Energy Audit

at

Guwahati Railway Station

N. F. Railway.

Guwahati,
Assam

(MONTH: FEBRUARY'2009)

Conducted By:

Petroleum Conservation Research Association, Eastern Region
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By
Petroleum Conservation Research Association, Eastern Region

Introduction

The Project

The project is to undertake Energy Audit of Guwahati Railway Station under N. F. Railway at Guwahati, Assam.

The basic objective of the Energy Audit was to study the operations/performance of both Electrical and Thermal energy intensive equipments/ systems for identification of potential areas wherein energy savings are practically feasible.

Profile of Guwahati Railway Station:

The Guwahati Railway Station is the busiest railway Station of N. F. Railway. The importance of Guwahati Railway Station in making Guwahati as the Gateway to North – Eastern India is immense. Connecting trains to almost all the important locations of India are available from Guwahati Railway Station. This Railway Station has a total of seven numbers of platforms and is located in the heart of the Guwahati city.

The responsibility of proper maintenance of the electrical equipments and also to provide uninterrupted power supply to the station premise rests on the Senior Divisional Electrical Engineer, Guwahati.

The main sources of Energy being used are Electrical Power purchased from Lower Assam Electricity Distribution Company Ltd. In case of failure of power supply from Lower Assam Electricity Distribution Company Ltd, the power requirement of Guwahati Railway Station is fulfilled by DG Set which is fuelled by HSD.

Prevailing rates of various Energy Sources

- Purchased Power = Rs 5.00/ unit (last one years avg.)
- HSD = Rs.33.0/ Litre

Tariff Structure

Charges on Billing Demand	@ Rs 145/- per KVA
Energy Charges	@ Rs 5.00/- per unit
Contract Demand	2268 KVA
Billing Demand	2268 KVA

Scope of Work

The study was aimed at identifying the potential for reduction of energy consumption in the following areas:

- **Electrical Distribution System**: Study and analysis of contract demand, power factor, performance of transformers and motors above 5 HP, pumps and their flow, and suggestions to improve performance.
- **Pumping System**: Study and analysis of the pumping system including the pumps and motors and suggestions for improvement.
- **Illumination System**: Study of the lighting systems and measures for improvements wherever feasible.
- **DG set**: In addition to above, the study also covered the performance of DG set, to suggest measures for Energy Efficiency Improvements.

Methodology

The Methodology adopted for achieving the desired objectives viz: Assessment of the Current operational status and Energy savings included the following:

- Discussions at site with the concerned officials for **identification of major areas of focus** and other related systems;
- A team of engineers visited the Guwahati Railway Station and had discussions with the concerned officials/supervisors to collect data/ information on the operations and Load Distribution. The data was analyzed to arrive at a **base line**

energy consumption pattern.

- **Measurements and monitoring** with the help of appropriate instruments including continuous and/ or time-lapse recording, as appropriate and visual observations were made to identify the energy usage pattern and losses in the system.
- Computation and **in-depth analysis** of the collected data, including utilization of computerized analysis and other techniques as appropriate to draw inferences and to **evolve suitable energy conservation plans** for improvements/ reduction in specific energy consumption.

Participation

Petroleum Conservation Research Association (PCRA), Eastern Region, appreciates the keen interest shown by the Officers and Staff under Senior Divisional Electrical Engineers Office of Guwahati in carrying out an Energy Audit in Guwahati Railway Station with special praise for the active co – ordination of;

Energy Audit at Guwahati Railway Station was executed by the team of PCRA Engineers and by the certified energy auditors from N. F. Railway comprising of;

- Sri. R. S. Singh, Divisional Electrical Engineer, Dibrugarh Workshop
- Sri. D. P. Hazarika, Section Engineer, New Guwahati Diesel Shed

A team of PCRA engineers comprising of the following officials were involved in conducting the study.

