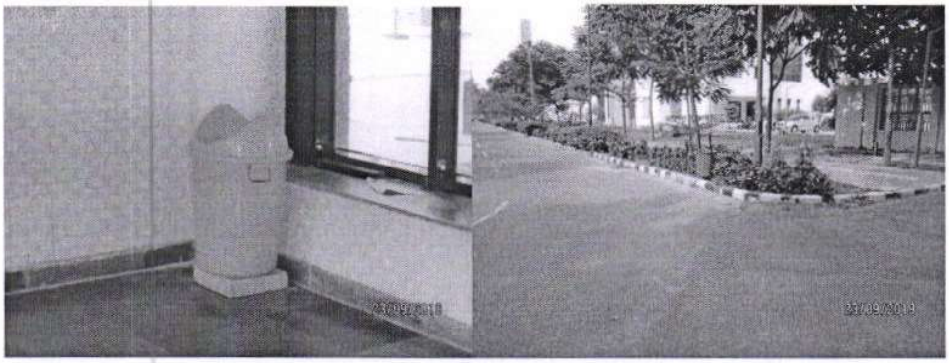
STATUS OF MUNICIPAL / SOLID WASTE HANDLING

Dust bins and garbage bins are placed at every nick and corner of the campus. Here it is observed that all type of the Municipal waste is collected in common bin. The Non organic collected waste is then shifted to the nearest pickup point from which the waste is transported to MunicipalLand fill where as organic waste is treated and converted into compost in the campus only.



SOLID CHIMICAL WASTE

There is no solid chemical waste generated in the campus.

ORGANIC WASTE

The organic waste generated in the form of food left over, leafs and tree waste all over the campus. It is treated and converted into compost using electro-mechanical composter.

ELECTRONIC WASTE

The non functioning computers are stored in a room with the intent to dispose it off to authorized vendor on later date.

RECYCLABLE WASTE

Time to time old newspapers, magazine and used papers from office are handed over to authorized vendor.

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CARBON FOOT PRINT

Carbon foot print is the amount of carbon dioxide released into the atmosphere as a result of the activities of a particular individual, organization, or community. In the institute like this Carbon Dioxide is generated by burning of petroleum product like petrol, Diesel and LPG or use of electricity.

CALCULATION METHODOLOGY

Electricity = 0.85 kg CO_2 per KWh, Source: CO_2 emission factor database, version 06, CEA **(Government of India)**, http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm .

Motor gasoline/ Petrol = 2.296 kg CO_2 per liter, Source: Emission factors are taken from the file "Emission factors from across the sector -tool", extracted from http://www.ghgprotocol.org/calculation-tools/alltools.

Diesel= 2.653 kg CO_2 per litre, Source: Emission factors are taken from the file "Emission factors from across the sector -tool", extracted from http://www.ghgprotocol.org/calculation-tools/alltools.

Liquefied petroleum gas (LPG) = 2.983 kg CO_2 per kilogram, Source: Emission factors are taken from the file "Emission factors from across the sector -tool" extracted from http://www.ghgprotocol.org/calculation-tools/alltools.

Public conveyance bus : Number of users per year X 0.105 (Emission Factor)**kg CO_2 per passenger/Km=** Output value in (Kg of CO_2).source https://www.carbonfootprint.com/calculator.aspx

Carbon Footprint : Add (1+2+3+4+5) = Output value in (Kg of CO_2)

CALCULATION OF CARBON FOOT PRINT

S.no.	Fuel type	Unit	Consumption per year	Emission Factor	Total in KG
1	Electricity	KWh	2363651	0.85	2009103
2	Motor gasoline/ Petrol	liter	42000	2.296	96432
3	Diesel	liter	614640	2.653	1630640
4	Liquefied petroleum gas (LPG)	kilogram	6300	2.983	18792.9
5	Public conveyance bus	Number of users	6499200	0.105	682416
	Total carbon foot print in KG				4437384
	Total carbon foot print in matric ton				4437.38

Total carbon foot print of university is 4437.38 metric ton **CO_2 per year**

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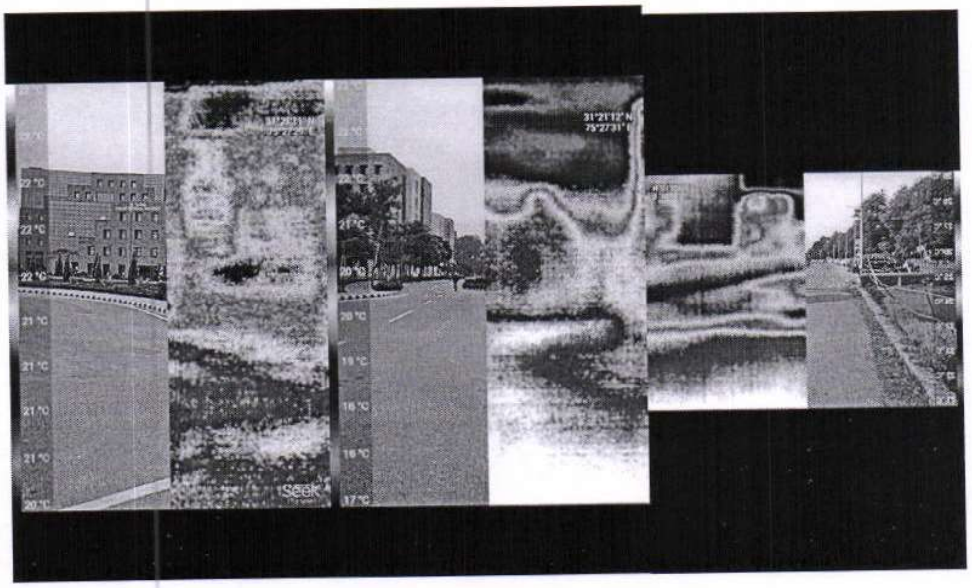
157

HEAT ISLAND IMPACT

The heat island effect implies to cities or metropolitan areas are transformed into islands of heat. Temperatures in these regions can get as much as 3 to 5°C higher compared to the adjacent rural areas.

The hard paved surface, Black roof top and vehicle standing outside in direct sun enhance heat island impact.

Study was conducted from 25.11.2019 using thermal camera. The average daily ambient temperature detected by nearby metrological station no 420710 was 16.4°C with average maximum temperature 24.3°C whereas minimum average temperature 9.8°C (weather data source https://en.tutiempo.net/climate/11-2019/ws-420710.html). It is concluded from the captured thermal camera that the temperature of roads are 5°C higher than raw land. Vehicles parked at side of road exposed to sunlight is having 10°C more temperature than raw land.



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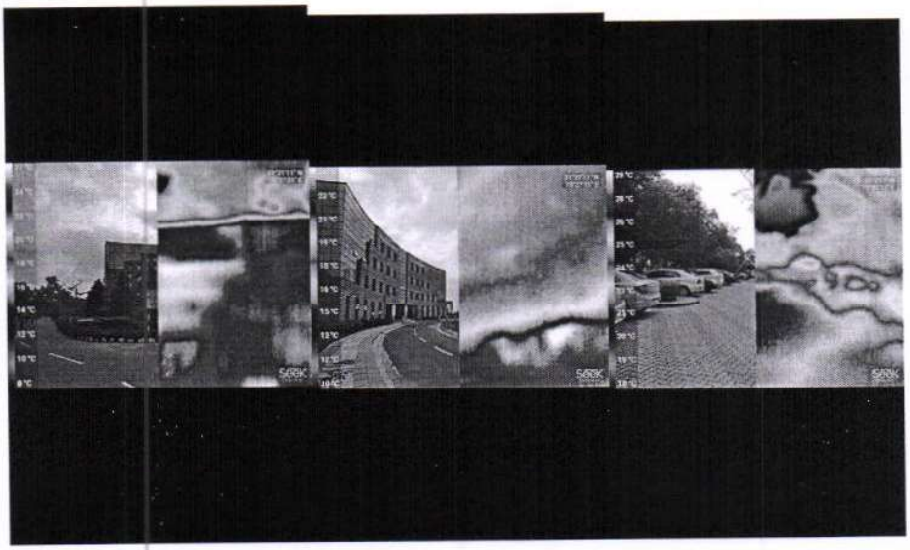
156



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RECOMMENDATIONS

GENERAL

Based on the baseline study or the observation made earlier section, this portion outlines measures to be adopted to make campus Green.

BUILDING MAINTENANCE

Although maintenance of Building infrastructure is in owners scope even then work can be priorities for follow up. The classification of priorities and its contains are as follows

HIGH PRIORITY WORK

Definition: Work that does not qualify as an emergency, but cannot wait to be scheduled asroutine maintenance and repair. Generally, these are NOT issues related to health, safety, or security but have impact on the function of the building. The Chief Custodian must put in a work order for these issues and be sureto be specific in the description of the assistance needed.

Following are typical examples of high priority work orders:

- Broken fence or gates
- Leaking or broken sprinkler heads, valves
- Broken tree limbs or fallen trees
- Leaking plumbing
- Cracked glass windows
- Street lights not working.

MEDIUM PRIORITY WORK

Definition: Medium priority work order falls into the routine maintenance work request. These work orders are the everyday repairs required to keep the building in proper working order.

Most work orders will fall into this priority for completion. The Chief Custodian must put in a work order for these issues.

Some examples can be:

- Repair electrical switch or outlet
- Replace light ballast
- Urinal stopped up
- Door closer leaking hydraulic fluid
- Black Board Painting
- Drinking water facility either cooler or filter or both are not working

LOW PRIORITY WORK

Definition: Low priority work orders are issues needed to be completed within the scheduled period of time.These items, although routine, can be scheduled and completed as a craft person becomes available.

Some examples might be:

- Playground equipment painted
- Keys (replacement keys)
- Paint parking lot stripes
- Pick up bags of leaves for disposal

SOLID WASTE MANAGEMENT SYSTEM

it is proposed to have provision for segregation and collection of biodegradable & non-biodegradable waste within the premises. Biodegradable waste will be treated in existing Organic Waste converter within the premises.Non-biodegradable waste recyclable waste shall be handed over to recyclers and non - recyclable waste shall be shifted to nearest pick up point from which it is transported to land fill ground. No burning of solid waste in open shall be prohibited in campus.

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163

DISPOSAL OF ELECTRONIC WASTE

Electronic waste or **e-waste** describes discarded electrical or electronic devices. Informal processing of e-waste in developing countries can lead to adverse human health effects and environmental pollution. If electronic equipment is in operational condition then donate it. This will helps reduce pollution that would be generated while manufacturing a new product and therefore the pressure on natural resources. It also reduces the energy used in new product manufacturing.

Put unusable electronic equipment in a tamper proof plastic bag. Store it in leak proof containers till it is disposed off. Hand over all the e-waste to authorised recycler.

If electronic equipment are replaced by new one then hand over old one to the supplier itself.

HOUSE HOUSEKEEPING

The purpose effective housekeeping is to protect faculty, staff and students from injuries and illness by making all the area clean. Following shall be done for effective housekeeping:

- Dispose of all items in the proper labelled containers
- Anything flammable should be in a metal container and labelled
- Clean up spills immediately
- Stack Item properly make sure they cannot fall or block passages
- Avoid food and beverages in work area
- Never put liquids in an unlabelled container
- Do not remove any safe guards on equipment

ENERGY MANAGEMENT

Energy conservation is the need of the hour the first step toward energy consumption is to record the energy use. Following steps can reduce energy consumption:

- Energy record shall be maintained as per Performa enclosed
- Provide Power Factor correction method to claim incentives for maintaining better power factor.

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152

- High efficiency electronic ballasts shall be used on all Tube lights.
- Change incandescent lamp with either CFL or LED bulbs.
- Change existing T12/T 8 Tube light with T5 Tube light.
- Change existing fans with energy efficient fans
- Open window for day light or replace at least top two window panes with transparent glass.
- Switch off all the electrical equipment when it is not in use.
- Provide solar powered LED street light.
- Provide occupancy sensor and day light sensors to switch off lights and fan when operation of this is not required.
- Maximum demand mater shall be provided.
- Electricity supply company shall be approached to revise contract demand hence accordingly fixed charges will be reduced.
- Provide proper earthing for electrical equipment and building wiring system.
- Replace present conventional earthing system with no maintenance chemical earthing.

Similarly record of LPG shall be maintained and following steps will optimize use of LPG

- Clean the burner of stove periodically
- Use small burner in place of big one
- Make all the preparation before turning on LPG stove
- Check the flame of burner. Blue flame means gas stove is operating efficiently. Yellowish flame is an indicator that the burner needs cleaning
- Use pressure cookers as much as possible
- Use lids to cover the pans while cooking § Bring items taken out of refrigerators (like vegetables, milk etc.) to room temperature before placing on the gas stove for heating.
- Turn off the stove when it is not in use.

HVAC SYSTEM

Don't over-cool. The ideal thermostat setting is between 25°C and 27°C with ceiling fan operational. Every degree you raise your thermostat can result in a 5% savings on the cost of cooling your home.

- Keep lamps, Computers and other heat sources away from the air conditioner thermostat. Heat from these sources may cause the air conditioner unit to run longer than it should.
- Make sure that no furniture or other obstacles are blocking ducts or fans. This will enable cooled air to circulate more freely.
- When selecting a central air conditioning unit, be sure to choose one that is sized appropriately and uses the minimal amount of electricity to complete its task.
- Install a ventilating fan in your attic or in an upstairs window to help dissipate hot air and cool down the spaces.

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- Don't set thermostat at a colder setting than normal when you turn your air conditioner on. It will not cool the room any faster, but it will use more energy.
- Use a ceiling fan in conjunction with your air conditioner to spread cooled air to other rooms.
- Clean the outside air conditioner condenser coil once a year. Turn off the unit and spray the coils with water at a low pressure to remove dirt, dust, leaves and grime.
- Clean filter of indoor unit once in 15 days.
- Use duct tape to seal the cracks between each section of an air duct on your central air conditioning or forced heating system.
- Close your blinds, curtains and shades during the hottest part of the day. Keep out the daytime sun with vertical louvers or awnings on the outside of your windows.
- Keep lights low or off when not needed. Electric lights generate unnecessary room heat.
- Factors Affecting Energy Efficiency & Minimising Motor Losses in Operation

MOTOR PERFORMANCE

Motor performance is affected considerably by the quality of input power, that is the actual volts and frequency available at motor terminals vis-à-vis rated values as well as voltage and frequency variations and voltage unbalance across the three phases

PROPER PUMP SIZING

Pumps installed in the primeses are over sizedresulting in undersizing of pumps. Under-loading results in lower efficiency and power factor, and higher-than-necessary first cost for the motor and related control equipment.

MAINTENANCE

Inadequate maintenance lowers pump system efficiency, causes pumps to wear out more quickly and increases costs. Better maintenance will reduce these problems and the most important – **to save energy**.

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Proper maintenance includes the following:

- Replacement of worn impellers, especially in caustic or semi-solid applications.
- Bearing inspection and repair.
- Bearing lubrication replacement, once annually or semiannually.
- Inspection and replacement of packing seals.
- Inspection and replacement of mechanical seals.
- Wear ring and impeller replacement.
- Pump/motor alignment check.
- The largest opportunity is usually to avoid throttling losses.
- Typical energy savings for operations and maintenance are estimated to be **between 2% and 7% of pumping electricity use**

MONITORING

Monitoring in conjunction with operations and maintenance can be used to detect problems and determine solutions to create a more efficient system. Monitoring can determine clearances that need be adjusted, indicate blockage, impeller damage, inadequate suction, operation outside preferences, clogged or gas-filled pumps or pipes, or worn out pumps.

Monitoring should include:

- Wear monitoring
- Vibration analyses
- Pressure and flow monitoring
- Current or power monitoring
- Differential head and temperature rise across the pump (also known as thermodynamic monitoring)
- Distribution system inspection for scaling or contaminant build-up

CONTROLS

The objective of any control strategy is **to shut off unneeded pumps or to reduce the load of individual pumps**. Remote controls enable pumping systems to be started and stopped relatively quickly and accurately, and reduce the required labor with respect to traditional control systems.

MORE EFFICIENT PUMPS

Pump efficiency may degrade 10% to 25% in its lifetime. Industry experts however point out that this degrading performance is not necessarily due to the age of the pump but can also be caused by changes in the process which may have caused a mismatch between the pump capacity and its operation.

Nevertheless, it can sometimes be more efficient **to buy a need pump**, also because newer models are more efficient.

WATER MANAGEMENT

Material which is not measured cannot be saved hence it is advisable to put a meter and check the consumption on regular basis. A record shall be maintained for tank cleaning, water cooler cleaning and purifier maintenance with water consumption. Following provision shall be implemented for water conservation:

- Providing self closing (push cock) type pillar cock and bib cock to avoid wastage of water due to not closing the pillar tap.
- Provide low flow fitting and fixtures i.e. pillar cock and bib cock with 6/3 liter flush tank.
- Providing automatic auto sensor based flushing to urinal in place of normal flushing cistern which operates 24 hours.
- Providing dual flushing cistern for water closet 3 -6 litres in place of 10 liters cistern.
- All WC ablution taps to be self closing taps.
- Consumption requirement of fresh water will be reduced by 70 % by using.
- Provide drip irrigation and high efficient sprinkler irrigation system
- Rain water harvesting shall be adopted to enhance ground water table.
- Repair leakage in water distribution system on priority.
- Develop a regular maintenance protocol.
- Plant drought resistance trees (list enclosed).

WASTE WATER MANAGEMENT

Provide neutralization tanks for chemical waste.

FIRE AND SAFETY

Following steps will make campus safe from Fire

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148

- Evacuation plan is to be prepared and adopted.
- Provision of more fire extinguisher shall be made.
- Additional spiral stair case will make evacuation effective.
- Provide 20 kg fire extinguisher with moveable trolley to fight heavy fire and forest fire.

UNIVERSAL ACCESSIBILITY

Following steps will make property friendly for all:

- Provide more ramp at suitable location.
- Provide Tactile floor for Blind.
- Provide signage in Braille Language.
- Provision for handicap toilet can be made.

CARBON FOOT PRINT

Carbon foot print can be reduced by adopting following steps:

- Discourage driving by charging heavy parking charges and providing preferred parking for by-cyclers.
- Implement effective energy use system.
- Switch off lights, fan and equipments not in use.
- Preferred parking or charging point can be provided for electronic vehicle.
- Encourage vehicle users for pollution check and periodical check-up of air pressure of their vehicles.
- Use only energy efficient office and lab equipments.
- Maximum use of natural light and ventilation.
- Encourage users to walk by providing safe and covered pathways.

HEAT ISLAND IMPACT

Heat Island impact can be reduced by adopting following steps:

- Plant more and more trees.
- Provide light colour on hard surface.
- Shade roof using solar panel.
- Use grass pavers in place of regular pavers.
- Watering of road and other hard surface using recycle water.
- Use energy-efficient appliances and equipment

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POLICIES

GREEN AUDIT POLICY

Green Audit Policy is an act of determining whether operations and practices regarding General maintenance, Energy use, Water management and Waste management are in compliance with recommendations made in Green Audit Report and industries best practices. The policy is framed to review the actions in specified period of time. A committee can be formed to monitor status fof item in Green Audit compliance.

- Verify compliance with environmental regulations, internal policies, and accepted practices.
- Evaluate the effectiveness of Green "management systems" in place.
- Periodic review of records
- Identify and assess any reasonably foreseeable risks associated with hazardous conditions attributable to operations and prevent or mitigate such risks.
- An effective Green auditing program increases overall management effectiveness and comfort with the knowledge that the risks of potential exposure to adverse environmental issues are being addressed.

TOBACCO FREE POLICY

The University is committed formaintaining a safe and healthy work and academic environment, improving indoor and outdoor air quality, and promoting the comfort of students, faculty, staff, and guests. Intent of this policy is to prohibit consumption of all type of tobacco/ product contains traces of tobacco in the campus. This policy not only prohibit teaching,non-teaching staff and students but also applicable on visitors too.

The statement says that chewing, smoking or inhaling any is prohibited in all the nick and corner of the University.Thisapunishable offence and the culprit will be fined Rs.500/- against this act.

POLY-BAG PROHIBITION POLICY

Through this policy management wants to enforce States policy to ban use of Poly bags. This policy will encourage staff and students to use alternative of poly bag.

NO VEHICLE POLICY

The University is committed to reduce carbon foot print and enhance academic environment, improving indoor and outdoor air quality, and promoting the comfort of students, faculty, staff, and guests. Intent of this policy is to prohibit use of private vehicle and to promote use of public conveyance, vehicle pooling etc. This policy is not only applicable to teaching, non-teaching staff and students but also applicable on visitors too.

The statement encouraging use of public conveyance and vehicle pooling will be displayed in all the nick and corner of the University. High parking fee can be levied on person using private vehicle.

BY-CYCLE POLICY

The University is committed not only to reduce carbon foot print and enhance overall health of students, faculty, staff, and guests. intent of this policy is to encourage physical activity. This policy is not only applicable to teaching, non-teaching staff and students but also applicable on visitors too.

The statement encouraging use of cycle will be displayed in all the nick and corner of the University. Preferred parking will be provided near academic building for cyclists.

SITE PLANANNEXURE A

BUILDINGS GROUND FLOOR PLANS

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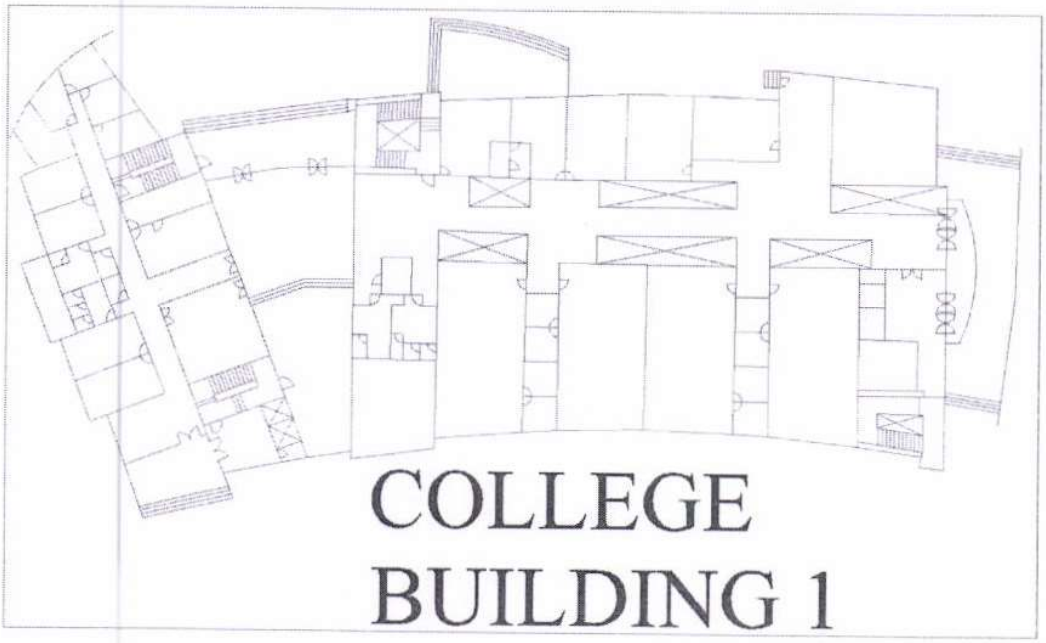
144



COLLEGE BUILDING 1

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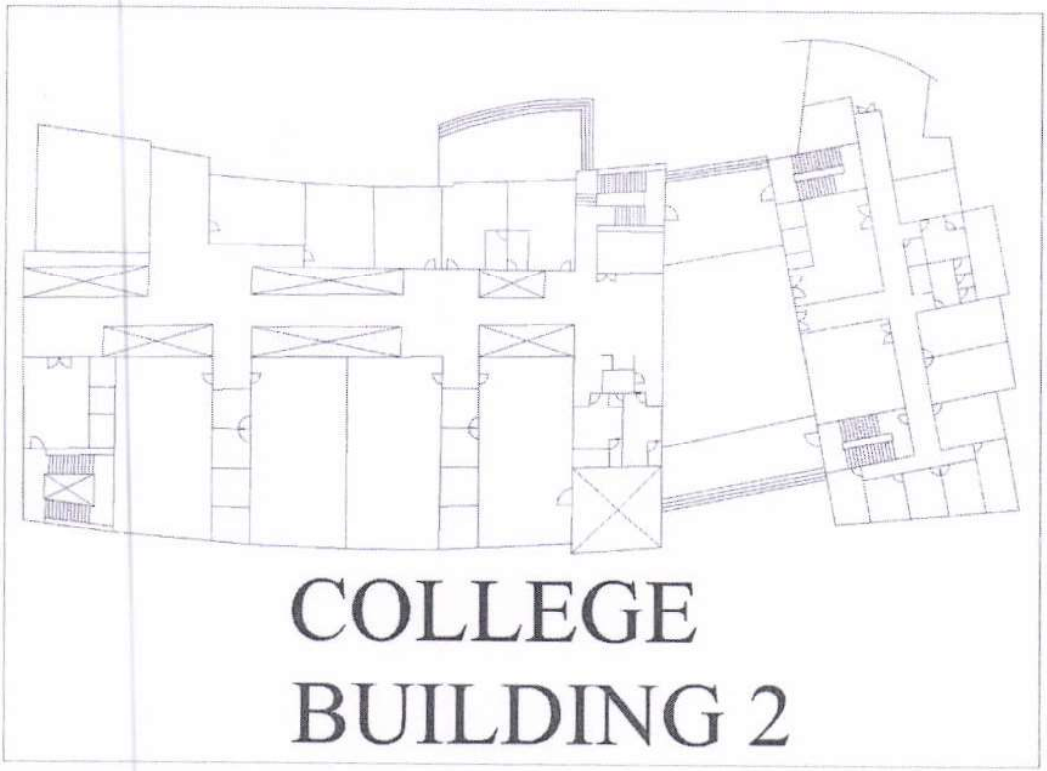

COLLEGE BUILDING 2

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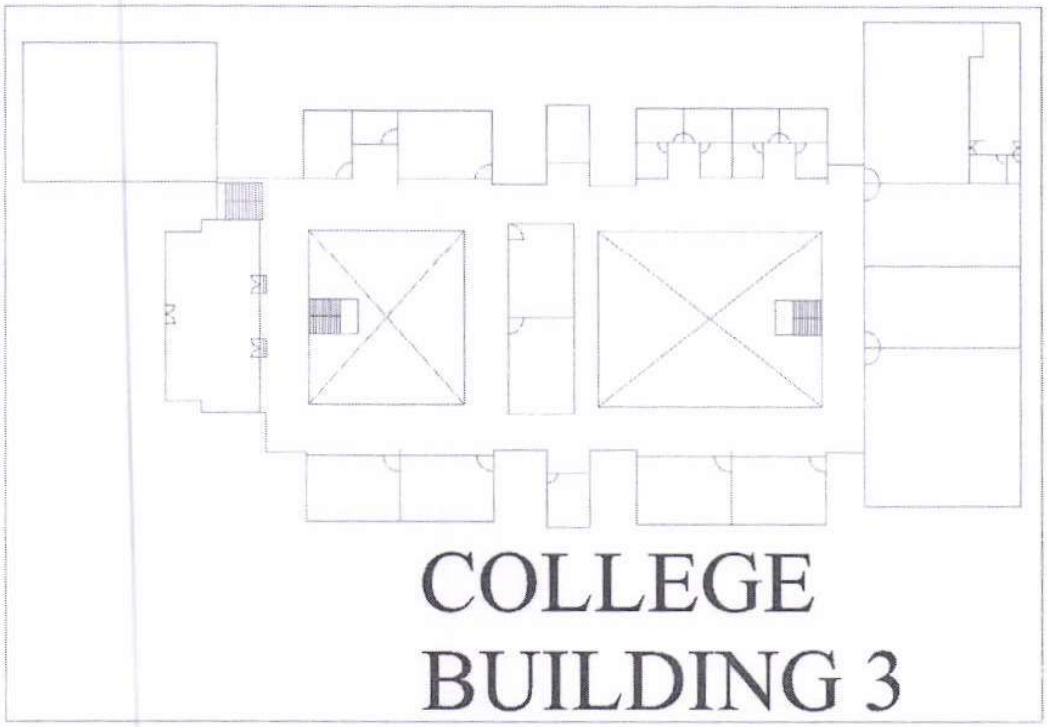

COLLEGE
BUILDING 3

: SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
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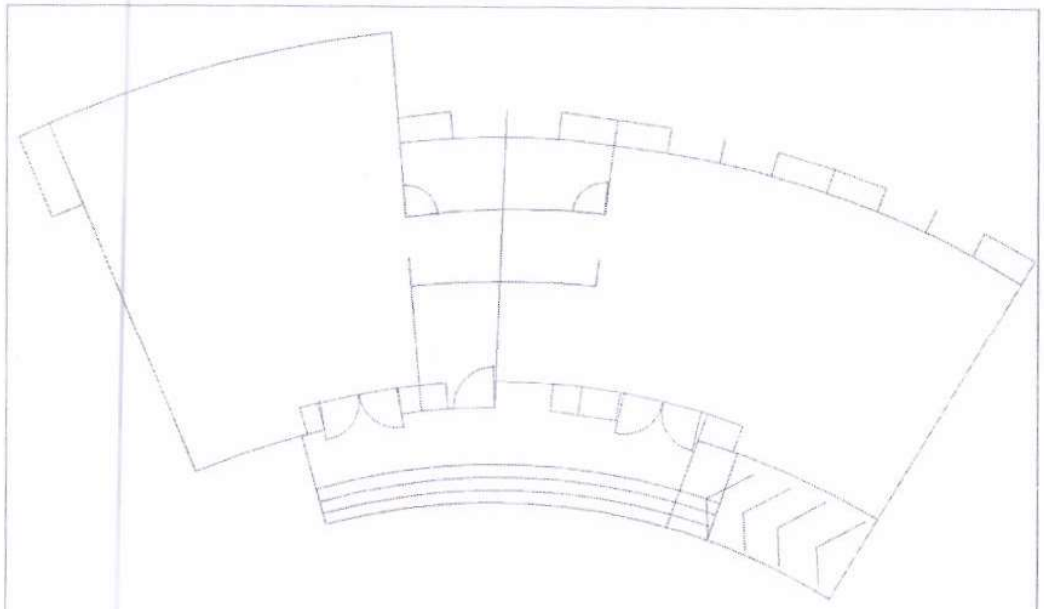
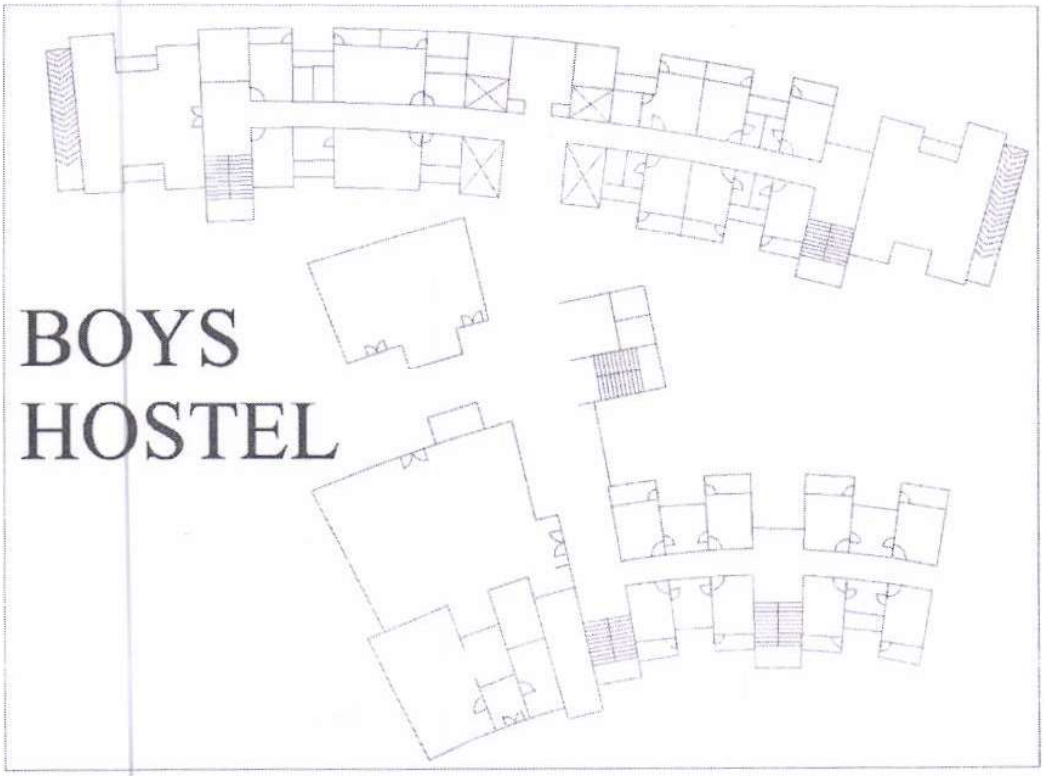


