J.C BOSE UNIVERSITY OF SCIENCE & TECHNOLOGY, YMCA

Mathura Road, Sector-6, Faridabad, Haryana-121006

DETAILED ENERGY AUDIT REPORT

2020

A-Z ENERGY ENGINEERS PVT. LTD.

PLOT NO. 12, 4860-62, HARBANS SINGH STREET, KOTHI NO. 24,
WARD NO. II, DARYA GANJ, NEW DELHI-11002
011-23240541, 9811402040 pp_mittal@yahoo.com

J.C BOSE UNIVERSITY OF SCIENCE & TECHNOLOGY, YMCA

Mathura Road, Sector-6, Faridabad, Haryana-121006

DETAILED ENERGY AUDIT REPORT

2020

A-Z ENERGY ENGINEERS PVT. LTD.

PLOT NO. 12, 4860-62, HARBANS SINGH STREET, KOTHI NO. 24,
WARD NO. II, DARYA GANJ, NEW DELHI-11002
011-23240541, 9811402040 pp_mittal@yahoo.com

For A-Z Energy Engineers Private Limited

Director

INDEX

List of Tables

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

AC	Air Conditioning
APFC	Automatic Power Factor Control
CFL	Compact Fluorescent Lamp
CFM	Cubic Feet per Minute
CoP	Coefficient of Performance
CO_2	Carbon Dioxide
CT	Cooling Tower
CW	Cooling Water
DG	Diesel Generator
EE	Energy Efficient
EER	Energy Efficiency Ratio
ENCON	Energy Conservation Measures
EPI	Energy Performance Index
FRP	Fibre Reinforced Plastic
FTL	Fluorescent Tube Light
HP	Horse Power
HPSV	High Pressure Sodium Vapour
HT	High Tension
HVAC	Heating, Ventilation and Air conditioning
ID	Induced Draft
IEEE	Institute of Electrical and Electronics Engineers
INR	Indian Rupees
IRR	Internal Rate of Return
kVA	Kilovolt Ampere
kVAh	Kilovolt Ampere Hour
kVAR	Kilovolt Ampere Reactive
kWh	Kilowatt Hour
LED	Light Emitting Diode
LT	Low Tension
MH	Metal Halide
Mkcal	Million Kilo Calories
PF	Power Factor
THD	Total Harmonic Distortion
TR	Ton of refrigeration
TRh	Ton of refrigeration in one hour
TOD	Time of Day
VFD	Variable Frequency Drive
WBT	Wet Bulb Temperature

BACKGROUND

Most of present human activities draw its energy from fossil fuel energy sources. The secondary form of energy, the Electricity, which is mainly generated from fossil fuel, is the lifeline of today's modern and highly mechanized lifestyle. Energy is a basic requirement for economic development in almost all major sectors of economy i.e. agriculture. Industry, transport, commercial, and residential (domestic); Consequently, consumption of energy in different forms has been steadily rising all over the country, and more so in Commercial Buildings, which has maintained a steady growth pattern in the past and the trend is likely to continue in future as well. However major concern is that the fossil fuel based sources of Energy are limited and these sources will get exhausted soon. Therefore Every nation whether developed or under-developed is very much concerned about optimal utilization of energy resources. Energy conservations is one of the initiatives which is a proven measure to optimize the uses to retard the depletion of energy resource.

Therefore considering the vast potential of energy saving and benefits of energy efficiency, the Government of India enacted the Energy Conservation Act, 2001 in October 2001. The Energy Conservation Act.2001, become effective from 1st March 2002. The Act provides for institutionalizing and strengthening delivery mechanism for energy efficiency programs in the country and provides a framework for the much needed coordination between various government entities. As per the EC Act, Government of India established "Bureau of Energy Efficiency" (BEE) with the mission to develop policy and strategies with a thrust on self-regulation and market principles, within the overall frame work of the Energy Conservation Act (EC Act) 2001 with the primary objective of reducing the energy intensity of the Indian economy.

ACKNOWLEDGEMENT

We A-Z Energy Engineer Pvt. Ltd. wish to express our gratitude to the Management of **J.C. Bose University of Science & Technology, YMCA** Faridabad for assigning this work of Detailed Energy Audit. We covey our special thanks to;

Name	Designation	Mobile
Mr. Dinesh Kumar	VC's	
Dr. Poonam Singhal	Associate Professor	9654022564
Mr. Anil Kumar	S.D.O	8860451489
Mr. Om Prakash	J.E	7015431787

We also thank to each & every official of Engineering Section for showing keen interest and co-operation during the course of our study.

We hope that the result provided will help to reduce energy bills of the unit.

AUDIT TEAM

Audit team for this assignment consisted of Energy Auditors, Engineers and Experts namely Dr. P.P. Mittal, Accredited Energy Auditor (AEA-011), Pankaj Chauhan, Sr. Energy Consultant and Sr. Raman Bhandari, Energy Analyst.

NOTE: It is intimated that this whole exercise is for Identifying Energy Saving Potential only. It is further recommended that the Management should go for Electrical Safety Audit also.

Place: **DELHI** Date: **March. 2020**

For A-Z Energy Engineers Private Limited

Director

1. Scope of the Work

The present audit laid emphasis on the following areas to identify energy saving opportunities:

- ✓ Power Distribution System
- ✓ Lighting system
- ✓ ACs & Ventilation
- ✓ Water Pumping and treatment System
- ✓ Transformers
- ✓ DG Sets
- ✓ Air washers and ventilation
- ✓ Solar System

2. Instruments Used for Energy Audit

The following portable instruments were used for data measurement:

- ✓ 3 – phase Power Analyzer
- ✓ Single phase Power Analyzer
- ✓ Anemometer
- ✓ Hygrometer
- ✓ Digital Thermometer
- ✓ Pressure gauge
- ✓ Lux Meter
- ✓ Thermograph Camera
- ✓ Flow Meter
- ✓ Earth Tester

3. Point of Appreciation

The engineering wing is aware of importance of energy conservation, and eager to learn innovative ways of reducing the electricity consumption, further

1. Plant is using LED Lights at various locations indoor & outdoor.
2. Solar LED Light used in outside area
3. Star-rated & Inverter type Air conditioners are being used.
4. The DG sets are excellently maintained.
5. All Panel and Equipment's are properly numbered.
6. Recording of energy parameters is done.

4. About the energy audit location

J.C. Bose University of Science and Technology, YMCA, Faridabad (erstwhile YMCA University of Science and Technology, Faridabad erstwhile YMCA Institute of Engineering, Faridabad) was established in the year 1969, as a joint venture of the National Council of YMCAs of India, Govt of Haryana, and the Central Agencies for Development Aid, Bonn, Germany. It started as an Indo-German project with an aim to impart technical education to a developing India on German pattern.

The labs & workshops have been setup with the assistance of German expertise. In 1996, State Govt. of Haryana took complete control of the Institute and upgraded it to University status in Dec. 2009. The university offers 4-year B.Tech degree course in seven disciplines i.e

- Civil Engineering
- Computer Science
- Information Technology
- Electronics & Instrumentation Control
- Electronics & Communication Engineering
- Electrical Engineering
- Mechanical Engineering

The university has added new chapters in it's glorious history i.e M.B.A., M.C.A, M.Tech. (Computer Engineering, Electrical Engineering, Electronics Engineering & Mechanical Engineering), M.Sc. (Physics, Maths, Chemistry & Environmental Sciences), M.A.(Mass Communication and Journalism) and Ph.D.

It follows it's course curriculum duly approved by the industries and the University. The salient features of German education have been retained & as such the University stands apart from other colleges of Haryana.

Right from the very beginning at institutional level, it has emphasized greatly on practical work related to industry. As a result our students are well accepted by the industries. The fact that many of them are entrepreneur with names of repute at national and international level establishes the same.

The University is situated on National Highway-2, Mathura Road, 30 km from National Capital, Delhi. The University campus is located in the sprawling Faridabad-Ballabgarh Industrial complex.

The sophisticated equipments/machines in the workshops and laboratories enable the students to operate various machines independently so as to acquire thorough knowledge and develop competence in their respective skills.

YMCA University has eight hostels in total.

Boys' Hostels		Room
1	Zakir Hussain Hall	40
2	Tagore Hall	40
3	CV Raman Hall	40
4	Nehru Hall	40
Girls' Hostels		
1	Kalpana Chawla Hall	28
2	Sarojini Hall	21
3	Mother Teressa Hall	22
4	Kasturba Hall	22

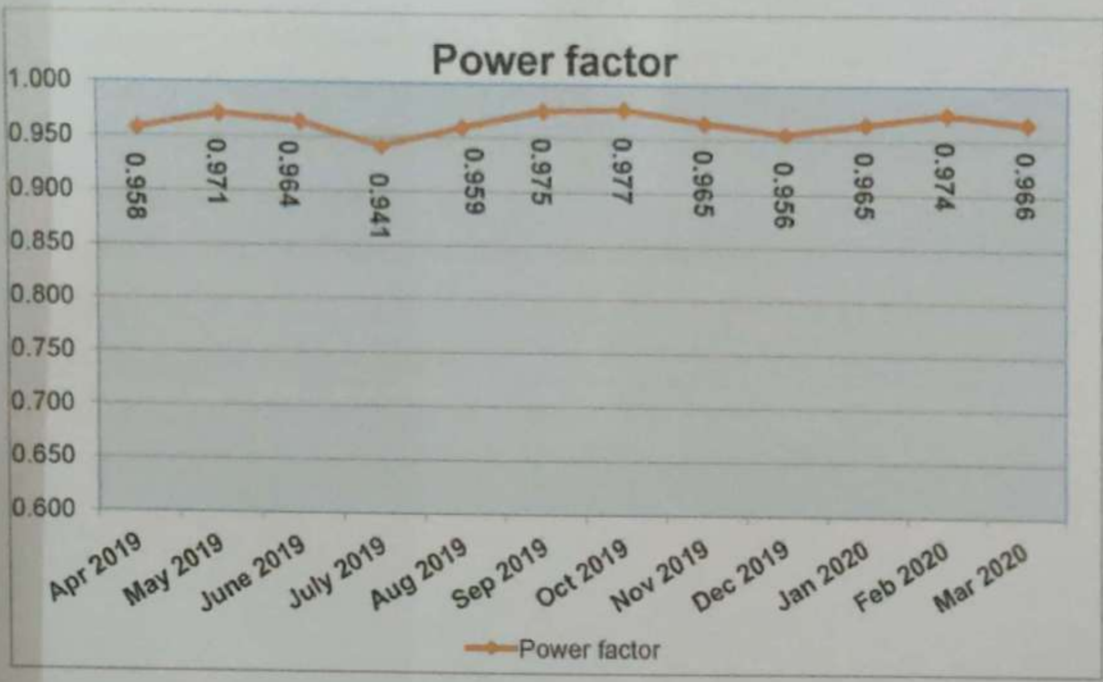
5. Executive Summary

The Electricity and HSD are sources of energy for the unit. The **J.C Bose University of Science & Technology, YMCA** is getting electrical power supply from Dakshin Haryana Bijli Vitran Nigam (DHBVN) at 11 kV supply. There is one transformer of 500 kVA (11kV/ 0.433kV) installed. The premise is also having two nos. diesel generators of 250 KVA & 500 KVA to provide power supply during power failure/emergency. The one year electrical bill analysis indicates that there is wide variation in MDI i.e depend upon season. In summer season MDI Increase (May to Nov.) and Winner season MDI is decrease.

The MDI show in graph last 12 month electricity bills. Maximum MDI 582 in the month of Sep. 2019 and Minimum228.8 in the month of Jan. 2020.

The major energy consuming equipment's in the premises are Lighting Fixture, A/C Unit, Fan/Ventilation, Computer/ Printer, water pumping system, Testing Equipments, and other equipment etc.

The Power Factor at transformer terminals was found low. Maximum power factor was 0.977 in the month of Oct. 2019, minimum power factor 0.941 in Jul. 2019 and average power factor 0.964



It is recommended that Installed APFC panel are required to be installed/shifted at load center-end for improving the power factor.

3000 lpd. Solar water heater installed in Girls hostel roof. Hot water is used in hostel but solar water heater panel not in work.

The harmonics levels measured in main incomer with in limit.

	TR-500 KVA
THD Phase1 (V)	1.7
THD Phase2 (V)	2.0
THD Phase3 (V)	1.7
THD Phase1 (A)	7.5
THD Phase2 (A)	7.0
THD Phase3 (A)	8.2

The summary of recommendations are as under:

1. Leftover conventional lights be replaced with energy efficiency lights.
2. Replacing Non-star rated ACs with BEE Star rated ACs and Ceiling fans with BEE Star Rated Fans.
3. Installation of capacitors at load end to raise Power Factor.
4. Proper maintenance of record of fuel uses i.e. HSD

5. Light sensor used in Lab & office
6. Use of smart building management system.
7. Energy Management Certification (ISO 50001 Certification) of the Campus
8. Cleaning of all light points.
9. Switching off lights in day-time where-ever not required
10. Switching off lights in day time at locations where there is enough light.
11. Cleaning Solar Panels Regularly.
12. Alignment of shafts and flat belts in motors.

For A-Z Energy Engineers Private Limited

Director

6. Energy Input, Conservation Option & Savings

6.1 Energy inputs

Electricity	For various machines, equipment, illumination system- offices and work place lighting, wards, cooling towers, motors, pumps, Instruments etc.
HSD	DG Sets

6.1.1 Electricity

The Electricity is major Energy input of the plant. The historical consumption pattern for last 12 months are as per following details:

Table.1: Details of Electrical Energy uses

S. No.	Billing Month	Power factor	Total electricity consumption (kWh)	Total electricity consumption (kVAh)
1	Apr 2019	0.958	59557.6	62200.0
2	May 2019	0.971	112099.2	115417.6
3	June 2019	0.964	126868.8	131575.2
4	July 2019	0.941	81348.0	86429.6
5	Aug 2019	0.959	101149.6	105425.6
6	Sep 2019	0.975	124837.6	128048.8
7	Oct 2019	0.977	130457.6	133564.0
8	Nov 2019	0.965	90249.6	93480.8
9	Dec 2019	0.956	73560.0	76984.0
10	Jan 2020	0.965	65763.2	68154.4
11	Feb 2020	0.974	70828.0	72708.0
12	Mar 2020	0.966	71035.2	73547.2
	TOTAL		**1107754**	**1147535**
	Avg.	**0.964**	**92312.9**	**95627.9**
	Max	**0.977**	**130457.6**	**133564.0**
	Min	**0.941**	**59557.6**	**62200.0**

6.1.2 HSD

HSD consumption is used in DG set in case of non-supply from grid, in emergency and maintenance etc.

6.2 Proposed Summary of savings

Table 2: Summary of Savings

S. No.	Proposed energy conservation measures	Quantity (nos.)	Total annual energy savings (kWh)	Total annual monetary savings (INR)	Anticipated investment (INR)	Simple payback period (Months)
1	Replacement of T8(36W) with (18W) LED Tube Light	794	26202	214856.0	500220.0	28
2	Replacement of T8(36Wx2) with (18Wx2) LED Tube Light	231	15246	125017.0	291060.0	28
3	Replacement of Sodium Vapor (150W) with (60) LED Light	4	1382	11335.68	21000.0	22
4	Replacement of Sodium Vapor (250W) with (90) LED Light	8	4378	35896.32	63000.0	21
5	Improved power factor	250 kVAr	30179	247468	262500.0	13
6	Installation of Solar PV System 75kWp	75 kWp	103500	848700	3750000.0	53-54

Remarks:

1. **The electricity rate has been taken as Rs. 8.2/kVAh.**
2. **Calculations are annual average basis. The actual savings will be proportion to uses of uses.**

7. Lighting Details

Various types of lighting fixtures are installed in different areas and locations. Premises has already installed energy efficient LED Lights at most of the places. But still some lighting fixtures needs to be replaced with LEDs. Energy Efficient LED Lights offer reduction in the power consumption besides excellent color rendering properties and high luminous efficacy. The detail of lighting fixtures are given below:

Table 3: Type of lighting

Srl	Fixture	Power Rating (Watt)
1	LED Tube Light	18/20
2	LED Tube (2')	9
3	LED Cobe	12
5	LED Cobe	6
6	LED Bulb	12
7	LED Light Out side	45/60
8	LED High Mast tower	350

7.1 Timed Based Control or Daylight Linked Control

Timed-turnoff switches are the least expensive type of automatic lighting control. In some cases, their low cost and ease of installation makes it desirable to use them where more efficient controls would be too expensive. Newer types of timed-turnoff switches are completely electronic and silent. The best choice is an electronic unit that allows the engineering staff to set a fixed time interval behind the cover plate. This system is recommended for street Lighting application in the building. Photoelectric cells can be used either simply to switch lighting on and off, or for dimming. They may be mounted either externally or internally. It is however important to incorporate time delays into the control system to avoid repeated rapid switching caused, for example, by fast moving clouds. By using an internally mounted photoelectric dimming control system, it is possible to ensure that the sum of daylight and electric lighting always reaches the design level by sensing the total light in the controlled area and adjusting the output of the electric lighting accordingly. If daylight alone is able to meet the design requirements, then the electric lighting can be turned off. The energy saving potential of dimming control is greater than a simple photoelectric switching system

7.2 Localized Switching

Localized switching should be used in applications, which contain large spaces. Local switches give individual occupants control over their visual environment and also facilitate energy savings. By using localized switching it is possible to turn off artificial lighting in specific areas, while still operating it in other areas where it is required, a situation which is impossible if the lighting for an entire space is controlled from a single switch.

7.3 Replacement of Tube Light (36W) T8 with LED based Light (18W)

The premises has also installed T8 tube light (36W). Though it is an energy efficient option, the energy efficiency can be further improved by replacing these T8 tube light with LED based tube lights (18W) as they provide similar or better lux levels with further enhanced energy savings

Recommendation

The replacement of T8 tube light (36W) with LED tube light (18W) will result in close to **55 percent energy savings** without compromising on light levels.

Energy and Financial Savings

The following parameters and assumptions have been considered while estimating the energy saving financial viability of this option:

Table 4: Savings in replacement of T8 tube light (40W) with LED tube light 18 Watt

Assumptions and Input parameters		
Cost parameters	**Unit**	**Value**
Existing T8 (40w) with choke need to be replaced	Number	794
Cost of LED base tube Light (18 W)	INR/ piece	600
Installation Cost	% of capital cost	5
Operating parameters		
Number of running hours	Per day	6
Number of operating days	Per year	250
Average life of LED lamps (18 W)	Hours	50,000
Average electricity tariff	INR/kVAh	8.2
Energy and financial savings		
Power consumption of T8 tube lights (36W)	W/piece	40
Power consumption of LED Light (18 W)	W/piece	18
Energy savings	W/piece	32
Annual energy saving	kWh/year	22
Annual monetary saving	INR/year	26202
Total investment requirement	INR	214856
Simple payback period	Months	500220
Internal rate of return	%	28

7.4 Replacement of Tube light (36Wx2) with LED based Light (18Wx2)

The premises had installed tube light (36Wx2) in the office area. Though it is an energy efficient option, the energy efficiency can be further improved by replacing these tube light with LED based lights (18W) as they provide similar or better lux levels with further enhanced energy savings

Recommendation

The replacement of T8 tube light (36Wx2) with LED lamps (18Wx2) will result in close to **55 percent energy savings** without compromising on light levels.

