7.1.6 Quality audits on environment and energy are regularly undertaken by the Institution and any awards received for such green campus initiatives:

1. Green audit
2. Energy audit
3. Environment audit
4. Clean and green campus recognitions / awards
5. Beyond the campus environmental promotion activities

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GREEN AUDIT

National Rural Institutions Sustainability Grading (NRISG)

2022-23

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NATIONAL RURAL SUSTAINABILITY GRADING 2022-23

A green campus is no longer a fad, but a clear mandate in India and several other progressive nations where environmental awareness is growing by the day. As per the University Grants Commission's notification: "A green campus is a higher education community with optimum land use, environmental planning and resource management i.e., improving energy efficiency, conserving resources, enhancing environmental quality including habitat preservation, healthy living environment, use of renewable energy and management of wastes and water recycling. The buildings within the campus should be based on green building concepts to the extent possible."

The concerted efforts of TKR College of Engineering & Technology in the direction of fostering "sustainabilityand swachtha" in the campus has made it possible to find a place in the most coveted MGNCRE initiated National Rural Institutions Sustainability Grading (NRISG)2022-23 . Thecollege is awarded a grading of A+ for Green Cover on Campus and surface water harvesting. Rooftop water harvesting, rooftop solar system and waste management with "B" grade.

Having been graded, there is more responsibility on our institution to transform ourselves into a sustainable institution where all its stakeholders continue to play a vital role in maintaining A+ grade even at a future date.

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National Rural Institutions Sustainability Grading(NRISG) 2022-23

SL.No	State	District Name	HEI Name	Green Cover on Campus	Surface Water	Rooftop Water	Rooftop Solar System	Waste Management
1	Assam	Cachar	Assam University Silchar	A+	A+	A	A+	A+
2	Assam	Cachar	Cachar College Silchar	A+	A	B	C	A
3	Assam	Cachar	Gurucharan College	A+	B	C+	C	A
4	Assam	Cachar	N.C Paul Memorial College	A+	C+	c	C	C+
5	Assam	Cachar	Radhamadhab College Silchar	A+	B	C+	C	C
6	Assam	Cachar	Ramanuj Gupta Degree college	A+	A	A	A+	A
7	Assam	Cachar	Silchar College	A+	C	B+	c	B+
8	Assam	Cachar	Silchar College of Education	A	B	B	B	C
9	Assam	Cachar	Teacher Training College	A+	B+	B	C	C+
10	Assam	Cachar	Women's college Silchar	A+	A	A	C+	C+
11	Assam	Kamrup Metropolita	Arya Vidyapeeth College Autonomous	B+	B+	A+	C+	B+
12	Assam	Kamrup Metropolita	Assam down town University	A+	A+	A+	C+	B+
13	Assam	Kamrup Metropolita	B Borooah College	C+	B+	B+	C+	A+
14	Assam	Kamrup Metropolita	Dispur College	A	C	B	C+	B+
15	Assam	Kamrup Metropolita	Gauhati Commerce College	A+	A+	B+	B+	A+
16	Assam	Kamrup Metropolita	Handique Girls' College	B+	C	C+	C+	C
			K C Das Commerce					

L1185

	A	B	C	D	E	F	G	H	I
1177	1175	Telangana	Rangareddi	Annamacharya institute of Tech&science, Rangareedi District and	B+	B+	B+	C+	C+
1178	1176	Telangana	Rangareddi	Aristotle College of management Rangareedi District and Telangana	A+	A	C	C	B+
1179	1177	Telangana	Rangareddi	Govt Degree college Maheshwaram Rangareedi District and	A+	C	C	C	C
1180	1178	Telangana	Rangareddi	Govt Polytechnic for Women Rangareedi District and Telangana	A+	B+	B+	C+	B
1181	1179	Telangana	Rangareddi	K G Reddy College of Engg, Rangareddi District and Telangana	A+	A+	A+	C+	A+
1182	1180	Telangana	Rangareddi	Maturi Venkata Subba Rao Engg college, Rangareedi	A+	A	A+	A+	A
1183	1181	Telangana	Rangareddi	Sri Indu college of Engg and Tech Rangareedi District and Telangana	A+	B+	C	B+	C+
1184	1182	Telangana	Rangareddi	St.Ann's P.G college for women Rangareedi District and Telangana	A+	A	A+	C	B+
1185	1183	Telangana	Rangareddi	TKR College Rangareedi District and Telangana	A+	A+	C+	B	B
1186	1184	Telangana	Rangareddi	Vidya Jyothi institute of Technology Rangareedi District and Telangana	A+	B+	A	B+	A+
1187	1185	Telangana	WARANGAL	ASM Degree College for Women's, Warangal	A+	A+	A+	A+	A+

NRISG

The first picture shows the attributes of NRISG(22-23) and TKR College of Engineering and Technology is highlighted in second picture.

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ENERGY AUDIT

SRI GAYATRI ENERGY SERVICES

we support you conserve

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Email:srigayatrienergyservices@gmail.com

CERTIFICATE

We here by certify that we carried out Energy Audit in the M/s **TKR College of Engineering & Technology** Hyderabad, Telangana during **27 November 2021** and following Observations were presented below. The Energy Bills were analyzed for energy consumption ,Power factor , Electrical Load distribution , Distribution Losses if any and Recommendation to reduce the same. We appreciate the efforts of the M/s **TKR College of Engineering & Technology,** Medibowli, Hyderabad ,Telangana for their Pro-Energy Conservation measures in this regard.

For M/s **Sri Gayatri Energy Services**

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Energy Audit Report
of

M/s TKR College of Engineering & Technology

Medbowli, Hyderabad

2021-22

By

SRI GAYATRI ENERGY SERVICES

We support you conserve

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Contents

ACKNOWLEDGEMENT 3

Disclaimer 4

Audit Study team 5

LIST OF INSTRUMENTS USED 5

CERTIFICATE 6

Executive Summary of Observations 7

Detailed Walk Through Energy Audit scope of work 8

Introduction of the Institution 9

Facility Description 9

Electrical Load Distribution 11

HVAC- Air Conditioning Systems 14

Introduction of Air Conditioning & Refrigeration System 15

Maintenance & Electrical Safety 18

Annexure I 20

Annexure -II -Abbreviations &Definitions 21

Annexure :3 HVAC 23

Annexure - 4 Lighting 24

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ACKNOWLEDGEMENT

M/s **Sri Gayatri Energy Services**, Hyderabad places on record its sincere thanks to progressive management of M/s **TKR College of Engineering & Technology** , Medibowli, Hyderabad, Telangana for entrusting the Energy Audit work of their College.

The study team is appreciative of the keen interest and encouragement shown by

1. Dr Shri **T. Harinath Reddy** - Secretary

2. Shri **T. Amarnath Reddy** – Treasurer

3. Dr. Shri **D.V. Ravi Shankar** – Principal

4. Dr. Shri **K. Raju** – Coordinator

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While implementing the recommendations site inspection should be done to constitute professional approach and adequacy of the site to be established without ambiguity and we exclude all representations and warranties relating to the content and use of this report.

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This is a walk through Audit conducted on request of M/s **TKR College of Engineering & Technology.**

Exceptions

Nothing in this disclaimer notice excludes or limits any warranty implied by law for death, fraud, personal injury through negligence, or anything else which it would not be lawful for to exclude.

We trust the data provided by the M/s **TKR College of Engineering & Technology** (Autonomous) Medibowli , Hyderabad, Telangana personnel is true to their best of knowledge and a preliminary Report was generated ,we didn't verify the correctness of it.

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Audit Study team	
Shri D.S.R.Murthy	Senior Energy Auditor
Shri Durga Rao	Engineer
Shri Sai Ganesh	Engineer

LIST OF INSTRUMENTS USED

- True RMS Power Meter
- Digital Earth Resistance meter (Clamp Type)
- Digital Earth Resistance Meter (Conventional Type , Kyoritsu, Japan)
- Digital Infrared Thermometer (Fluke)

CERTIFICATE

We here by certify that we carried out Energy Audit in the M/s **TKR College of Engineering & Technology** Hyderabad, Telangana during **2 December 2022** and following Observations were presented below. The Energy Bills were analyzed for energy consumption ,Power factor , Electrical Load distribution , Distribution Losses if any and Recommendation to reduce the same. We appreciate the efforts of the M/s **TKR College of Engineering & Technology,** Medibowli, Hyderabad ,Telangana for their Pro-Energy Conservation measures in this regard.

For M/s **Sri Gayatri Energy Services**

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Executive Summary of Observations

1. A Detailed Walk Through Energy Audit is carried out at the Campus with following observations.
2. The Power Factor at the Main Incoming panel (after Transformer) is satisfactory .
3. It is observed that the Demand is exceeding the CMD in couple of months and it is recommended to enhance the CMD to avoid the penalties.
4. It is observed that the Existing Fans installed are Energy Inefficient fans which may be replaced as and when opportunity comes with Energy Efficient one which result in energy savings (Detailed Calculation is enclosed).
5. The Loading of the UPS is observed to be moderate, where ever they are found to be low , it is recommended to check for the opportunity to shift the load to the other UPS and switch off the lowly loaded UPS to reduce the losses.
6. It is observed that some of the Split AC's installed are not of star rated , it is recommended to replace them with minimum 3 star rated AC's as and when the opportunity comes
7. It is recommended to replace the existing inefficient light fittings with efficient Light fittings.

Detailed Walk Through Energy Audit scope of work

1. Physical inspection of the premises with reference to Energy Efficient equipment/ Energy Conservation measures/ Renewable Energy.
2. Identifying the Energy saving Opportunities within the premises by installing efficient equipment /devices / system of the electrical installation.
3. Identifying the Energy Saving opportunities by adopting continuous suitable monitoring methods

Project Schedule :

1. Walk Through Audit : 1 day
2. Report generation : 2-3 Days

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Introduction of the Institution

TKR College of Engineering and Technology – a modern temple of learning, an off shoot of the TKR Educational Society was established in the year 2002 in a sprawling, lush green 20 acre campus at Meerpet, Hyderabad. The college provides a serene and tranquil environment to the students, boosting their mental potential and preparing them in all aspects to face the cut- throat global competition with a smile on the face and emerge victorious.

Sri Teegala Krishna Reddy, the Mayor of Hyderabad, is the founder chairman of TKR Educational Society. A Philanthropist by nature, "the friend of man, to vice alone of foe", and an urge to see our students excelling themselves in all fields prompted him to start the educational society; making it easy for education to be within arm's length of even a rural student and providing them with an independent and easy in the for pursuing their dreams and making them come true and in the process upholding moral and ethical values.

Facility Description

The Facility Receives Power supply from TSSPDCL at 11 KV, the installed transformer is 11 KV/433 V transformer of 400 KVA and the Contracted Maximum Demand with TSSPDCL is 350 KVA, The total connected Load is around 851 KW.
Hence it is recommended to reduce the same.

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Electrical Load Distribution

The Incoming power supply is from a 11 KV TSSPDCL ,with one Transformers of rating 11kV/433 V 400 KVA , The total connected load is around 851 KW . The emergency supply. taken care by DG Sets . All the three Blocks are equipped with UPS supply for Power back up for the computer systems. The details of the connected Load across the campus is given below

Total Connected Load , kW													
	Lighting			Fans			Split AC's			Computers			Total Connected Load , kW
Location	Qty	Rating(W)	Load,kW	Qty	Rating(W)	Load,kW	Qty	Rating(W)	Load,kW	Qty	Rating(W)	Load,kW	
G Floor	300	36	10.8	250	80	20	20	1.175	23.5	60	250	15.00	69.30
1 st Floor	405	36	14.58	350	80	28	40	1.175	47	98	285	27.93	117.51
2nd Floor	800	36	28.8	700	80	56	20	1.175	23.5	390	325	126.75	235.05
3rd Floor	850	36	30.6	650	80	52	10	1.175	11.75	548	350	191.80	286.15
4th Floor	800	36	28.8	680	80	54.4	10	1.175	11.75	54	300	16.20	111.15
T Block	95	36	3.42	45	80	3.6	8	1.175	9.4	55	265	14.525	31.00
													851.16

The Power Measurements are carried out

Power Measurements AY 2020						
Location	Phase	Voltage	Ampere	kVA	Power factor	kW
Main Incoming Power Supply	R	237.8	454	103.2	0.98	105.4
	Y	238.5	463	106.9	0.995	107.53
	B	241.8	471	108.3	0.96	112.9

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The Energy Bills Analysis is carried out to Understanding the Consumption pattern of the Institute

TKR College of Engineering and Technology , Medibowli, Hyderabad 2021-22											
	UNITS							CHARGES			
Month	KWH	KVAH	PF	Actual KVA	Billed KVA	TOD1	TOD2	Demand	Energy	TOD	Total
NOV22	92935	94215	0.98641	309	309	16857	13447	147060	829092	30304	1012108
OCT22	73597	74488	0.98804	303	303	12577	10344	144210	655494	22921	827094
SEP22	97398	98517	0.98864	328	328	16343	14081	156085	866949	30424	1059369
AUG22	88743	90025	0.98576	356	356	15277	12702	166250	792220	27979	998120
JULY22	75871	76876	0.98693	327	327	12166	11128	155325	676508	23294	859740
JUN22	124870	127665	0.97811	469	469	17265	16542	166250	1291969	38878	1617997
MAY22	117358	120280	0.97571	467	467	16559	15312	13060	938184	31871	1519291
APR22	107633	109867	0.97967	424	424	16053	15179	165360	856962	31232	1233335
MAR22	88544	90250	0.9811	349	349	15596	12824	136344	703950	28420	874129
FEB22	60598	62465	0.97011	280	280	11267	8772	109200	487227	20039	620213
JAN22	58672	60325	0.9726	280	280	11410	8979	109200	470535	20389	603743
DEC21	89868	92296	0.97369	293	293	16508	13099	11420	719908	29607	869323

Saving Opportunities

1. The Actual Demand is observed to be recorded more than the CMD, it is recommended to enhance the CMD to 450 kVA to avoid paying penalty of Rs 3,0020/- every month.
2. The Individual Floor Wise Power Factor to be improved to reduce the losses .

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Introduction of Air Conditioning & Refrigeration System:

The present Air conditioning system in the college is of Package Units, Split Air Conditioning units of star rated.The Air conditioning is analyzed for energy saving opportunities .The detailed measurements are taken on sample basis at some of the locations .

The Measurements of sample Split AC units are done in blocks and tabulated below

Split Air Conditioners 2021-22												
Sl. No	Location	No. of A.C. Unit	Type of A.C.	Rated TR	Power kw	Inlet Temp.(°c)	Outlet Temp.(°c)	Flow m/sec	Arrived TR	Specific Power KW/TR	COP	EER
1	Ground Floor	1	Split AC	1.5	1.152	23.7	20.5	0.38	1.53	0.75	4.67	15.95
2	First Floor	1	Split AC	1.5	1.225	24.2	22.3	0.75	1.79	0.68	5.14	17.55
3	Second Floor	1	Split AC	1.5	1.25	25.1	23.1	0.45	1.13	1.10	3.18	10.86
4	Third Floor	1	Split AC	1.5	1.32	23.2	22.3	0.83	0.94	1.41	2.50	8.54
5	Fourth Floor	1	Split AC	1.5	1.48	24.3	22.8	0.63	1.19	1.25	2.82	9.63
6	Computer Lab	1	Split AC	1.5	1.25	24.5	23.5	0.83	1.04	1.20	2.93	10.02
7	T Block	1	Split AC	1.5	1.25	25.3	24.6	0.83	0.73	1.71	2.05	7.01

Energy Efficiency Opportunities

Reduce heat loads

Any reduction in heat loads results in a reduction in required refrigeration capacity and therefore energy consumption. There

are three main methods for reducing heat loads:

- Improving insulation.

- Reducing air leakage.

-Reducing incidental and auxiliary gains.

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Insulation improvements

The walls of a refrigerated space should be well maintained to guard against damage or degradation of the insulating material.

visual inspection will give first indications of problems while thermographic inspection will show up cold areas where insulation is poor.

- Air leakage

Air can leak through the degraded fabric of an enclosure or through an access such as a door. Taking the steps outlined above should prevent fabric leakage, while reducing air leakage through doors is outlined below:

Reduce temperature lifts

The efficiency of refrigerating plant is dependent upon the size of the temperature lift between the evaporator and the condenser: the smaller the lift the more efficient the system.