- Sh. K.L. Bhutia, Deputy Director & SRO Guwahati
- Sh. A. Chakroborty, Jt. Director
- Sh. Rabindranath Mandal, Jt. Director

Energy Conservation Opportunities (ECO's) Suggested

Electrical Savings					
ECO's	**Energy Savings (Annual)**			**Estimated Investment**	**Simple Payback period**
	Quantum (KWh)	**KL of oil equivalent**	**Rs Lacs**	**Rs Lacs**	**Months**
Reduction of contract Demand to 1639kVA from the present 2268 kVA by making contract demand as 70% of the Connected load			12.00	NIL	N/A
Reduction of contract Demand to 1340kVA by reducing the Connected load			16.18	NIL	N/A
Replacement of existing pumping system with new energy efficient system.	1,10,000		5.50	5.00	11
Replacement of 40W FTL with T5 lamps	1,04,000		5.19	4.15	9.5

Study & Analysis

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(A) Electrical Distribution System of Guwahati Railway Station

The power supply to the Guwahati Railway Station is made through the following two transformers;

Transformer Details		Ratings (kVA)	Measured Values				Yr. of Mfg.
Make	Purpose		HT Voltage (kV)	LT Voltage (V)	HT FLC (Amp.)	LT FLC (Amp)	
Bharat Electric	For Station	500	11	433	13.12	333.35	
Prag Electricals	For PRS	250	11	433	13.12	333.35	1991

These two transformers are fed from the grid of ASEB through a 33 kV/ 11 kV.

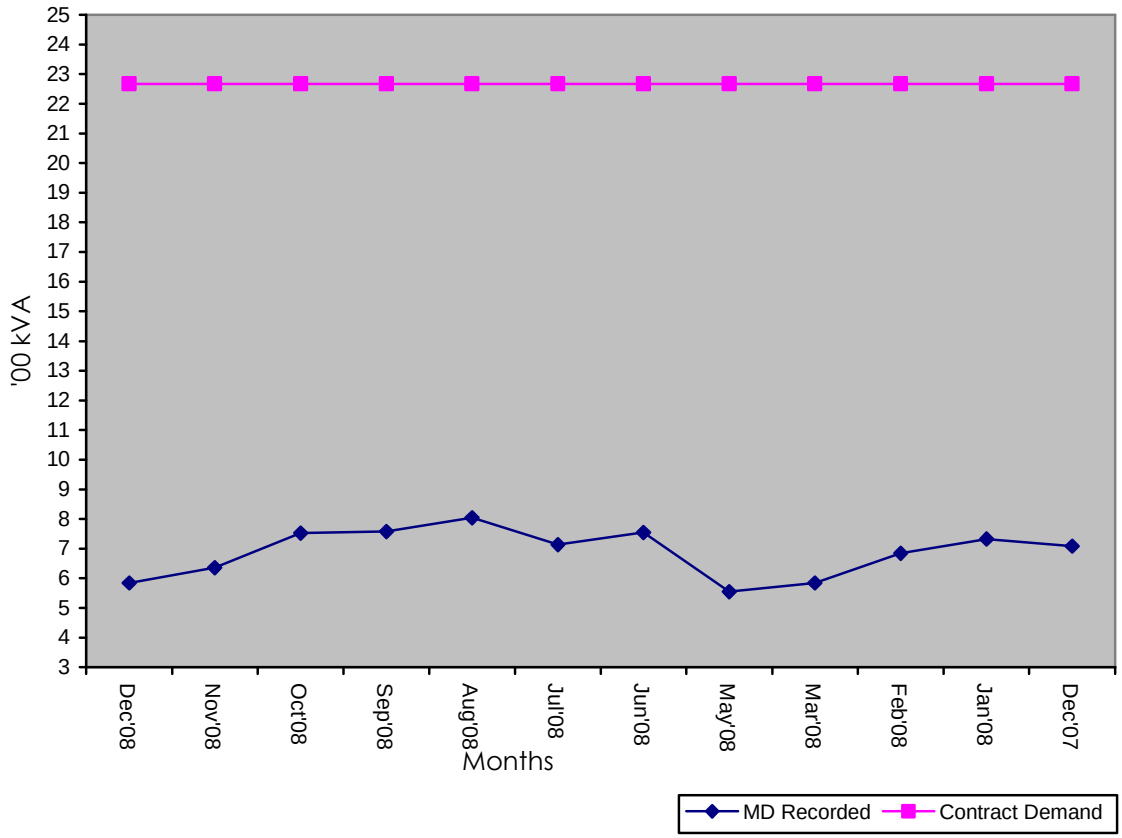
(i) Study of the Electrical Distribution System:

