ENERGY AUDIT

AT

INDIAN OIL CORPORATION,

KANDLA (OLD), KUTCH

CONDUCTED BY
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for giving us this opportunity to contribute in their endeavor of efficient energy management. We are thankful to all Technical staff for coordinating and co operation given to us in detailed energy audit work.

SCOPE OF THE STUDY:

1.1 Scope of the Study

As per clause5 of Govt. order No. GHU/99/31/GUE/1196/9018/K1, Dated 5th Oct, 1999 and generally covering following points.

1.1.1 Electricity consumption & Electricity Billing:

Summary for the past year's monthly electricity consumption and production data. Calculation of specific energy consumption, KWH/TON of material produced etc. and comments on the same.

Calculation of load factor and method to reduce maximum Demand. Comments on average power factor and methods to improve power factor Exploring possibility of better use of time of use tariff
Performance Evaluation of Major Utilities and Process Equipment:

Electrical Distribution Networks:

Transformers: Performance evaluation through simultaneous measurements of major electrical parameters on HT & LT side and rationalization of transformers, if needed.

Power Factor: Measurements of distortion & displacement power factor at various points viz., PCC, MCC, load centers etc., and analysis of the same for optimizing the network losses.

Metering & Monitoring Status: Review of existing meters for adequate monitoring requirements.

Electrical Equipment:

Electrical measurements of all major electrical parameters viz., voltage, current, power factor, KW, frequency etc., of important equipment (motors, furnaces, electrolysis, lighting, etc.), with significant energy consumption. Loads susceptible to generation of harmonics shall be checked for present harmonic level. System unbalance with respect to voltage and current shall be checked.

CPP & DG sets:

Review of performance including major auxiliaries and suggestions for optimization.

Pumps :

Measurement of Head/pressure, flow, power and determination of pump efficiencies based on measured parameters and critical study of piping/ducting/valves/dampers pressure losses, system layout etc.

Lighting:

Measurements of light intensity and all major electrical parameters viz., voltage, current, PF, KW. Study of type of lamps and chokes used; day and night time lighting etc.

1.1.2 Preparation of report based on analysis of above data:

The report shall provide existing Energy Profile of the unit with percentage share of major equipment/processes, Utility etc., so that it becomes a basic document for future monitoring.

Detail of measures to be taken to improve Energy Efficiency and reduce losses for all the above areas. Estimation of energy and monitoring savings, investment requirement and simple payback periods. The measures shall also be categorized into operational changes, minor modifications and retrofits (negligible & moderate investment) and use of
more efficient equipment/process (major investment). The investment proposals shall be backed up with quotations received from vendors or vendor's addresses.

Attempt shall also be made to carry out the measurements of various parameters to the extent possible. In the event of inability of measurements due to some constraints, reasonable estimation can be made. Reasons for estimation shall be justified.

1.1.3 METHODOLOGY & TIME SCHEDULE

No. of visits made for study of plant operations, collecting necessary data and making measurements on important equipment.

On completion of the study visits, a note incorporating all measurements taken and the approach adopted was submitted to you.

Analysis of the collected data and report preparation was done in our Baroda office. After completion of this, the final report is being submitted to you.

EXECUTIVE SUMMARY FOR SAVING:

- SUMMARY FOR ELECRICAL ENERGY SAVING SCHEME

Sr. No.	Scheme	Annual Saving	Investment Rs.	Pay Back Months	Implementation schedule
1	Saving by minimizing working in the peak hours to about 3% and shifting the load to the night hours	2,55,472	Nil	Immediate	
2	Install Constant Voltage Stabilizer	14,20,653	9,00,000	7.7	
3	Saving by reduction in CD at NFST	9,15,070	Nil	Immediate	
4	Saving by totally isolating the idle loaded Transformer at NFST	79440	Nil	Immediate	
5	Saving (only lighting load) by tap changing of Transformer at FST	2,92,180	Nil	Immediate	
6	Saving by installation of Capacitor and APFC panel in order to improve PF	7,64,051	2,00,000	4	
7	Saving by installation of Flux maxiox on the D.G. Set	1,20,000	70,000	7	
8	Installing Own CPP	1.13 Cr.	3 Cr.	31	
8	Saving by installation of Amtech VFD at the Pump at FST	2,69,160	250000	11	
9	Saving by group filling of the trucks	2,69,160	Nil	Immediate	
10	Saving by installation of the AUTO PHOTO Cell Device	1,13,512	24000	2.5	
11	Saving by replacing the magnetic chokes with the Intellux Electronic Ballasts	97,627	1,17,750	14	
12	Saving by installation of Automatic Electronic Flow Metering & filling truck and railway wagon	Not quantified (Detailed study may be taken up as advantages are many)	60.51 lakhs		

INTRODUCTION:

INDIAN OIL CORPORATION LIMITED, Kandla is a public limited company belonging to fortune 500 companies. This is a fore shore facility to receive the white products like MS, High Speed Diesel (HSD), Superior Kerosene Oil (SKO), Naptha from Kandla port or other refinery like Reliance, Jamnagar and to supply the same as per the market demand to various customers. The products are supplied by Pumping the product through the pipe line, road tanker filling, Rail wagon filling and sea Tanker filling.

The Fore terminal went in for an expansion and New Fore terminal facility was created.

There are 25 tanks out of which 7 are in the Foreshore Facility (FST) having 71.85 ton KL storage capacity and the rest come under the New Fore shore Terminal (NFST) having 418.963 TKL storage capacity as follows:

Product	**Tank Nos**	**Total Tanks**	**Total TMT* Capacity**
LAN	T1 to T7	7	71.858
MS	T9,T20,T21	3	92.432
SKO	T10,T13,T14,T16,T17	5	90.070
HSD	T8,T9,T11,T12,T15,T18,T19,T22 to T25	10	236.461
	Total	**25**	**490.821**

*TMT (Thousand metric ton)

The unit was commissioned in 1983. Subsequently the further expansion was taken up with NFST and additional receipt, storage and pumping facilities were added to the refinery.

The area is prone to natural calamities. It had faced severe damage during the cyclonic storms which brought the high tide right in to the plant submerging all the areas in the sea water. Most of the records are lost and no data about the rated capacities and the design aspects of the pumps are available.

The plant faced second calamity on 26th Jan, 2001, there was severe earth quack damaging many piping and tanks.

The Men Power Strength and Company's Working Schedule and Organogram, is given in Annexure IA, IB and IC respectively.

PRODUCTION DATA

The comprehensive list of its products handled with receipts and dispatches is given in annexure II.

The company's energy requirements are as follows :

ELECTRICAL ENERGY SYSTEM

ORGANIZATION	**NFST**	**FST**
Power Supply Company	GEB	GEB
Power Tariff	HTP-1	HTP-1
Consumer No.	31259	31229
Supply Voltage	11 KV	11 KV
Security Deposit	17,18,000	65,350
GEB Connection Date	04/03/1994	24/08/1984
Last CD Adjustment	---	600KVA to 300 KVA since June '2001
Present CD	1000 KVA	300 KVA
Average Actual Demand	525.5	219.67
Average Units consumed per month	217447.83	51056.17
Average Monthly Bill per month in Rs. /month	16,07,158.5	3,75,692
Average Power Factor	0.917	0.948
Average Rate in Rs./Unit	7.39	7.36

2. Electricity Consumption and Bills : Summary for the past year's monthly electricity consumption and production and production data.
Calculation of Specific Energy Consumption (KWH/TON of materials produced, KWH/M2 etc.) and comments on the same.