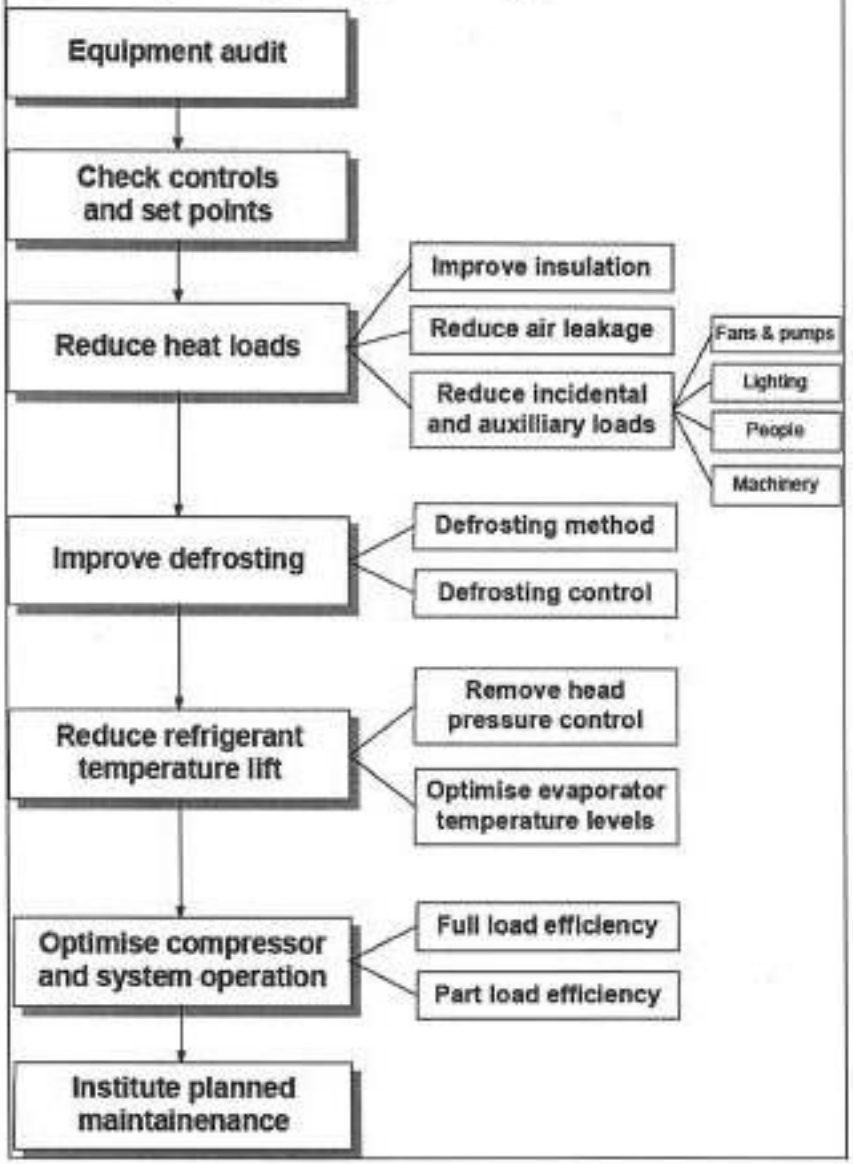
- Head pressure control

Many systems maintain a higher lift than is necessary through the use of head pressure control. This practice aims to maintain ahigh pressure in the condenser to ensure a controlled supply of refrigerant to the evaporator. The control pressure can be reduced using a balanced port thermostatic expansion valve or an electronic expansion valve, while the installation of a liquid line pump can further reduce the need for such control. Lowering the control pressure allows the condensing pressure to fall as the outside temperature falls

from the design condition and can improve energy efficiency by5o%, particularly during winter. The cost of these measures varies between 15,000 to 150000 if installed at the time of refrigerant replacement and will normally pay back in about two years.

The Package Units measurements are carried out on sample basis at various locations and following are the details tabulated calculating the SPC (Specific Power Consumption) , EER(Energy Efficiency Ratio), COP(Coefficient of Performance) .

Figure 1: Optimising energy efficiency



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1. **Electrical Single Line Diagram / Lay Out Diagram / Equipment Layout / Electrical Control diagram**

   i. Check for Unauthorized Temporary Installations
   ii. Modification to be Updated
   iii. SLD reflects the actual installation
   iv. Duly approved by statutory authorities

2. **Importance of Electrical Safety in the Overall Safety System**

   Periodicity of comprehensive Electrical Safety check

   i. Understanding of electrical hazards
   ii. Electrical checkpoints in the safety checklist
   iii. Implementation priority for electrical hazards
   iv. Electrical Work Permit System
   v. Safe Electrical Operating Procedures

3 **Electrical Preventive Maintenance**

   i. Is there an Electrical Preventive Maintenance programme in place
   ii. Is the programme implemented? What is the slippage?
   iii. Are the relevant standards (statutes and non-statutory) referred and incorporated in the EPM programme?
   iv. Electrical Tests, Records, Test Procedure and periodicity (earth resistance, insulation resistance tests)
   v. Is the EPM programme only documented?
   vi. Transformer tests (dielectric strength, acidity, sludge deposits, dissolved gases, etc.) and periodicity
   vii. Periodic calibration of meters (ammeter, voltmeter, relays, temperature gauges) and test instruments (insulation resistance megger, earth resistance megger, multi-meters, etc.)

4 **Earthing System**

   i. Installation as per approved design?
   ii. Installation and Maintenance as per IS 3043?
   iii. Earth resistance measured periodically?
   iv. Test procedure
   v. Acceptable earth resistance values
   vi. Is the earthing system modified when electrical installation is modified?
   vii. Are neutral earth pits independent and separate?
   viii. Are earth pits identified?
   ix. Are two and distinct earth connections provided?
   x. Is the earth continuity tested?
   xi. Is bonding and earthing carried out to avoid ESD hazards?

Annexure I

Conversion factors

CONVERSION TABLES

1 Kcal	3.9685 Btu
1 KWh	3413 Btu
1 KWh	860 kcal
1 Btu	1.055 kJ
1 calorie	4.186 joules
1 hp	746 Watts
1 kg	2.2 lb (pounds)
1 meters	3.28 feet
1 inch	2.54 cm
1 kg/cm²	14.22 psi
1 atmosphere	1.0332 kg/cm²
1 kg/cm²	10 meters of water column @ 4 °C
1 kg/cm²	9.807 × 10 4 passels
1 Ton of Refrigeration	3023 kcal/hour
1 Ton of Refrigeration	12000 Btu/hour
1 US Gallon	3.785 liters
1 imperial Gallon	4.546 liters
°F	1.8 × °C + 32
°k	°c + 273

Annexure -II -Abbreviations &Definitions

Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
Btu	British thermal unit
Btu/ft2	British thermal units per square foot
J/m²	Joules per square meter
kVA	kilovolt-amperes
kW	kilowatts
kWh	kilowatt-hours
kWh/m²	kilowatt-hours per square meter

Definitions:

Basic definitions of terms

Absorber. The component of the vapour absorption chilling package wherein the refrigerant vapour is absorbed by the liquid absorbent.

Air Handling Unit. An air cooling unit, consisting of a blower or blowers, heat exchanger and filters with refrigerant, chilled water or brine on the tube side to perform one or more of the functions of circulating, cooling, cleaning, humidifying, dehumidifying and mixing of air.

Brine. Solution of anti-freeze substances like Sodium Chloride, Calcium Chloride, Mono-ethylene Glycol, Ethyl Alcohol etc.

Coefficient of Performance. The ratio of Net Refrigerating Effect divided by Compressor Shaft Power or Thermal Power Input. The numerator and denominator should be in the same measuring units.

Compressors. Machines in which compression of refrigerant vapour is effected by the positive action of linear motion of pistons, rotating elements (screws, vanes, scrolls etc.) or conversion of velocity energy to pressure in a centrifugal device.

Compressor, hermetic. Sealed compressor & motor unit, where the electric motor is cooled by the refrigerant and both the compressor and electric motor are not accessible for maintenance.

Compressor, open. Compressor is externally coupled to the prime mover and the refrigerant does not cool the prime mover.

Compressor, semi-hermetic. Compressor motor unit, where the electric motor is cooled by the refrigerant and the compressor is accessible for maintenance.

Condenser. The heat exchanger, which utilizes refrigerant to water/air heat transfer, causing the refrigerant to condense and the water/air to be heated. De-superheating or sub-cooling of the refrigerant may also occur.

Energy Efficiency Ratio. The ratio of Net Refrigerating Effect (Btu/hr) divided by Shaft Power (Watts) or Thermal Power Input (Watts) consumed.

Electric Motor. Electrically operated rotary prime mover.

Enthalpy. The heat content of a substance at a particular temperature.

Engine. Internal combustion engine used as prime mover.

Evaporator. The heat exchanger wherein the refrigerant evaporates and, in the process, cools another fluid l(generally water, brine or air).

Fluid. The substance that is usefully cooled in the chilling package (generally water, brine or air).

Generator. The component of a vapor absorption chilling package wherein the absorbent solution is heated to evaporate the refrigerant and concentrate the absorbent.

Gross Calorific Value. The amount of heat produced per unit of fuel when complete combustion takes place at constant pressure, the products of combustion are cooled to the initial temperature of the fuel and air, and the vapor formed during combustion is condensed.

Net Refrigeration Effect. The useful cooling effect (or heat removal) in the evaporator.

Psychometric Chart. A chart or plotted curves showing the various parameters of air at different temperatures at atmospheric pressure. The parameters shown include dry bulb temperature, wet bulb temperature, relative humidity, moisture content, enthalpy and sensible heat factor.

Refrigerant. The substance that evaporates in the evaporator to provide cooling effect.

Shaft Power. Power at the shaft of any rotary equipment.

Specific Fuel Consumption. The ratio of Thermal Power Input (kg/h of liquid fuel or m3/h of gaseous fuel consumed to the Net Refrigerating Effect (Tons of Refrigeration).

Specific humidity. Mass of water vapor per unit mass of dry air.

Specific Power Consumption. The ratio of Shaft Power (kW) to the Net Refrigerating Effect (Tons of Refrigeration).

Specific Steam Consumption. The ratio of Thermal Power Input (kg/h of steam) to the Net Refrigerating Effect (Tons of Refrigeration).

Speed. The number of revolutions per minute of the shaft.

Temperature, dry bulb. The temperature indicated by any temperature sensing element when held in air.

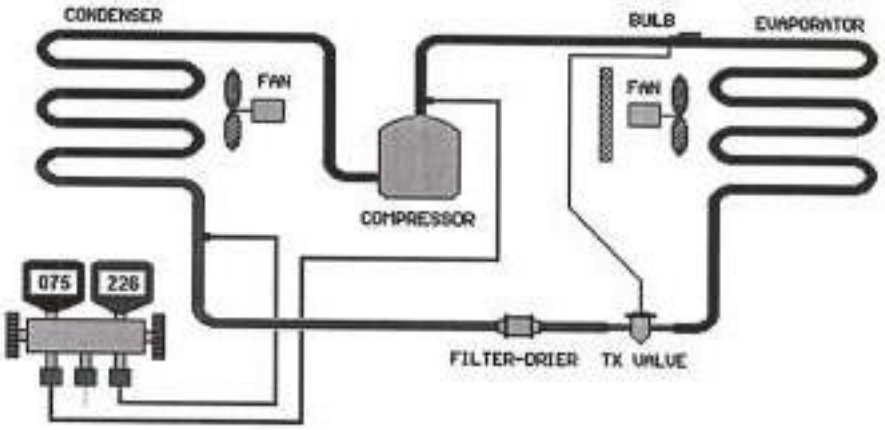
Temperature, Inlet. Temperature measured at the inlet stream of the heat exchanger.

Temperature, Outlet. Temperature measured at the outlet stream of the heat exchanger

Annexure :3 HVAC

Introduction & back ground

Refrigeration Basics



- Refrigeration is the removal of heat from a material or space, so that it's temperature is lower than that of its surroundings.
- When refrigerant absorbs the unwanted heat, this raises the refrigerant's temperature ("Saturation Temperature") so that it changes from a liquid to a gas — it evaporates. The system then uses condensation to release the heat and change the refrigerant back into a liquid. This is called "Latent Heat".
- This cycle is based on the physical principle, that a liquid extracts heat from the surrounding area as it expands (boils) into a gas.
- To accomplish this, the refrigerant is pumped through a closed looped pipe system.
- The closed looped pipe system stops the refrigerant from becoming contaminated and controls its stream. The refrigerant will be both a vapor and a liquid in the loop.

Annexure - 4 Lighting

Recommended illumination Levels as Per IS 3646 Part I-1992			
Type of Interior Activity	Range of Service Illuminanace in Lux	Quality Class of Direct Glare Limitation	Remarks
Education			
Assembly Halls	200-300-500	3	
Teaching Spaces	200-300-500	1	
Lecture Theatres			
i) General	200-300-500	1	
ii) Demo Benches	300-500-700	1	Localized Lighting may be appropriate
iii) Seminar Rooms	300-500-750	1	
iv) Art Rooms	300-500-750	1	
v) laboratories	300-500-750	1	
vi) Libraries	200-300-500	1	
vii)Music Rooms	200-300-500	1	
viii) Sports Hall	200-300-500	1	
ix) Work Shop	200-300-500	1	
x)Computer Work station	300-500-750	1	
xi)Bath Rooms	50-100-150		Supplementary local lighting near mirror
xii) Office Rooms	300-500-750	1	
xiii) Entrance Halls, Lobbies	150-200-300	2	
xiv) Corridors, Passageway, Stairs	50-100-150	2	

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Light Source Comparison			
Attributes	Incandescent	CFL	LED
Colur Rendering Index	100	Greater than 80	40-80
Watts/ Lamp	100	23	1
Lumen/Lamp	1600	1600	30
Lumen/Watt	16	60-80	20-30
Life (Hrs)	750	8000	50,000

Colour Rendering Index

1500 K	Candlelight
2680 K	40 W incandescent lamp
3000 K	200 W incandescent lamp
3200 K	Sunrise/sunset
3400 K	Tungsten lamp
3400 K	1 hour from dusk/dawn
5000-4500 K	Xenon lamp/light arc
5500 K	Sunny daylight around noon
5500-5600 K	Electronic photo flash
6500-7500 K	Overcast sky
9000-12000 K	Blue sky

Energy Audit Report
of

M/s TKR College of Engineering & Technology

Medibowli, Hyderabad

2020-21

By

SRI GAYATRI ENERGY SERVICES

we support you conserve

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Contents

ACKNOWLEDGEMENT 3

Disclaimer 4

Audit Study team 5

LIST OF INSTRUMENTS USED 5

CERTIFICATE 6

Executive Summary of Observations 7

Detailed Walk Through Energy Audit scope of work 8

Introduction of the Institution 9

Facility Description 9

Electrical Load Distribution 11

HVAC- Air Conditioning Systems 14

Introduction of Air Conditioning & Refrigeration System 15

Maintenance & Electrical Safety 18

Annexure I 20

Annexure -II -Abbreviations &Definitions 21

Annexure :3 HVAC 23

Annexure - 4 Lighting 24

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ACKNOWLEDGEMENT

M/s **Sri Gayatri Energy Services,** Hyderabad places on record its sincere thanks to progressive management of M/s **TKR College of Engineering & Technology** , Medibowli, Hyderabad, Telangana for entrusting the Energy Audit work of their College.

The study team is appreciative of the keen interest and encouragement shown by

1. Dr Shri **T. Harinath Reddy** - Secretary

2. Shri **T. Amarnath Reddy** – Treasurer

3. Dr. Shri **D.V. Ravi Shankar** – Principal

4. Dr. Shri **K. Raju** – Coordinator

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Disclaimer

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While implementing the recommendations site inspection should be done to constitute professional approach and adequacy of the site to be established without ambiguity and we exclude all representations and warranties relating to the content and use of this report.

In no event We will be liable for any incidental, indirect, consequential or special damages of any kind, or any damages whatsoever, including, without limitation, those resulting from loss of profit, loss of contracts, goodwill, data, information, income, anticipated savings or business relationships, whether or not advised of the possibility of such damage, arising out of or in connection with the use of this report..