Energy and Financial Savings

The following parameters and assumptions have been considered while estimating the energy saving financial viability of this option:

Table 5: Savings in replacement of T8 tube light (36Wx2) with LED tube light 18x2 Watt

Assumptions and Input parameters		
Cost parameters	**Unit**	**Value**
Existing T8 (36Wx2) need to be replaced	Number	231
Cost of LED based lights (18 Wx2)	INR/ piece	1200
Installation Cost	% of capital cost	5
Operating parameters		
Number of running hours	Per day	8
Number of operating days	Per year	250
Average life of LED lamps (18 W)	Hours	50,000
Average electricity tariff	INR/kVAh	8.2
Energy and financial savings		
Power consumption of T8 tube lights (36WX2)	W/piece	80
Power consumption of LED Light (18WX2)	W/piece	36
Energy savings	W/piece	44
Annual energy saving	kWh/year	15246
Annual monetary saving	INR/year	125017
Total investment requirement	INR	291060
Simple payback period	Months	28
Internal rate of return	%	37.00%

An energy saving of 55 percent can be achieved by replacing the existing T8 tube lights (36 Wx2) with LED tube lights (18Wx2). Implementation of this measure needs an investment of INR 291060 and will have a simple payback period of 28 months. Additionally, the IRR comes out to be 37.00 %.

7.5 Replacement of Sodium Vapour (150W) with LED Light (60W)

The premise has installed Sodium Vapour/HPSV Lamps (150W) in the plant shed Light. The average energy consumption of one such lamp is around 180W because of inherent losses of magnetic ballast. There are energy efficient induction lamps/LED based lamps available in the market & should be used to replace the existing metal halides lamps. These lamps provide similar or better light levels. Moreover, the life of these energy efficient lamps is very high i.e. around 50,000 hours.

Recommendation

The replacement of Sodium Vapor/HPSV Lamps (150W) with LED lamps (60 W) will result in close to **66.7 percent energy savings** without compromising on light levels.

Energy and Financial Savings

The following parameters and assumptions have been considered while estimating the energy savings and financial viability of this option:

Table 6: Savings in replacement of sodium vapour (250W) with LED light 60 Watt

Assumptions and Input parameters		
Cost parameters	**Unit**	**Value**
Existing Sodium Vapour lamps need to be replaced	Number	4
Cost of LED Light (60W)	INR/ piece	5000
Installation Cost	% of capital cost	5
Operating parameters		
Number of running hours	Per day	8
Number of operating days	Per year	360
Average life of LED lamps (60 W)	Hours	50,000
Average electricity tariff	INR/kVAh	8.2
Energy and financial savings		
Power consumption of Sodium/HPSV	W/piece	180
Power consumption of LED Light (60W)	W/piece	60
Energy savings	W/piece	120
Annual energy saving	kWh/year	1382
Annual monetary saving	INR/year	11336
Total investment requirement	INR	21000
Simple payback period	Months	22
Internal rate of return	%	47.59%

An energy saving of 66.67 percent can be achieved by replacing the existing Sodium Vapour (150W) with LED street lights (60W). Implementation of this measure needs an investment of INR 21000 and will have a simple payback period of 22 months. Additionally, the IRR comes out to be 47.59 %.

7.6 Replacement of Sodium Vapour (250W) with LED Light (90W)

The premise has installed Sodium Vapour/HPSV Lamps (250W) in the plant shed Light. The average energy consumption of one such lamp is around 280W because of inherent losses of magnetic ballast. There are energy efficient induction lamps/LED based lamps available in the market & should be used to replace the existing metal halides lamps. These lamps provide similar or better light levels. Moreover, the life of these energy efficient lamps is very high i.e. around 50,000 hours.

Recommendation

The replacement of Sodium Vapor/HPSV Lamps (250W) with LED lamps (90W) will result in close to **67.86 percent energy savings** without compromising on light levels.

Energy and Financial Savings

The following parameters and assumptions have been considered while estimating the energy savings and financial viability of this option:

Table 7: Savings in replacement of sodium vapour (250W) with LED light 90 Watt

Assumptions and Input parameters		
Cost parameters	**Unit**	**Value**
Existing Sodium Vapour lamps need to be replaced	Number	8
Cost of LED Light	INR/ piece	7500
Installation Cost	% of capital cost	5
Operating parameters		
Number of running hours	Per day	8
Number of operating days	Per year	360
Average life of LED lamps (90 W)	Hours	50,000
Average electricity tariff	INR/kVAh	8.2
Energy and financial savings		
Power consumption of Sodium/HPSV	W/piece	280
Power consumption of LED Light (90W)	W/piece	90
Energy savings	W/piece	190
Annual energy saving	kWh/year	4378
Annual monetary saving	INR/year	35896
Total investment requirement	INR	63000
Simple payback period	Months	21
Internal rate of return	%	50.42%

An energy saving of 66.67 percent can be achieved by replacing the existing Sodium Vapour (250W) with LED street lights (90W). Implementation of this measure needs an investment of INR 63000 and will have a simple payback period of 21 months. Additionally, the IRR comes out to be 50.42 %

8. Improvement in operating power factor

The premises is being billed on kVAh basis; therefore the effect of power factor is inbuilt in the billing structure. They have no APFC panel. Based on the electrical bills the operating power factor on the main incomer varies from 0.941 - 0.997, the average power factor was around 0.964, which appears to be on the lower side. It is thus recommended to install more capacitor banks on the main feeder so that the overall system power factor is maintained at around 0.99 (lag). Improvement in the power factor would subsequently reduce the KVAh consumption, resulting in energy savings as follows ;

Table 8: Historical pattern of power factor

Sr. No.	Billing Month	Power factor	Electricity consumed (kWh)	Electricity consumption (kVAh)
1	Apr 2019	0.958	59557.6	62200.0
2	May 2019	0.971	112099.2	115417.6
3	June 2019	0.964	126868.8	131575.2
4	July 2019	0.941	81348.0	86429.6
5	Aug 2019	0.959	101149.6	105425.6
6	Sep 2019	0.975	124837.6	128048.8
7	Oct 2019	0.977	130457.6	133564.0
8	Nov 2019	0.965	90249.6	93480.8
9	Dec 2019	0.956	73560.0	76984.0
10	Jan 2020	0.965	65763.2	68154.4
11	Feb 2020	0.974	70828.0	72708.0
12	Mar 2020	0.966	71035.2	73547.2
	Total		**1107754**	**1147535**
	Avg.	**0.964**	**92312.9**	**95627.9**
	Max	**0.977**	**130457.6**	**133564.0**
	Min	**0.941**	**59557.6**	**62200.0**

Table 9: Savings in Improve power factor

Improvement of Power Factor		
Assumptions and Input parameters		
Particulars	**Unit**	**Value**
Existing Average Power Factor (2019-20)		0.964
Proposed Power Factor		0.999
Installation Cost	% of capital cost	5
Operating parameters		
Particulars	Unit	Value
Annual units	kWh	1107754
Cost of - 250 KVAR Capacitor	@180/-kVAr	250000
Average electricity tariff	INR/kVAh	8.2
Energy and financial savings		
Parameters	**Unit**	**Value**
Annual kVAh at -0.964 P.F	kVAh/Unit	1149122
Annual kVAh at -0.999 P.F	kVAh/Unit	1118943
Annual energy saving	kVAh/year	30179
Annual monetary saving	INR/year	247468
Total investment requirement	INR	262500
Simple payback period	Months	12.7

Implementation of this measure needs an investment of INR 262500 and will have a simple payback period of 13 months.

It is thus recommended to replace damage/De-rated capacitor banks on the APFC Panel or the capacitor banks wherein the delivery is poor (less than 70%) or out of order may be replaced, so that the overall system power factor is maintained at around 0.99 (lag). Improvement in the power factor would subsequently reduce the KVAh consumption. The variation of power factor show in above table.

Based on the electrical bills (11 KV) for Year Apr. 2019 to Mar. 2020 the operating power factor on the main incomer is varies from 0.941 - 0.997, the average power factor was around 0.964, which is slightly on lower side.

Month	electricity consumed (kWh)	electricity consumption (kVAh)	Present Power Factor	KVAh Consumption post improvement power factor to 0.999	Net Reduction in KVAh Consumption	Corresponding reduction in Energy Charges (Rs) 6.75
Apr 2019	59557.6	62200.0	0.958	59617.2	2582.8	21178.8
May 2019	112099.2	115417.6	0.971	112211.4	3206.2	26290.7
June 2019	126868.8	131575.2	0.964	126995.8	4579.4	37551.1
July 2019	81348.0	86429.6	0.941	81429.4	5000.2	41001.4
Aug 2019	101149.6	105425.6	0.959	101250.9	4174.7	34232.9
Sep 2019	124837.6	128048.8	0.975	124962.6	3086.2	25307.1
Oct 2019	130457.6	133564.0	0.977	130588.2	2975.8	24401.7
Nov 2019	90249.6	93480.8	0.965	90339.9	3140.9	25755.1
Dec 2019	73560.0	76984.0	0.956	73633.6	3350.4	27473.0
Jan 2020	65763.2	68154.4	0.965	65829.0	2325.4	19068.0
Feb 2020	70828.0	72708.0	0.974	70898.9	1809.1	14834.6
Mar 2020	71035.2	73547.2	0.966	71106.3	2440.9	20015.3
TOTAL	**1107754**	**1147535**	**0.964**	**1108863.3**	**38671.9**	**317109.9**

9. Window/Split AC Units Specification

Split / Window AC's are installed at several locations in the station building. The details of AC are as follows:

Identification	Star Rating	Type	No. of AC
AC		Split	19
AC	2*	Split	5
AC	3*	Split	73
AC	5*	Split	22
AC		Window	8

Identification	TR	No. of AC	Location
Central AC	8.5 Ton	3	Multimedia Centre
Central AC	22 Ton	2	Computer Hall
Central AC	11 Ton	2	Lab
Cassette AC		16	Auditorium

Indicative TR Load Profile for Air Conditioning

Small Office Cabins	:	0.1 TR m^2
Medium Size Office with 10-30 people occupancy with Central A/c	:	0.06 TR/m^2
Large Multistoried office complex with Central A/c	:	0.04 TR/m^2

Electrical measurement parameter

Sr. No.	Fixture	Type	Volts	I	kW	Power Factor
1	Office	Split	230.0	11.3	2.0	0.785
2	Office	Split	231.0	12.5	2.2	0.760
3	Lab	Split	230.0	11.9	2.1	0.780
4	Class	Split	228.0	12.8	2.3	0.800
5	Lab	Split	230.0	12	2.2	0.795
6	Office	Split	231.0	11.3	2.1	0.810

Window A/Cs, Split AC and Cassette AC of various capacity & type installed in the complex. Some Air conditioning system is not operating during the energy audit. Most of AC is 3 to 5 Star rating installed in the building, A-Z Energy Engineers Pvt. Ltd. acknowledges and appreciates the commitment of the management towards conservation of Energy. Further it is recommended to replace left-over non-star rates ACs with Star Rated ACs, resulting further saving in energy,

Recommendation/ Observation of AC System

- Monthly cleaning schedule Air Filters
- Replace Damage filters.
- Yearly service
- Check and clean condenser coils
- Check and clean air filters
- Check pipe Insulation

10. Water Pumping System

Water pumping systems meet the daily water requirement for various functions such as station colony and drinking purposes. There are 11 nos. pumps of different type capacity are installed in campus area. There are two sources of water supply one is Huda supply & other is Submersible.

All Pumps are running 3-4 hr. per day for different time as per required. During the audit we have measured the power and flow of pumps. There are no pressure gauge point on pipe line to measured pressure. we have taken the discharge pressure from tank height because the pressure gauge point is not available on pipe line.

Table 10: Details of water Pumps

Pumps	Girls Mess	Main Tank	Sakuntalam Hall	Admin Block	Boy Hostel-1	Boy Hostel-2	Boy Hostel-3	Boy Hostel-4	Main Ground	Girls Hostel-1	Girls Hostel-2
Rated Motor											
HP	10	10	2	2	2	2	2	2	10	2	10
KW	7.5	7.5	1.5	1.5	1.5	1.5	1.5	1.5	7.5	1.5	7.5
Rated Pump											
% eff	80	80	80	80	80	80	80	80	80	80	80
Head (M)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Flow LPM	450	450	100	100	100	100	100	100	450	100	450
Flow m3/h	27	27	6	6	6	6	6	6	27	6	27

The water pumps parameters were recorded by using a portable power analyzer. During the recording, the power analyzer recorded all the electrical parameters for further detailed analysis and water flow meter measured the water flow.

Table 11: Measurement of Pump Efficiency

Description		Unit	Girls Mess	Main Tank	Boy Hostel -3	Boy Hostel-4	Main Ground	Girls Hostel-2
Rated Parameter	Head	Mtr	NA	NA	NA	NA	NA	NA
	Flow	M^3/Hr	27	27	6	6	27	27
	Power	KW	7.5	7.5	1.5	1.5	7.5	7.5
	Pump Efficiency	%	80	80	80	80	80	80
Measured Parameter	Total Head	Mtr	61	24	61	61	61	61
	Flow	M^3/Hr	11.2	70	3.4	4.1	18.8	18.4
	Power	KW	9.7	9.8	1.9	1.8	8.4	8.9
	Pump Efficiency	**%**	**21.81**	**53.08**	**33.80**	**43.02**	**42.27**	**39.05**

MEASURED ELECTRICAL PARAMETERS

Sr. No.	Fixture	Rated (HP)	Rated (kW)	ELECTRICAL PARAMETERS			
				Volt	I	kW	Power Factor
1	Girls Mess	10	7.5	415.0	18.60	9.7	0.725
2	Main Tank	10	7.5	414.0	18.50	9.8	0.742
3	Sakuntalam Hall	2	1.5				
4	Admin Block	2	1.5				
5	Boy Hostel -1	2	1.5	225.0	9.10	1.5	0.750
6	Boy Hostel-2	2	1.5	230.0	11.00	1.9	0.760
7	Boy Hostel-3	2	1.5	230.0	11.00	1.9	0.740
8	Boy Hostel-4	2	1.5	228.0	10.40	1.8	0.750
9	Main Ground	10	7.5	410.0	15.60	8.4	0.760
10	Girls Hostel-1	2	1.5	230.0	10.50	1.8	0.740
11	Girls Hostel-2	10	7.5	415.0	17.20	8.9	0.720

Observations:

- Pressure gauge point was not available in delivery side of pump.
- No flow meter was connected with delivery line.
- Non availability of Characteristics curve of pump.
- The measured efficiency of water supply submersible Pump is low i.e.
- Energy savings are possible by replacing this inefficient pump with new efficient pump.

11. Self-Power Generation

11.1 DG sets

The premises is getting electrical power supply from the Dakshin Haryana Bijli Vitran Nigam (DHBVN) and unit is also having two nos. DG Sets of capacities to provide power supply during power failure and provide power backup during day/night operations. The Technical details of these DG sets are as under:

Table 12: Technical details of DG sets

Name Plate Data		DG-1	DG-2
Rated	kVA	250	500
	KW	200	400
Voltage	L.V	415	415
Amp.	L.V	348	695.6
Phase		3	3
P.F.		0.8	0.8
RPM		1500	1500
Hz		50	50
Excitation	Volts	48	56
Excitation	Amps	2.3	3.0

Further observations and recommendations are as under:

1. The standard specific fuel consumption (SFC) of DG sets is in the range of 3.0 to 3.5 kWh/ltr, present Average SPC of all DG set is above average 3.1 kWh/Ltr. which is good.
2. D.G sets are neat & clean
3. DG set room have been with Proper Ventilation
4. However, there is No-Load Testing schedule

Recommendations for Energy Efficiency Measures in DG Sets

1. Ensure Steady load condition on the DG set and avoid idle running.
2. Improve air filtration.
3. Ensure fuel oil storage, handling and preparation as per manufacturers' guidelines/oil company data.
4. Calibrate and overhaul fuel injectors and injection pumps regularly as recommended by manufacturer.
5. Ensure compliance with maintenance checklist
6. Ensure steady load conditions, avoiding fluctuations, imbalance in phases, harmonic loads.
7. Carryout regular field trials to monitor DG set performance, and maintenance planning as per requirements.
8. Efficiency of DG Set can be increase by loading 70-80% load
9. The starting current of squirrel cage induction motor is as much as six times the rated current for a few seconds with direct-on-line starters. In practice, it has been found that the starting current value should not exceed 200% of the full load capacity of the alternator. The voltage and frequency throughout the motor starting interval recovers and reaches rated values usually much before the motor has picked up full speed
10. It is always recommended to have the load as much balanced as possible, since the unbalanced loads can cause heating of the alternator, which may result in unbalanced output voltage. The maximum unbalanced load between phases should not exceed 10% of the capacity of the generating sets.
11. The electricity rules clearly specify that two independent earths to the body and neutral should be provided to give adequate protection to the equipment in case of an earth fault and to drain away any leakage of potential from the equipment to the earth.

11.2 Solar PV Based Power Generation

The College has lot of space at roof-top. Where solar PV panels can be installed. **Solar photovoltaic technologies** convert solar energy into useful energy forms by directly absorbing solar photons—particles of light that act as individual units of energy—and either converting part of the energy to electricity.

The units or kWh output of a solar panel will depend on the panel efficiency and availability of sunlight in a location. The factor that defines this output is called CUF (or Capacity Utility Factor). For India, it is typically taken as 19% and the calculation of units goes as:

Units Generated Annually (in kWh) = System Size in Kw * CUF * 365 * 24.

So typically a 1 kW capacity solar system will generate 1600-1700 kWh of electricity per year. This can provide electricity for 25 years.

Around 75 kW of solar PV based power plant can be installed in the areas as recommended above. There are various options for capital Investment

The resultant monitory benefit has been worked out as follows:

Table 13: Calculation of Solar PV generation

• Total Capacity of SPV	=	75 KW
• Area required per KW	=	10 m2/ KW
• Area required for 50 KW	=	750 m2
• Facing	=	Shedow free South facing
• CUF/PLF	=	19%
• 1kWp solar rooftop	=	4.6 kWh

Inputs	Unit	Value
Capacity of Plant	kWp	75
CUF/PLF	%	19%
1kWp solar rooftop	kWh	4.6
Inputs	**Unit**	**Value**
Capacity of Plant	kWp	75
Cost (Per Kw)	₹	50000
Electricity Tariff	₹ /Unit or kWh	8.2
Average Yearly generation	kWh (Units)	103500
Total Generation in 25 Years	kWh (Units)	2587500
Tariff rate (Avg over 25 Years)	₹	8.2
Average Monthly Savings	₹	70725
Average Annually Savings	₹	848700
Total Savings over 25 years	₹	21217500
Total Capital Investment	₹	3750000
Simple Payback	**Months**	**53-54**

It is recommended to install a Solar Photovoltaic Cell (75 KW) for Power Generation for lighting load in the Building, which would supply light to lighting feeder. **Solar photovoltaic technologies** convert solar energy into useful energy forms by directly absorbing solar photons—particles of light that act as individual units of energy—and either converting part of the energy to electricity.