Electricity Connections:

At present the unit has two separate connections one to FST and NFST. The connection from GEB for FST is of 300 KVA and to NFST is of 1000 KVA. The actual bills for the two units are given in Annexure III A (for FST) and Annexure III B (for NFST).

Calculation of Load Factor and methods to reduce Maximum Demand.

$$\text{Load Factor (FST)} = \frac{\text{(Sum of KWH during the working days)}}{\text{(Max. Demand KVA X AVG. Pf X Duration in days X Work.Hours)}}$$

$$= \frac{51056.17}{219.67 \times 0.948 \times 300 \times 8}$$

$$= 10.215\ \%$$

$$\text{Load Factor (NFST)} = \frac{\text{(Sum of KWH during the working days)}}{\text{(Max. Demand KVA X AVG. Pf X Duration in days x Work. Hrs)}}$$

$$= \frac{217447.83}{525.5 \times 0.917 \times 300 \times 8}$$

$$= 18.8\%$$

The load factor is very low due to the varying pumping requirements. The plants are designed to cater to maximum loads but actual load depends on the marketing requirement. The petroleum products have to be transferred in the shortest possible time so that the demurrage charges are not levied on them by the Railways or the shipping companies. Hence, for such installations which are only doing the business of receipt, storage and transfer the load factor may fluctuate widely depending upon actual requirements.

The Daily Consumption of Electricity of the past two months is given in Annexure IV(A & B)
From the figures it can be seen that the daily consumption is varying very widely with more than 100% variations:

	KWH/Day	Power factor
FST Min	1184	0.73
FST Max	2768	(leading 0.77)
FST AVG	1909	0.95
NFST Min	2175	0.69
NFST MAX	6150	(leading 0.83)
NFST AVG.	4305	0.97

The power factor is also fluctuating widely. This clearly indicates the need for APFC to keep the power factor near unity. As the major loads are only pumps, it is suggested to put the capacitor banks near the load attached with it so that there is saving in the cable losses as well.

No cyclic or weekly patterns are observed. But at times the power factor is leading or more than unity. It is understood that leading power factor will not only increase the cable losses but also the capacitor losses are also unnecessarily incurred. It is recommended to install the capacitors attached with the loads so that they are on only when the pump is running and also to keep the APFC in working condition. Present APFC's were mal functioning and thus the capaitor banks were kept on manual mode.

The 24 Hours Readings of KWH, Voltage & Pf, KVAh are given in Annexure V.

As can be seen from the graph of hourly consumption, the present consumption during the peak hrs is 33% and during the night hrs is only 34%. All the efforts should be to minimize the consumption during the peak hrs and maximize it during the night hrs.

Night Concession:

Generally, the transfer of the fuels takes place during the day time only. It should be noted that GEB gives concession of Rs. 0.50 per unit consumed in excess of 1/3rd of the total units consumed during the night hrs (10 pm to 6 am).

Time of use charges:

It is also important to note that there is a provision in the GEB tariff that any consumption during the peak hrs(7 a.m. to 11 a.m.) & (5p.m. to 9 p.m.), GEB charges Rs 0.75 extra per unit. With the tax the implication comes to almost a rupee per unit extra. This additional burden can be reduced by educating the operating staff to avoid operations of the electric loads & pumps during peak hrs or slightly reschedule the operations such that consumption during such peak hrs is minimized.

The savings if the peak hrs consumption is reduced to just about 30 % by shifting pumping operations during non peak hrs/night hrs.

SAVING IN TIME OF USE CHARGES

NFST
Saving = 33% - 30 % = 3% of the average units consumed during peak hours
= Rs. 0.03 x 70422.67
= Rs. 2122.70 per month

Yearly Saving = Rs. 2122.70 x 12 = Rs. 25,472/-

Shifting any load from the peak hrs to the night hrs will give savings on those units as follows:

Saving due to peak hrs units consumption: 0.75 per unit
Saving due to shifting the load to night hrs: 0.50 per unit
Taxes on these units@ 60% duty & 4% ST: (0.75+0.50) x 1.64 = Rs 2.05/unit

FST
However, as our Contract Demand (HTP-1 Tariff) in FST is only 300 KVA, the time of use charges are not applicable(applicability is >= 500 KVA of contract demand)

The saving in present case will be only when the filling operations are shifted to the night hrs.

The saving on 37 KW pump will be as follows:

Assuming 100% load during the peak hours and 15% load as single truck loading, the savings could be as follows:

The present load during day hrs:

32.23*60*0.85+25.5*60*0.15 = 1643+230 = 1873 units per day

These units when shifted to night hrs will give benefit of 0.5 paise per unit
So the savings will be (including 60% duty & 4% sales tax)
Saving = 1873 * 0.5*1.64 = 1536 per day
= 1536 *300 = Rs. 460758 per year.

Assuming even 50% of the load during the night hrs,
it will give a saving of Rs. 2,30,000 per annum.

Savings: Rs. 2,30,000
Investment: Nil
Payback: Immediate

Hence, maximize the pump running during 11 am to 6 pm. and the truck/wagon loading can also be rescheduled accordingly. Of course, the best is to make use of the night hrs to almost save Rs. 1.5 per unit consumption. But there may be practical difficulties associated. However, all possible loads could be shifted to the night hrs.

Total Saving in Time of Use Charges and shifting the load to the night hours

Annual Saving = Rs. 230000 + 25472 = Rs. 2,55,472
Investment = Nil
Pay back = Immediate

As seen from the Graph of the Voltage Variation, the Voltage is varying between 420 to 465 volts. The lower limit of the voltage of 420 Volts was achieved by deliberately changing the transformer tap during the audit period to save energy.
Otherwise normally the Voltage remains on Higher side and varies between 450 to 465 volts.

The High Voltage has got several disadvantages which are listed below:-

THE ADVERSE EFFECT OF HIGH VOLTAGE:

Electrical equipments are designed for 230 volts (Single Phase) or 400 volts
(3 phase) and operate with optimum efficiency at the rated voltage. 90% of industrial load consists of motors. Electric motors draw considerably high current at high voltage, which increases energy consumption, MDI, and reduces power factor. These additional power losses of motors at high voltage results in frequent failure of motors.

At higher voltage, the power consumption in the lighting loads also increases and the rate of bulb, tube and chokes failure increases considerably.
The table below gives approximate quantitative advantage of a voltage stabilizer at various fluctuations levels:

Input voltage variation	% age reduction in breakdown possible	Approximate power saving possible due to stabilized voltage near rated value
380-420 Volts	No reduction in breakdown	No saving, no stabilizer required
380-440 Volts	Upto 20% reduction	Up to 5%
380-460 Volts	Up to 40% reduction	Up to 7%
380-480 Volts	Up to 60% reduction	Up to 10%

The unbalanced input voltage between phase to phase should be avoided. The unbalanced load will have the flowing adverse effect on three phase motors.