This is a walk through Audit conducted on request of M/s **TKR College of Engineering & Technology.**

Exceptions

Nothing in this disclaimer notice excludes or limits any warranty implied by law for death, fraud, personal injury through negligence, or anything else which it would not be lawful for to exclude.

We trust the data provided by the M/s **TKR College of Engineering & Technology** (Autonomous) Medibowli , Hyderabad, Telangana personnel is true to their best of knowledge and a preliminary Report was generated, we didn't verify the correctness of it.

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Audit Study team	
Shri D.S.R.Murthy	Senior Energy Auditor
Shri Durga Rao	Engineer
Shri Sai Ganesh	Engineer

LIST OF INSTRUMENTS USED

- True RMS Power Meter
- Digital Earth Resistance meter (Clamp Type)
- Digital Earth Resistance Meter (Conventional Type , Kyoritsu, Japan)
- Digital Infrared Thermometer (Fluke)

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CERTIFICATE

We here by certify that we carried out Energy Audit in the M/s **TKR College of Engineering & Technology** Hyderabad, Telangana during **27 November 2021** and following Observations were presented below. The Energy Bills were analyzed for energy consumption ,Power factor , Electrical Load distribution , Distribution Losses if any and Recommendation to reduce the same. We appreciate the efforts of the M/s **TKR College of Engineering & Technology,** Medbowli, Hyderabad ,Telangana for their Pro-Energy Conservation measures in this regard.

For M/s **Sri Gayatri Energy Services**

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Executive Summary of Observations

1. A Detailed Walk Through Energy Audit is carried out at the Campus with following observations.
2. The Power Factor at the Main Incoming panel (after Transformer) is satisfactory .
3. It is observed that the Demand is exceeding the CMD in couple of months and it is recommended to enhance the CMD to avoid the penalties.
4. It is observed that the Existing Fans installed are Energy Inefficient fans which may be replaced as and when opportunity comes with Energy Efficient one which result in energy savings (Detailed Calculation is enclosed).
5. The Loading of the UPS is observed to be moderate, where ever they are found to be low , It is recommended to check for the opportunity to shift the load to the other UPS and switch off the lowly loaded UPS to reduce the losses.
6. It is observed that some of the Split AC's installed are not of star rated , it is recommended to replace them with minimum 3 star rated AC's as and when the opportunity comes
7. It is recommended to replace the existing inefficient light fittings with efficient Light fittings.

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Detailed Walk Through Energy Audit scope of work

1. Physical inspection of the premises with reference to Energy Efficient equipment/ Energy Conservation measures/ Renewable Energy.
2. Identifying the Energy saving Opportunities within the premises by installing efficient equipment /devices / system of the electrical installation.
3. Identifying the Energy Saving opportunities by adopting continuous suitable monitoring methods

Project Schedule :

1. Walk Through Audit : 1 day
2. Report generation : 2-3 Days

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Introduction of the Institution

TKR College of Engineering and Technology – a modern temple of learning, an off shoot of the TKR Educational Society was established in the year 2002 in a sprawling, lush green 20 acre campus at Meerpet, Hyderabad. The college provides a serene and tranquil environment to the students, boosting their mental potential and preparing them in all aspects to face the cut- throat global competition with a smile on the face and emerge victorious.

Sri Teegala Krishna Reddy, the Mayor of Hyderabad, is the founder chairman of TKR Educational Society. A Philanthropist by nature, "the friend of man, to vice alone of foe", and an urge to see our students excelling themselves in all fields prompted him to start the educational society; making it easy for education to be within arm's length of even a rural student and providing them with an independent and easy in the for pursuing their dreams and making them come true and in the process upholding moral and ethical values.

Facility Description

The Facility Receives Power supply from TSSPDCL at 11 KV, the installed transformer is 11 KV/433 V transformer of 400 KVA and the Contracted Maximum Demand with TSSPDCL is 350 KVA, The total connected Load is around 810 KW.
Hence it is recommended to reduce the same.

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Electrical Load Distribution

The Incoming power supply is from a 11 KV TSSPDCL ,with one Transformers of rating 11kV/433 V 400 KVA , The total connected load is around 810.39 KW . The emergency supply. taken care by DG Sets . All the three Blocks are equipped with UPS supply for Power back up for the computer systems. The details of the connected Load across the campus is given below

Total Connected Load , kW													
	Lighting			Fans			Split AC's			Computers			Total Connected Load , kW
Location	Qty	Rating(W)	Load,kW	Qty	Rating(W)	Load,kW	Qty	Rating(W)	Load,kW	Qty	Rating(W)	Load,kW	
G Floor	275	36	9.9	225	80	18	18	1.175	21.15	60	250	15.00	64.05
1 st Floor	396	36	14.256	342	80	27.36	35	1.175	41.125	98	285	27.93	110.67
2nd Floor	790	36	28.44	690	80	55.2	17	1.175	19.975	375	325	121.88	225.49
3rd Floor	825	36	29.7	625	80	50	7	1.175	8.225	535	350	187.25	275.18
4th Floor	775	36	27.9	665	80	53.2	6	1.175	7.05	54	300	16.20	104.35
T Block	90	36	3.24	43	80	3.44	8	1.175	9.4	55	265	14.575	30.66
													810.39

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The Power Measurements are carried out

Power Measurements AY 2021						
Location	Phase	Voltage	Ampere	kVA	Power factor	kW
Main Incoming Power Supply	R	237.8	437.69	99.96	0.98	102
	Y	238.5	423.65	93.12	0.96	97
	B	241.8	480.27	100.44	0.93	108

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The Energy Bills Analysis is carried out to Understanding the Consumption pattern of the Institute

TKR College of Engineering and Technology , Medibowli, Hyderabad 2021-22											
	UNITS							CHARGES			
Month	KWH	KVAH	PF	Actual KVA	Billed KVA	TOD1	TOD2	Demand	Energy	TOD	Total
NOV21	81842	84397	0.9697	303	303	14389	11584	118326	658296	25973	807659
OCT21	80322	82509	0.9735	322	322	16354	11970	125736	643570	28324	802580
SEP21	72544	74512	0.9736	384	384	8412	9710	136500	581193	18122	766962
AUG21	83889	85873	0.9769	292	292	13826	12072	114036	669809	25898	814895
JULY21	62942	64254	0.9796	292	292	9824	8142	114192	501204	17966	637218
JUN21	23539	24264	0.9701	280	280	4190	3645	109200	189259	7835	302585
MAY21	34604	35588	0.9724	280	280	5018	4554	109200	277586	9572	391513
APR21	52356	53516	0.9783	280	280	6806	6546	109200	417424	13352	470667
MAR21	82300	84054	0.9791	302	302	12560	12280	117780	655621	24840	788755
FEB21	59330	61032	0.9721	280	280	9972	8776	109200	476049	18748	597424
JAN21	35398	36788	0.9622	280	280	5930	5170	109200	286946	11100	409453
DEC20	44762	46334	0.9661	280	280	7442	7592	109200	361405	15034	488419

Saving Opportunities

1. The Actual Demand is observed to be recorded more than the CMD, it is recommended to enhance the CMD to 425 KVA from 350 KVA and there by Demand charges savings of Rs 16150/- on account of Demand Charges.
2. The Individual Floor Wise Power Factor to be improved to reduce the losses .

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Introduction of Air Conditioning & Refrigeration System:

The present Air conditioning system in the college is of Package Units, Split Air Conditioning units of star rated.The Air conditioning is analyzed for energy saving opportunities .The detailed measurements are taken on sample basis at some of the locations .

The Measurements of sample Split AC units are done in blocks and tabulated below

Split Air Conditioners 2021

Sl. No	Location	No. of A.C. Unit	Type of A.C.	Rated TR	Power kw	Inlet Temp.(°c)	Outlet Temp.(°c)	Flow m/sec	Arrived TR	Specific Power KW/TR	COP	EER
1	Ground Floor	1	Split AC	1.5	1.152	25.4	23.1	0.45	1.30	0.89	3.97	13.57
2	First Floor	1	Split AC	1.5	1.225	23.7	22.3	0.75	1.32	0.93	3.79	12.93
3	Second Floor	1	Split AC	1.5	1.35	25.4	23.1	0.45	1.30	1.04	3.39	11.57
4	Third Floor	1	Split AC	1.5	1.375	23.2	22.3	0.83	0.94	1.46	2.40	8.20
5	Fourth Floor	1	Split AC	1.5	1.65	24.3	22.8	0.63	1.19	1.39	2.53	8.64
6	Computer Lab	1	Split AC	1.5	1.25	24.5	23.5	0.83	1.04	1.20	2.93	10.02

Energy Efficiency Opportunities

Reduce heat loads

Any reduction in heat loads results in a reduction in required refrigeration capacity and therefore energy consumption. There

are three main methods for reducing heat loads:

- Improving insulation.
- Reducing air leakage.
- Reducing incidental and auxiliary gains.

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Insulation improvements

The walls of a refrigerated space should be well maintained to guard against damage or degradation of the insulating material.

visual inspection will give first indications of problems while thermographic inspection will show up cold areas where insulation is poor.

- Air leakage

Air can leak through the degraded fabric of an enclosure or through an access such as a door. Taking the steps outlined above should prevent fabric leakage, while reducing air leakage through doors is outlined below:

Reduce temperature lifts

The efficiency of refrigerating plant is dependent upon the size of the temperature lift between the evaporator and the condenser: the smaller the lift the more efficient the system.

- Head pressure control

Many systems maintain a higher lift than is necessary through the use of head pressure control. This practice aims to maintain ahigh pressure in the condenser to ensure a controlled supply of refrigerant to the evaporator. The control pressure can be reduced using a balanced port thermostatic expansion valve or an electronic expansion valve, while the installation of a liquid line pump can further reduce the need for such control. Lowering the control pressure allows the condensing pressure to fall as the outside temperature falls

from the design condition and can improve energy efficiency by50%, particularly during winter. The cost of these measures varies between 15,000 to 150000 if installed at the time of refrigerant replacement and will normally pay back in about two years.

The Package Units measurements are carried out on sample basis at various locations and following are the details tabulated calculating the SPC (Specific Power Consumption) , EER(Energy Efficiency Ratio), COP(Coefficient of Performance) .

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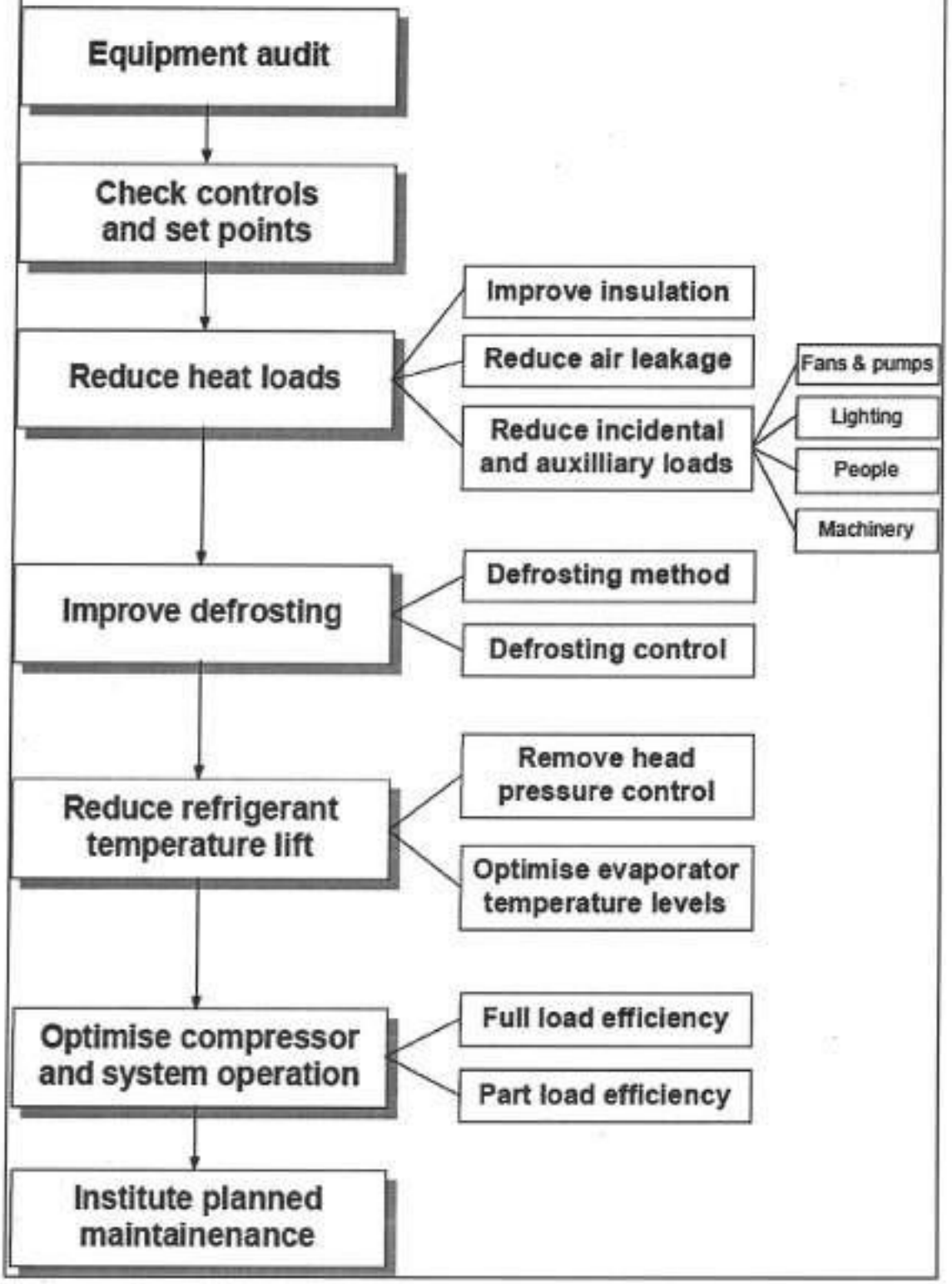
Figure 1: Optimising energy efficiency



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1. **Electrical Single Line Diagram / Lay Out Diagram / Equipment Layout / Electrical Control diagram**
    i. Check for Unauthorized Temporary Installations
    ii. Modification to be Updated
    iii. SLD reflects the actual installation
    iv. Duly approved by statutory authorities

2. **Importance of Electrical Safety in the Overall Safety System**

    Periodicity of comprehensive Electrical Safety check

    i. Understanding of electrical hazards
    ii. Electrical checkpoints in the safety checklist
    iii. Implementation priority for electrical hazards
    iv. Electrical Work Permit System
    v. Safe Electrical Operating Procedures

3 **Electrical Preventive Maintenance**

i. Is there an Electrical Preventive Maintenance programme in place
ii. Is the programme implemented? What is the slippage?
iii. Are the relevant standards (statutes and non-statutory) referred and incorporated in the EPM programme?
iv. Electrical Tests, Records, Test Procedure and periodicity (earth resistance, insulation resistance tests)
v. Is the EPM programme only documented?
vi. Transformer tests (dielectric strength, acidity, sludge deposits, dissolved gases, etc.) and periodicity
vii. Periodic calibration of meters (ammeter, voltmeter, relays, temperature gauges) and test instruments (insulation resistance megger, earth resistance megger, multi-meters, etc.)

4 **Earthing System**

i. Installation as per approved design?
ii. Installation and Maintenance as per IS 3043?
iii. Earth resistance measured periodically?
iv. Test procedure
v. Acceptable earth resistance values
vi. Is the earthing system modified when electrical installation is modified?
vii. Are neutral earth pits independent and separate?
viii. Are earth pits identified?
ix. Are two and distinct earth connections provided?
x. Is the earth continuity tested?
xi. Is bonding and earthing carried out to avoid ESD hazards?