Average solar irradiation in HARYANA state is 1156.39 W/sq.m. 1kWp solar rooftop plant will generate on an average over the year 4.6 kWh of electricity per day (considering 5.5 sunshine hours)

It is recommended to install a Solar Photovoltaic Cell (75 KW) in the premises. The resultant benefits in terms of energy savings workout to **Rs. 8.5 Lacs per annum** with an estimated investment of Rs. **37.5 Lacs** and simple payback period of **53-54 months.**

12. Power Quality

12.1 HARMONICS

- Harmonics are the periodic steady-state distortions of the sine wave due to equipment generating a frequency other than the standard 50 cycles per second as now a day's equipment became more sophisticated and with the proliferations of non-linear loads, harmonics have become a pronounced problem on many power systems. Now a-days in many areas non-linear load are approaching significantly.

The Effects of the Harmonics current are:

- Additional copper losses
- Increased core losses
- Increased electromagnetic interference with communication circuits.

The Effects of the Harmonics Voitage are:

- Increased dielectric stress on insulation
- Electro static interference with communication circuits
- Resonance between reactance and capacitance

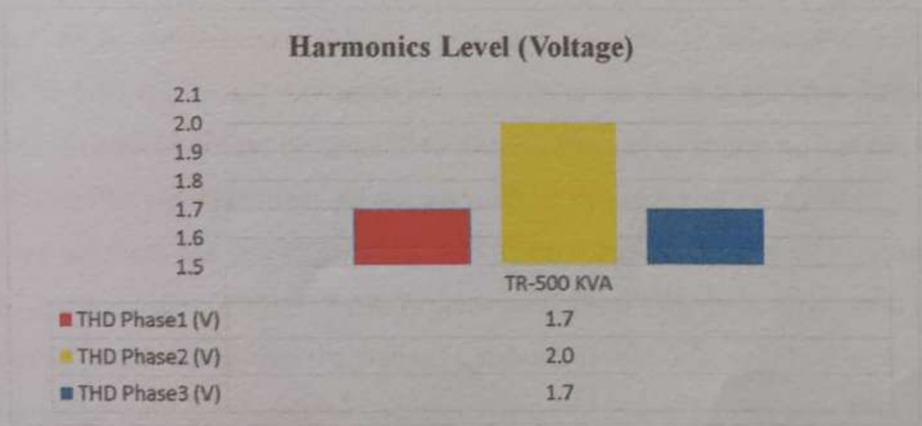
- **Causes:** There are many sources of harmonics in Power system but all harmonics sources share a common characteristic. This is a non-linear voltage current operating relationship and any device that alters the sinusoidal wave form of voltage or current is harmonics producer. The following are the source of harmonics: **Electronic ballasts; non—linear loads; variable frequency drives, diodes, transistors, thyrusters, rectifier output, frequency conversion, Transformers; circuit breakers; phone systems; capacitor banks; motors, Computers (power supplies) PC, laptop, mainframe, Servers, Monitors, Video display, Copiers, scanners, FAX machines, printers, plotters, lighting controls, UPS systems, battery charges & data centers etc. etc.**
- **Effects:** Overheating of electrical equipment; random breakers tripping, High Neutral current due to 3rd Harmonics, interference with communication, non-proper recording of metering, increase in cooper loss, heating of equipment's such as transformer & generators, breakers & fuse operation occur.

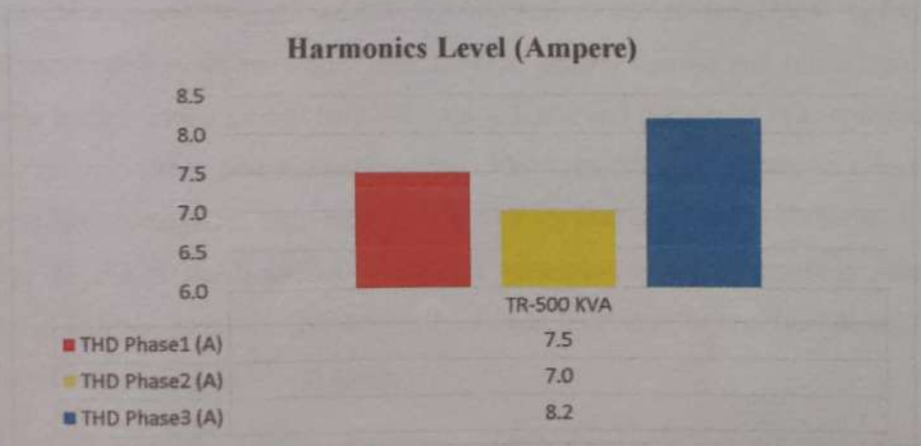
Harmonics contents can place serious Burden on power distribution system. If harmonics distortion may suppose 35%, the distribution of harmonics then will be 5th order 27% 7th order 5%, 11th order – 2 % and 13th order 1%.

- **Solutions:** Harmonics filters employ the use of power electronic technology, which monitors the nonlinear load and dynamically corrects a wide range of harmonics, such as the 3rd to 51st harmonics orders. By the injection of a compensating current into the load, the waveform is restored which dramatically reduce distortion to less than 5% THD, meeting IEEE 519 standards. Further to meet other power quality demand surge protection, metering, relay protection, control, SCADA and communication can be one of the solution. Solution can range from simply tightening connections in a switchboard to help overheating of conductors, to use of a 200% rated neutral in a panel board.

The total harmonic distortion (THD) of current or voltage is equal to the effective value of all the harmonics divided by the effective value of the fundamental.

Table 14: Level of harmonics in Main Incomer





As per IEEE 519-992& IEEE C-57.110-1986 The current harmonics should be less than 8% as higher value may result in mal-operation of electronics system like control & protection etc. and may result in de-rating of transformer, the most preferred international standard of harmonic for Voltage should not be more than 3% and for current it should not be more than 8%.

HARMONIC CAN BE LIMITED WITH FOLLOWING METHODS:

1. 12 Pulse drives
2. Harmonic filters
3. High-end performance drives
4. Power re-distribution

Further:

1. Every harmonic can create problem, the nature of problem can be different. Due to higher voltage harmonic there can be components failure in electronic circuits, in higher current harmonics there can be high heat generation, which can lead to burning and fire, again due to higher third & ninth harmonic, there will be higher neutral current which can be very dangerous for maintenance team, due to higher negative harmonic there can be mechanical problems which leads to machine failures etc. Therefore, it will be incorrect to say any harmonic is to be given more preference. Mitigation to harmonic should always be specific to the problem and of course be just not more and not less. This is where many people get mislead by marketing team.
2. Every machine has inbuilt capacity to withstand certain amount of harmonics, be it voltage or current. IEEE 519 A& B gives more details on the subject, though there is nothing much mentioned in Indian standard on the subject (To the best of my knowledge). As per thumb rule, voltage harmonic should be less than 3% and current harmonics should be less than 8%. All odd harmonics are dangerous. As I mentioned earlier third & ninth harmonic will increase neutral current and related problems as these are generated mostly by single phase loads and the circuit is completed through the neutral. Other odd harmonics (5th, 7th, 11th, 13th etc.) will be either positive harmonics or negative harmonics. Besides higher current and heat (Other problems will also be there) the negative harmonics will also cause mechanical problems to complicate the problems further. So the danger level is to be analyzed depending upon the situation and problem at hand.

12.2 Power factor

The concept of power factor in the case of sinusoidal voltages and currents, relates to the real power, reactive power, and apparent power associated with a load consisting of resistance and reactance bringing about a direct phase shift between the voltage and current.

Capacitor is a device that generates reactive current and consumes very less power. Installing capacitor will improve the power factor and will also reduce the kVA demand of the system and will increase the capacity of the network i.e. the network cables can be loaded further. Reduction in reactive current will result in reduction of I^2R losses and efficiency of the system will improve.

So it is recommended to keep 50% PF the capacitor at down stream (Load end) of the electrical distribution network and balance 50% at up stream (power house) end with automatic features (APFC). It is the best suited reactive compensating method as it will reduce distance transport of reactive power. It is also recommended to replace all the capacitors which have more than 35% reduction in rated capacity.

Table 15: Measures power factor main Incomer

	Max.	Min.	Ave.
Power Factor	0.980	0.948	0.963

It is recommended that instead of installing all the capacitors at the beginning 50% should be shifted to load center immediately. As at the main supply system also average power factor recorded is found to be 0.910, it is recommended that at individual locations power factor correction system be installed after conducting detailed study at the time of operation of Air Conditioning system. The location of power factor correction should by taking following into account:

1. It should be on the main distribution board.
2. It should be either on sub-distribution board
3. It should be at the load end.

The benefits of power factor can be summarized as under:

1. Rebate from State Electricity Board
2. Improvement in Voltage
3. Reduction in maximum demand charges
4. Reduce heat loss

13. Cables

The electric current corresponds to Total Power (kVA) that depends on power factor, flows from utility-supply point to various load points of the unit through power cables (mostly made of aluminum). During the above power transport, considerable power is wasted to oppose the resistance of the cable. The cable resistance increases with length but decreases with cross-section i.e. increase in size. Therefore, the cable capacity has to be selected accordingly to keep the loss within 0.75% and it is only active load which cause the change in PF from no load to full load. By applying capacitor, we will change the PF of supply system hence I^2R of the old cable between supply source and motor.

14.1 Flowing current in feeders

The cable loss is proportional to I^2R (square of current flow and resistance of cable). Normally the current rating given by manufacturer is to withstand thermal stress. Energy conservation point of view, the above needs to be devalued based on length i.e. to curtail excess energy loss caused by off centered powerhouse, longer cables are to carry lesser than the rated current.

14.2 Reducing loss

There are two methods to reduce I^2R cable loss in feeders. They are: (i) reducing the current in cables by adding capacitors near to load or bifurcating the overloaded feeders (ii) reducing the resistance of cable by increasing its size or running additional run of cable of equal size.

14.3 Capacitor shifting/addition

It is possible to reduce current; thereby I^2R losses in cable by providing additional capacitors near to feeder end/ motor end.

14. Energy Demand Management

The energy audit study was under taken at this complex comprising of offices & workshop areas. Electricity is the main energy source for this complex. Electricity is used for meeting requirements of equipment's, machines, AC's, lightings, fans, air-conditioning, Water pumps & office equipment etc.

14.1 Electricity Bill Analysis

The J.C. Bose University of Science & Technology, YMCA is getting electrical power supply from Uttar Haryana bijli Vitran Nigam (UHBVN) at 11 kV supply.

There are one transformer of 500 KVA (11kV / 0.433kV). The premise is also having two nos. diesel generators to provide power supply during power failure /emergency.

Table 16: Technical details of Connection

Parameter	Details
Consumer Name	M/S YMCA
Address	Faridabad
Supply From	DHBVN
Supply Voltage	11KV (HT)
A/C No.	6176201000
K No.	F31BSHT1X
Sanctioned Load (kW)	650
Meter Sr. No.	563825

Table 17: Historical Electrical Bill Analysis

Sr. No.	Billing Month	MDI	Power factor	Total Unit (kWh)	Total Unit (kVAh)	Energy Charge	Fixed Charges	Fuel Surcharge	Electricity Duty	Municipal Tax	Arrears/Out Standing Dues	Non Energy Charges	Sundry Allowances	Total Payable Amount	Inr/Unit kvah
1	Apr 2019	290.24	0.958	59557.6	62200.0	398080.00	105994.48	22036.31	5955.76	10522.22	-	280335.0	-	822924	8.7
2	May 2019	536.64	0.971	112099.2	115417.6	738672.64	102575.30	41476.70	11209.92	17654.49	835021.08	-	-	1746610	7.9
3	June 2019	496.96	0.964	126868.8	131575.2	842081.28	105994.48	46941.46	12686.88	19900.34	-	-	-22472.62	1005132	7.8
4	July 2019	489.44	0.941	81348.0	86429.6	553149.44	102575.30	30098.76	8134.80	13716.47	-	-	4494.57	712169	8.2
5	Aug 2019	515.84	0.959	101149.6	105425.6	674723.84	105994.48	37425.35	10114.96	16362.87	-	-	-	844622	8.0
6	Sep 2019	582.88	0.975	124837.6	128048.8	819512.32	105994.48	46189.91	12483.76	19433.93	-	-	-	1003614	7.8
7	Oct 2019	542.40	0.977	130457.6	133564.0	854809.60	102575.30	48269.31	13045.76	20113.08	-	-	-1785.00	1037028	7.8
8	Nov 2019	403.68	0.965	90249.6	93480.8	598277.12	105994.48	33392.35	9024.96	14753.28	-	-	3486.00	764928	8.1
9	Dec 2019	259.68	0.956	73560.0	76984.0	492697.60	102575.30	27217.20	7356.00	12449.80	-	-	-	642296	8.3
10	Jan 2020	228.80	0.965	65763.2	68154.4	436188.16	105994.48	24332.38	6576.32	11330.30	-	-	3486.00	587908	8.6
11	Feb 2020	256.16	0.974	70828.0	72708.0	465331.20	105994.48	26206.36	7082.80	11950.64	-	-	-	616565	8.5
12	Mar 2020	256.48	0.966	71035.2	73547.2	470702.08	99156.13	26283.02	7103.52	11922.82	-	-	-	615168	8.4
	Total			**1107754**	**1147535**	**7344225**	**1251419**	**409869**	**110775**	**180110**				**10398964**	
	Avg.	**404.9**	**0.964**	**92312.9**	**95627.9**	**612018.8**	**104284.9**	**34155.8**	**9231.3**	**15009.2**				**866580.3**	**8.2**
	Max	**582.9**	**0.977**	**130457.6**	**133564.0**	**854809.6**	**105994.5**	**48269.3**	**13045.8**	**20113.1**				**1746610.1**	**8.7**
	Min	**228.8**	**0.941**	**59557.6**	**62200.0**	**398080.0**	**99156.1**	**22036.3**	**5955.8**	**10522.2**				**587907.6**	**7.8**

