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Determination of Losses in Distribution System at 0.433 kV bus Voltage in Cardiothoracic and Neuro Science Centre at AIIMS, New Delhi.

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Abstract — **Electricity has become the lifeline of modern society, Homes, Offices, Industry, Schools, Hospitals, Transportation, Communication, Road lighting, Markets all depend on reliable Electric Supply with cheaper Prices. Life comes to a standstill without electricity. Electricity has become an integral and inevitable part of every body's life. In all the energy sources both conventional and non-conventional, Electrical energy is the cleanest form of energy.**

Electrical energy is converted from various forms of conventional and non-conventional energy sources at suitable locations, transmitted at high voltage over long distance and distributed to the consumers at a medium or low voltage, however penetration of renewable energy and interconnection of Distributed Generation at distribution lateral the losses could observed is very high, hence goal should be efficient means losses in the distribution should be as less as possible and should deliver the quality power to the customer means the voltage should not contain any harmonics, it should not contain any sags, swells or flickers.

The Cardio and Neuro Science Centre in AIIMS are very vast distribution system having three no 1.6 MVA Distribution Transformer and fifteen no outgoing feeder in main LT Panel for providing the electrical power to various of sub-section of Emergency and normal area through power cable. Hence determination of Energy loss is required at distribution level due to load current and source voltage and achieving for reduces the monthly energy bills consumption as well as compliance of electricity regulation of power quality and reliability indices, standards of performance of grid stability and environmental obligations such as carbon foot print reduction.

Index Terms — **Energy losses; Load Current; Source Voltage; Strategies to reduce monthly Energy Bills.**

I. INTORDUCTION

Determination of losses in low voltage (LV) side of Distribution System in hospital area is required as their lot of medical equipment are used for patient care, for running these medical equipment various speed drive, Single phase UPS, which creates more unbalance in downstream lateral causing producing harmonics pollution, excessive neutral current, long run cable contributes higher source impedance and hence higher voltage harmonics are produced due to various line losses and voltage losses are happening on account of load current and source voltage [1].

There are Electrical Distribution System in Cardio Neuro Science Centre in AIIMS, having 3 Nos 1.6 MVA Distribution Transformer and 9 Nos O/G feeder for providing the electrical power to various area Viz Cardiothoracic and Neuro Science Centre, Cardiothoracic and Vascular Surgery (CTVS), Neuro Surgery, Catheterization Laboratory (Cath Lab) having very sensitive and critical medical equipment.

The power distributed from main LT panel to different location through power cable connected between O/G feeder to load end. The total Energy consumption for year April/2021 to Mar/2022 in Cardiothoracic and Neuro Science Centre is about 4153241.90 KWH [7].

II. MODELLING OF LV DISTRIBUTION SYSTEM

The Low Voltage grid is composed by three no 1.6 MVA Distribution Transformer and 9 Nos O/G feeder and laid aluminium armored cable of size 3.5X 400.0 sq. mm/ 3.5X 300.00 sq. mm/ 3.5X240.0 sq. mm/ 3.5X185.0 sq. mm/ 3.5X150.0 sq. mm/ Single core 150.0 sq. mm armored cable for power distribution to different section of LT panel from where load is connected as details of the SLD of Fig.1 [7].

A. Single Line Diagram of LV Distribution System

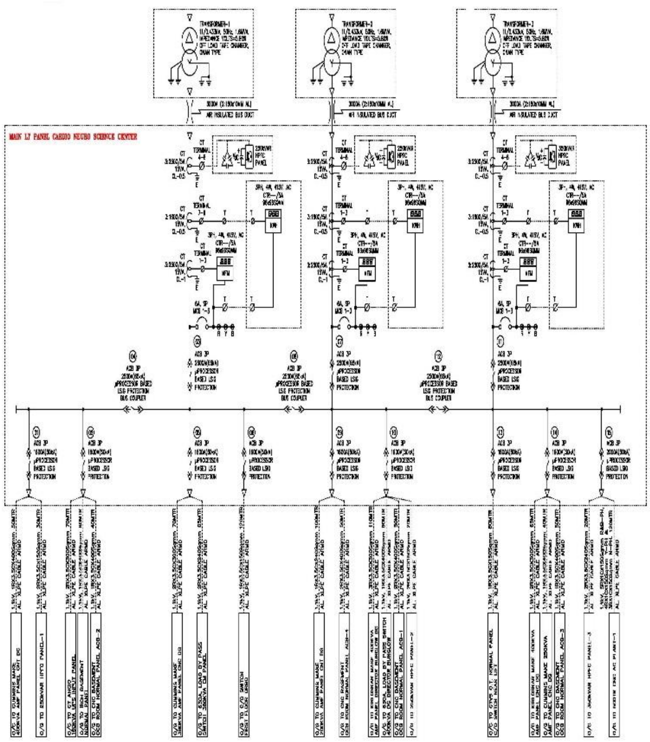

Figure 1: Schematic Diagram of Main LT Substation CNC

B. Rating of Transformer

Using Name Plate of Transformer, the date is collected in Table No 1.

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Table No 1: Parameter's value of Distribution Transformer

Rating (MVA)		1.6
Rated Current (Amps)	H.V	83.98
	L.V	2225.93
Rated Voltage (kV)	H.V	11
	L.V	0.415
Frequency (Hz)		50
Impedance volt (%)	(%)	5.8
Types of Cooling		ONAN
Maximum total Losses at 50 % Rated Load (watt)		4200
Maximum total Losses at 100 % Rated Load (watt)		11600
Energy Efficiency Level		2
Confirming to		IS1180(Part 1):2014

C. Rating of Air Circuit Breaker

Using Name Plate of Air Circuit Breaker, the data collected in Table No 2.