Annexure I

Conversion factors

CONVERSION TABLES

1 Kcal	3.9685 Btu
1 KWh	3413 Btu
1 KWh	860 kcal
1 Btu	1.055 kJ
1 calorie	4.186 joules
1 hp	746 Watts
1 kg	2.2 lb (pounds)
1 meters	3.28 feet
1 inch	2.54 cm
1 kg/cm²	14.22 psi
1 atmosphere	1.0332 kg/cm²
1 kg/cm²	10 meters of water column @ 4 °C
1 kg/cm²	9.807 × 10 4 passels
1 Ton of Refrigeration	3023 kcal/hour
1 Ton of Refrigeration	12000 Btu/hour
1 US Gallon	3.785 liters
1 imperial Gallon	4.546 liters
°F	1.8 × °C + 32
°k	°c + 273

Annexure -II -Abbreviations &Definitions

Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
Btu	British thermal unit
Btu/ft2	British thermal units per square foot
J/m²	Joules per square meter
kVA	kilovolt-amperes
kW	kilowatts
kWh	kilowatt-hours
kWh/m²	kilowatt-hours per square meter

Definitions:

Basic definitions of terms

Absorber. The component of the vapour absorption chilling package wherein the refrigerant vapour is absorbed by the liquid absorbent.

Air Handling Unit. An air cooling unit, consisting of a blower or blowers, heat exchanger and filters with refrigerant, chilled water or brine on the tube side to perform one or more of the functions of circulating, cooling, cleaning, humidifying, dehumidifying and mixing of air.

Brine. Solution of anti-freeze substances like Sodium Chloride, Calcium Chloride, Mono-ethylene Glycol, Ethyl Alcohol etc.

Coefficient of Performance. The ratio of Net Refrigerating Effect divided by Compressor Shaft Power or Thermal Power Input. The numerator and denominator should be in the same measuring units.

Compressors. Machines in which compression of refrigerant vapour is effected by the positive action of linear motion of pistons, rotating elements (screws, vanes, scrolls etc.) or conversion of velocity energy to pressure in a centrifugal device.

Compressor, hermetic. Sealed compressor & motor unit, where the electric motor is cooled by the refrigerant and both the compressor and electric motor are not accessible for maintenance.

Compressor, open. Compressor is externally coupled to the prime mover and the refrigerant does not cool the prime mover.

Compressor, semi-hermetic. Compressor motor unit, where the electric motor is cooled by the refrigerant and the compressor is accessible for maintenance.

Condenser. The heat exchanger, which utilizes refrigerant to water/air heat transfer, causing the refrigerant to condense and the water/air to be heated. De-superheating or sub-cooling of the refrigerant may also occur.

Energy Efficiency Ratio. The ratio of Net Refrigerating Effect (Btu/hr) divided by Shaft Power (Watts) or Thermal Power Input (Watts) consumed.

Electric Motor. Electrically operated rotary prime mover.

Enthalpy. The heat content of a substance at a particular temperature.

Engine. Internal combustion engine used as prime mover.

Evaporator. The heat exchanger wherein the refrigerant evaporates and, in the process, cools another fluid I(generally water, brine or air).

Fluid. The substance that is usefully cooled in the chilling package (generally water, brine or air).

Generator. The component of a vapor absorption chilling package wherein the absorbent solution is heated to evaporate the refrigerant and concentrate the absorbent.

Gross Calorific Value. The amount of heat produced per unit of fuel when complete combustion takes place at constant pressure, the products of combustion are cooled to the initial temperature of the fuel and air, and the vapor formed during combustion is condensed.

Net Refrigeration Effect. The useful cooling effect (or heat removal) in the evaporator.

Psychometric Chart. A chart or plotted curves showing the various parameters of air at different temperatures at atmospheric pressure. The parameters shown include dry bulb temperature, wet bulb temperature, relative humidity, moisture content, enthalpy and sensible heat factor.

Refrigerant. The substance that evaporates in the evaporator to provide cooling effect.

Shaft Power. Power at the shaft of any rotary equipment.

Specific Fuel Consumption. The ratio of Thermal Power Input (kg/h of liquid fuel or m3/h of gaseous fuel consumed to the Net Refrigerating Effect (Tons of Refrigeration).

Specific humidity. Mass of water vapor per unit mass of dry air.

Specific Power Consumption. The ratio of Shaft Power (kW) to the Net Refrigerating Effect (Tons of Refrigeration).

Specific Steam Consumption. The ratio of Thermal Power Input (kg/h of steam) to the Net Refrigerating Effect (Tons of Refrigeration).

Speed. The number of revolutions per minute of the shaft.

Temperature, dry bulb. The temperature indicated by any temperature sensing element when held in air.

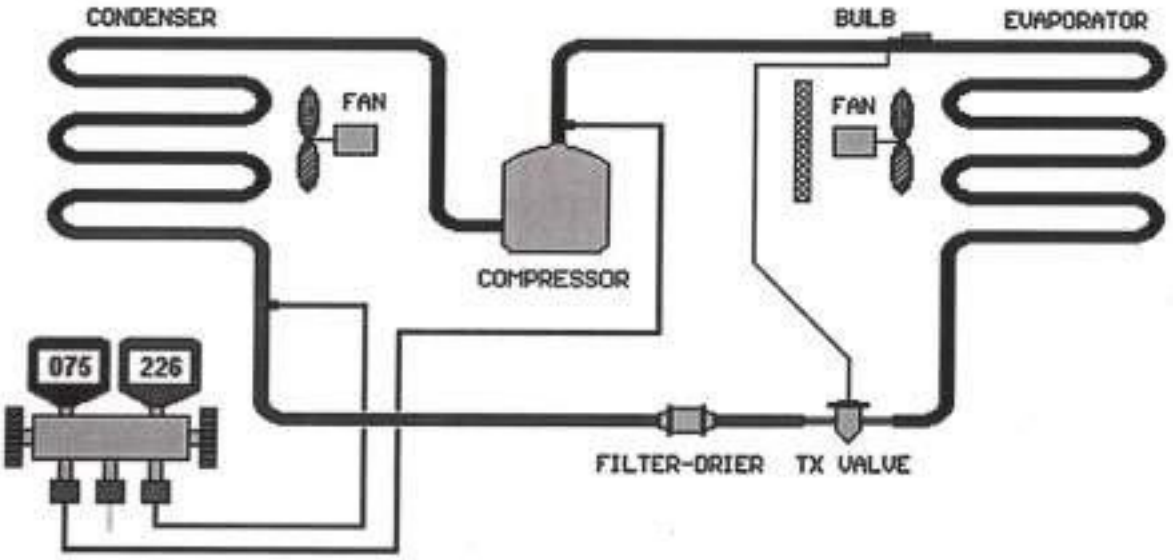
Temperature, Inlet. Temperature measured at the inlet stream of the heat exchanger.

Temperature, Outlet. Temperature measured at the outlet stream of the heat exchanger

Annexure :3 HVAC

Introduction & back ground

Refrigeration Basics



- Refrigeration is the removal of heat from a material or space, so that it's temperature is lower than that of its surroundings.
- When refrigerant absorbs the unwanted heat, this raises the refrigerant's temperature ("Saturation Temperature") so that it changes from a liquid to a gas — it evaporates. The system then uses condensation to release the heat and change the refrigerant back into a liquid. This is called "Latent Heat".
- This cycle is based on the physical principle, that a liquid extracts heat from the surrounding area as it expands (boils) into a gas.
- To accomplish this, the refrigerant is pumped through a closed looped pipe system.
- The closed looped pipe system stops the refrigerant from becoming contaminated and controls its stream. The refrigerant will be both a vapor and a liquid in the loop.

Annexure - 4 Lighting

Recommended Illumination Levels as Per IS 3646 Part I-1992			
Type of Interior Activity	Range of Service Illuminanace in Lux	Quality Class of Direct Glare Limitation	Remarks
Education			
Assembly Halls	200-300-500	3	
Teaching Spaces	200-300-500	1	
Lecture Theatres			
i) General	200-300-500	1	
ii) Demo Benches	300-500-700	1	Localized Lighting may be appropriate
iii) Seminar Rooms	300-500-750	1	
iv) Art Rooms	300-500-750	1	
v) laboratories	300-500-750	1	
vi) Libraries	200-300-500	1	
vii)Music Rooms	200-300-500	1	
viii) Sports Hall	200-300-500	1	
ix) Work Shop	200-300-500	1	
x)Computer Work station	300-500-750	1	
xi)Bath Rooms	50-100-150		Supplementary local lighting near mirror
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xiii) Entrance Halls, Lobbies	150-200-300	2	
xiv) Corridors, Passageway, Stairs	50-100-150	2	

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Light Source Comparison			
Attributes	**Incandescent**	**CFL**	**LED**
Colur Rendering Index	100	Greater than 80	40-80
Watts/ Lamp	100	23	1
Lumen/Lamp	1600	1600	30
Lumen/Watt	16	60-80	20-30
Life (Hrs)	750	8000	50,000

Colour Rendering Index

1500 K	Candlelight
2680 K	40 W incandescent lamp
3000 K	200 W incandescent lamp
3200 K	Sunrise/sunset
3400 K	Tungsten lamp
3400 K	1 hour from dusk/dawn
5000-4500 K	Xenon lamp/light arc
5500 K	Sunny daylight around noon
5500-5600 K	Electronic photo flash
6500-7500 K	Overcast sky
9000-12000 K	Blue sky

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Medbowli, Meerpet, Hyderabad-97.

Energy Audit Report
of

M/s **TKR College of Engineering & Technology**
Medibowli, Hyderabad

2019-20

By

SRI GAYATRI ENERGY SERVICES
we support you conserve

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Contents

ACKNOWLEDGEMENT 3

Disclaimer 4

Audit Study team 5

LIST OF INSTRUMENTS USED 5

CERTIFICATE 6

Executive Summary of Observations 7

Detailed Walk Through Energy Audit scope of work 8

Introduction of the Institution 9

Facility Description 9

Electrical Load Distribution 10

HVAC- Air Conditioning Systems 13

Introduction of Air Conditioning & Refrigeration System 14

Maintenance & Electrical Safety 17

Annexure I 19

Annexure -II -Abbreviations &Definitions 20

Annexure :3 HVAC 22

Annexure - 4 Lighting 23

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M/s **Sri Gayatri Energy Services,** Hyderabad places on record its sincere thanks to progressive management of M/s **TKR College of Engineering & Technology ,** Medbowli , Hyderabad, Telangana for entrusting the Energy Audit work of their College.

The study team is appreciative of the keen interest and encouragement shown by

1. Dr Shri T. Harinath Reddy - Secretary

2. Shri T. Amarnath Reddy – Treasurer

3. Dr Shri D V Ravi Shankar – Principal

4. Dr. Shri K. Raju – Coordinator

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Audit Study team	
Shri D.S.R.Murthy	Senior Energy Auditor
Shri Durga Rao	Engineer
Shri Sai Ganesh	Engineer

LIST OF INSTRUMENTS USED

- True RMS Power Meter
- Digital Earth Resistance meter (Clamp Type)
- Digital Earth Resistance Meter (Conventional Type , Kyoritsu, Japan)
- Digital Infrared Thermometer (Fluke)

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CERTIFICATE

We here by certify that we carried out Energy Audit in the M/s **TKR College of Engineering & Technology** Medbowli, Hyderabad., Telangana during 26 November 2019 and following Observations were presented below. The Energy Bills were analyzed for energy consumption ,Power factor , Electrical Load distribution , Distribution Losses if any and Recommendation to reduce the same. We appreciate the efforts of the M/s **TKR College of Engineering & Technology**, Medbowli, Hyderabad, Telangana for their Pro-Energy Conservation measures in this regard.

For M/s **Sri Gayatri Energy Services**

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Executive Summary of Observations

1. A Detailed Walk Through Energy Audit is carried out at the Campus with following observations.
2. The Power Factor at the Main Incoming panel (after Transformer) is satisfactory .
3. It is observed that some of the Split AC's installed are not of star rated , it is recommended to replace them with minimum 3 star rated AC's as and when the opportunity comes .
4. It is observed that the Existing Fans installed are Energy Inefficient fans which may be replaced as and when opportunity comes with Energy Efficient one which result in energy savings (Detailed Calculation is enclosed).
5. The Loading of the UPS is observed to be moderate, where ever they are found to be low , it is recommended to check for the opportunity to shift the load to the other UPS and switch off the lowly loaded UPS to reduce the losses.
6. The recorded Demand exceeded CMD it is recommended to enhance the CMD .

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Detailed Walk Through Energy Audit scope of work

1. Physical inspection of the premises with reference to Energy Efficient equipment/ Energy Conservation measures/ Renewable Energy.
2. Identifying the Energy saving Opportunities within the premises by installing efficient equipment /devices / system of the electrical installation.
3. Identifying the Energy Saving opportunities by adopting continuous suitable monitoring methods

Project Schedule :

1. Walk Through Audit : 1 day
2. Report generation : 2-3 Days

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Introduction of the Institution

TKR College of Engineering and Technology – a modern temple of learning, an off shoot of the TKR Educational Society was established in the year 2002 in a sprawling, lush green 20 acre campus at Meerpet, Hyderabad. The college provides a serene and tranquil environment to the students, boosting their mental potential and preparing them in all aspects to face the cut- throat global competition with a smile on the face and emerge victorious.

Sri Teegala Krishna Reddy, the Mayor of Hyderabad, is the founder chairman of TKR Educational Society. A Philanthropist by nature, "the friend of man, to vice alone of foe", and an urge to see our students excelling themselves in all fields prompted him to start the educational society; making it easy for education to be within arm's length of even a rural student and providing them with an independent and easy in the for pursuing their dreams and making them come true and in the process upholding moral and ethical values.

Facility Description

The Facility Receives Power supply from TSSPDCL at 11 KV, the installed transformer is 11 KV/433 V transformer of 400 KVA and the Contracted Maximum Demand with TSSPDCL is 350 KVA, The total connected Load is around 750.8 KW.
Hence it is recommended to reduce the same.

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Electrical Load Distribution

The Incoming power supply is from a 11 KV TSSPDCL ,with one Transformers of rating 11kV/433 V 400 KVA , The total connected load is around 750.8 KW . The emergency supply. taken care by DG Sets . All the three Blocks are equipped with UPS supply for Power back up for the computer systems. The details of the connected Load across the campus is given below

Total Connected Load , kW													
	Lighting			Fans			Split AC's			Computers			Total Connected Load , kW
Location	Qty	Rating (W)	Load, kW	Qty	Rating (W)	Load, kW	Qty	Rating (W)	Load, kW	Qty	Rating (W)	Load, kW	
G Floor	265	36	9.54	231	80	18.48	15	1.175	17.625	46	250	11.50	57.15
1 st Floor	398	36	14.328	295	80	23.6	28	1.175	32.9	92	285	26.22	97.05
2nd Floor	754	36	27.144	675	80	54	12	1.175	14.1	325	325	105.63	200.87
3rd Floor	775	36	27.9	634	80	50.72	8	1.175	9.4	532	350	186.20	274.22
4th Floor	755	36	27.18	590	80	47.2	7	1.175	8.225	48	300	14.40	97.01
T Block	85	36	3.06	39	80	3.12	5	1.175	5.875	47	265	12.455	24.51
													750.80

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The Power Measurements are carried out

Power Measurements AY 2017-18						
Location	Phase	Voltage	Ampere	kVA	Power factor	kW
Main Incoming Power Supply	R	237.8	382	90.65	0.98	92.5
	Y	238.5	430.6	102.5	0.995	103.6
	B	241.8	438	105.7	0.96	110.2

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The Energy Bills Analysis is carried out to Understanding the Consumption pattern of the Institute

TKR College of Engineering and Technology , Medibowli, Hyderabad 2018-19											
	UNITS							CHARGES			
Month	KWH	KVAH	PF	Actual KVA	Billed KVA	TOD1	TOD2	Demand	Energy	TOD	Total
NOV19	115090	117828	0.977	385	385	19164	16002	136500	919058	35166	1125250
OCT19	57430	58938	0.974	372	372	9792	9024	145080	459716	18816	636717
SEP19	109850	112722	0.975	391	391	16782	15950	136500	879231	32732	1087362
AUG19	95554	98236	0.973	361	361	14794	14176	136500	766240	28970	946496
JULY19	83636	86200	0.970	359	359	12108	12402	140010	757676	24510	842573
JUN19	95350	97138	0.982	324	324	13946	13994	126360	757676	27940	904160
MAY19	108056	110100	0.981	409	409	14746	14582	159510	858780	29328	1060822
APR19	109424	112086	0.976	400	400	14326	15658	136500	874270	29984	1086947
MAR19	93050	94754	0.982	517	517	13916	13786	136500	849943	31857	1154401
FEB19	91508	94484	0.969	280	280	16840	13616	128700	736975	30456	901800
JAN19	54916	56476	0.972	280	280	9792	8336	109200	440512	18128	571229
DEC18	74996	77370	0.969	302	302	13350	11706	118092	603486	25056	751276

Saving Opportunities

1. The Actual Demand is observed to be recorded more than the CMD , It is recommended to increase the CMD to 350 KVA from 400 KVA and there by Demand charges penalty of Rs 95950/- on account of Demand Charges.
2. The Individual Blockwise Power Factor to be improved to reduce the losses .
3. The UPS Loading to be improved OR shift the low loaded UPS load to other UPS .

