

Computation of Losses in Primary and Secondary Distribution System - A Case Study

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ABSTRACT

The developing country like India faces shortage of electrical power. Power distribution utilities in India are facing many problems like commercial loss due to various inefficiencies, and high technical losses. This has a very bad effect on the economic growth of our country. Power system losses in India comprises of technical losses, non-technical losses & revenue losses. So, there is a need of proper energy accounting and audit in the power distribution system that helps the power distribution utilities to compute the energy losses. This paper aims at the estimation and computation of technical losses in the power distribution system. For this, the calculation of the technical losses for HT feeders, power transformers, and secondary distribution system using load factor and loss load factor approaches.

Keywords: technical losses, power transformer, loss load factor, HT feeder), secondary distribution etc.

I. INTRODUCTION

Energy has always been an integral part of mankind civilisation historical as well as present day scenario, and there is no reason to abide that in future our existence will be more and more dependent on energy. Electrical energy finds innumerable uses in houses, industries, agriculture sector, commercial sector and in transport sector. Electrical energy is a convenient form of energy because it can be generated centrally in bulk and transmitted economically over a long distance and then finally distributed at the consumer level by the utilities. The economy of the power system is affected by certain factors mainly transmission and distribution losses commonly known as T&D losses.

India experiences severe endemic electric energy and peaking electric power shortage. Power

system is paralysed with huge mounting commercial losses due to various inefficiencies, technical losses and increasing subsidy burden on state. This shortfall of power has a very detrimental effect on the country's economic growth. As the total distribution losses equal to the technical, non-technical and revenue losses hence, it is very important to firstly understand the nature, causes & the impact of technical losses in both primary and secondary distribution system in detail to proceed further in the work.

The World Resources Institute estimates electricity transmission and distribution (T&D) losses in India to be 27 percent - the highest in the world. [2]. The T&D losses are due to a variety of reasons, viz., substantial energy sold at low voltage, sparsely distributed loads over hip hazard rural electrification, low investment in distribution system, improper billing and high energy pilferage.

In general, the cost of electricity per consumer is increased by system losses as these losses increase the operating cost of the electric utilities.

The main objective of this dissertation is to estimate and compute the technical losses in the power primary and secondary distribution system. Firstly, the technical losses for HT feeders, power transformers are calculated and then secondary distribution system technical losses are computed based on feeder data and load profile of transformers using load factor and loss load factor approaches.

Section-2 gives a brief description about the measurement of technical loss. Then, the approach for computing the power losses of the network is given in section-3. Lastly, in section-4 a case study is implemented using load factor and load loss factor to calculate the technical losses of the network. Conclusion is put forth in section-5.

II. MEASUREMENT OF TECHNICAL LOSS

System loss is basically arithmetic difference between the units purchased from bulk suppliers and the units billed to consumers in the respective period. The total system loss for any given period is expressed as percentage of total energy input in the system and is computed as follows [9]:

Total distribution loss = (Energy input- Energy sold)/ Energy input/ 100

The total losses comprises of technical loss and commercial loss. The commercial loss mainly consists of losses due to theft of energy and unrecovered billed amount [3-4]. While, technical losses are the losses occurred in the electrical elements during transportation of energy from the source to consumer end and mainly comprises of ohmic and iron losses. Technical loss is an inevitable consequence of transfer of energy across transmission and distribution networks.

2.1 Loss due to lines/feeders

Line losses occur due to loss in conductors/cables where lower size conductors are used. This causes sags and temperature rise in conductors which further aggravate the loss. Loss in higher loaded phase wire occurs due to unbalanced loading. Losses in the feeder occur due to current in neutral wire of lower size conductor [5-6]. Sometimes loosening of strands may cause of losses in cable. Loss in the feeder is calculated as below:

$$P_{\text{loss}} = I^2 * (r/l * L) = I^2 R$$

Where,

I is current

r/l is resistance / Kilometre

L is length of cable in Kilometres

For a 3-phase system, the losses for each phase are calculated separately according to the measured current as:

$$P_{\text{loss total}} = P_{\text{loss-a}} + P_{\text{loss-b}} + P_{\text{loss-c}} \\ = I_a^2 R_a + I_b^2 R_b + I_c^2 R_c$$