Table No 2: Parameter's value of Air Circuit Breaker

Rating (Amps)	2500/1600 Amps - 3 Pole
Protection	LSIG
Rated Service Voltage at 50/60 Hz (Ue)	690 V AC
Rated Insulation Voltage at 50/60 Hz (Ui)	1000 Volt
Rated Impluse withstand voltage (Uimp)	12 kV
Rated Ultimate Short Circuit, breaking Capacity Ics @ 440 Volt	65 kA for 2500 Amps
Rated Short Circuit, breaking Capacity Icu @ 440 Volt	65 kA for 2500 Amps
Rated Short/ time withstand current (Icw) @ 440 Volt	65 kA for 2500 Amps
Rated making Capacity in short circuited @440V (Icm)	143 kA for 2500 Amps
Mechanical Life	2500 Amps - 20000 Operation 1600 Amps - 25000 Operation
Electrical life @ 440V AC	2500 Amps - 8000 Operation 1600 Amps - 10000 Operation

D. Size and Quantity of armored Aluminium cable of 1.1 kV Grade

By taking the manual measurement the armored cable laid from O/G feeder to Different section of load panel in CN Centre in Table No 3.

Table No 3: Measurement value of armored aluminium cable

Out Going Feeder	3.5X 400.0 sq. mm	3.5X300.0 sq. mm	3.5X 240.0 sq. mm	3.5X 185.0 sq. mm	3.5X150.0 sq. mm	1X 150 sq. mm
ACB NO 01	50				60	
ACB NO 02	40	130				
ACB NO 05		140				
ACB NO 06					120	
ACB NO 09	100		100			
ACB NO 10		330			40	
ACB NO 13					80	
ACB NO 14	40					
ACB NO 15			40			1800
400 KVA EM Load Panel DG Room CNC	60					
250 KVA EM Panel DG Room CNC	55	15	365			
380 KVA EM Panel DG Room CNC	45					
400 KVA EM Panel Director Bungalow Side DG	80			60		
400 KVA Load EM Panel Basement CNC		130			40	
380 KVA Load EM Panel Basement CNC	50	80	60			
400 KVA Load EM Panel Basement CNC Dir Bunglow Side DG			75	230		
250 KVA Load EM Panel Basement CNC	90	90				
Normal Panel -01 Basement OCB Room CNC	45	130	70	60		
Normal Panel -02 Basement OCB Room CNC	335	90		60		
TOTAL (Length of Cable)	990	1135	710	410	340	1800

III.

III. Energy Loss in LV Distribution System

There are various distribution losses in LV side of system which will be describe below.

A. Classification of Energy Losses

There are two type of Energy Loss in LV Side of Distribution System:

- Energy Losses Due to Load Current;
- Energy Losses Due to Source Voltage.

1) Energy Losses Due to Load Current

The line losses are occurring in distribution system due to flowing the load current from feeder section to load end through power cable [2].

There are five type of Energy Losses due to load current:

- Effective Losses
- Reactive Losses
- Unbalanced Losses
- Distortion Losses
- Neutral Losses

a) Effective Losses

Effective losses due to the resistance of long run power cable scatted over the large areas and these losses is proportional to the I^2R losses in lumped line [3].

b) Reactive Losses

Reactive losses due to the associate of reactive component of current due to reactance of load element.

c) Unbalanced Losses

The load in three phase networks is unbalanced due to more no of single-phase lateral in distribution side, excess neutral current will flow and losses are occurring in distribution network. The problem in distribution network exists in both three-wire and four-wire systems due to the fact the loads are switched on and off by end users simultaneously.

d) Distortion Losses

The harmonic current generated by nonlinear load and travelling through transformer, cable impedance, losses are occurring in distribution system network as results of equipment are overheating due to "skin effect" and energy losses due to the poor distortion power factor.

e) Neutral Losses

The excess current is flowing in neutral due to the unbalanced load in downstream lateral and presence of triple harmonics in load current, the losses are occurring in LV side of distribution system [3].

2) Energy Loss Due to Source Voltage

The source voltage losses in LV side of distribution system are occurs due to long run aluminium cable contributes higher source impedance and hence higher voltage harmonics are produced [5].

There are two type of Energy Loss due to Source Voltage:

- Voltage Unbalanced Losses

- Voltage Distortion Losses

a) Voltage Unbalanced Losses
When source voltage is unbalance due to Grid polluted network, the losses are occurring in LV side of distribution transformer [6].

b) Voltage Distortion Losses
The current harmonic (distorted waveform) flow through system impedance (source and line impedance) and distorted the harmonic voltage waveform. Thus, voltage harmonic losses are generated in LV side of distribution system [4].

IV. METHODOLOGY AND EXPERIMENT

The proposed methodology for evaluation of total distribution losses due to load current and source voltage is applied on LV Side of Distribution network in Cardiothoracic and Neuro Science Centre [7].

The network used LT main 1, LT main 2, LT main 3 in Substation having sanctioned load from utility is 1299 kW. The load distributed among the network through different long root armoured power cable.

A. *Proposed Instrument for Measurement Taken*

The measurement taken by three phase power quality [PQ] Analyzer [FLUKE 438] in LT Main 1, LT Main 2, LT Main 3 and whole distribution losses are calculated for Peak and off-Peak Loading Condition.

B. *Measurement Recorded through PQ Analyzer*

a) Measurement recorded in Main Incomer LT-1 of low voltage side of Distribution Transformer 1 during off peak hour on 7th May 2022 at 18:31 IST.