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Introduction of Air Conditioning & Refrigeration System:

The present Air conditioning system in the college is of Package Units , Split Air Conditioning units of star rated . The Air conditioning is analyzed for energy saving opportunities . The detailed measurements are taken on sample basis at some of the locations .

The Measurements of sample Split AC units are done in blocks and tabulated below

Split Air Conditioners -2019												
Sl. No	Location	No. of A.C. Unit	Type of A.C.	Rated TR	Power kw	Inlet Temp.(°c)	Outlet Temp.(°c)	Flow m/sec	Arrived TR	Specific Power KW/TR	COP	EER
1	First Floor	1	Split AC	1.5	1.152	25.3	22.8	0.39	1.23	0.94	3.74	12.79
2	Second Floor	1	Split AC	1.5	1.225	24.7	21.9	0.44	1.55	0.79	4.45	15.17
3	Third Floor	1	Split AC	1.5	1.35	25.4	23.1	0.45	1.30	1.04	3.39	11.57
4	Fourth Floor	1	Split AC	1.5	1.375	23.7	22.3	0.36	0.63	2.17	1.62	5.53
5	G Floor	1	Split AC	1.5	1.65	24.3	21.7	0.41	1.34	1.23	2.86	9.75
6	T Block	1	Split AC	1.5	1.525	25.2	22.3	0.38	1.39	1.10	3.19	10.90

Energy Efficiency Opportunities

Reduce heat loads

Any reduction in heat loads results in a reduction in required refrigeration capacity and therefore energy consumption. There

are three main methods for reducing heat loads:

- Improving insulation.
- Reducing air leakage.
- Reducing incidental and auxiliary gains.

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Insulation improvements

The walls of a refrigerated space should be well maintained to guard against damage or degradation of the insulating material.

visual inspection will give first indications of problems while thermographic inspection will show up cold areas where insulation is poor.

- Air leakage

Air can leak through the degraded fabric of an enclosure or through an access such as a door. Taking the steps outlined above should prevent fabric leakage, while reducing air leakage through doors is outlined below:

Reduce temperature lifts

The efficiency of refrigerating plant is dependent upon the size of the temperature lift between the evaporator and the condenser: the smaller the lift the more efficient the system.

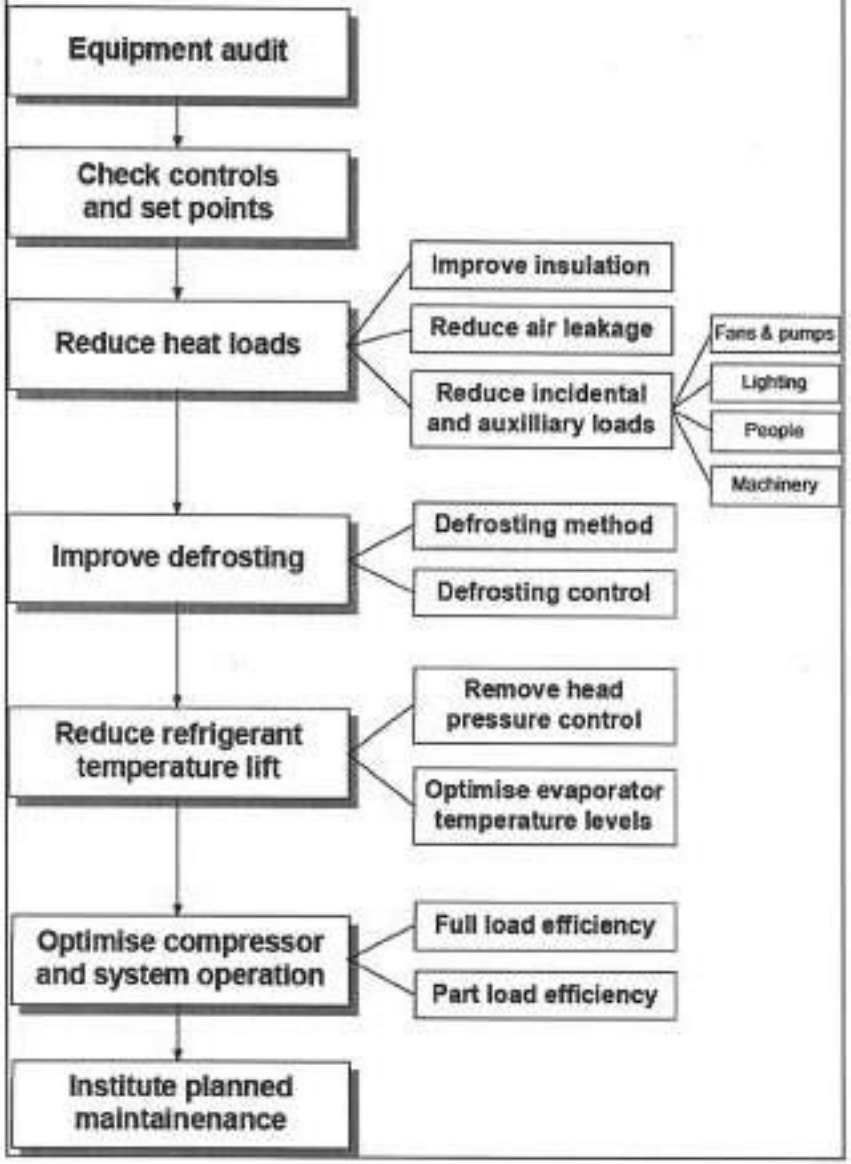
- Head pressure control

Many systems maintain a higher lift than is necessary through the use of head pressure control. This practice aims to maintain ahigh pressure in the condenser to ensure a controlled supply of refrigerant to the evaporator. The control pressure can be reduced using a balanced port thermostatic expansion valve or an electronic expansion valve, while the installation of a liquid line pump can further reduce the need for such control. Lowering the control pressure allows the condensing pressure to fall as the outside temperature falls

from the design condition and can improve energy efficiency by50%, particularly during winter. The cost of these measures varies between 15,000 to 150000 if installed at the time of refrigerant replacement and will normally pay back in about two years.

The Package Units measurements are carried out on sample basis at various locations and following are the details tabulated calculating the SPC (Specific Power Consumption) , EER(Energy Efficiency Ratio), COP(Coefficient of Performance) .

Figure 1: Optimising energy efficiency



1. **Electrical Single Line Diagram / Lay Out Diagram / Equipment Layout / Electrical Control diagram**
    i. Check for Unauthorized Temporary installations
    ii. Modification to be Updated
    iii. SLD reflects the actual installation
    iv. Duly approved by statutory authorities

2. **Importance of Electrical Safety in the Overall Safety System**

    Periodicity of comprehensive Electrical Safety check

    i. Understanding of electrical hazards
    ii. Electrical checkpoints in the safety checklist
    iii. Implementation priority for electrical hazards
    iv. Electrical Work Permit System
    v. Safe Electrical Operating Procedures

3 **Electrical Preventive Maintenance**

    i. Is there an Electrical Preventive Maintenance programme in place
    ii. Is the programme implemented? What is the slippage?
    iii. Are the relevant standards (statutes and non-statutory) referred and incorporated in the EPM programme?
    iv. Electrical Tests, Records, Test Procedure and periodicity (earth resistance, insulation resistance tests)
    v. Is the EPM programme only documented?
    vi. Transformer tests (dielectric strength, acidity, sludge deposits, dissolved gases, etc.) and periodicity
    vii. Periodic calibration of meters (ammeter, voltmeter, relays, temperature gauges) and test instruments (insulation resistance megger, earth resistance megger, multi-meters, etc.)

4 **Earthing System**
    i. Installation as per approved design?
    ii. Installation and Maintenance as per IS 3043?
    iii. Earth resistance measured periodically?
    iv. Test procedure
    v. Acceptable earth resistance values
    vi. Is the earthing system modified when electrical installation is modified?
    vii. Are neutral earth pits independent and separate?
    viii. Are earth pits identified?
    ix. Are two and distinct earth connections provided?
    x. Is the earth continuity tested?
    xi. Is bonding and earthing carried out to avoid ESD hazards?

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Annexure I

Conversion factors

CONVERSION TABLES

1 Kcal	3.9685 Btu
1 KWh	3413 Btu
1 KWh	860 kcal
1 Btu	1.055 kJ
1 calorie	4.186 joules
1 hp	746 Watts
1 kg	2.2 lb (pounds)
1 meters	3.28 feet
1 inch	2.54 cm
1 kg/cm²	14.22 psi
1 atmosphere	1.0332 kg/cm²
1 kg/cm²	10 meters of water column @ 4 °C
1 kg/cm²	9.807 x 10 4 passels
1 Ton of Refrigeration	3023 kcal/hour
1 Ton of Refrigeration	12000 Btu/hour
1 US Gallon	3.785 liters
1 imperial Gallon	4.546 liters
°F	1.8 x °C + 32
°k	°c + 273

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Annexure -II -Abbreviations &Definitions

Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
Btu	British thermal unit
Btu/ft2	British thermal units per square foot
J/m²	Joules per square meter
kVA	kilovolt-amperes
kW	kilowatts
kWh	kilowatt-hours
kWh/m²	kilowatt-hours per square meter

Definitions:

Basic definitions of terms

Absorber. The component of the vapour absorption chilling package wherein the refrigerant vapour is absorbed by the liquid absorbent.

Air Handling Unit. An air cooling unit, consisting of a blower or blowers, heat exchanger and filters with refrigerant, chilled water or brine on the tube side to perform one or more of the functions of circulating, cooling, cleaning, humidifying, dehumidifying and mixing of air.

Brine. Solution of anti-freeze substances like Sodium Chloride, Calcium Chloride, Mono-ethylene Glycol, Ethyl Alcohol etc.

Coefficient of Performance. The ratio of Net Refrigerating Effect divided by Compressor Shaft Power or Thermal Power Input. The numerator and denominator should be in the same measuring units.

Compressors. Machines in which compression of refrigerant vapour is effected by the positive action of linear motion of pistons, rotating elements (screws, vanes, scrolls etc.) or conversion of velocity energy to pressure in a centrifugal device.

Compressor, hermetic. Sealed compressor & motor unit, where the electric motor is cooled by the refrigerant and both the compressor and electric motor are not accessible for maintenance.

Compressor, open. Compressor is externally coupled to the prime mover and the refrigerant does not cool the prime mover.

Compressor, semi-hermetic. Compressor motor unit, where the electric motor is cooled by the refrigerant and the compressor is accessible for maintenance.

Condenser. The heat exchanger, which utilizes refrigerant to water/air heat transfer, causing the refrigerant to condense and the water/air to be heated. De-superheating or sub-cooling of the refrigerant may also occur.

Energy Efficiency Ratio. The ratio of Net Refrigerating Effect (Btu/hr) divided by Shaft Power (Watts) or Thermal Power Input (Watts) consumed.

Electric Motor. Electrically operated rotary prime mover.

Enthalpy. The heat content of a substance at a particular temperature.

Engine. Internal combustion engine used as prime mover.

Evaporator. The heat exchanger wherein the refrigerant evaporates and, in the process, cools another fluid l(generally water, brine or air).

Fluid. The substance that is usefully cooled in the chilling package (generally water, brine or air).

Generator. The component of a vapor absorption chilling package wherein the absorbent solution is heated to evaporate the refrigerant and concentrate the absorbent.

Gross Calorific Value. The amount of heat produced per unit of fuel when complete combustion takes place at constant pressure, the products of combustion are cooled to the initial temperature of the fuel and air, and the vapor formed during combustion is condensed.

Net Refrigeration Effect. The useful cooling effect (or heat removal) in the evaporator.

Psychometric Chart. A chart or plotted curves showing the various parameters of air at different temperatures at atmospheric pressure. The parameters shown include dry bulb temperature, wet bulb temperature, relative humidity, moisture content, enthalpy and sensible heat factor.

Refrigerant. The substance that evaporates in the evaporator to provide cooling effect.

Shaft Power. Power at the shaft of any rotary equipment.

Specific Fuel Consumption. The ratio of Thermal Power Input (kg/h of liquid fuel or m3/h of gaseous fuel consumed to the Net Refrigerating Effect (Tons of Refrigeration).

Specific humidity. Mass of water vapor per unit mass of dry air.

Specific Power Consumption. The ratio of Shaft Power (kW) to the Net Refrigerating Effect (Tons of Refrigeration).

Specific Steam Consumption. The ratio of Thermal Power Input (kg/h of steam) to the Net Refrigerating Effect (Tons of Refrigeration).

Speed. The number of revolutions per minute of the shaft.

Temperature, dry bulb. The temperature indicated by any temperature sensing element when held in air.

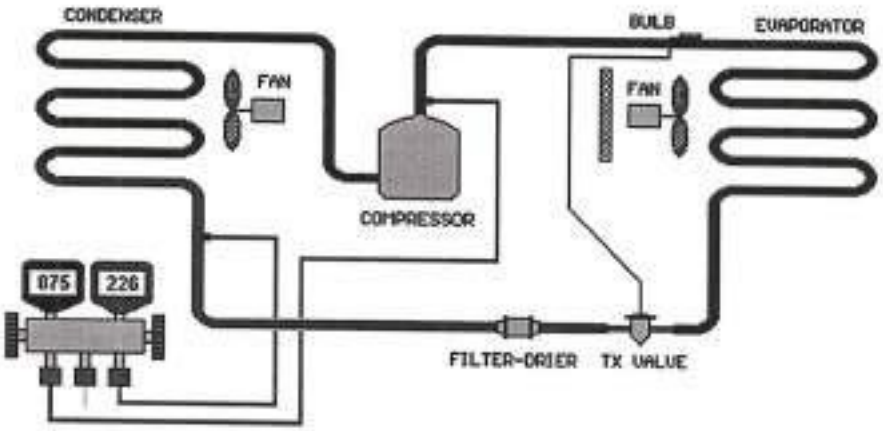
Temperature, Inlet. Temperature measured at the inlet stream of the heat exchanger.

Temperature, Outlet. Temperature measured at the outlet stream of the heat exchanger

Annexure :3 HVAC

Introduction & back ground

Refrigeration Basics



- Refrigeration is the removal of heat from a material or space, so that it's temperature is lower than that of its surroundings.
- When refrigerant absorbs the unwanted heat, this raises the refrigerant's temperature ("Saturation Temperature") so that it changes from a liquid to a gas — it evaporates. The system then uses condensation to release the heat and change the refrigerant back into a liquid. This is called "Latent Heat".
- This cycle is based on the physical principle, that a liquid extracts heat from the surrounding area as it expands (boils) into a gas.
- To accomplish this, the refrigerant is pumped through a closed looped pipe system.
- The closed looped pipe system stops the refrigerant from becoming contaminated and controls its stream. The refrigerant will be both a vapor and a liquid in the loop.

