

Issue # EE 08:

Name: G.PANDIAN
Designation: Engineering Officer
Company name: Central Power Research Institute
Complete postal address: Energy Research Centre
P.B.No. 3506, Sreekrishna Nagar, Sreekariyam,
Thiruvananthapuram – 695 017
Fax no: 0471 - 599687
Email ID : agpandian@hotmail.com
User ID: agpandian



What is reactive power and under which circumstances may power factor corrections reduce electricity consumption in a plant, or reduce electricity costs only, or reduce both electricity costs and electricity consumption."

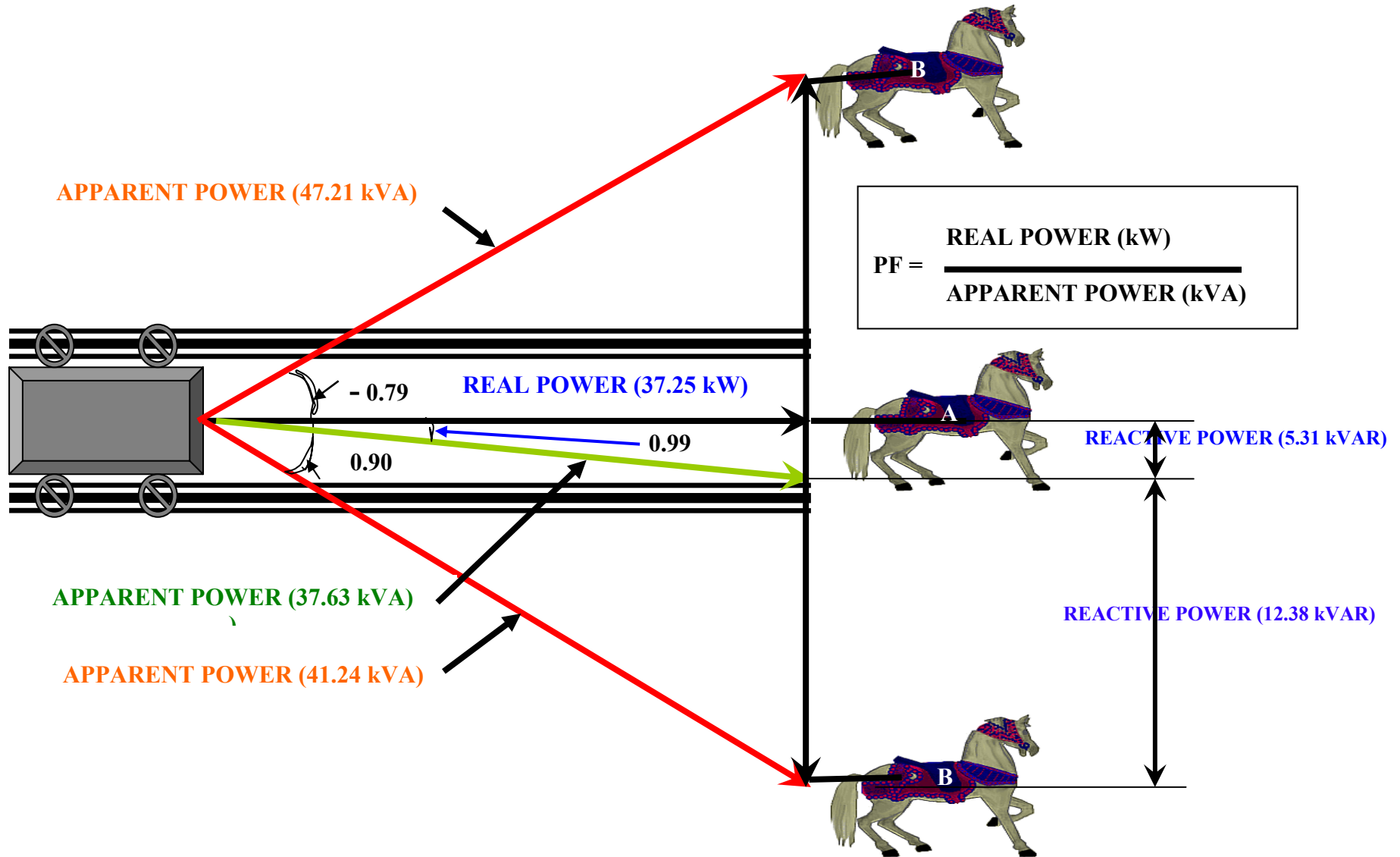
- i. **Working power:** “Active power” or “True power” or “Real power” used in all electrical components to perform the work of heating, lighting, motion, etc. This is expressed in kW or kilowatts.
- ii. **Reactive power:** This is a non working power and it is used to generate and sustain a magnetic field in order to operate an inductive load, like a motor, compressor, ballast, etc. It is measured in kVAR’s or kilovolt-amperes-reactive. Capacitors act as reactive current generator.
- iii. **Apparent power:** The Working power and Reactive power make up apparent power which is called kVA or kilovolt-amperes.
- iv. **Power Factor:** The ratio of working power to apparent power is called Power factor. The power factor indicates the utilization of electrical power. When current and voltage are in phase the power used and VA are the same.

