



TKR COLLEGE OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS)

(Sponsored by TKR Educational Society , Approved by AICTE, Affiliated by JNTUH,
Accredited by NBA & NAAC with 'A' Grade)



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 "sustainability and 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. The college 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.

Principal
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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 Metropolitan	Arya Vidyapeeth College Autonomous	B+	B+	A+	C+	B+
12	Assam	Kamrup Metropolitan	Assam down town University	A+	A+	A+	C+	B+
13	Assam	Kamrup Metropolitan	B Borooah College	C+	B+	B+	C+	A+
14	Assam	Kamrup Metropolitan	Dispur College	A	C	B	C+	B+
15	Assam	Kamrup Metropolitan	Gauhati Commerce College	A+	A+	B+	B+	A+
16	Assam	Kamrup Metropolitan	Handique Girls' College	B+	C	C+	C+	C
17			K C Das Commerce					

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

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


Flat: 401, SS Enclave, 2-1-255, St. No:14, Nallakunta, Hyderabad, M:9848050598
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 **2 December 2023** 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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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

Warranties and Liability

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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)

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

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.

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	14.575	31.00
													850.16

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

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

TKR College of Engineering and Technology , Medibowli, Hyderabad 2022-23

Month	UNITS							CHARGES			
	KWH	KVAH	PF	Actual KVA	Billed KVA	TOD1	TOD2	Demand	Energy	TOD	Total
NOV23	92935	94215	0.98641	309	309	16857	13447	147060	829092	30304	1012108
OCT23	73597	74488	0.98804	303	303	12577	10344	144210	655494	22921	827094
SEP23	97398	98517	0.98864	328	328	16343	14081	156085	866949	30424	1059369
AUG23	88743	90025	0.98576	356	356	15277	12702	166250	792220	27979	998120
JULY23	75871	76876	0.98693	327	327	12166	11128	155325	676508	23294	859740
JUN23	124870	127665	0.97811	469	469	17265	16542	166250	1291969	38878	1617997
MAY23	117358	120280	0.97571	467	467	16559	15312	13060	938184	31871	1519291
APR23	107633	109867	0.97967	424	424	16053	15179	165360	856962	31232	1233335
MAR23	88544	90250	0.9811	349	349	15596	12824	136344	703950	28420	874129
FEB23	60598	62465	0.97011	280	280	11267	8772	109200	487227	20039	620213
JAN23	58672	60325	0.9726	280	280	11410	8979	109200	470535	20389	603743
DEC22	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 .

HVAC- Air Conditioning Systems

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 2022-23												
Sl. No	Location	No. of A.C. Unit	Type of A.C.	Rated TR	Power kw	Inlet Temp.(^o c)	Outlet Temp.(^o c)	Flow m/sec	Arrived TR	Specific Power KW/TR	CO P	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.

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 a high 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 by 50%, particularly during winter. The cost of these measures varies between 15,000 to 150,000 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) .