1. With 5% unbalanced input voltage between phase to phase, the load will be unbalanced and the capacity of the motor may reduce by 40%
2. Power consumption of the three phase motor will increase by 20-25%
3. To avoid the frequent tripping of the overload relays and to continue production, setting of the motor relay is kept at higher than the actual required. The motors (Particularly smaller motors up to 7.5 hp) can not withstand this high current for long time and inmost cases the motor burns out and this high current flows the relays, contactors and cables etc. resulting in higher losses and in some cases failure and fires.

   The best option for such units is to install servo voltage stabilizer with individual phase control. Ms. Jindal make stabilizers are quite sturdy and proven ones for such purpose.

   It is proposed to install a constant voltage stabilizer and maintain the voltage between 400 to 415 V only. This will give a good amount of saving in the power consumption of about 6%

   One for FST and another for NFST with each of 300 and 750 KVA.

   FST: 300 KVA: Rs 3,25,000/-
   NFST: 750 KVA: Rs. 5,75,000/-

   Savings: 0.06 x (52765*6.94 +217448* 7.39)*12 = Rs.1420653/- Per annum
   Investment: 900000/-
   Payback: 7.7 months

SPECIFIC POWER CONSUMPTION:

Since FST & NFST are only pumping stations there is no defined out put for the unit. The dispatches are also through the different modes like trucks, rakes and through the pipeline. All the receipts and dispatches are not in the hands of the unit but based on the marketing requirements. Hence it is not possible to establish any bench mark specific power consumption. However, the unit can make its own internal bench marks for filling the trucks, Railway rakes or transfer based on the time it takes to complete the filling per unit in minutes.

To evaluate if it is economical to combine the FST & NFST loads and become one consumer of GEB. And if so whether to draw an LT cable or a HT cable for combining the FST & NFST loads:

Clearly at the present demand of 300 KVA of FST and 1000 KVA of NFST when the actual max demand is 236 in FST and 526 in NFST totaling to 236+526 = 726. However the KVA peak may not occur at both the places at a time and considering the 90% cases of the combined peaks the KVA reduction could be 685 KVA. This does give advantage in KVA saving to he tune of 10% however this advantage may be countered by the removal of exemption of the time of use charges on FST (being less than 500 KVA) and the low slab of the demand charges on FST (Rs. 85 per KVA upto 500 KVA).

The advantage of the reduction in the contract demand for NFST will be available in any case even with out combining. It is proposed to reduce the contract demand for NFST to 640 (The maximum it ever touched in last 12 months) and add the expansion of 100 KVA of the water oil separator to 740 at 0.92 PF. As the power factor will be improved to 0.99 the KVA demand can be accordingly reduced to 749*0.92/0.99 = 687. We may keep the contract demand at 700. Of course with the application of VFD the Contract demand can be further lowered.

In case the FST & NFST are combined then the CD could be 700 + 250 = 950 KVA. Keeping 90% as the factor for combining we get 855 KVA say 850 KVA. However, at present since the load on FST is only 300 KVA, all the consumptions in FST is exempted from the time of use charges. More over the 300 KVA of FST and the first 500 KVA of the NFST falls in the lowest tariff bracket (Rs. 85 per KVA) in the demand charges. Besides there could be a strategic reason that the feeder from GEB to FST & NFST are separate and in case of any failure of one the other could be mobilized to take care of the strategic dispatches. By combining the economic loss will be:

	FST*	**NFST**	**Combined**	
Contract Demand in KVA	300	1000	**1300**	
85% of CD	255	850	**1105**	
Avg. Actual Demand	235	540	**792**	
Avg. Units Consumed	52765	217448	**270213**	
Time of Use	0	52817	**52817**	
Best PF achieved	0.932	0.917	**0.92**	
Bill/month	365986	1607158	**2243357**	
Total Bill / month(NFST + FST) = Rs. 2243357				

*** Since June 2001 when CD was reduced to 300 KVA**

The proposed new billing with reduced CD for NFST:

	FST*	**NFST**	**Total (fst+nfst)**	**Combined**
Contract Demand in KVA	300	700	**1000**	**850**
85% of CD	255	595	**1105**	**722**
Avg. Actual Demand	235	540	**792**	**761**
Avg. Units Consumed	52765	217448	**270213**	**270213**
Time of Use charges	0	52817	**52817**	**60798**
Best PF achieved	0.99	0.99	**0.99**	**0.99**
PF Rebate	8887	35208	**44095**	**44025**
Bill/month	350553	1473161	**1823714**	**1833289**

The saving by individual billing is **1833289 – 1823714 = Rs. 9575/- say 10,000 /month which is marginal and thus only reduction in the CD for NFST to 700 KVA is proposed and continue the operations as at present for the time being.**
The total savings due to demand reduction(excluding the Pf rebate) will be:

Saving : Rs. 1607158 – 1473161- 35208*1.64) = Rs. 76256 * 12 = Rs 915070/-
Investment: Nil
Payback Immediate

Thus, unless the load on FST is beyond 500 KVA, it is not attractive to combine the FST & NFST.

Thus, it can be seen that if at all one plans to go for combining the loads in future to get various advantages, a HT cable is economical to be laid.

FORE SHORE TERMINAL(FST)

As seen from Annexure III A, Maximum Actual Demand = 296 KVA

H.T. Cable loss:
HT current = KVA/(1.73* Volts), At 300 KVA load, = 16 A [300*1000/(1.73 * 11000)]
Considering the Short Circuit Current capacity requirement of 4 KA for 1 second,
50 mm^2 XLPE Armoured Aluminium cable has been selected. These will take care of all other safety factors to be taken for the cable selection purpose for the site condition and the site ambient condition, Underground laying and site soil condition.
Resistance of 50 mm^2 cable = 0.822 ohm/km
Length of the cable = 700 meter
HT Cable loss = $3 \times I^2 \times R \times L$
= $3 \times (16)^2 \times 0.822 \times 0.7$ = 4419 watts = 0.4419 KW

L.T. Cable loss:

At 300 KVA load,
LT Current = 394.11 A(300*1000/1.73 * 440) = say 400 A

The requirement for the 400 A capacity is 4cables of 185 mm^2
Resistance = 0.164 ohm /km
Length = 700 meter

Cable loss = $3 \times I^2 \times R \times L$
= $3 \times (100)^2 \times 0.164 \times 0.7$
=3444 watts/cable = 3.444 KW/cable

Total LT Cable loss = 4 x 3.444
= 13.776 KW.
Now, If the LT Cable is installed, then the Transformer will be isolated from the load.
Hence, the Transformer loss will be zero.

The Actual LT cable loss = 13.776 – 3.12 = 10.65 KW

The reduction in the CD for NFST will give the following savings:

Savings: Rs. 2243357 - . 1823714 = Rs. 419643/-
Investment: Nil
Payback: Immediate

A) PERFORMANCE EVALUATION OF MAJOR UTILITIES AND PROCESS EQUIPMENTS :

ELECTRICAL MOTOR READINGS

The observed electrical loads on the panels are given in Annexure VI respectively for FST & NFST.