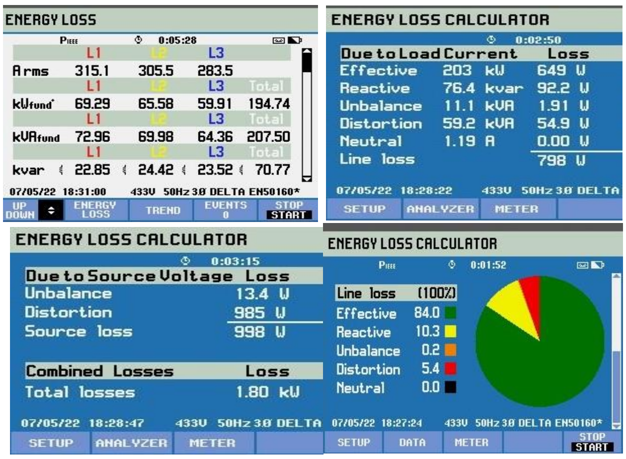

Figure 2: Data Captured in LT Main-1 during off peak load condition

b) Measurement recorded in Main Incomer LT-1 of low voltage side of Distribution Transformer 1 during peak hour on 9th May 2022 at 13:05 IST

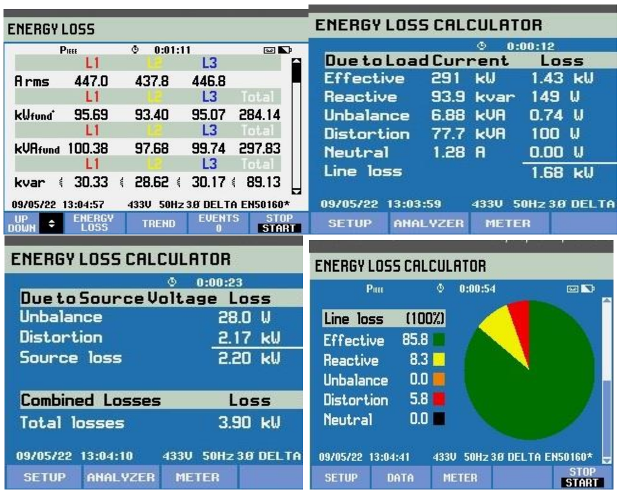

Figure 3: Data Captured in LT Main-1 during peak load condition

c) Measurement recorded in Main Incomer LT-2 of low voltage side of Distribution Transformer 2 during off peak hour on 7th May 2022 at 18:44 IST

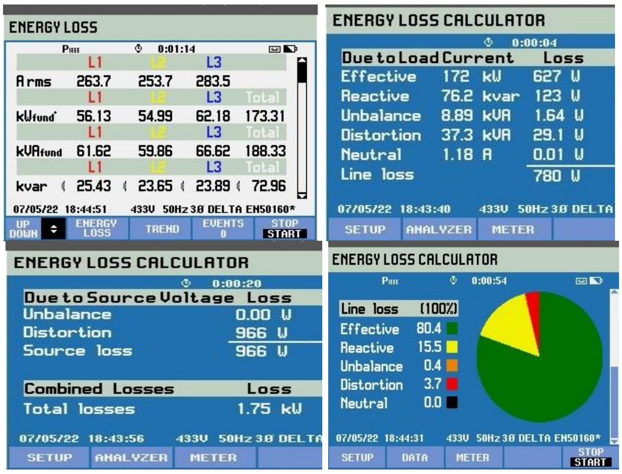

Figure 4: Data Captured in LT Main-2 during off peak load condition

d) Measurement recorded in Main Incomer LT-2 of low voltage side of Distribution Transformer 2 during peak hour on 9th May 2022 at 13:09 IST

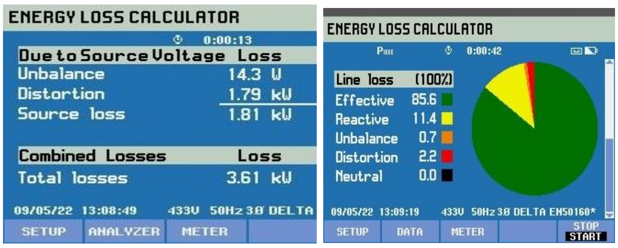

Figure 5: Data Captured in LT Main-2 during peak load condition

e) Measurement recorded in Main Incomer LT-3 of low voltage side of Distribution Transformer 3 during off peak hour on 7th May 2022 at 18:39 IST

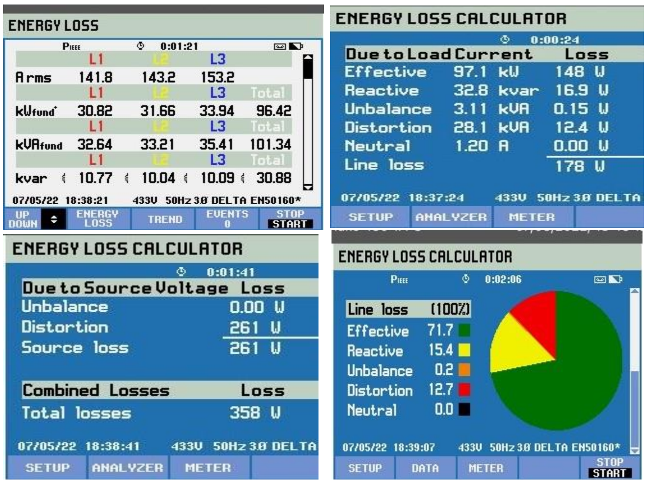

Figure 6: Data Captured in LT Main-3 during off peak load condition

f) Measurement recorded in Main Incomer LT-3 of low voltage side of Distribution Transformer 3 during peak hour on 9th May 2022 at 12:59 IST