2.2 Loss in Transformers

Distribution transformers are expected to convert up to 95-98% of input power into usable output power [1]. The distribution transformer installed in the distribution system gets overloaded. Oversized transformer can contribute to inefficiency, but when the transformers are appropriately matched to their loads, efficiency increases. However, when the transformer is lightly loaded, no load losses of the transformer become a prominent part of input energy and leads to a high percentage energy loss. Factors contributing towards losses in transformer are:

- Oversized transformers operating at low loading: improper selection of transformer based on its expected load and day efficiency result in high no-load losses. Losses are high on weekend.
- Undersized transformers: this causes higher loading on the transformer, resulting in high operating losses.
- Unbalanced load in secondary side: there can be a significant unbalance in the system due to load balance in different phase, as more consumers may be connected to a particular phase. This results neutral shifting. This cause the over fluxing due to higher voltage on a certain limb which result in technical losses.
- Low oil level/oil leakage: oil serve as dual purpose of insulation and cooling. Leakage and contamination of oil with moisture can reduce the insulation resistance of oil. Sludge formation in oils can adversely affect the cooling and lead to higher temperature and losses.

III. APPROACHES FOR CALCULATION OF LOSS

3.1 Load Factor

The ratio of the average load during a designated period to the peak or maximum load occurring in that period. [8]

$$LF = \text{Average load} / \text{Maximum load}$$

3.2 Load Loss Factor

The actual losses of the circuit / plant item is calculated by applying a factor to the total losses assuming maximum current to flow through that circuit / plant item during the whole period. This factor is called as Load Loss Factor (LLF) which is defined as:

Load Loss Factor = Loss at maximum current (kWh) / Actual loss (kWh) during period

There are methods giving the relationship between the Load Loss Factor (LLF) and the Load Factor (LF). The formulae used for the calculations are shown below. The methods outlined in this document are to be used to calculate the Loss Components for the various categories in the distribution network. These Loss Components will then be used to calculate the overall LLF's for the various customer connections [7-8].

This part gives the relation between load factor and load loss factor via an empirical equation. As loss is an approximate square function of the demand as given in the equation above, it is required to calculate exact relation between load factor and load loss factor for calculation of the losses. The empirical equation given below gives relationship between load factor and load loss factor.

$$LLF = k * LF + (1-k) * LF^2 \text{ or } LLF = 0.2 * LF + 0.8 * LF^2$$

Where k = coefficient.

$$K = \frac{LLF - LF^2}{LF - LF^2}$$

It can be proved that coefficient k varies from consumer to consumer depending upon type and class of the consumer which can be derived from the following equation.

IV. CASE STUDY

The utility taken for the case is BSES Rajdhani power limited, a power distribution company that supply power to west and south Delhi. BSES Rajdhani power limited is broadly divided into west and south circle. The west circle of this utility comprises of 10 divisions, namely,

Dwarka, Janakpuri, Vikaspuri, Palam, Mundka, Jaffarpur, Najafgarh, Tagore garden, Punjabi Bagh and Nangloi. Here, we considered Janakpuri division of west circle, BSES Rajdhani power limited. The Janakpuri division includes various categories of consumer like, industrial, domestic and commercial. This division serves approx. 1, 24,000 consumers with consumption of around 470 units per consumer per month for domestic and commercial consumers and around 3000 units per industrial consumer per month. A total of 64 outgoing 11 kV feeders that supply power to the areas of Mayapuri industrial area, Janakpuri, Rajouri garden, Sagarapur etc.. The details of 11 KV feeders that supply power to the consumers in the Janakpuri division are as:

| S.NO. | Name of 11 KV feeder | No. of consumers (Approx.) | Category of consumer |
|-------|-------------------------------------|----------------------------|----------------------|
| 1 | AJANTA F. D. | 195 | Industrial |
| 2 | C-88 MAYAPURI | 151 | Industrial |
| 3 | D BLOCK KHAZAN BASTI | 226 | Industrial |
| 4 | D-1 JKP | 3466 | Domestic |
| 5 | DDU HOSPITAL | 172 | Commercial |
| 6 | DDU STAFF QRS. | 3225 | domestic |
| 7 | F BLOCK MAYAPURI | 295 | Industrial |
| 8 | FACILITY CENTER | 181 | Industrial |
| 9 | KACHHA TIHAR | 3961 | Domestic |
| 10 | MAHARANI S/STN. | 1838 | Commercial+ Domestic |
| 11 | MIG RAJOURI GARDEN | 3455 | Domestic |
| 12 | POLICE CHOWNKI HARI NAGAR | 2380 | Domestic +Commercial |
| 13 | O/H SHIV N.G.R | 3575 | Domestic |
| 14 | PUMPING STN., SWARG ASH.,SUBHASHNGR | 1731 | Commercial+ domestic |
| 15 | SELF FINANCE S/STN. | 246 | Industrial |
| 16 | TIHAR JAIL | 3761 | Domestic |
| 17 | AJANTA S/STN. | 3788 | Domestic |
| 18 | FATEH NAGAR | 2993 | Domestic |
| 19 | SUBHASH NAGAR S/STN.-2 | 2627 | Domestic |
| 20 | GURUDWARA S/STN | 2835 | Domestic |
| 21 | J-3 RAJOURI GARDEN | 3692 | Domestic |
| 22 | LIG RAJAURI GARDEN+TDI | 1895 | Domestic+ commercial |

| | | | |
|----|------------------------------------|------|-----------------------|
| | MALL | | |
| 23 | 14 BLOCK SUBHASH NAGAR | 2687 | Domestic |
| 24 | CET PLANT MAYAPURI | 194 | Industrial |
| 25 | FATEH NAGAR | 3721 | Domestic |
| 26 | G BLOCK HARI NAGAR | 1527 | Domestic+ commercial |
| 27 | GANDHI PARK I/D S/STN.-1 | 3263 | Domestic |
| 28 | GURUDWARA R/GARDEN | 1422 | Domestic + commercial |
| 29 | J BLOCK RAJOURI GARDEN | 1825 | Domestic+ commercial |
| 30 | LIG RAJOURI GARDEN | 3311 | Domestic |
| 31 | MIG RAJOURI GARDEN | 3556 | Domestic |
| 32 | MTNL FDR NO. II | 1688 | Commercial |
| 33 | MTNL NO-1 & AJANTA INDOOR | 1824 | Commercial |
| 34 | TIKONA PARK ASHOK NAGAR | 2951 | Domestic |
| 35 | B -II S/STN JKP | 2833 | Domestic |
| 36 | C - 1 S/STN JKP | 3145 | Domestic |
| 37 | C BLOCK DABRI MOD | 2664 | Domestic |
| 38 | O/G TO C-II BLOCK JKP | 2884 | Domestic |
| 39 | OG TO A-4 S/STN JKP | 3056 | Domestic |
| 40 | P&T QUARTERS | 375 | Commercial |
| 41 | B-2 BOOSTER PUMP-JKP | 1791 | Domestic +Commercial |
| 42 | BOOSTER PUMP DELHI 43CANTT. | 1655 | Domestic +Commercial |
| 43 | C- 4 JANAKPURI | 3235 | Domestic |
| 44 | C-3 COMPLAINT CENTER JKP | 2488 | Domestic |
| 45 | C.C.R.A. S/STN JKP | 2491 | Domestic |
| 46 | COMM. CENTER S/S NO. 1 PETROL PUMP | 1672 | Commercial |
| 47 | D -2 JANAKPURI | 2789 | Domestic |
| 48 | D-1 S/STN JKP | 2579 | Domestic |
| 49 | D.D.U. HOSPITAL NO II | 1661 | Commercial |
| 50 | D.D.U. HOSPITAL NO-I | 1769 | Commercial |
| 51 | INSTUTIONAL AREA | 246 | Commercial |
| 52 | M S BUILDING (COMM. CENTER JKP) | 325 | Commercial |
| 53 | MUSICAL | 2874 | Domestic |

| | FOUNTAIN JKP | | |
|----|-----------------------------|------|-------------------------|
| 54 | TIHAR JAIL NO.-5 | 2945 | Domestic |
| 55 | GOPINATH BAZAR | 1524 | Domestic+ commercial |
| 56 | BOOSTER (JANAKPURI) | 2864 | Domestic |
| 57 | DISTT., SRVC CNTR JKP | 1445 | Commercial |
| 58 | JYOTI SHIKHAR | 251 | Commercial |
| 59 | NANGLI ZALIB | 3281 | Domestic |
| 60 | PLOT NO. 11, D.C. DDA | 1456 | Domestic+ Commercial |
| 61 | PLOT NO. 13 LIC BLDG. | 358 | Commercial |
| 62 | B-3 S/STN JANAKPURI | 3411 | Domestic |
| 63 | PLOT NO.-7 DISTT. CENTRE | 189 | Commercial |
| 64 | Rewari MYP | 820 | Industrial |