The efficacy of the electrical distribution system is evaluated through the study of the electricity Bill.

Guwahati Railway Station has a contract demand of 2268 kVA. The components of the electricity Bill is tabulated below;

Sl. No.	Month / Year	Units Consumed	PF Penalty/ (Rebate)	Units Billed	MD Recorded (kVA)	Fixed Charges
1	December'08	360300.00	(7206)	353094	584.00	334935.35
2	November'08	355140.00	(7103)	348037	636.00	324130.98
3.	October'08	404220.00	(9084)	395136	752.00	334935.35
4	September'08	375300.00	(7506)	367794	758.00	313326.63
5	August'08	400380.00	(8008)	392372	804.00	345739.73
6	July'08	379440.00	(7589)	371851	714.00	334935.35
7	June'08	337020.00	(6740)	330280	755.00	313326.63
8	May'08	373620.00	(7472)	366148	555.00	345739.73
9	March'08	343680.00	(7874)	335806	584.00	334935.35
10	February'08	336360.00	(6727)	329633	684.00	313326.63
11	January'08	366600.00	(7332)	359268	732.00	335159.84
12	December'07	365400.00	(7308)	358092	708.00	335159.84

The comparison of the Maximum Demand Recorded with respect to the Contract Demand during the period for which the data from the Electricity Bill was collected is graphically depicted as below;



(ii) Analysis of the Electrical Distribution System:

Guwahati Railway Station is category VIII (HT Bulk Supply Others) customer of Lower Assam Electricity Distribution Company Ltd. For this category of Customer the Contract Demand should be 70% to 105% as declared by the consumer of the connected load converted to kVA at 0.85 power factor. And the Fixed Charges applicable for this category of customers is Rs. 145.00 per kVA or part thereof per month.

In case of Guwahati Railway Station the Contract Demand is 97% of the Connected Load converted to kVA at 0.85 power factor. This makes the Contract Demand of Guwahati Railway Station as 2268 kVA.

The analysis of the Electricity Bill of Guwahati Railway Station reveals the following;

a) The Maximum Demand (MD) recorded during the period for which Data was collected is far less than the contract demand. The maximum MD recorded was 804.00 kVA for the month of August' 08.

b) Power Factor rebate is being availed by Guwahati Railway Station indicating that correction in this regard is already being made.

c) The transformer efficiency is good and the transformer losses as a percentage of the total energy consumption is likely to be less than 2% thus leaving nearly zero opportunity for efficiency enhancement.

(iv)Recommendations:

The maximum MD recorded over the period of last one year for which the data were collected is 804.00 kVA. This is only 35.45% of the Contract Demand. This opens up the major scope for reducing the electricity cost by way of reducing the Fixed Charges through reduction in the Contract Demand.