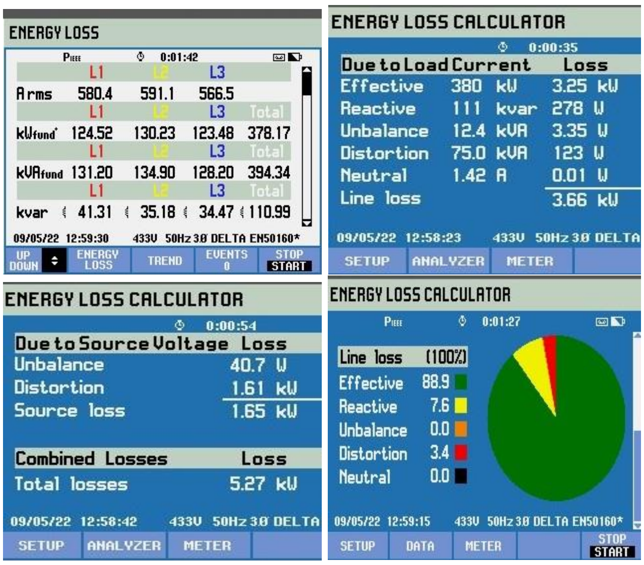

Figure 7: Data Captured in LT Main-3 during peak load condition

C. Data formulated in a Single Tabulated form

a) Measurement recorded on basis of Data captured in PQ Analyzer in Main Incomer LT- 1 during off peak and peak load condition.

Table No 4: Parameter's value of LT-1

Details Location	LT Main -1 in CNC Substation at 0.433 kv Bus Voltage							
	OFF PEAK HOUR (7 May 2022 at 18:39 IST)				PEAK HOUR (9 May 2022 at 13:05 IST)			
Details Paramenter	"R" Phase	"Y" Phase	"B" Phase	Total	"R" Phase	"Y" Phase	"B" Phase	Total
Load Current (Arms)	315.1	305.5	283.5		447.0	437.8	446.8	
Active Power (kW found)	69.29	65.58	59.91	194.74	95.69	93.4	95.07	284.14
Apparent Power(kVA	72.96	69.98	64.36	207.5	100.38	97.68	99.74	297.83
Reactive Power (kvar)	22.85	24.42	23.52	70.77	30.33	28.62	30.17	89.13

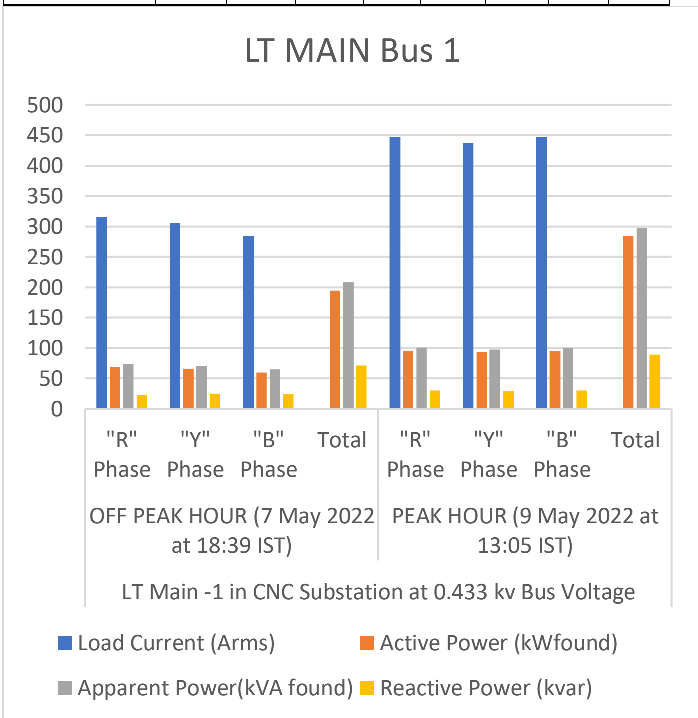

Figure 8: Power flow scenario of LT Main – 1 during peak and off-peak load condition

b) Measurement recorded on basis of Data captured in PQ Analyzer in Main Incomer LT- 2 during off peak and peak load condition.

Table No 5: Parameter's value of LT-2

Details Location	LT Main -2 in CNC Substation at 0.433 kv Bus Voltage							
	OFF PEAK HOUR (7 May 2022 at 18:44 IST)				PEAK HOUR (9 May 2022 at 13:09 IST)			
Details Paramenter	"R" Phase	"Y" Phase	"B" Phase	Total	"R" Phase	"Y" Phase	"B" Phase	Total
Load Current (Arms)	263	253.7	283.5		445.4	415.2	382.9	
Active Power (kW found)	69.29	65.58	62.18	173.31	95.24	88.27	82.45	265.94
Apparent Power(kVA	72.96	69.98	66.62	188.33	101.32	95.25	86.97	284.13
Reactive Power (kvar)	22.85	24.42	23.89	72.96	34.58	35.78	27.66	98.08

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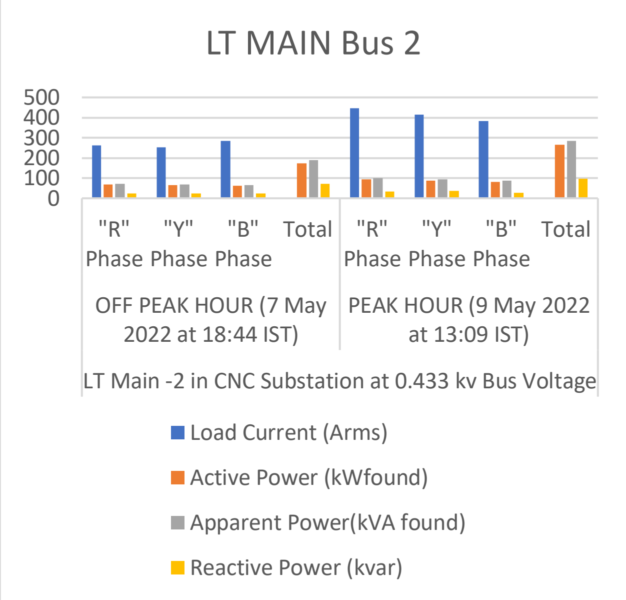