BANK & POST OFFICE

140



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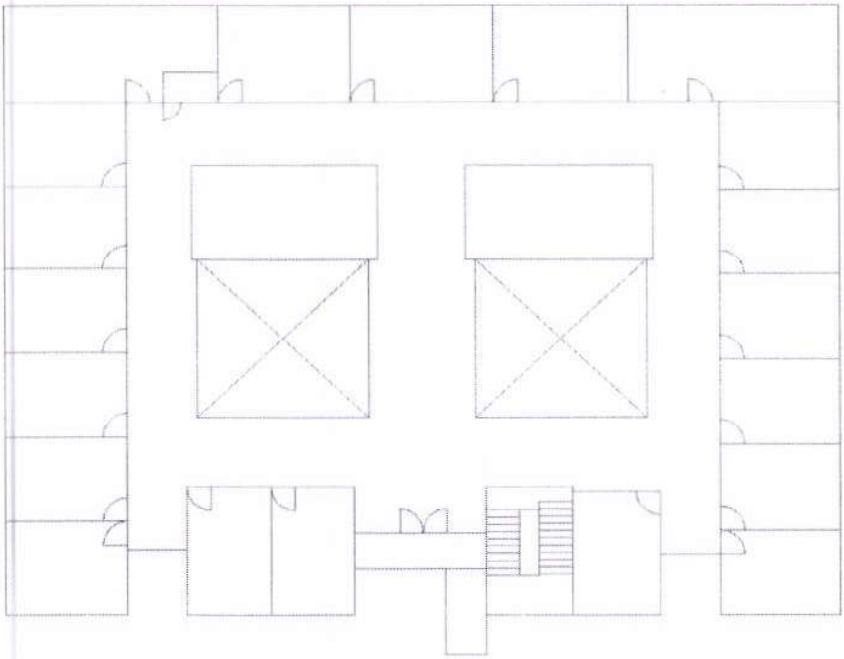

GIRLS HOSTEL 1

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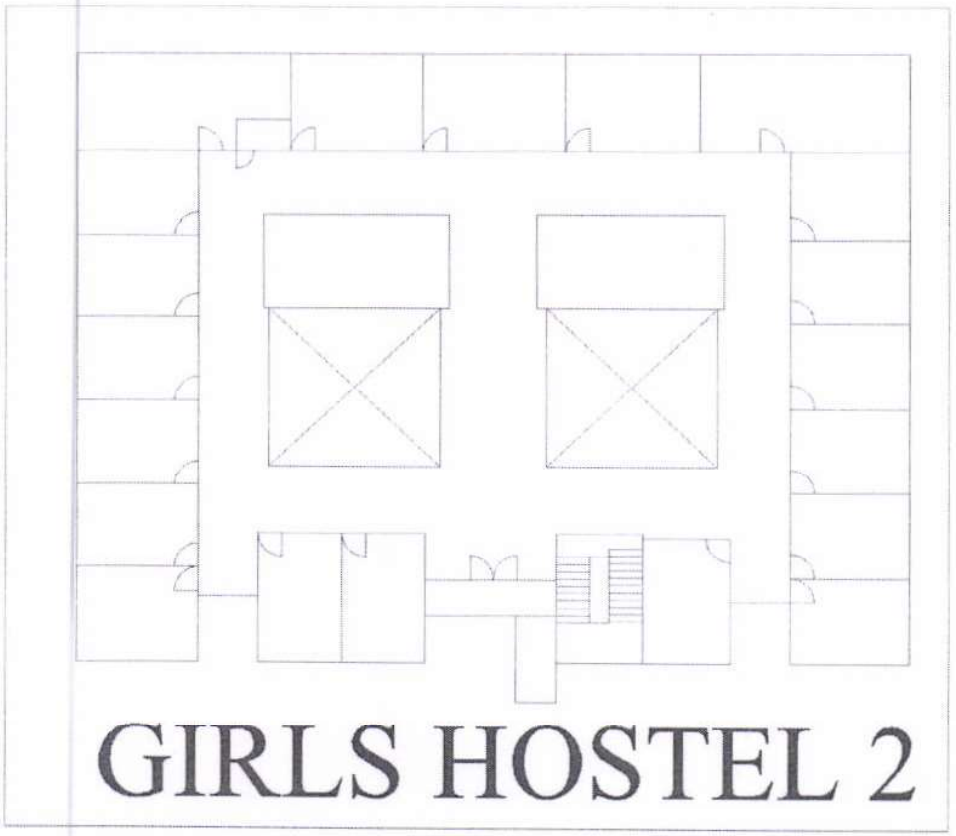

GIRLS HOSTEL 2

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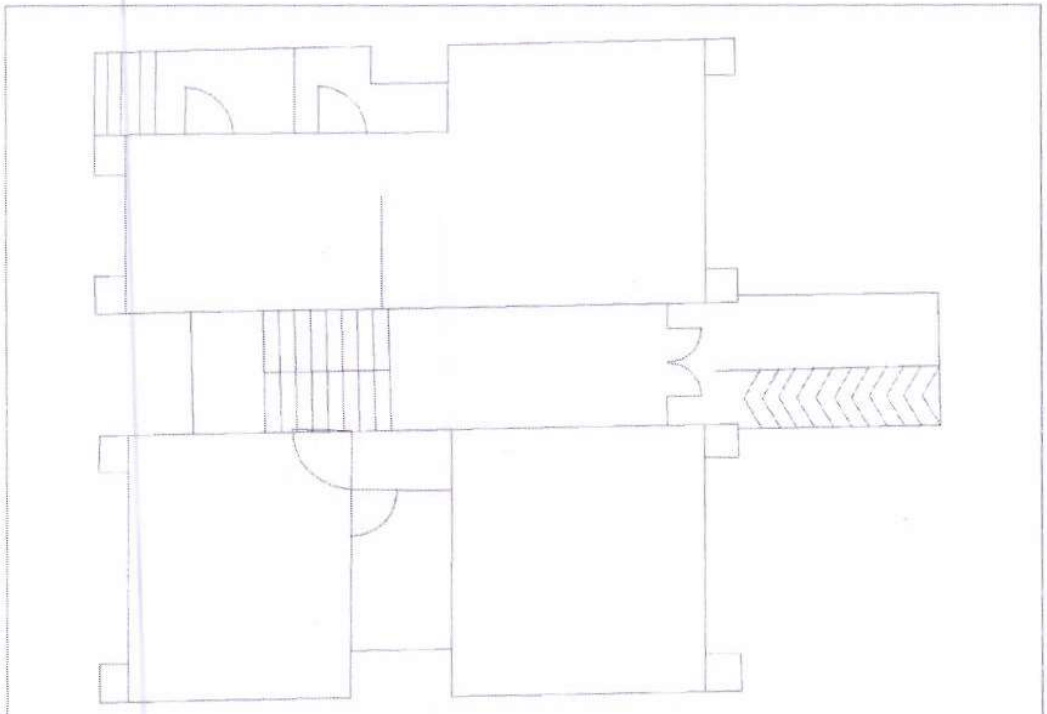

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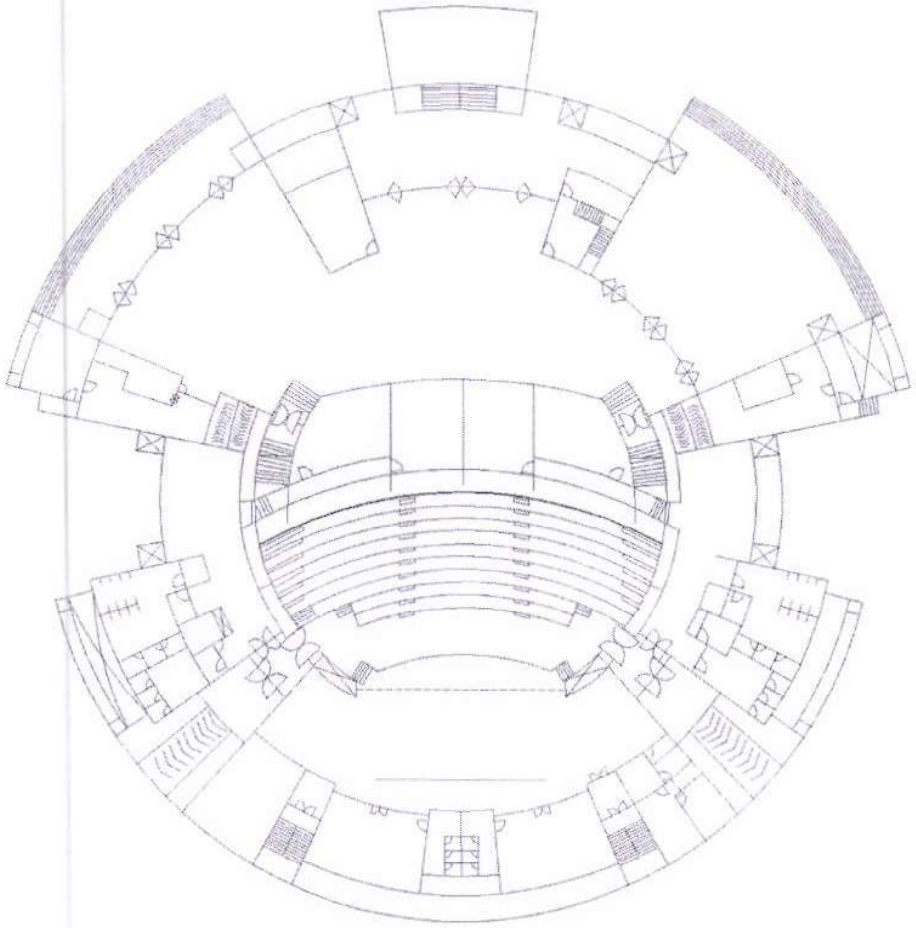

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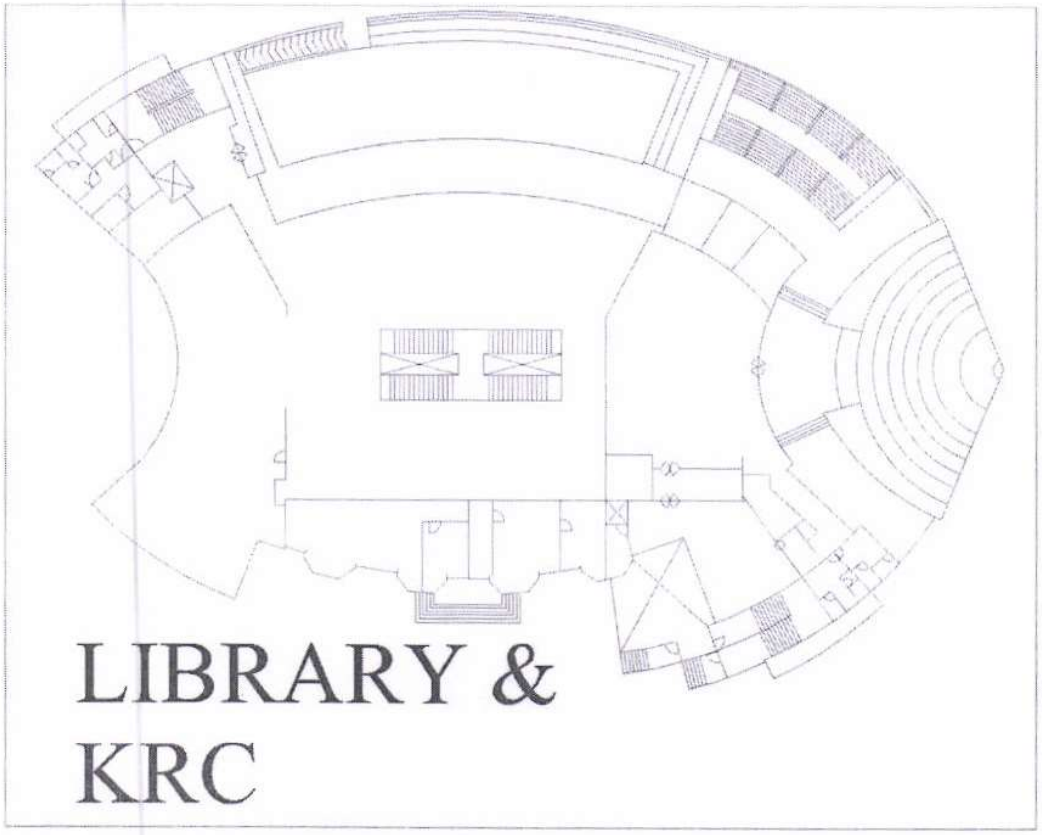

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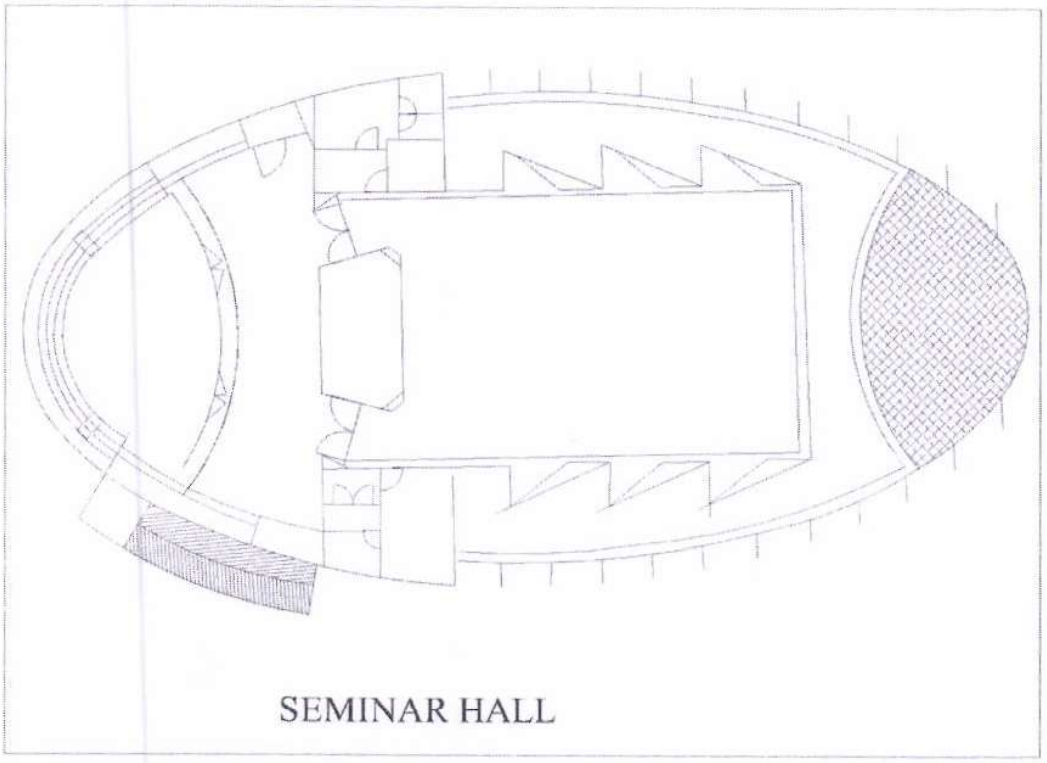
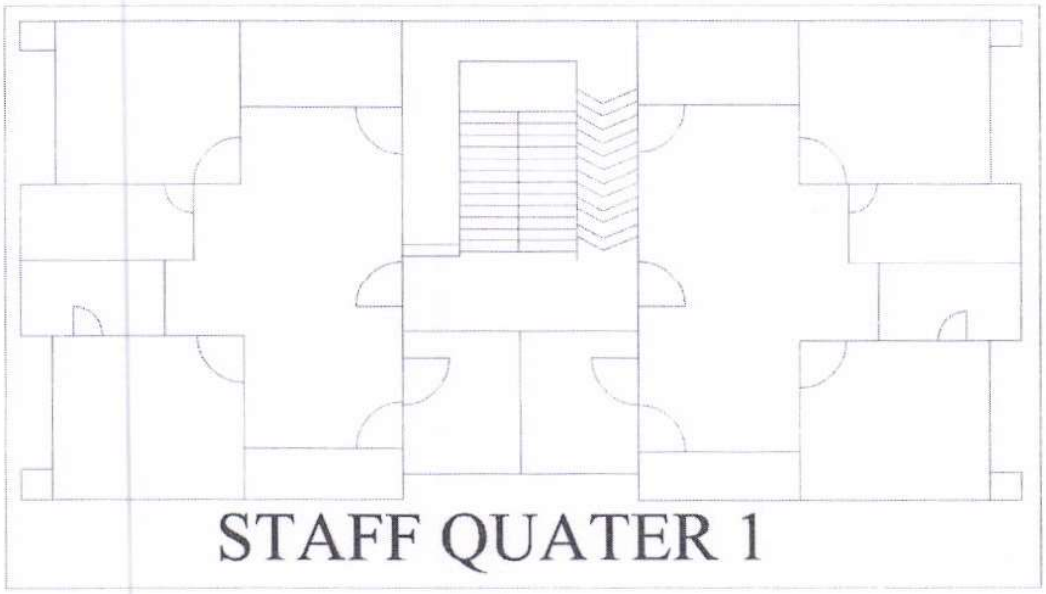


SEMINAR HALL

H.P. SINGH
EXECUTIVE ENGINEER
PUNJAB TECHNICAL UNIVERSITY
JALANDHAR



STAFF QUATER 1

H.P. SINGH
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PUNJAB TECHNICAL UNIVERSITY
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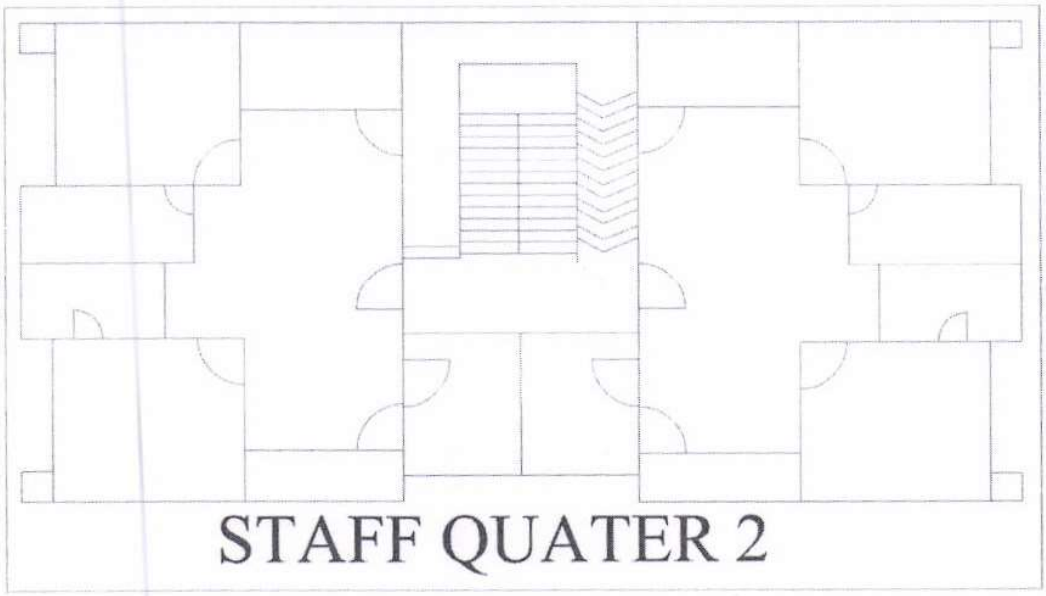

STAFF QUATER 2

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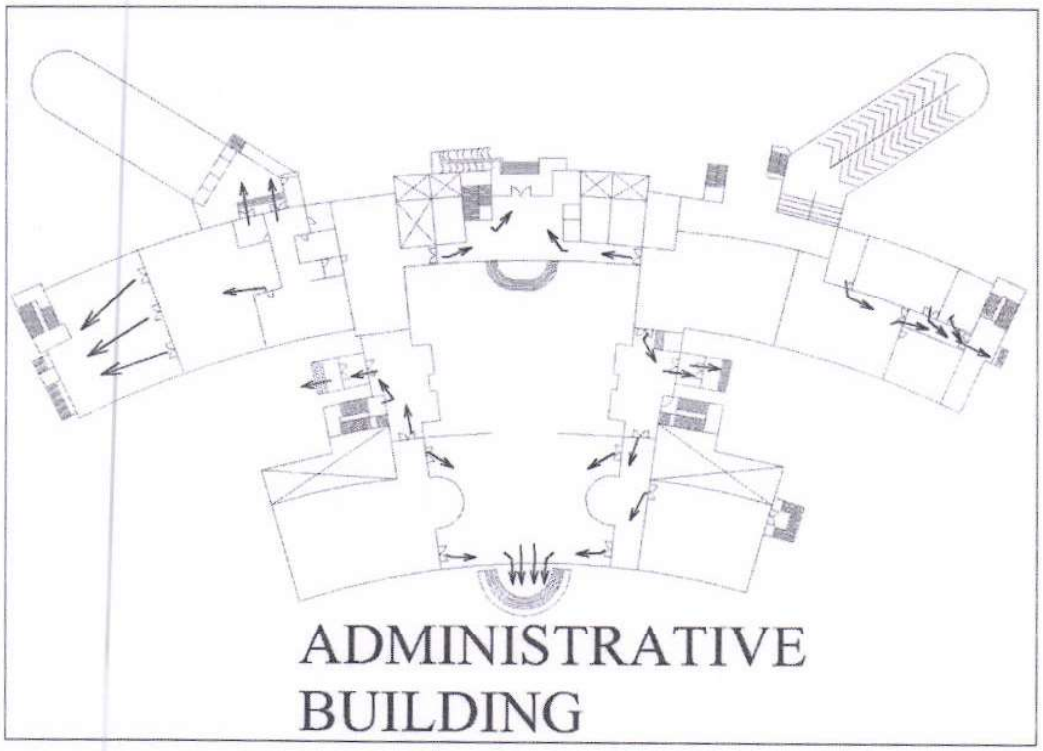
131

FIRE ESCAPE ROUTE



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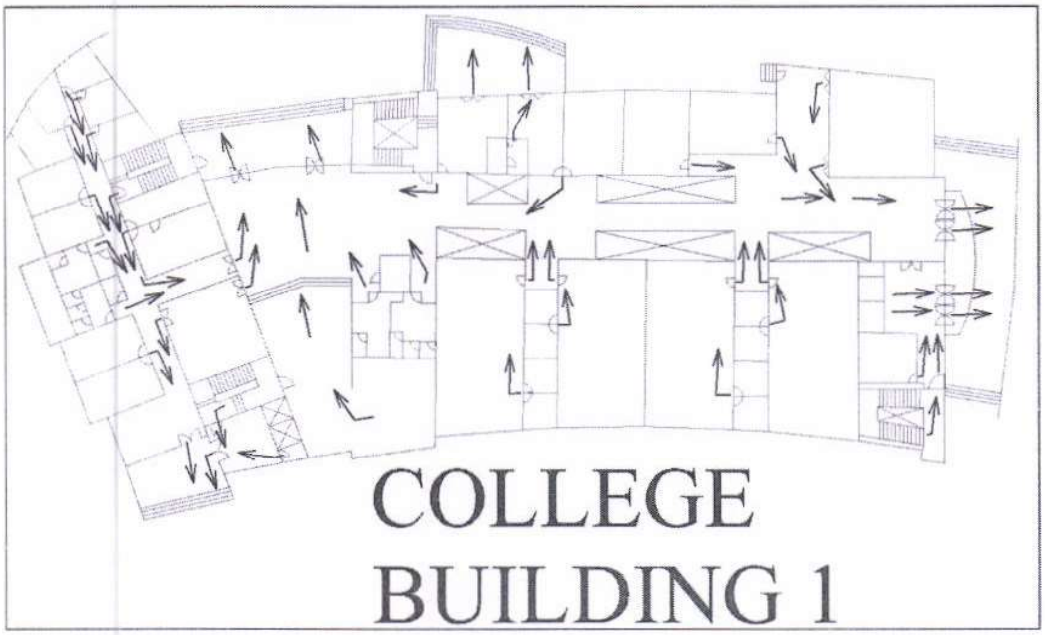

COLLEGE BUILDING 1

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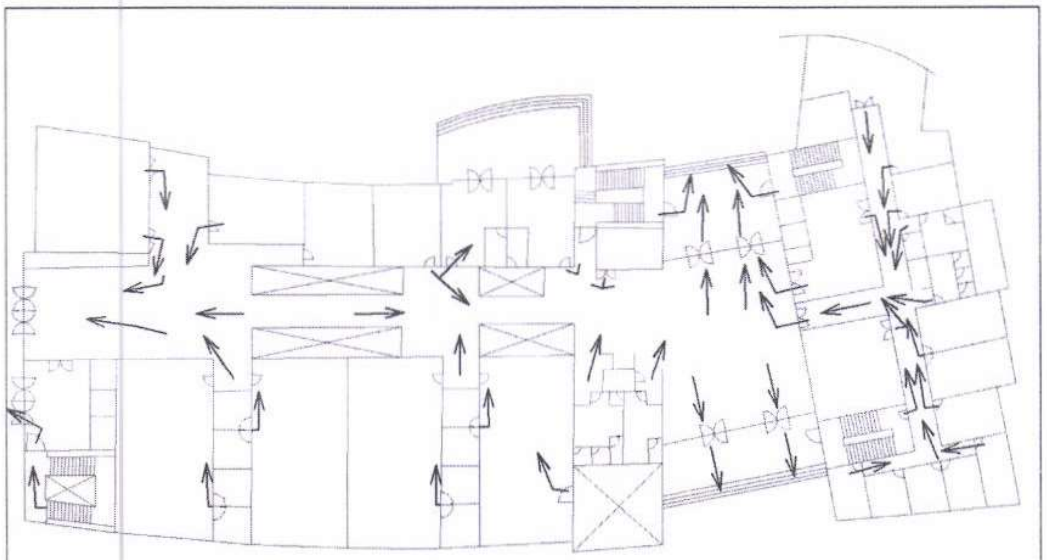

COLLEGE BUILDING 2

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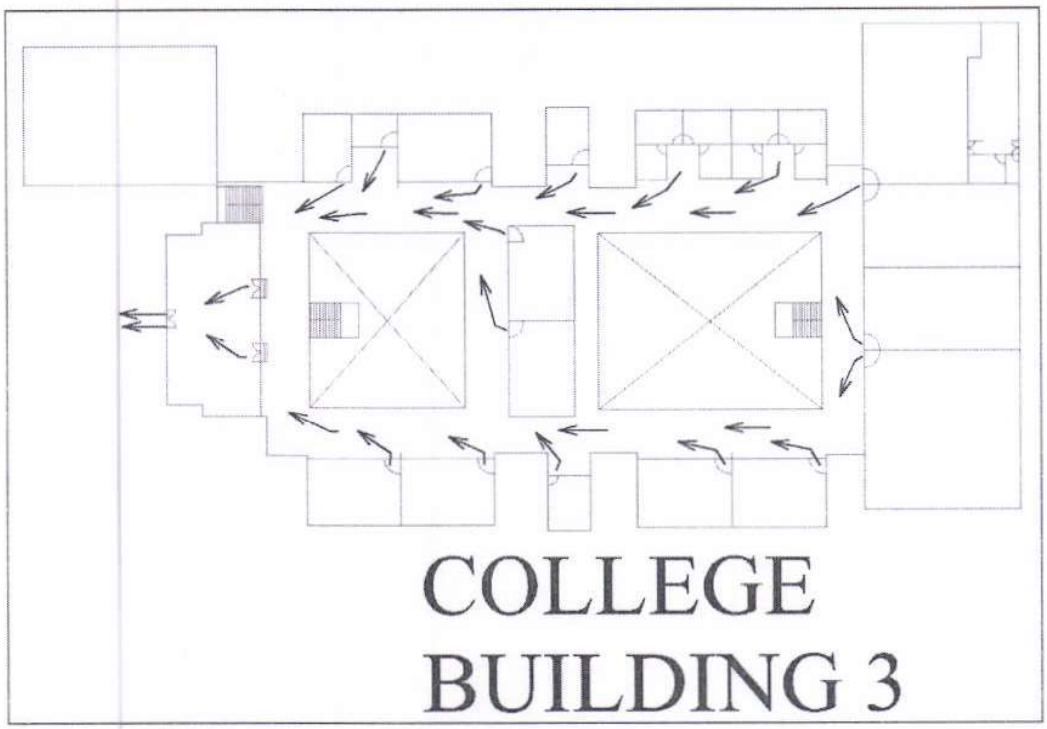