1. Electrical Distribution Networks:

Transformers: Performance evaluation through simultaneous measurements of major electrical parameters on H.T. & L.T. side and rationalization of transformers, if needed.

Transformers are used for stepping down the voltage from 11,000 volts to 433 volts as per requirement of process in both the Plants. Power demand is about 525.5 KVA (NFST) and @ 219.67 KVA (FST), & contract demand is 1000 KVA (NFST) and 300 KVA(FST). To cater this demand Two transformer are installed out of which One of the Two is Stand by and the other is isolated from the load in both FST & NFST. Load variation on Transformer is very high during 24 hrs.

The Details of the Transformers are given in Annexure VII

The Electrical load on the Transformers was measured and is given in Annexure VIII.

From the readings it can be seen that there is slight imbalance in the loading The R phase is loaded by 30% more than the B phase.

Similarly, during the testing of only lighting load in the NFST, it can be seen That the office lighting is having load imbalance as well as the total lighting load is also not balanced.

The single phase loads may please be checked and action taken to balance out the loads.

There is also another Lighting Transformer that is used in order to give right Voltage for the High Mast Lighting Towers that are at quite a far distance. During the audit period it was noticed that the tap position of the Transformer was at No. 3 and as per the Transformer details it was found that the Transformer at Tap No. 3 would give Primary and Secondary both sides 433 volts. There is no need for such a Transformer as its unnecessarily consuming Power and increasing the losses.

It is recommended to by pass the Transformer and it can be observed that there is no change in the Lighting effect and the High Mast Towers are working properly even when the Transformer is not connected to the load. So, the losses of the Transformer would be saved. The no load and load loss in this transformer were not available. Hence it is not possible to quantify the losses.

The details of this transformer were not available but with installation of the Jindal make voltage stabilizer the saving in the lighting loads due to the reduced voltage will also be taken care of. After installation of the constant voltage transformer the existing transformer may be auctioned and disposed off.

Transformer Losses for NFST:

$$\text{KVA load at maximum } \eta = \left(\frac{\text{Iron loss}}{\text{Cu loss}}\right)^{1/2} \times \text{Full load KVA}$$

$$= \left(\frac{1.26}{7.68}\right)^{1/2} \times 750$$

$$= 303.78 \text{ KVA}$$

The Transformer will be at its best efficiency if it is working @ 305 KVA load.

Transformer No. 1

$$\text{The Transformer losses (TR 1)} = \text{No load loss} + \left(\frac{\text{Ave. KVA loading}}{\text{Rated KVA loading}}\right)^2 \times \text{Full load loss}$$

$$= 1.26 + \left(\frac{525.5}{750}\right)^2 \times 7.68$$

$$= 5.03 \text{ KW}$$

Transformer No. 2

$$\text{The Transformer losses (TR 2)} = \text{No load loss} + \left(\frac{\text{Ave. KVA loading}}{\text{Rated KVA loading}}\right)^2 \times \text{Full load loss}$$

$$= 1.32 + \left(\frac{525.5}{750}\right)^2 \times 7.62$$

= 5.06 KW

Both the transformers are kept on though they are not run in parallel. The electrical system is such that only one transformer can run at a time only. It is proposed to totally isolate the stand by transformer and run it on scheduled weekly changeover basis only. It is important to keep the dielectric of the oil being checked regularly and the breather valve silica gel also to be routinely replaced. This will give savings in the no load losses as follows:

NFST: core losses (No LOAD LOSS = 1.32 KW)

Savings: 1.32*24*365*6.87 = Rs.79,440/annum
Investment: Nil
Payback: Immediately

The Voltage at the Fore Shore Terminal were observed to be High and a Trial was conducted by checking the saving by reducing the voltage by tap changing on the transformer.

The Tap position of Transformer –II was changed from Tap No.3 to Tap No. 1 during the audit period with the co-operation from the engineers and technicians of the organization.

After the Tap position was changed the following results were obtained :-

Results of the Tap Changing on Transformer II at FST , IOC, Kandla

The trial was conducted with co-operation from engineers and technicians

Date	Time		Tap Position	Meter Reading	Voltage
	From	To		KW	
	1:00 a.m.	8:00 a.m.			
22/01/02			Tap No. 3	736	460
23/01/02			Tap No. 1	668	425

Saving in KW = 736 – 668 = 68 KW in 7 Hours

Saving in KWH /Hr. = 9.71
% saving is = 9.23 %

Taking 12 hrs a day of lighting load and 365 days a year with unit rate (Dec'01) at Rs 6.87 per unit, we get total annual saving in lighting load alone as :

Annual Saving in lighting load = 9.71 x 12 x 365 x 6.87 = Rs. 2,92,180/- per annum.
Investment : Nil
Payback: Immediate

CHECK LIST FOR TRANSFORMER:

- Switch off idle transformers in cyclic rotation on the primary side. If need be self-heating tapes may be used to maintain the oil temperature within reasonable limits.
- Switch off transformers and re-adjust the load on holidays and during power cuts.
- Select and use transformers having less loss.
- Provide necessary circuit breakers and disconnects to the transformers and adopt split bus system in substations to allow flexibility of operation.
- Monitor the tap positions of distribution transformers on a seasonal monthly basis and re adjusts the same as and when required.
- Select power transformers with OLTC and auto control.

Power Factor: Measurement of distortion & displacement power factor at various points viz. PCC,MCC, load centers etc. and analysis of the same for optimizing the network losses.

Average Power Factor and methods to improve power factor.

The present average power factor of the company over the last year is 0.917(NFST) & 0.948(FST).

NFST

There are 300KVAR of capacitor installed in order to bring the PF up. Out of these 300 KVAR capacitors, only 50 KVAR were connected to the load and the other 200 KVAR are out of order and other 50 KVAR were kept isolated.

FST

There are 300 KVAR of capacitor installed in order to bring PF up. Out of these 300 KVAR capacitors , only 50 KVAR were connected to the load and 150 KVAR capacitors were found to be Out of order and the other 100 KVAR were kept OFF.

The APFC Panel is installed in both FST and NFST but not working properly and so the PF is maintained manually by keeping the Capacitor ON.

It is important to check the current of the capacitors against their rated and determine the performance of the capacitor. The fused capacitors should be replaced.

The Details regarding the proper selection of the Capacitor of low
KW loss / KVAr as well as the other advantages are given in Annexure IX.

The Details of the Capacitors is given in Annexure X.

It is generally observed that power capacitors are installed to improve the power factor with out regard to the harmonics. It must be understood that Pf is a combination of the distortion in the wave form of voltage and current and displacement in the phase angle between voltage and the current. Thus it is recommended to carry out a detailed harmonics study of the system and accordingly take the corrective action by suitably installing harmonics filters others there could be enhanced losses and malfunctioning of electronic circuitry.

The Measurement of the Capacitor is given in Annexure XI.