Improving the Power Factor can maximize current carrying capacity, improve voltage to equipment, and reduce power losses & electric consumption and lower electricity cost. Industrial users try to keep VA to minimum by having a ‘Power factor’ as near to unity as possible, providing suitable reactive power compensation using capacitors. So, that electricity consumption will be reduced and electricity cost can be saved.

The electricity supply company will charge the consumers based on Contract demand or maximum demand on kVA or specified by the electricity supplier plus Active power consumption (kWh) or apparent power consumption (kVAh).

The details of power factor correction for reducing electricity consumption and cost saving analysed with actual data measurements for the following loads.

- i. Fixed load of 40 kW (Study – I)
- ii. Variable loads for different timings (Study –II)



HORSE B SHOULD BE BROUGHT ALWAYS NEARER TO HORSE A SO, THAT THE TWO HORSES ENERGY WILL BE UTILISED FOR PULLING THE CAR WITHOUT WASTING ENERGY

MEASURED DATA (Study -I)

Date 25/09/2003 10:46:40		Period: 00:00:05			
	Phase 1	Phase 2	Phase 3	Phase III	
Voltage (V)	236	237	237	236	
Maximum Voltage (V)	236	237	237		
Minimum Voltage (V)	236	237	237		
Current(A)	75	56	66	66	
Maximum Current(A)	75	56	66		
Minimum Current(A)	75	56	66		
Power (kW)	16	9	13	38	
Reactive P. L (kvar)	0	0	0	0	
Reactive P. C (kvar)	8	10	8	26	
Power factor	-0.87	-0.66	-0.84	-0.80	
	Active(kWh)	Reactive L(kvarh)	Reactive C(kvarh)		
Energies	29.304	14.297	5.236		
Frequency (Hz)	49.8				

Date 25/09/2003 10:56:40		Period: 00:00:05			
	Phase 1	Phase 2	Phase 3	Phase III	
Voltage (V)	238	239	239	238	
Maximum Voltage (V)	238	239	239		
Minimum Voltage (V)	238	239	239		
Current(A)	69	44	59	58	
Maximum Current(A)	69	44	59		
Minimum Current(A)	69	44	59		
Power (kW)	16	9	13	38	
Reactive P. L (kvar)	5	5	5	16	
Reactive P. C (kvar)	0	0	0	0	
Power factor	0.93	0.87	0.91	0.91	
	Active(kWh)	Reactive L(kvarh)	Reactive C(kvarh)		
Energies	35.068	15.661	8.108		
Frequency (Hz)	50.4				