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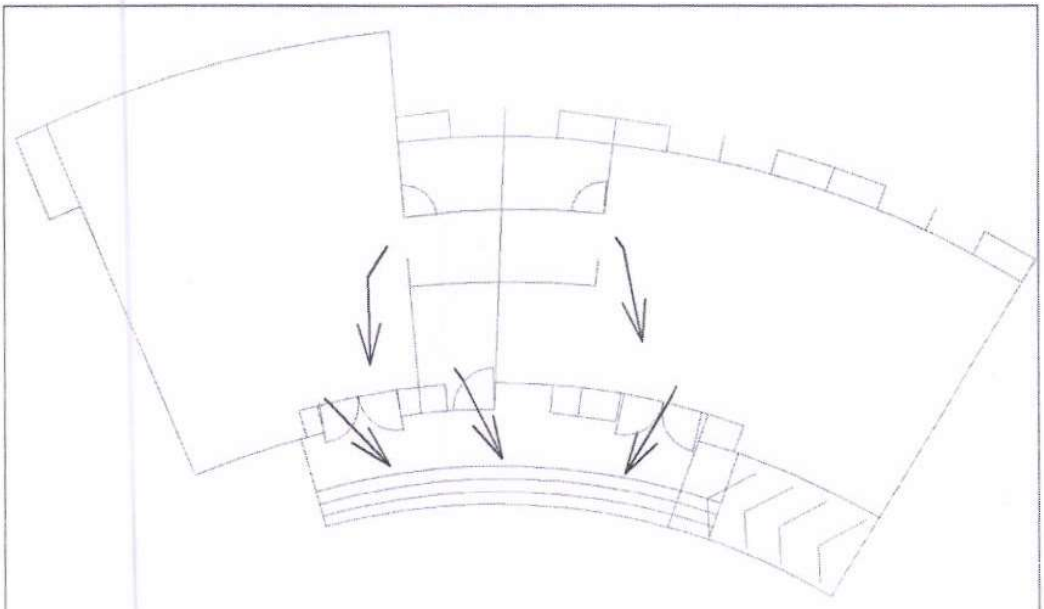

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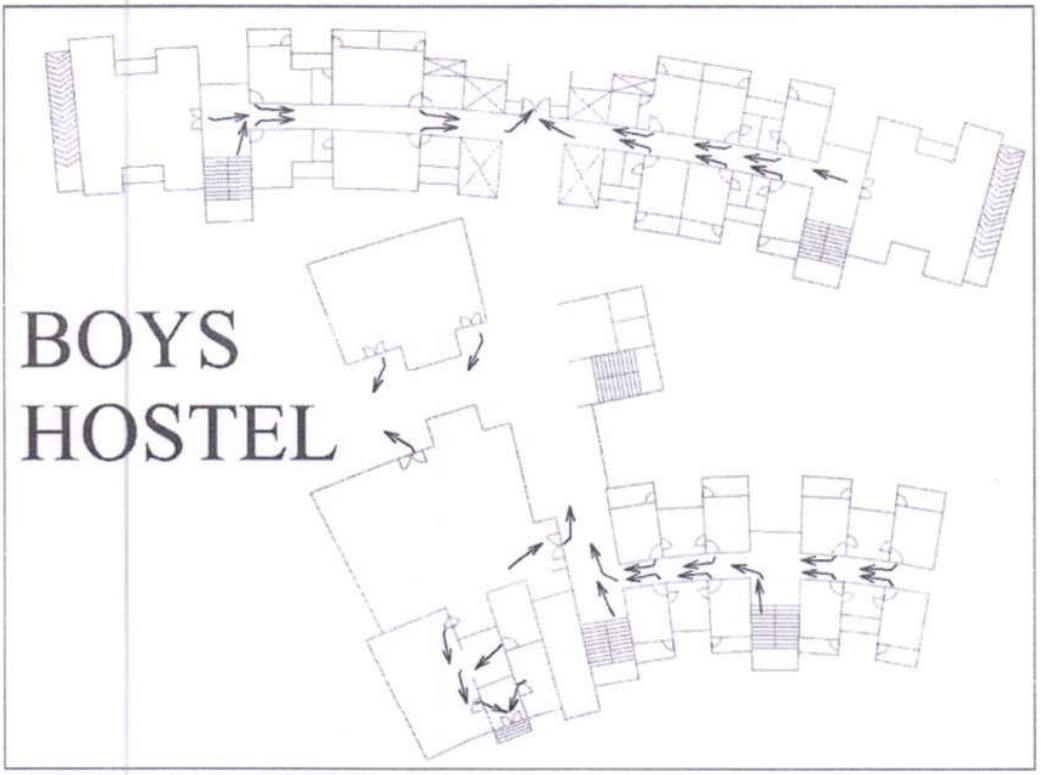

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GIRLS HOSTEL 1

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PUNJAB TECHNICAL UNIVERSITY
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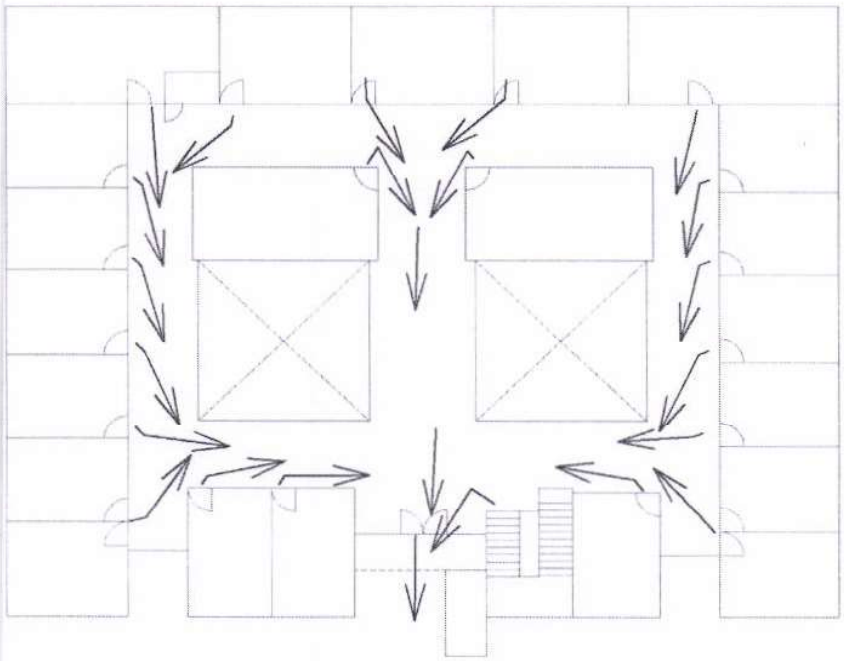

GIRLS HOSTEL 2

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DIRECTOR RESIDENCE

M.P. SINGH
EXECUTIVE ENGINEER
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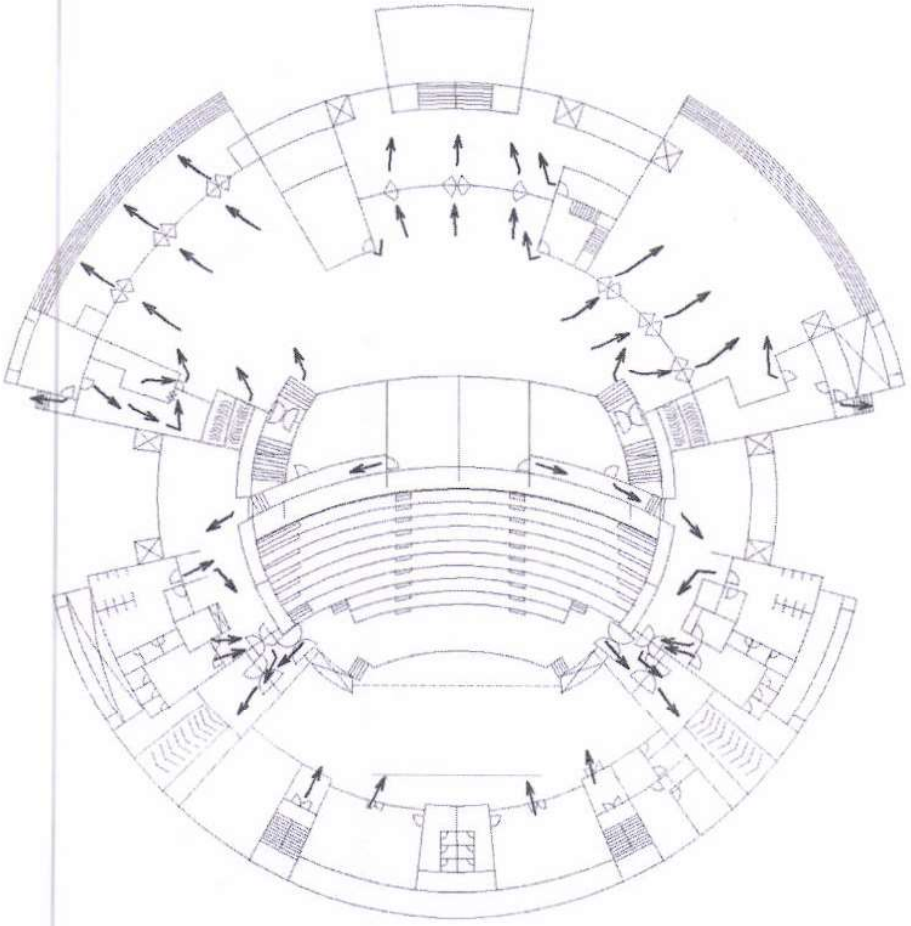

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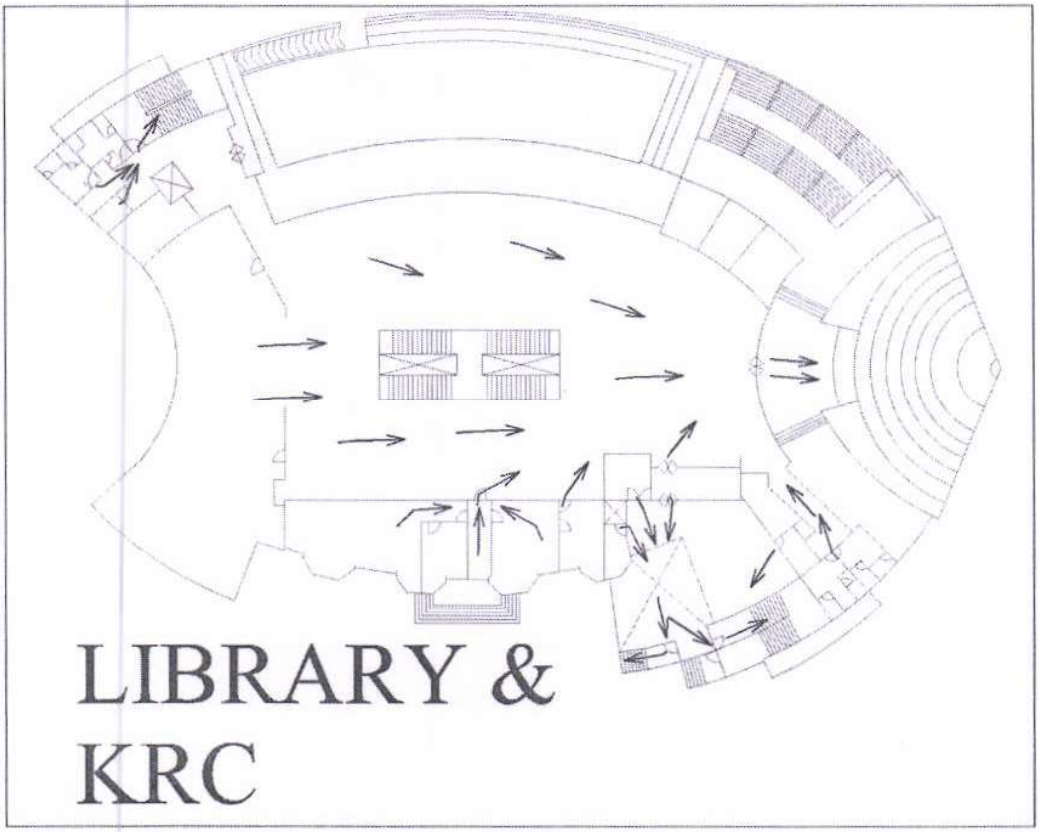

LIBRARY &
KRC

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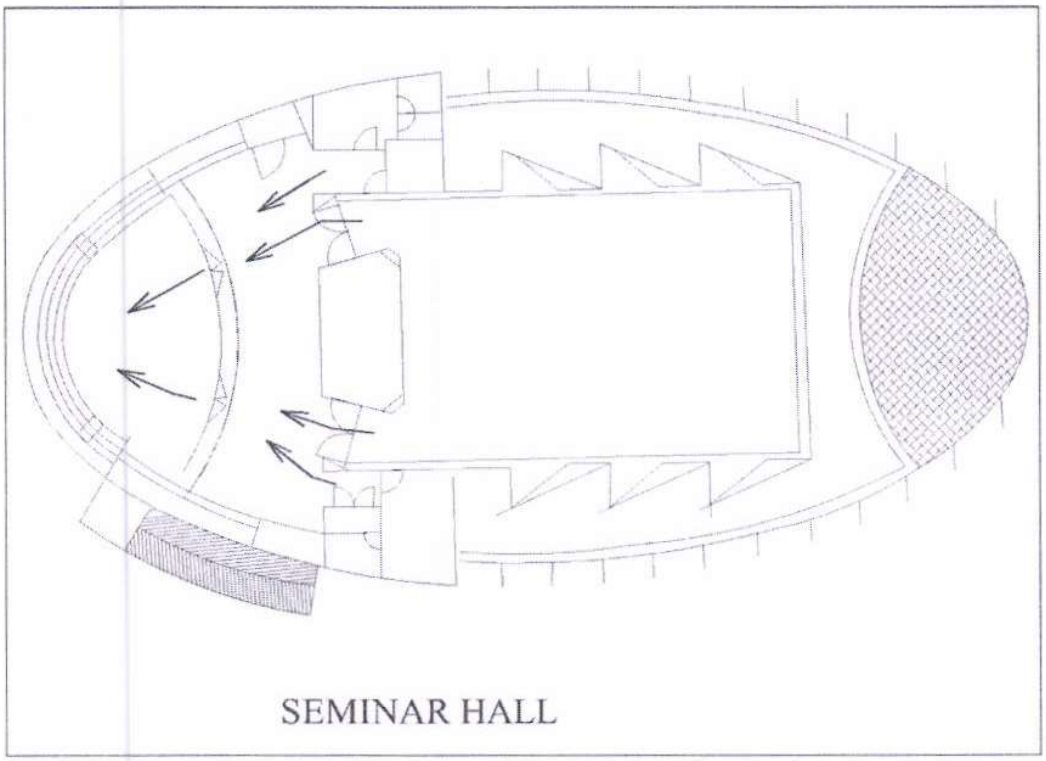
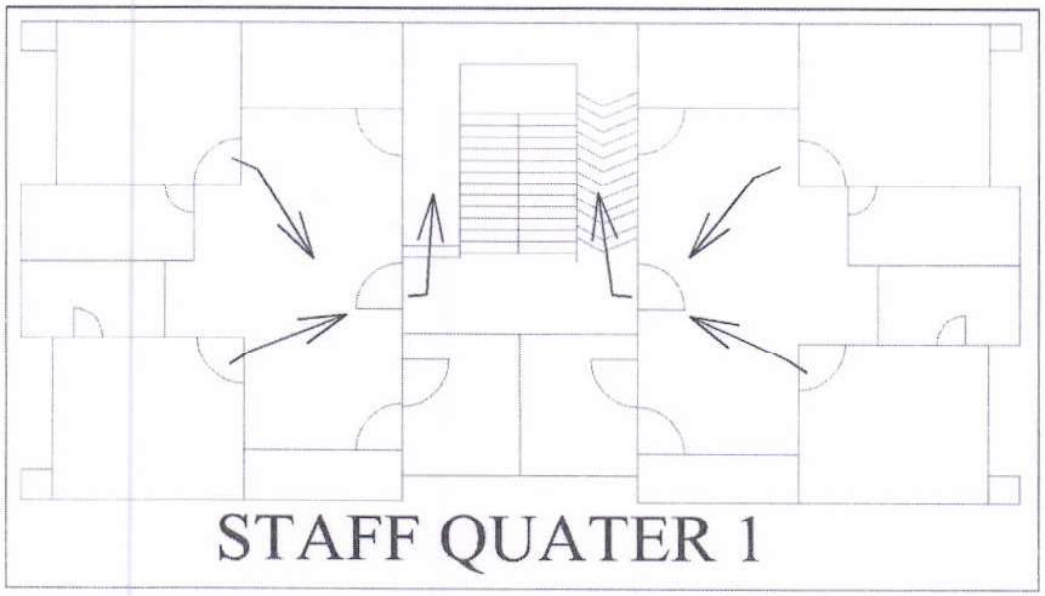


SEMINAR HALL



STAFF QUATER 1

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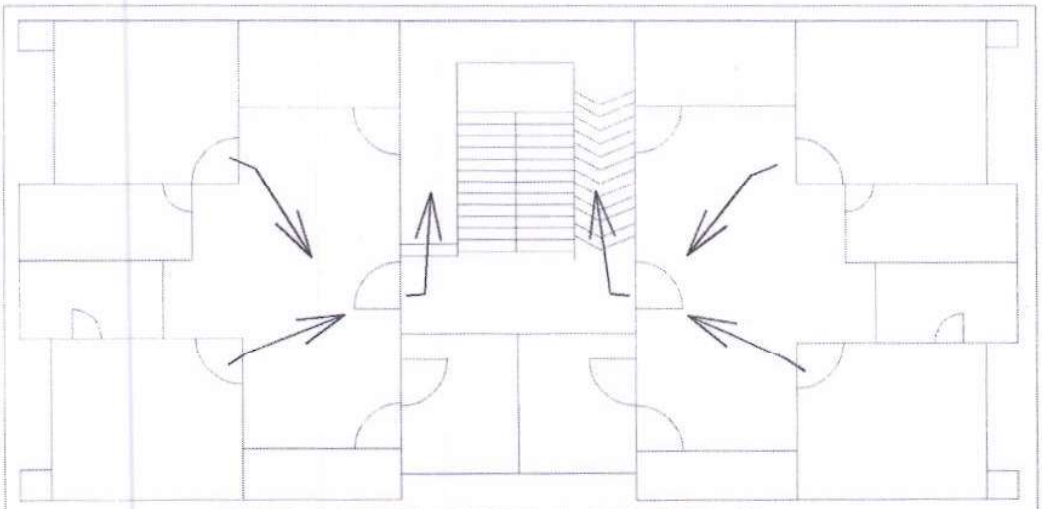

STAFF QUATER 2

ANNEXURE B

DROUGHT RESISTANT SPECIES

Tree species	Common Name	Tree species	Common Name
Prosopis cineraria	Khejri	Azadirachtaindica	Neem
Capparisdeciduas	Kiari , Caperbrush	Diospyrosmelanoxylon	Tendu
Tamarixaphylla		Ougeiniaoojeinensis	
Acacia tortillas		Commiphoracaudata	
Zizyphusnummularia	JungliBer	Bauhinia variegata	Kachnar
Prosopisjuliflora	Kikar	Eucalyptus tereticornis	
Tecomellaundulata	Rugtora/Wavy leafed Tufmella	PongamiaPinnata	Karanj
Colophospermummopane		Casiasiamea	
Salvadoraoleoides		Anacardiumoccidentale	Cashew
Acacia aneura		Holopteliaintegrifolia	
Parkinsonia aculeate		Acacia catechu	Katha
Dichrostachys cineraria		Boswelliaserrata	Lobaw
Acacia holosericea		Buteamonosperma	Palash
Borassusflabellifera	Tar	Cassea fistula	Amaltas
Tree species	**Common Name**	**Tree species**	**Common Name**
Grewiatenax	Falsa	Albiziaamara	
Commiphorawightii	Guggal	Dalbergialatifolia	Eastern Rose wood
Acacia seyal		ErythrinaIndica	Coral Tree
Eucalyptus	Eucalyptus	Ficusbengalensis	Banyan

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Tree species	Common Name	Tree species	Common Name
camaldulensis			
Hardwickiabinnata		Ficusreligiosa	Peepal
Pithecelobiumdulce	Jungle Jalebi	Santalum album	Sandal
Celtisaustralis		Syzgiumcuminii	Clove
Acacia albida		Terminaliaalata	
Albizialebbek	Shirish	Madhucalatifolia	Mahua
Acacia nilotica	Babul	Acacia auriculiformis	
Acacia ferruginea		Terminaliabellirica	Harad
Casuarinaequisetifolia	Jhar	Dendrocalamusstrictus	LathiBaans
Leucaenaleucocephala	Subabul	Moringaoleifera	Drumstick
Meleaazedirach		Terminaliaarjuna	Arjun
Sesbaniagrandiflora			
Tamarindusindica	Imli		
WrightiaTinctoria			
Morusindica/alba	Mulberry		

Source : Manual on norms and standards for EC of large construction projects-MoEF

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ANNEXURE C

EXPENDITURE ON GREEN INITIATIVES AND WASTE MANAGEMENT

Year wise Expenditure

Year	Expenditure on green initiatives and waste management excluding salary component (INR in Lakhs)
2013-14	
2014-15	
2015-16	
2016-17	
2017-18	

Detail breakup of expenditure

S.NO	YEAR	LIGHT	WATER	PLANTS
1	2013-14			
2	2014-15			
3	2015-16			
4	2016-17			
5	2017-18			

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ANNEXURE D

STANDARD FORMAT FOR ENERGY RECORD

1. Standard format for electricity record
Meter No/ IBRS No Location

S.No.	Duration of bill	Reading in Last bill	Reading in this bill	Unit Consumed	Electricity use charges	Fixed charges	Other Charges	Power (P.F.) Factor	Payment details

2. Standard format for LPG record
Connection No.
Location of Use

S.No.	Date of Refill	Supply agency	Amount Payable in this bill	Weight of Cylinder	Date of use	Duration of use	Date and time of empty

Standard format for machine operation

S.No.	Date	Time from	Time till

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ANNEXURE E

CALCULATION FOR PERCENTAGE OF ELECTRICITY CONSUMED FOR LIGHTING

BY LED

Total lighting load

S.No.	LUMINAIRES	Connected load in KW
1	Tube light T5/T8	139
2	CFL	80.6
4	LED (B)	84.1
5	Metal Halide	92
	Total energy consumption **(A)**	395.7
	Total energy consumption by LED	84.1
	Percentage of energy consumption by LED (C/D)x100	**21.25%**

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ANNEXURE F

Electricity consumption from April 2015 to September 2019

Months	MDI	KWH	KVAH	PF	CD In KVA	SL In KW
Sep-19	1460	332708	298200	1.12	3396	3056.84
Aug-19	2080	459931	395160	1.16	3396	3056.84
Jul-19	-	-	-			
Jun-19	1329	260418	263882	0.99	3396	3056.84
May-19	1080	239392	241636	0.99	3396	3056.84
Apr-19	700	138808	139830	0.99	3396	3056.84
Mar-19	661	100066	100428	1.00	3396	3056.84
Feb-19	980	186272	186534	1.00	3396	3056.84
Jan-19	962	235852	236324	1.00	3396	3056.84
Dec-18	916	174178	174524	1.00	3396	3056.84
Nov-18	562	99900	100222	1.00	3396	3056.84
Oct-18	1476	136126	136376	1.00	3396	3056.84
Sep-18	1476	214670	216780	0.99	3396	3056.84
Aug-18	1627	293294	296822	0.99	3396	3056.84
Jul-18	1264	265010	270002	0.98	3396	3056.84
Jun-18	1377	249802	255558	0.98	3396	3056.84

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Months	MDI	KWH	KVAH	PF	CD In KVA	SL In KW
May-18	1249	243638	249620	0.98	3396	3056.84
Apr-18	1056	163470	167794	0.97	3396	3056.84
Mar-18	636	106854	109732	0.97	3396	3056.84
Feb-18	832	151318	152828	0.99	3396	3056.84
Jan-18	1117	213330	217020	0.98	3396	3056.84
Dec-17	779	227960	237594	0.96	3396	3056.84
Nov-17	-	-	-			
Oct-17	1016	144300	147714	0.98	3396	3056.84
Sep-17	1203	404210	415843	0.97	3396	3056.84
Aug-17	-	-	-			
Jul-17	1907	318844	331643	0.96	2000	2000
Jun-17	1337	252295	260709	0.97	2000	2000
May-17	1086	218533	226120	0.97	2000	2000
Apr-17	1061	149885	155781	0.96	2000	2000
Mar-17	299	104912	113442	0.92	2000	2000
Feb-17	753	139915	143152	0.98	2000	2000
Jan-17	738	164064	168203	0.98	2000	2000

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Months	MDI	KWH	KVAH	PF	CD In KVA	SL In KW
Dec-16	691	108339	110515	0.98	2000	2000
Nov-16	229	63431	66089	0.96	2000	2000
Oct-16	891	106792	111347	0.96	2000	2000
Sep-16	931	164686	169064	0.97	2000	2000
Aug-16	891	199593	204407	0.98	2000	2000
Jul-16	1079	140935	143676	0.98	2000	2000
Jun-16	1128	165717	169046	0.98	2000	2000
May-16	810	138630	142485	0.97	2000	2000
Apr-16	625	78768	81198	0.97	2000	2000
Mar-16	162	42563	45174	0.94	2000	2000
Feb-16	613	90102	91963	0.98	2000	2000
Jan-16	640	134238	137931	0.97	2000	2000
Dec-15	640	134238	136931	0.98	2000	2000
Nov-15	615	91765	94127	0.97	2000	2000
Oct-15	567	74477	78732	0.95	2000	2000
Sep-15	868	192689	197078	0.98	2000	2000
Aug-15	836	125220	127280	0.98	2000	2000
Jul-15	884	118320	120320	0.98	2000	2000

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108

Months	MDI	KWH	KVAH	PF	CD In KVA	SL In KW
Jun-15	863	148620	150080	0.99	2000	2000
May-15	596	84520	86480	0.98	2000	2000
Apr-15	-	45940	47520	0.97		
Mar-15						
Feb-15						
Jan-15						

Abbreviations

Abbreviations	Full form		
MDI	Maximum demand (import)	PF	Power factor
KWH	kilo Watt Hour	CD	Contract Demand
KVAH	Kilo Volt Ampere Hours	SL	Sanctioned Load

ANNEXURE G

BACK GROUND CALCULATION FOR CALCULATING CARBON FOOT PRINT

	LPG consumption				
S.No	Description	Numbers	weight of Cylinder in Kg	Months for operations	Total in Kg
1	BOYS HOSTEL	68	19	68	87856
2	GIRLS HOSTEL	16	15	12	2880
		20	12	12	2880
3	canteen	15	19	12	3420
	Total LPG consumption per year				6300

	Calculation for diesel consumption				
S.No	Description	Numbers	Fuel consumption liters/month	Months for operations	Total in liters
	Fuel for bus				
1	Own buses				
a.	42 seater	1	560	12	6720
	560 liter/month				
b	26 seater	2	250	12	6000
	250 liters/month				
	distance 35 km per day				
2	hired buses				
a.	52 seater	4	450	12	21600
	450 liter/month				
	distance 40 per day				
	Private four wheeler approaching University per month (taking 20 working day in a month) with average running 20 km/day fuel efficiency 16 km/liter	100	25	12	30000
	Total diesal consumption per year by vehicle				64320

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~~106~~

DG Set Fuel consumption

S. No	Location	Capacity in KVA	Nos.	Fuel consumption per set lt/hr	Fuel consumed in a month in lt	Months for operations	Total in liters
1	G+7	62.5	1	12	48	12	6912
2	AB 3	82.5	1	14	56	12	9408
3	AB 3	180	1	30	120	12	43200
4	G+7	380	2	55	220	12	145200
5	AB1,AB 2	500	2	80	360	12	345600
	Total diesal consumption per year by DG Set						550320

Note : operation time considering 4 hours a day

Total diesel consumption in liters per year in the campus 614640

	Calculation for Petrol consumption				
S.No	Description	Numbers	Fuel consumption liters/month	Monthes for operations	Total in liters
1	Private four wheeler approaching University per month (taking 20 working day in a month) with average running 20 km/day fuel efficiency 16 km/liter	100	25	12	30000
2	Private Two wheeler approaching University per month (taking 20 working day in a month) with average running 20 km/day fuel efficiency 50 km/liter	125	8	12	12000
	Total diesal consumption per year				42000

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105

Calculation for Public conveyance bus

80% of the above 2708

S.No	number of users	Average distance covered per day	Nos.	Monthes for operations	Total no of users
1	2708	10	20	12	6499200

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104

7.1.6 – 2 Energy Audit Report

Ref: 902.05/11/14

Phone 91-172-2792325,2795001
Fax 91-172-2793143
Website www.pscst.gov.in

Punjab State Council for Science & Technology

A Scientific & Industrial Research Organization approved by DSIR & Central Govt. under Clause (ii) of Sub-Section (I) of Section 35 of Income Tax Act, 1961
(A State Govt. Undertaking)
MGSIPA Complex, Institutional Area, Sector 26, Post Box No. 727, Chandigarh-160 019 (India)

Ref. No : PSCST/ 0/349 Dated 30/10/2014

Registrar,
Punjab Technical University,
Jalandhar-Kapurthala Highway,
Kapurthala

Subject: Energy Audit of PTU's Administrative Building at Kapurthala.

I am grateful to Punjab Technical University (PTU) for awarding the work of carrying out detailed energy audit of its complex at Kapurthala. PSCST has completed the field audit and has recommended 8 energy saving options based on the energy conservation measures (ECM) identified during audit. A summary of annual savings identified is as below:

Short term energy saving proposals (5 nos.)

- Annual Savings with zero investment (2 nos.) : Rs. 8.60 lacs
- Annual Savings with investment of Rs. 2.0 lacs (3 nos.) : Rs. 2.64 lacs

Long term energy saving proposals

- Annual Savings with investment of Rs. 47.55 lacs (3 nos.) : Rs. 20.52 lacs

I am enclosing copy of draft detailed energy audit report for perusal and comments. Further, before finalizing the report, findings & comments can be discussed with implementation team at mutual convenient date & venue, preferably in mid November, 2014.

With regards,

DA: Draft Report

29/10/14
Additional Director

H.P.SINGH
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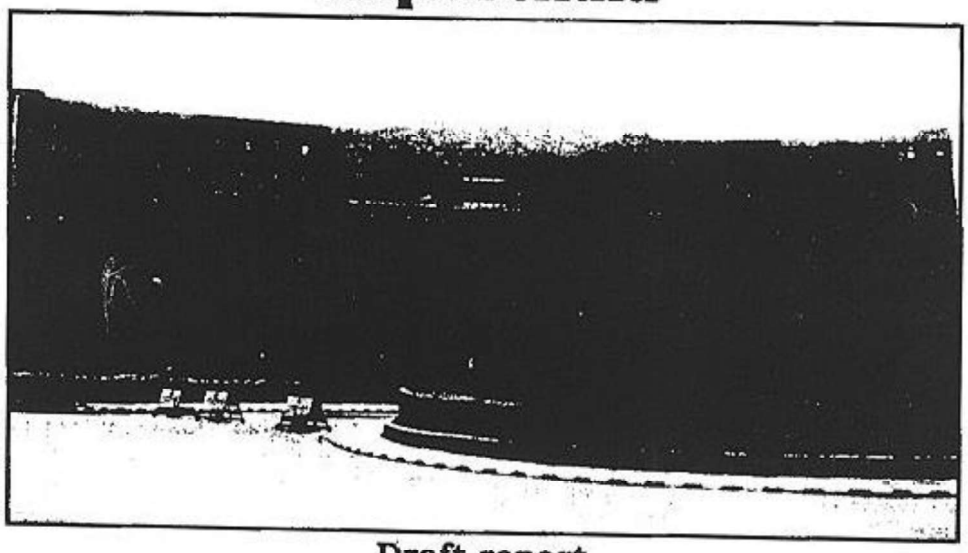
Detailed Energy Audit Report

for

Punjab Technical University Kapurthala



Draft report
October 2014

Punjab State Council for Science & Technology
MGSIPA Complex, Sector 26, Chandigarh-160 019
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INDEX

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JALANDHAR

ACKNOWLEDGEMENT

We express our gratitude to Punjab Technical University (PTU), Kapurthala for giving us an opportunity to undertake the energy audit of their complex. The energy audit is indeed a very important assignment as the electricity tariffs are increasing day by day and the reduction in energy bill has become very important.