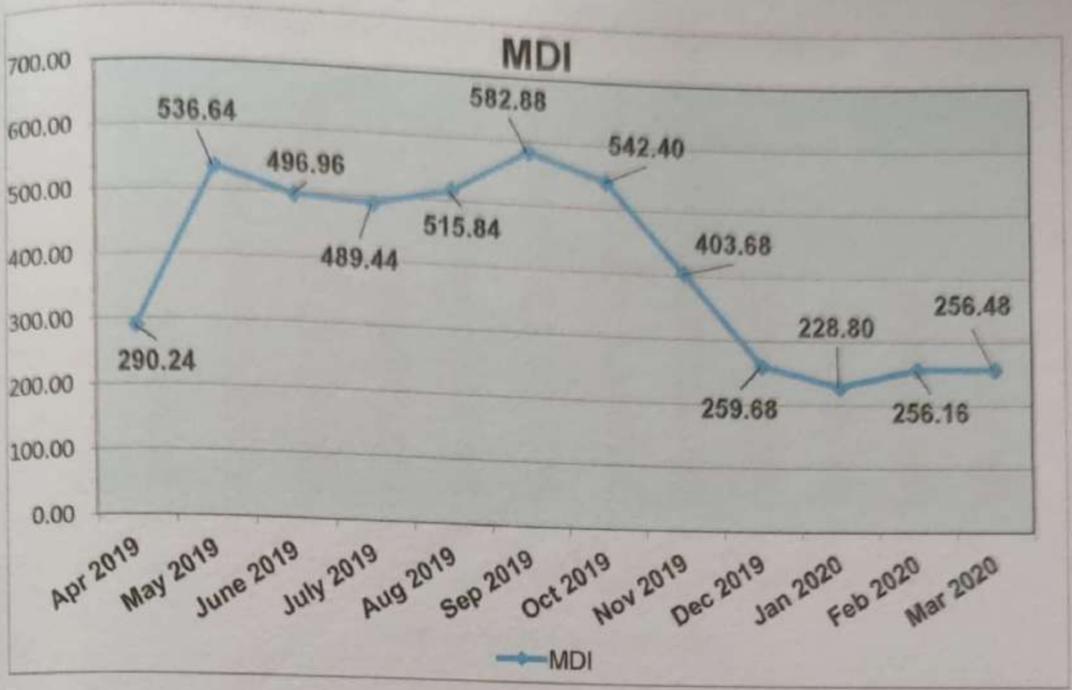


Figure 14.1: Historical Trend of MDI

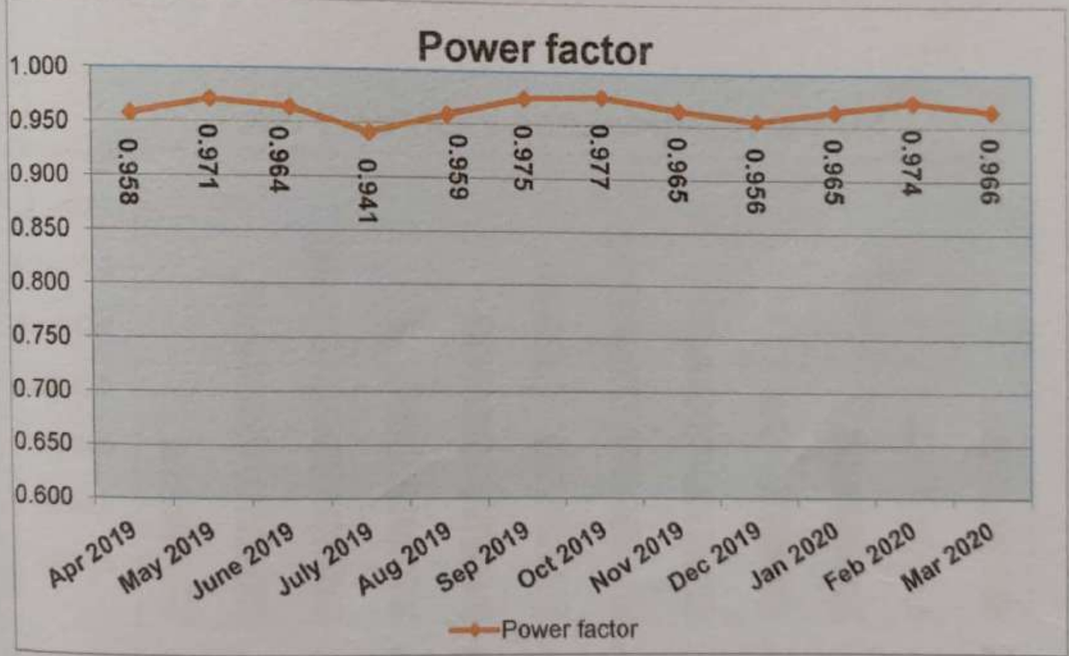


Figure 14.2: Historical Power Factor Variation

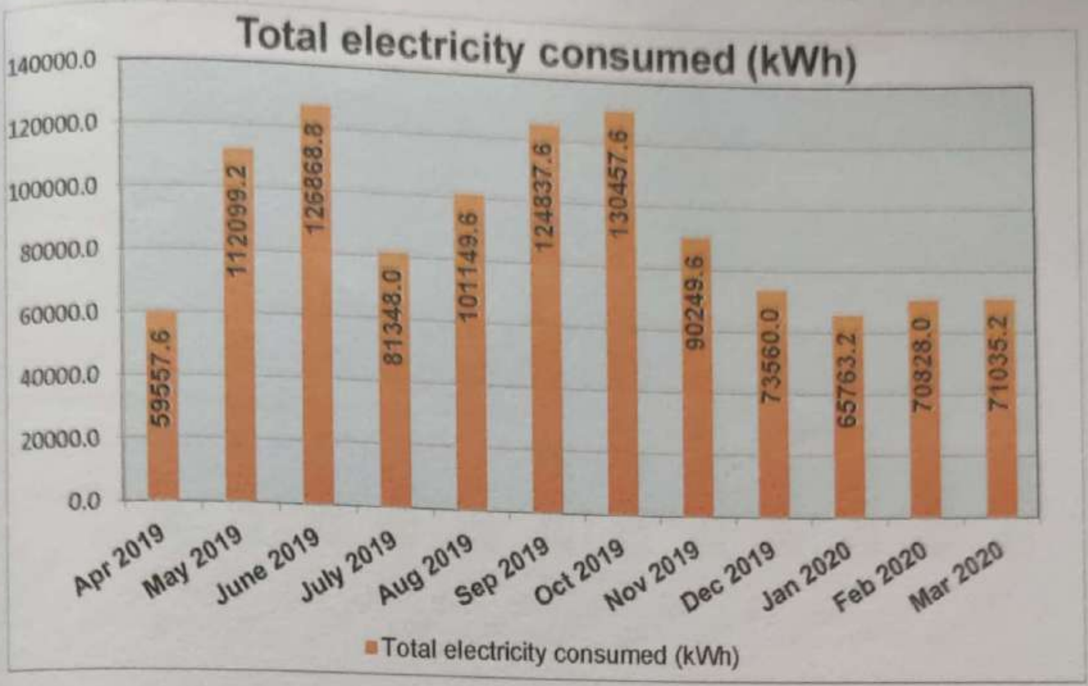


Figure 14.3: Historical trends of Active Power Consumption

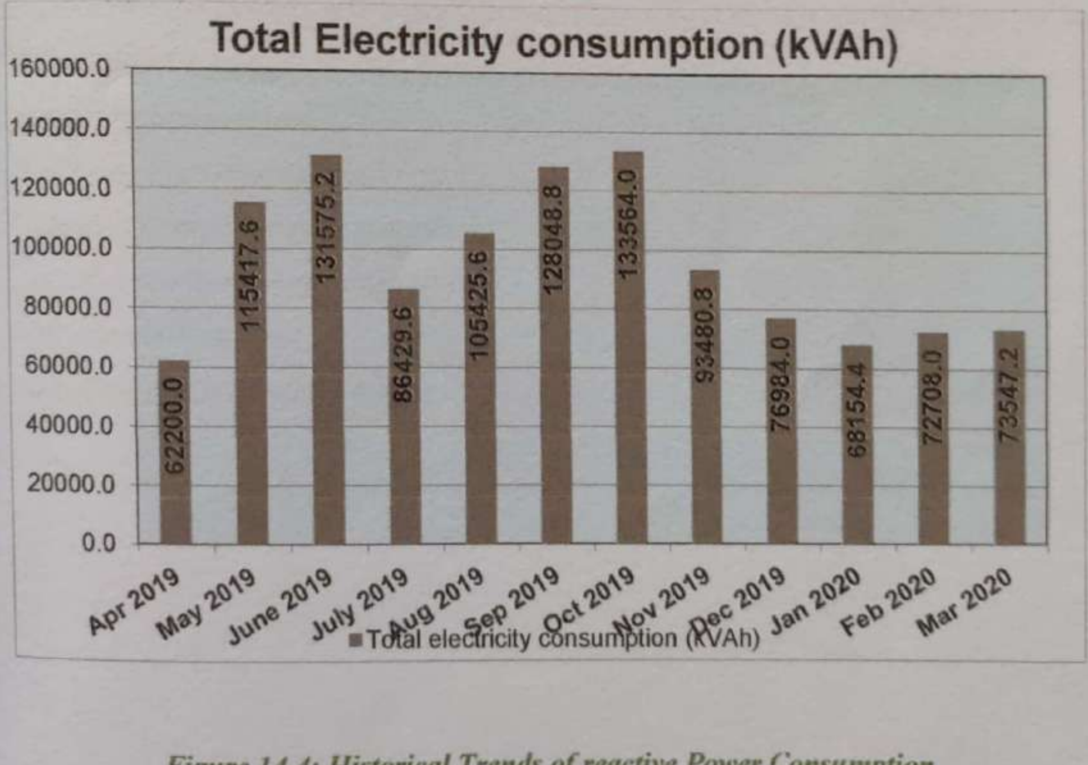


Figure 14.4: Historical Trends of reactive Power Consumption

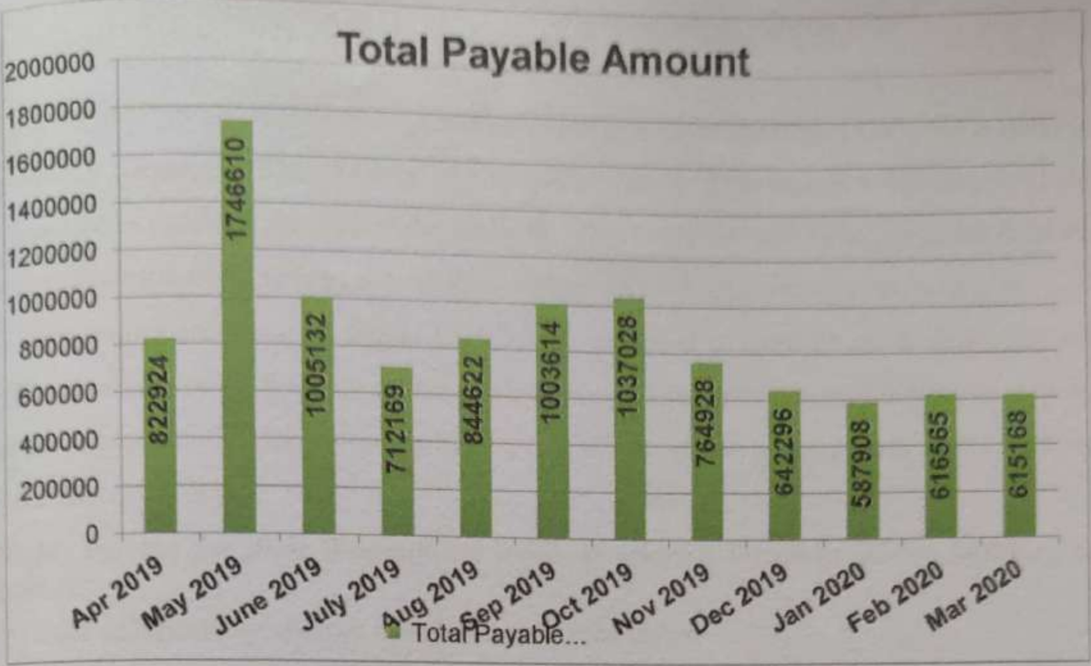


Figure 14.5: Historical Trends of Electricity cost

NOTE

It is suggested the demand of the Industry to reduce Electricity cost. This can be achieved as below:

a. Re-schedule the load
b. Staggering of motor load
c. Shedding of non-essential load.
d. Operation of captive power generation
e. To install reactive power compensator
f. Use demand controller
g. Switching off non-essential loads.

15. Illumination & LUX Levels

To study, analyze and identify energy conservation options in lighting, a study of the unit lighting load was conducted. The purpose of the study was to determine the lighting load and its distribution in various sections of the buildings, determine the quality of illumination provided, and recommend measures to improve illumination and reduce electricity consumption.

A high quality and accurate digital LUX meter was used to measure the illumination level at various sections of the building during working hours. Other performance indicators such as type of lamps used, luminaries, mounting height, physical condition of lamps, use of day lighting, etc. were also noted down.

Major reasons for poor illumination levels at selected locations of the building are as follows:

- Poor reflectors/no reflector installed for the tube lights.
- Large height of installed fittings from the working plane.
- Reduction in illumination due to ageing.
- Very old fittings and dust deposition on luminaries

Table 18: Table of assessment of lighting Load

	Location	Lux Level	
	Office Building		
1	Ist Floor (Account Section)	280	360
2	2nd Floor (Computer Centre)	300	400
	Mechanical Block		
3	CV-501	250	320
4	MO Room-406	120	160
5	M-301	140	220
	Main Building		
6	C-402 (Animation Graphic)	280	340
7	S-11 (B.SC Physics Lab)	300	380
8	COE	280	380
9	CC-03 (DBMS Lab)	140	175
10	F-10 (Chemistry Lab)	270	340
11	Power Electronics Lab	120	170
12	RAC Work Shop	140	180
13	Registrar office	260	390
14	MBA _Lecture Hall-1	140	180

Assessment of Lighting System

Example : Room

Lux Measured = Average Lux = 286

287	284

Length of the Room = 18ft.

Width of the Room = 14ft

Working Place Height = 10ft

STEP 1	Measure the Floor area of the interior :	Area = 18 x 14 = 252 sqft
STEP 2	Calculate the Room Index 18 x 14 / 10 (18 + 14) = .78	RI = .78
STEP 3	Determine the total circuit watts of the installation by a power meter if a separate feeder for lighting is available. If the actual value is not known a reasonable approximate can be obtained by totaling up the lamp wattage including the ballasts	Total Circuit watts 54 W x 16 = 864 32 W x 4 = 128 TOTAL = 992W
STEP 4	Calculate Watts per square meter, Value of Step 3 ÷ Value of Step 1	W/m^2 = 3.9
STEP 5	Ascertain the average maintained luminance by using Lux Meter, Eav. Maintained	Eav.maint = 286
STEP 6	Divide 5 by 4 to calculate Lux per Watt per square Meter	$Lux/W/m^2$ = 72.77
STEP 7	Obtain target $Lux/W/M^2$ lux for type of the type of interior/ application and RI (2)	Target $Lux/W/m^2$ = 36
STEP 8	Calculate Installed Load Efficacy Ratio (6 ÷ 7)	ILER = 2.02

ILER 0.75 or over = Satisfactory to Good

Measuring Units Light Level – illuminance

Illuminance is measured in foot candles (ftcd, fc, fcd) or lux in the metric SI system). A foot candle is actually one lumen of light density per square foot, one lsux is one lumen per square meter.

- 1 lux = 1 lumen / sq meter = 0.0001 phot = 0.0929 foot candle (ftcd, fcd)
- 1 phot = 1 lumen / Sq centimeter = 10000 lumens / sq meter = 10000 lux
- 1 foot candle (ftcd, fcd) = 1 lumen / sqft = 10.752 lux

Common Light Level Outdoor

Common light levels outdoor at day and night can be found in the table below :

Table 19: Lux level of different natural occasions

Condition	Illumination	
	(ftcd)	(lux)
Sunlight	10,000	107,527
Full Daylight	1,000	10,752
Overcast Day	100	1075
Very Dark Day	10	107
Twilight	1	10.8
Deep Twilight	.1	1.08
Full Moon	.01	.108
Quarter Moon	.001	.0108
Starlight	.0001	.0011
Overcast Night	.0001	.0001

Common and Recommended Light Levels Indoor

The outdoor light level is approximately 10,000 lux on a clear day. In the building, in the area closes to windows, the light level may be reduced to approximately 1,000 lux. In the middle area its may be as low as 25- 50 lux. Additional lighting equipment is often necessary to compensate the low levels.

Earlier it was common with light levels in the range 100 -300 lux for normal activities. Today the light level is more common in the range 500 – 1000 lux – depending on activity. For precision and detailed works, the light level may even approach 1500 – 2000 lux.

The table below is a guidance for recommended light level in different work spaces:

Table 20: Required lux level for various activities

Activity	Illumination (lux, lumen/m^2)
Public areas with dark surroundings	20 -50
Simple orientation for short visits	50 -100
Working areas where visual tasks are only occasionally performed	100 -150
Warehouse, Homes, Theaters, Archives	150
Easy Office work, classes	250
Normal Office work, PC work, Study library, Groceries, show room, laboratories	500
Supermarkets, Mechanical workshops, Office landscapes	750

Normal Drawing work, very detailed mechanical works	1000
Detailed drawing work, very detailed mechanical works	1500 -2000
Performance of visual tasks of low contract and very small size for prolonged periods of time	2000 -5000
Performance of visual tasks of low contract and very small size for prolonged period of time	2000 -5000
Performance of very prolonged and exacting visuals tasks	5000 – 10000
Performance of very special visual tasks of extremely low contract and small size	10000 - 20000

16. Energy Balancing

Energy balancing starts from energy accounting and it is one of the principal activities integrated with energy management system aimed to help the energy manager in preparation of an energy balance sheet. Energy balance sheet helps to identify and fix energy guzzlers and take corrective measures. ***It is not possible to prepare an energy balance sheet without metering set-up at important nodes. It is an important activity for the management to initiate and install such metering facilities at least at selected important nodes***of electrical distribution network starting from transformers outgoing point to motor end. Energy accounting could be done either by manual process or with the aid of data acquisition system supported by menu driven specially software packages to monitor, record and control the process sequences and thereby energy. The diesel storage and distribution system has no measurement, records and monitoring system. The diesel consumed by individual DG set are not measured and recorded, which is not proper practice both for energy efficiency and economic prospective.

17. Transformers and load profile

17.1 Transformers

The J.C. Bose University of Science & Technology, YMCA faridabad is getting electrical power supply from Dakshin Haryana bijli Vitran Nigam Ltd. (DHBVN) at 11 kV supply. There are one transformers of 500 kVA (11kV/ 0.433kV). The premise is also having two nos. diesel generators to provide power supply during power failure /emergency. These DG sets are used to provide power backup during day/Night operations. Load profile of power show in below graph.

Table 21: Technical Specifications of transformers

Name Plate Data		TRF-1
Rated	kVA	500
Voltage	H.V	11000
	L.V	433
Amp.	H.V	26.2
	L.V	666.7
Impedance Volt	%	4.38
Phase		3
Frequency	HZ	50
Cooling Type		ONAN
Vector Group		Dyn11
Mfg.	Year	2007
Make		Crompton Greaves

17.2 Load profile for Main Incomer (Transformer-500 KVA)

The load profile of the electrical parameters was recorded by using a portable 3-phase power analyzer. During the recording, the power analyzer recorded all the electrical parameters for further detailed analysis. The analysis of the different parameters recorded Load hours reading at the L.T incoming main supply is given below.

Load (real power) profile and apparent power profile is the variation in the electrical load versus time. In any electrical system, the vector sum of the active power (kW) and reactive power (kVAR) make up the total (or apparent) power (kVA) used. This is the power generated by a generation station for the user to perform a given amount of work. The total power is measured in kVA (Kilo Volts-Amperes) and the load or active power is measured in kW (kilowatts) and they become equal as and when the power factor approaches unity. Total electricity charges (units and demand) are based on the load or active power (kW) and apparent power (kVA).

During the energy audit studies, the total operating load at the transformer was recorded to find out the variation in the load at different times of the day. The following graph depicts the variation in the load and apparent power of the premises:

Load Profile main incomer of Transformer-500 KVA

Transformer-1 (200 KVA)			
	Max.	Min.	Ave.
Voltage Phase1 (V)	420.4	398.3	410.4
Voltage Phase2 (V)	418.6	397.2	409.2
Voltage Phase3 (V)	420.9	398.3	410.6
THD Phase1 (V)	1.7	1.1	1.3
THD Phase2 (V)	2.0	1.3	1.5
THD Phase3 (V)	1.7	1.3	1.4
Arms Phase1 (A)	251.8	189.5	212.2
Arms Phase2 (A)	210.3	135.7	170.5
Arms Phase3 (A)	214.1	129.7	162.2
THD Phase1 (A)	7.5	5.3	6.5
THD Phase2 (A)	7.0	3.7	5.0
THD Phase3 (A)	8.2	4.0	6.3

Power (kW)	147.38	109.41	124.42
Apparent Power (kVA)	152.04	114.63	129.01
Power Factor (P.F)	0.980	0.948	0.963
Frequency (Hz)	50.1	49.8	50.0

Table 22: Loading patter of transformer

Observation

- Transformer temperature is Normal
- Silica Gel ok.
- Oil level ok.
- There was a slight variation in phase-to-phase voltage.
- The power factor varied from 0.948 to 0.980 during the load hours of measurement period and Average 0.963.
- Harmonics level in the system is under limits in voltage & current. The percentage of average voltage THD is in the range of 1.1 % to 2.0 %. This is well within the recommended limits as per IEEE Standards i.e. 4% variation for voltage & 15% variation for current.
- The percentage of average current THD is in the range of 3.7 % to 8.2 %. The current harmonics in the system are more than the recommended limits as per IEEE Standards. So, it is recommended to install the harmonics controller in the system to bring the Voltage & current THD levels within the limits.

Overall power quality

The analysis of various power quality parameters given above indicates that the overall quality of power received by the facility is good and most of the parameters are within the desired range except the current harmonics in the system.

It is recommended that regular de-hydration of transformer oil should be carried out to remove the moisture. This de-hydration should be got done at regular interval based on condition monitoring.

TRANSFORMER LOSSES AND EFFICIENCY

The efficiency of the transformer not only depends on the design, but also on the effective operating load. Transformer losses consist of two parts No-Load loss and Load loss.

1. No-Load loss (also called core loss): These losses occur whenever the transformer is energized. It does not vary with load.
2. Load-Loss (also called copper loss): It is the power lost in the primary and secondary winding of the transformer. Whenever the transformer remained energized and it varies with square of the current.

18. Capacitor

Capacitor is a device that generates reactive current and consumes very less power. Installing capacitor will improve the power factor, will also reduce the kVA demand of the system and will increase the capacity of the network. Capacitor is passive equipment very useful to reduce the load current by improving PF.

There are no APFC Panels installed in premises. It is recommended that Installed 250 KVAr APFC panel are required to be installed at load center-end for improving the power factor.

The advantages of Power Factor improvement by capacitor

- A Reactive components of the network are reduced and so also the total current in the system from the source end.
- I2R power losses are reduced in the system because of reduction in current.
- Voltage level at the load end is increased.
- kVA loading on the source generators as also on the transformers and line upto the capacitors reduces giving capacity relief. A high power factor can help in utilities the full capacity of the electrical system.

Cost benefits of Power Factor improvement

- Reduced kVA (Maximum Demand) charges in electricity bill
- Reduced distribution losses (kWh) within the plant network
- Better voltage at motor terminals and improved performance of motors
- A high power factor eliminates penalty charges imposed when operating with low power factor
- Investment on system facilities such as transformers, cables, switchgears etc for delivering load is reduced.

19. Earthing

The electricity rules clearly specify that two independent earths to the body and neutral should be provided to give adequate protection to the equipment in case if an earth fault, and also to drain away any leakage of potential voltage from the equipment to the earth for safe working. As there is no standard of earth resistance value, it varies on different type of soil resistivity, ideally it should be Zero but for different kind of soil for electrical equipment it should be better to below .8 Ohm and for electronics equipment it should be below .4 Ohm but best value is .1 Ohm.