Calculation Of Economic Feasibility of Capacitors:

	FST	**NFST**
Maximum Registered Demand	296	540
Present Power Factor	0.948	0.917
The load in KW = KVA x Pf	280.6	495.18
Proposed Pf	0.99	0.99
Estimated MD with Pf at 0.99 = (Load in	283.43	500.18

KW) / (0.99) KVA		
Reduction in MD = (1)-(5) KVA =	12.57	39.82
Saving in Demand charges :	= Rs. 85 x 12.57 = Rs. 1,070/month = Rs. 1070 x 12 x 1.24 = Rs. 15,922 per year	= Rs.120 x 40 = Rs. 4,800 /month = Rs. 4800x 12 x 1.24 = Rs. 71,424 per year
Extra capacitor required to improve PF to 0.99	= 280.6 x 0.22 = 61.73 KVAr	= 495.18 x 0.31 = 153.5 KVAr

Saving = Rs. 15922 + 71424
= Rs. 87,346 per year

Considering Cost of Capacitor is Rs. 330 per KVAr
Investment of installing Capacitor = Rs. (60 + 155) x 330 = 215 * 330
= Rs. 70,950/-

The Saving will be further increased because of the PF Rebate available due to improvement in PF above 0.95.

PF Rebate

There is a rebate of 1% is available on every 1% improvement in power factor above 95%. By proper attendance to the Automatic Power Factor Control Panel power factor should be improved to 0.99. The investment for this would be negligible. There shall be reduction in KVA demand by 52.4 KVA. Rebate of Rs. 36,565.5(NFST) and Rs. 8,912 (FST) per month should be availed on account of power factor improvement rebate.

Yearly Rebate = Rs. (36565.5 + 8912) x 12 x 1.24
=Rs. 6,76,705.2 per year
Total Saving if PF is improved to 0.99

Total Saving = Rs. 87346 + 676705.2 = Rs. 764051.2 per year
Total Investment = Rs. 2,00,000/-(Considering APFC at FST & NFST)
Payback Period = (200000/676705.2) x 12 = 4 months

While selecting the capacitor ensure watts / kvar are as low as possible. Now polypropylene capacitor have very low loss at 0.2 – 0.3 watts per KVAR compared Paper capacitors which have around 2 to 4 and mix dielectric which have around 0.5 to 1.0 watts per KVAR.

While procuring any new capacitors following specifications should be specified:

Capacitor Type : Oil filled Mix di electric type
Losses: not more than 0.2 watts per KVAr with test certificate
Body: MS painted
Guarantee : Min 30 months with out fall in KVAr value

Comparison of different types of Capacitors with oil filled mixed dielectric Capacitors is given in Annexure IX.

Some of the Capacitors were found to be FUSED OFF and some of them were not working properly. Due to proximity t the sea and the harsh quality of the power the ordinary capacitors will not last long and hence we strongly recommend the following specification for the capacitors:

There are certain Capacitors that are kept OFF due to the manual working of the APFC Panel. The problem in the APFC Panel should be located and the control of Capacitors should be made Automatic as per the requirement.

Recently, the APFCR available is a micro-controller based PF correction relay, which controls four to sixteen capacitor banks for automatic correction of PF.
This APFC senses the PF of any one phase. The signal processing circuit is fully isolated and has harmonic filters. This ensures smooth operation of relay under severe harmonic generating loads. The relay employs the standard first-in-first out switching sequence to ensure that all banks are utilised equally. This, along with the in built switching time delay, enhances capacitor life.

The load remains greatly varied due to working of the Pumps only for some time and hence, it would be very difficult to make the Capacitors work manually. The APFC Panel which is already installed should be kept on AUTO in order to maintain the PF close to unity. Or new microprocessor based APFC should be installed to regulate the PF around 0.99.

The recent development by TRINITY ENGINEERING, dealt by Syguru Technology Services, 820 Siddharth Complex, Baroda 390 007, make APFCR available is a microprocessor controller based PF correction relay, which controls four to sixteen capacitor banks for automatic correction of PF. This APFC senses the PF of any one phase. The signal processing circuit is fully isolated and has harmonic filters. This ensures smooth operation of relay under severe harmonic generating loads. The relay employs the standard first-in-first out switching sequence to ensure that all banks are utilised equally. This, along with the in built switching time delay, enhances capacitor life.

Metering and monitoring Status

Review of existing meters for adequate monitoring requirements is given in Annexure XII

Besides the GEB meter are there bus wise meter. Many of the meters are not working and there is no schedule of calibrating the meters. It is recommended that all the meters should be calibrated regularly and for all the pumps there should be hrs meters and KW meters as well so that proper control on their performances can be established.

The hand held MECO 4500 type Power Clamp on meter should be used so that walk through audits are conducted periodically and actual pf, KW etc are measured.

There were several KW and Ammeter, pressure gauges which were not working properly. The meters give the actual consumption & quality of a particular utility and they should be regularly maintained and periodically calibrated.

It is important to install energy management meters like DIRIS Ap of HPL SOCO MEC or SPV-r from MECO Instruments which give all the parameter and are very rugged and accurate.

It was also observed that the differential pressure meters in most of the filters were out of order. This is not only a loss but also a source of system inefficiency. More the pressure drop across the filter more will be the power consumption. Hence timely cleaning of the filter elements is important. For this, special differential pressure gauges as per the specifications given in the Appendix I are to be procured.

There are good power management meters available. The meters from MECO SPVR or the SOCOMEC make DIRIS Ap**,** and the electronic energy meters from SOCOMEC dealt by Syguru Technology Services, 820 Siddharth Complex, Baroda 390 007, Telefax 0265 325034.

2. Electrical Equipment: Measurements of all major electrical parameters viz. voltage, current, power factor, KW, frequency etc. of important equipments (motors, furnaces, electrolysis, lighting etc.) with significant energy consumption.

Electrical motors:

The Details of the various motors is given in Annexure XIII.

Actual measurements of electrical load was taken using hand held Power Meter. The meter gives instantaneous readings of KW, PF, Freq, V , I.

The Actual Measurement of the certain Electrical motors were taken and the Consumption of these motors is given in Annexure XIV.

The induction motors have very good efficiency at full load full load current and even at half loads.

Energy Efficient Motors:

The plant is having large number of electric motors as follows:

Most of the motors are high efficiency and this trend should be maintained for all the future motor procurements.

The motors procured in future must have high efficiency specially those which are running continuously. The high efficiency motors one pays more cost of 20 to 50% but pay backs are good. The main feature of the high efficiency motors are :

More copper in the stator and rotor to reduce the copper losses
Improved Quality of Stamping to reduce iron losses.
Improved design of fan & ventilation circuit
Improved electromagnetic design & manufacturing methods to reduce stray losses

Bureau of Indian standards (BIS) has brought out IS 12615 : 1990 on energy efficient motors.

Table given in the Annexure XV gives the performance data, these values are quite low and standard motors of many manufacturers surpass these values.

HARMONICS

The Harmonics measurement is given in Annexure XVI

The Harmonics were measured at the LT Main of the both the Terminals.
The Harmonics were found to be varying between 1.63 to 3.72 in the Voltage side and it was found to be varying between 10.87 to 18.75 in the Current side.