The Contract Demand can be reduced through the adoption of the following **measure;**

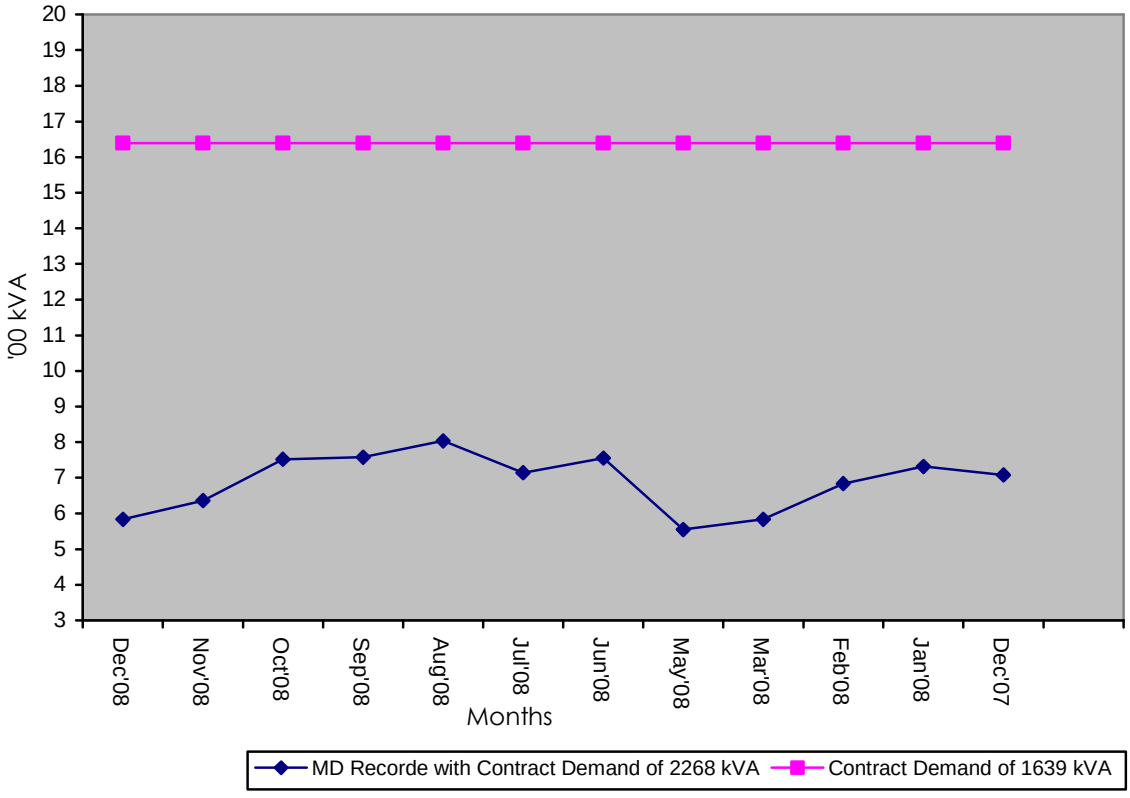
a) **Short Term Measure**:

As Guwahati Railway Station is a category VIII (HT Bulk Supply Others) customer of Lower Assam Electricity Distribution Company Ltd, hence as a short term measure the Contract Demand can be reduced from the present 97% of the Connected Load converted to kVA at 0.85 power factor to the minimum of 70% of the Connected Load converted to kVA at 0.85 power factor. This will reduce the