Figure 9: Power flow scenario of LT Main – 2 during peak and off-peak load condition

c) Measurement recorded on basis of Data captured in PQ Analyzer in Main Incomer LT- 3 during off peak and peak load condition

Table No 6: Parameter's value of LT-3

Details Location	LT Main -3 in CNC Substation at 0.433 kv Bus Voltage							
	OFF PEAK HOUR (7 May 2022 at 18:39 IST)				PEAK HOUR (9 May 2022 at 12:59 IST)			
Details Paramenter	"R" Phase	"Y" Phase	"B" Phase	Total	"R" Phase	"Y" Phase	"B" Phase	Total
Load Current (Arms)	141.8	143.2	153.2		580.4	591.1	566.5	
Active Power (kWfound)	30.82	31.66	33.94	96.42	124.52	130.23	123.48	378.17
Apparent Power(kVA	32.64	33.21	35.41	101.34	131.2	134.9	128.2	394.34
Reactive Power (kvar)	10.77	10.04	10.09	30.88	41.31	35.18	34.47	110.99

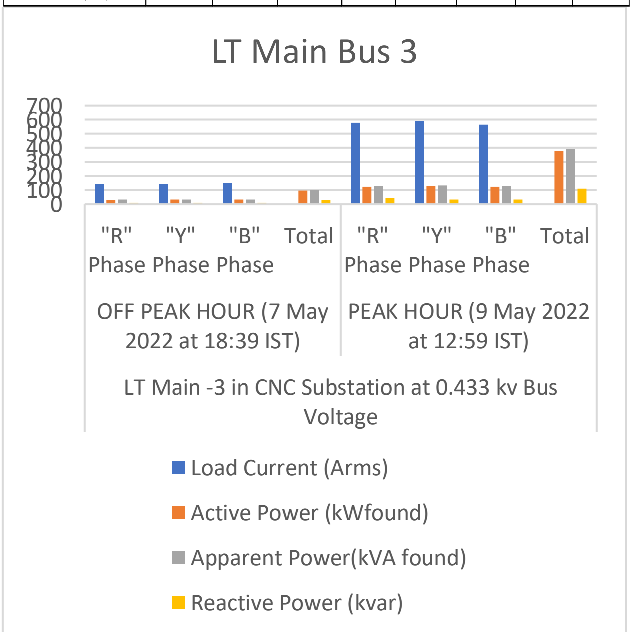

Figure 10: Power flow scenario of LT Main – 3 during peak and off-peak load condition

d) Measurement recorded on basis of Data captured in PQ Analyzer in Main Incomer LT- 1,2,3 during off peak and peak load condition

Table No 7: Parameter's value of LT-1,2,3

Details Location	LT Mains in CNC Substation at 0.433 kv Bus Voltage							
	OFF PEAK HOUR (7 May 2022 at 18:39 IST)				PEAK HOUR (9 May 2022 at 13:09 IST)			
Details Paramenter	LT-1	LT-2	LT-3	Total	LT-1	LT-2	LT-3	Total
Active Power (kW found)	194.74	173.31	96.42	464.47	284.14	265.94	378.17	928.25
Apparent Power(kVA found)	207.5	188.33	101.34	497.17	297.83	284.13	394.34	976.3
Reactive Power (kvar)	70.77	72.96	30.88	174.61	89.13	98.08	110.99	298.2

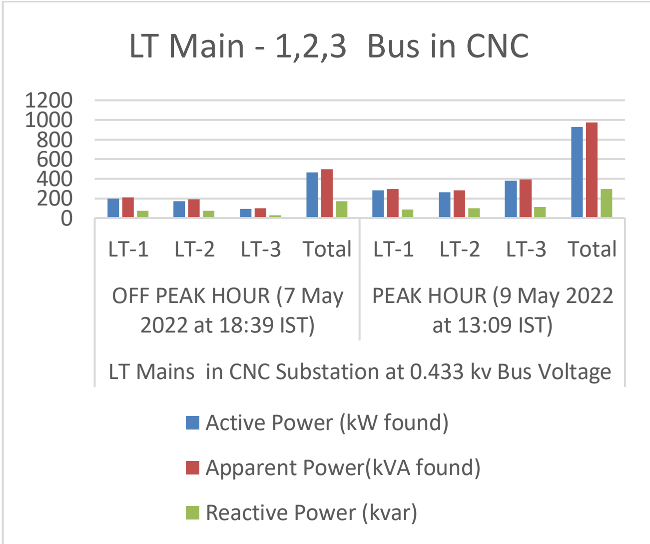

Figure 11: Power flow scenario of LT Main – 1,2,3 during peak and off-peak load condition

D. Summarized Losses in LV Side Distribution System in Cardiothoracic and Neuro Science Centre.

a) Measurement recorded on basis of Data captured in PQ Analyzer in Main Incomer LT- 1 during off peak load condition

Table No 8: Various Losses in LT-1 during off peak load condition

LT MAIN -1 OFF PEAK HOUR		
Loss Due to Load Current in watts		Contributed Percentage of total losses
Effective Loss	649	36.13%
Reactive Loss	92.2	5.13%
Unbalance Loss	1.91	0.11%
Distortion Loss	54.9	3.06%
Neutral Loss	0.00	0.00%
Loss Due to Source Voltage in watts		
Unbalance Loss	13.4	0.75%
Distortion Loss	985	**54.83%**
Total Losses	1796.41	100.00%