Harmonics reflect the distortion of the wave form and detoriate the quality of the power and all tube light chokes. Harmonics represent the distortion in the wave form. This leads to increased transmission losses, increased transformer heating, excessive motor heating, random fuse blowing etc. The harmonics can be filtered through proper selection of the filters.

The Influence of Harmonics is given in Annexure XVII

3. C.P.P./D.G. Sets : Review of performance including major auxiliaries and suggestions for optimization.

The Details of the D.G. Sets is given in Annexure XVIII

PERFORMANCE OF DG SETS

DG sets are installed to operate only during power cut or power failure, as they are not design to work as base generating sets.

During the audit period, it was made possible to run the DG Set No. 1 of NFST for about 30 minutes and the decrease in the fuel level was measured in order to observe the fuel consumption. The total load on these DG Set was measured with the help of hand held MECO 4500 Power Clamp meter.

The measurement taken at the DG Set is given in Annexure XIX

From the Annexure XIX it is noted:

Total load on the DG Set = 150 KW
Total HSD consumption = 25 litres
Time for which DG was run = 30 minutes
Cost of 1 litre of HSD = Rs. 20

The load for 1 hour = 150 KW
Total HSD consumption for 1 hour = 50 litres

Specific Consumption of the D.G. Set = 150 / 50
= 3.0 KWH/litre

Hence, fuel cost per unit in the DG set running is = Rs. 6.66 per unit

The fuel consumption in the DG set is high compared to efficient DG sets. The bench mark figure of 3.5 units per Liter of HSD is possible.

PROPOSED SYSTEM TO REDUCE POWER COST IN D.G. SETS

The efficiency of the DG Set can be improved by 5 % by installation of the FLUX maxiox.

The Fire hydrant pumps which are run with the help of the sets which are consuming HSD would also give about 5% more efficiency by the installation of these unique fuel efficiency improving products like Maxiox. The concept and working about the Maxiox is given in annexure XX. The Maxiox is to be installed on the fuel line just before the fuel injection point.

Assuming about 2000 hrs of annual working the saving will be

Saving: 0.06*2000*50*20 = 120000/-
Investment: 70000/-
Payback: 7 months

PROPOSAL FOR OWN CAPTIVE POWER PLANT:

Since the GEB rates are very high and IOC has its own fuel, it is proposed to install CPP of 1000 KVA DG sets. Now a days, there are DG sets based on the FO/GAS (which is the cheapest fuel available).The present GEB tariff is very high around Rs.7 per unit. The total load in the complex is about 800 KVA. It is proposed to install a FO/ GAS based DG generator which are very energy efficient. They will give a power cost of about Rs. 3.5 per unit.

The savings will be Rs 7 – Rs. 3.5 = Rs 3.5 per unit
Total units in a month (52765+217448 = 270213 units per month)
Savings per Year = Rs. 270213*12*3.5 = 1,13,48,946/-
Taking investment at Rs 3 Crore per MVA for 1000 KVA DG set.

Savings: Rs.1,13,48,946/-
Investment: Rs. 3,00,00,000/-
Payback: 31 months

Check List for efficient working of DG sets

Drain water and sediment form fuel tank and fuel filter through drain cock.

- Check for fuel, oil , water and exhaust leaks.
- Check engine oil and top-up if necessary.
- Fill radiator/surge tank with treated water.
- Check air cleaner oil level and charge oil if required.
- Check airline connected for leaks.
- Remove and clean air compressor breather, if equipped.
- Drain air receiver tank at the beginning of D.G. set.
- Clean crankcase.
- Check oil level in hydraulic governor, if provided.
- Keep the diesel tank full. Do not run the D.G. set without diesel.
- Check the diesel quality. Do not use moisture content diesel.
- Maintain humidity of D.G. sets as per design to save alternator.
- Operate D.G. set at required RPM based on required load.
- Do not operate D.G. set under load.

4. Pumps: Measurement of Head/Pressure, Flow, Power of pumps. Determination of pump efficiencies based on measured parameters and critical study of piping/ducting/valve/damper pressure losses, system layout etc.

There are 13 Pumps in the Fore Shore Terminal and 10 Pumps in the New Fore Shore Terminal.

The Details of the Pumps is given in Annexure XIV.

It was found that the Pump No. FST No. 11 was in operation during the audit period and the time for filling of the 12 KL capacity of tankers was found to be 15 minutes. When there were 5 tankers to be filled then also it took 15 minutes and when only 1 tanker filling was done then also the time taken was 15 minutes.

The flow and the pressure was maintained by BYPASSING of the Pump.
When the tanker was about to be filled then the throttling was done to about more then 50 % in order to control the flow.

All the Pumps are By passed to reduce the back pressure.

There is great amount of energy loss when there is only 1 truck filling and BYPASS valves are opened to a great extent in order to maintain pressure.

Also, the peak kick load was found to go beyond 1000 Ampere of Current i.e. consumption of a great amount of Power but by the installation of Variable Frequency Drive, all such problems can be avoided.

It is advised to put vector controlled VFD (Variable Frequency Drive) for maintaining line pressure in order to save energy and avoid the re-circulation of the product and as a result there will be temperature gain which increases the product loss as well.

It will not only reduce the peak kick load due to soft start but also save power due to loading proportionate to the load in closed loop.

At Pump No. 11 (FST)

Rated KW = 37 KW
KW consumed when 1 truck filling = 25.5 KW
KW consumed when 5 truck filling = 32.31 KW
Kick load = Above 100 A
Rated Flow = 48000 LPM
Head = 32 m
When the Pump was Shut off then 4 turns of the BY PASS valve were opened and when only 1 truck was to be filled then the BY PASS valve was opened about
3 to 3.5 turns.

The following observations were made during the working of these Pump

Time	Condition	Pressure in psi	Current in Ampere
1:00	1 truck filling	45-50	46
1:17	5 truck filling	25-30	49
1:25	5 truck filling	30-35	57
1:27	5 truck filling	35-40	56
1:28	5 truck filling	30-35	56
1:29	5 truck filling	30	53.3
1:32	5 truck filling	28	50

As can be seen from the above table the By pass valve is opened more than 30 to 40% when there is only 1 truck being filled. Moreover, the valve at the truck end is also being throttled. We estimate enough savings to the tune of about 50% under such circumstances.

Saving by installation of VFD = 50% of KW consumed
= 0.5 x 32.31
= 16.16 KW
Considering 8 hours of working of pump

Annual Saving = Rs. 16.16 x 8 x 300 x 6.94 = Rs. 2,69,160/- per year
Investment = Rs. 2,50,000
Payback period = 11 months.