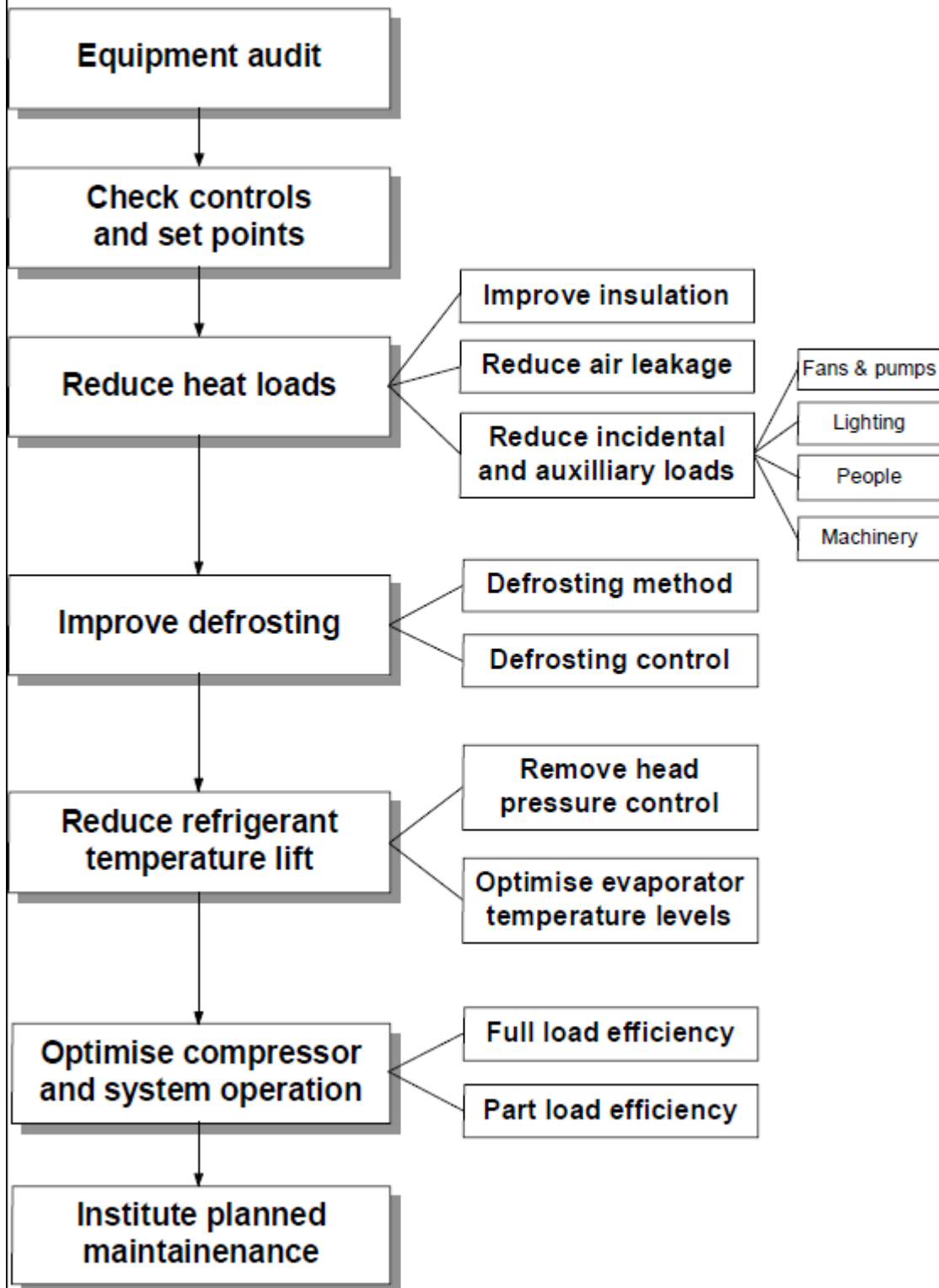


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Figure 1: Optimising energy efficiency



Maintenance & Electrical Safety



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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/cm ²	14.22 psi
1 atmosphere	1.0332 kg/cm ²
1 kg/cm ²	10 meters of water column @ 4 °C
1 kg/cm ²	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/ft ²	British thermal units per square foot
J/m ²	Joules per square meter
kVA	kilovolt-amperes
kW	kilowatts
kWh	kilowatt-hours
kWh/m ²	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 (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.

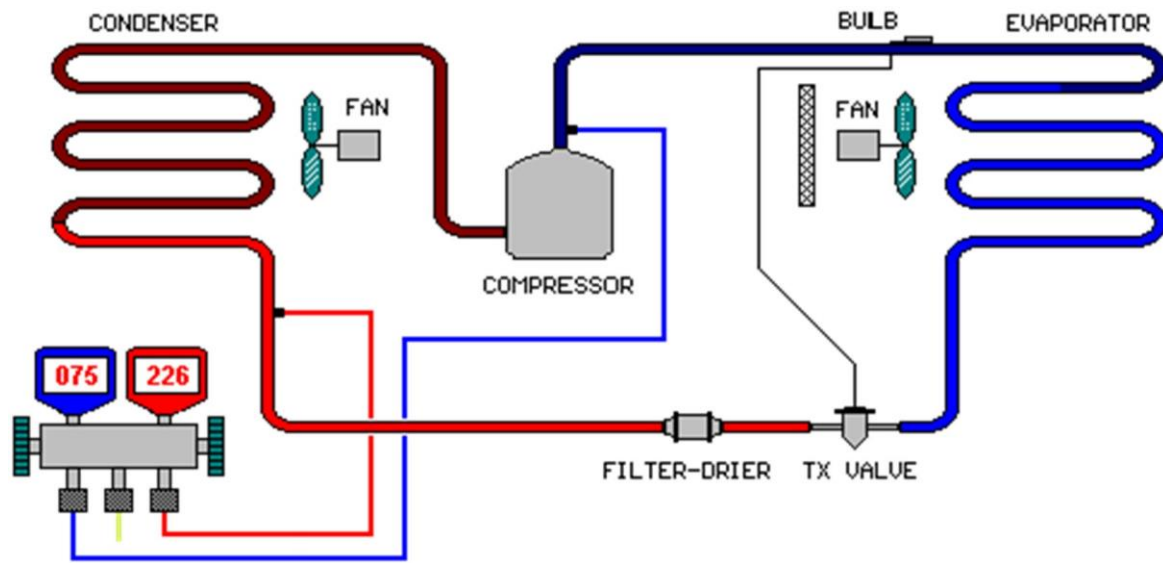
Temperature, Outlet. Temperature measured at the outlet stream of the heat exchange


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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 its 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 Illuminance 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
Colour 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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