Table 23: Details of Earth Resistance at various locations

Sr. No.	Location	Ohm
1	Transformer	0.98
2	Transformer	0.96
4	Main L.T Distribution Panel	1.2
5	Main L.T Distribution Panel	2.1
6	DG-250 KVA	2.2
7	DG-200 KVA	2.4
9	DG-500 KVA	1.1
10	DG-500 KVA	1.1
12	Panel	0.8

20. General Tips for Energy Conservation

20.1 Electricity

- Schedule your operations to maintain a high load factor
- Minimize maximum demand by tripping loads through a demand controller
- Use standby electric generation equipment for on-peak high load periods.
- Correct power factor to at least 0.99 under rated load conditions.
- Set transformer taps to optimum settings.
- Shut off unnecessary computers, printers, and copiers at night.

20.2 Motors

- Properly size to the load for optimum efficiency.
- (High efficiency motors offer of 4 - 5% higher efficiency than standard motors)
- Check alignment.
- Provide proper ventilation
- (For every 10°C increase in motor operating temperature over recommended peak, the motor life is estimated to be halved)
- Check for under-voltage and over-voltage conditions.
- Balance the three-phase power supply.
- (An Imbalanced voltage can reduce 3 - 5% in motor input power)
- Demand efficiency restoration after motor rewinding.

20.3 Drives

- Use variable-speed drives for large variable loads.
- Use high-efficiency gear sets.
- Use precision alignment.
- Check belt tension regularly.
- Eliminate variable-pitch pulleys.
- Use flat belts as alternatives to v-belts.
- Use synthetic lubricants for large gearboxes.
- Eliminate eddy current couplings.
- Shut them off when not needed.

20.4 Fans

- Use smooth, well-rounded air inlet cones for fan air intakes.
- Avoid poor flow distribution at the fan inlet.
- Minimize fan inlet and outlet obstructions.

- Clean screens, filters, and fan blades regularly.
- Use aerofoil-shaped fan blades.
- Minimize fan speed.
- Use low-slip or flat belts.
- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable fan loads.
- Use energy-efficient motors for continuous or near-continuous operation
- Eliminate leaks in ductwork.
- Minimize bends in ductwork
- Turn fans off when not needed.

20.5 Blowers

- Use smooth, well-rounded air inlet ducts or cones for air intakes.
- Minimize blower inlet and outlet obstructions.
- Clean screens and filters regularly.
- Minimize blower speed.
- Use low-slip or no-slip belts.
- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable blower loads.
- Use energy-efficient motors for continuous or near-continuous operation.
- Eliminate ductwork leaks.
- Turn blowers off when they are not needed.

20.6 Pumps

- Operate pumping near best efficiency point.
- Modify pumping to minimize throttling.
- Adapt to wide load variation with variable speed drives or sequenced control of smaller units.
- Stop running both pumps -- add an auto-start for an on-line spare or add a booster pump in the problem area.
- Use booster pumps for small loads requiring higher pressures.
- Increase fluid temperature differentials to reduce pumping rates.
- Repair seals and packing to minimize water waste.
- Balance the system to minimize flows and reduce pump power requirements.
- Use siphon effect to advantage: don't waste pumping head with a free-fall (gravity) return.

20.7 Chillers

- Increase the chilled water temperature set point if possible.
- Use the lowest temperature condenser water available that the chiller can handle.
- (Reducing condensing temperature by 5.5°C, results in a 20 - 25% decrease in compressor power consumption)
- Increase the evaporator temperature
- (5.5°C increase in evaporator temperature reduces compressor power consumption by 20 - 25%)
- Clean heat exchangers when fouled.
- (1 mm scale build-up on condenser tubes can increase energy consumption by 40%)
- Optimize condenser water flow rate and refrigerated water flow rate.
- Use water-cooled rather than air-cooled chiller condensers.
- Use energy-efficient motors for continuous or near-continuous operation.
- Specify appropriate fouling factors for condensers.
- Do not overcharge oil.
- Install a control system to coordinate multiple chillers.
- Study part-load characteristics and cycling costs to determine the most-efficient mode for operating multiple chillers.
- Run the chillers with the lowest operating costs to serve base load.
- Avoid oversizing -- match the connected load.
- Isolate off-line chillers and cooling towers.
- Establish a chiller efficiency-maintenance program. Start with an Energy & Safety Audit and follow-up, then make a chiller efficiency-maintenance program a part of your continuous energy management program.

20.8 HVAC (Heating / Ventilation / Air Conditioning)

- Tune up the HVAC control system.
- Consider installing a building automation system (BAS) or energy management system (EMS) or restoring an out-of-service one.
- Balance the system to minimize flows and reduce blower/fan/pump power requirements.
- Eliminate or reduce reheat whenever possible.
- Use appropriate HVAC thermostat setback.
- Use building thermal lag to minimize HVAC equipment operating time.
- In winter during unoccupied periods, allow temperatures to fall as low as possible without freezing water lines or damaging stored materials.
- In summer during unoccupied periods, allow temperatures to rise as high as possible without damaging stored materials.
- Improve control and utilization of outside air.
- Use air-to-air heat exchangers to reduce energy requirements for heating and cooling of outside air.

- Reduce HVAC system operating hours (e.g. -- night, weekend).
- Optimize ventilation.
- Ventilate only when necessary. To allow some areas to be shut down when unoccupied, install dedicated HVAC systems on continuous loads (e.g. -- computer rooms).
- Provide dedicated outside air supply to kitchens, cleaning rooms, combustion equipment, etc. to avoid excessive exhausting of conditioned air.
- Use evaporative cooling in dry climates.
- Clean HVAC unit coils periodically and comb mashed fins.
- Upgrade filter banks to reduce pressure drop and thus lower fan power requirements.
- Check HVAC filters on a schedule (at least monthly) and clean/change if appropriate.
- Check pneumatic controls air compressors for proper operation, cycling, and maintenance.
- Isolate air conditioned loading dock areas and cool storage areas using high-speed doors or clear PVC strip curtains.
- Install ceiling fans to minimize thermal stratification in high-bay areas.
- Relocate air diffusers to optimum heights in areas with high ceilings.
- Consider reducing ceiling heights.
- Eliminate obstructions in front of radiators, baseboard heaters, etc.
- Check reflectors on infrared heaters for cleanliness and proper beam direction.
- Use professionally-designed industrial ventilation hoods for dust and vapor control.
- Use local infrared heat for personnel rather than heating the entire area.
- Use spot cooling and heating (e.g. -- use ceiling fans for personnel rather than cooling the entire area).
- Purchase only high-efficiency models for HVAC units.
- Put HVAC window units on timer control.
- Don't oversize cooling units. (Oversized units will "short cycle" which results in poor humidity control.)
- Install multi-fueling capability and run with the cheapest fuel available at the time.
- Consider dedicated make-up air for exhaust hoods. (Why exhaust the air conditioning or heat if you don't need to?)
- Minimize HVAC fan speeds.
- Consider desiccant drying of outside air to reduce cooling requirements in humid climates.
- Seal leaky HVAC ductwork.
- Seal all leaks around coils.
- Repair loose or damaged flexible connections (including those under air handling units).
- Eliminate simultaneous heating and cooling during seasonal transition periods.
- Zone HVAC air and water systems to minimize energy use.
- Inspect, clean, lubricate, and adjust damper blades and linkages.
- Establish an HVAC efficiency-maintenance program. Start with an Energy & Safety Audit and follow-up, then make an HVAC efficiency-maintenance program a part of your continuous energy management program.

20.9 Lighting

- Reduce excessive illumination levels to standard levels using switching,de-lamping, etc. (Know the electrical effects before doing de-lamping.)
- Aggressively control lighting with clock timers, delay timers, photocells, and/or occupancy sensors.
- Install efficient alternatives to incandescent lighting, mercury vapor lighting, etc. Efficiency (lumens/watt) of various technologies range from best to worst approximately as follows: low pressure sodium, high pressure sodium, metal halide, fluorescent, mercury vapor, incandescent.
- Select ballasts and lamps carefully with high power factor and long-term efficiency in mind.
- Upgrade obsolete fluorescent systems to Compact fluorescents and electronic ballasts
- Consider lowering the fixtures to enable using less of them.
- Consider day-lighting, skylights, etc.
- Consider painting the walls a lighter color and using less lighting fixtures or lower wattages.
- Use task lighting and reduce background illumination.
- Re-evaluate exterior lighting strategy, type, and control. Control it aggressively.
- Change exit signs from incandescent to LED.

20.10DG Sets

- Optimize loading
- Use waste heat to generate steam/hot water /power an absorption chiller or preheat process or utility feeds.
- Use jacket and head cooling water for process needs
- Clean air filters regularly
- Insulate exhaust pipes to reduce DG set room temperatures
- Use cheaper heavy fuel oil for capacities more than 1MW

20.11Buildings

- Seal exterior cracks/openings/gaps with caulk, gasketing, weatherstripping, etc.
- Consider new thermal doors, thermal windows, roofing insulation, etc.
- Install windbreaks near exterior doors.
- Replace single-pane glass with insulating glass.
- Consider covering some window and skylight areas with insulated wall panels inside the building.
- If visibility is not required but light is required, consider replacing exterior windows with insulated glass block.
- Consider tinted glass, reflective glass, coatings, awnings, overhangs, draperies, blinds, and shades for sunlit exterior windows.

- Use landscaping to advantage.
- Add vestibules or revolving doors to primary exterior personnel doors.
- Consider automatic doors, air curtains, strip doors, etc. at high-traffic passages between conditioned and non-conditioned spaces. Use self-closing doors if possible.
- Use intermediate doors in stairways and vertical passages to minimize building stack effect.
- Use dock seals at shipping and receiving doors.
- Bring cleaning personnel in during the working day or as soon after as possible to minimize lighting and HVAC costs.

20.12Water & Wastewater

- Recycle water, particularly for uses with less-critical quality requirements.
- Recycle water, especially if sewer costs are based on water consumption.
- Balance closed systems to minimize flows and reduce pump power requirements.
- Eliminate once-through cooling with water.
- Use the least expensive type of water that will satisfy the requirement.
- Fix water leaks.
- Test for underground water leaks. (It's easy to do over a holiday shutdown.)
- Check water overflow pipes for proper operating level.
- Automate blow-down to minimize it.
- Provide proper tools for wash down -- especially self-closing nozzles.
- Install efficient irrigation.
- Reduce flows at water sampling stations.
- Eliminate continuous overflow at water tanks.
- Promptly repair leaking toilets and faucets.
- Use water restrictors on faucets, showers, etc.
- Use self-closing type faucets in restrooms.
- Use the lowest possible hot water temperature.
- Do not use a heating system hot water boiler to provide service hot water during the cooling season -- install a smaller, more-efficient system for the cooling season service hot water.
- If water must be heated electrically, consider accumulation in a large insulated storage tank to minimize heating at on-peak electric rates.
- Use multiple, distributed, small water heaters to minimize thermal losses in large piping systems.
- Use freeze protection valves rather than manual bleeding of lines.
- Consider leased and mobile water treatment systems, especially for de-ionized water.
- Seal sumps to prevent seepage inward from necessitating extra sump pump operation.
- Install pretreatment to reduce TOC and BOD surcharges.
- Verify the water meter readings. (You'd be amazed how long a meter reading can be estimated after the meter breaks or the meter pit fills with water!)
- Verify the sewer flows if the sewer bills are based on them.

20.13 Miscellaneous

- Meter any unmetered utilities. Know what is normal efficient use. Track down causes of deviations.
- Shut down spare, idling, or unneeded equipment.
- Make sure that all of the utilities to redundant areas are turned off -- including utilities like compressed air and cooling water.
- Install automatic control to efficiently coordinate multiple air compressors, chillers, cooling tower cells, boilers, etc.
- Renegotiate utilities contracts to reflect current loads and variations.
- Consider buying utilities from neighbors, particularly to handle peaks.
- Leased space often has low-bid inefficient equipment. Consider upgrades if your lease will continue for several more years.
- Adjust fluid temperatures within acceptable limits to minimize undesirable heat transfer in long pipelines.
- Minimize use of flow bypasses and minimize bypass flow rates.
- Provide restriction orifices in purges (nitrogen, steam, etc.).
- Eliminate unnecessary flow measurement orifices.
- Consider alternatives to high-pressure drops across valves.
- Turn off winter heat tracing that is on in summer.

ANNEXURES

Annex I –Certification

This part shall indicate certification by Accredited Energy Auditor stating that:

(i) The data collection has been carried out diligently and truthfully;

(ii) All data monitoring devices are in good working condition and have been calibrated or certified by approved agencies authorized and no tempering of such devices has occurred

(iii) All reasonable professional skill, case and diligence had been taken in preparing the energy audit report and the contents thereof are a true representation of the facts;

(iv) Adequate training provided to personnel involved in daily operations after implementation of recommendations; and

(v) The energy audit has been carried out in accordance with the Bureau of Energy Efficiency (Manner and Intervals of Time for the Conduct of Energy Audit) Regulations, 2010.

For A-Z Energy Engineers Private Limited

Director

(Dr. P.P. Mittal)

Accredited Energy Auditor AEA-011

Annex II –Certificate of Accreditation

ENERGY IS LIFE
BEE
CONSERVE IT

BUREAU OF ENERGY EFFICIENCY

Examination Registration No. : EA-6851

Accreditation Registration No. : AEA-0011

Certificate of Accreditation

This is to certify that Mr./Ms. Prem Prakash Mittal having its trade/registered office at Delhi has been given accreditation as accredited energy auditor. The certificate shall be effective from 26th day of February 2013

The certificate is subject to the provisions of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

This certificate shall be valid until it is cancelled under regulation 9 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010

On cancellation, the certificate of accreditation shall be surrendered to the Bureau within fifteen days from the date of receipt of order of cancellation.

Your name has been entered at AEA No. 0011 in the register of list of accredited energy auditors. Your name shall be liable to be struck out on the grounds specified in regulation 8 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

Given under the seal of the Bureau of Energy Efficiency, Ministry of Power, this 26th day of May, 2014.

Secretary,
Bureau of Energy Efficiency
New Delhi

ANNEX III–Lighting Details

Location	Tube (36W)	Tube (36Wx2)	T5(14WX4)	LED Tube Light 18/20W	LED Tube 9W	LED Light (36W) 2'x2'	LED Panel (6W)	LED Panel (12W)	Led Bulb (12W)	LED	LED Street Light (60W)	Bay LED (W)	High mast Tower (LED)	CFL (36W*2)	CFL (12WX2)	Sodium Light (150W)	Sodium Light (250W)	Fan	Wall Fan	Ext fan	Fresher	Wall Mountain Fan (180W)	AC (S)	AC 2*(S)	AC 3*(S)	AC 5*(S)	AC (W)	Geezer
Office Building																												
Ground Floor-J.E Room	1			1														1										
Panel/TR Room	4	2																										
J.E Civil	2																	1										
J.E Civil	3													1				2	1									
S.D.O Civil						2		4										2			1							
Out siide Gallery								7																				
Ist Floor (Account Section)						44		34										27	4		1		1		1			
2nd Floor (Computer Centre)						22	64											20			2							
3rd Floor (Community college of Skill Development						39	14											42			2			1	4			
Stair								12																				
Bank Building																												
Ist Floor						30	18											21			1				4			
2nd Floor						30	18											21			1				4			

Stair case								12																				
Mechanical Block																												
4th FLOOR																												
CV-501						10												10										
CV-502						10												10										
CV-503																												
CV-504																												
CV-506						20												16										
CV-507																												
CV-508						10												10										
Gallery						10																						
Toilet (HE)					1			5													2							
Toilet (she)					1			5													2							
3rd FLOOR																												
Room						6												2										
Dr. Truna Narula (Asst. Professor)						4												2										
MO Room-406	11																	10										
MO Room-409	11																	10										
Dr. Vasdev Malhotra (Asst. Professor)																												
MO Room-404																												
MO Room-405																												
MO Room-403																												
MO Room-401	11																	10										
MO Room-402	11																	10										
Toilet	3																			1								
Gallery	8																											
2nd FLOOR																												
M-309	11																	10										

M-302	11																	10										
M-301	10																	10										
M-303																												
M-304																												
M-306	10																	10										
M-307																												
Room						6												2										
Room						6												2										
Toilet	7																			2								
Gallery	8																											
1st FLOOR																												
Dept. of Humanities						19												9							1			
Dr. Rajeev saha	3																	3										
ML-204	11																	11										
ML-205	9																	9										
Chairman (Mechanical Engg.)	3																	2										
ML-202	12																	10					3					
Computational Lab	7																	12										
Toilet	2																											
Gallery	10																											
Gr. FLOOR																												
MO-105	2																	2					1					
MO-104	13																	13						2				
Robotics Lab																												
Office	3																	1										
SOM Lab	15																	11										
ML-101	12																	14										
Toilet	6																			1								

Gallery	10																											
Shakuntalam Hall												77																
Toilet (he)							4														1							
Toilet (she)							4														1							
o/P Executive Engineers (Civil)	6					2												1	4						1			
Affiliation Branch	5					8												5								1		
Dean student welfare	9		5															4					2			1		
Canteen	4																	2										
Main Building																												
3rd FLOOR (Dept. of Computer application																												
CT-4						12												10										
CT-02						12												10										
CT-05						8												8										
C-407						8												8										
CT-01						8												8										
CT-06						8												8										
C-402 (Animation Graphic)						10												8										
C-401						15												8							1			
Toilet				4																								
Gallery				8		7																						
2nd FLOOR																												
L.T-08	11																											
SR-25						4												3	4									
Toilet	1																			1								
Toilet	1																											
Gallery	5			1				11																				
SR-22				1														1										

S-1 (Electr. Engg Dept.)						6												6										
S-10						9												9								2		
S-09						5												5								2		
S-11 (B.SC Physics Lab)						7												6										
S-8						6												6	1									
S-11						6												6										
S-7						6												6										
E-323	2																	1										
E-324	1																	1										
E-324A	2																	1										
E-325	2																	1										
E-326	2			1														1	1									
Faculty room	4																	4										
S-12						4												4								2		
S-13 (B.Sc Hons. Physics Computer Lab)				6														10										
Toilet	1																											
S-10						9												9								2		
Faculty of Humanities & Science	12			1		4												15										
B.tech Physics Lab						10												9								2		
Chairmen Chemistry						3												1										
Toilet									1																			
COE																												
Hall/Corridor						14												11	8						4			
Room-9						3												4								1		
Room-8						3												2							1			
Room-6						2												2							1			

Room-7						2												2					1					
Controller of examinations						12												7										
Room-3 to 5						10												4							2			
Pantry						1													1						1			
Room-11				2		5												6										
Toilet					2																2							
1ST FLOOR																												
F-10 (Chemistry organic)						8												7										
Store	2																	2										
F-11 (Chemistry Lab)						6												6										
F-12 (Chemistry Lab)						6												6										
Dept. of Computer																												
Chairman Office	1					6												4								1		
CC-03 (DBMS Lab)		10																5					1			2		
CC-04 (DSD Lab)		12																5					3					
SR-14	3	4																2					1					
CC-6 (Internet & web Technologies Lab)		15																4										
CC-07 (Soft ware testing Lab0		20																8					2					
CC-09		13																8							3			
CC-08 (Mat Lab)	4	16																					1		1			
Gallery		4																5										
CR-11		4																2							2			
SR-15	2	2																2								1		
CC-02 (Focap Lab)	8																	8									2	
CC-01						9												6								2		
Gallery						9																						
Toilet	2																			2								

