# Distribution Transformer Failure Analysis in Gujarat DISCOM

Parth Rawal, Pratipalsinh Jadeja, Vishal Devdhar

*Electrical Department / Government Polytechnic Rajkot / Gujarat Technological University, Gujarat, India*

***Abstract*—Utilities deliver power to their customer through a network of generation, transmission lines, substation & distribution system. A distribution system carries power from substation transformer through feeder circuit to distribution transformer located near customer. Distribution spending is one of the largest costs for most utilities also cause of concerns as network increases day by day along with the increasing power demand. Utilities are constantly looking forward to increase productivity in the distribution system. This means reducing losses, improving customer service & protecting assets. A Distribution transformer is utilized to step down the voltage from 11 KV to 0.433/.250 KV so that the electrical power is usable for providing supply to customer such as domestic, industrial, etc. A consumer expects uninterrupted power supply because during failure of power all work be it domestic, official, industrial comes to standstill. Hence, transformer failure leads economic loss, interrupted power supply in industries, offices. This paper present types of failure in distribution transformer, means for reducing distribution losses & recent practices in this regards by Gujarat DISCOM.**

***Keywords*—Distribution transformer, transformer failure, fault tree, capacity failure, load wise failure.**

## I. GUJARAT DISCOM & REFORMS

The promulgation of the Gujarat Electricity Industry (Reorganization and Regulation) Act in 2003 for reorganization of the electricity industry in Gujarat and for establishing an Electricity Regulatory Commission in the state for regulation of the electricity sector paved the way for the organizational restructuring of GEB. The vertically integrated GEB was unbundled into seven companies one each for generation and transmission, four distribution companies (Discoms) and a holding company known as Gujarat Urja Vikas Nigam Limited (GUVNL). The generation, transmission and distribution companies have been structured as subsidiaries of GUVNL. GUVNL acted as the planning and coordinating agency in the sector when reforms were undertaken. It is now the single bulk buyer in the state as well as the bulk supplier to distribution companies. It also carries out the function of power trading in the state. [6]

*Distribution Reforms in Gujarat and their Impact:*

The focus areas of distribution reforms in Gujarat have been as follows:

- Reduction of distribution losses
- Commercial loss reduction
- Improvement in revenues
- Improvement in customer services

*Reduction of distribution losses:*

The distribution companies in Gujarat have focused on reducing distribution losses by a combination of measures such as implementation of technology, strict measures to tackle theft, strengthening of the network, and changing processes and procedures.

*Jyoti Gram Yojana:*

Though the villages in the state were largely electrified as per prescribed parameters, there was a significant gap in the quality of power supplied to these villages. This was attributable to the unauthorized use of power in these villages through illegal means resulting in frequent transformer failures, poor voltage stability and poor reliability of supply. Further there was a rapid increase in demand for power in the rural areas. In this backdrop, the GoG launched the Jyoti Gram Yojana (JGY) as a pilot initiative in eight districts in September 2003 with the objective of supplying reliable and quality power. This scheme was part of the bigger objective of facilitating growth of the rural economy in the state. The pilot was successfully completed in October 2004 and in November 2004 the scheme was extended to the entire state.

*The JGY had the following characteristics:*

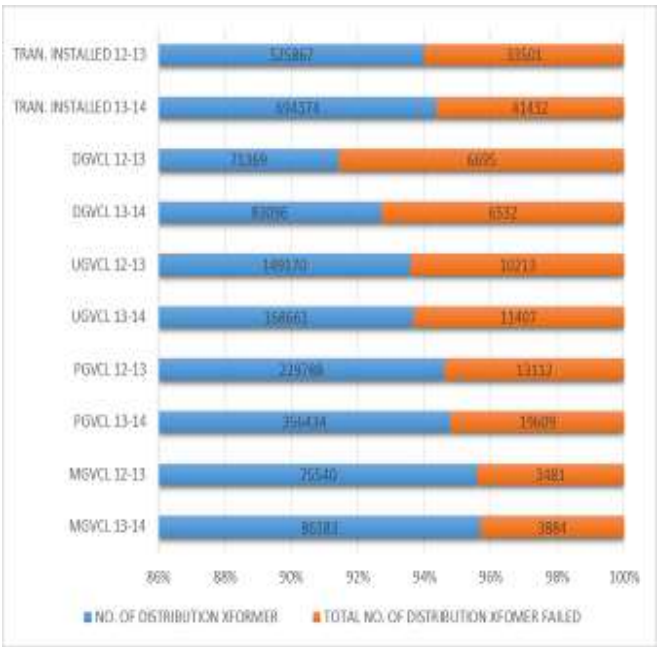
- Bifurcation of rural feeders into:
  - Agricultural feeders catering solely to demand for agricultural purposes
  - Rural feeders catering to load other than agriculture
- Erection of 11/22 kV HT lines in rural areas to separate the agriculture load from the village transformer center.
  - Metering of Transformers on JGY Feeders