ANALISED DATA

Power factor leading		PF CORRECTION AND COST SAVING FOR 40 kW				Power factor lagging			
30 kVAR Capacitor connected through APC - (ON)					30 kVAR Capacitor connected through APC - (OFF)				
PARTICULARS	L1	L2	L3	III	PARTICULARS	L1	L2	L3	III
Line voltage	408.76	410.50	410.50	409.92	Line voltage	412.23	413.96	413.96	413.38
Phase voltage	236.00	237.00	237.00	236.67	Phase voltage	238.00	239.00	239.00	238.67
Current	75	56	66	65.67	Current	69	44	59	57.33
PF	- 0.87	- 0.66	- 0.84	- 0.79	PF	0.93	0.87	0.91	0.90
Power (kW)	15.40	8.76	13.14	37.30	Power (kW)	15.27	9.15	12.83	37.25
Total kVA (X)				47.21	Total kVA (Y)				41.24
Reactive power C (kVAR)				28.95	Reactive power L (kVAR)				17.69
Cost saving based on kVAh charges					Cost saving on kVA charges				
Saving kVAh (X-Y)	Hrs.	kVAh saving per Month	Rate per kVAh	Total kVAh saving per Month	Cost saving per Month Rs.	Saving kVA (X-Y)	Rate per kVA	Cost saving Rs.	
5.97	8	47.78	3.90	1433	5,590.35	5.97	150	895.89	
5.97	24	143.34	3.90	4300	16,771.06				
PF correction from - 0.79 (leading) to 0.99 (lagging)					PF correction from 0.90 (lagging) to 0.99 (lagging)				
Voltage	409.92	409.92			Voltage	413.38	413.38		
Current	65.67	53.06	Reduced current	12.60	Current	57.33	52.56	Reduced current	4.78
PF	- 0.79	0.99			PF	0.90	0.99		
kW	37.30	37.30			kW	37.25	37.25		
kVA	47.21	37.67	Saving kVA	9.54	kVA	41.24	37.63	Saving kVA	3.61
	kVAR C	kVAR C	Total kVAR C available			kVAR L	kVAR C	Additional kVAR required for canceling kVAR L	
	28.95	5.31	34.26			17.69	5.31	12.38	
kVAR actually required				11.26	kVAR actually required				12.38

MAXIMUM 10 – 12 kVAR Capacitors required for 40 kW load

Cost saving based on kVAh charges										
Saving kVAh	Hrs.	kVAh saving / Month	Rate per kVAh	Cost saving per Month Rs.		Saving kVAh	Hrs.	kVAh saving / Month	Rate per kVAh	Cost saving per Month Rs.
9.54	8	2289.09	3.90	8,927.44		3.61	8	866.45	3.90	3,379.16
9.54	24	6867.26	3.90	26,782.31		3.61	24	2599.36	3.90	10,137.49
Cost saving based on kVA charges										
	Saving kVA	Rate/kVA	Cost saving Rs.			Saving kVA	Rate/kVA	Cost saving Rs.		
	9.54	150	1,430.68			3.61	150	541.53		

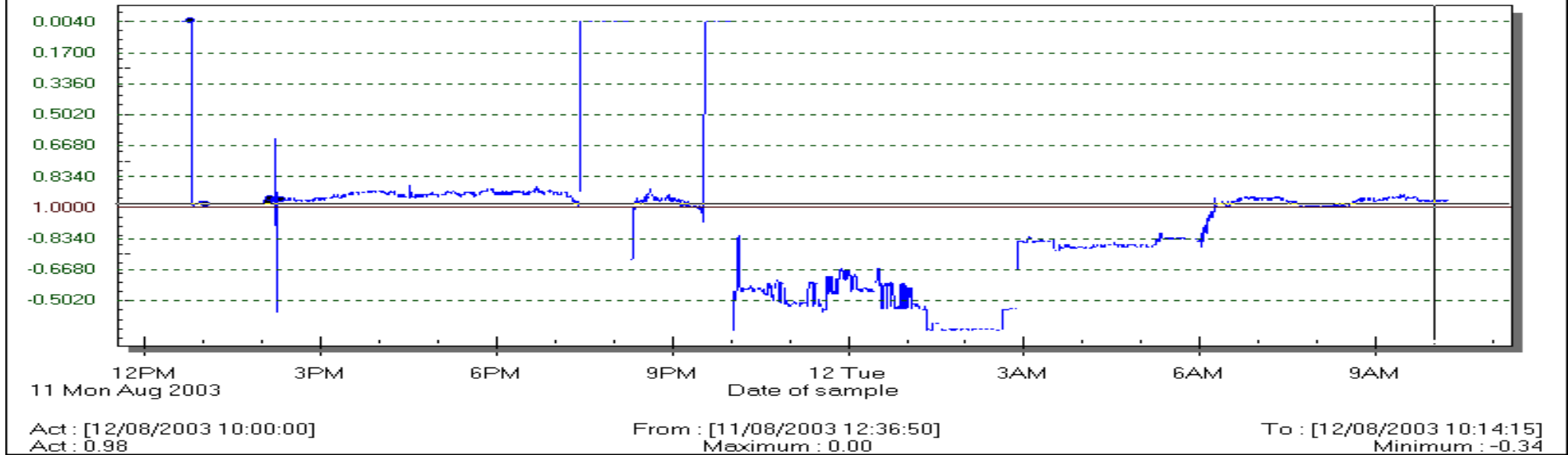
MALFUNCTIONING OF AUTOMATIC POWER FACTOR CONTROLLER THE POWER FACTOR WAS LEADING. AGAIN THE DATA WAS MEASURED AFTER DISCONNECTING THE 30 kVAR CAPACITORS FROM THE LOAD AND DATA ANALYSIED.