Contract Demand to 1639 kVA from the present Contract Demand of 2268 kVA

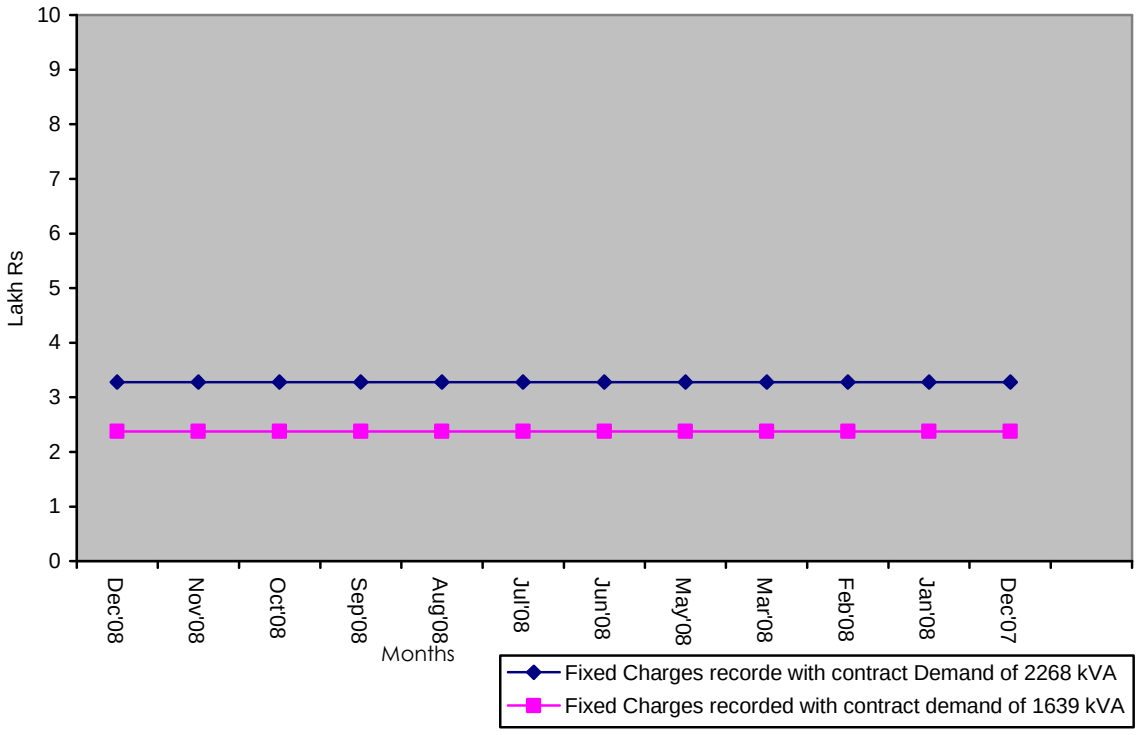
The comparison of the Maximum Demand Recorded with respect to the Contract Demand of 1639 kVA over the period of last one year for which the data were collected reveals that the maximum MD of 804.00 kVA that was recorded is 49%. Thus adoption of this measure also keeps the MD well below the contract demand.

The comparison of the Maximum Demand Recorded with respect to the Contract Demand of 1639 kVA during the period of last one year is graphically depicted as below;



Adoption of this measure will ensure sufficient reduction in the electricity Bill through reduction of Fixed Charges for Guwahati Railway Station. Had this measure been taken earlier, then the reduction in Fixed

charges on a 30 days Billing period basis, over the period of last one year is depicted pictorially as below;



This reveals that the savings that could have been made through reduction of Fixed Charges by reducing the Contract Demand in the said period of one year would have been Rs. 12 lacs.

b) **Medium Term Measure**:

As a medium term measure the option of reducing the Connected Load can be worked out. Keeping a margin of 30% above the highest MD recorded during the period of last one year, the connected load can be reduced to such an extent that the **Contract Demand is reduced to 1340 kVA. In such a case the Fixed Charges will be Rs. 1.94 lacs per month on a 30 days billing period basis.**

Considering the Fixed Charges at Rs. 1.94 lacs the savings that could have been achieved works out to be **Rs. 16.18 lacs**.

(B) Pumping System of Guwahati Railway Station:

Adequate Supply of water is a very important aspect of Guwahati Railway Station. Large quantities of water are required for meeting the purpose of Drinking at Railway Station, Cleaning of the station premise, filling of water in coaches, etc.

The majority of the water requirement at the Guwahati Railway Station is met from the pumping Station at Uzanbazar. Apart from this 3 (three) submersible pumps are installed for meeting the water requirement.