During field studies, the management was found to be progressive as it has done very well on energy conservation front by implementing several energy conservation initiatives, such as:

- Maintaining power factor above 0.95
- Good electrical transmission & distribution system
- Separate feeders for inside & outside lights
- Separate floor wise control panel for indoor lights
- Utilization of T8 & CFL light fixtures in indoor lighting
- Energy Conservation by switching ON alternate street lights
- Good insulation practices in HVAC system

We are also thankful to Shri H.P. Singh, Executive Engineer and Shri. Vishal Beri, Estate Officer for coordinating the field visits and providing all possible help during energy audit in the campus. We also express our profound thanks to the officers and staff of Punjab Technical University, especially Sh. P.C. Thakur, AAE; Sh. Pankaj Sharma, Sh. Ram Singh and Sh. Jasbir Singh, technicians for their assistance to the energy audit team.

The PSCST team worked in close collaboration with the team of CII-AVANTHA Centre for carrying out the detail energy audit of the complex. We are especially grateful to Sh. R. Narayanan, Head, CII-AVANTHA Centre for readily agreeing to take up this assignment with us, Sh. Sanjay Namdeo, Senior Counselor for his comments from time to time, and the CII team comprising Sh. Manpreet Singh & Sh. Mohd. Khalid for their active participation.

Additional Director

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ENERGY AUDIT TEAM

S. No.	Name & Designation
1.	Sh. S.K. Jain, *Additional Director, PSCST*
2.	Sh. Pritpal Singh, *Senior Engineer, PSCST*
3.	Sh. Krishan Kant Singla, *Certified Energy Auditor,* *Process Engineer, PSCST*
4.	Sh. Manpreet Singh, *Certified Energy Auditor,* *Counsellor, CII*
5.	Sh. Mohd. Khalid *Engineer, CII*
6.	Ms. Rajeena *Steno Typist, PSCST*

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CHAPTER 1.0
EXECUTIVE SUMMARY

Punjab Technical University (PTU) was established in the Year 1997 under the Punjab Technical University Act, 1996 (Punjab Act No. 1 of 1997) to provide for the establishment and incorporation of a University for the advancement of technical education and development thereof in the State of Punjab and for matters connected therewith. In pursuance of this Act, the University has 494 affiliated colleges. At present, after 15 year of its existence, PTU is providing education to approximately 5 lac students from Punjab and other States in the fields of Engineering, Management, Architecture and Pharmacy.

Punjab Technical University is propelled by the vision and wisdom & is continuously strived to discharge its duties for the overall improvement of quality of education and to make sure that the courses it offers remain relevant to society and useful to students in the globalized work environment.

Punjab Technical University has evinced interest in availing the services of the Punjab State Council for Science and Technology, Chandigarh for conducting a detailed energy audit of their Complex, Kapurthala. The annual power consumption of the PTU Complex during the year 2013 (January to December 2013) was 13.21 lacs kWh and energy bill for this period was Rs. 1.01 crores.

PSCST team carried out the preliminary energy audit on 26.05.2014 & detailed energy audit of their energy intensive equipments from 30.06.2014 to 02.07.2014 jointly with CII-AVANTHA Centre for Competitiveness for SMEs.

1.1 Methodology

1.1.1 Pre-audit Visit

A preliminary visit of Punjab Technical University Complex was made for finalizing the audit schedule and discussions were held with senior management. A walk-through audit was also conducted so as to familiarize with institution activities and to get first hand information like building layout, energy consumption data, electrical distribution system, specifications of the energy intensive equipments & existing instrumentation. The requisite information for all energy intensive equipments installed in their campus was supplied by Punjab Technical University Complex management on the questionnaire provided by PSCST. The data was analyzed & it was observed

98

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that the total connected load of the equipments installed is 3300kW, with its distribution as under:

Table-1.1: Total Load of equipments installed at PTU

Area	Load (kW)	Load (% age)
HVAC (Chillers 4nos,Primary Pumps 4 nos., Secondary pumps 3 nos. & fresh air fans 18 nos.,AHUs 41 nos.,CDS pumps)	1240	52%
Split/Window AC (30 nos of ACs)	94.50	4%
Hot water generator	400	17%
Lighting	178	7.5%
Pumping, Plumbing And Fire Fighting pumps (Submersible pump 1 no, Sump pumps 3 nos., fire pump 1 no., terrace pump 1 no., fountain pumps 2nos., jocky pumps 1 no & STP pumps)	160	6.7%
Fans / Water coolers	75	3.0%
General Load (Dispenser, Oven, Heater, Computer, projector)	210	9%
Lifts (4 nos.)	23.12	0.8%
Total	**2380**	**100%**

1.1.2 Detailed Energy Audit

Detailed energy audit of various equipments installed in the PTU Complex was carried out by using various digital energy audit instruments such as Three Phase power analyzer, ultrasonic flow meter, pressure gauge, lux meter, distance meter, multimeter, power clamp meter, hygro-thermometer. During the detailed study, the following observations were made:

Power Distribution System

- Two 1000kVA transformers are being operated throughout the year, as working load during day time in summers is 670-740 kW. However, the average running load during night time throughout the year is only 30-50kW.
- The average annual Power Factor (PF) during the period January 2013 to December 2013 was 0.96. Average Power Factor at substation during day time & night time was observed to be 0.98-0.99.
- Automatic Power Factor Control (APFC) panel of 350 kVAR each has been installed on the two 1000kVA transformers to maintain the power factor. The capacitor banks were working efficiently.

Heating, Ventilation & Air-conditioning (HVAC) System

- No control system to regulate the flow of chilled water to HVACs in the isolated/unoccupied areas.
- The specific power consumption of air cooled screw chiller plant was 1.46 kW/TR. Whereas, water cooled screw chillers have specific power consumption of 0.7 to 0.8 kW/TR.
- The available head of return water from AHUs, at inlet of chiller plant is 2.9 kg/cm^2 which is sufficient for the operation in chilling plant & at times may not require primary water pumps.
- Low temperature (20-24^{0}C) maintained in the centrally air conditioned areas. No automated sensor based system to maintain the inside temperature.

Lighting

- Operation of the indoor lights during night time even when there is no occupancy.
- Use of T8 fixtures for indoor lighting

1.1.3 Analysis & Report Preparation

The data collected during these field studies was analyzed for identifying the scope of energy conservation. The Cost Benefit Analysis with regards to recommended Energy Conservation Measures (ECM) was prepared for calculating the payback period.

The report has been prepared considering the minimum number of hours of operation of following equipments in consultation with the concerned staff/ officers.

Table-1.2: No. of Operating Hours of Various Equipments

Equipment/ Location	No of hours/day/ equipment	Total no. of hours/ year / equipment
• Transformers	24 hrs/d	8760
• HVAC		
○ Chillers	10 hrs/d	1250
○ Chilled water pump	10 hrs/d	1250
○ Condenser water pumps	10 hrs/d	1250
• Indoor lights	10-20 hrs/d	3000-6000
• Street light	10hrs/d	3650
• Submersible pumps	6-12 hrs/d	1800-3600

1.1.4 Recommendations

Based on the energy conservation measures identified, the cost benefit analysis like simple payback period of all the ECMs has been calculated. It has been observed that there is a annual energy saving potential of

4,02,604 kWh amounting to Rs.30.92 lacs besides power factor incentive of Rs.0.84 Lacs. Thus, there is total annual saving potential of Rs.31.76 Lacs with an investment of Rs.49.55 lacs. The simple pay-back period of the investment is only 1.6 years. The investment cost has been prepared while taking into account the prevailing market rates.

The recommendations which have early payback period are termed as short term measures and recommendations which have long payback period are termed as long term measures. It is proposed that the energy conservation measures requiring no investment should be implemented immediately and the remaining ECMs are proposed to be implemented in two phases as short term measures and long term measures.

Short Term Measures:

The following ECMs can lead to saving of Rs. 8.60 lacs with zero investment.

- Optimize operation of transformers.
- Optimize the contract demand power supply from PSPCL.

Further, the following ECMs are recommended to be implemented in the first phase which has a saving potential of Rs. 2.64 lacs per annum with an investment of Rs. 2.0 lacs having simple payback period as 9 months.

- Improve overall power factor of complex to unity.
- Modify chilled water circulation system & eliminate the use of primary pumps.
- Optimize power consumption of lighting by automation.

Long Term Measures:

The following ECMs are recommended to be implemented in the second phase which has a saving potential of Rs. 20.52 lacs per annum with an investment of Rs. 47.55 lacs having simple payback period as 28 months.

- Replace existing air cooled screw chiller with water cooled screw chiller.
- Replace 36 W fluorescent tube lights with 18 W LED tube lights.
- Replace 18 W fluorescent tube lights with 9 W LED tube lights.
- Replace 150 W HPSV Street Lights With 60 W LED Street Light.
- Replace 70 W HPSV Street Lights With 30 W LED Street Light

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1.1.5 Summary of annual savings identified

Short Term Energy Saving Proposals

Annual Savings with zero Investment *(2 Proposals)*	:	Rs. 8.60 Lacs
Annual Savings with Investment of Rs.2.00 Lacs *(3 Proposals)*	:	Rs. 2.64 Lacs

Long Term Energy Saving Proposals

Annual Savings with Investment of Rs.47.55 Lacs *(3 proposals)*	:	Rs. 20.52 Lacs
Total annual savings with investment of Rs.49.55 Lacs. ***(8 Proposals)***	:	**Rs.31.76 Lacs**
Average payback period for capital proposals	:	1.6 years

Each Energy Conservation Idea should be seen as an opportunity for improvement. The management of PTU Complex should have a firm commitment so that the complex:

- Achieves energy conservation on a time bound basis.
- Make energy conservation a permanent activity.
- Achieve lowest auxiliary energy consumption.
- Implement the recommended proposals and reap the benefit.
- Achieve the status of best energy efficient complex in India.

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List of Energy Saving Proposals at Punjab Technical University, Kapurthala

Sr. No.	Energy saving proposals	Annual Savings (Rs. in Lacs)	Invest. Required (Rs. in Lacs)	Simple Payback (Months)
1	Optimize operation of transformers	0.56	-	-
2	Optimize the contract demand power supply from PSPCL	8.04	-	-
3	Improve overall power factor of complex to unity	0.84	0.50	7
4	Replace existing air cooled screw chillers with water cooled screw chiller.	11.52	25	25
5	Modify chilled water circulation system and eliminate use of primary pumps.	0.80	0.50	8
6	Replace 36 watts & 18 watts fluorescent tube lights with 18 watts & 9 watts LED tube lights	5.32	12.55	28
7	Replace 150W HPSV street lights with 60 watts LED & 70W HPSV with 30W LED street lights.	3.68	10.0	12
8	Optimize power consumption of lighting by automation	1.0	1.0	12
	Observations			
1	Optimize power consumption of lighting by switching off indoor lights in night.			
2	Install Roof top Solar Photovoltaic system			
	Total	**31.76**	**49.55**	**19**

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CHAPTER 2.0
INTRODUCTION

Punjab Technical University (PTU) was established in the Year 1997 under the Punjab Technical University Act, 1996 (Punjab Act No. 1 of 1997) to provide for the establishment and incorporation of a University for the advancement of technical education and development thereof in the State of Punjab and for matters connected therewith. In pursuance of this Act, the University has 494 affiliated colleges. At present, after 15 year of its existence, PTU is providing education to approximately 5 lac students from Punjab & other States in the fields of Engineering, Management, Architecture and Pharmacy.

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Punjab Technical University has evinced interest in availing the services of the Punjab State Council for Science and Technology, Chandigarh for conducting a detailed energy audit of their Complex, Kapurthala.

Preliminary visit of PTU Complex was carried out on 26.05.2014 and discussions were held with the senior management. A walk through audit of the campus was also conducted so as to familiarize with the institution activity, obtain first hand information like building layout, energy consumption data, electrical distribution system, identification of energy intensive equipments and existing instrumentation. The information w.r.t. all energy intensive equipments installed in the campus was supplied by PTU on the questionnaire provided by PSCST. The detailed energy audit of PTU Complex was carried out from 30.06.2014 to 02.07.2014 to study the existing energy consumption pattern and identify energy conservation measures.

The contents of this report are based on the actual data provided by the PTU officials and measurements carried out by PSCST and CII energy audit team.

The management was found to be progressive as it has done very well on energy conservation front by implementing several energy conservation initiatives such as:

- Maintaining power factor above 0.95
- Good electrical transmission & distribution system

H.P. SINGH
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- Separate feeders for inside & outside lights
- Separate floor wise control panel for indoor lights
- Utilization of T8 & CFL light fixtures in indoor lighting
- Switching ON alternate lights in street lighting
- Good insulation practices in HVAC system

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CHAPTER 3.0
GENERAL & TECHNICAL ASPECTS

3.1 General/ Administrative

Table-3.1: General Aspects

Parameter	Description
Name of the Institution	Punjab Technical University, Kapurthala
Land area and year of construction	74 acres, 2008
Total Built up area (Sq. m) approx.	24,749
Total number of employees in the office	610
Occupancy information *(5 days a week, daily 9.00 AM to 5 PM)*	60,000 visitor/ Annum
Power Tariff :	
• Energy Charges	Rs.7.68 per kWh *However, basic tariff rate excluding PF incentive, ED and rentals works out to Rs. 6.39 per kWh*
• Minimum charges (monthly)`	Rs.5.98 Lacs
• P.F Penalty/Rebate	Yes, applicable
Status of Bill Payments on time/Delay in Bill Payments, percentage paid	On Time

3.2 Detail of Visitors

Punjab Technical University remains open for 5 days (except Saturday, Sunday and Public Holidays) in a week. As such it remains open for around 270-280 days in a year. As per the data provided by the management, approximately, 60,000 persons visit the University Complex during the period January, 2013-December 2013.

The technical data is provided in table-3.2 below:

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Table-3.2: Technical Aspect

S.No.	Item		Description
1.	Source of Supply		Punjab State Power Corporation Ltd.
2.	Voltage Level of Incoming Supply		11 kV-HT line
3.	a)	Main Transformer	1000 kVA – 02 No.
4.	Break up of all major loads		Details at Table 4.3
5.	Power Requirement of the plant: *(Based on Monthly Energy bill period Jan 2013- Dec2013)*		
	a)	Connected Load	2380 kW
	b)	Contract Demand	2000 kVA
	c)	Maximum Demand	998 kVA
	d)	Average power factor	0.95 to unity
	e)	Annual electricity bill	Rs 1.01 Crore *(Approx.)*
	f)	Annual electricity consumption- table-4.2	13.19 Lacs kWh
6.	Other Sources of Power Supply		
	• Installed DG capacity		2 No. - 380 kVA each 1 No. – 62.5 kVA
	• Total electricity generated from DG		Only during power break-down
7.	LT Capacitor Bank Details *(Installed in substations or load centre with APFC)*		350 kVAR Capacitor Bank *(25 kVAR- 6 nos. & 50 kVAR- 4 nos. for each transformer)*
9.	Major Equipments/Main motors		• Transformers • HVAC Plant • AHU's • Hot Water Generator • Pumps • DG Sets • Lighting • Lifts
9.	Load distribution pattern		

Equipment	No.	Load(kW)
HVAC Plant	4	1240
Split & Window AC	30	94.5
Hot Water Generator	1	400
Lighting	3262	178
Pumps/motors		160
Fans Water Coolers	825 22	75
General Load	-	210
Lifts	4	23.126
Total		**2380**

89

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CHAPTER 4.0
ENERGY CONSUMPTION PATTERN

4.1 Energy Use Pattern

Punjab Technical University complex receives power from Punjab State Power Corporation Limited (PSPCL) at 11 kV voltage level. D.G. sets are used only during power failure/ break-down. The energy consumption is recorded from the main meter installed on the HT site of 11 kV grid and through the monthly bills. The parameters like energy consumption during day and night, monitoring the energy consumption in different areas, power factor and maximum demand etc. were studied.

The Specific Energy Consumption based on covered area (kWh/sq.ft.) and average occupancy (kWh/person) has been calculated on the basis of data supplied by the organization for the period January 2013- December 2013.

Table-4.1: Specific Energy Consumption (SEC) at PTU Complex

Yearly Data *(Jan 2013- Dec 2013)*	Quantity	Unit	Energy Consumption (in *Lac kcal)*	Av. worked out Unit Cost (Rs.)	Total Cost *(Rs in Lacs)*	SEC based on covered area *(kWh/ Sq.ft./Year)*	SEC based on occupancy (kWh/ *Person)*
Annual Electricity Consumption	1,319,638	kWh	1,134	7.68	101	4.98	6.2
Annual Diesel Consumption	5,000	Litres	45	60	3.0		
Covered area of Building	264,638	Sq.ft.					
Average Occupancy /annum	60,000	Persons					

4.2 Electrical Energy Consumption Pattern

Total electrical energy consumption pattern and energy charges based on the monthly bills of last 12 months is given in the **Table-4.2.** The variation in the Energy Consumption is attributed mainly due to the seasonal variation. The Power consumption goes up in the peak summer & peak winter seasons due to the additional load of HVACs system in summers and utilization of hot water generator in winters.

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Table-4.2: Monthly Energy Consumption Pattern

Month & Year *(As per bill cycle)*	MDI *(kVA)*	Total Energy *(kWh)*	Total Energy Bill *(Rs.)*	Actual Power Factor
Jan-13	633.34	162504	10,31,126	Unity
Feb-13	626.80	151088	9,66,350	0.99
Mar-13	597.32	55904	5,69,879	Unity
Apr-13	461.62	34928	5,92,710	Unity
May-13	998.24	100824	7,06,796	0.96
june-13	973.42	133424	9,85,030	0.96
july-13	952.90	155956	11,78,309	0.95
Aug-13	931.82	149812	10,55,090	0.94
Sep-13	931.7	143290	10,11,740	0.93
Oct-13	828.18	111042	7,88,680	0.94
Nov-13	509.94	54830	6,12,624	0.97
Dec-13	613.98	66036	6,41,960	Unity
		1319638	**1,01,40,294**	**0.96 (Average)**

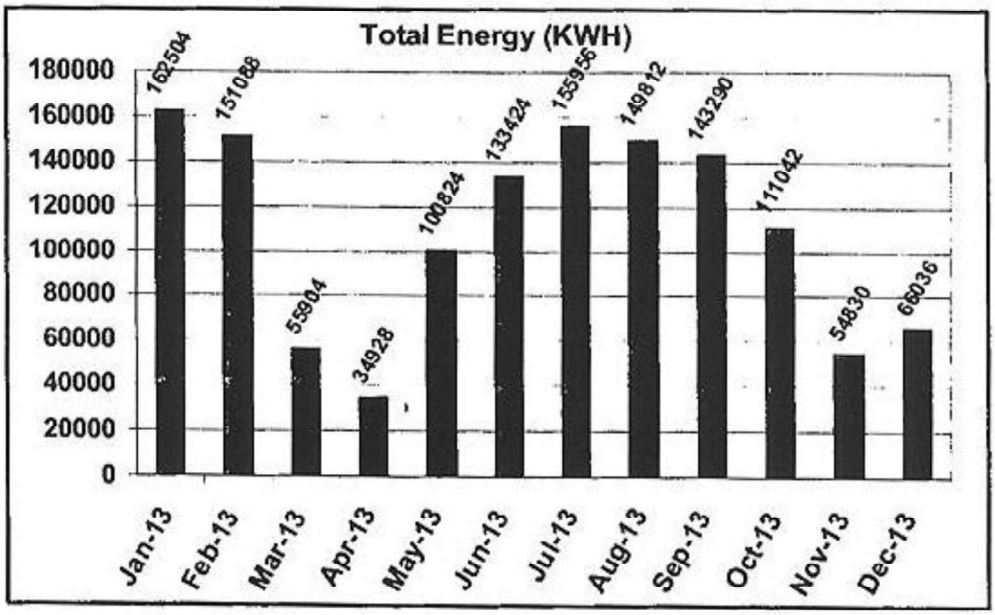

Figure-4.1: Energy Consumption Pattern (May 2013- April 2014)

From the above, maximum energy consumption has been observed during the winter months of January & February *(1.5 lac to 1.62 lac kWh)* whereas, Maximum Demand Index (MDI) during this period was only 626 to 633 kVA. The MDI during summer months *(May to September)* ranged between 930-1000 kVA with energy consumption ranging between 1.0 lac to 1.43 lac kWh. Minimum monthly charges has been levied during the months March – April & November – April due to low MDI & energy consumption.

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While auditing, power consumption during working hours ranged between 670-740 kW whereas, power consumption during non-working hours was only 30-50 kW. The connected load of outdoor lighting during non-working hours was only 18 kW.

4.3 Connected Load Details

Table-4.3: Connected load Details at Punjab Technical University Complex

Area	Load (kW)	Load (% age)
HVAC *(Chillers 4nos, Primary Pumps 4 nos., Secondary pumps 3 nos. & fresh air fans 18 nos., AHUs 41 nos., CDS pumps)*	1240	52%
Split/Window AC *(30 nos of ACs)*	94.50	4%
Hot water generator	400	17%
Lighting	178	7.5%
Pumping, Plumbing And Fire Fighting pumps *(Submersible pump 1 nos, Sump pumps 3 nos., fire pump 1 nos., terrace pump 1 nos., fountain pumps 2nos., jockey pumps 1 nos, STP pumps)*	160	6.7%
Fans / Water coolers	75	3.0%
General Load *(Dispenser, Oven, Heater, Computer, projector)*	210	9%
Lifts *(4 nos.)*	23.12	0.8%
Total	**2380**	**100%**

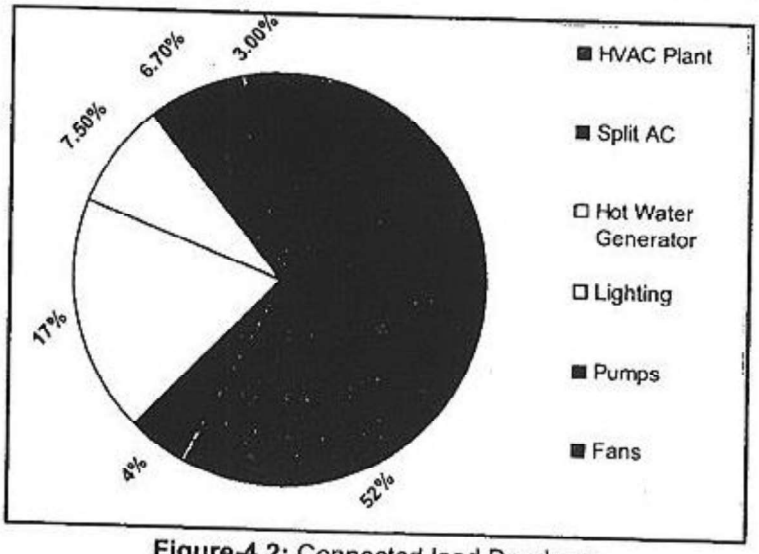

Figure-4.2: Connected load Break-up

It is evident from the above that 73% of the total connected load is for HVAC & heating ventilation system only and HVAC/heating plant is used, depending on the season (summer or winter). Whereas, remaining 27%

connected load is for pumps, lighting system and other auxiliary load. It was also noticed that the actual electricity load is less than the total connected load as the MDI varied between 509 to 1000 kVA against the sanctioned contract demand of 2000 kVA. Therefore, the sanctioned load can be optimised/ reduced so as to avoid monthly minimum charges.

4.4 Electrical power Distribution System:

Punjab Technical University Complex receives power from PSPCL at 11 kV and steps down to 400 V through 1000 kVA Transformer, which is supplied to the main complex.

The design specifications of transformers are given in Table-4.4 below:

Table-4.4: Design Data for 11/0.4 kV Transformers

Sr. No.	Description	Transformer 1	Transformer 2,
1	Make	VOLTAMP	VOLTAMP
2	Type	ONAN	ONAN
3	Rating (kVA)	1000	1000
4	Primary Voltage (kV)	11	11
5	Primary Current (Amps)	52.49	52.49
6	Secondary Voltage (kV)	0.400	0.400
7	Secondary Current (A)	1443.38	1443.38
8	OLTC (With/Without)	WITH	WITH
9	Rated No Load Loss (kW)	1.2	1.2
10	Rated copper loss (kW)	12	12

4.4.1 Loading Pattern of Transformers

The log of power data for 2 transformers was noted using portable instrument on HT/LT side of the transformer. The logging for each of the transformer was made to ascertain the actual load variation on the transformer. During the study period, the maximum load, average load and minimum load registered on each of the transformer are presented in Table-4.5 & Figures-4.3 to Figure-4.5 below.

As informed by the management, two transformers of 1000 kVA each operate throughout the year. During audit, the average loading on the transformers was found to be low. During day time, operating load on transformer no.1 & transformer no.2 varied between 240-290 kW and 430-450 kW respectively. Energy consumption during the night hours was in the range

of 30-50 kW, which is 3-5% of the total connected load. The voltage range during the night was 380-420 volts.

Table-4.5: Load Distribution on all Transformers

Sl. No.	Transformer no.	Maximum load (kVA)	Minimum load (kVA)	Average load (kVA)	Percentage loading (%)
	During working hrs				
1	Transformer 1	290	240	265	24– 29 %
2	Transformer 2	450	430	440	43-45%
	During non working hrs.				
3.	Transformer 1	50	30	40	3-5%

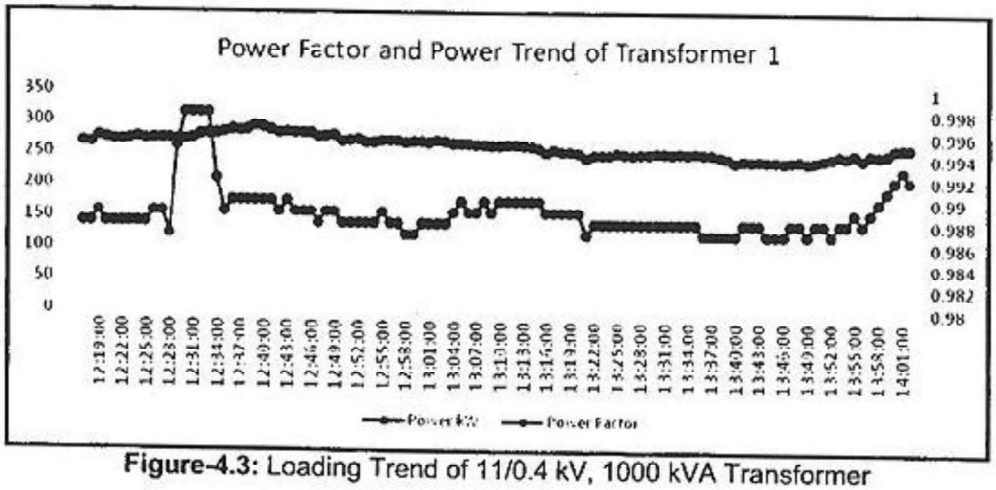

Figure-4.3: Loading Trend of 11/0.4 kV, 1000 kVA Transformer

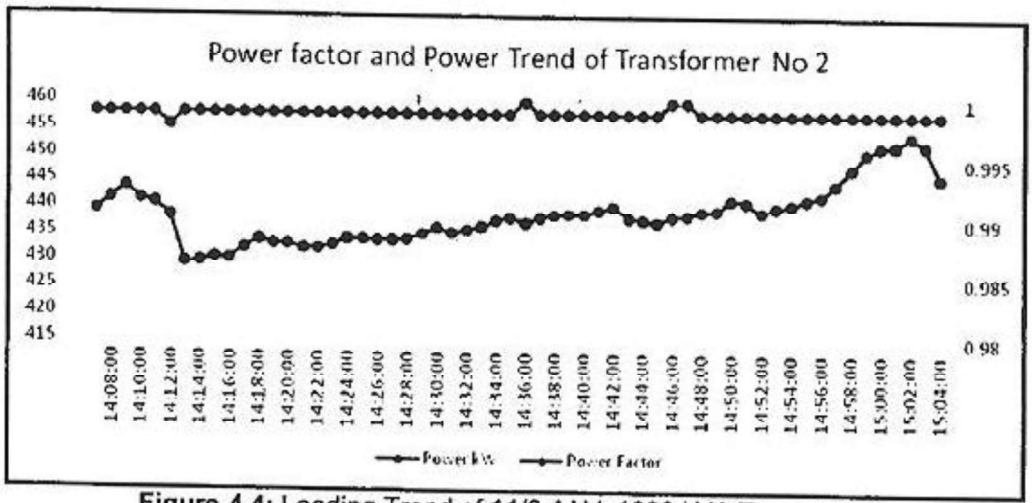

Figure-4.4: Loading Trend of 11/0.4 kV, 1000 kVA Transformer

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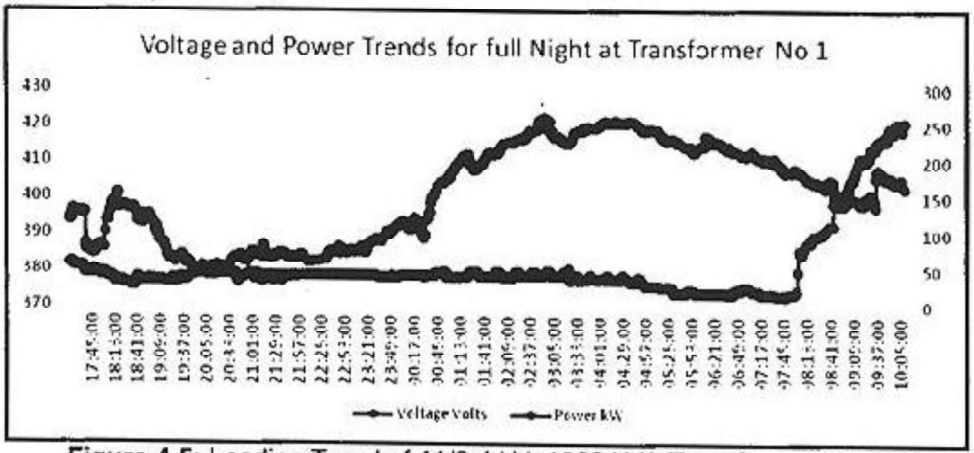

Figure-4.5: Loading Trend of 11/0.4 kV, 1000 kVA Transformer (Night time)

4.4.2 Harmonic Distortion:

The devices like motors with drives, computers, UPS, Air Conditioners, fax machines, photocopies, printer etc. are extensively being used in the complex. All these devices draw non sinusoidal currents and cause distortion in voltage and current waveforms leading to harmonics. Harmonics occurs as spikes at intervals which are multiples of the main frequency and these distort the pure sine wave form of the supply voltage and current. These can be measured with the help of advanced electrical measuring instruments.