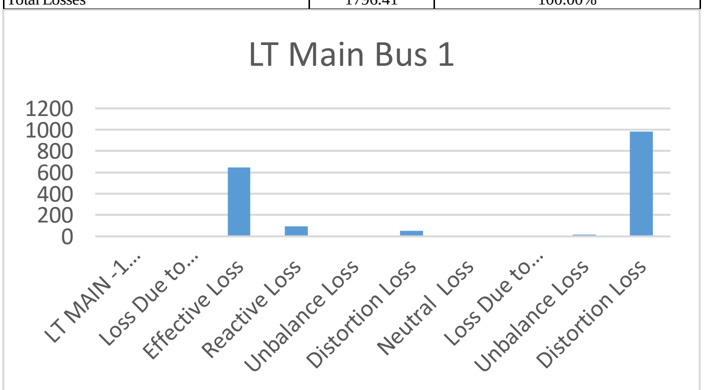

Figure 12: Major contribution of Losses in LT 1 during off-peak loading

b) Measurement recorded on basis of Data captured in PQ Analyzer in Main Incomer LT- 1 during peak load condition

Table No 9: Various Losses in LT-1 during peak load condition

LT Main CNC Substation at 0.433 kv Bus Voltage		
LT MAIN -1 PEAK HOUR		
Loss Due to Load Current in watts		Contributed Percentage of total losses
Effective Loss	1430.00	36.88%
Reactive Loss	149	3.84%
Unbalance Loss	0.74	0.02%
Distortion Loss	100.00	2.58%
Neutral Loss	0.00	0.00%
Loss Due to Source Voltage in watts		
Unbalance Loss	28.00	0.72%
Distortion Loss	2170.00	**55.96%**
Total Losses	3877.74	100.00%

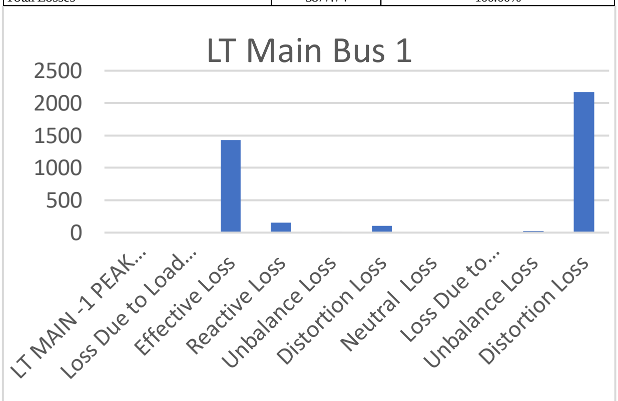

Figure 13: Major contribution of Losses in LT 1 during peak loading

c) Measurement recorded on basis of Data captured in PQ Analyzer in Main Incomer LT- 2 during off-peak load condition

Table No 10: Various Losses in LT-2 during off peak load condition

LT Main CNC Substation at 0.433 kv Bus Voltage		
LT MAIN -2 OFF PEAK HOUR		
Loss Due to Load Current in watts		Contributed Percentage of total losses
Effective Loss	627	35.90%
Reactive Loss	123	7.04%
Unbalance Loss	1.64	0.09%
Distortion Loss	29.1	1.67%
Neutral Loss	0.01	0.00%
Loss Due to Source Voltage in watts		
Unbalance Loss	0.00	0.00%
Distortion Loss	966	**55.30%**
Total Losses	1746.75	100.00%

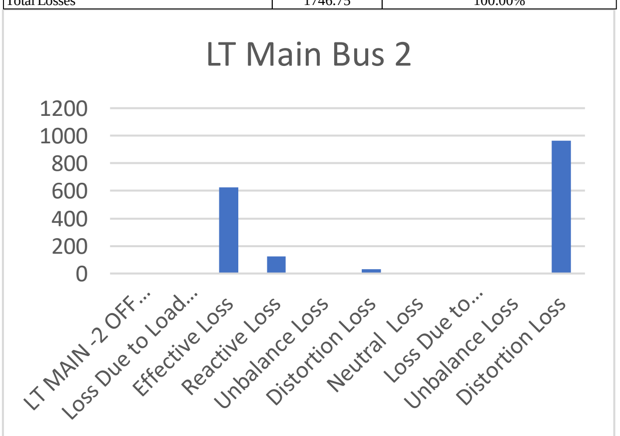

Figure 14: Major contribution of Losses in LT 2 during off peak loading

d) Measurement recorded on basis of Data captured in PQ Analyzer in Main Incomer LT- 2 during peak load condition

Table No 11: Various Losses in LT-2 during peak load condition

LT Main CNC Substation at 0.433 kv Bus Voltage		
LT MAIN -2 PEAK HOUR		
Loss Due to Load Current in watts		Contributed Percentage of total losses
Effective Loss	1560.00	43.03%
Reactive Loss	214.00	5.90%
Unbalance Loss	9.05	0.25%
Distortion Loss	37.9	1.05%
Neutral Loss	0.01	0.00%
Loss Due to Source Voltage in watts		
Unbalance Loss	14.3	0.39%
Distortion Loss	1790	**49.38%**
Total Losses	3625.26	100.00%

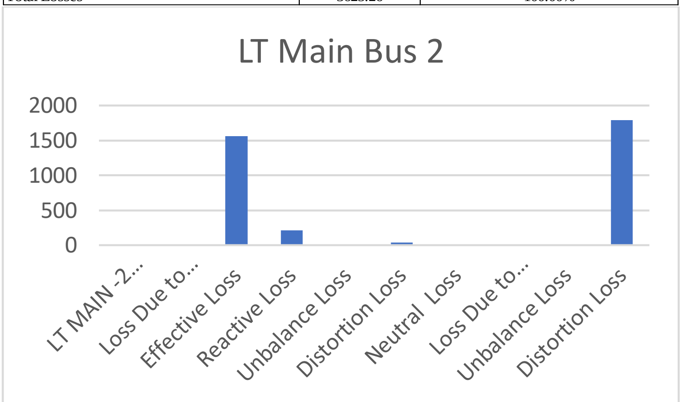

Figure 15: Major contribution of Losses in LT 2 during peak loading

e) Measurement recorded on basis of Data captured in PQ Analyzer in Main Incomer LT- 3 during off- peak load condition