Annexure - 4 Lighting

Recommended illumination Levels as Per IS 3646 Part I-1992			
Type of Interior Activity	Range of Service Illuminanace in Lux	Quality Class of Direct Glare Limitation	Remarks
Education			
Assembly Halls	200-300-500	3	
Teaching Spaces	200-300-500	1	
Lecture Theatres			
i) General	200-300-500	1	
ii) Demo Benches	300-500-700	1	Localized Lighting may be appropriate
iii) Seminar Rooms	300-500-750	1	
iv) Art Rooms	300-500-750	1	
v) laboratories	300-500-750	1	
vi) Libraries	200-300-500	1	
vii)Music Rooms	200-300-500	1	
viii) Sports Hall	200-300-500	1	
ix) Work Shop	200-300-500	1	
x)Computer Work station	300-500-750	1	
xi)Bath Rooms	50-100-150		Supplementary local lighting near mirror
xii) Office Rooms	300-500-750	1	
xiii) Entrance Halls, Lobbies	150-200-300	2	
xiv) Corridors, Passageway, Stairs	50-100-150	2	

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Light Source Comparison			
Attributes	**Incandescent**	**CFL**	**LED**
Colur Rendering Index	100	Greater than 80	40-80
Watts/ Lamp	100	23	1
Lumen/Lamp	1600	1600	30
Lumen/Watt	16	60-80	20-30
Life (Hrs)	750	8000	50,000

Colour Rendering Index

1500 K	Candlelight
2680 K	40 W incandescent lamp
3000 K	200 W incandescent lamp
3200 K	Sunrise/sunset
3400 K	Tungsten lamp
3400 K	1 hour from dusk/dawn
5000-4500 K	Xenon lamp/light arc
5500 K	Sunny daylight around noon
5500-5600 K	Electronic photo flash
6500-7500 K	Overcast sky
9000-12000 K	Blue sky

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- True RMS Power Meter
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- Digital Earth Resistance Meter (Conventional Type , Kyoritsu, Japan)
- Digital Infrared Thermometer (Fluke)

CERTIFICATE

We here by certify that we carried out Energy Audit in the M/s **TKR College of Engineering & Technology** Medibowli, Hyderabad., Telangana during 26 November 2019 and following Observations were presented below. The Energy Bills were analyzed for energy consumption ,Power factor , Electrical Load distribution , Distribution Losses if any and Recommendation to reduce the same. We appreciate the efforts of the M/s **TKR College of Engineering & Technology,** Medibowli, Hyderabad, Telangana for their Pro-Energy Conservation measures in this regard.

For M/s **Sri Gayatri Energy Services**

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Executive Summary of Observations

1. A Detailed Walk Through Energy Audit is carried out at the Campus with following observations.
2. The Power Factor at the Main Incoming panel (after Transformer) is satisfactory .
3. It is observed that some of the Split AC's installed are not of star rated , it is recommended to replace them with minimum 3 star rated AC's as and when the opportunity comes .
4. It is observed that the Existing Fans installed are Energy Inefficient fans which may be replaced as and when opportunity comes with Energy Efficient one which result in energy savings (Detailed Calculation is enclosed).
5. The Loading of the UPS is observed to be moderate, where ever they are found to be low , It is recommended to check for the opportunity to shift the load to the other UPS and switch off the lowly loaded UPS to reduce the losses.
6. The recorded Demand exceeded CMD it is recommended to enhance the CMD .

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Detailed Walk Through Energy Audit scope of work

1. Physical inspection of the premises with reference to Energy Efficient equipment/ Energy Conservation measures/ Renewable Energy.
2. Identifying the Energy saving Opportunities within the premises by installing efficient equipment /devices / system of the electrical installation.
3. Identifying the Energy Saving opportunities by adopting continuous suitable monitoring methods

Project Schedule :

1. Walk Through Audit : 1 day
2. Report generation : 2-3 Days

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Introduction of the Institution

TKR College of Engineering and Technology – a modern temple of learning, an off shoot of the TKR Educational Society was established in the year 2002 in a sprawling, lush green 20 acre campus at Meerpet, Hyderabad. The college provides a serene and tranquil environment to the students, boosting their mental potential and preparing them in all aspects to face the cut- throat global competition with a smile on the face and emerge victorious.

Sri Teegala Krishna Reddy, the Mayor of Hyderabad, is the founder chairman of TKR Educational Society. A Philanthropist by nature, "the friend of man, to vice alone of foe", and an urge to see our students excelling themselves in all fields prompted him to start the educational society; making it easy for education to be within arm's length of even a rural student and providing them with an independent and easy in the for pursuing their dreams and making them come true and in the process upholding moral and ethical values.

Facility Description

The Facility Receives Power supply from TSSPDCL at 11 KV, the installed transformer is 11 KV/433 V transformer of 400 KVA and the Contracted Maximum Demand with TSSPDCL is 350 KVA, The total connected Load is around 750.8 KW.
Hence it is recommended to reduce the same.

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Electrical Load Distribution

The Incoming power supply is from a 11 KV TSSPDCL ,with one Transformers of rating 11kV/433 V 400 KVA , The total connected load is around 750.8 KW . The emergency supply. taken care by DG Sets . All the three Blocks are equipped with UPS supply for Power back up for the computer systems. The details of the connected Load across the campus is given below

Total Connected Load , kW													
	Lighting			Fans			Split AC's			Computers			Total Connected Load , kW
Location	Qty	Rating (W)	Load, kW	Qty	Rating (W)	Load, kW	Qty	Rating (W)	Load, kW	Qty	Rating (W)	Load, kW	
G Floor	265	36	9.54	231	80	18.48	15	1.175	17.625	46	250	11.50	57.15
1 st Floor	398	36	14.328	295	80	23.6	28	1.175	32.9	92	285	26.22	97.05
2nd Floor	754	36	27.144	675	80	54	12	1.175	14.1	325	325	105.63	200.87
3rd Floor	775	36	27.9	634	80	50.72	8	1.175	9.4	532	350	186.20	274.22
4th Floor	755	36	27.18	590	80	47.2	7	1.175	8.225	48	300	14.40	97.01
T Block	85	36	3.06	39	80	3.12	5	1.175	5.875	47	265	12.455	24.51
													750.80

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The Power Measurements are carried out

Power Measurements AY 2017-18						
Location	Phase	Voltage	Ampere	kVA	Power factor	kW
Main Incoming Power Supply	R	237.8	382	90.65	0.98	92.5
	Y	238.5	430.6	102.5	0.995	103.6
	B	241.8	438	105.7	0.96	110.2

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The Energy Bills Analysis is carried out to Understanding the Consumption pattern of the Institute

TKR College of Engineering and Technology , Medibowli, Hyderabad 2018-19											
	UNITS							CHARGES			
Month	KWH	KVAH	PF	Actual KVA	Billed KVA	TOD1	TOD2	Demand	Energy	TOD	Total
NOV19	115090	117828	0.977	385	385	19164	16002	136500	919058	35166	1125250
OCT19	57430	58938	0.974	372	372	9792	9024	145080	459716	18816	636717
SEP19	109850	112722	0.975	391	391	16782	15950	136500	879231	32732	1087362
AUG19	95554	98236	0.973	361	361	14794	14176	136500	766240	28970	946496
JULY19	83636	86200	0.970	359	359	12108	12402	140010	757676	24510	842573
JUN19	95350	97138	0.982	324	324	13946	13994	126360	757676	27940	904160
MAY19	108056	110100	0.981	409	409	14746	14582	159510	858780	29328	1060822
APR19	109424	112086	0.976	400	400	14326	15658	136500	874270	29984	1086947
MAR19	93050	94754	0.982	517	517	13916	13786	136500	849943	31857	1154401
FEB19	91508	94484	0.969	280	280	16840	13616	128700	736975	30456	901800
JAN19	54916	56476	0.972	280	280	9792	8336	109200	440512	18128	571229
DEC18	74996	77370	0.969	302	302	13350	11706	118092	603486	25056	751276

Saving Opportunities

1. The Actual Demand is observed to be recorded more than the CMD , it is recommended to increase the CMD to 350 KVA from 400 KVA and there by Demand charges penalty of Rs 95950/- on account of Demand Charges.
2. The Individual Blockwise Power Factor to be improved to reduce the losses .
3. The UPS Loading to be improved OR shift the low loaded UPS load to other UPS .

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Introduction of Air Conditioning & Refrigeration System:

The present Air conditioning system in the college is of Package Units , Split Air Conditioning units of star rated . The Air conditioning is analyzed for energy saving opportunities . The detailed measurements are taken on sample basis at some of the locations .

The Measurements of sample Split AC units are done in blocks and tabulated below

Split Air Conditioners -2019												
Sl. No	Location	No. of A.C. Unit	Type of A.C.	Rated TR	Power kw	Inlet Temp.(°c)	Outlet Temp.(°c)	Flow m/sec	Arrived TR	Specific Power KW/TR	COP	EER
1	First Floor	1	Split AC	1.5	1.152	25.3	22.8	0.39	1.23	0.94	3.74	12.79
2	Second Floor	1	Split AC	1.5	1.225	24.7	21.9	0.44	1.55	0.79	4.45	15.17
3	Third Floor	1	Split AC	1.5	1.35	25.4	23.1	0.45	1.30	1.04	3.39	11.57
4	Fourth Floor	1	Split AC	1.5	1.375	23.7	22.3	0.36	0.63	2.17	1.62	5.53
5	G Floor	1	Split AC	1.5	1.65	24.3	21.7	0.41	1.34	1.23	2.86	9.75
6	T Block	1	Split AC	1.5	1.525	25.2	22.3	0.38	1.39	1.10	3.19	10.90

Energy Efficiency Opportunities

Reduce heat loads

Any reduction in heat loads results in a reduction in required refrigeration capacity and therefore energy consumption. There

are three main methods for reducing heat loads:

- Improving insulation.

- Reducing air leakage.

-Reducing incidental and auxiliary gains.

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Insulation Improvements

The walls of a refrigerated space should be well maintained to guard against damage or degradation of the insulating material.

visual inspection will give first indications of problems while thermographic inspection will show up cold areas where insulation is poor.

- Air leakage

Air can leak through the degraded fabric of an enclosure or through an access such as a door. Taking the steps outlined above should prevent fabric leakage, while reducing air leakage through doors is outlined below:

Reduce temperature lifts

The efficiency of refrigerating plant is dependent upon the size of the temperature lift between the evaporator and the condenser: the smaller the lift the more efficient the system.

- Head pressure control

Many systems maintain a higher lift than is necessary through the use of head pressure control. This practice aims to maintain ahigh pressure in the condenser to ensure a controlled supply of refrigerant to the evaporator. The control pressure can be reduced using a balanced port thermostatic expansion valve or an electronic expansion valve, while the installation of a liquid line pump can further reduce the need for such control. Lowering the control pressure allows the condensing pressure to fall as the outside temperature falls

from the design condition and can improve energy efficiency by50%, particularly during winter. The cost of these measures varies between 15,000 to 150000 if installed at the time of refrigerant replacement and will normally pay back in about two years.

The Package Units measurements are carried out on sample basis at various locations and following are the details tabulated calculating the SPC (Specific Power Consumption) , EER(Energy Efficiency Ratio), COP(Coefficient of Performance) .

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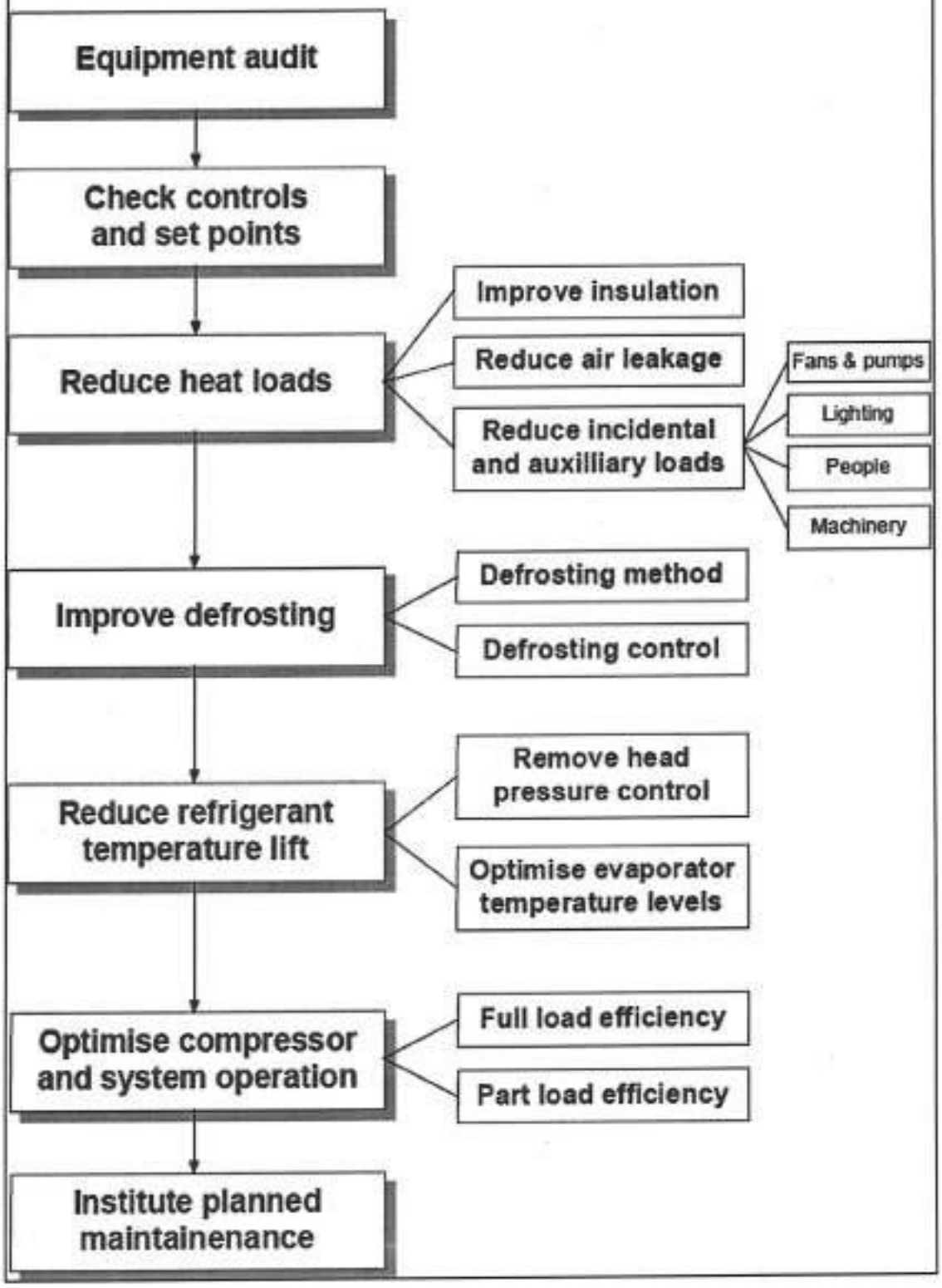
Figure 1: Optimising energy efficiency



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1. **Electrical Single Line Diagram / Lay Out Diagram / Equipment Layout / Electrical Control diagram**
    i. Check for Unauthorized Temporary Installations
    ii. Modification to be Updated
    iii. SLD reflects the actual installation
    iv. Duly approved by statutory authorities

2. **Importance of Electrical Safety in the Overall Safety System**

    Periodicity of comprehensive Electrical Safety check

    i. Understanding of electrical hazards
    ii. Electrical checkpoints in the safety checklist
    iii. Implementation priority for electrical hazards
    iv. Electrical Work Permit System
    v. Safe Electrical Operating Procedures

3 **Electrical Preventive Maintenance**

    i. Is there an Electrical Preventive Maintenance programme in place
    ii. Is the programme implemented? What is the slippage?
    iii. Are the relevant standards (statutes and non-statutory) referred and incorporated in the EPM programme?
    iv. Electrical Tests, Records, Test Procedure and periodicity (earth resistance, insulation resistance tests)
    v. Is the EPM programme only documented?
    vi. Transformer tests (dielectric strength, acidity, sludge deposits, dissolved gases, etc.) and periodicity
    vii. Periodic calibration of meters (ammeter, voltmeter, relays, temperature gauges) and test instruments (insulation resistance megger, earth resistance megger, multi-meters, etc.)

4 **Earthing System**
    i. Installation as per approved design?
    ii. Installation and Maintenance as per IS 3043?
    iii. Earth resistance measured periodically?
    iv. Test procedure
    v. Acceptable earth resistance values
    vi. Is the earthing system modified when electrical installation is modified?
    vii. Are neutral earth pits independent and separate?
    viii. Are earth pits identified?
    ix. Are two and distinct earth connections provided?
    x. Is the earth continuity tested?
    xi. Is bonding and earthing carried out to avoid ESD hazards?