Many problems can arise from harmonic current in a power system. These include overheating of neutral conductors, motors, transformers, switch gears, voltage drop, low power factor, reduced capacities, capacitor failures, circuit breaker, tripping with no apparent reason etc. These problem leads to increased electricity bills besides being operational and maintenance concerns.

The harmonic trends at main incomer, LT side of transformer no.1 & 2 was checked by using digital power analyzer. Total harmonic distortion (THD) in voltage at HT side of transformer was observed to be in the range of 1-2% and current harmonic distortion was observed to be in the range of 3-10% as shown in figure-4.6 below:

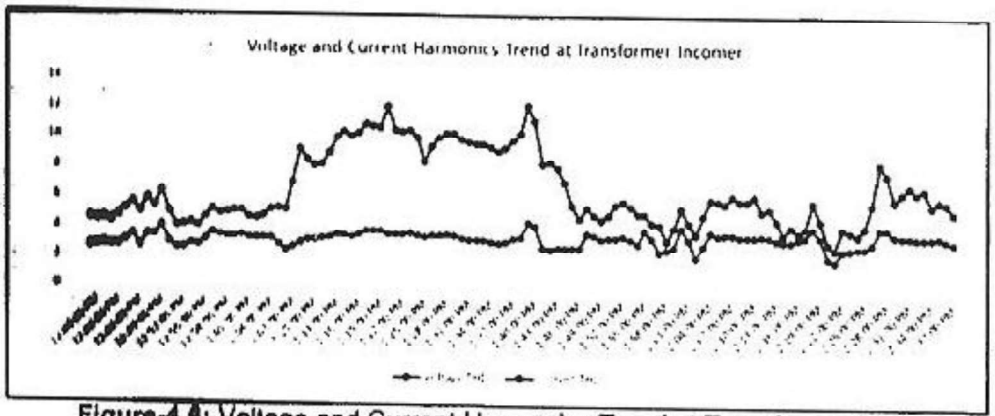

Figure-4.6: Voltage and Current Harmonics Trend at Transformer Incomer

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The total voltage harmonics at LT site of 11 KVA transformer no. 1 was observed to be in the range of 1.5 to 2.0% and current harmonics were in the range of 5.5 to 7.0%. Similarly, the voltage harmonics on LT side of transformer no. 2 was 0.6-0.8% and the current harmonics was observed to be in the range of 1.2-1.8% as shown in figure-4.7 & figure-4.8 below. These observations are well within the permissible range of 3-5% for voltage and upto 10% for current harmonics.

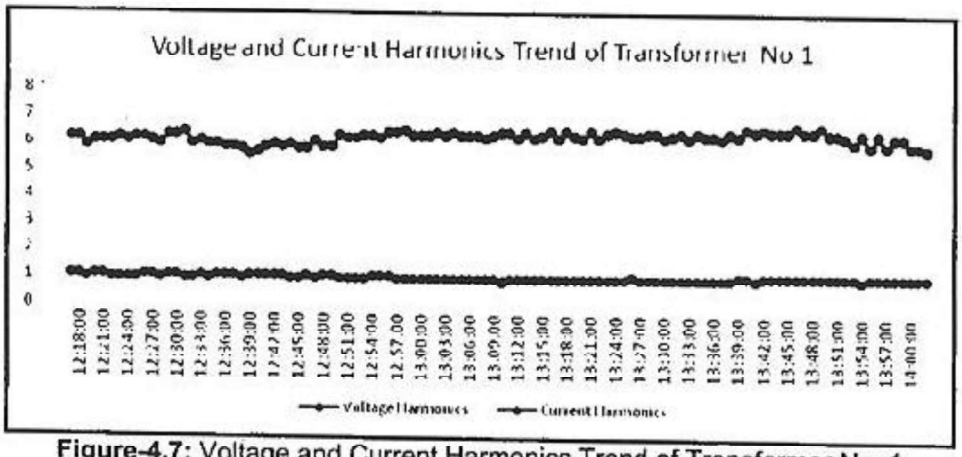

Figure-4.7: Voltage and Current Harmonics Trend of Transformer No. 1

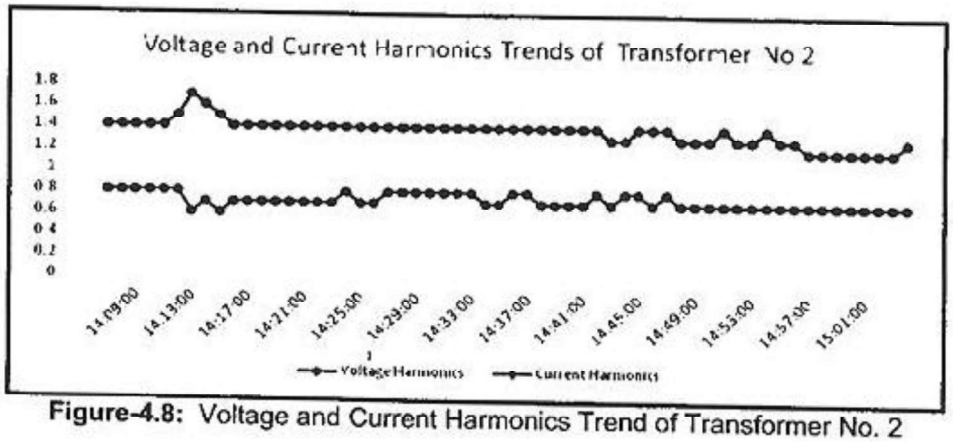

Figure-4.8: Voltage and Current Harmonics Trend of Transformer No. 2

4.5 Recommendations

1. Operate only one 1000 kVA transformer during night time (6 PM to 7AM) throughout the year.
2. Operate only one 1000 KVA transformer during the holidays.

4.6 Benefits

The annual saving potential is **Rs. 0.56 Lacs**, which requires no investment. Details are given in Energy Saving Proposal-1.

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ENERGY SAVING PROPOSAL No. 1

Optimise operation of transformers

As observed during the audit, the average loading on transformers is very less. During day time, it varies between 25-45% whereas, during night time, it is less than 10%.

Existing Scenario

- 2 Nos of 1000 kVA transformers operate throughout the year
- Average loading of complex in May to October = 900 kW
- Average loading of complex in November to April = 550 kW
- Average Loading of complex during night time = 30-50 kW

A. Recommendations

1. *Operate only one 1000 kVA transformer during Night Hours (6 PM to 7 AM) throughout the year*
2. *Operate only one 1000 KVA transformer during the holidays*

Existing Scenario:

- Two Transformers (1000 kVA) are operated
- Actual total effective load is 50 kW
- % load to the individual transformers is 2% & 3%
- Losses
  - ❑ Iron loss = 1.2* kW
  - ❑ FL. Copper losses = 12* kW

  *Standard losses of transformer

Losses calculation:

- When both transformers are in operation : 2.41 kW
  [(1.2) + 12 x (0.02) ^{2}] + [(1.2) + 12 x (0.03)^2]
- When one transformer in operation : 1.24 kW
  (1.2) + 12 x (0.05) ^{2}
- Saving potential in kW : 1.17 kW
  (2.41 kW – 1.24 kW)
- Annual Savings on working days : **0.30 Lacs**
  1.17 x 13 hrs/day x 20 days/month x 12 months x Rs.7.68/unit
- Annual Savings during non working days : **0.26 Lacs**
  1.17 x 24 hrs/day x 120 days/annum x Rs. 7.68/unit

B. Savings:

Annual Savings (0.30+0.26) : **0.56 Lacs**

Investment : **Nil**

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ENERGY SAVING PROPOSAL No. 2

Optimize the contract demand power supply from PSPCL

As analyzed from the electricity bills of the complex, the Maximum Demand Index (MDI) is very less compared to contract demand.

Existing Scenario

- Contract Demand of the Complex = 2000 kVA
- MDI of Jan,2013 - Dec,2014 = 998 kVA
- Minimum monthly charges based on contract demand = Rs. 5,98,000
- PTU paid the energy bills of March, April, November & December 2013 on minimum monthly charges (MMC) bases.

Table-4.6: Monthly Energy Consumption Pattern

Month & Year *(As per bill cycle)*	MDI	kVAh	Total Energy *(kWh)*	Total Energy Bill *(Rs.)*	Actual Power *(Rs./ kWh)* factor	
Jan-13	633.34	163198	162504	10,31,126	Unity	6.34
Feb-13	626.80	151904	151088	9,66,350	0.99	6.39
Mar-13	597.32	56082	55904	5,69,879	Unity	10.19
Apr-13	461.62	34992	34928	5,92,710	Unity	16.96
May-13	998.24	104564	100824	7,06,796	0.96	7.0
June-13	973.42	138320	133424	9,85,030	0.96	7.38
July-13	952.90	163650	155956	11,78,309	0.95	7.55
Aug-13	931.82	149134	149812	10,55,090	0.94	7.04
Sep-14	931.7	153990	143290	10,11,740	0.93	7.06
Oct-14	828.18	118034	111042	7,88,680	0.94	7.10
Nov-14	509.94	56418	54830	6,12,624	0.97	11.17
Dec-14	613.98	66298	66036	6,41,960	Unity	9.72
		1356584	1319638	1,01,40,294	0.96 (Average)	

PTU management has got approval of contract demand of 2000 kVA based on the connected load is around 1950 kW, which includes, the load of stand by motors/equipments installed in the campus. Whereas, the MDI during the last one year has never exceeded 1000 kVA as shown in the table above. Therefore, the levy of monthly minimum charges (MMC) during the four months can be avoided by re-scheduling/optimizing the contract demand by declaring the connected load of standby equipment/motors & subsequently take approval

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obtaining approval of PSPCL for the same. The annual MDI trend of PTU is as shown in figure-4.9.

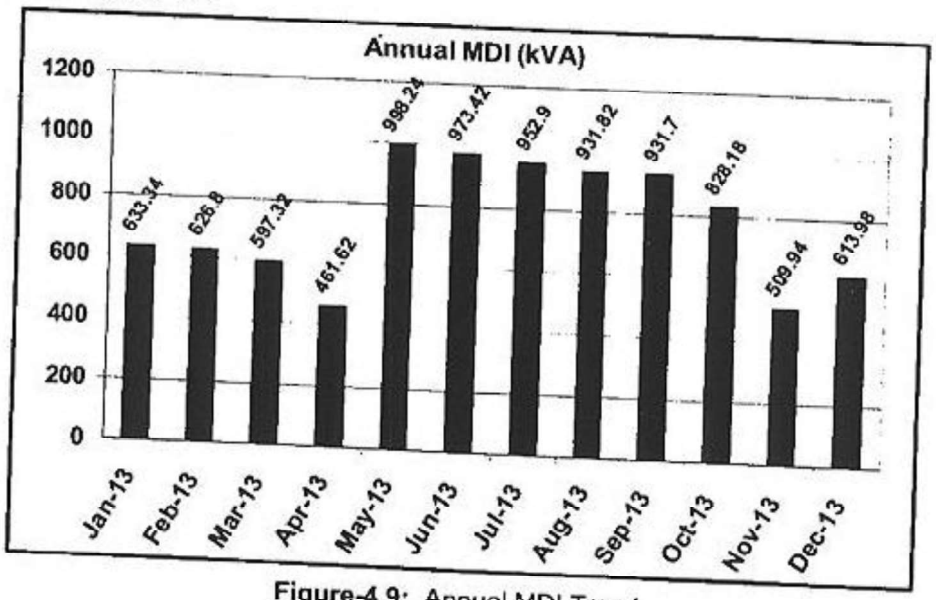

Figure-4.9: Annual MDI Trend

Recommendations:

- Reduce the contract demand of 2000 kVA to 1300 kVA from PSPCL

A. Savings Due to Recommendation

Month	Basic unit rate	Existing MMC (for 2000 kVA Contract Demand)	Energy Consumption	Energy Cost	Proposed MMC (for 1300 kVA Contract Demand)	Energy Cost After Reducing contract demand to 1300 kVA	Saving Potential
	Rs./kWh	Rs.	kWh	Rs.	Rs.	Rs.	
Jan-13	6.39	598000	162504	1038401	388700	1038401	0
Feb-13	6.39	598000	151088	965452	388700	965452	0
Mar-13	6.39	598000	55904	357227	388700	388700	209,300
Apr-13	6.39	598000	34928	223190	388700	388700	209,300
May-13	6.39	598000	100824	644265	388700	644265	0
Jun-13	6.39	598000	133424	852579	388700	852579	0
Jul-13	6.39	598000	155956	996559	388700	996559	0
Aug-13	6.39	598000	149812	957299	388700	957299	0
Sep-13	6.39	598000	143290	915623	388700	915623	0
Oct-13	6.39	598000	111042	709558	388700	709558	0
Nov-13	6.39	598000	54830	350364	388700	388700	209,300
Dec-13	6.39	598000	66036	421970	388700	421970	176,030
B. Savings due to Recommendation							**803,930**
C. Investment							**Nil**

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Power Factor Analysis

The management has installed Automatic Power Factor Correction Panel (APFC panel) at transformer end and is maintaining power factor above 0.95. During the study, it was observed that Power Factor (PF) at 11 kV grid varied between 0.982 to 0.99 (figure-4.9). The Power Factor at 11kV transformer no. 1 was in the range of 0.988 to 0.998 during day time and 0.998 to unity at night time. The trend of power factor recorded during the study period *(during the day time)* at 11 kV main incomer & both the transformers is shown in figure-4.10, figure-4.11 & figure-4.12. However, the average Power factor analysed from the energy bills provided by the management for the period January 2013 to December 2013 is 0.968, which can be further improved to nearly unity. Improving the power factor at the mains would result in rebate from State Electricity Board (SEB).

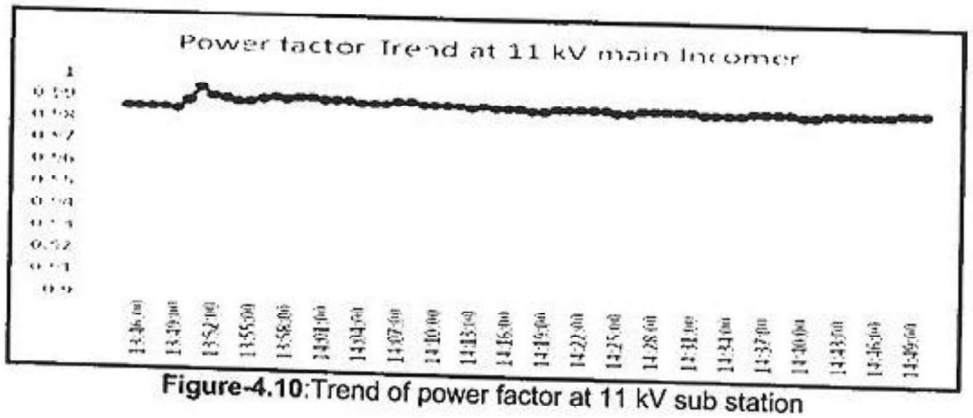

Figure-4.10:Trend of power factor at 11 kV sub station

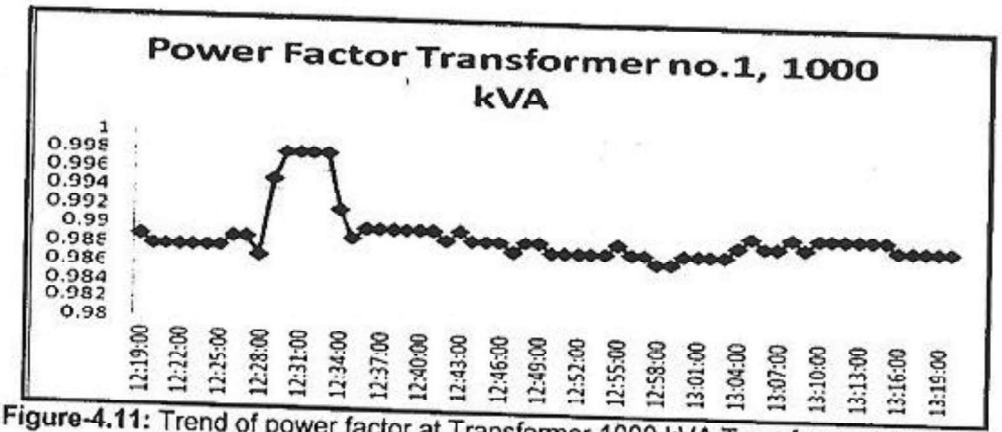

Figure-4.11: Trend of power factor at Transformer 1000 kVA Transformer1 (day time)

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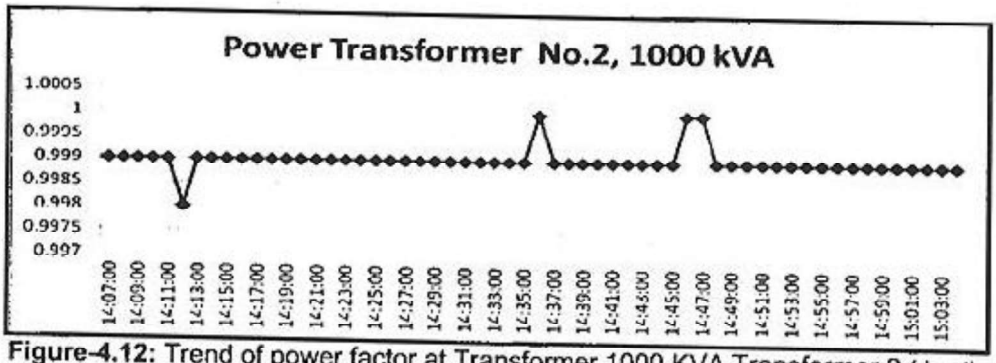

Figure-4.12: Trend of power factor at Transformer 1000 KVA Transformer 2 (day time)

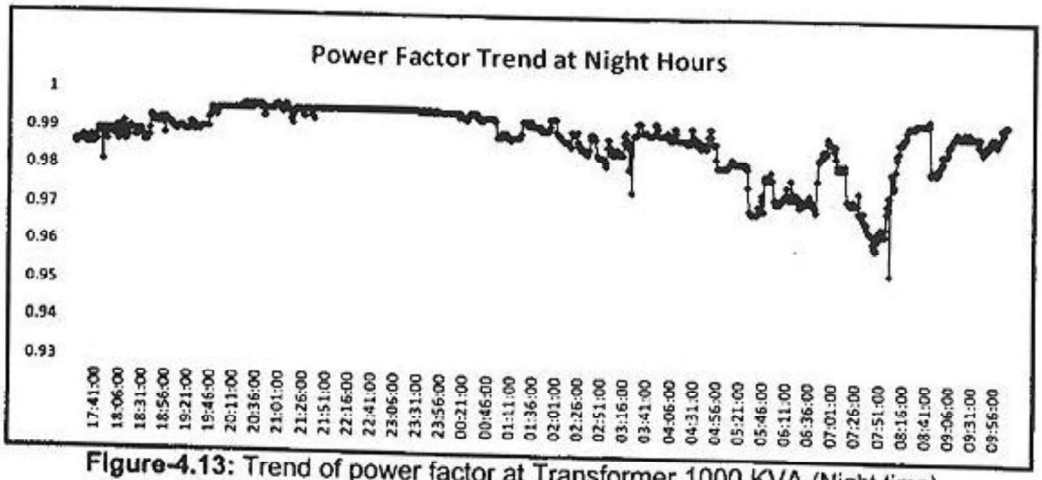

Figure-4.13: Trend of power factor at Transformer 1000 KVA (Night time)

It was noted that, each transformer has APFC panel of 350 kVAR with 6 capacitor banks of 25kVAR and 4 capacitor banks of 50 kVAR on each transformer. From the above, it is clear that the minimum capacity of capacitor bank is 25kVAR. Lot of fluctuations in the hourly power consumption have been observed during the study for which capacitor bank of small steps such as 2kVAR, 5kVAR & 10kVAR are recommended to maintain the power factor to near unity.

It is, therefore, proposed that 2 APFC Panels of small capacitor bank of 25 kVAR of small steps (10 kVAR x 1 nos, 5 kVAR x 3 nos) for both transformers of 1000 kVA be provided.

Capacitor Health Checkup

The output of all the capacitor banks installed in both the transformers at 11 kVA substations was checked with details as below:

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Table-4.7: Capacitor Health Checkup 1000 KVA Transformer 1

Rated Parameters			Measured Parameters Current				
Capacitor No	kVAR @ 440V	kVAR @ 400V	Current	R	Y	B	Actual kVAR
C1	25	20.7	29.8	28.2	28.2	29.1	19.6
C2	25	20.7	29.8	27.9	28.6	28.3	19.1
C3	25	20.7	29.8	28.6	28.6	28.9	19.7
C4	25	20.7	29.8	27.2	28.3	28.8	19.4
C5	25	20.7	29.8	28.6	28.6	28.9	19.7
C6	25	20.7	29.8	27.5	27.7	28.5	19.2
C7	50	41.3	59.6	56.5	56	57.1	38.4
C8	50	41.3	59.6	28.8	57	56.7	33
C9	50	41.3	59.6	56.6	56.3	55.1	37.5
C10	50	41.3	59.6	55.8	56.7	56.8	38

Table-4.8: Capacitor Health Checkup 1000 KVA Transformer 2

Rated Parameters			Measured Parameters Current				
Capacitor No	kVAR @ 440V	kVAR @ 400V	Current	R	Y	B	Actual kVAR
C1	25	20.7	29.8	28.4	29.3	30.1	19.4
C2	25	20.7	29.8	28	27.7	28.2	18.88
C3	25	20.7	29.8	29	28.2	28.8	19.4
C4	25	20.7	29.8	28.1	28.6	29.3	19.8
C5	25	20.7	29.8	27.6	28.8	29	19.6
C6	25	20.7	29.8	28.5	28	28.4	19.4
C7	50	41.3	59.6	57.1	58.5	57.2	38.9
C8	50	41.3	59.6	55.4	57.8	57.2	38.5
C9	50	41.3	59.6	55.8	56.7	57.3	38.9
C10	50	41.3	59.6	56.8	57.8	57.6	39.2

The performance of all the capacitors at transformer no. 1 and transformer no. 2 was found to be satisfactory.

Recommendations

- Maintenance of existing APFC relay system
- Installation of small capacitors in the system to maintain the power factor as during the night, load is less and system required small sized capacitance to maintain the PF near unity.
- Therefore, add 10/5 kVAR capacitor banks in the system to maintain the PF near unity in night time also.

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- Regularly, check the health of capacitor banks after every 15 days. If the output current of capacitors reduces less than 70%, the capacitor should be replaced with new capacitor.

Benefits

The annual savings potential is **Rs. 0.84 Lacs**. The investment required is **Rs. 0.50 Lacs**, which will be paid back in **7 Months**.

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ENERGY SAVING PROPOSAL No. 3

Improve overall power factor to unity

It is possible to achieve power factor of unity at 0.4 KV sub-station by adding small capacitor banks in all the existing APFC panels. The energy saving potential has been worked out as under:

Table-4.9 : Saving Potential by Improving the Power Factor to Unity

Month & Year *(As per bill cycle)*	Energy Bill *(Rs.)*	Actual Power factor	Saving opportunity @ Unity PF
Jan-13	10,31,126	Unity	0
Feb-13	9,66,350	0.99	2,415
Mar-13	5,69,879	Unity	0
Apr-13	5,92,710	Unity	0
May-13	7,06,796	0.96	7,067
june-13	9,85,030	0.96	9,850
july-13	11,78,309	0.95	14,728
Aug-13	10,55,090	0.94	15,826
Sep-14	10,11,740	0.93	17,705
Oct-14	7,88,680	0.94	11,830
Nov-14	6,12,624	0.97	4,594
Dec-14	6,41,960	Unity	0
	1,01,40,294	**0.96 (Average)**	**84,015**

The %age saving in energy bill is feasible by improving the power factor to unity is worked out as under:

Table-4.10 : Saving Potential by Improving the Power Factor

Avg. Power Factor	Total Bill amount during the Last 1 Year	Saving Opportunity	
		PF = Unity	% age
0.968	1.01 Crores	0.84 Lacs	0.82 %

Annual Savings = **0.84 Lacs**

Investment = **Rs 0.50 Lacs**

(Investment estimated for 2 APFC Panels of small capacitor bank of 25 kVAR of small steps of (10 kVAR x 1 no, 5 kVAR x 3 Nos) for both 1000 kVA transformers @ Rs. 1000/ kVAR; necessary electrical modification, if required, @ Rs. 25000/transformer).

Payback = **7 Months**

CHAPTER 5.0

HEATING, VENTILATION & AIRCONDITIONING SYSTEM

5.1 Chiller System

Heating, Ventilation Air Conditioning (HVAC) system is provided in Punjab Technical University Complex, Jalandhar mainly for Offices, Examination Room, meeting room and library for human comfort application. A detailed energy audit for the HVAC system of PTU was conducted. This plant consists of 4 air-cooled screw chillers with specifications given in the table-5.1 below:

Table-5.1: Details of Chilling Unit

System Details	Unit	Air cooled screw
Manufacturer		Climaventta, Italy
Model No.		FOCS-3602/B-S
Rated capacity at full load	TR	200
Installed capacity	TR	3 x 200 & 1x 50
Refrigerants		R134A
Drive motor name plate rating	kW	289.9
Voltage	V	400
Frequency	Hz	50

5.1.1 Vapour Compression Refrigeration system

The vapor compression refrigeration cycle for the chiller is given in the figure-5.1.

As shown, heat flows naturally from a hot to a colder body. In refrigeration system, the opposite must occur i.e. heat flow from a cold to a hotter body. This is achieved by using refrigerant, which absorbs heat and hence boils or evaporates at a low pressure to form a gas. The gas is then compressed to a higher pressure, such that it transfers the heat it has gained to ambient air or water and turns back (condenses) into a liquid. In this way heat is absorbed, or removed, from a low temperature source and transferred to a higher temperature source.

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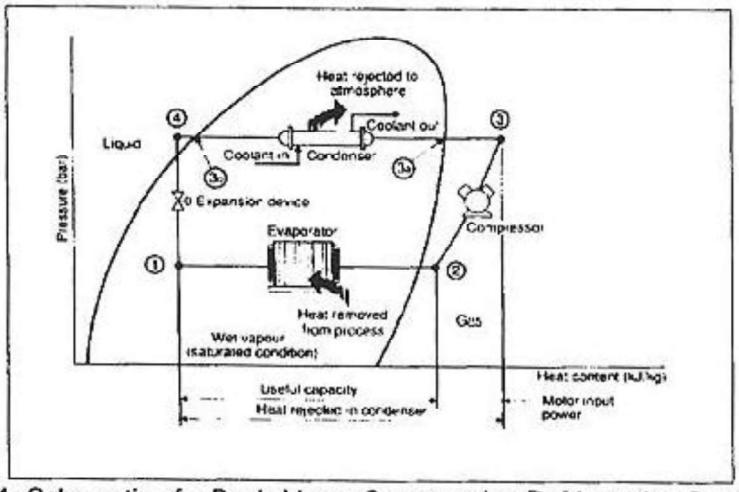

Figure-5.1: Schematic of a Basic Vapor Compression Refrigeration System

The refrigeration cycle can be broken down into the following stages (refer fig.-5.1)

1- 2: Low pressure liquid refrigerant in the evaporator absorbs heat from its surroundings, usually air, water or some other process liquid. During this process it changes its state from a liquid to a gas, and at the evaporator exit is slightly superheated.

2- 3: The superheated vapour enters the compressor where its pressure is raised. There will also be a big increase in temperature, because a proportion of the energy input into the compression process is transferred to the refrigerant.

3-4: The high pressure superheated gas passes from the compressor into the condenser. The initial part of the cooling process (3 - 3a) de-superheats the gas before it is then turned back into liquid (3a - 3b). The cooling for this process is usually achieved by using air or water. A further reduction in temperature happens in the pipe work and liquid receiver (3b - 4), so that the refrigerant liquid is sub-cooled as it enters the expansion device.

4–1: The high-pressure sub-cooled liquid passes through the expansion device, which both reduces its pressure and controls the flow into the evaporator.

It can be seen that the condenser has to be capable of rejecting the **combined heat** inputs of the evaporator and the compressor; i.e. (1 - 2) + (2 - 3) **has to be the same** as (3 - 4). There is no heat loss or gain through the expansion **device.**

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5.2 Connected load pattern of HVAC system equipment

The connected load of HVAC system equipments *(including hot water generator)* is approximately 1640.55 kW. The details of different equipments installed are given in the table-5.2 below:

Table-5.2: Connected Load Details of HVACs

S. No	Description	Qty	Connected Load *(kW)*	Load *(% age)*
1	200 TR Air Cooled Chillers	3	869.7	53.02
2	50 TR Chiller	1	85.9	5.24
3	Fan Condenser for 200 TR Plant	12	52.20	3.18
4	Fan Condenser for 60 TR Plant	6	7.2	0.44
5	Secondary Pumps	3	45	2.74
6	Primary Pumps	4	22	1.34
7	Air Handling Units	41	143.45	8.74
8	CDS Pumps	2	11	0.67
9	Hot Water Generator	1	400	24.38
10	Load of Service lamps in AHU rooms	41	4.1	0.25
	Total		**1640.55**	

The chiller unit and hot water generator operates during the summer and winter months respectively. Therefore, connected load of the HVACs during the summer is 1240.6 kW whereas in winters the connected load of heating system is 592 kW.

3 no. of capacity 200 TR each & 1 no. chiller of 50TR capacity have been installed to meet the cooling load of the facility. The HVAC plant is operated from May to September of every summer season. One chiller plant is operated from may to mid of june & two chiller plants are operated from mid june to end of September. Again only one plant is operated in the month of October.At the time of study also, two chillers were in operation which were connected to a centralized network as illustrated in figure-5.2 below.