RECULAR CHECKING AND MAINTENANCE IS REQUIRED FOR AUTOMATIC POWER FACTOR CONTROLLER. OTHERWISE IT IS BETTER TO OPERATE MANUALLY FOR POWER FACTOR CORRECTION TO AVOID EXCESS ENERGY CONSUMPTION AND OVER LOADING OF ELECTRICAL COMPONENTS TO SAVE ENERGY COST.

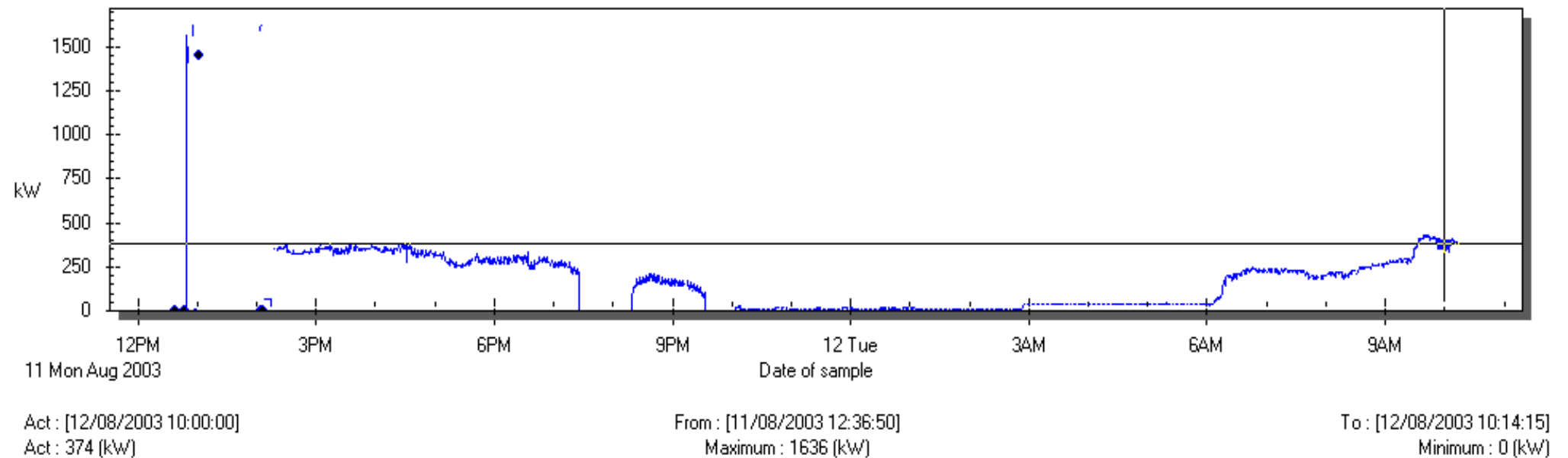
FOR STUDY – II ALSO CAPACITORS ARE CONNECTED FOR DIFFERENT LOADS AND THERE IS NO AUTOMATIC POWER FACTOR CONTROLLER OR MAUAL OPERATION. DURING NIGHT TIME POWER FACTOR LEADING WHEN LOAD IS VERY LOW AND LAGGING WHEN LOAD IS VERY HIGH AND CONSUMING EXCESS kVAh.