Table No. 4.1 Details of Janakpuri Division 11 KV feeders

From table no.4.1 shown above, the Janakpuri division is divided into four clusters, namely, domestic, industrial, commercial and domestic + commercial. The domestic cluster comprises maximum no. of domestic consumers, similarly, commercial cluster comprises of maximum commercial activity and commercial + domestic contains mixed bag of domestic and commercial consumers. From these 64 HT feeders, 32 HT feeders mainly consist of domestic consumers, i.e., majority of the consumers in these feeders are domestic ones. Similarly, eight 11 KV feeders belong to industrial consumers, thirteen feeders belong to commercial consumers and eleven feeders belong to commercial + domestic consumers.

4.1 HT feeder data and power transformer load profile

This sub-section comprises of computation of power losses of the network based on the approach of load factor and load loss factor. For the sake of simplicity, four 11 feeders are taken one from each cluster of Janakpuri division. Firstly, the feeder data for 24 hours for these four 11 kV feeders is shown in Table nos. 4.3 and 4.4 respectively. Then, LF, LLF and K are calculated for these feeders based on the feeder data. Table no.4.2 shows the load variation of 24 hours of Commercial and Industrial 11 KV feeder of Janakpuri Division.

| Feeder Name/Type of Feeder | JYOTI SHIKHAR Commercial | Rewari MYP Industrial |
|----------------------------|--------------------------|-----------------------|
| Size of Cable | 300 Sqmm | 300 Sqmm |
| Time | Amp | Amp |
| 1 | 75 | 243 |
| 2 | 76 | 244 |
| 3 | 78 | 250 |
| 4 | 77 | 239 |
| 5 | 80 | 240 |
| 6 | 84 | 230 |
| 7 | 102 | 254 |
| 8 | 295 | 263 |
| 9 | 315 | 299 |
| 10 | 314 | 357 |

| | | |
|----|-----|-----|
| 11 | 316 | 394 |
| 12 | 320 | 409 |
| 13 | 285 | 335 |
| 14 | 297 | 342 |
| 15 | 323 | 359 |
| 16 | 354 | 398 |
| 17 | 367 | 415 |
| 18 | 373 | 388 |
| 19 | 380 | 386 |
| 20 | 365 | 334 |
| 21 | 294 | 307 |
| 22 | 124 | 263 |
| 23 | 96 | 248 |
| 24 | 88 | 244 |

Table No. 4.2 Load variation of 24 hours of Commercial and Industrial 11 KV feeder

Similarly, table no. 4.3 shows the load variation of 24 hours of remaining two clusters, domestic and domestic + commercial 11 KV feeder of Janakpuri Division.

| Feeder Name | GOPINATH BAZAR (Domestic + Commercial) Cluster | MIG RAJOURI GARDEN Domestic Cluster |
|---------------|--|-------------------------------------|
| Size of Cable | 240 Sqmm | 300 Sqmm |
| Time | Amp | Amp |
| 1 | 98 | 86 |
| 2 | 96 | 93 |
| 3 | 87 | 87 |
| 4 | 98 | 87 |
| 5 | 115 | 102 |
| 6 | 211 | 124 |
| 7 | 223 | 236 |
| 8 | 239 | 228 |
| 9 | 241 | 238 |
| 10 | 194 | 151 |
| 11 | 180 | 114 |
| 12 | 180 | 116 |
| 13 | 164 | 116 |
| 14 | 177 | 123 |
| 15 | 280 | 125 |
| 16 | 285 | 128 |
| 17 | 290 | 188 |
| 18 | 240 | 212 |
| 19 | 245 | 221 |
| 20 | 232 | 218 |
| 21 | 196 | 198 |
| 22 | 132 | 146 |
| 23 | 124 | 112 |
| 24 | 102 | 98 |

Table No. 4.4 Load variation of 24 hours of domestic and (domestic + commercial) feeder

4.2.1 Load curve and load duration curve of 11 KV feeders

This part of the section gives the load curve and load duration curve of the feeder data. Figs. 4.1 to 4.4 gives the load curve of the 11 KV feeders based on the feeder data given in table nos. 4.2 to 4.3.