The study of the pumping station at Uzanbazar is not within the scope of this work, for which energy efficiency study is made only with regard to the 3 submersible pumps installed nearby to the Railway Station. The details of these pumps are as below;

Sl. No.	Submersible pumps near	Rated			Operating Head (M)	Hours of operation per day
		Power in		Capacity (Gallons per Hour)		
		H.P	kW			
1.	Power House	25	18.64	15,000	46	16
2.	Poda Colony	20	14.91	10,000	46	12
3.	33kVA Sub - station	20	14.91	10,000	46	12

(i) Study of the Pumping System:

After making an on site studies of the above pumps, the following data with regard to the pumps are obtained after on site measurement;

Sl. No.	Pumps located at	Voltage (Volt)		Current (Ampere)		Measured Power (kW)	pf	Flow M^3/Hr	Hydraulic Power required (kW)
		V_R	V_T	I_R	I_T				
1.	Power House	427	425	33.5	31.5	18.2	0.76	35	4.39
2.	Poda Colony	409	409	22.4	22.6	8.0	0.52	8.52	1.07
3.	33kVA Sub-station	396	396	15.8	15.4	8.8	0.83	8.52	1.07

(ii) Analysis of the Pumping System:

The study of all the 3 pumps studied reveals that the Hydraulic power required for pumping is much less than the actual power drawn by the pumps. This reveals that the operation of the pumping system of Guwahati Railway Station is highly energy in – efficient and there is a lot of scope for achieving energy efficiency in operating the pumps of Guwahati Railway Station.

The maximum scope for saving in power for operating the pumps is tabulated as below;

Sl No	Pumps located at	Measured Power (kW)	Hydraulic Power required (kW)	Hrs. of operation per day	Unit Charges (Rs)	Savings potential in kWH / Year	Saving potential in Rs. / Year.
1.	Power House	18.2	4.39	16	5.00	79,545	3,98,000
2.	Poda Colony	8.0	1.07	12	5.00	29,937	1,49,700
3.	33kVA Sub-station	8.0	1.07	12	5.00	29,937	1,49,700
Total saving potential per year						1,39,419	6,97,400

Under realistic situation, if we consider pump efficiency as 60% and motor efficiency as 90%, the actual power that will be necessary for fulfilling the pumping requirement in an optimal condition for the different pumps can be calculated by the following formula;

$$\frac{\text{Hydraulic Power Required}}{\text{Pump Efficiency (0.6) X Motor Efficiency (0.9)}}$$

Using the above formula the achievable savings in energy for the pumps in Guwahati Railway Station are detailed as below;

Sl. No.	Pumps located at	Required Power (kW)	Actual Power Consumed (kW)	Savings in kWH/ Year	Savings in Rs. / Year.
1.	Power House	8.13	18.20	58,000	2,90,000

2.	Poda Colony	1.98	8.0	26,000	1,30,000
3.	33kVA Sub-station	1.98	8.0	26,000	1,30,000
Total achievable savings per year				1,10,000	5,50,000

(iii) Recommendations:

1. The loss that is presently being incurred due to in – efficient operation of the pumping system at Guwahati Railway Station amounts to Rs. 5,50,000.00 per year. Whereas the replacement of the existing pumping system with a new one will cost a maximum amount of Rs. 5,00,000.00.

2. It is highly recommended that the existing system is replaced by a new one as the pay back period for such measure for achieving energy efficiency will be 11 months only.

3. And if the scrap value of the existing pumping system is taken into consideration than the pay – back period for replacement will be even lesser than 11 months.

(C) ILLUMINATION SYSTEM OF GUWAHATI RAILWAY STATION:

For the purpose of studying the illumination system of Guwahati Railway station, the Railway Station is divided into Five Lighting Zones as described below;

1. Lighting Zone #1:
   This zone comprises of Platform NO. 1; The Retiring Rooms: Concourse: Current Reservation office premise; Foot Over – bridges; Waiting Hall; Crew room and the Parking Area

2. Lighting Zone #2:
   This zone comprises of the Platform No. 2; and platform No. 3

3. Lighting Zone #3:
   This zone comprises of Platform No. 4; and Platform No. 5

4. Lighting Zone #4:
   This zone comprises of Platform No. 6; and Platform No. 7

5. Lighting Zone #5:
   This zone comprises of the Passenger Reservation System office premise, including the office of the Sr. Area Manager; Sr. Divisional Electrical Engineer and Assistant Divisional Finance Manager.