Scanned by CamScanner

SR-13 (Dr. Parul Gupta)						5												3	1									
F-08 (Environmental Science Lab)								9										9							1			
F-10 (Chemistry Lab)						8												7										
F-11 (Chemistry Lab)						6												6										
F-12 (Chemistry Lab)						6												6										
Gallery	1							7																				
E-217 Nitin Goel (Asst. Professor)						2												1										
Corridor						2		1																				
Dept. Library (Electrical Engg. Dept)	1																	1										
Toilet	1																											
Electronic Engineering Dept.	1		2															2										
Chair person (Dept. of Electronic Engg.)						2												1							1			
Toilet							8																					
Microwave Engineering lab	6																	3					1					
Gallery	2			3				1																				
Instumentation Lab	2	9																9	1						2			
Computer Centre	12																	11					1		1			
EL-221	2					3												3							1			
Microprocessor Lab	14					3												14							1			
Power Electronics Lab	11																	5							2			
Gallery								6																				
GROUND FLOOR																												
Library	92																	42							10			
CC-05 (Net Lab)		10																8	1								5	
Office				2														1										

Office				2														1										
SR-1						2												1							1			
SR-2						2												1					1					
RL-01			5															5								1		
Toilet					1		6														1							
Tequip cell						4												4							1			
Gallery								5																				
Lift lobby						4																						
G-08 (Chemistry Lab)	1							6										8										
Dr. Anju Gupta(Asst Professor)	2																	1										
Chairperson Office						4												1	1						1			
Electrical Machine Lab	3							8										9										
Renewable Energy & project lab	5							3										4										
Gallery								8																				
Water testing lab						6												6							2			
Conference Hall						5												4							2			
Smart Class room (Elect. Engg Dept.)						8												7							3			
Main Entrance Corridor								11										1										
Chairperson (Dept. of mathematics)	2					2												1	1									
Office of mathematics	1																	1										
Office	2					2												1										
Office	4																	2										
COE Office	2																	1									1	
Gallery								2																				
Internalawality assurance cell			6															5							1			

Work shop Supdtt.	3																1											
Toilet							8																					
Gallery								4																				
Work shop		80																				8						
Advance Communication Lab_Lalit Mohan	15																7											
RAC Work Shop	27			8													18								6			
Purchase section	2							3									4	1										
Store Main	6																2		2									
Galley	2							5																				
Registrar/ VC office																												
Registrar office					1	9											5								1			
Pantry				2													1											
MMC		18				16											11	8										
Gallery								6																				
Board room reception							12										2									1		
Board room Hall							3	17																				
Corridor		3																										
VC PA office		3															1								1			
V.C Office			2					21									5							2		1		
MBA Block																												
Lecture Hall-1	11																7											
Lab						4									11		5								1			
Smart Class room	11																7											
Lecture Hall-2	8																5											
Stair Office	1																1											
Staff Room	4																3											
Chairperson	2																1											
Staff Room	2																2											

Toilet	1																											
Corridor								4																				
Auditorium										46																		
Dispensary								17										6								2		
Public relation office						6												3								1		
Boys Hostel																												
Nehru Hall				16					112									36										
Gallery	16																											
Toilet	16																											8
C.V Raman				16					112									36										
Gallery	16																											
Toilet	16																											8
Zakhir Hall				16					112									36										
Gallery	16																											
Toilet	16																											8
TV room	6																	5										
Reading Room	4	6																5										
Gym	6																	4		2								
Out Side Area											6																	
Girls Hostel																												
Kalpna Chawala Hall									84									84										
Gallery	12																											
Toilet	8																											8
Mother Teresa									66									44										
Gallery	9																											
Toilet	6																											6
Sarojini Hall									63									42										
Gallery	12																											
Toilet	6																											6

Sarojini Hall																												
Gallery																												
Toilet																												
Kashturba Hall									66									44										
Gallery	12																											
Toilet	6																											6
Reading Room	4																	4										
GYM	3																	7										
TV room	2																	2										
Mass/Kitchen	10																	9										
Out Side Area																	4											
Campus outer Area													12			4	4											
TOTAL	**794**	**231**	**20**	**90**	**6**	**652**	**159**	**234**	**616**	**46**	**6**	**77**	**12**	**1**	**11**	**4**	**8**	**1322**	**38**	**11**	**17**	**8**	**19**	**5**	**73**	**22**	**8**	**50**

ANNEX IV–Venders List

The details of suppliers/manufacturers of energy efficient technologies are provided below.

Srl.	Product / Equipment	Agency Name / Address
1	DG Synchronization, Automation and capacitors	SGS Industrial Controls & Solutions Pvt. Ltd. Floor-II, MadanpurKhadar, SaritaVihar, New Delhi Tel. 011-29942516, 41402992
2	Eco-Ventilators	Nu Plast Pipes &profilies SCF – 124, Sector – 17 Market, Faridabad - 121002 Tel. 0129-6456217, 4070023
3	Electrical measurement Instrument	Riken Instrument Ltd. 369, Industrial Area, Phase –II, Panchkula Haryana Tel. : 0172-2591651, 2592028 www.rikeninstrumentation.com
4	Energy Management & Control System	Manaco Energy Solutions (P) Ltd. A-6, Shanti Apts. 21 & 22,1st Cross St.TTKRoad, Alwarpet Chennai-18, Tel. 044-42316164 www.mesco.co.in
5	Energy Saving Products	Gautam Enterprises 205, VinayIndl. Est. ChicholiBunder Link Road, Malad(W) Mumbai – 6, India
4	Energy Saving Products	Techmark Engineers & Consultants K-1/28, Ground Floor, Chittaranjan Park, New Delhi – 110019Tel. 011-26238349
5	Flue Gas Analyzer/ Oxygen Analyzer	Nevco Engineers Pvt. Ltd. 90A, (2nd Floor) Amritpuri B, main Road, East of kailash, Opp. Iskcon Temple, New Delhi – 110 065 Tel. 26226328, 26213009 www.nevco.co.in
6	Flue Gas Analyzer/ Oxygen Analyzer	ACE Instruments & Controls 1 Birandari, Above Kashi Dairy MG Road, Ghatkopar (W) Mumbai – 400 086 Tel. 5125153, 5122762
7	FRP Blades & Cooling Tower accessories	Eneertech Engineers SCO 144 – 145, Sector – 34A, Chandigarh Tel. 0172-5018077, 9876022225
8	HVAC related instruments Thermocouples pipe fittings pressure gauges	Waaree, 36 Damjishamji Industrial Complex, Off Mahakali caves Road, Andheri (E) Mumbai tel. 02266963030, 26874778
9	Infrared Temperature Meters (600 °C to 1800 °C	Toshniwal Industries Pvt. Ltd. Industrial Area Mahukupura, Ajmer – 305 002 Tel. 91145 2695171, 91145 2695205
10	Infrared Temperature Meters (upto 1500 °C)	KusamMeco, G-17, Bharat Industrial Area, T.J. Road, Sewree Mumbai – 400015 Tel. 02224156638, 24124540
11	AC Drives	Rockers Control System

		SCO 819 2nd Floor, NAC Manimajra, Chandigarh – 160101 Tel. 0172-2730900, 5071627
12	AC Drives	Allen Bradley India Ltd. C – 11, Industrial Area, Site – IV, Sahibabad, Ghaziabad
13	AC Drives	Asea Brown Boveri Ltd. Guru Nanak Foundation Building, 15 – 16, Qutab Institutional Area, SaheedJeet Singh Sansnwal Marg, New Delhi 110 067
14	AC Drives	Crompton Greaves Ltd. Machine 3 Division, A – 6 / 2, MIDC Area, Ahmednagar
15	Automation, Panel Meters	Conzerv System 44P, Electronic City Phase –II, East Hosur Road, Banglore – 560100
16	Automation, Panel Meters	Selec controls Pvt. Ltd. E-121 Ansa Industrial Estate, Saki Vihar Road, Mumbai 400072 Tel.: 022-28471882, 28476443 www.selecindia.com
17	Building Automation, sensors, twilight Switches	Electro Art Plot No. K-11, MIDC Area, Ambad, Nasik – 422010 Tel. 0253-5603954, 2380918, www.electronicswitchesindia.com
18	Burners	Wesman Engineering (P) Ltd. 503-504 Eros Apartments, 56, Nehru Place, New Delhi – 110019 Tel. : 26431723, 26434577
19	Burners, Furnace RecuperatorsHor air Generation, Heating & Pumping unit Laddle pre-heating	ENCON 12/3, Mathura Road, Faridabad – 121003 Tel. : 0129-25275454 www.encon.co.in
20	Capacitors	Asian Electronics Ltd. Plot No. 68, MIDC, Satpur, Nasik – 422 007
21	Capacitors	Shreem Capacitors Pvt. Ltd. /39, VikramVihar, Lajpat Nagar-IV, New Delhi – 110024
22	Capacitors & APFC Panels	Matrix Controls & Engineers Pvt. Ltd. E-725, DSIDC Industrial Complex, Narela, GT Road, Delhi – 011-27786945 / 46 / 47 Rajeev Batra 9811624440, Rajeev@matrixcapacitor.com
23	Capacitors & APFC Panels	Standard Capacitors B-70/43, DSIDC Complex, Lawrence Road, Industrial Area,, Delhi – 110035Tel: 011-27181490, 27151027 www.standardcapacitors.com
24	Capacitors & APFC Panels	Saif Electronics 174, Hira Building, 1st Floor, Carnac Road, Opposite Police Commissioner Officer Mumbai Tel. 022-22064626, 22086613 www.saifel.com

25	Insulations	Llyod Insulations (India) Ltd. PB NO. 4321, Kalkaji Industrial Area, Punj Sons Premises, New Delhi Tel. : 26430746-7
26	Insulations	Hirnal Supply (India) Ltd. 168, Rajagarden, New Delhi – 110015 Tel: 011-25438602, 25448602
27	Insulations	Technical & Management Consultancy Center SCO – 324, 2nd Floor, Cabin – 203, Sector – 9, Panchkula Ry_tmcc@yahoo.com
28	LED Lighting	Synergy Solar (P) Ltd. SCO 133, Sector 28D, Chandigarh Tel. : 0172-6451133, www.synergysolars.com
29	Lighting system	Philips India Ltd. Regional Office-North, 9th Floor Ashoka Estate, 24, Barakhamba Road, New Delhi – 110 001 Tel. : 3353280, 3317442
30	Lighting system	Crompton Greaves Ltd. Lighting Business Group, 405, Concorde, RC Dutt Road, Baroda – 390 007
31	Lighting system	Osram India Ltd. Signature Towers, 11th Floor, Tower B, South City-I, Gurgaon -122001Tel.: 0124-6526175, 6526178, 6526285
32	Lighting system	Asian Electronics Surya Place, First Floor, K-185, Sarai Julena New Friends Colony, New Delhi – 110 025
33	Lighting system	Philips India Limited, Technopolis Knowledge Park, Nelco Complex, Mahakali Caves Road, Chakala, Andheri (E) Mumbai – 400 093 Tel : 022 56912000
34	Lighting system	Surya Roshni Ltd. Padma Tower_I, Rajendra Palace, New Delhi – 110 006
35	Lighting system	Wipro Limited SCO – 196-197, Sector – 34-A, Chandigarh – 160 022
36	Lighting Voltage Control Systems	Jindal Electric & machinery Corporation C – 57, Focal Point, Ludhiana – 141010 Tel. : 2670250, 2676890
37	Lighting Voltage Control System	ES Electronics (India) Pvt. Ltd. Plot No. 82, KIADB Industrial Area, Bommasandra – Jigani Link Road, JiganiHobli Banglore – 562 106

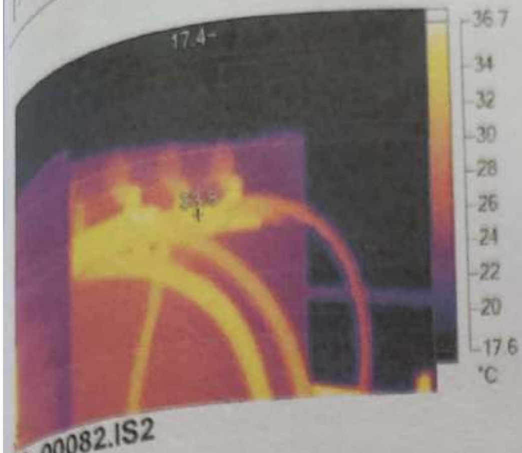
ANNEX V–Thermography Report

J.C BOSE UNIVERSITY OF SCIENCE & TECHNOLOGY, YMCA

Mathura Road, Sector-6, Faridabad, Haryana-121006

INDEX

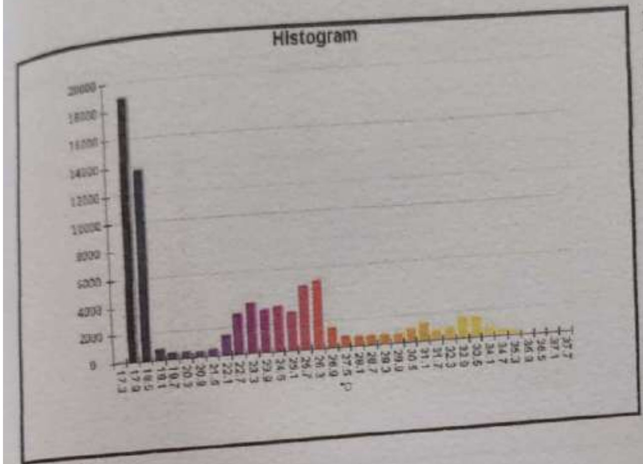
Sr. No.	Thermography Picture Location	PIC. No.
1	Transformer O/P	IR_00082
2	Main ACB	IR_00083
3	Change Over	IR_00084
4	Change Over	IR_00085
5	M/C Lab	IR_00086
6	Account section	IR_00087
7	COE	IR_00088
8	O/G Supply	IR_00089
9	Bus Bar	IR_00090
10	Bus Bar	IR_00091
11	Boys Hostel	IR_00092
12	V.C Office	IR_00093
13	Mechanical Light Load	IR_00094
14	Bank Building	IR_00095
15	*GTW Main work shop*	IR_00096
16	Bus Bar	IR_00097
17	New MBA	IR_00098
18	Girls Hostel	IR_00099
19	Computer Lab	IR_00100
20	Post Office	IR_00101
21	L.T Cable	IR_00102
22	L.T Cable	IR_00103



IR_00082.IS2

Transformer O/P

Visible Light Image



Graph

REMARKS

NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	22.8°C
Image Range	17.4°C to 37.4°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

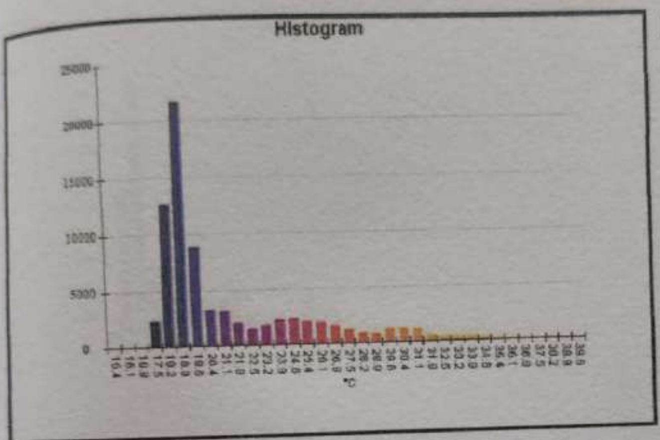
Main Image Markers

Name	Temperature	Emissivity	Background
Centerpoint	33.8°C	0.95	22.0°C
Hot	37.4°C	0.95	22.0°C
Cold	17.4°C	0.95	22.0°C

IR_00083.IS2

Main ACB

Visible Light Image



Graph

REMARKS

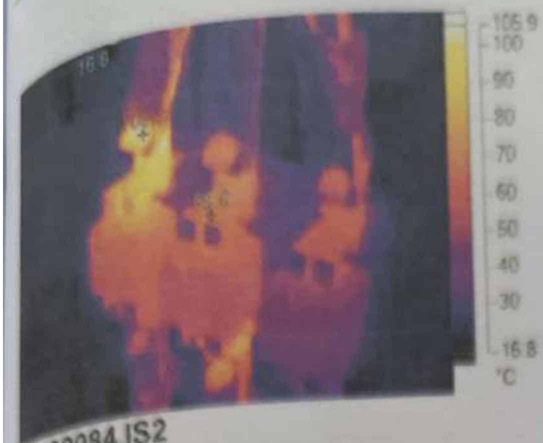
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	21.5°C
Image Range	15.9°C to 39.7°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

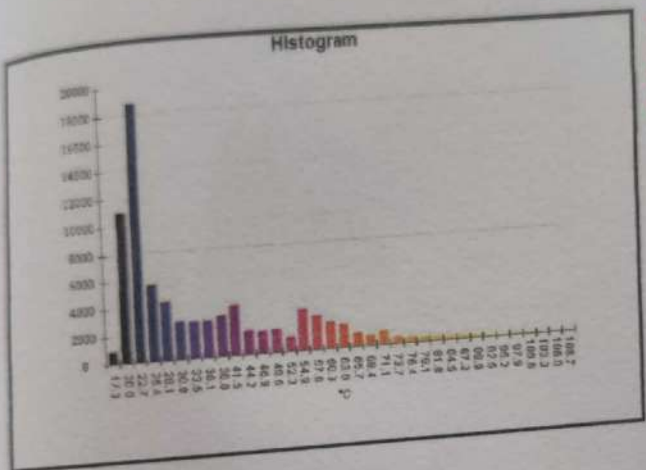
Name	Temperature	Emissivity	Background
Centerpoint	25.3°C	0.95	22.0°C
Hot	39.7°C	0.95	22.0°C
Cold	15.9°C	0.95	22.0°C



IR_00084.IS2

Visible Light Image

Change Over



Graph

REMARKS

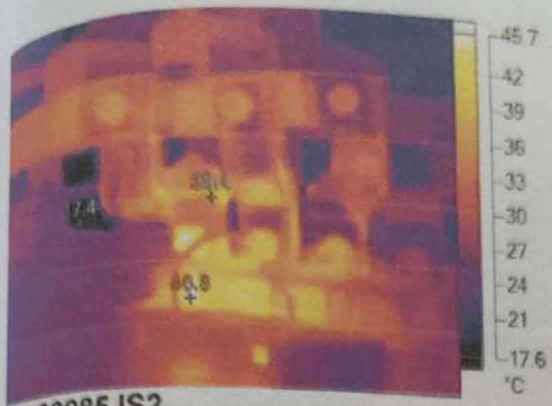
IMPROPER CONTACT NEEDS CHECK-UP AND REPAIR HOT SPOT TEMPERATURE OVER RANGE

Image Info

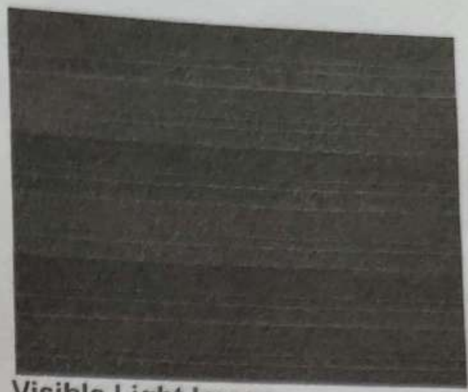
Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	35.7°C
Image Range	16.6°C to 109.3°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