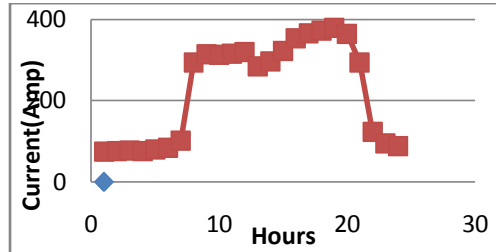


Fig 4.1 Load curve of JyotiShikhar commercial feeder

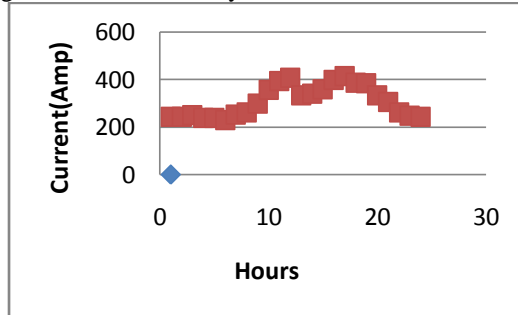


Fig.4.2 Load curve of Rewari MYP industrial

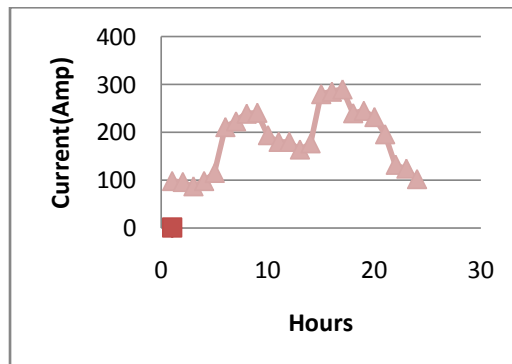


Fig.4.3 Load curve of Gopinath Bazar domestic + commercial area

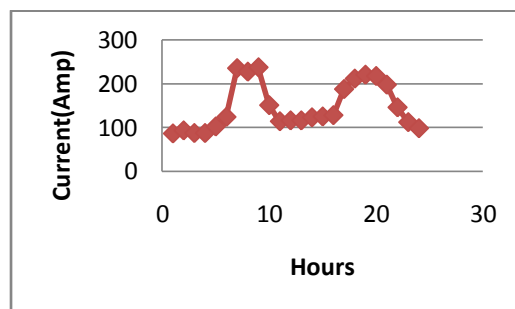


Fig. 4.4 Load curve of MIG Rajauri Garden domestic area

Similarly, Figs. 4.5 to 4.8 give the load duration curve of the 11 KV feeders based on the feeder data given in table nos. 4.2 to 4.3.

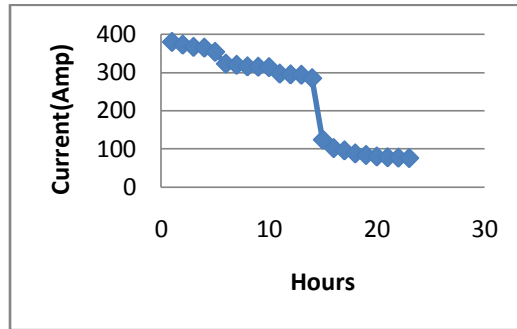


Fig 4.5 Load duration curve of JyotiShikhar commercial feeder

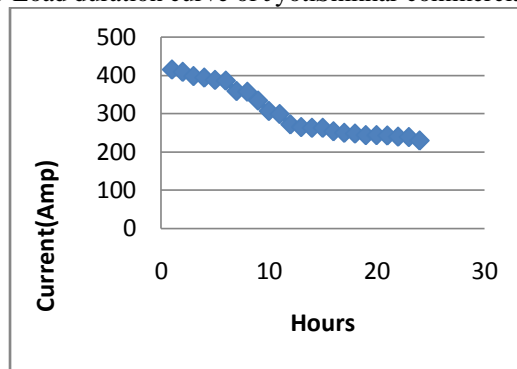


Fig.4.6 Load duration curve of Rewari MYP industrial area

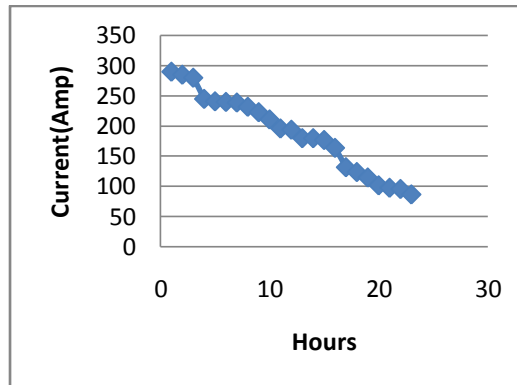


Fig.4.7 Load duration curve of Gopinath Bazar (domestic + commercial Cluster) 11 KV feeder