Table No 12: Various Losses in LT-3 during off-peak load condition

LT Main CNC Substation at 0.433 kv Bus Voltage		
LT MAIN -3 OFF PEAK HOUR		
Loss Due to Load Current in watts		Contributed Percentage of total losses
Effective Loss	148	33.76%
Reactive Loss	16.9	3.85%
Unbalance Loss	0.15	0.03%
Distortion Loss	12.4	2.83%
Neutral Loss	0.00	0.00%
Loss Due to Source Voltage in watts		
Unbalance Loss	0.00	0.00%
Distortion Loss	261	**59.53%**
Total Losses	438.45	100.00%

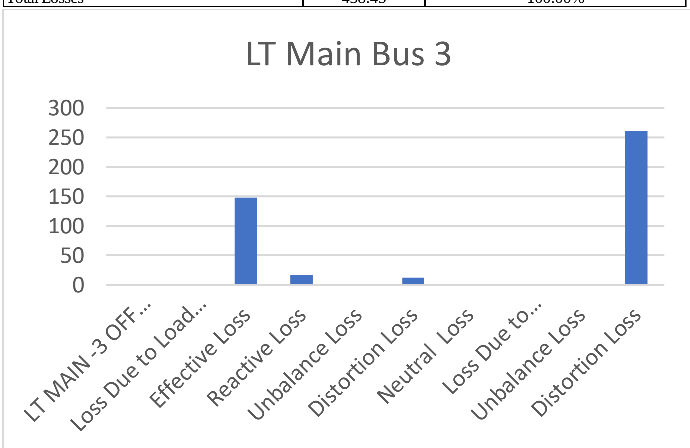

Figure 16: Major contribution of Losses in LT 3 during off peak loading

f) Measurement recorded on basis of Data captured in PQ Analyzer in Main Incomer LT- 3 during peak load condition

Table No 13: Various Losses in LT-3 during peak load condition

LT Main CNC Substation at 0.433 kV Bus Voltage		
LT MAIN -3 PEAK HOUR		
Loss Due to Load Current in watts		Contributed Percentage of total losses
Effective Loss	3250.00	**61.25%**
Reactive Loss	278.00	5.24%
Unbalance Loss	3.35	0.06%
Distortion Loss	123.00	2.32%
Neutral Loss	0.01	0.00%
Loss Due to Source Voltage in watts		
Unbalance Loss	40.70	0.77%
Distortion Loss	1611.00	30.36%
Total Losses	5306.06	100.00%

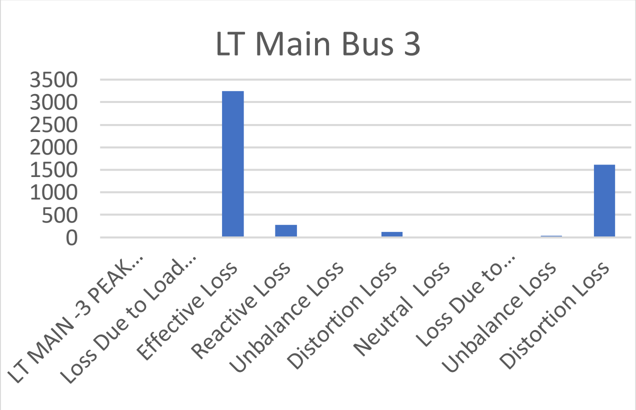

Figure 17: Major contribution of Losses in LT 3 during peak loading

E. Monthly Bills Reading for Cardiothoracic and Neuro Science Centre.

On the basis of Electricity bills reading the total energy consumption would be calculated for year April/2021 to March/2022.

Table No 14: Total Energy consumption for year April/2021 to March/2022

Details Location	LT Main CNC Substation at 0.433 kV Bus Voltage					
	Total Energy Consumption for Year April/2021 to Mar/2022					
	LT Main-1 Total Sanctioned Load: 399 kW			LT Main -2&3 Total Sanctioned Load: 900 kW		
Bills Consumption Cycle	Total Consumed Energy in KVAH	Power Factor	Total Consumed Energy in KWH	Total Consumed Energy in KVAH	Power Factor	Total Consumed Energy in KWH
Apr-21	130697.60	0.989	129259.93	179544.00	0.937	168232.73
May-21	117593.00	0.995	117005.04	294469.90	0.946	278568.53
Jun-21	111556.00	0.994	110886.66	131060.00	0.933	122278.98
Jul-21	123500.80	0.996	123006.80	227395.20	0.946	215115.86
Aug-21	137193.00	0.989	135683.88	320549.60	0.937	300354.98
Sep-21	133817.60	0.991	132613.24	300945.60	0.953	286801.16
Oct-21	156380.80	0.984	153878.71	226236.00	0.939	212435.60
Nov-21	163097.60	0.978	159509.45	248847.20	0.948	235907.15
Dec-21	102112.00	0.968	98844.42	208795.20	0.920	192091.58
Jan-22	107484.8	0.985	105872.53	210585.60	0.866	182367.13
Feb-22	86921.60	0.930	80837.09	305150.40	0.930	283789.87
Mar-22	121331.84	0.980	118905.20	224726.24	0.930	208995.40
Total Consumed Energy in KWH		**LT 1**	**1466302.94**	**Total Consumed Energy in KWH**	**LT 2+ LT 3**	**2686938.963**
TOTAl Unit in KWH for Year April/2121 to Mar/2022						**4153241.90**

V. RESULTS

The Energy losses due to Load Current and Source voltage on each LT-1, LT-2, LT-3 are obtained during off-peak and peak loading condition and also percentage of distribution losses are evaluated.

a) Various individual losses obtained in percentage manner in LT main Substation (LT-1, LT-2, LT-3) during off-peak and peak loading Condition.