While installing a VFD the important specifications should be used to call for the quotations as given as below:

SPECIFICATIONS FOR VFD FOR AC DRIVE
HAVING,

- Free Standing IP 41 panel Coated with Rust Grip
- Remote Station For Operator
- Inbuilt PID Controller & Inbuilt Timer for Pattern and Traverse Run Applications
- Input RFI Filter/Input Choke
- Output SINUS Filter

Advantages of SINUS Filter :

(1) Motor can be at any distance from the AC drive
(2) No insulation failures because of high frequency switching of IGBT PWM converter
(3) Reduced motor peak voltage
(4) Near sinusoidal wave form
(5) Motor current and voltage harmonics within acceptable limits.
(6) Extended motor life
(7) Eliminate motor repetitive voltage stress failures
(8) Improvement inefficiency of motor
(9) Eliminate long lead motor over voltage problem
Reduced motor temperature by reducing harmonics

Savings due to group filling of trucks:

It is interesting to note that the truck loading whether single or in group take the same time (15 minutes) however the power consumption varies greatly. From Annexure VI we find that the actual load on the pump motor is as follows:
One truck filling : 25.5 KW per truck
Five truck Filling :32.23 KW for 5 trucks (6.5 KW per Truck)

Obviously from the above it is clear that IOC will be able to save when there are maximum truck filling taking place at a time. The truck operators and the marketing department should inform the buyers and release the trucks such that they save maximum power in filling.

From The above the filling time observed was about 15 minutes per truck or set of 5 trucks. There is practically no difference in the filling time. But the power consumption is increasing from 25.5 KW for 1 truck filling to 32.23 KW for 5 trucks filling.

Energy saved per truck when group filling is done:

25.5 – 6.5 = 19 KW per truck.
At the present rate of Rs 7 per unit it comes to 19 x 7 = Rs 133 per truck

Thus, IOC should set a system to take up group filing
Encourage the truck drivers to come during non peak hrs, specially during the night time operations.

Taking average load as 60 trucks per day and taking 15% occasions when single trucks are filled. The saving will be as follows: 60*300*0.25*133 = Rs. 359100 per annum

Savings: Rs. 3,59,100/- per annum
Investment: Nil
Payback: Immediate

Lighting : Measurements of light intensity and all major electrical parameters viz voltage, ampere, power factor, kW, etc. Study of type of lamps used, type of chokes used, day and night time lighting etc.

The Details of the Lighting load is given in Annexure XXI.

Lighting make

40 watt choke = 40 nos. – Bajaj Make /Philips make
Tube Rod = 110 Nos. – Anchor make /Bajaj make /Mysore make

Lamp = 18 nos.= 60 W – Bajaj make
= 6 nos. = 40 W } Installed = 4+ 1 Hand Lamp + Test Lamp

400 W choke = 6 nos. – Bajaj make = 390 (installed)
Lamp = 6 nos. – Bajaj make

125 W lamp – 12 nos. Ceema make
Choke = 6 nos. Bajaj make

125 W lamp = 12 nos. Ceema make = 614 (Installed)
Choke = 6 nos – Bajaj make

160 W, Simple chokeless,

Mercury Vapour Lamp = 70 nos.= 52 (installed)

The High Mast Lighting Towers working is done with the help of Timer setting switch.

Instead, it is recommended to install Photo Cell Device which works on the light intensity and makes the circuit ON & OFF depending on the intensity of light setting.

Saving by installation of AUTO PHOTO CELL Device:

The High Mast Lighting Towers working is done with the help of Timer setting switch. In such type of system the lights are switched ON much earlier and switched OFF much later than it is necessary. It means wastage of Power.

Instead, it is recommended to install AUTO PHOTOCELL Control Device, the automatic light control switch, which employs a photo sensor to control the switch, automatically, pre adjusted to a desired intensity of natural light available at sun rise or sunset times. The lights are switched ON or OFF whichever the case may be. It means the optimizing the light availability and saving in Power.

SPECIFICATIONS of AUTO PHOTO-CELL Switch

Input main supply : 415 $\pm$ 15%, 50 Hz
Output: relay 5A/ML-4
Load: 63A
Sensitivity adjustment: Provided
Timer: Optional
By pass: Provided
On & Off Delay: Provided
Consumption: 1.5KW
Enclosure: MS (Waterproof)
Size: 460x300x120 mm

The installation of AUTO PHOTO is likely to give 30 min savings in lighting load per day.

Saving = (132/2) x 365 x 3.8 x 1.24 = Rs. 1,13,512
Investment = (4 x 6000) = 24,000
Payback = 2.5 months

LIGHTING

The performance characteristics of florescent lamp depends on the characteristic of Ballast equipment . The typical of this is the effect of variation from the rated line voltage on the condition of lamp operation. In the magnetic ballast the energy loss increases with the increase of voltage and the power loss varies from 35watts at 200 volts to 70 watts at 270 volts. There are number of manufacturers of Electronics Ballasts available in the market. Following aspects are to be looked into for deciding the type of the Electronic Ballasts to be used:

1. ISI mark for performance and safety.
2. Low Harmonics Distortion – Harmonics leads to reduction in the power factor which increases the KVA demand to be paid to SEB. This also affects the performance of other electronic instruments and leads to burning of Capacitors and heating of transformers.
3. High quality of light output with respect to the fluctuations in the power supply voltage from 140-275. This makes the user feel more comfortable and helps to enhance the productivity
4. Stroboscopic Effect – The stroboscopic effect has a negative effect and in extreme cases it can result into headache and discomfort. Continuous working in the stroboscopic light is not conducive to our eyes which the nature has made for natural sun light.
5. Power Factor – Look for high power factor other wise you may buy a cheaper ballast with low power factor and pay additionally in installing the Capacitor banks to improve the power factor to avoid penalty and reduce the cable losses.
6. Lamp life and Warranty – Look for longer guarantee and better lamp life. It happens that you buy a cheaper ballast and end up paying heavily by way of frequent tube replacements.
7. Voltage Variation – The Power consumption with metallic ballasts varies from 35watts to 70 watts with voltage variation from 200 to 260 Volts, whereas in the non ISI mark electronic ballast power consumption varies from 28 to 40 watts. In the case of ISI marked Electronic ballasts the power consumption is 35 watts from 140 to 275 volts.

Comparison by Actual Measurements

TWIN TUBE LIGHT FIXTURE			SINGLE TUBE LIGHT FIXTURE	
	Magnetic choke (Philips make)	**Intelux electronic ballast**	Magnetic choke (Philips make)	**Intelux electronic ballast**
Voltage	247.4	244	240.2	240.2
Watt	108.1	66.7	50.6	35
V.A	196.1	66.7	94.9	35
VAR	165	000	79.5	000
P F	0.546	**0.993**	0.527	**0.995**
I RMS	0.79 Amp	0.27 Amp	0.39Amp	0.15Amp
Hz	48.46	48.02	49.48	49.48
Total Harmonics Distortion %	13.92 %	**7.4 %**	10%	**6.5%**