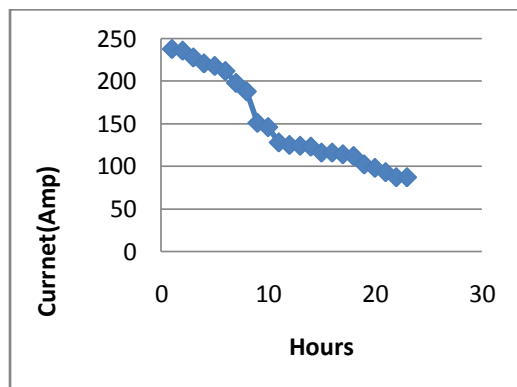


Fig. 4.8 Load duration curve of MIG Rajauri Garden domestic 11 KV feeder

4.2.2 Load Profile of Power Transformer

This sub-section deals with the have the load profile of power transformer of 33 KV grid Rewariline that serves the industrial consumers of Mayapuri Phase-1, Janakpuri division. The power

transformer of 20MVA that supplies power to industrial consumers of Mayapuri phase is considered. Table no. 4.4 gives the load profile of 24 hours load variation of 20 MVA power transformer.

| Transformer name | Rewari Substation |
|------------------|-------------------|
| Time | Amp |
| 1 | 521 |
| 2 | 522 |
| 3 | 494 |
| 4 | 446 |
| 5 | 444 |
| 6 | 466 |
| 7 | 472 |
| 8 | 494 |
| 9 | 456 |
| 10 | 658 |
| 11 | 688 |
| 12 | 714 |
| 13 | 752 |
| 14 | 690 |
| 15 | 782 |
| 16 | 782 |
| 17 | 778 |
| 18 | 756 |
| 19 | 834 |
| 20 | 796 |
| 21 | 720 |
| 22 | 680 |
| 23 | 666 |
| 24 | 614 |

Table No. 4.4 Load variation of 24 hours of power transformer

Similarly, Figs. 4.9 to 4.10 give the load curve and load duration curve respectively of the 20MVA Power Transformer based on data given in table no. 4.5.

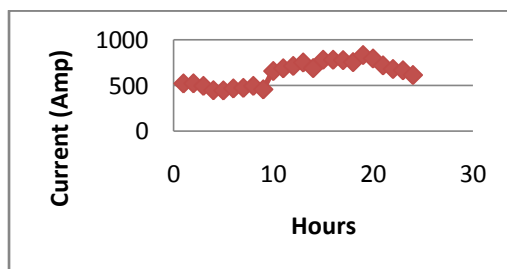


Fig.4.9 Load curve of Rewari power transformer

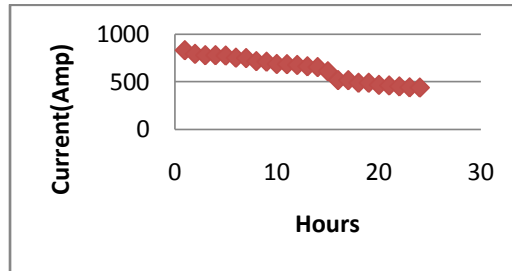


Fig. 4.10 Load duration curve of Rewari power transformer

4.3 Computation of Power Losses of the Network

Lastly, the technical losses in the 11 KV feeders of four clusters and 20 MVA power transformer of Janakpuri division, BSES Rajdhani power limited are calculated.

4.3.1 Losses in Feeders

Loss in a feeder for a given period (which is one month in this case) is given by the equation below.

$$\text{Technical loss in MU} = I^2 \times R \times L \times \text{LLF} \times 24 \times 30 \times 10^{-9}$$

I = Load in amp.