Table No 15: Comparison various distribution losses

Details Location	LT Main CNC Substation at 0.433 kv Bus Voltage						
	OFF PEAK HOUR				PEAK HOUR		
Details Paramenter	LT-1	LT-2	LT-3	Details Paramenter	LT-1	LT-2	LT-3
Loss Due to Load Current in percentage				**Loss Due to Load Current in percentage**			
Effective Loss	36.13%	35.90%	33.76%	Effective Loss	36.88%	43.03%	**61.25%**
Reactive Loss	5.13%	7.04%	3.85%	Reactive Loss	3.84%	5.90%	5.24%
Unbalance Loss	0.11%	0.09%	0.03%	Unbalance Loss	0.02%	0.25%	0.06%
Distortion Loss	3.06%	1.67%	2.83%	Distortion Loss	2.58%	1.05%	2.32%
Neutral Loss	0.00%	0.00%	0.00%	Neutral Loss	0.00%	0.00%	0.00%
Loss Due to Source Voltage percentage				**Loss Due to Source Voltage percentage**			
Unbalance Loss	0.75%	0.00%	0.00%	Unbalance Loss	0.72%	0.39%	0.77%
Distortion Loss	**54.83%**	**55.30%**	**59.53%**	Distortion Loss	**55.96%**	**49.38%**	30.06%
Total Combined Loss in Percentage	100.00%	100.00%	100.00%	Total Combined Loss in Percentage	100.00%	100.00%	100.00%

b) Total losses obtained in LV side of distribution system in Cardiothoracic and Neuro Science Centre for year.

Table No 16: Total Distribution losses for Year

Details Location	LT Main CNC Substation at 0.433 kv Bus Voltage								
	OFF PEAK HOUR					PEAK HOUR			
Details Paramenter	LT-1	LT-2	LT-3	Total		LT-1	LT-2	LT-3	Total
Loss Due to Load Current in Watt									
Effective Loss	649	627	148	1424		1430.00	1560.00	3250.00	6240.00
Reactive Loss	92.2	123	16.9	232.1		149	214.00	278.00	641
Unbalance Loss	1.91	1.64	0.15	3.7		0.74	9.05	3.35	13.14
Distortion Loss	54.9	29.1	12.4	96.4		100.00	37.9	123.00	260.90
Neutral Loss	0.00	0.01	0.00	0.01		0.00	0.01	0.01	0.02
Total Line Loss	798.01	780.75	177.45	1756.21		1679.74	1820.96	3654.36	7155.06
Loss Due to Source Voltage in watt									
Unbalance Loss	13.4	0.00	0.00	13.4		28.00	14.3	40.70	83.00
Distortion Loss	985	966	261	2212		2170.00	1790	1611.00	5571.00
Total Source Loss	998.4	966	261.00	2225.4		2198.00	1804.30	1651.70	5654.00
Combined Loss in Watt	1796.41	1746.75	438.45	3981.61		3877.74	3625.26	5306.06	12809.06
Total Combined Loss in kW	1.80	1.75	0.44	3.98		3.88	3.63	5.31	12.81
Probably Off Peak Hour Assumed from 06:00 PM to 08:00 AM) = 14 Hours/ Days, Hence Total Energy Loss/ Day in KWH				55.74	Probably Peak Hour Assumed from 08:00 AM to 06:00 PM) = 10 Hours/ Days, Hence Total Energy Loss/ Day in KWH				128.09
Total Energy Loss during Off Peak Hour in a Year[365 Days]				20346	Total Energy Loss during Peak Hour in a Year [365 Days]				46753.069
Total Energy Loss in LV Side of Distribution System in a Year									67099.10

(I) Total Energy Consumed for year in Cardiothoracic and Neuroscience Centre = 4153241.90 KWH

(II) Total Energy Loss in LV Side of Distribution System = 67099.10 KWH

% Distribution Loss in Year =

$$\frac{\text{Total Energy Loss in a year in KWH}}{\text{Total Energy Consumed for Year in KWH}} \text{X100}$$

$$= \frac{67099.10}{4153241.90} \text{X100} = 1.615\ \%$$

VI. CONCLUSION

The main target of this work is to calculated the total energy losses in distribution system at 0.433 kV bus voltage in Cardiothoracic and Neuro Science Centre in AIIMS.

a) The total energy loss are line loss and source loss due to load current and source voltage which is additive of Effective, Reactive, Unbalance, Distortion, Neutral losses. The total energy losses are calculated annually 67099.10 KWH which is **1.615 % (approx.)** of total energy consumed in a year of 4153241.90 KWH.

b) The Percentage of distortion losses in LT-I and LT-II are more which is around **55.00% (approx.)** due to source voltage during peak and off-peak hours and play major role of all over the total losses in distribution system in low voltage side.

c) It is also seen that the percentage of effective loss in LT-III are more which is **61.25% (approx.)** during peak hour. As LT-III in CNC Substation are basically used for HVAC System and power cable used for AC Plant are single core type, 5RX1CX150 sq. mm for R and B-Phase, 4RX1CX150 for Y phase, 3RX1CX150 sq.mm for N-phase, and total quantity 1800-meter (approx.) length there are more enormous voltage drop at full load current, as a results effective loss are higher.

d) The topology is implemented on LT-1, LT-2, LT-3 of bus voltage 0.433kV, 1.6MVA, 50 Hz three phase Distribution system in Cardiothoracic and Neuro Science Centre, AIIMS.

VII. SCOPE OF FUTURE WORK

- Reducing losses in Distribution system network by proper load balancing periodically and additive the harmonic mitigation technique.
- Monitoring the voltage profile at Load terminal, causing the higher drawl of current by inductive load due to low voltage and corrective measure to be taken.
- Replacement of old and outlived aged equipment Viz Distribution Transformer, Power Cable and same upgraded respectively.

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