Name	Temperature	Emissivity	Background
Centerpoint	68.8°C	0.95	22.0°C
Hot	109.3°C	0.95	22.0°C
Cold	16.6°C	0.95	22.0°C

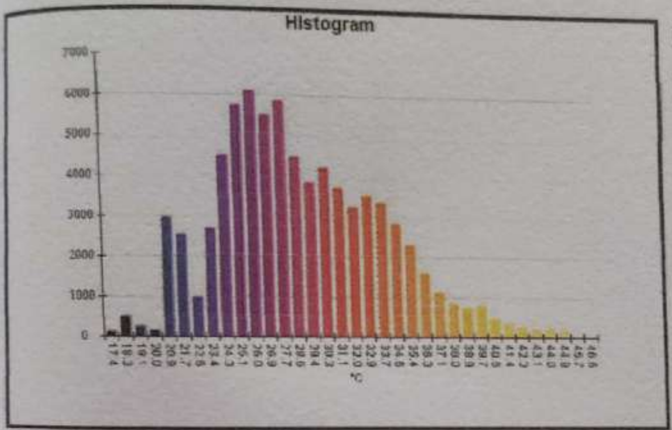


IR_00085.IS2



Visible Light Image

Change Over



Graph

REMARKS

NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	29.0°C
Image Range	17.4°C to 46.8°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

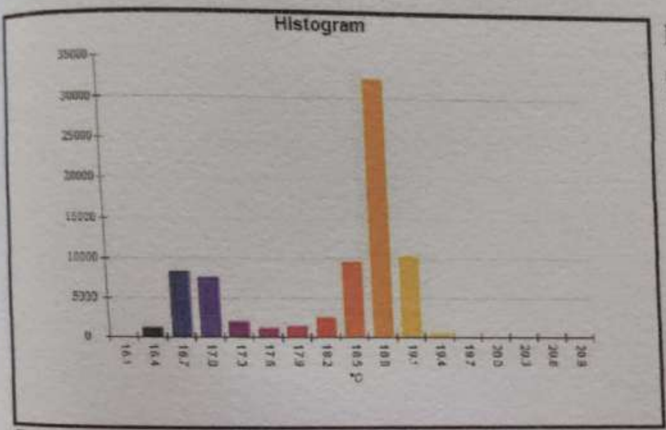
Main Image Markers

Name	Temperature	Emissivity	Background
Centerpoint	38.4°C	0.95	22.0°C
Hot	46.8°C	0.95	22.0°C
Cold	17.4°C	0.95	22.0°C

IR_00086.IS2

Visible Light Image

M/C Lab



Graph

REMARKS

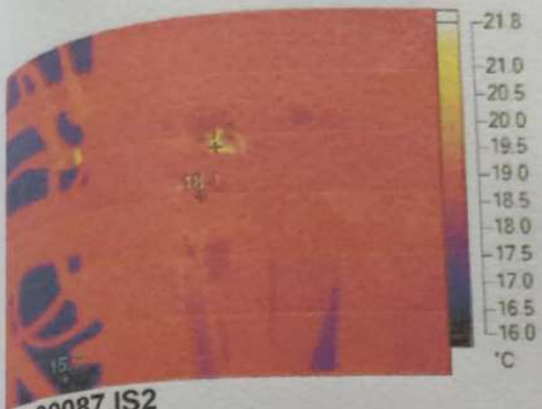
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	18.3°C
Image Range	16.2°C to 20.2°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

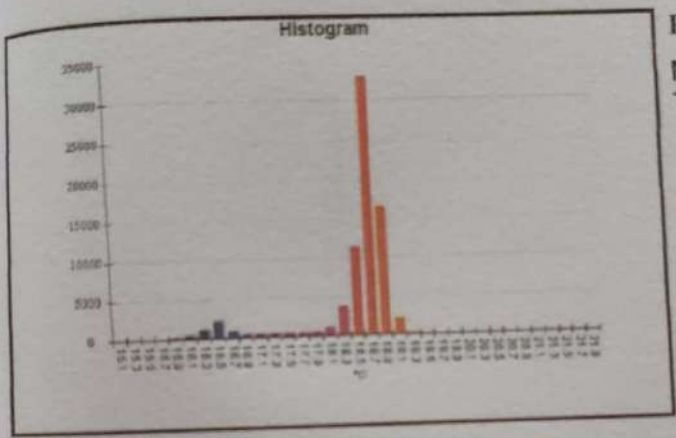
Name	Temperature	Emissivity	Background
Centerpoint	16.7°C	0.95	22.0°C
Hot	20.2°C	0.95	22.0°C
Cold	16.2°C	0.95	22.0°C



IR_00087.IS2

Account section

Visible Light Image



Graph

REMARKS

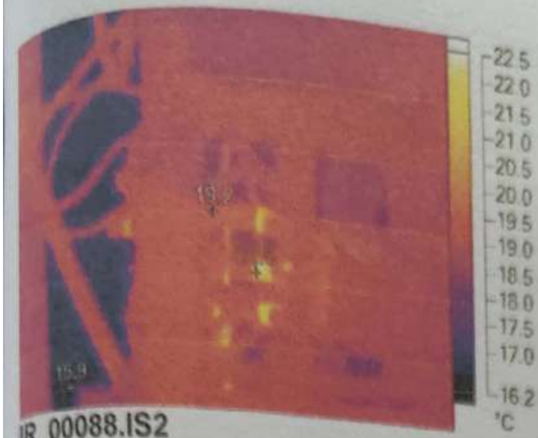
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	18.5°C
Image Range	15.7°C to 21.8°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

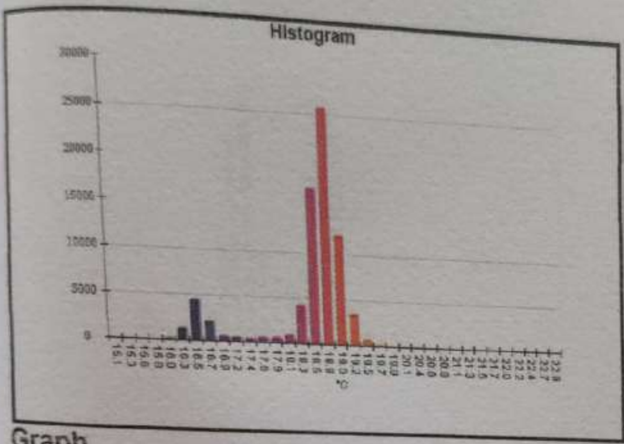
Name	Temperature	Emissivity	Background
Centerpoint	18.4°C	0.95	22.0°C
Hot	21.8°C	0.95	22.0°C
Cold	15.7°C	0.95	22.0°C



IR_00088.IS2

COE

Visible Light Image



Graph

REMARKS

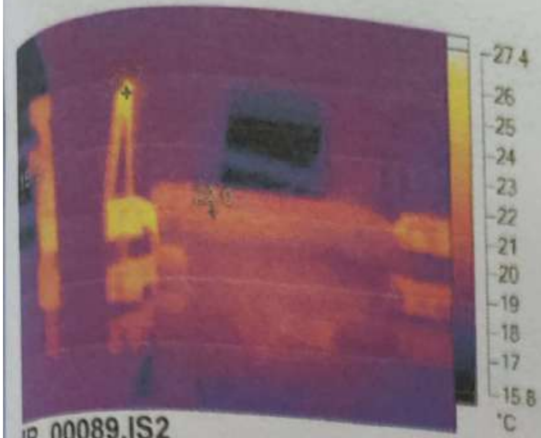
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	18.5°C
Image Range	15.9°C to 22.5°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

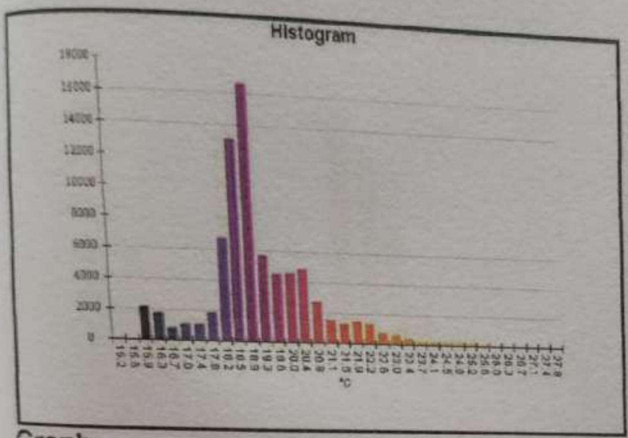
Name	Temperature	Emissivity	Background
Centerpoint	19.2°C	0.95	22.0°C
Hot	22.5°C	0.95	22.0°C
Cold	15.9°C	0.95	22.0°C



IR_00089.IS2

Visible Light Image

O/G Supply



Graph

REMARKS

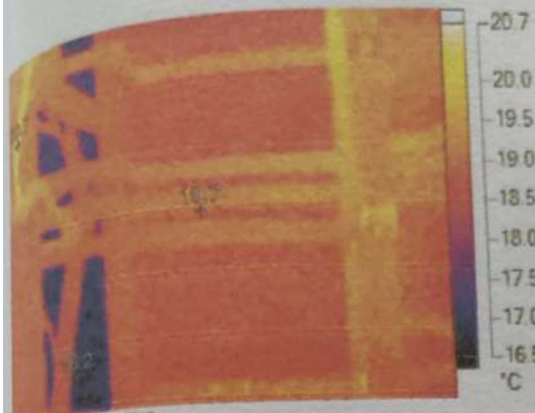
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	19.2°C
Image Range	15.5°C to 27.7°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

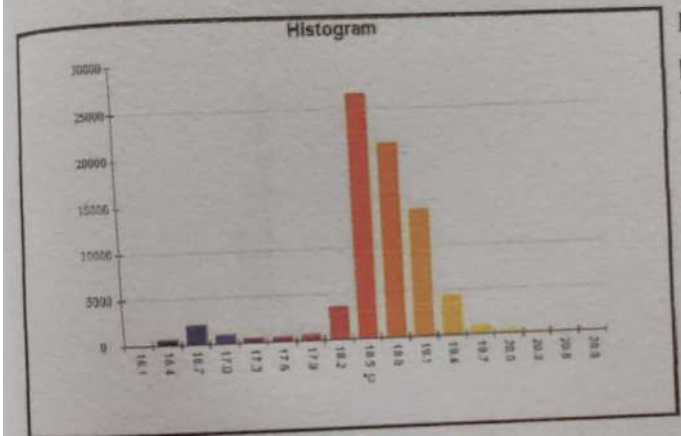
Name	Temperature	Emissivity	Background
Centerpoint	22.0°C	0.95	22.0°C
Hot	27.7°C	0.95	22.0°C
Cold	15.5°C	0.95	22.0°C



IR_00090.IS2

Visible Light Image

Bus Bar



Graph

REMARKS

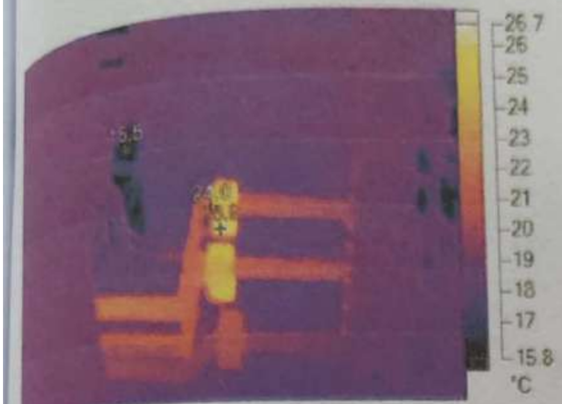
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	18.6°C
Image Range	16.2°C to 20.7°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

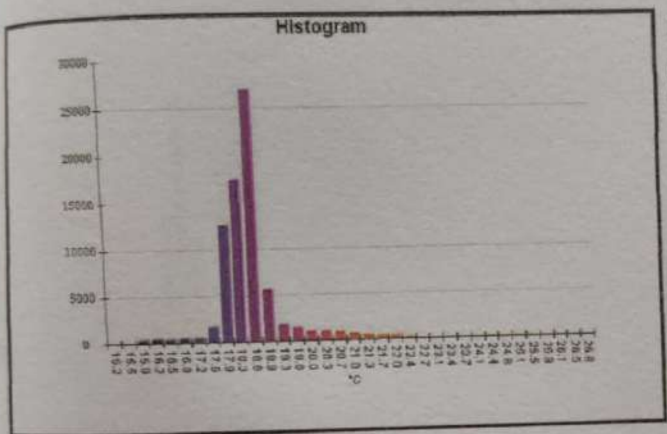
Name	Temperature	Emissivity	Background
Centerpoint	18.7°C	0.95	22.0°C
Hot	20.7°C	0.95	22.0°C
Cold	16.2°C	0.95	22.0°C



IR_00091.IS2

Visible Light Image

Bus Bar



Graph

REMARKS

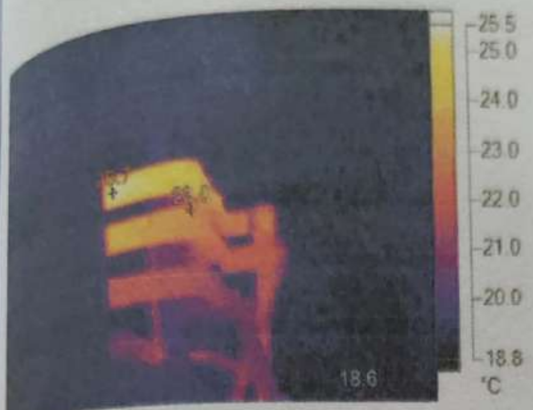
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

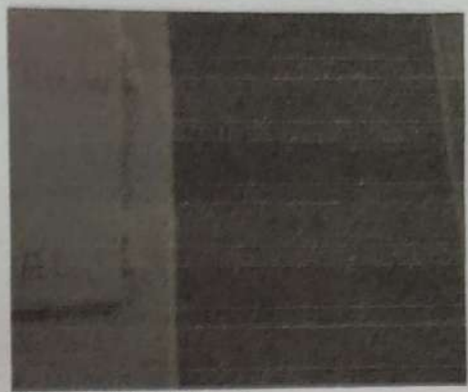
Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	18.6°C
Image Range	15.5°C to 26.9°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

Name	Temperature	Emissivity	Background
Centerpoint	24.0°C	0.95	22.0°C
Hot	26.9°C	0.95	22.0°C
Cold	15.5°C	0.95	22.0°C

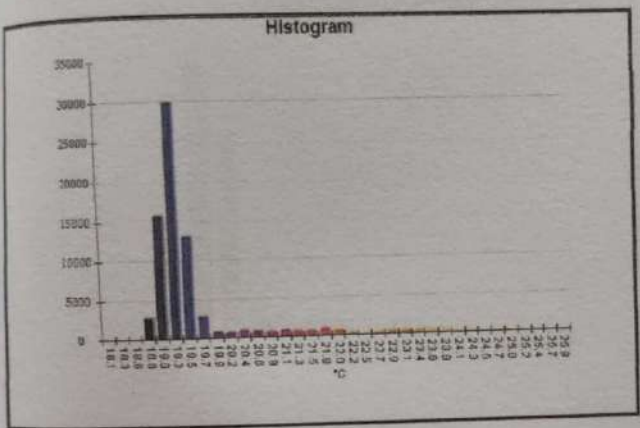


IR_00092.IS2



Visible Light Image

Boys Hostel



Graph

REMARKS

NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

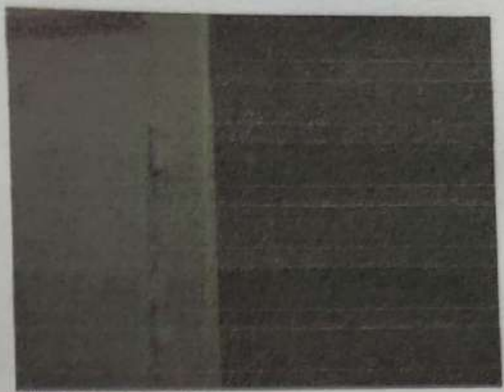
Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	19.6°C
Image Range	18.6°C to 25.7°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

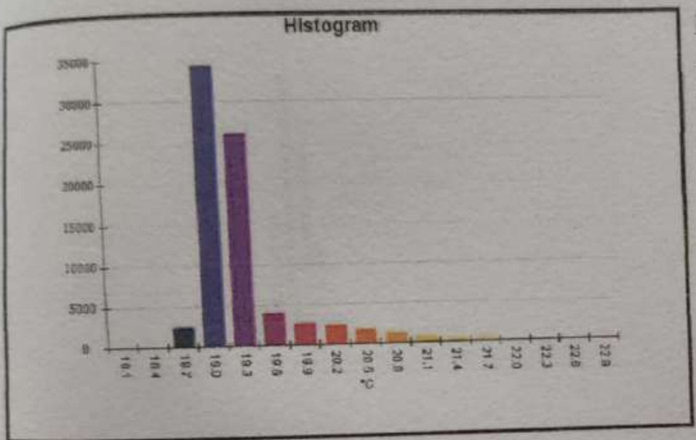
Name	Temperature	Emissivity	Background
Centerpoint	23.0°C	0.95	22.0°C
Hot	25.7°C	0.95	22.0°C
Cold	18.6°C	0.95	22.0°C

IR_00093.IS2

V.C Office



Visible Light Image



Graph

REMARKS

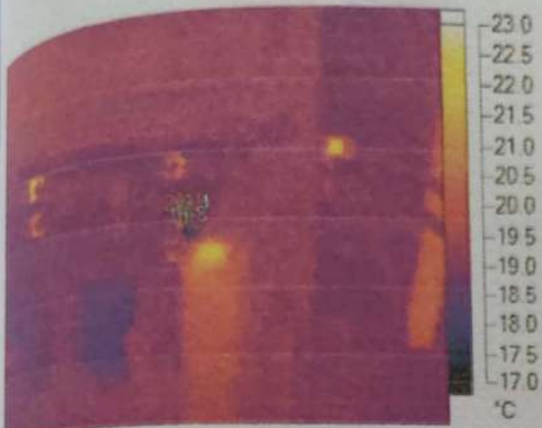
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	19.3°C
Image Range	18.4°C to 22.0°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