MEASURED DATA (Study -II)

CPRI, ERC, THIRUVANANTHAPURAM (Power factor)



CPRI, ERC, THIRUVANANTHAPURAM (Active power)



ANALISED DATA

I	TIME	From	14.20	to	21.00	Hrs.
TIME	Existing PF	kW	Existing kVA consumption (A)	New PF	Improved kVA consumption (B)	Saving kVA (A-B)
14.20	0.96	344	358	0.99	347	11
14.28	0.96	359	374	0.99	363	11
15.00	0.95	349	367	0.99	353	15
15.03	0.96	375	391	0.99	379	12
15.14	0.94	381	405	0.99	385	20
16.00	0.91	366	402	0.99	370	33
16.30	0.94	382	406	0.99	386	21
17.00	0.93	335	360	0.99	338	22
18.00	0.93	285	306	0.99	288	19
19.00	0.93	248	267	0.99	251	16
20.30	0.96	182	190	0.99	184	6
21.00	0.96	164	171	0.99	166	5
Avg.	0.94	314	333	0.99	317	16
kVA charges	Avg. Existing kVA (A)	Avg. Improved kVA (B)	Saving kVA (A-B)	Rate per kVA	Cost saving Rs.	
	333	317	16	150	2,373	
kVAh charges	Saving kVAh (A-B)	Hrs.	Total kVAh saving	Rate per kVAh	Saving per Month Rs.	
	16	7	111	3.90	12,958	
II	TIME	From	22.30	to	6.00	Hrs.
TIME	Existing PF	kW	Existing kVA consumption (A)	New PF	Improved kVA consumption (B)	Saving kVA (A-B)
22.30	-0.57	7	12	0.99	7	5
23.00	-0.48	5	10	0.99	5	5
0.00	-0.62	13	21	0.99	13	8
1.00	-0.57	19	33	0.99	19	14
2.00	-0.35	7	20	0.99	7	13

3.00	-0.81	40	49	0.99	40	9
4.20	-0.79	38	48	0.99	38	10
5.00	-0.80	38	48	0.99	38	9
6.00	-0.83	40	48	0.99	40	8
Avg.	-0.65	23	32	0.99	23	9
kVA charges	Avg. Existing kVA (A)	Avg. Improved kVA (B)	Saving kVA (A-B)	Rate/kVA	Cost saving Rs.	
	32	23	9	150	1,351	
kVAh charges	Saving kVAh (A-B)	Hrs.	Total kVAh saving	Rate per kVAh	Saving per Month Rs.	
	9	7	63	3.90	7,379	
III	TIME	From	7.00	to	10.00	Hrs.
TIME	Existing PF	kW	Existing kVA consumption (A)	New PF	Improved kVA consumption (B)	Saving kVA (A-B)
7.00	0.95	216	227	0.99	218	9
8.00	0.99	198	200	0.99	200	0
9.00	0.96	264	275	0.99	267	8
10.00	0.95	374	394	0.99	378	16
Avg.	0.96	263	274	0.99	266	8
kVA charges	Avg. Existing kVA (A)	Avg. Improved kVA (B)	Saving kVA (A-B)	Rate/kVA	Cost saving Rs.	
	274	266	8	150	1,253	
kVAh charges	Saving kVAh (A-B)	Hrs.	Total kVAh saving	Rate per kVAh	Saving per Month Rs.	
	8	3	25	3.90	2,933	
Total saving of kVAh & Cost						
	Working Hrs. per Day	Total kVAh saving	Rate per kVAh	kVAh saving per Month	Cost saving per Moth Rs.	
	17	199	3.90	5967	23,269	

ALL DECIMAL VALUES ARE ROUNDED UP AND AVERAGE VALUES ARE TAKEN FOR CALCULATION