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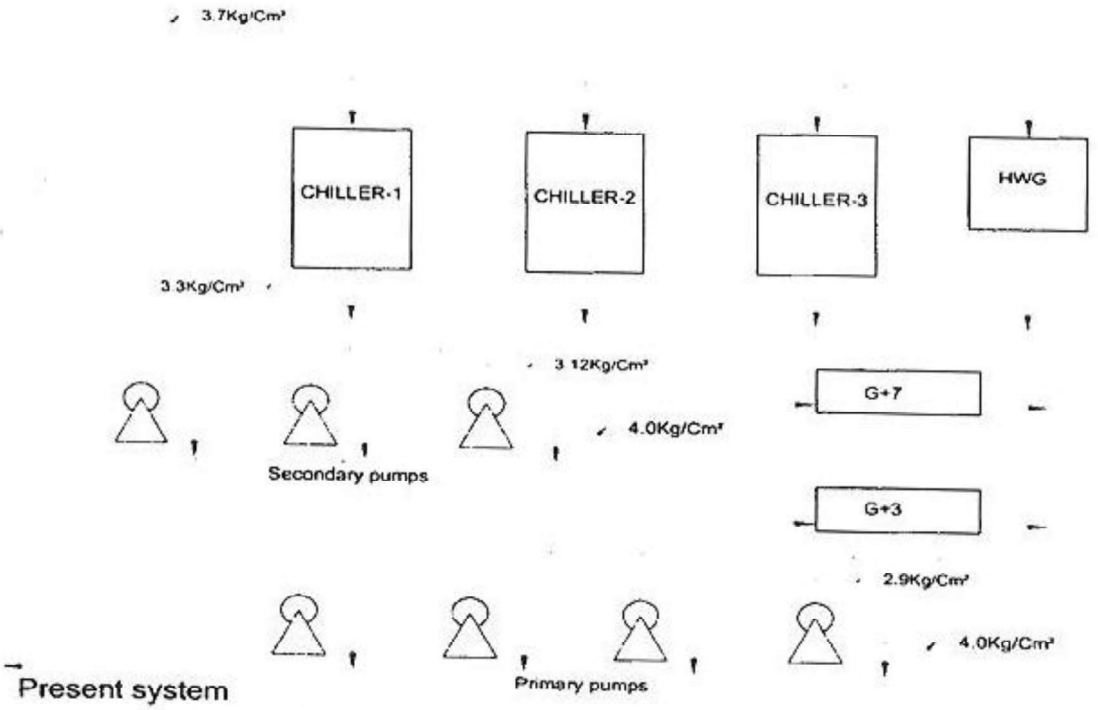

Figure-5.2: Centralized Chiller system for facility

5.2.1 Observations

During the study, chiller 1 & chiller 2 were in operation. The operating parameters of both the 200TR air-cooled screw chiller were monitored at normal load condition. The chilled water temperature in supply line (input) and return line (output) were monitored and also noted from the control panel of chillers. Similarly operating electrical parameters of compressors mainly voltage, current, power factor and kW were measured by using portable power analyser. Chilled water flow rate was monitored by using ultrasonic flow meter. The electrical parameters measured are given in table-5.3 below:

Table-5.3: Electrical Parameters Measurement

	Voltage *(V)*	Current *(Amps)*	PF *(%age)*	Power *(kW)*
Chiller No.1	386	470	0.87	273
Chiller No.2	386	330	0.86	183

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The average specific power consumption (kW/TR) of chiller1 & chiller 2 was calculated in table-5.3(a) & 5.3 (b) given below:

Table-5.3 (a): Specific Power Consumption of Chiller-1

Power Consumption (kW)	Inlet Chilled Water Temperature (°C)	Outlet Chilled Water Temperature (°C)	Chilled Water Flow (m^3/hr)	TR Generated	SEC (kW/TR)
273	12.4	7.1	114	200	1.37
273	12.5	7.2	114	200	1.37
275	12.8	7.4	114	204	1.35
276	12.7	7.3	114	204	1.36
273	12.2	7.0	114	196	1.39
270	12.9	7.8	114	192	1.40
278	12.6	7.3	114	200	1.39
273	12.6	7.4	114	196	1.39
174	11.4	6.9	80	119	1.46

Table-5.3 (b): Specific Power Consumption of Chiller-2

Power Consumption (kW)	Inlet Chilled Water Temperature (°C)	Outlet Chilled Water Temperature (°C)	Chilled Water Flow (m^3/Hr)	TR Generated	SEC (kW/TR)
183	12.2	8.8	123	138	1.32
190	12.5	9	123	142	1.33
195	12.2	8.6	123	146	1.33
173	12	8.9	123	126	1.37
170	11.9	9	123	118	1.44
180	12.9	9.4	123	142	1.26

The SEC of chiller-1 & chiller-2 was observed in the range of 1.35 to 1.45 kW/TR and 1.26 to 1.44 kW/TR. Designed parameters were not available for the comparison. Whereas, the specific energy consumption (SEC) of water cooled screw chillers of same capacity is reported to be less than 0.7 kW/TR.

5.3 Air Handling Unit (AHU) System

Air handling units are installed to maintain a clean environment with controlled temperature and relative humidity in the process areas. 41 AHUs have been installed to maintain a room condition of 22 ± 2°C and 55%± 5%

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relative humidity for G+3 & G+7 buildings. During the energy audit, 6 nos. of AHUs were covered to evaluate the performance.

Table-5.4: Details of AHUs installed in the complex

Sr. No	AHU No.	Area Name	Capacity *(CFM)*	Motor Input. *(kW)*
1	AHU-1	Ground Floor(G+7)	6,000	2.2
2	AHU-2	Ground Floor(G+7)	5,000	2.2
3	AHU-3	First Floor(G+7)	5,000	2.2
4	AHU-4	First Floor(G+7)	8,000	3.7
5	AHU-5	First Floor(G+7)	8,000	3.7
6	AHU-6	First Floor(G+7)	8,000	3.7
7	AHU-7	Second Floor(G+7)	7,000	3.7
8	AHU-8	Second Floor(G+7)	7,000	3.7
9	AHU-9	Second Floor(G+7)	7,000	3.7
10	AHU-10	Second Floor(G+7)	8,000	3.7
11	AHU-11	Third Floor(G+7)	8,000	3.7
12	AHU-12	Third Floor(G+7)	7,000	3.7
13	AHU-13	Third Floor(G+7)	7,000	3.7
14	AHU-14	Third Floor(G+7)	8,000	3.7
15	AHU-15	Fourth Floor(G+7)	8,000	3.7
16	AHU-16	Fourth Floor(G+7)	7,000	3.7
17	AHU-17	Fourth Floor(G+7)	7,000	3.7
18	AHU-18	Fourth Floor(G+7)	8,000	3.7
19	AHU-19	Fifth Floor(G+7)	10,000	5.5
20	AHU-20	Fifth Floor(G+7)	8,000	3.7
21	AHU-21	Fifth Floor(G+7)	7,000	3.7
22	AHU-22	Fifth Floor(G+7)	6,000	2.2
23	AHU-23	Sixth Floor(G+7)	8,000	5.5
24	AHU-24	Sixth Floor(G+7)	7,000	3.7
25	AHU-25	Sixth Floor(G+7)	7,000	3.7
26	AHU-26	Sixth Floor(G+7)	6,000	2.2
27	AHU-27	Seventh Floor(G+7)	10,000	2.2
28	AHU-28	Seventh Floor(G+7	7,000	3.7
29	AHU-29	Seventh Floor(G+7	4,000	5.5
30	AHU-30	Ground Floor(G+3)	2,000	2.2
31	AHU-31	Ground Floor(G+3)	1,600	1.1
32	AHU-32	Ground Floor(G+3)	5,000	0.75

33	AHU-33	First Floor(G+3)	5,000	2.2
34	AHU-34	First Floor(G+3)	8,000	3.7
35	AHU-35	First Floor(G+3)	10,000	5.5
36	AHU-36	Second Floor(G+3)	8,000	2.2
37	AHU-37	Second Floor(G+3)	5,000	3.7
38	AHU-38	Second Floor(G+3)	10,000	5.5
39	AHU-39	Third Floor(G+3)	5,000	3.7
40	AHU-40	Third Floor(G+3)	8,000	2.2
41	AHU-41	Third Floor(G+3)	10,000	5.5

The air handling systems are located on respective floor or zone in order to facilitate maintenance without disturbance to the process area. A fresh air window is provided in each of the AHU room for mixing it with return air. The AHUs are installed to cater the human comfort-cooling requirement in complex.

The temperature & relative humidity of both delivery air & return air from AHU were measured using hygrometer. The average air velocity across the coil was also checked using anemometer. The measured parameters are given in the table-5.5 below:

Table-5.5: Measured Values of AHU

S.No	Description	Units	AHU 28	AHU 19	AHU 14	AHU 41
1	Filter area	m^2	0.475	0.645	0.57	0.684
2	Supply air dry bulb temperature	°C	20.6	22.8	19.3	18
3	Supply air Relative humidity	%	52	48	48	48
4	Return air dry bulb temperature	°C	27.8	25.8	25.5	26.2
5	Return air Relative humidity	%	61.4	58	58	55.6
6	Air velocity	m/s	4.2	6.5	3.6	8.25

The overall kW/TR of HVAC System was calculated as 1.46

Overall kW/TR (chiller1 + chiller2) = (Total kW)/Total tonnage
= [(kW) chiller1+ (kW) chiller2 + (kW) Primary Pumps + (kW) Secondary Pumps]/ Total Tonnage generated
= (273+176+8.4+12.36)/318
= 1.50 kW/TR

5.4 Recommendations

- It is proposed to replace one existing air cooled screw chiller 1 with water cooled screw chillers which can be operated from May to October.
- One existing air cooled screw chiller can be used during the months of June to September in addition to the proposed water cooled plant.

5.5 Benefits

The implementation of above recommendations has a saving potential of Rs. 11.52 Lacs. The investment for one new water cooled screw chiller, condenser pumps & cooling tower would be Rs. 35.0 lacs. However, the salvage value of existing air cooled screw chiller would be Rs. 10.0 lacs and the net investment required would be Rs. 25 lacs only. This gets paid back within **2.1 Years**.

ENERGY SAVING PROPOSAL NO 4

Replace existing Chiller1 with water cooled screw chiller.

During the detailed energy audit two of the 200 TR chillers were studied to evaluate the saving potential by replacing existing chillers with water cooled screw chillers.

The energy consumption pattern of chiller no. 1 at normal running load was recorded and is given in the figure-5.3 below:

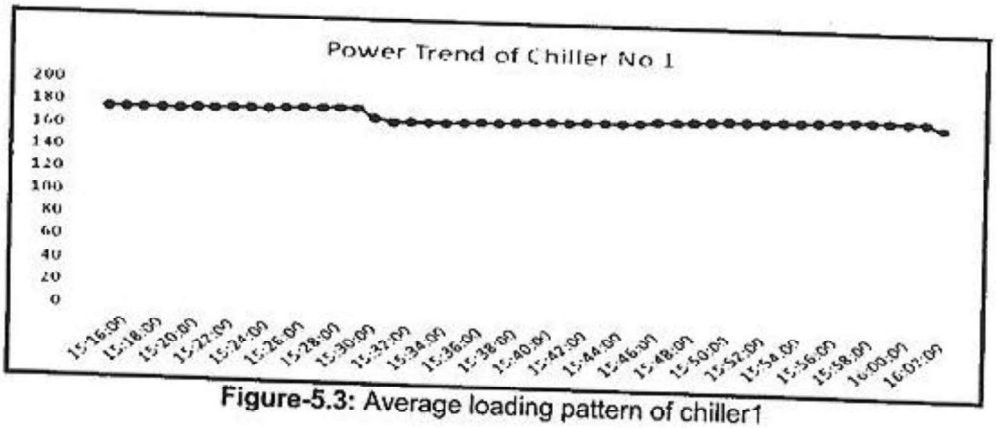

Figure-5.3: Average loading pattern of chiller1

The average power consumption and the TR generated by chiller-1 during the monitoring period was recorded as 273 kW and 200 TR, respectively. Therefore, the average energy consumption worked out to be 1.36 kW/TR. However, the energy consumption of 2 no. chilled primary water pumps was 8.4 kW & power consumption of secondary water pump was 12.36kW respectively. Thus average energy consumption for chiller plant-I works out to be 1.46 kW/TR.

PSCST had recently conducted energy audit of water cooled chillers of capacity 350 TR wherein specific energy consumption of chiller was found to be as low as 0.495 kW /TR. The same can be corroborated with technical literature wherein recommended SEC of similar water cooled chillers at full load is 0.64 kW /TR or less. Further, as per efficiency recommendations Air Conditioning & Refrigeration Institute (ARI) standard 550/590, the recommended full load SEC of air cooled chillers with screw compressor of capacity upto 200 tones is 1.23 kW /TR or less.

The existing air cooled screw chillers are operating at the SEC of 1.46 kW /TR. Replacement of existing system with water cooled screw chiller will reduce the SEC by 0.6 kW/TR.

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Recommendation

It is therefore recommended to replace one existing air cooled chiller used from May to September with water cooled screw chillers.

Benefits

Energy Consumption of existing Air Cooled Screw Chiller Plant	=	1.46 kW/TR
Energy Consumption of proposed Water Cooled Screw Chiller Plant	=	0.86 kW/TR
Energy consumption reduction	=	{1.46-0.86} kW/TR
	=	0.6 kW/TR
Operating hours	=	1250 hrs/year
Annual savings	=	*0.6 kW/TR x 200 TR x 1250 hrs/ year x Rs 7.68 /unit*
	=	**Rs. 11.52 Lacs**
Investment *(Investment estimated for 1 new water cooled Screw chillers 200 TR each, condenser water pumps and cooling towers)*	=	**Rs. 35.0 Lacs**
Salvage value of existing chillers	=	**Rs. 10.0 Lacs**
Payback	=	**2.1 Years**

The annual saving potential is **Rs. 11.52 Lacs**, which requires investment of **Rs. 0.25 Lacs**. This gets paid back within **2.1 Years**.

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ENERGY SAVING PROPOSAL NO 5

Modify chilled water circulation system and eliminate use of primary pumps.

The performance of the existing operation of the primary chilled water pumps and secondary chilled water pumps was analysed. Four primary chilled water pumps are installed before the chillers and three secondary pumps are installed after the chillers as illustrated in figure-5.4 below. Out of these, 2 primary pumps and 1 secondary pumps were in operation during the audit. The rated/design and measured values of chilled water pumping system is given in the Table-5.6.

Table-5.6: Parameters for Chilled Water Circulation Pumping Network

S.No	Unit	Rated Values				Measured Values				
		Q (m^3/hr)	H (m)	kW	Efficiency (%)	Q (m^3/hr)	H suction (kg/cm^2)	H discharge (kg/cm^2)	kW	Efficiency (%age)
1	Primary Pump 1	109.39	12	5.5	65	79.66	2.9	4.0	4.2	57.06
2	Primary Pump 2	109.39	12	5.5	65	79.66	2.9	4.0	4.1	58.45
3	Primary Pump 3	109.39	12	5.5	65	79.66	2.9	4.0	4.1	56.06
4	Secondary Pump	NA	NA	NA	NA	240	3.1	3.7	12.36	26.35

Analysis:

The chilled water circulation pump transfers the chilled water in the circulation circuit of the network. The chilled water from chillers is pumped by the secondary pumps to AHUs for G+7 & G+3. The water is returned by gravity flow at the inlet of primary pumps. Primary pumps are used to pump the water to the condensers of the chillers as illustrated in figure below. As seen from the above table, the measured head at the inlet of primary pumps is already high *(more than 2.9 kg/cm²)*. Therefore, return chilled water of AHUs can be directly sent to the chillers, bypassing the primary chilled water pumps. However, the primary pumps can be used during exigencies by providing pressure switch with transmitter, when available head at the outlet of secondary pumps is less than the required head.

Present System

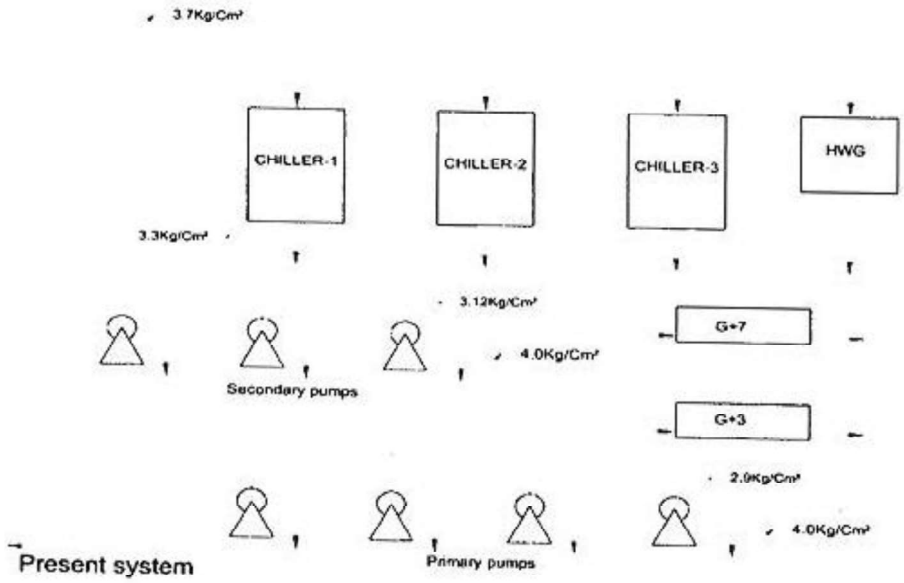

Figure-5.4: Present Chilled Water Circulation System of HVAC Plant

Proposed System

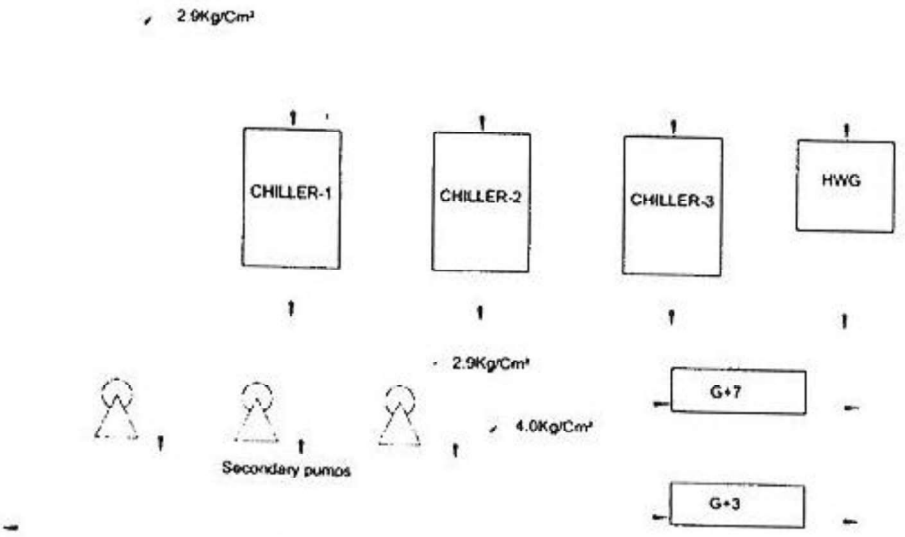

Figure-5.5: Proposed Chilled Water Circulation System of HVAC Plant

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Recommendations

- Eliminate the use of primary chilled water pumps.
- Feed the return water of AHUs directly to the inlet of chillers

Benefits

Operating hours	=	10 Hrs/day x 25 days x 5 months
	=	1250 hrs/year
Saving potential by eliminating primary pumps	=	8.4 kW
Annual savings	=	8.4 kW x 1250 hrs/ year x Rs. 7.68/ unit
	=	**Rs. 0.80 lacs**
Investment *(Estimated investment for modification of existing chilled water line)*	=	0.50 Lacs
Payback	=	8 months

The annual saving potential is **Rs. 0.80 Lacs**, which requires investment of **Rs.0.50 Lacs**. This gets paid back within **8 Months**.

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CHAPTER 6.0
DIESEL GENERATOR

Three Diesel Generator sets have been installed to takecare backup electrical power in case of power failure. Rating of 2 DG sets is 350 kVA each and 1 DG set is 62.5 kVA. Performance analysis was carried out on DG sets-of 350 kVA to check the specific power generation of DGs.

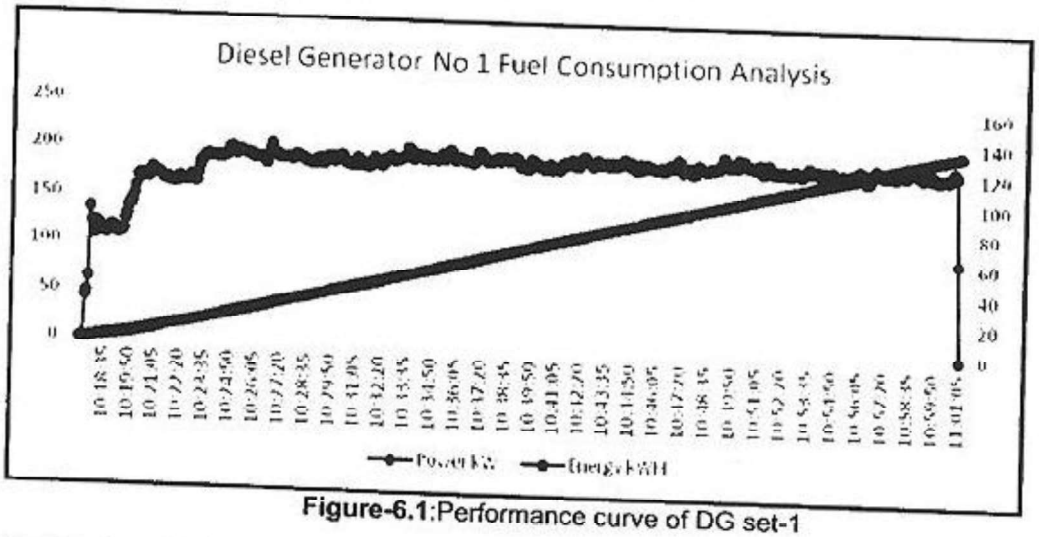

Figure-6.1:Performance curve of DG set-1

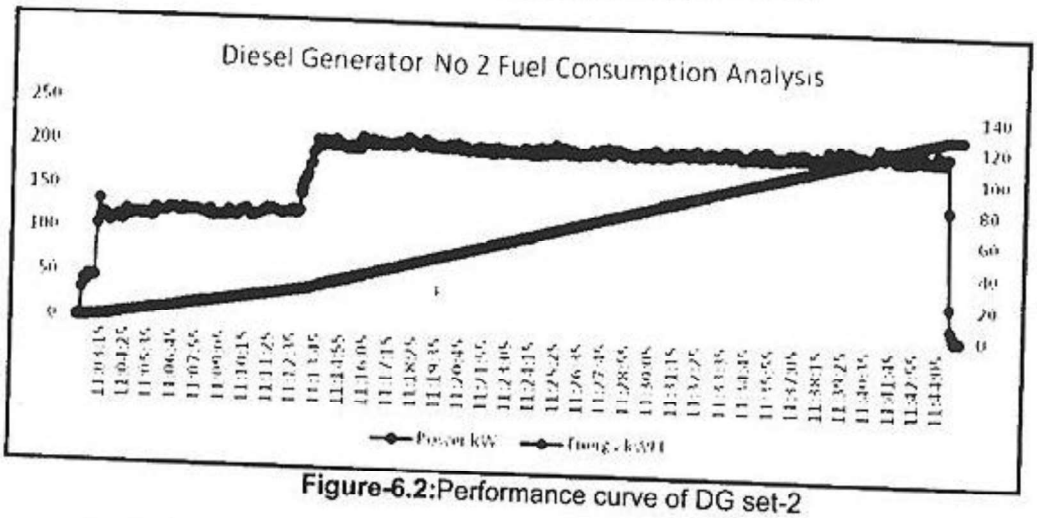

Figure-6.2: Performance curve of DG set-2

In the figures above, blue (upper) line is showing average loading in kW on the DG and red (below) line is showing units generated in kWh by DG set. The Specific Power Generation was worked out as given in the table-6.1 below. The average loading of DG set 1 was 190-200 KVA & the loading of DG set 2 was 200-210 KVA. The average loading of the DG sets was found to be in the range 55-60%.

Table-6.1: Calculation of Specific Power Generation of DG set

Description	Units	DG-1	DG-2
Energy Meter			
Start Reading	kWh	33317	58319
Stop Reading	kWh	33459	58456
Total Units Generated	kWh	142	137
Total Fuel Consumed	Litres	40.3	37.5
Specific Power Generation	kWh/Liter	3.52	3.65

The Specific Power Generation of DG set-1 and DG set-2 was observed as 3.52 kWh/litre and 3.65 kWh/litre respectively, which is above the minimum recommended level of 3.50 kWh/litre. Therefore, the performance of DG sets is satisfactory.

However, it is recommended that Maintenance/ overhauling of DG sets are to be carried out periodically to maximize the sp. power generation.

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Chapter 7.0
LIGHTING

The Lighting system and illumination in different areas of Complex was studied in detail. The total connected lighting load of the complex was 178.65 kW with its distribution as under:

Indoor light load - 160 kW
Outdoor light load - 18.65 kW

The indoor lights installed in the complex are 18 Watt & 36 Watt tubes and 18 Watt CFL .The various type of light fixtures installed in the indoor and outdoor lights are given in Table-7.1 below:

Table-7.1: Details of Indoor & Outdoor Light Fixtures

S No.	Type of Fixture	Quantity
A	**Indoor Lights**	
1.	4x18 E. Tube set (PH)	238
2.	1x36 E. Tube set (PH	699
3.	2x36 E. Tube set (PH)	652
4.	2x36 box type. Tube set (PH)	28
5.	1x36 box Tube set (PH)	334
6.	2x18 CFL	1007
7.	1x18 CFL	111
8.	70 W Halide lamp	16
B.	**Outdoor Lights**	
1.	HPSV lamps at 6 meter pole	56
2.	CFL lamps at 4 meter pole	7
3.	Mercury vapour lamps at hump pipes	3
4.	HPSV lamps at 3 meter pole	63
5.	CFL lamps at 1 meter environment lighting	36
6.	HPSV face light	12

As detailed above, the indoor lighting is mostly based on fluorescent tube lights/CFLs. Whereas, sodium vapour lamps/ CFLs have been used for outdoor lighting. As per Bureau of Energy Efficiency (BEE) recommendations, LED tube light fittings provide more lumens and are energy efficient. The LED

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fixtures can be replaced within the existing fittings directly. Further, the use of LEDs will also improve power factor in the supply grid.

During the audit, the operation of lights during the day and night time was studied for identifying feasibility of energy conservation in lighting system. The lux levels of lighting in indoor and outdoor area, both during day time and night time were also monitored using lux meter. The average lux levels in various areas are given in table-7.2. It was also observed that the occupancy level is negligible in washrooms and lights are kept ON.

Table-7.2: Measured Lux Levels at Various Locations in the Complex

Area	Lux Level	Fixtures
Banquet Hall	300	FTLs(*4x18 W)* : 58 nos. , FTLs *(2x36 W)* : 10 nos.
Washroom	50	FTLs *(2x36 W)* : 60 nos.
VIP Canteen	120	FTLs *(4x18W)* : 28 nos. FTLs *(28 W)* : 2 nos.
Canteen	100	FTLs *(1x36W)* : 20 nos.
7th Floor, Distance Education Store	120	FTLs *(2x36W,1x36)* : 78 nos.
6th Floor	Not in operation	FTLs *(2x36W,1x36)* : 78 nos.
5th Floor	150	FTLs *(2x36 W)* : 25 nos
4th Floor	120	FTLs *(2x36W,1x36)* : 78 nos.
3rd Floor	120	FTLs *(2x36W,1x36)* : 78 nos.
2nd Floor	120	FTLs *(2x36W,1x36)* : 78 nos.
1st Floor	120	FTLs *(2x36W,1x36)* : 78 nos.
Ground Floor	120	FTLs *(2x36W,1x36)* : 78 nos.
VC Office	120	FTLs *(2x36W,1x36)* : 78 nos.

7.1 Observations

- Around 3400 nos. of 36 watts (T8) & 18 watts Fluorescent Tube Light (FTL) fixtures with electronic chokes are being used for illumination at different areas. Out of these, 2400 are T8 fixtures and 1000 are 18 watts FTL fixtures. Majority of light fixtures are installed in storage rooms/non occupied area which are in use for short duration. Out of the total lights, approximately 35% of the T8 FTL fixtures and 50% of the 18 W FTLs fixtures are commonly used during the day time which can be replaced with the 18W LED fixtures and 9W LED fixtures respectively. The power consumption of remaining fixtures in the stores/un occupied areas can be further reduced by controlling additional light operation/ optimising its operation by installing the sensors.

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- 56 nos. of 150 watts High Pressure Sodium Vapour (HPSV) and 63 nos of 70 watts fixtures are being used for street light illumination at different areas. These fixtures are reported to be with Copper Chokes. The 150W HPSV fixtures can be replaced with the 60W LED lamps and 70W HPSV fixtures can be replaced with the 30W LED lamps.

7.2 *Recommendations*

- **Proposal No. 6:** Replace 800 nos. of 36W FTL's & 500 nos. of 18W FTL's with 18W LED tube light fittings & 9W LED tube lights, respectively, which remain operational most of the time in indoor lighting, in a phased manner under the fault replacement policy.
- **Proposal No. 7:** Replace 56 nos. of 150W High Pressure Sodium Vapour (HPSV) fixtures & 63 nos. 70W fixtures with 60W & 30W LED fittings respectively in outdoor lighting.
- **Proposal No. 8:** Iinstallation of occupancy sensor in washrooms and stores.

7.3 *Benefits*

The implementation of above recommendations has a saving potential of **Rs. 7.26 Lacs** with an investment of **Rs. 23.55 Lacs.** The recommendations wise details are as under:

Recommendation	Saving Potential	Investment	Payback Period
Recommendation 6	Rs. 5.32 Lacs	Rs. 12.55 Lacs	28 months
Recommendation 7	Rs. 3.68 Lacs	Rs. 10.0 Lacs	33 months
Recommendation 8	Rs. 1.0 lac	Rs. 1.0 lac	12 months

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Energy Saving Proposal no. 6

Replace 800 nos 36 watts with 18 watts LED fluorescent tube lights and 500 nos. of 18 watts fixtures with 9 watts LED tube lights

Approximately 800 nos. of 36W & 500 nos. of 18W Fluorescent Tube Light fixtures are commonly used for illumination of different indoor areas. These fixtures are with electronic chokes. These fittings can be replaced with 18 watts & 9 watts LED Tube light fittings directly.

The advantages of LED tube light fittings are:

- It gives equivalent/more lumens output while consuming less power.
- It has better colour rendering index and gives more bright light
- It Improves Power factor (approx. 0.95 lag.) across the supply grid.

Recommendation

There is a potential of savings by replacing existing fittings with new energy efficient LED fittings Moreover, the LED based fittings have average life of more than 50,000 hrs.