The installed fittings in the above Lighting Zones are tabulated as below;

Lighting Zones	Power Supplied (kW)	Numbers of						Total Power Consumed
		CFL of				FTL of		
		36 W	18 W	11 W	9 W	46 W	26 W	
Zone#1	22.78	353		58		303	144	31.03
Zone#2	4.13					176		8.10
Zone#3	5.96					150		6.90
Zone#4	6.80					152		6.99
Zone#5				119	8	405	188	24.90
Grand Total		353		177	8	1186	332	77.92

(i) Study of the Illumination System:

Illumination survey of Guwahati Railway Station was carried out in night on 21st & 22nd of February, 2009. During the survey the illumination level of the various Lighting Zones as described above was carried out.The color rendering index was noted in Lux measured with Luxmeter during the study at the Lighting Zones. The measured values are tabulated as below;

Lighting Zones	Number of Fittings					No. of Readings taken	Measured Lux level		
	CFL of			FTL of					
	36 W	11W	9 W	46 W	26 W		Max	Mini	Avg
Zone#1	353	58		303	144	223	249	14	93.5
Zone#2				176		56	84	3	40.8
Zone#3				150		42	61	9	29.3
Zone#4				152		57	68	3	34.3
Zone#5	353	119	8	405	188	98	796	26	369.1

The study of the measured values taken at the different Lighting Zones of Guwahati Railway Station reveals the following;

- There is wide variation of illumination levels in different locations, specially in Lighting zones # 2, 3, & 4 and thus it requires uniformity of distribution of illumination levels.

- The illumination level in lighting zones # 1 & 5 are OK, but the illumination level of lighting zones # 2, 3, & 4 requires improvement.

- The Lighting fixtures are covered with dust and insects and needs cleaning for improvement of illumination level without any additional investment.

- Conventional FTL of 46W ratings with copper choke comprises of about 58% of the total lighting fixtures. With the advancement in the technology, several energy efficient lighting systems are available today, which would not only reduce the energy consumption but also improve the illumination levels. A comparative study of the average power consumption viz., Lux Levels for different tube lights is given herein:

Type	Voltage (Volts)	Current (mA)	Power Factor	Power Drawn (W)	Lux Level
Asian (28 Watt with Electronic Ballast)	235	131.5	0.89	27.50	> 250
Osram (28 Watt with Electronic Ballast)	235	131.0	0.89	27.39	> 250
Philips (36 Watt with	235	250.0	0.72	42.30	200-250

Type	Voltage (Volts)	Current (mA)	Power Factor	Power Drawn (W)	Lux Level
Copper Ballast)					
Existing Tube lights (40 Watt with Copper Choke)	235	291.0	0.72	49.23	200-250

Recommendations for Energy Savings

- Maintain and clean all lighting fixtures. Maintain record of all lighting fixtures against each location.
- Use natural light wherever feasible. This will allow putting off all the lamps during sunny days.
- Replace all 40 watt conventional TFL (T12 & T8) under a failure replacement policy with 28 watt energy efficient TFL (T5). Lamp efficacy (in lumen/watt) of T5 is much higher than T8. Burning hour of T5 is almost 3.5 times of T8. The resultant benefit in terms of Energy Savings has been worked out as follows:

Savings due to replacement of 40W FTL with T5 lamps:	
Nos. of FTL	1186
Power consumption by existing 40W FTL, Watt	52
Running hours	10
Expected Power consumption by T5, Watt	28
Average nos. of day per year	365
Annual savings, KWH Costing per unit of power, Rs/ kWH	**103894** **5.00**
Annual savings, Rs.	**5,19,000**
Investment (@ Rs.350/- per T5), Rs.	4,15,000
Payback Period, Yr.	0.79 = 9 months 14 days