FEATURES COMPARISON–ELECRONIC & MAGNTIC BALLASTS – 1 X 36 W FTL lamp

Sr. No.	MAGNETIC BALLAST	OTHER ELECTRONIC BALLAST	INTELUX ELECTRONIC BALLAST
1	Some are with ISI mark	None with ISI mark Not confirming to Nati9onal & international Standards.	ISI marking as per ISI13021 (Part 1) Also tested as per IEC other international standards
2	**Supply voltage fluctuation performance** a) 180v to 270v operation but i) light output is varying ii) power consumption is varying power consumption at 1) 200 V is 30=35 watts 2) 240V is 55 watts 3) 260 V is 70 watts	**Supply voltage fluctuation performance** a) light output varies. b) power consumption is not constant, so reduction in electricity bill is not guaranteed . 1) 180 V is 28 watts 2) 240 V is 35 watts 3) 260 V is 40 watts	**Supply voltage fluctuation performance** a) light output is constant in the range of 145 V to 280V b) power consumption is constant so reduction in electricity bill is guaranteed between 35 to 50% power consumption is 35W from 140 V to 275V for F.T.L. i) 200 V is 35 watts ii) 240 V is 35 watts iii) 260 V is 35 watts
3	Flickers continuously(80%) stroboscopic effect exists, Causes Eye Strain.	light flickers, stroboscopic effect is present an it gives eyestrain, headache, etc.	Instant start, flicker- free light(2%) No stroboscopic effect. Does not cause Eye strain
4	**Lamp life** a) tube light current crest factor > 1.5 b) tube light current variable (0.45A). c) tube light is not isolated from input supply All tje above factors decrease the lamp life.	**Lamp life** a) tube light current crest factor>2.0 b) tube light current variable (0.35A) c) Tube light is not isolated from input supply All the above factors decrease the lamp life.	**Lamp life** a) tube light current crest factor <1.45 b) tube light current is constant(0.32A) c) tube light is isolated from input supply variation all the above factors increase the lamp life.
5	No EMI & RFI	EM/RFI is not fully protected.	No EMI/RFI
6	Low power factor <0.50 Hence VA load is much more.	Power factor is 0.8 to 0.93 Hence VA load is still more.	High power factor is 0.995 Hence reduces the VA load.
7	Warrantee 6 months to 1 year common.	warrantee 6 months 1 year common.	highly reliable 3 years warrantee. Estimated life > 4000 hours
8	Total harmonic distortion > 12%	total harmonic distortion > 30% Reduces the life of supply transformers & heat load on the internal wiring.	total harmonic distortion > 10% which increase the life of supply transformers Meets IEE 555-2
9	Single lamp operation only	only series operation available	parallel operation (even if one lamp fails other will not be

			effected)
10	Starter & capacitor are required Hence additional weight.	No starter, No capacitor. Lighter in weight	No starter, No capacitor. Lighter in weight
11	Ballast for max. 1 tube light available	ballast for max.2 tube light available	ballast for 6 tube lights available

The measured LUX values at various locations is given in Annexure XXII.

The Recommended LUX values is given in Annexure XXIII.

Calculation Sheet for Saving of Power with Intelux Ballasts

Sr. No.	Type of fixtures	No.	Hours/day	Days/yr.	Power Saving/fixture in watts	Annual Saving (units)	Rs. / unit	Annual Saving in Rs.	Remarks
		A	B	C	D	AxBxCxD	F	G	
1	Twin Tubes	75	12	300	40.7	10989 KWH	7.16	78681.24	
2	Single Tubes	35	12	300	21.0	2646 KWH	7.16	18945.36	

As seen from the above table

Saving = Rs. 78681.24 + 18945.36 = Rs. 97,626.6

Investment:
For single tube light = 900 x 35 = Rs. 31500/-
For Twin tube light = 1150 x 75 = Rs. 86,250

Total Investment = Rs. 31500 + 86250 = Rs. 117750/-

Payback period = (97626.6/117750) x 12 = 14 months

TANKS & PIPING

There are 25 Tanks and there are 4 valve for each Tank. 2 valves for inlet and 2 valves for outlet. There is a Hammer blind between two valves. There are motorised valves which are used in NFST. The details of the Motorised valves is given below:-

BEACON ROTORK CONTROLS LTD., MADRAS 600 098
415 v, 50 Hz. , 3 phase,

KW	1.2	1.6	2.5	3.7	4.8	7,5	Total
SPEED	48/36	24	24		48		
AVG AMP	3.1		9		15		
MIN	15	15	15		15		
LOCKRD ROTOR	/25.	30	60		104		
Torque setting Nm		610	610		1017		
Nos.	6	88	97	27	3	6	227

There are several Petroleum products which are transferred with the help of pipe lines.
The fluid temperature must not go high in order to maintain its original properties.
These products are highly volatile and can easily vapourise when exposed to the Sun rays directly.

The Industrial Product "SUPERTHERM" is a highly reflective and insulative coating approved by NASA lab USA for their space shuttle programme. Water based easy to apply like a paint.

Th**e** details of **"SUPERTHERM"** is given in Annexure XXIV **.**

Since the atmosphere in Kandla is quite corrosive, it is also proposed to first give a coat of rust grip as an anti rust and then apply the supertherm on it. This will not only enhance the life of the tanks, piping and pumping system but also save the evaporation losses in the system. The details on **Rust Grip** are given in Annexure XXV.

The coating of Supertherm on the petroleum storage tanks will not only reduce the evaporation losses but will also enhance the life of the tanks and reduce the frequency of the painting.

In such corrosive near sea saline conditions it is important to note that anti rust paint together with the application of the Supertherm will do wonders to the savings and improved maintenance in the refinery.

There are several pipes, which are filled with scale, and dust formation layer is formed from the inside. Hence, the inside diameter of the pipe is decreased to a great extent and it resists the flow of the material. As a result of which the back pressure increases and the Electrical consumption also increases.

In order to overcome the above difficulty the best solution is to install FLUX maxguard, a unique device capable of protecting the piping system perfectly by using the concept high magnetic flux creating the cathodic protection in the piping network. Details about the device are given in Annexure XXVI.

AUTOMATED ELECTRONIC FLOW METERING & FILLING OF TRUCKS & RAILWAY WAGONS:

Like the above pump all the pumps will give a lot of saving due to the Peculiar way & Methodology of the loading the trucks where a lot of valve throttling is involved specially for last 5 minutes when the truck is coming close to the final point of filling. During such times the valve is kept in most throttled stage and a person keeps taking the dip continuously from the trucks.

Now there are electronic pre set metering systems available to set the quantity of fuel desired in a vessel. There is a ramp-up stage, peak delivery and ramp-down phase in a filling operation. There are many advantages like:

1. Energy Saving
2. Improved productivity
3. No pilferage
4. On line accounting
5. Accurate measurement of product (calculated @ 15'C)
6. Reduced waiting period for the customer
7. More customer satisfaction
8. Time saving & Quicker operations
9. Improved records keepings
10. Improved quality of work
11. Reduced demurrage
12. Improved product security
13. Reduced Manpower
14. Enhanced safety

Once the defined quantity is set the valve will stop after the calibrated quantity has passed through the meter. This will not only expedite the filling operations but also reduce the manual errors and save a lot of time and energy. As the speed of filling picks, it may be better to re-schedule all the filling and transfer operations such that the maximum advantage of avoiding the peak time for the time of use charges can be avoided and night time filling can be taken up to avail the night time consumption concession.

Investment: Rs. 60.51 Lakhs

The savings are many but have not been quantified as it calls for a detailed study. The brochure and offer of the party is enclosed for further discussions. See appendix II.