R = Resistance of the conductor in ohms/ kilometre

L = Length of the feeder in kilometres

LLF = Load loss factor

The technical losses of these four 11 KV feeders in million units (MUs) are shown in table No.

| | JyotiShikharCX | Rewari MYP IX | GopinathDX+CX | MIG Rajauri Garden DX |
|---------------------|----------------|---------------------|---------------|--------------------------------|
| Size of conductor | 300 Sqmm | 300 Sqmm | 300 Sqmm | 240 Sqmm |
| Length | 3 KM | 2 KM | 3.5 KM | 5 KM |
| Peak load | 380 | 415 | 245 | 238 |
| LF | 0.76 | 0.68 | 0.72 | 0.76 |
| LLF | 0.61 | 0.50 | 0.55 | 0.64 |
| K | 0.17 | 0.17 | 0.12 | 0.34 |
| Loss in MU | 0.06 MU | 0.05 MU | 0.01 MU | 0.03 MU |
| Technical Loss in % | 1.9 | 1.3 | 2.3 | 2.6 |

Table No. 4.5 Technical loss in MU for 11 KV feeders

In the similar manner, technical loss in MU can be calculated for remaining feeders.

4.3.2 Loss in power transformer

Loss in power transformer can be calculated by equation for calculation of technical loss is given under:

$$\text{Technical loss of Transformer in MU for month} = \{ \text{No load loss} + [(\% \text{ loading})^2 * \text{rated Cu. loss} * \text{LLF}] \} * 24 * 30 / 10^6$$

The technical losses of power transformer in million units (MUs) is shown in table no. 4.6

4.4 Computation of Power Losses in Distribution Transformers

This section gives the load profile of distribution transformer as well computation of losses in

distribution. There are nineteen distribution transformers in the Mayapuri industrial area phase-1 that supply power to nearly 820 industrial consumers.

| Power transformer (20 MVA) | |
|----------------------------|----------|
| Peak load | 834 |
| Full load | 1250 |
| % loading | 71.21 |
| LF | 0.76 |
| LLF | 0.61 |
| K | 0.18 |
| No load loss | 1.72 KW |
| Full load loss | 7.3KW |
| Loss in MU | 0.002 MU |
| Loss in % | 0.9 |

Table 4.6 Technical Loss of Power Transformer

| Sr. No. | Feeder Name | Transformer Rating (KVA) | No. of consumers |
|---------|----------------------------------|--------------------------|------------------|
| 1 | A-8, S/STN, MAYAPURI PH-1 | 630 | 30 |
| 2 | A-23, S/STN, MAYAPURI PH-1 | 630 | 20 |
| 3 | A-15, S/STN, MAYAPURI PH-1 | 990 | 105 |
| 4 | A-4, S/STN, MAYAPURI PH-1 | 630 | 20 |
| 5 | A-43, MAYAPURI, PH-1 | 1000 & 630 | 83 |
| 6 | COMMUNITY CENTRE, MAYAPURI, PH-1 | 1000 & 630 | 77 |
| 7 | A-42, MAYAPURI PH-1 | 400 | 8 |
| 8 | B-138, MAYAPURI PH-1 | 990 | 20 |

| | | | |
|----|--|----------|----|
| 9 | B-75, MAYAPURI PH-1 | 1000 | 10 |
| 10 | POLICE STATION, MAYAPURI PH-1 | 400 | 6 |
| 11 | SHOPPING CENTER MAYAPURI PH-1 | 990 KVA | 85 |
| 12 | B- 80/1, MAYAPURI PH-1 | 630 KVA | 14 |
| 13 | LUMAX, MAYAPURI PH-1 | 1000 KVA | 49 |
| 14 | WH -38, MAYAPURI PH-1 | 1000 KVA | 23 |
| 15 | WH -49, MAYAPURI PH-1 | 1000 KVA | 64 |
| 16 | B-32 MAYAPURI PH-1 | 1000 KVA | 98 |
| 17 | B-24 MAYAPURI PH-1 | 990 | 37 |
| 18 | B-125 MAYAPURI PH-1, KIOSK S/STN. | 1000 | 17 |
| 19 | B-125 TRF NO-1, | 1000 | 33 |

Table No. 4.7 Details of Mayapuri PH-1 DTs

Loss in the Distribution transformer can be calculated by the same formulae as for power transformer and is given below:

Technical loss of Transformer in MU for month =
 $\{ \text{No load loss} + [(\% \text{ loading})^2 * \text{rated Cu. loss} * \text{LLF}] \} * 24 * 30 / 10^6$ [25]