Benefits

Replacement of 800 nos 36 watts fluorescent tube lights with 18 watts LED

Power Consumption Data of 1 fixture

Existing Fixture	=	40 W
Proposed (LED based)	=	18 W
Power saving per fitting	=	40-18 W
	=	22 W
Total No. of fittings	=	800 nos.
Total Savings Potential	=	22W x 800 nos.
	=	17.6 kW
Annual savings	=	17.6 kWx3000hrs.x Rs7.68/Unit
	=	**Rs 4.05 Lacs**
Investment *(Investment estimated for 800 new LED fixtures and necessary electrical modification if required in the system @ Rs. 1100 /fixture)*	=	**Rs 8.8 Lacs**
Payback	=	**2.17 years**

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Replace 500 nos 18 watts fluorescent tube lights with 9 watts LED

Benefits

Power Consumption Data of 1 fixture

Existing Fixture	=	20 W
Proposed Fixture (LED)	=	9 W
Power saving per fitting	=	20-9 W
	=	11 W
Total No. of fittings	=	500 nos.
Total Savings Potential	=	11W x 500 nos.
	=	5.5 kW
Annual savings	=	5.5 kWx 3000hrs.x Rs 7.68/Unit
	=	**Rs 1.27 Lacs**
Investment *(Investment estimated for 500 new 9 watts LED fixtures and necessary electrical modification if required in the system @ Rs. 750 /fixture)*	=	**Rs 3.75 Lacs**
Payback period	=	**2.95 years**

The annual savings potential is **Rs 1.27 Lacs**. The investment required is **Rs. 3.75 Lacs**, which will be paid back in **2.95 Years.**

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ENERGY SAVING PROPOSAL NO 7

Replace 150W HPSV street lights with 60 watts LED & 70W HPSV with 30W LED street lights.

56 nos. of 150 watts High Pressure Sodium Vapour (HPSV) fixtures & 63 nos. of 70 watts fixtures are being used for street light illumination at different areas. These fixtures are with traditional Copper Chokes. We can replace 150W HPSV fixtures with 60W LED lamps & 70W HPSV fixtures with 30W LED lamps.

LED fixtures have the following advantages –

- Gives equivalent/more lumens output while consuming very less power.
- Better Colour rendering index.
- Gives more bright light
- Improved Power factor (approx. 0.95 lag.)
- Life of the LED lamps is 50,000 hours (10 years) whereas, the life of HPSV lamp is 15,000 hours (4 years).

Benefits

Replacement 56 nos 150 watts High Pressure Sodium Vapor fixtures with 30 watts LED

Power Consumption Data of 1 fixture

Existing Fixture	=	165 W
Proposed (LED based)	=	60 W
Power saving per fitting	=	165-60 W
	=	105 W
Total No. Of fittings	=	56 nos.
Total Savings Possible	=	105 W x 56 nos.
	=	5.9 kW
Annual savings	=	5.9 kW x 3650 hrs. X Rs 7.68 /Unit
	=	**Rs 1.65 Lacs**
Saving on account of reduction in the repair/ maintenance/replacement @ Rs. 1000/- per HPSV lamp per annum	=	**Rs. 0.56 lacs**
Total Annual Saving	=	**Rs. 2.21 lacs**
Investment *(Investment estimated for 56 new LED street lights and necessary electrical modification if required in the system at the rate of Rs.10,000 / street light)*	=	**Rs 5.6 Lacs**
Payback	=	**2.5 years**

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Replace 63 nos 70 watts lighting fixtures with 30 watts LED

Power Consumption Data of 1 fixture

Existing Fixture	=	77 W
Proposed (LED based)	=	30 W
Power saving per fitting	=	77-30 W
	=	47 W
Total No. Of fittings	=	63 nos.
Total Savings Possible	=	47 W x 63 nos.
	=	3.0 kW
Annual savings	=	3.0 kW x 3650 hrs. X Rs 7.68/Unit
	=	**Rs 0.84 Lacs**
Saving on account of reduction in the repair/ maintenance/replacement @ Rs. 1000/- per HPSV lamp per annum	=	**Rs. 0.63 lacs**
Total Annual Saving	=	**Rs. 1.47 lacs**
Investment *(Investment estimated for 63 new LED street lights and necessary electrical modification if required in the system at the rate of Rs. 7,000 / street light)*	=	**Rs 4.41 Lacs**
Payback period	=	**3.0 years**

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ENERGY SAVING PROPOSAL NO 8

Optimize power consumption of lighting by automation

During audit, it was observed that the occupancy in washrooms is very low. Therefore the lights remain ON continuously. Each Washroom has 3 nos. of 2x36 watt lighting fixtures. The total connected load of washrooms is about 12 kW.

Recommendation

It is recommended to optimize power consumption of washroom lighting system by identifying and removal of unwanted/extra lights and by installing occupancy sensors. It is estimated that there would be around 30% reduction in the energy in the washrooms by installation of occupancy sensors.

Benefits

Annual Savings = 12 kW x 30% x12 hrs.x 300 days/annum x Rs.7.68/Unit
= **Rs.1.0 Lacs**

Investment *(For Occupancy Sensors)* = **Rs. 1.0 Lacs**

Simple Payback = **1 year**

The total annual saving potential is **Rs. 1.0 lacs**. The investment required is **Rs. 1.0 Lacs**, which will be paid back in 1.0 **year.**

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Chapter 8.0

OTHER OBSERVATIONS

Optimize power consumption of lighting by switching off indoor lights in night.

As per the data provided by Punjab Technical University in the questionnaire, the indoor lights are kept ON from 8:30 AM to 5:30 PM during day time & outdoor lights are kept ON from 7:00 PM to 5:30 AM. The total connected load of the outdoor lighting is 18 kW. However, during the energy audit, it was observed that in most of the areas, the indoor lights during night time were also kept ON & the total working load during the night (i.e. 7:00 PM to 5:00 AM) was in the range of 34-44 kW and the load from 5:00 AM to 8:00 AM reduced to 17-22 kW due to switching off the outdoor lights.

As per the total connected load of outdoor lighting, the total working load during night should not exceed 20 kW/hr. The unwanted indoor lights can be switched off during the night/non working hours which will result in saving of at least 5 kW/hr.

Recommendations

Switch off the indoor lights during night/non-working period.

Benefits

Total working load measured during night *(7:00 PM to 5:00 AM)*	=	34-44 kW
Total connected/working load of outdoor lights	=	18 kW
Power Consumption of indoor lighting during night time	=	10-15 kW
Saving Potential by Switching off the indoor lights	=	5 kW
Annual Savings	=	5 kW/hr x 3000 hrs.x Rs. 7.68/unit
	=	**Rs. 1.15 lacs**
Investment	=	**Nil**
Payback	=	Nil

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CHAPTER 9.0
MANAGEMENT ASPECTS & CONCLUSIONS

9.1 *Objectives of Punjab Technical University, Kapurthala should be*

- To have a firm top management commitment so that the complex achieves energy conservation on a time bound basis.
- To make Energy conservation a permanent activity
- To achieve lowest auxiliary energy consumption.
- To achieve the status of best energy efficient complex in India.
- To implement the recommended proposals and reap the benefits.

9.2 *Approaches to an Energy Conservation Idea*

- Each energy conservation idea should be seen as an opportunity for improvement. The approach must be on how to implement each proposal and overcome the problems, if any.
- It is easier to say a proposal is not possible or not implementable, but the benefit comes from the actual implementation, which needs lot of courage, conviction and will power to implement.

9.3 *Specific Recommendation*

- Punjab Technical University should form an energy conservation committee. The committee should consist of senior operating and maintenance personnel.
- The committee should meet once in a month with a specific agenda to review the progress of implementation of proposals and to guide the implementation team.
- The management should also select a senior person, as Energy Manager and he should co-ordinate all implementation activities.
- The main responsibility of implementing the proposals and achievement of savings should be with the concerned operating and maintenance personnel and not with the Energy Manager.
- The immediate task of Team should be to implement the identified proposals and get the savings.
- It is recommended to introduce a suggestion scheme for energy conservation. The energy conservation committee should review all suggestions and good proposals should be implemented.

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9.4 *Assign specific responsibility*

- While, the overall responsibility for energy conservation rests with the top management, the concerned operating / maintenance personnel should implement and periodically report progress on energy saving proposals.
- Therefore, each energy saving proposal should be assigned to a specific operating / maintenance personnel for implementation and monitoring.
- Specific time bound action plan is required for implementation and monitoring of energy saving proposals.

9.5 *Monitoring of proposals*

- All the implemented proposals are to be monitored on a proposal-by-proposal basis for actual achievement of savings on a monthly basis.

9.6 *Motivational aspects*

- The successful management of energy depends on motivation of technical personnel and their commitment. It is recommended that operating / Maintenance staff be deputed for training programs in specific areas like
  - Pumps
  - HVAC
  - Cooling towers
  - DG sets
  - Motors
  - Electrical distribution
  - Lighting

9.7 *Conclusions*

The detailed energy audits conducted jointly by the plant and energy teams have identified an annual energy saving potential of **Rs. 31.76 Lacs**, based on the present energy cost.

The summary of annual savings identified

Total annual saving (8 Proposals)	= Rs.31.76 Lacs
Annual Savings without Investment (2 Proposals)	= Rs. 8.60 Lacs
Investment required (6 proposals)	= Rs.49.55 Lacs
Average payback period for capital proposals	= 19 Months

It is proposed that the management should

- Assign specific responsibility for implementation of proposals.
- Monitor savings achieved on a proposal by proposal basis.
- Punjab Technical University team, should have the goal of a achieving the best energy efficient complex status in the country.

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ANNEXURE – I

PROPOSED FORMAT FOR MONITORING THE IMPLEMENTATION OF ENERGY SAVING PROPOSALS

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FORMAT FOR MONITORING THE IMPLEMENTATION OF ENERGY SAVING PROPOSALS

S No	Energy saving proposals	Annual Savings (Rs Lacs)	Investment (Rs Lacs)	Simple Payback (Months)	Dept / Person Responsible	Target Dates	Remarks
1							
2							
3							
4							
5							
Total							

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ANNEXURE - II

LIST OF INSTRUMENTS

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List of Instruments used during Energy Audit

1. Three Phase Electrical Power Analyzer
2. Digital Ultra Sonic Water Flow Meter
3. Digital Pressure Gauge
4. Digital Lux meter
5. Digital Distance Meter
6. Digital Multi-meter
7. Digital power clamp meter
8. Power factor meter
9. Digital Hygro Thermo Meter
10. Digital Anemometer

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ANNEXURE-III

LIST OF ENERGY EFFICIENT EQUIPMENTS SUPPLIERS

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ADDRESS OF ENERGY SAVING EQUIPMENT SUPPLIERS

SUPPLIER OF TRANSFORMER	
1. Crompton Greaves Limited. (Transformer Division) Kanjur Marg (East), Mumbai-400042, India. Tel: +91-022-25782974, 67558000,67558202, 67558211,67558390, FAX: +91-022-67558305. 25798214 Contact Person: Mr. B Ukil Email: cg.power@cgl.co.in	2. EMCO Limited Plot # F-5, Road No. 28, Wagle Industrial Estate, Thane-400 604. (India Tel : (91-22) 40404802 Fax :(91-22) 2582 0571 Contact Person: Mr M.K. Pradhan Mobile:996 757 8113 Email:pradhan@emcoindia.com
3. Bharat Heavy Electricals Ltd. Integrated Office Complex Lodhi Road, New Delhi – 110 003 Tel : (011) 26001010 Fax : (011) 26493021 (011) 26492534	4. ABB Ltd. 14 Mathura Road , Faridabad, 121003 Tel : (0129) 227 5592 Fax : (0129) 227 9692 Contact Person Mr. Sanjib Chaudhuri Email: sanjib.chaudhuri@in.abb.com

SUPPLIER FOR SOFT START-CUM-ENERGY SAVER	
1. BHEL BHEL House, Siri Fort, New Delhi- 110049, Tel, : 011 26001010 Fax : 011 26493021 Contact Person : Mr. N Ramakrishna Contact No. - 9945530146	2.Danfoss Industry Pvt Ltd VI floor, JMD Pacific Square,Sector – 15,N.H.-8, Hoshiarpur -122001 Tel : 0124 4036677 Fax : 0124 4039321 Contact Person: Mr. Mahendra Chalke Contact No.-09967971799
3. Siemens Ltd. Thane Belapur Road Thane – 400601, Tel : (022)27623502 Fax :(022)27623727 Contact Person Mr. Rajesh Jain Contact No. 9987089336	4. ABB Ltd. 14 Mathura Road , Faridabad, 121003 Tel : (0129) 227 5592 Fax : (0129) 227 9692 Contact Person Mr. BV Ravishankar / Mr. R Narayanan Contact No. (080) 222318231

AUTOMATIC STAR-DELTA-STAR CONVERTOR	
1. BHEL BHEL House, Siri Fort, New Delhi- 110049, Tel : +91 11 26001010 Fax : +91 11 26493021 +91 11 26492534	2.Danfoss Industry Pvt Ltd VI floor, JMD Pacific Square,Sector – 15,N.H.-8, Hoshiarpur -122001 Tel : +911244036677 Fax : +911244039321

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Contact Person : Mr. N Ramakrishna Contact No. - 9945530146	Contact Person: Mr. Mahendra Chalke Contact No.-09967971799
3. Siemens Ltd. Thane Belapur Road Thane – 400601, Tel : (022)27623502 Fax :(022)27623727 Contact Person Mr. Rajesh Jain Contact No. 9987089336	4. ABB Ltd. 14 Mathura Road , Faridabad, 121003 Tel : (0129) 227 5592 Fax : (0129) 227 9692 Contact Person Mr. BV Ravishankar Contact No. (080) 222318231
5. Phoenix Contact A - 58/2, Okhla Indl. Area, Phase - II, New Delhi -110 020 Tel (011) 30262 800 Fax (011) 26383 285 Email:works@phoenixcontact.co.in Contact Person Mr. Ashish Manchanda Contact No. - 9350043430	6. PMI ASSOCIATES 114,GH-3 DDA Flats, Paschim Vihar, New Delhi -110063(India) Tel : 011-25253104 Fax : 011-25280319 Contact Person: Mr. Sandeep Sharma Contact No. 0910037099

SUPPLIER FOR APFC	
1. BHEL BHEL House, Siri Fort, New Delhi- 110049, Tel : +91 11 26001010 Fax : +91 11 26493021 +91 11 26492534 Contact Person : Mr. N Ramakrishna Contact No. - 9945530146	2.Danfoss Industry Pvt Ltd VI floor, JMD Pacific Square,Sector – 15,N.H.-8, Hoshiarpur -122001 Tel : +911244036677 Fax : +911244039321 Contact Person: Mr. Mahendra Chalke Contact No.-09967971799
3. Siemens Ltd. Thane Belapur Road Thane – 400601, Tel : (022)27623502 Fax :(022)27623727 Contact Person Mr. Rajesh Jain Contact No. 9987089336	4. CONZERV SYSTEMS PVT LTD 87, 1st Floor Industrial Development Colony (IDC) Mehrauli Road Hoshiarpur - 122 001, Tel:- 0124 4268899 Fax:- 0124 4268957 Email: del.sales@conzerv.com
5. NAAC Energy Controls (P) Ltd C-135 Hosiery Complex, Phase II (Extn.), Noida – 201305 Tel.: 0120-4221631, 32, 33, 34 Contact Person: Mr. Chander M. Kapoor Cell: 09811199085	6. EPCOS India Pvt Limited 11'th Floor, 28 Dr. Gopal Das Towers Barakhamba Road, New Delhi- 110 001 Tel: 011 23704143, 23704144 Fax: 011 23704146

SUPPLIER FOR CAPACITORS BANK	
1. BHEL BHEL House, Siri Fort, New Delhi- 110049, Tel : +91 11 26001010 Fax : +91 11 26493021 Contact Person : Mr. N Ramakrishna Contact No. - 9945530146	2. ABB Ltd. Plot Nos 5 & 6 2nd Phase 560058 Bangalore Phone: 08022949328 Fax : 080 22949339 Contact Person: Mr. Uday Sampat

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3. Siemens Ltd. Thane Belapur Road Thane – 400601, Tel : (022)27623502 Fax :(022)27623727 Contact Person Mr. Rajesh Jain Contact No. 9987089336	4. MAGNEWIN MAGNETICS L - 49, M.I.D.C., Kupwad - 416436. Dist. Sangli, Tel.: 0233 - 2645041 / 2645456 Fax : 0233 – 2645856
5. NAAC Energy Controls (P) Ltd C-135 Hosiery Complex, Phase II (Extn.), Noida – 201305 Tel.: 0120-4221631, 32, 33, 34 Fax: (91)-(120)-4221635 Contact Person: Mr. Chander M. Kapoor Cell: 09811199085	6. EPCOS India Pvt Limited 11'th Floor, 28 Dr. Gopal Das Towers Barakhamba Road, New Delhi- 110 001 Tel: 011 23704143, 23704144 Fax: 011 23704146
7. Madhav Capacitors Pvt. Ltd. B-5-2, M.I.D.C. Indl. Estate, Bhosari, Pune - 411 016. Tel: 020 - 27122360/27122762 Fax : 020 - 2712 27 62	8. HOC_AGE Engineering Ltd. 165, HSIDC KUNDLI, Indl. Area, Distt. Sonepat – 130128 Tel: 0130 – 6452667
SUPPLIER FOR ENERGY EFFICIENT MOTORS	
1. BHEL BHEL House, Siri Fort, New Delhi- 110049, Tel : +91 11 26001010 Fax : +91 11 26493021 Contact Person : Mr. N Ramakrishna Contact No. - 9945530146	2. Crompton Greaves Limited (LT Motors Division): A/6-2, MIDC Industrial Area, Ahmednagar- 414111 Tel: 0241- 2777500, 2777372 FAX: 0241-2777508, 2776103 Contact Person: Mr. Ramesh Kumar Email:ramesh.kumar@cgl.co.in
3. Siemens Ltd. Thane Belapur Road Thane – 400601, Tel : (022)27623502 Fax :(022)27623727 Contact Person Mr. Rajesh Jain Contact No. 9987089336	4. Kirloskar Brothers ltd Jeevan Tara Building, 5, Parliament Street, New Delhi 110 001 Tel : +91-011-41501055 to 62 Fax : +91-011-23342002 Email delhi@kbl.co.in
5. Bharat Bijlee Ltd. Milap Niketan, 4th Floor, 8A, Bahadur Shah Zafar Marg, New Delhi, 110 002. Tel: 011-23356033, 23319694 Fax: 011-23319413 Email: bbldelhi@del.bharatbijlee.com Contact Person: Ms. Pratibha Chopra Cell : 09810096684	**6.** Navyug Electric Motors & Pumps Ltd. Plot-4, Phase-II, GIDC, Vatva, Ahmedabad - 382 445 Tel : 079 25831432, 25831433 Fax : 079 25831434

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SUPPLIER FOR ENERGY EFFICIENT PUMPS

1. BHEL BHEL House, Siri Fort, New Delhi- 110049, Tel : +91 11 26001010 Fax : +91 11 26493021 Contact Person : Mr. N Ramakrishna Contact No. - 9945530146	2. Crompton Greaves Limited (LT Motors Division): A/6-2, MIDC Industrial Area, Ahmednagar- 414111 Tel: 0241- 2777500, 2777372 FAX: 0241-2777508, 2776103 Contact Person: Mr. Ramesh Kumar Email:ramesh.kumar@cgl.co.in
3. BHARAT BIJLEE LTD. Milap Niketan, 4th Floor, 8A, Bahadur Shah Zafar Marg, New Delhi, 110 002. Tel: 011-23356033, 23319694 Fax: 011-23319413 Contact Person: Ms. Pratibha Chopra Cell : 09810096684 Email: bbldelhi@del.bharatbijlee.com	4. Kirloskar Brothers ltd Jeevan Tara Building, 5, Parliament Street, New Delhi 110 001 Tel : +91-011-41501055 to 62 Fax : +91-011-23342002 Email delhi@kbl.co.in Contact Person: Mr. P K Tayal Cell: 09425048723
5. Shakti Pumps (India) Limited, Plot no. 401,402 & 413, Sector 3, Pithampur-454775 Tel: 07292- 410500, 410700 Fax: 07292 407044	6. Grundfos Pumps India Pvt. Ltd. B - 1/ D-5, 1st Floor Mohan Co-operative Indl Estate Mathura Road, New Delhi - 110044 Tel: (011) 4222 6090 Fax: (011) 4222 6020 E-mail: salesindia@grundfos.com

SUPPLIER FOR VARIABLE SPEED/FREQUENCY DRIVES/PROCESS AUTOMATION

1. Amtech Electronic (I) Ltd, E-6, GIDC, Electronics Zone, Gandhinagar - 382028, Tel : (079)-23289101, 23289102, Fax : (079)-23289111 Email: info@amtechelectronics.com Contact Person Mr. S B Mahajani Contact No. - 9913143673	2. Crompton Greaves Ltd (LT Motors Division) A/6-2, MIDC Industrial Area, Ahmednagar- 414111 Tel: (0241)- 2777500, 2777372 FAX: (0241) 2777508, 2776103 Contact Person: Mr. Ramesh Kumar Email:ramesh.kumar@cgl.co.in
3. Rockwell Automation India Ltd A-66,Sector-64, Noida-201301(U.P) India Tel : (0120) 4671477 Fax : (0120) 4217928 Contact Person Mr. Meenu Singhal Contact No. - 9811150530	4. Phoenix Contact A - 58/2, Okhla Indl. Area, Phase - II, New Delhi -110 020, Tel (011) 30262 800 Email:works@phoenixcontact.co.in Contact Person Mr. Ashish Manchanda Contact No. - 9350043430
5. Honeywell Automation India Ltd 86, 1st Floor,Okhla Phase III New Delhi - 110020 Tel.: 011-66116300 Fax: 011-66116327 Contact Person Mr. Prabhat Verma Contact No. - 9818230888	6. ABB Ltd. Plot Nos 5 & 6 2nd Phase Bangalore 560058 Tel: 080- 22949355 Fax: 080-22949389 Contact Person Mr. K Sreevatsa Cell: 099014 90980

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SUPPLIER OF ELECTRONIC BALLAST	
1. OSRAM India Private Limited Signature Towers, 11th Floor Tower B, South City - 1 122001 Hoshiarpur, Tel.: 0124 238 31 80 Fax: 0124 238 31 82	2. Bajaj Electricals 1/10, Asaf Ali Road New Delhi 110002 Tel +91-11-23236055 Fax +91-11-23230214 E-mail: del_cic@bajajelectricals.com
3. Philips Electronics India Ltd Ashoka Estate, 9th Floor, 24, Barakhamba Road, Connaught Place New Delhi – 110001 Tel: 011-43529800, 23353280 Fax: 011 23314332 Contact Person: Mr. S K. Dangi Email: s.k.dangi@philips.com	4. G.K. Energy Marketers Pvt. Ltd. F. No 601 , B No 11 B , Opp Data Mandir , Lokmanya Nagar , LBS Road , Navi Peth, PUNE - 411030 Ph. no – (020) 2432 1115 Fax No – (020) 2432 1115 Contact Person : Mr. Gopal Kabra Cell – 09970450000

SUPPLIER OF CFL & METAL HALIDE LAMPS	
1. OSRAM India Private Limited Signature Towers, 11th Floor Tower B, South City - 1 122001 Hoshiarpur, Tel.: 0124 238 31 80 Fax: 0124 238 31 82	2. Bajaj Electricals 1/10, Asaf Ali Road New Delhi 110002 Tel +91-11-23236055 Fax +91-11-23230214 E-mail: del_cic@bajajelectricals.com
3. Philips Electronics India Ltd Ashoka Estate, 9th Floor, 24, Barakhamba Road, Connaught Place New Delhi – 110001 Tel: 011-43529800, 23353280 Fax: 011 23314332 Contact Person: Mr. S K. Dangi Email: s.k.dangi@philips.com	4. Crompton Greaves Limited (Lighting Division) Kanjur Marg (East), Mumbai -400 042. India. Tel: 022-67558000, 67558425/26 FAX: 022- 25787283 Contact Person: Mr. B Chakrabarti Email: biswa.chakrabarti@cgl.co.in

SUPPLIER OF LED & T- 5 LAMPS	
1. OSRAM India Private Limited Signature Towers, 11th Floor Tower B, South City - 1 122001 Hoshiarpur, Tel.: 0124 238 31 80 Fax: 0124 238 31 82	2. Bajaj Electricals Ltd 1/10, Asaf Ali Road New Delhi 110002 Tel +91-11-23236055 Fax +91-11-23230214 E-mail: del_cic@bajajelectricals.com
3. Philips Electronics India Ltd Ashoka Estate, 9th Floor, 24, Barakhamba Road, Connaught Place New Delhi – 110001 Tel: 011-43529800, 23353280 Fax: 011 23314332 Contact Person: Mr. S K. Dangi Email: s.k.dangi@philips.com	4. Crompton Greaves Limited (Lighting Division) Kanjur Marg (East), Mumbai -400 042. Tel: 022-67558000, 67558425/26 FAX: 022- 25787283 Contact Person: Mr. B Chakrabarti Email: biswa.chakrabarti@cgl.co.in

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1. Crompton Greaves Limited (Lighting Division) Kanjur Marg (East), Mumbai -400 042. India. Tel: +91-022-67558000, 67558425/26 FAX: +91-022- 25787283 Contact Person: Mr. B Chakrabarti Email: biswa.chakrabarti@cgl.co.in	2. N. N. Projects Limited C-102, 10th Floor, Super M I, DLF City, Phase IV Hoshiarpur - 122 002, Tel: +91-(124)- 4042483 Fax : +(91)-(124)- 2386431 E-mail: info@nnprojects.com Contact Person: Mr. Gurdeep Singh Juneja Contact No. 9910018286
3. Duex Industrial Systems H-312, Sharad Industrial Estate, Lake Road, Bhandup (W), Mumbai 400078 Tel: 022-32688683 Contact Person: Mr. Nitin Thakur Contact No. 09324082483	4. CONZERV SYSTEMS PVT LTD 87, 1st Floor Industrial Development Colony (IDC) Mehrauli Road Hoshiarpur - 122 001, Phone:- 0124 4268899 Fax:- 0124 4268957 Email: del.sales@conzerv.com

SUPPLIER OF SOLAR PV & LIGHTING SYSTEMS

1.Tata BP Solar India Ltd UG/70-74, World Trade Centre Hotel Intercontinental Complex Barakhamba Road, New Delhi 110 001 Tel : 011 2341 1537 / 8 Fax : 011 2341 1520 Contact Person Mr. Amit Kumar Contact No. 09910018286	2. NEPC India Limited G-39, 3rd Floor, Pawan House, Connaught Circus, New Delhi-110001 Tel: 011 -43581298 / 1299 Fax: 011 41516499 Contact Person Mr.Rakesh Gupta Cell No: 9810106461 mailto:rakeshgupta@nepcindia.co.in Email: rakeshguptanepc@yahoo.com rakeshgupta@nepcindia.co.in
3. G.K. Energy Marketers Pvt. Ltd. F. No 601 , B No 11 B , Opp Data Mandir , Lokmanya Nagar , LBS Road , Navi Peth, PUNE - 411030 Ph. no – (020) 2432 1115 Fax No – (020) 2432 1115 Contact Person : Mr. Gopal Kabra Mob - 09970450000	4. Emmvee Solar Systems (P) Ltd. First Floor , No: 6 & 8 , R-23 , North Enclave , Opp : Nehru Place , Kalkaji, New Delhi – 110 019 Tel : 011-40502620 / 22 Fax : 011 40502623 Contact Person : Mr. Krishan Kumar Mobile : 098119 73344
5. Maharishi Solar Technology Ltd A-14, Mohan Co-op Indl Estate, Mathura Road, New Delhi 110044 Tel.: 011-30881700, 26959529 Fax : 011-26959669 Contact Person : Mr. Pawan Kulshrest Mob - 09899704676	6. Bharat Heavy Electricals Ltd. Integrated Office Complex Lodhi Road, New Delhi – 110 003 Tel : (011) 26001010 Fax : (011) 26493021 (011) 26492534

SUPPLIER OF CHILLERS SYSTEMS

1. Kirloskar Pneumatic Co. Ltd. Hadapsar Industrial Estate, Pune 411 031. Tel. : 020-26870133, 26727000 Fax : 020-26870297,,26870634 Contact Person: Mr. Hemadri N. Buzruk Cell: 09881495489	2. Voltas Ltd. EM&R BG, A43, Mohan Co-op Indl. Estate, Mathura Road, Delhi 110044 Tel: 011 66505550-5570 Fax: 011 26950022/26950081 Contact Person: Mr. Rajiv Saxena Email: rsaxena@voltas.com
3. Reynold India Pvt. Ltd C-38 & 39, Sector 2 Noida, 201 301 Tel : 0120-4252000/4664000 Fax No : 0120 -4252005 *Contact Person :* Mr. Vijay Bali Cell No: 09810100836	4. Werner Finley India Ltd. #9, Cauverynagar, Near Swayam Prabha Kalyanamantapa, Kamakshipalya, Magadi Main Road, Bangalore - 560 079 Tel:080-23289889 23288369 Fax: 080-232883191 *Contact Person:* Mr. J.R.Gundu Rao Cell No: 09845511586
5. Flamingo Chillers Pvt Ltd Z - 51-52 Okhla Indl Area, Phase 2, Delhi - 110020 Phone : 011 - 41610234, 35 Fax: 011 - 41610234	6. Schneider Electric (I) Pvt. Ltd. A-29, Mohan Co-Op. Indl. Estate, Mathura Road, New Delhi 110044 Ph.011-39404000, 41590000, Fax-011-41678010, 41678011
7. Hitachi Home & Life Solutions (I) Ltd. Central Air Conditioning Mr. Arpit Akotiya 022-27689287/83 Mob. 09321836063	

SUPPLIER OF EVAPORATIVE COOLING SYSTEM

1. Sumaya HMX Systems Ltd., # A 422, 1st Cross, 1st Stage, Peenya Industrial Area, Bangalore - 560 058 Tel: 080 -372 1065 / 372 2325 Fax: 080 -372 2326	2. Mamata Energy Pvt Ltd Plot No. 858, Kothari Industrial Estate, Behind Hutch Tower, Rakanpur-Santej Road, Santej - 382 721, Telefax : 02764-268328 Contact Person: Mr. Ashish Zha

SUPPLIER OF COOLING TOWERS

1. Tekni Engineering Pvt. Ltd. 10, Krishna Apartmnet, Bhudrapura, Ambawadi, Ahmedabad 380 006 Phone : 079-26460313. Contact Person: Mr. A. R. Dhoble Cell No.: 09426069087	2. Gem Cooling Towers Pvt. Ltd. S.F. No. 100A, Arasur, Coimbatore - 641 407, Tel : 0422 2360013, 2360130, 2360131, 2360059, 2360129 Fax : 0422 2360523