Suppliers:

- ASIAN Electronics Ltd., 12, Aswini Dutta Road, Kolkata-700 029, Phone: (033) 2465 0589/0239, e-mail: aeccal@cal2.vsnl.net.in
- Philips India ltd, Motorola excellence centre, 5th floor, 415/2, Mehrauli Gurgoan Road, Sector 14, Gurgoan-122001
- Linear Technologies India Pvt. Limited, K-37, Green Park, Main Basement, New Delhi-110016
- Eurolight Electricals Limited, 20, Sadashiv Peth, Rahi Chambders, L B S Road, Pune-411030

Note: The supplier(s) mentioned above is not necessarily the only ones or the best available. Competitive rates, specifications etc. of other suppliers may be obtained for comparisons. Some of the parties are doing business on ESCO concept also.

(D) Diesel Generator Sets:

For the purpose of back up power supply in case of power cuts by ASEB, Guwahati Railway Station has three numbers of DG Sets. The details of the DG sets are tabulated as below;

Sl. NO.	Make	Mfg Year	Capacity (kVA)	Voltage (V)	Current (A)
1.	Kirloskar Cummins Ltd	1984	200	415	278.5
2.	Jackson - Cummins	2008	380	415	529.0
3.	Kirloskar Cummins Ltd	1993	200	415	278.5
4.	Greaves Ltd.	2000	380	415	529.0

(i) Study of the DG Sets:

For the purpose of studying the performance of the DG Sets located at Guwahati Railway Station, trail run on the DG set indicated in the Serial No. 1 of the above table is performed. The key parameters that were being noticed during trail run for performance appraisal are;

Sl. No.	Description	Readings
1	Duration of Trial	1 Hour
2	kWH Generated	82.589 kWH
3	HSD Initial, Liter	382.99 liters
4	HSD Final. Liter	357.67 liters
5	HSD Consumption, Liter	25.32 liters
6	**SFC, Liter/ kWh**	**0.31 liter/ kWh**
7	**SPG, kWh/ Liter**	**3.26 kWh/ Liter**
8	Cooling Water temperature	45^0C

(ii) Analysis of the DG Sets:

1. The specific power generation of 3.26 kWh/ liter of HSD is lower as this should normally be greater than 3.8 kWH/ Liter.

2. Due to improper maintenance of log book the evaluation of energy consumption and thus the potentiality of energy savings in DG sets cannot be evaluated.

3. The calibration of the different meters should be done regularly with proper record maintenance.

4. The ventilation of the DG room is not good.

(iii) Recommendations:

1. For the purpose of enhancing the specific power generation, the DG sets needs overhauling with special consideration to fuel injection and discharge system; removal of hot spots; and reduction of blow – by.

2. The log book should be properly maintained so that the performance of the DG sets can be assessed in – house by monitoring the parameters such as specific power generation as lube oil consumption with respect to fuel oil consumption. Proper maintenance of Log book will also be helpful to assess the potentiality of energy savings that can be made in DG sets.

3. In case of DG sets it is seen that for a rise of every 3°C in intake temperature beyond 32°C the engine output drops by about 1.2%. It is therefore essential to make arrangements for proper ventilation

so that hot air is continuously removed by circulation of cool air. Using insulation lagging can also reduce heat radiation from the exhaust pipe and manifold.

4. Load management of DG sets significantly influences fuel consumption. Optimum fuel efficiency can be attained when the DG sets are loaded between 65% - 85%. Also the DG sets should have proper load balancing. It may be noted that at no point of time the difference between maximum and minimum current in the R, Y and B phase should be more than 10%. It is necessary to distribute the loads judiciously or avoid single-phase loads in a three-phase system.