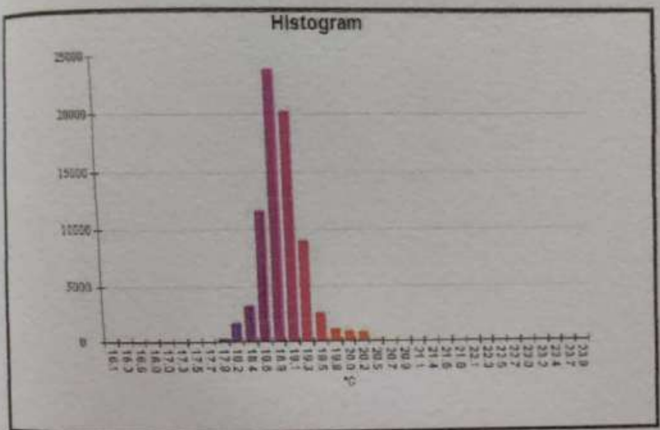
Name	Temperature	Emissivity	Background
Centerpoint	19.2°C	0.95	22.0°C
Hot	22.0°C	0.95	22.0°C
Cold	18.4°C	0.95	22.0°C



IR_00094.IS2

Visible Light Image

Mechanical Light Load



Graph

REMARKS

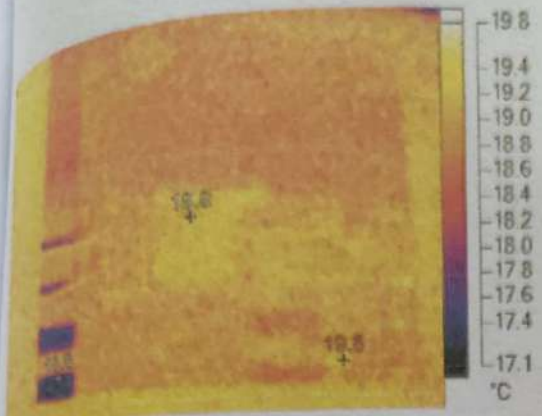
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	19.0°C
Image Range	16.8°C to 23.1°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

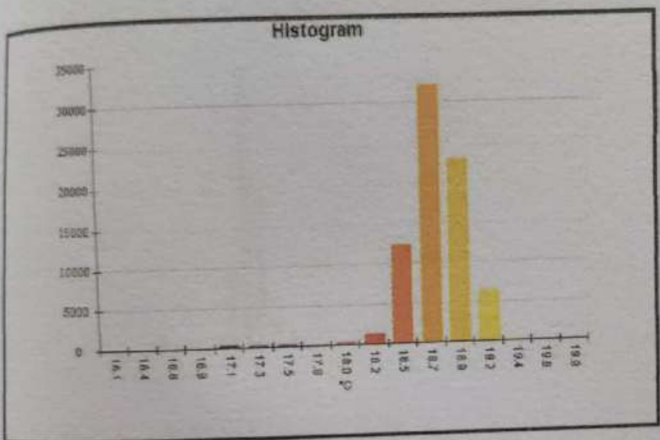
Name	Temperature	Emissivity	Background
Centerpoint	19.4°C	0.95	22.0°C
Hot	23.1°C	0.95	22.0°C
Cold	16.8°C	0.95	22.0°C



IR_00095.IS2

Bank Building

Visible Light Image



Graph

REMARKS

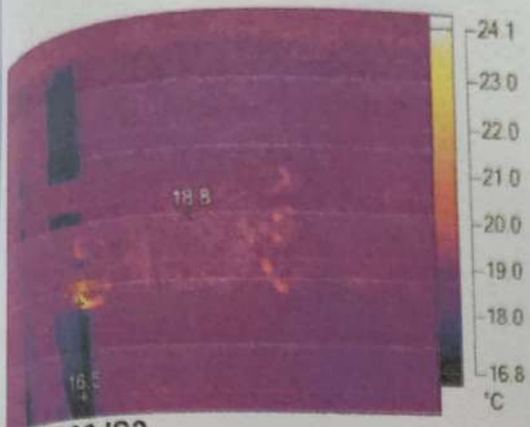
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	18.7°C
Image Range	16.8°C to 19.6°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

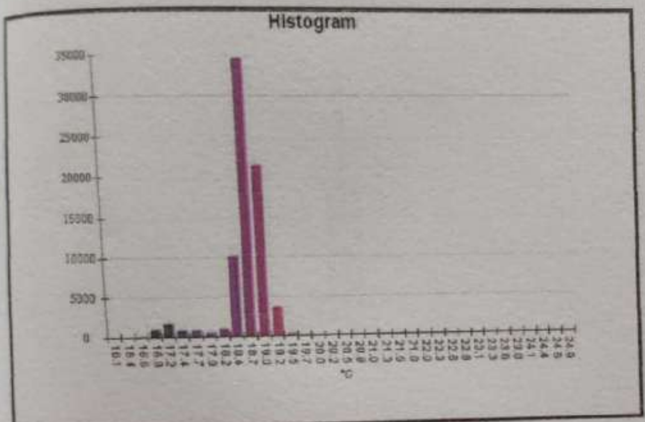
Name	Temperature	Emissivity	Background
Centerpoint	18.8°C	0.95	22.0°C
Hot	19.6°C	0.95	22.0°C
Cold	16.8°C	0.95	22.0°C



IR_00096.IS2

Visible Light Image

GTW Main work shop



Graph

REMARKS

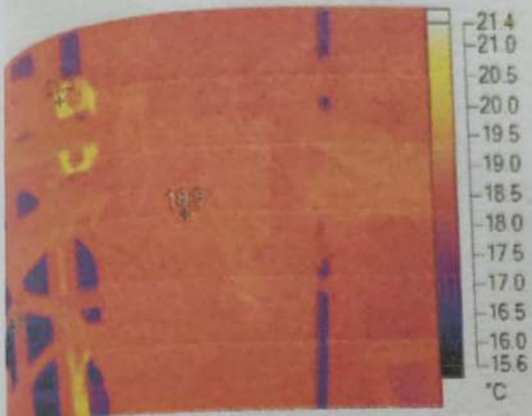
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

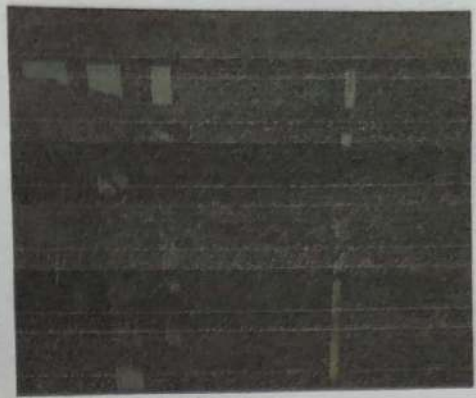
Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	18.7°C
Image Range	16.5°C to 24.2°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

Name	Temperature	Emissivity	Background
Centerpoint	18.8°C	0.95	22.0°C
Hot	24.2°C	0.95	22.0°C
Cold	16.5°C	0.95	22.0°C

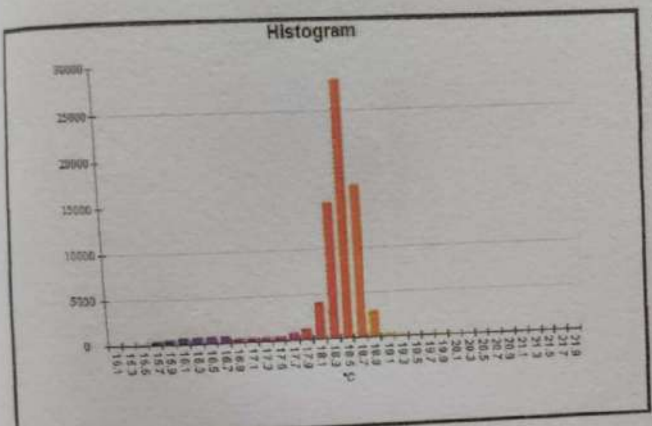


IR_00097.IS2



Visible Light Image

Bus Bar



Graph

REMARKS

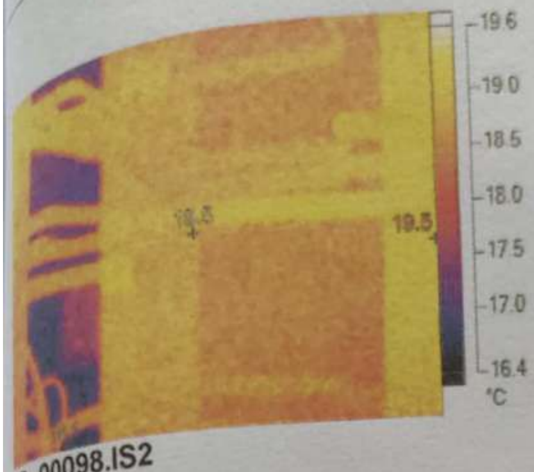
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	18.3°C
Image Range	15.3°C to 21.3°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

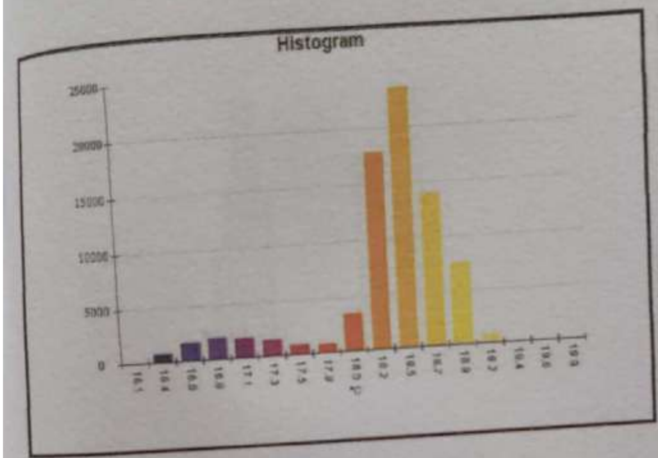
Name	Temperature	Emissivity	Background
Centerpoint	18.5°C	0.95	22.0°C
Hot	21.3°C	0.95	22.0°C
Cold	15.3°C	0.95	22.0°C



IR_00098.IS2

Visible Light Image

New MBA



Graph

REMARKS

NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	18.3°C
Image Range	16.1°C to 19.5°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

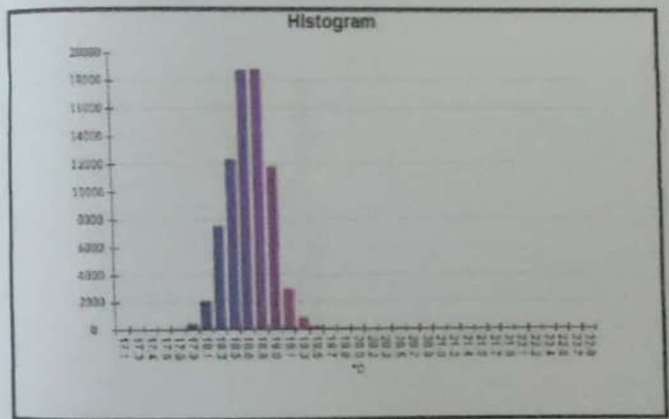
Main Image Markers

Name	Temperature	Emissivity	Background
Centerpoint	18.5°C	0.95	22.0°C
Hot	19.5°C	0.95	22.0°C
Cold	16.1°C	0.95	22.0°C

IR_00099.IS2

Visible Light Image

Girls Hostel



Graph

REMARKS

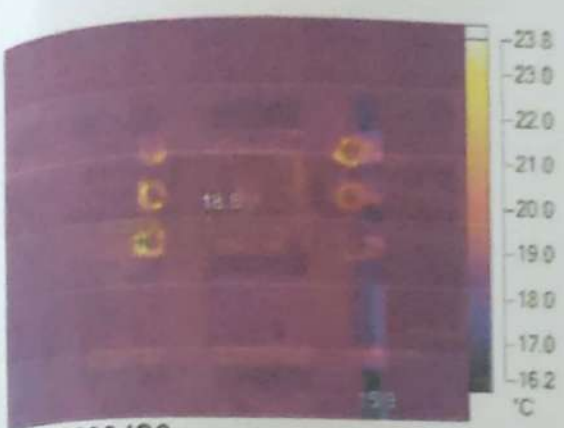
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	18.7°C
Image Range	17.5°C to 22.8°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

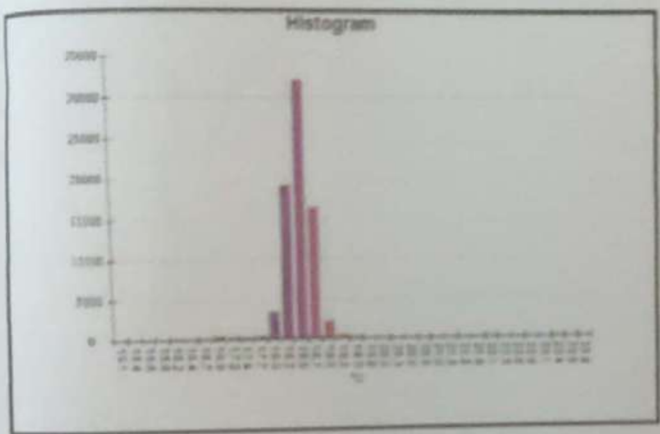
Name	Temperature	Emissivity	Background
Centerpoint	18.4°C	0.95	22.0°C
Hot	22.8°C	0.95	22.0°C
Cold	17.5°C	0.95	22.0°C



IR_00100.IS2

Visible Light Image

Computer Lab



Graph

REMARKS

NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	18.5°C
Image Range	15.9°C to 23.9°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

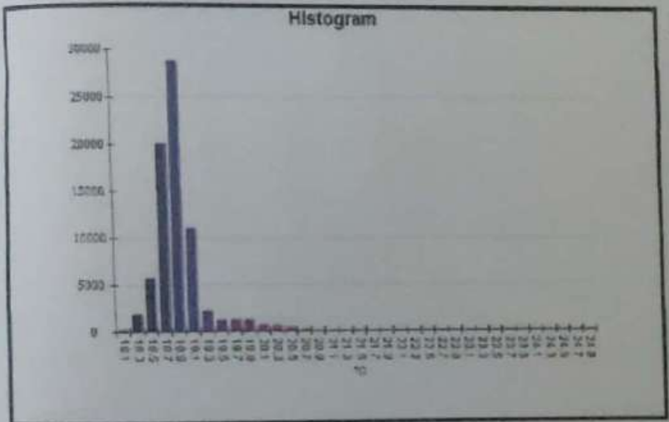
Main Image Markers

Name	Temperature	Emissivity	Background
Centerpoint	18.6°C	0.95	22.0°C
Hot	23.9°C	0.95	22.0°C
Cold	15.9°C	0.95	22.0°C

IR_00101.IS2

Visible Light Image

Post Office



Graph

REMARKS

NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	19.0°C
Image Range	18.0°C to 24.7°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

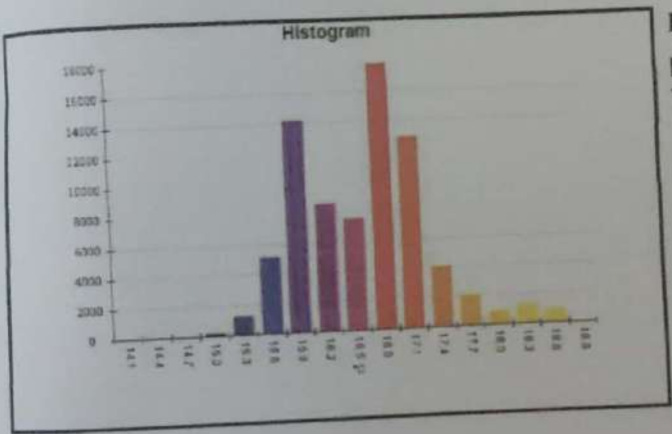
Main Image Markers

Name	Temperature	Emissivity	Background
Centerpoint	18.9°C	0.95	22.0°C
Hot	24.7°C	0.95	22.0°C
Cold	18.0°C	0.95	22.0°C

IR_00102.IS2

Visible Light Image

L.T Cable



Graph

REMARKS

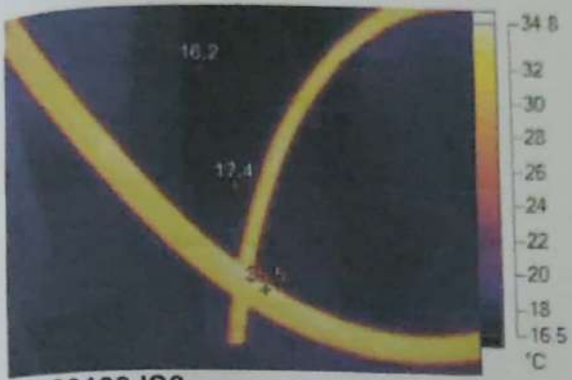
NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

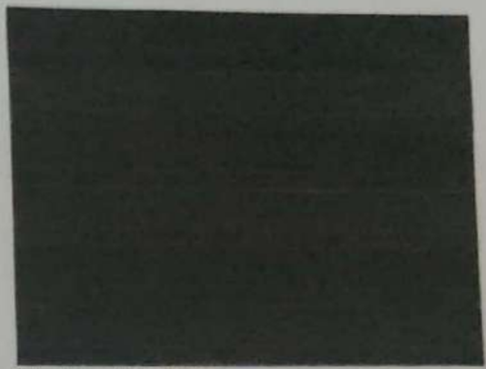
Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	16.6°C
Image Range	14.9°C to 19.0°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

Name	Temperature	Emissivity	Background
Centerpoint	16.1°C	0.95	22.0°C
Hot	19.0°C	0.95	22.0°C
Cold	14.9°C	0.95	22.0°C

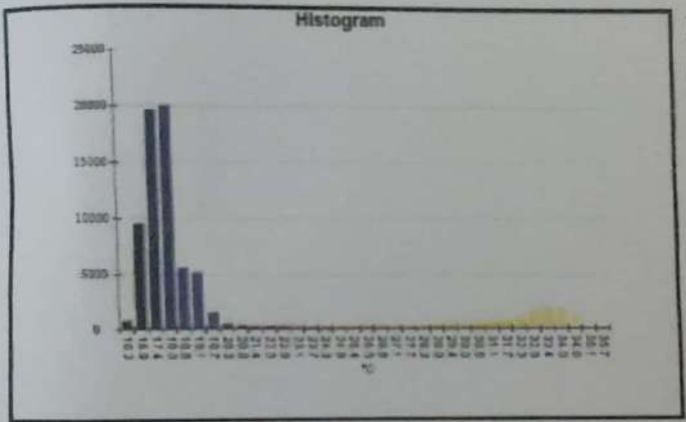


IR_00103.IS2



Visible Light Image

L.T Cable



Graph

REMARKS

NO ISSUE NOTICED HOT SPOT TEMPERATURE NORMAL

Image Info

Background temperature	22.0°C
Emissivity	0.95
Transmission	1.00
Average Temperature	20.2°C
Image Range	16.2°C to 35.5°C
Camera Model	TiS45
IR Sensor Size	160 x 120
Camera Manufacturer	Fluke Thermography

Main Image Markers

Name	Temperature	Emissivity	Background
Centerpoint	17.4°C	0.95	22.0°C
Hot	35.5°C	0.95	22.0°C
Cold	16.2°C	0.95	22.0°C