Annexure I

Conversion factors

CONVERSION TABLES

1 Kcal	3.9685 Btu
1 KWh	3413 Btu
1 KWh	860 kcal
1 Btu	1.055 kJ
1 calorie	4.186 joules
1 hp	746 Watts
1 kg	2.2 lb (pounds)
1 meters	3.28 feet
1 inch	2.54 cm
1 kg/cm²	14.22 psi
1 atmosphere	1.0332 kg/cm²
1 kg/cm²	10 meters of water column @ 4 °C
1 kg/cm²	9.807 × 10 4 passels
1 Ton of Refrigeration	3023 kcal/hour
1 Ton of Refrigeration	12000 Btu/hour
1 US Gallon	3.785 liters
1 imperial Gallon	4.546 liters
°F	1.8 × °C + 32
°k	°c + 273

Annexure -II -Abbreviations &Definitions

Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
Btu	British thermal unit
Btu/ft2	British thermal units per square foot
J/m²	Joules per square meter
kVA	kilovolt-amperes
kW	kilowatts
kWh	kilowatt-hours
kWh/m²	kilowatt-hours per square meter

Definitions:

Basic definitions of terms

Absorber. The component of the vapour absorption chilling package wherein the refrigerant vapour is absorbed by the liquid absorbent.

Air Handling Unit. An air cooling unit, consisting of a blower or blowers, heat exchanger and filters with refrigerant, chilled water or brine on the tube side to perform one or more of the functions of circulating, cooling, cleaning, humidifying, dehumidifying and mixing of air.

Brine. Solution of anti-freeze substances like Sodium Chloride, Calcium Chloride, Mono-ethylene Glycol, Ethyl Alcohol etc.

Coefficient of Performance. The ratio of Net Refrigerating Effect divided by Compressor Shaft Power or Thermal Power Input. The numerator and denominator should be in the same measuring units.

Compressors. Machines in which compression of refrigerant vapour is effected by the positive action of linear motion of pistons, rotating elements (screws, vanes, scrolls etc.) or conversion of velocity energy to pressure in a centrifugal device.

Compressor, hermetic. Sealed compressor & motor unit, where the electric motor is cooled by the refrigerant and both the compressor and electric motor are not accessible for maintenance.

Compressor, open. Compressor is externally coupled to the prime mover and the refrigerant does not cool the prime mover.

Compressor, semi-hermetic. Compressor motor unit, where the electric motor is cooled by the refrigerant and the compressor is accessible for maintenance.

Condenser. The heat exchanger, which utilizes refrigerant to water/air heat transfer, causing the refrigerant to condense and the water/air to be heated. De-superheating or sub-cooling of the refrigerant may also occur.

Energy Efficiency Ratio. The ratio of Net Refrigerating Effect (Btu/hr) divided by Shaft Power (Watts) or Thermal Power Input (Watts) consumed.

Electric Motor. Electrically operated rotary prime mover.

Enthalpy. The heat content of a substance at a particular temperature.

Engine. Internal combustion engine used as prime mover.

Evaporator. The heat exchanger wherein the refrigerant evaporates and, in the process, cools another fluid I(generally water, brine or air).

Fluid. The substance that is usefully cooled in the chilling package (generally water, brine or air).

Generator. The component of a vapor absorption chilling package wherein the absorbent solution is heated to evaporate the refrigerant and concentrate the absorbent.

Gross Calorific Value. The amount of heat produced per unit of fuel when complete combustion takes place at constant pressure, the products of combustion are cooled to the initial temperature of the fuel and air, and the vapor formed during combustion is condensed.

Net Refrigeration Effect. The useful cooling effect (or heat removal) in the evaporator.

Psychometric Chart. A chart or plotted curves showing the various parameters of air at different temperatures at atmospheric pressure. The parameters shown include dry bulb temperature, wet bulb temperature, relative humidity, moisture content, enthalpy and sensible heat factor.

Refrigerant. The substance that evaporates in the evaporator to provide cooling effect.

Shaft Power. Power at the shaft of any rotary equipment.

Specific Fuel Consumption. The ratio of Thermal Power Input (kg/h of liquid fuel or m3/h of gaseous fuel consumed to the Net Refrigerating Effect (Tons of Refrigeration).

Specific humidity. Mass of water vapor per unit mass of dry air.

Specific Power Consumption. The ratio of Shaft Power (kW) to the Net Refrigerating Effect (Tons of Refrigeration).

Specific Steam Consumption. The ratio of Thermal Power Input (kg/h of steam) to the Net Refrigerating Effect (Tons of Refrigeration).

Speed. The number of revolutions per minute of the shaft.

Temperature, dry bulb. The temperature indicated by any temperature sensing element when held in air.

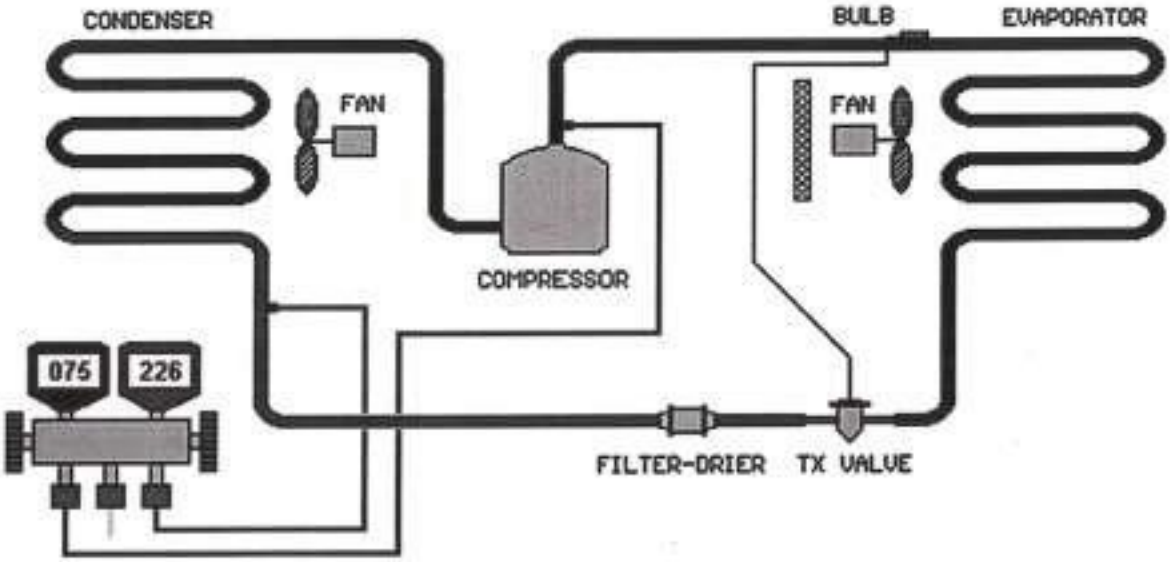
Temperature, Inlet. Temperature measured at the inlet stream of the heat exchanger.

Temperature, Outlet. Temperature measured at the outlet stream of the heat exchanger

Annexure :3 HVAC

Introduction & back ground

Refrigeration Basics



- Refrigeration is the removal of heat from a material or space, so that it's temperature is lower than that of its surroundings.
- When refrigerant absorbs the unwanted heat, this raises the refrigerant's temperature ("Saturation Temperature") so that it changes from a liquid to a gas — it evaporates. The system then uses condensation to release the heat and change the refrigerant back into a liquid. This is called "Latent Heat".
- This cycle is based on the physical principle, that a liquid extracts heat from the surrounding area as it expands (boils) into a gas.
- To accomplish this, the refrigerant is pumped through a closed looped pipe system.
- The closed looped pipe system stops the refrigerant from becoming contaminated and controls its stream. The refrigerant will be both a vapor and a liquid in the loop.

Annexure - 4 Lighting

Recommended Illumination Levels as Per IS 3646 Part I-1992			
Type of Interior Activity	Range of Service Illuminanace in Lux	Quality Class of Direct Glare Limitation	Remarks
Education			
Assembly Halls	200-300-500	3	
Teaching Spaces	200-300-500	1	
Lecture Theatres			
i) General	200-300-500	1	
ii) Demo Benches	300-500-700	1	Localized Lighting may be appropriate
iii) Seminar Rooms	300-500-750	1	
iv) Art Rooms	300-500-750	1	
v) laboratories	300-500-750	1	
vi) Libraries	200-300-500	1	
vii)Music Rooms	200-300-500	1	
viii) Sports Hall	200-300-500	1	
ix) Work Shop	200-300-500	1	
x)Computer Work station	300-500-750	1	
xi)Bath Rooms	50-100-150		Supplementary local lighting near mirror
xii) Office Rooms	300-500-750	1	
xiii) Entrance Halls, Lobbies	150-200-300	2	
xiv) Corridors, Passageway, Stairs	50-100-150	2	

Light Source Comparison			
Attributes	**Incandescent**	**CFL**	**LED**
Colur Rendering Index	100	Greater than 80	40-80
Watts/ Lamp	100	23	1
Lumen/Lamp	1600	1600	30
Lumen/Watt	16	60-80	20-30
Life (Hrs)	750	8000	50,000

Colour Rendering Index

1500 K	Candlelight
2680 K	40 W incandescent lamp
3000 K	200 W incandescent lamp
3200 K	Sunrise/sunset
3400 K	Tungsten lamp
3400 K	1 hour from dusk/dawn
5000-4500 K	Xenon lamp/light arc
5500 K	Sunny daylight around noon
5500-5600 K	Electronic photo flash
6500-7500 K	Overcast sky
9000-12000 K	Blue sky

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Energy Audit Report
of

M/s **TKR College of Engineering & Technology**
Medbowli, Hyderabad

2017-18

By

SRI GAYATRI ENERGY SERVICES
we support you conserve

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Contents

ACKNOWLEDGEMENT 3

Disclaimer 4

Audit Study team 5

LIST OF INSTRUMENTS USED 5

CERTIFICATE 6

Executive Summary of Observations 7

Detailed Walk Through Energy Audit scope of work 8

Introduction of the Institution 9

Facility Description 9

Electrical Load Distribution 10

HVAC- Air Conditioning Systems 13

Introduction of Air Conditioning & Refrigeration System 14

Maintenance & Electrical Safety 17

Annexure I 19

Annexure -II -Abbreviations &Definitions 20

Annexure :3 HVAC 22

Annexure - 4 Lighting 23

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ACKNOWLEDGEMENT

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The study team is appreciative of the keen interest and encouragement shown by

1. Dr Shri T. Harinath Reddy - Secretary

2. Shri T. Amarnath Reddy – Treasurer

3. Dr Shri D V Ravi Shankar – Principal

4. Dr. Shri K. Raju – Coordinator

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While implementing the recommendations site inspection should be done to constitute professional approach and adequacy of the site to be established without ambiguity and we exclude all representations and warranties relating to the content and use of this report.

In no event We will be liable for any incidental, indirect, consequential or special damages of any kind, or any damages whatsoever, including, without limitation, those resulting from loss of profit, loss of contracts, goodwill, data, information, income, anticipated savings or business relationships, whether or not advised of the possibility of such damage, arising out of or in connection with the use of this report.

This is a walk through Audit conducted on request of M/s **TKR College of Engineering & Technology.**

Exceptions

Nothing in this disclaimer notice excludes or limits any warranty implied by law for death, fraud, personal injury through negligence, or anything else which it would not be lawful for to exclude.

We trust the data provided by the M/s **TKR College of Engineering & Technology** (Autonomous) Medibowli , Hyderabad, Telangana personnel is true to their best of knowledge and a preliminary Report was generated , we didn't verify the correctness of it.

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Audit Study team	
Shri D.S.R.Murthy	Senior Energy Auditor
Shri Durga Rao	Engineer
Shri Sai Ganesh	Engineer

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Electrical Load Distribution

The Incoming power supply is from a 11 KV TSSPDCL ,with one Transformers of rating 11kV/433 V 400 KVA , The total connected load is around 710.93 KW . The emergency supply. taken care by DG Sets . All the three Blocks are equipped with UPS supply for Power back up for the computer systems. The details of the connected Load across the campus is given below

Total Connected Load , kW													
	Lighting			Fans			Split AC's			Computers			Total Connected Load , kW
Location	Qty	Rating (W)	Load, kW	Qty	Rating (W)	Load, kW	Qty	Rating (W)	Load, kW	Qty	Rating (W)	Load, kW	
G Floor	265	36	9.54	231	80	18.48	7	1.175	8.225	46	250	11.50	47.75
1 st Floor	398	36	14.328	295	80	23.6	19	1.175	22.325	92	285	26.22	86.47
2nd Floor	725	36	26.1	675	80	54	12	1.175	14.1	305	325	99.13	193.33
3rd Floor	675	36	24.3	634	80	50.72	8	1.175	9.4	507	350	177.45	261.87
4th Floor	755	36	27.18	590	80	47.2	7	1.175	8.225	48	300	14.40	97.01
T Block	85	36	3.06	39	80	3.12	5	1.175	5.875	47	265	12.455	24.51
													710.93

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The Power Measurements are carried out

Power Measurements AY 2017-18						
Location	Phase	Voltage	Ampere	kVA	Power factor	kW
Main Incoming Power Supply	R	237.8	341	80.85	0.98	82.5
	Y	238.5	363	86.4	0.995	87.3
	B	241.8	364	87.8	0.96	91.,5

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The Energy Bills Analysis is carried out to Understanding the Consumption pattern of the Institute

TKR College of Engineering and Technology , Medibowli, Hyderabad 2017-18											
	UNITS							CHARGES			
Month	KWH	KVAH	PF	Actual KVA	Billed KVA	TOD1	TOD2	Demand	Energy	TOD	Total
NOV18	96840	99526	0.973	350	350	15684	13454	136500	776302	29138	956180
OCT18	88454	90600	0.976	411	411	13766	12700	136500	706680	26466	922818
SEP18	101682	103960	0.978	379	379	15612	13286	136500	810888	28898	1005299
AUG18	94962	96924	0.980	350	350	15204	12724	136500	756007	27928	934518
JULY18	73578	76116	0.967	298	298	10488	9084	116298	593704	19572	734141
JUN18	71956	74434	0.967	304	304	10776	8494	118716	580585	19270	723037
MAY18	70830	72954	0.971	323	323	10984	8636	126204	569041	19620	719242
APR18	88830	89996	0.987	347	347	11738	11640	135330	701812	23378	865919
MAR18	82456	82476	0.9998	462	462	12178	10090	136500	739809	25608	994694
FEB18	72830	72892	0.999	280	280	13121	12700	109200	568557	23022	694349
JAN18	54514	54992	0.991	280	280	8934	8943	109200	428937	17886	551144
DEC17	67286	67286	1.000	280	280	`10469	10469	109200	524830	20938	633855

Saving Opportunities

1. The Actual Demand is observed to be recorded more than the CMD, it is recommended to increase the CMD to 350 KVA from 400 KVA and there by Demand charges penalty of Rs 95950/- on account of Demand Charges.
2. The Individual Blockwise Power Factor to be improved to reduce the losses.
3. The UPS Loading to be improved OR shift the low loaded UPS load to other UPS .

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Introduction of Air Conditioning & Refrigeration System:

The present Air conditioning system in the college is of Package Units , Split Air Conditioning units of star rated . The Air conditioning is analyzed for energy saving opportunities . The detailed measurements are taken on sample basis at some of the locations .

The Measurements of sample Split AC units are done in blocks and tabulated below

Split Air Conditioners -2018												
Sl. No	Location	No. of A.C. Unit	Type of A.C.	Rated TR	Power kw	Inlet Temp.(° c)	Outlet Temp.(° c)	Flow m/sec	Arrived TR	Specific Power KW/TR	COP	EER
1	First Floor	1	Split AC	1.5	1.152	25.3	22.8	0.39	1.23	0.94	3.74	12.79
2	Second Floor	1	Split AC	1.5	1.225	24.7	21.9	0.44	1.55	0.79	4.45	15.17
3	Third Floor	1	Split AC	1.5	1.35	25.4	23.1	0.45	1.30	1.04	3.39	11.57
4	Fourth Floor	1	Split AC	1.5	1.375	23.7	22.3	0.36	0.63	2.17	1.62	5.53
5	G Floor	1	Split AC	1.5	1.65	24.3	21.7	0.41	1.34	1.23	2.86	9.75
6	T Block	1	Split AC	1.5	1.525	25.2	22.3	0.38	1.39	1.10	3.19	10.90

Energy Efficiency Opportunities

Reduce heat loads

Any reduction in heat loads results in a reduction in required refrigeration capacity and therefore energy consumption. There

are three main methods for reducing heat loads:

- Improving insulation.
- Reducing air leakage.
- Reducing incidental and auxiliary gains.