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3. Paltech Cooling Towers & Equipments Limited B- 604 Sushant Lok, Phase- 1 Hoshiarpur, Haryana - 122 002 Tel : 0124 4222483/84/85/ Contact Person : Mr. H. P. Yadav Cell : 09871096333 E-Mail: hpyadav@paltech.in	4. Artech Cooling Towers (P) Ltd Plot No. 5021, B/H, Meghmani Organics, G.I.D.C. Ankleshwar - 393 002. Tel: (02646) 250302, 309661 Fax: (02646) 250302
Power Analyzer	
1. Fluke 16/1113, Tank Road Karol Bagh, New Delhi, Delhi 110005 Tel :011 25738858 Mobile : 09818515888	2.Nevco Engineers Pvt Ltd 90-A(2nd Floor),Amrit Puri-B Main Road,East of Kailash,New Delhi-110065 Contact Person Mr.Vinod Bhat Contact No : 09810711178
3. CONZERV SYSTEMS PVT LTD 87, 1st Floor Industrial Development Colony (IDC) Mehrauli Road Hoshiarpur - 122 001, Phone:- 0124 4268899 Fax:- 0124 4268957 Email: del.sales@conzerv.com	4. MECO Instruments Pvt. Ltd. Plot No. EL-1, MIDC Electronic Zone, TTC Industrial Area, Mahape, Navi Mumbai 400710. Tel: 022-27673311-16 Fax: 0091-22-27673310, 27673330
FLOW METERS	
1. Fluke 16/1113, Tank Road Karol Bagh, New Delhi, Delhi 110005 Tel :011 25738858 Mobile : 09818515888	2. Siemens Ltd. Thane Belapur Road Thane – 400601, Maharashtra,India Tel : 022-27623502 Fax : 022- 27623727 Contact Person Mr. Rajesh Jain Cell No. 9987089336
3. ABB Ltd. 14 Mathura Road , Faridabad, 121003 Tel : (0129) 2448131 Fax : (0129) 4023006 Contact Person: Mr. Sudhir Kulkarni Cell No: 098105 06367	4.Nevco Engineers Pvt Ltd 90-A(2nd Floor),Amrit Puri-B Main Road,East of Kailash,New Delhi-110065 Contact Person Mr.Vinod Bhat Cell No : 09810711178

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ANNEXURE- IV

PHOTOGRAPHS

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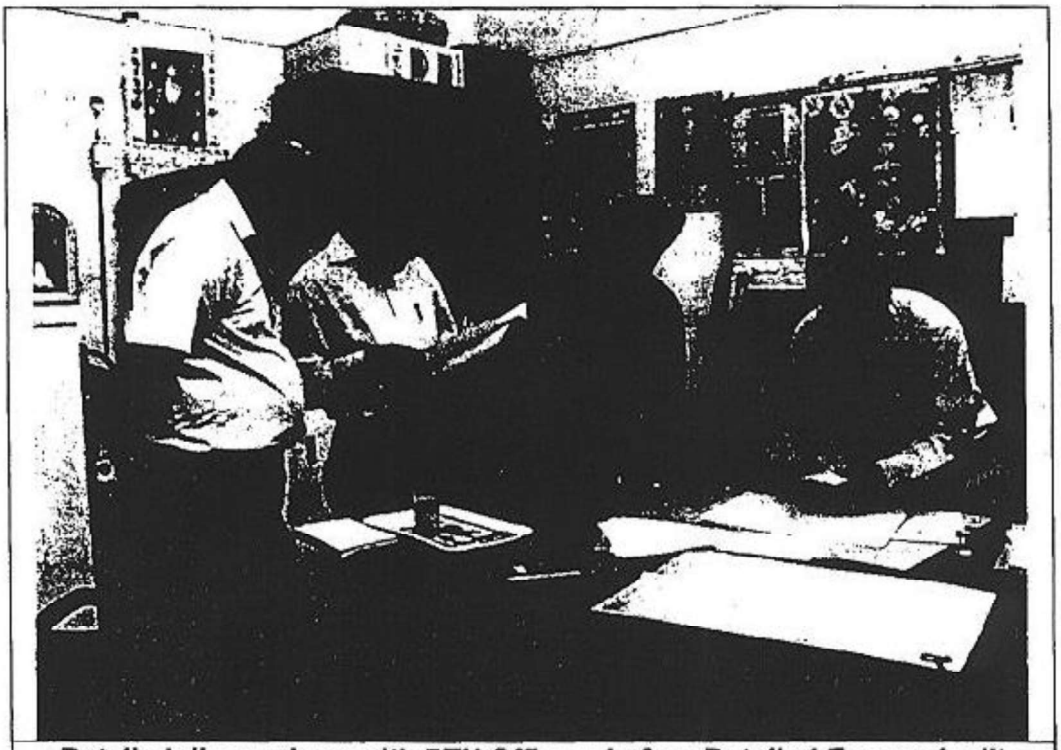
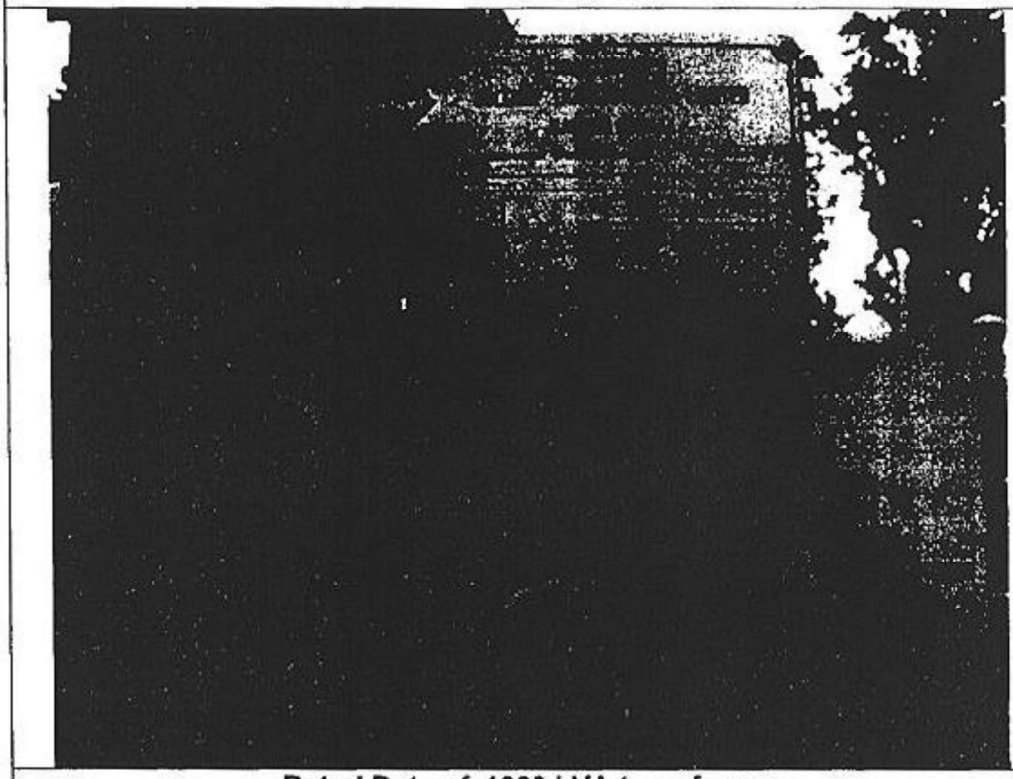


Detailed discussions with PTU Officers before Detailed Energy Audit



Rated Data of 1000 kVA transformer

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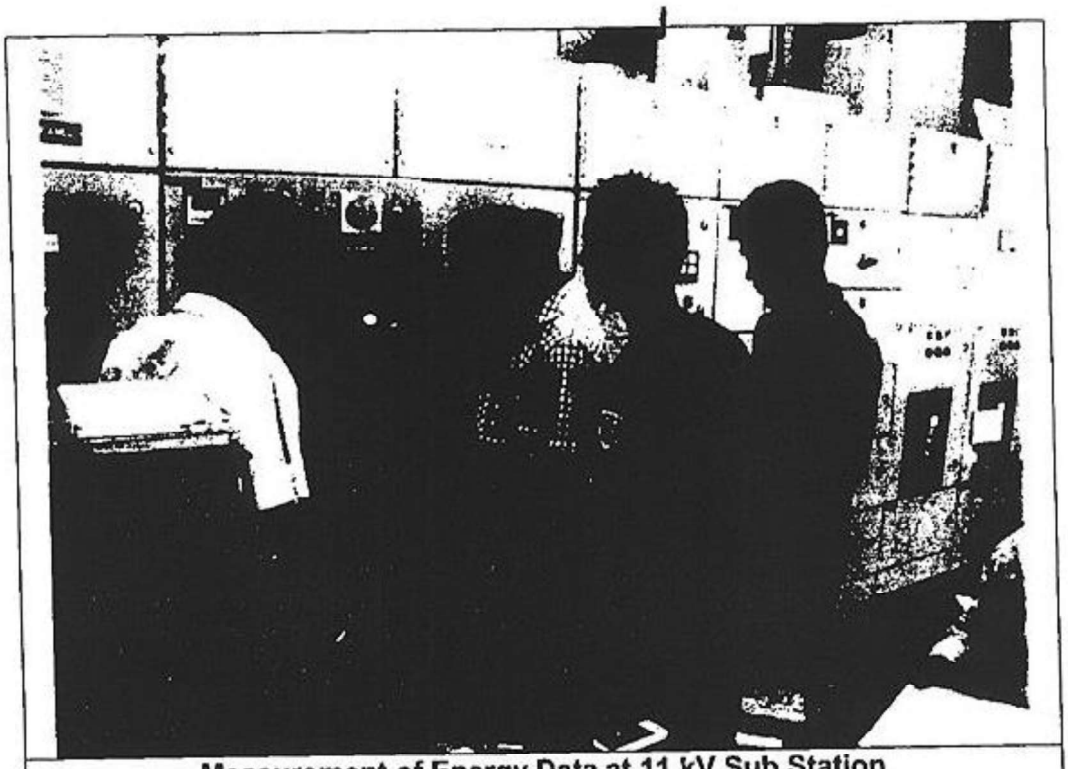
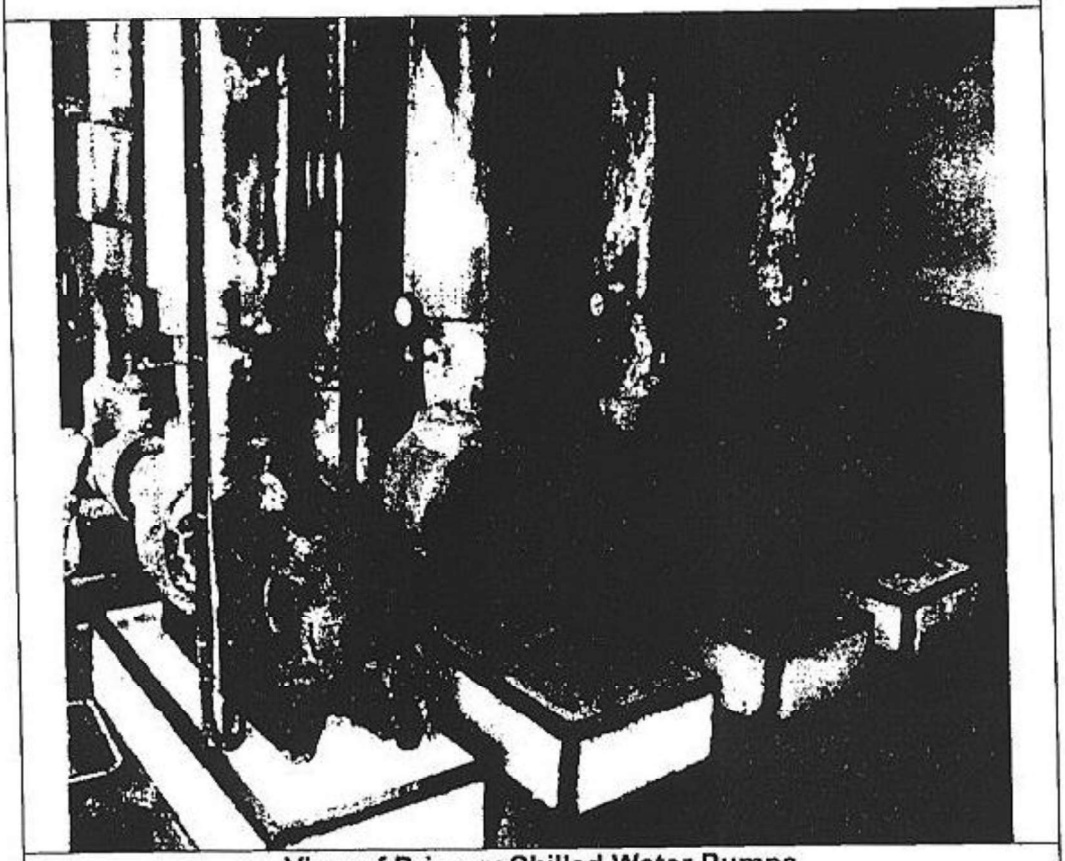


Measurement of Energy Data at 11 kV Sub Station



View of Primary Chilled Water Pumps

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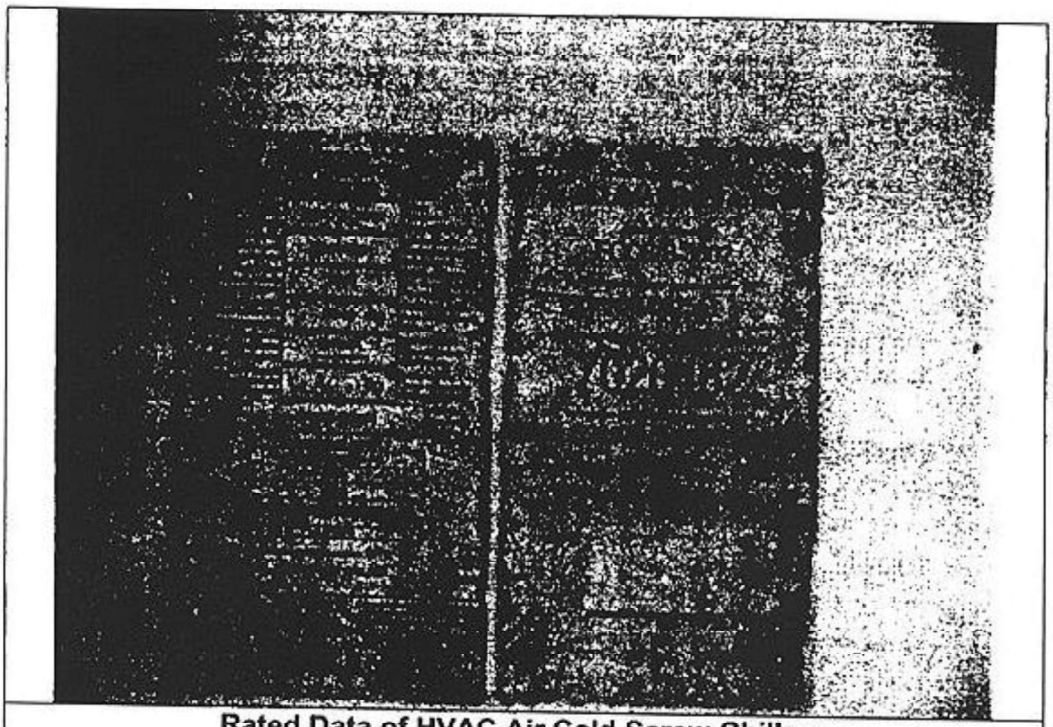

Rated Data of HVAC Air Cold Screw Chillers

View of Detailed Energy Audit of HVAC Plant

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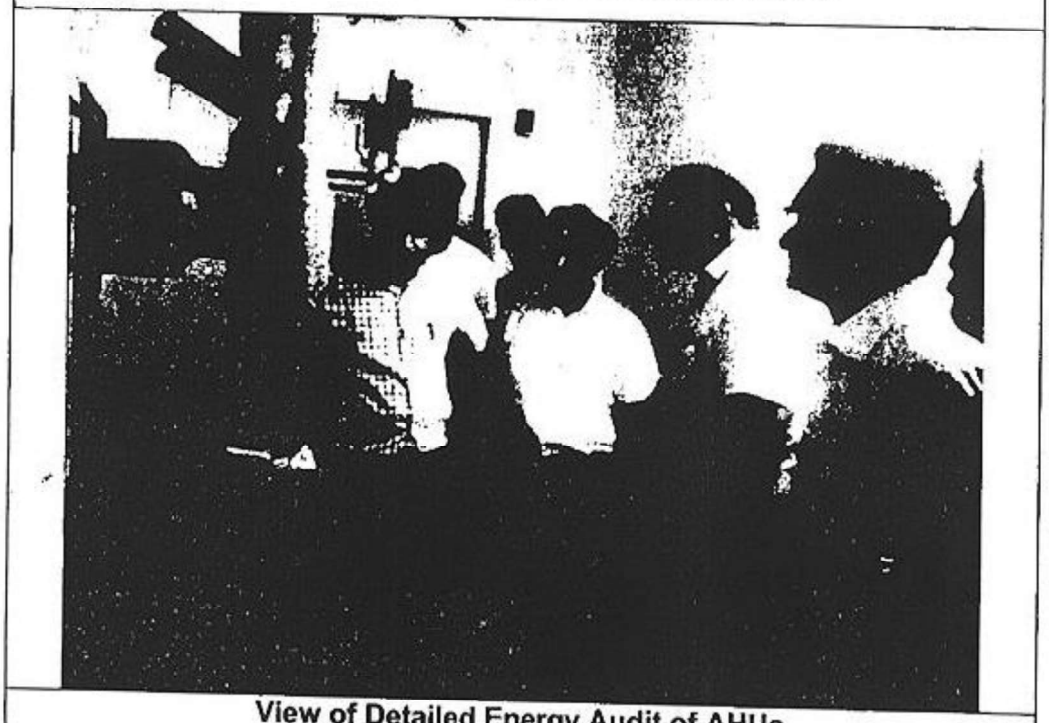
View of Detailed Energy Audit of HVAC Plant



View of Detailed Energy Audit of AHUs

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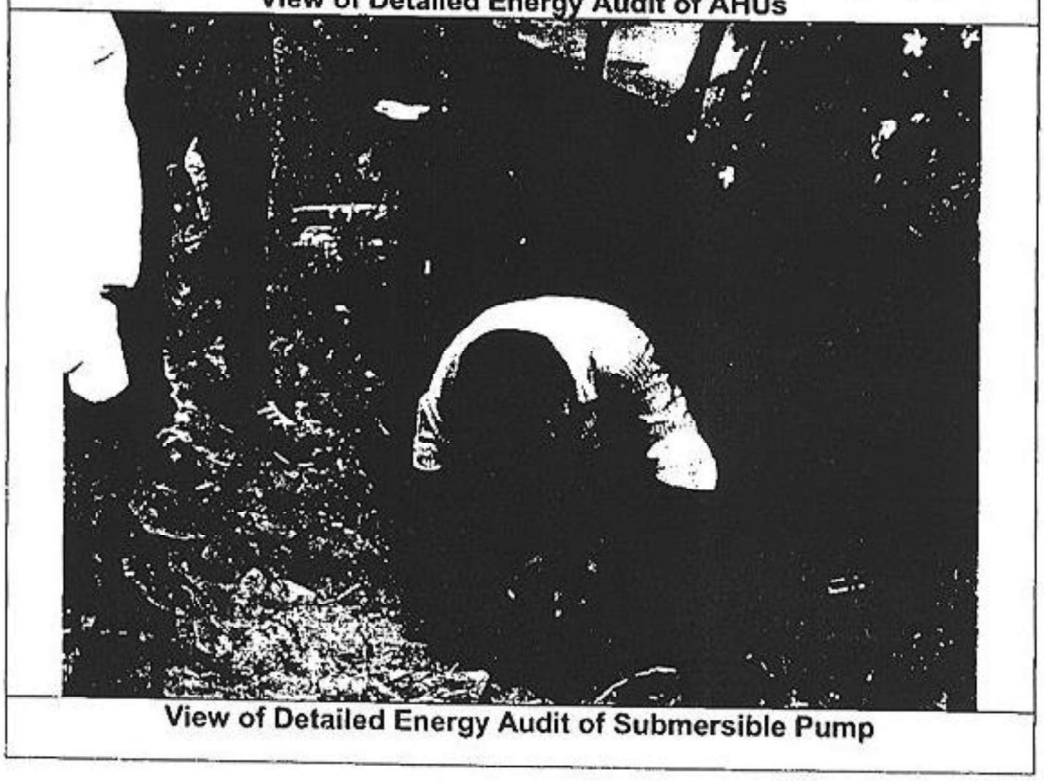
View of Detailed Energy Audit of AHUs



View of Detailed Energy Audit of Submersible Pump

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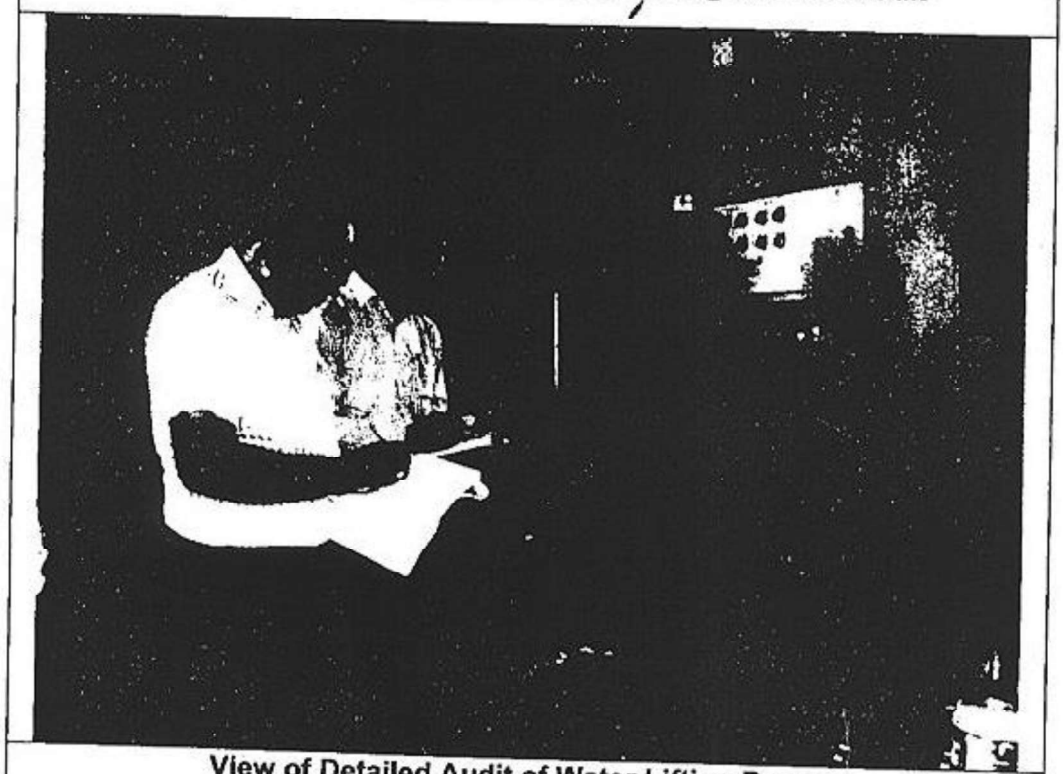
Discussions with the PTU Officials during Detailed Audit



View of Detailed Audit of Water Lifting Pumps

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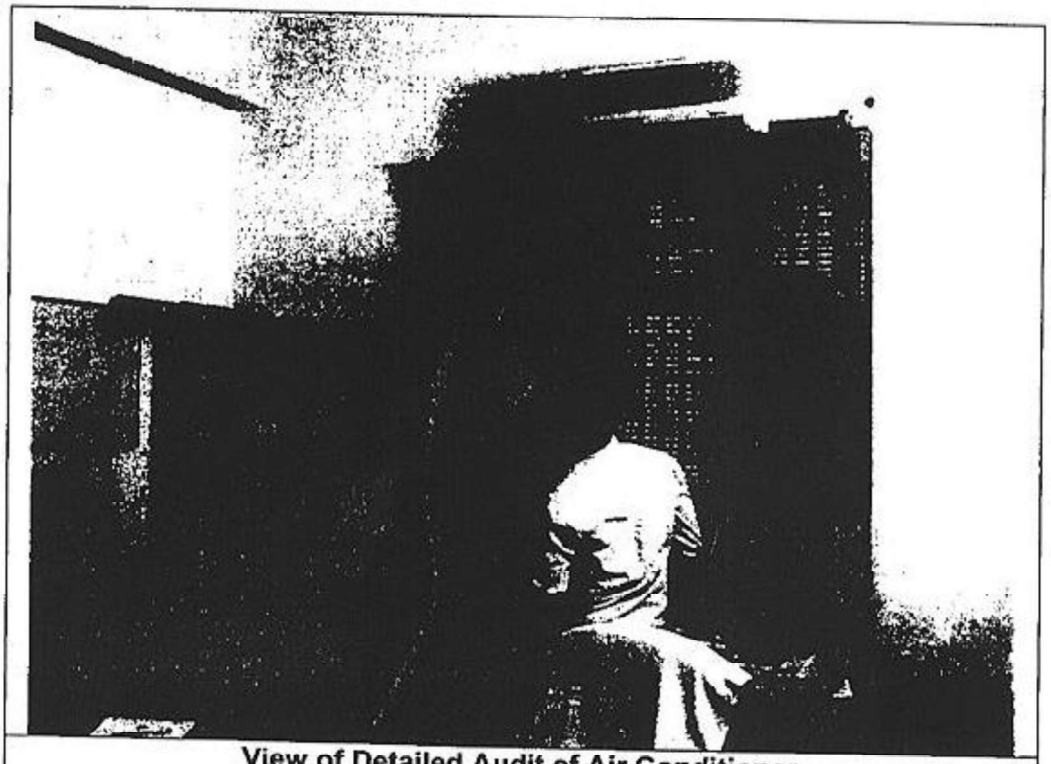

View of Detailed Audit of Air Conditioner

Detailed Discussions with senior officials of PTU

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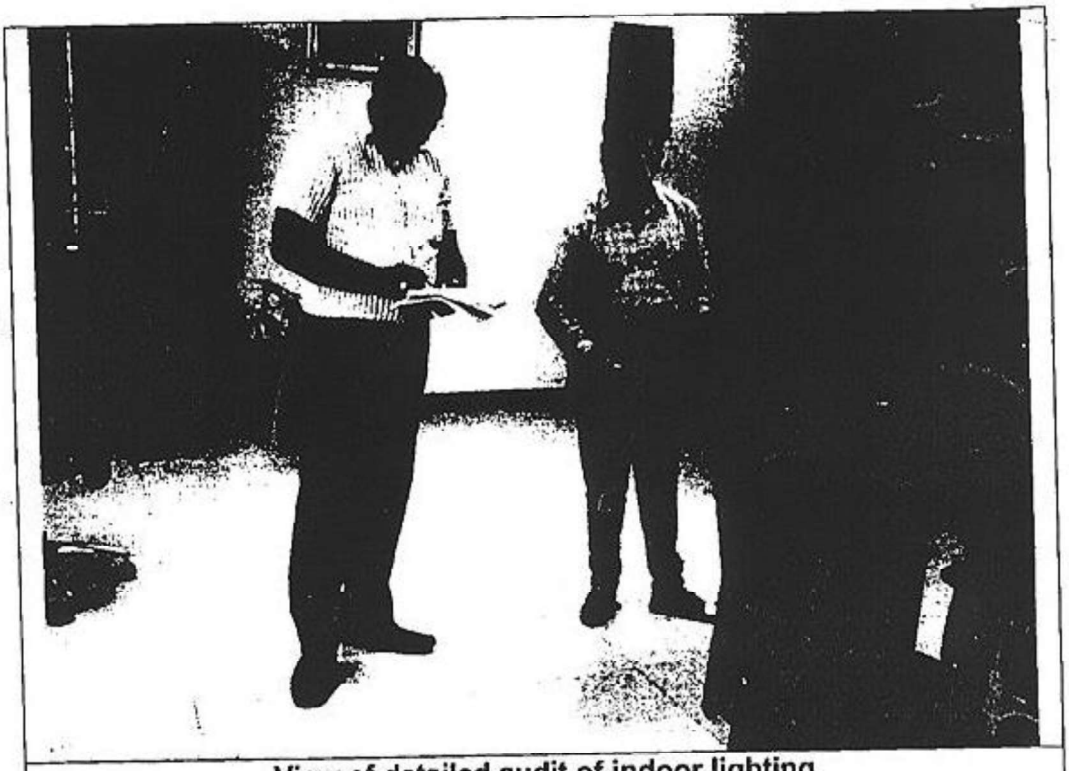
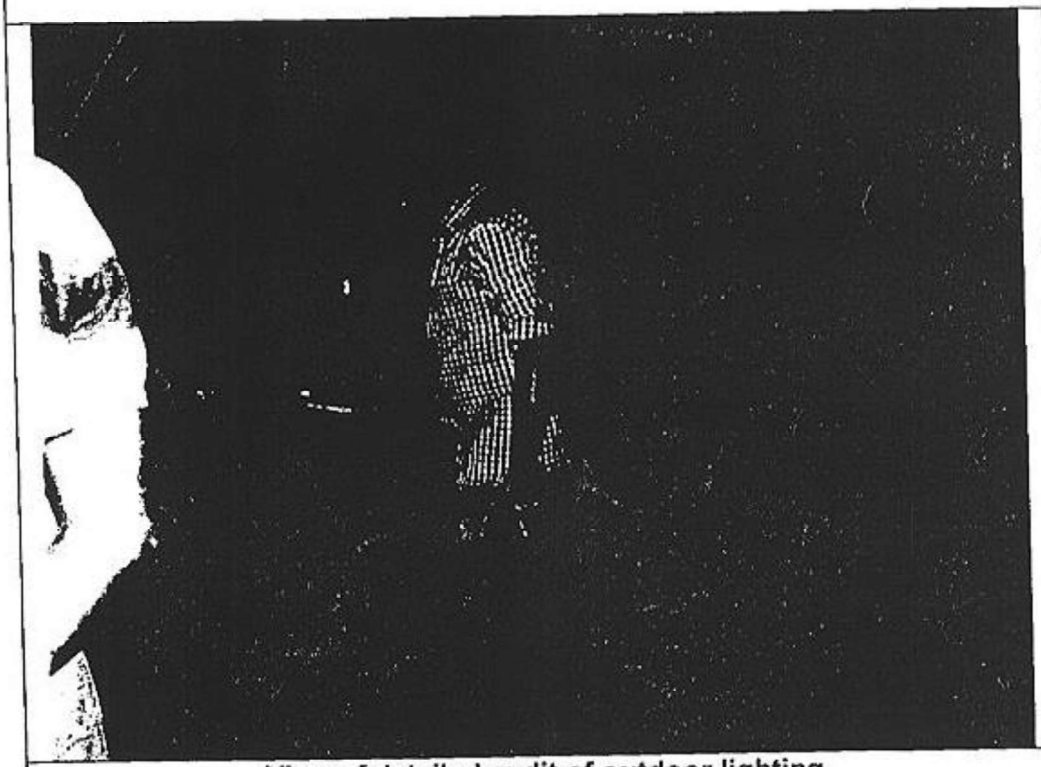


View of detailed audit of indoor lighting



View of detailed audit of outdoor lighting

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