This part deals with the load profile of Distribution transformer that serves the consumers of Mayapuri, Janakpuri division. The Distribution transformer of rating 1000 KVA located at shopping center, Mayapuri is considered here. Table no. 4.8 gives the load profile of 24 hours load variation of this DT.

| Transformer name | Shopping Center |
|------------------|-----------------|
| Time | Amp |
| 1 | 175 |
| 2 | 174 |
| 3 | 174 |
| 4 | 176 |
| 5 | 178 |
| 6 | 180 |

| | |
|----|-----|
| 7 | 195 |
| 8 | 228 |
| 9 | 315 |
| 10 | 350 |
| 11 | 367 |
| 12 | 378 |
| 13 | 316 |
| 14 | 321 |
| 15 | 323 |
| 16 | 367 |
| 17 | 468 |
| 18 | 541 |
| 19 | 480 |
| 20 | 345 |
| 21 | 294 |
| 22 | 237 |
| 23 | 197 |
| 24 | 187 |

Table 4.8 Load variation in Shopping Center DT

Load curve and Load duration curve of distribution transformer are shown in fig.4.11 and 4.12 based on load profile of DT as given in table no. 4.9.

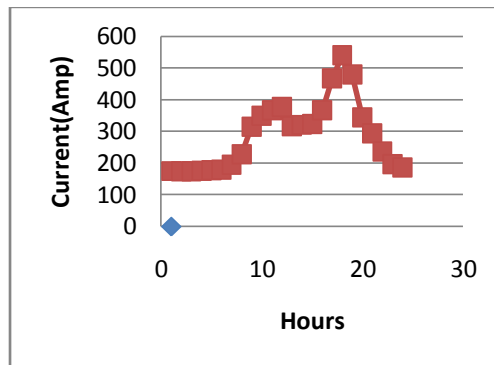


Fig.4.11 Load curve of Shopping Center DT

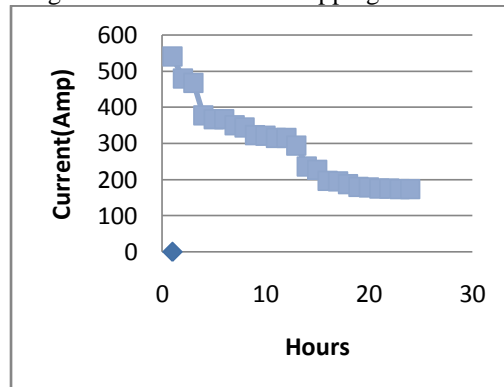


Fig.4.12 Load duration curve of Shopping Center

Lastly, the technical loss % based on load factor and load loss factor approach are computed. The technical losses of Distribution transformer in million units (MUs) of these 7 DT's are shown in table no. 4.9

| T.F Name | Peak Load in Amp | Full Load in Amp | % Loading | Value of "K" | Loss (MU) | Loss % |
|------------------|------------------|------------------|-----------|--------------|-----------|--------|
| Lu max-85 | 1159 | 1250 | 92.72 | 0.17 | 0.0040 | 1.6 |
| A-15 | 982 | 1237 | 79.38 | 0.18 | 0.0025 | 2.2 |
| B-32 | 644 | 1250 | 51.52 | 0.19 | 0.0014 | 2.5 |
| A-43 | 434 | 1250 | 34.72 | 0.18 | 0.0012 | 1.4 |
| Shoppin g Center | 541 | 1237 | 43.73 | 0.17 | 0.0013 | 1.9 |
| WH-49 | 859 | 1237 | 69.44 | 0.16 | 0.0021 | 2.3 |
| B-125 | 686 | 1237 | 54.45 | 0.18 | 0.0016 | 1.3 |

Table No. 4.9 Loss Calculation in Distribution Transformer

V. CONCLUSION

The power distribution utilities in India have huge amount of debt (approx. two lacs seventy five thousand crore rupees) due to high T&D loss% and AT&C loss % in the distribution sector. This results in the poor customer satisfaction, poor quality and unreliable power etc. The losses in the primary and secondary distribution system mainly comprises of technical losses, non-technical losses & revenue not realized. The reasons for the technical losses are lack of inadequate T&D capacity, too many transformation stages, improper load distribution and extensive rural electrification etc. The case study of Janakpuri division of BSES Rajdhani power limited, a power distribution utility of Delhi was considered and computed the technical losses for primary and secondary distribution system using load factor and loss load factor approaches.

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