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Insulation Improvements

The walls of a refrigerated space should be well maintained to guard against damage or degradation of the insulating material.

visual inspection will give first indications of problems while thermographic inspection will show up cold areas where insulation is poor.

- Air leakage

Air can leak through the degraded fabric of an enclosure or through an access such as a door. Taking the steps outlined above should prevent fabric leakage, while reducing air leakage through doors is outlined below:

Reduce temperature lifts

The efficiency of refrigerating plant is dependent upon the size of the temperature lift between the evaporator and the condenser: the smaller the lift the more efficient the system.

- Head pressure control

Many systems maintain a higher lift than is necessary through the use of head pressure control. This practice aims to maintain ahigh pressure in the condenser to ensure a controlled supply of refrigerant to the evaporator. The control pressure can be reduced using a balanced port thermostatic expansion valve or an electronic expansion valve, while the installation of a liquid line pump can further reduce the need for such control. Lowering the control pressure allows the condensing pressure to fall as the outside temperature falls

from the design condition and can improve energy efficiency by50%, particularly during winter. The cost of these measures varies between 15,000 to 150000 if installed at the time of refrigerant replacement and will normally pay back in about two years.

The Package Units measurements are carried out on sample basis at various locations and following are the details tabulated calculating the SPC (Specific Power Consumption) , EER(Energy Efficiency Ratio), COP(Coefficient of Performance) .

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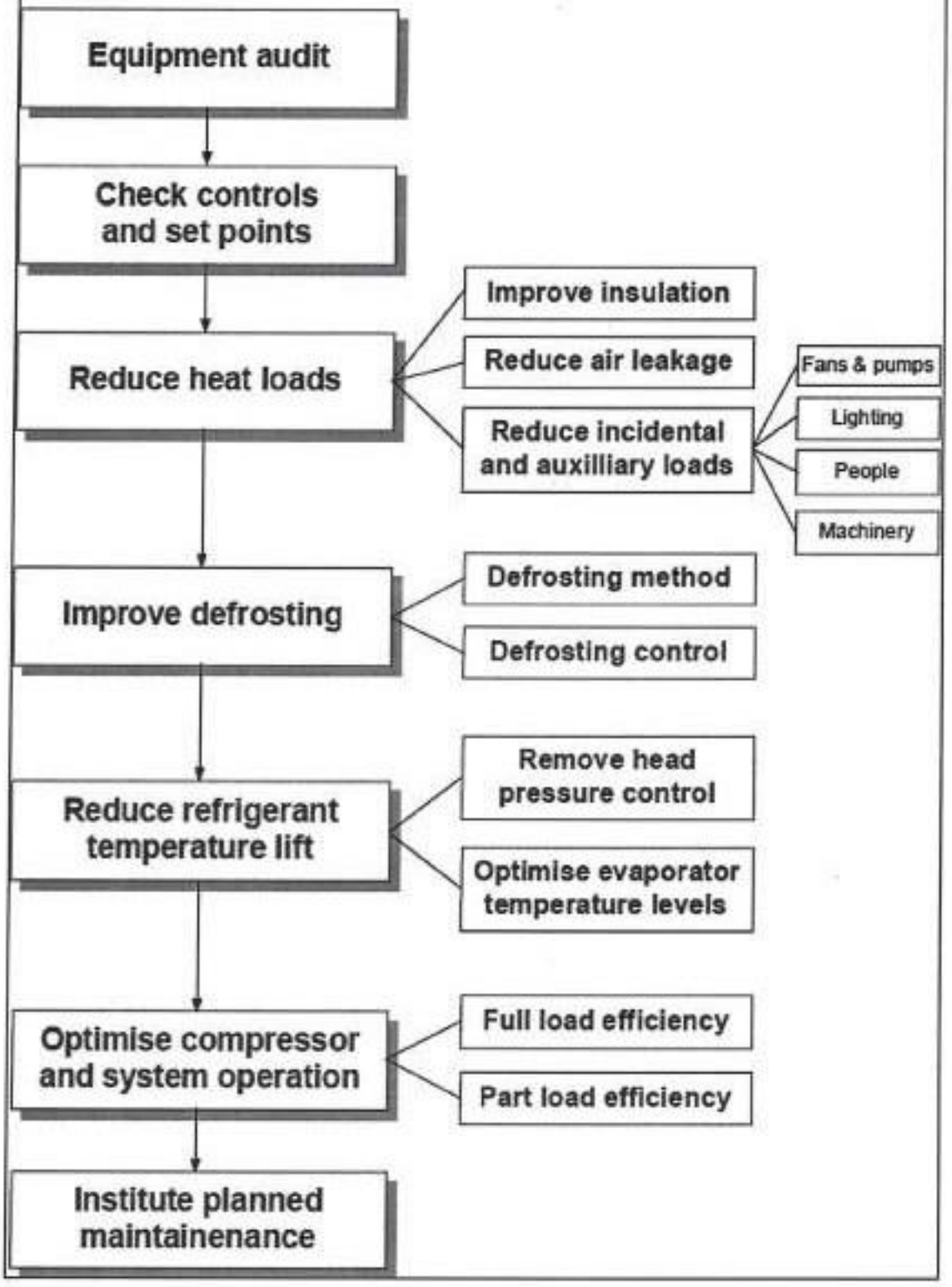
Figure 1: Optimising energy efficiency



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1. **Electrical Single Line Diagram / Lay Out Diagram / Equipment Layout / Electrical Control diagram**
    i. Check for Unauthorized Temporary Installations
    ii. Modification to be Updated
    iii. SLD reflects the actual installation
    iv. Duly approved by statutory authorities

2. **Importance of Electrical Safety in the Overall Safety System**

    Periodicity of comprehensive Electrical Safety check

    i. Understanding of electrical hazards
    ii. Electrical checkpoints in the safety checklist
    iii. Implementation priority for electrical hazards
    iv. Electrical Work Permit System
    v. Safe Electrical Operating Procedures

3 **Electrical Preventive Maintenance**

i. Is there an Electrical Preventive Maintenance programme in place
ii. Is the programme implemented? What is the slippage?
iii. Are the relevant standards (statutes and non-statutory) referred and incorporated in the EPM programme?
iv. Electrical Tests, Records, Test Procedure and periodicity (earth resistance, insulation resistance tests)
v. Is the EPM programme only documented?
vi. Transformer tests (dielectric strength, acidity, sludge deposits, dissolved gases, etc.) and periodicity
vii. Periodic calibration of meters (ammeter, voltmeter, relays, temperature gauges) and test instruments (insulation resistance megger, earth resistance megger, multi-meters, etc.)

4 **Earthing System**

i. Installation as per approved design?
ii. Installation and Maintenance as per IS 3043?
iii. Earth resistance measured periodically?
iv. Test procedure
v. Acceptable earth resistance values
vi. Is the earthing system modified when electrical installation is modified?
vii. Are neutral earth pits independent and separate?
viii. Are earth pits identified?
ix. Are two and distinct earth connections provided?
x. Is the earth continuity tested?
xi. Is bonding and earthing carried out to avoid ESD hazards?

Annexure I

Conversion factors

CONVERSION TABLES

1 Kcal	3.9685 Btu
1 KWh	3413 Btu
1 KWh	860 kcal
1 Btu	1.055 kJ
1 calorie	4.186 joules
1 hp	746 Watts
1 kg	2.2 lb (pounds)
1 meters	3.28 feet
1 inch	2.54 cm
1 kg/cm²	14.22 psi
1 atmosphere	1.0332 kg/cm²
1 kg/cm²	10 meters of water column @ 4 °C
1 kg/cm²	9.807 × 10 4 passels
1 Ton of Refrigeration	3023 kcal/hour
1 Ton of Refrigeration	12000 Btu/hour
1 US Gallon	3.785 liters
1 imperial Gallon	4.546 liters
°F	1.8 × °C + 32
°k	°c + 273

Annexure -II -Abbreviations &Definitions

Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
Btu	British thermal unit
Btu/ft2	British thermal units per square foot
J/m²	Joules per square meter
kVA	kilovolt-amperes
kW	kilowatts
kWh	kilowatt-hours
kWh/m²	kilowatt-hours per square meter

Definitions:

Basic definitions of terms

Absorber. The component of the vapour absorption chilling package wherein the refrigerant vapour is absorbed by the liquid absorbent.

Air Handling Unit. An air cooling unit, consisting of a blower or blowers, heat exchanger and filters with refrigerant, chilled water or brine on the tube side to perform one or more of the functions of circulating, cooling, cleaning, humidifying, dehumidifying and mixing of air.

Brine. Solution of anti-freeze substances like Sodium Chloride, Calcium Chloride, Mono-ethylene Glycol, Ethyl Alcohol etc.

Coefficient of Performance. The ratio of Net Refrigerating Effect divided by Compressor Shaft Power or Thermal Power Input. The numerator and denominator should be in the same measuring units.

Compressors. Machines in which compression of refrigerant vapour is effected by the positive action of linear motion of pistons, rotating elements (screws, vanes, scrolls etc.) or conversion of velocity energy to pressure in a centrifugal device.

Compressor, hermetic. Sealed compressor & motor unit, where the electric motor is cooled by the refrigerant and both the compressor and electric motor are not accessible for maintenance.

Compressor, open. Compressor is externally coupled to the prime mover and the refrigerant does not cool the prime mover.

Compressor, semi-hermetic. Compressor motor unit, where the electric motor is cooled by the refrigerant and the compressor is accessible for maintenance.

Condenser. The heat exchanger, which utilizes refrigerant to water/air heat transfer, causing the refrigerant to condense and the water/air to be heated. De-superheating or sub-cooling of the refrigerant may also occur.

Energy Efficiency Ratio. The ratio of Net Refrigerating Effect (Btu/hr) divided by Shaft Power (Watts) or Thermal Power Input (Watts) consumed.

Electric Motor. Electrically operated rotary prime mover.

Enthalpy. The heat content of a substance at a particular temperature.

Engine. Internal combustion engine used as prime mover.

Evaporator. The heat exchanger wherein the refrigerant evaporates and, in the process, cools another fluid I(generally water, brine or air).

Fluid. The substance that is usefully cooled in the chilling package (generally water, brine or air).

Generator. The component of a vapor absorption chilling package wherein the absorbent solution is heated to evaporate the refrigerant and concentrate the absorbent.

Gross Calorific Value. The amount of heat produced per unit of fuel when complete combustion takes place at constant pressure, the products of combustion are cooled to the initial temperature of the fuel and air, and the vapor formed during combustion is condensed.

Net Refrigeration Effect. The useful cooling effect (or heat removal) in the evaporator.

Psychometric Chart. A chart or plotted curves showing the various parameters of air at different temperatures at atmospheric pressure. The parameters shown include dry bulb temperature, wet bulb temperature, relative humidity, moisture content, enthalpy and sensible heat factor.

Refrigerant. The substance that evaporates in the evaporator to provide cooling effect.

Shaft Power. Power at the shaft of any rotary equipment.

Specific Fuel Consumption. The ratio of Thermal Power Input (kg/h of liquid fuel or m3/h of gaseous fuel consumed to the Net Refrigerating Effect (Tons of Refrigeration).

Specific humidity. Mass of water vapor per unit mass of dry air.

Specific Power Consumption. The ratio of Shaft Power (kW) to the Net Refrigerating Effect (Tons of Refrigeration).

Specific Steam Consumption. The ratio of Thermal Power Input (kg/h of steam) to the Net Refrigerating Effect (Tons of Refrigeration).

Speed. The number of revolutions per minute of the shaft.

Temperature, dry bulb. The temperature indicated by any temperature sensing element when held in air.

Temperature, Inlet. Temperature measured at the inlet stream of the heat exchanger.

Temperature, Outlet. Temperature measured at the outlet stream of the heat exchanger

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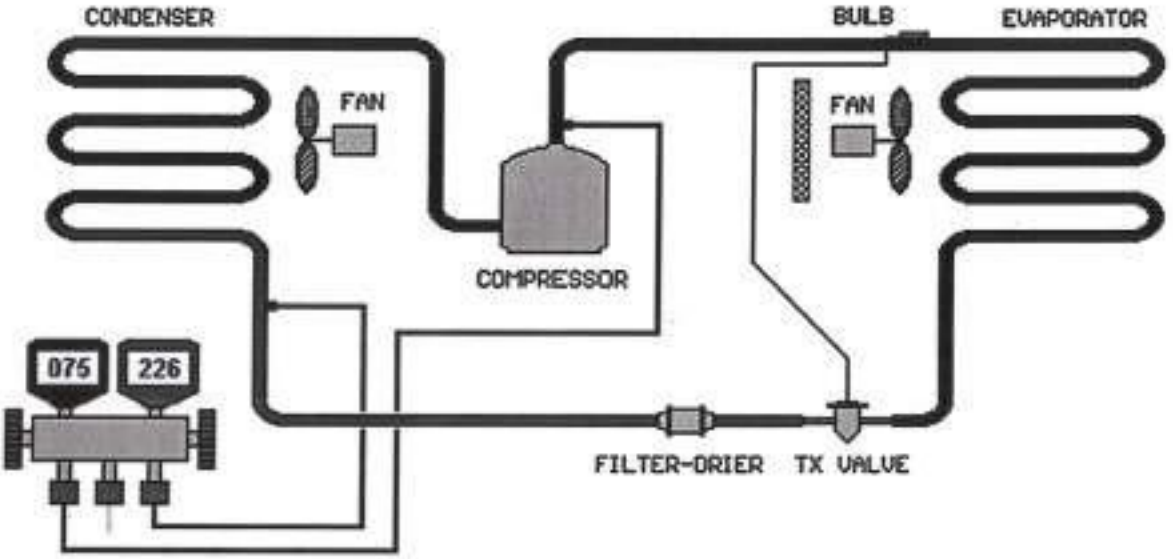
Annexure :3 HVAC

Introduction & back ground

Refrigeration Basics



- Refrigeration is the removal of heat from a material or space, so that it's temperature is lower than that of its surroundings.
- When refrigerant absorbs the unwanted heat, this raises the refrigerant's temperature ("Saturation Temperature") so that it changes from a liquid to a gas — it evaporates. The system then uses condensation to release the heat and change the refrigerant back into a liquid. This is called "Latent Heat".
- This cycle is based on the physical principle, that a liquid extracts heat from the surrounding area as it expands (boils) into a gas.
- To accomplish this, the refrigerant is pumped through a closed looped pipe system.
- The closed looped pipe system stops the refrigerant from becoming contaminated and controls its stream. The refrigerant will be both a vapor and a liquid in the loop.

Annexure - 4 Lighting

Recommended Illumination Levels as Per IS 3646 Part I-1992			
Type of Interior Activity	Range of Service Illuminanace in Lux	Quality Class of Direct Glare Limitation	Remarks
Education			
Assembly Halls	200-300-500	3	
Teaching Spaces	200-300-500	1	
Lecture Theatres			
I) General	200-300-500	1	
ii) Demo Benches	300-500-700	1	Localized Lighting may be appropriate
iii) Seminar Rooms	300-500-750	1	
iv) Art Rooms	300-500-750	1	
v) laboratories	300-500-750	1	
vi) Libraries	200-300-500	1	
vii)Music Rooms	200-300-500	1	
viii) Sports Hall	200-300-500	1	
ix) Work Shop	200-300-500	1	
x)Computer Work station	300-500-750	1	
xi)Bath Rooms	50-100-150		Supplementary local lighting near mirror
xii) Office Rooms	300-500-750	1	
xiii) Entrance Halls, Lobbies	150-200-300	2	
xiv) Corridors, Passageway, Stairs	50-100-150	2	

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Light Source Comparison			
Attributes	**Incandescent**	**CFL**	**LED**
Colur Rendering Index	100	Greater than 80	40-80
Watts/ Lamp	100	23	1
Lumen/Lamp	1600	1600	30
Lumen/Watt	16	60-80	20-30
Life (Hrs)	750	8000	50,000

Colour Rendering Index

1500 K	Candlelight
2680 K	40 W incandescent lamp
3000 K	200 W incandescent lamp
3200 K	Sunrise/sunset
3400 K	Tungsten lamp
3400 K	1 hour from dusk/dawn
5000-4500 K	Xenon lamp/light arc
5500 K	Sunny daylight around noon
5500-5600 K	Electronic photo flash
6500-7500 K	Overcast sky
9000-12000 K	Blue sky

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