- Providing round the clock 3-phase power supply to consumers other than agricultural consumers while ensuring improved quality of minimum 8 hours continuous power supply at pre- determined schedule to agriculture.

## II. GUJARAT DISCOM FAILURE ANALYSIS

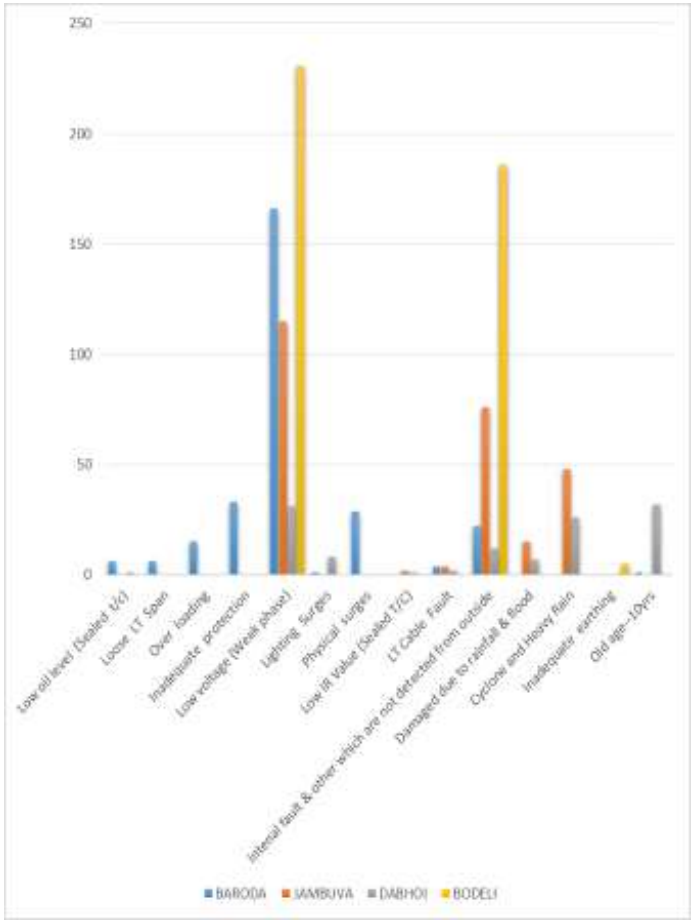
Utilities deliver power to their customer through a network of generation, transmission lines, substation & distribution system. A distribution system carries power from substation transformer through feeder circuit to distribution transformer located near customer. Distribution spending is one of the largest costs for most utilities also cause of concerns as network increases day by day along with the increasing power demand. Utilities are constantly looking forward to increase productivity in the distribution system. This means reducing losses, improving customer service & protecting assets. A Distribution transformer utilized to step down the voltage from 11 KV to 0.433/.250 KV so that the electrical power usable for providing supply to customer such as domestic, industrial, etc. A consumer expects uninterrupted power supply because during failure of power all work be it domestic, official, industrial comes to standstill. Hence, transformer failure leads economic loss, interrupted power supplies to industries, office, etc. [2]

From the survey done we get the following statistical data given in the figure. We found that at present we have total installed distribution transformer in Gujarat is 694374 & failure transformer every year is 41432 so from data we get that percentage failure of transformer is around 6 % & repair or replacement cost per transformer is 2 to 3 lakhs.



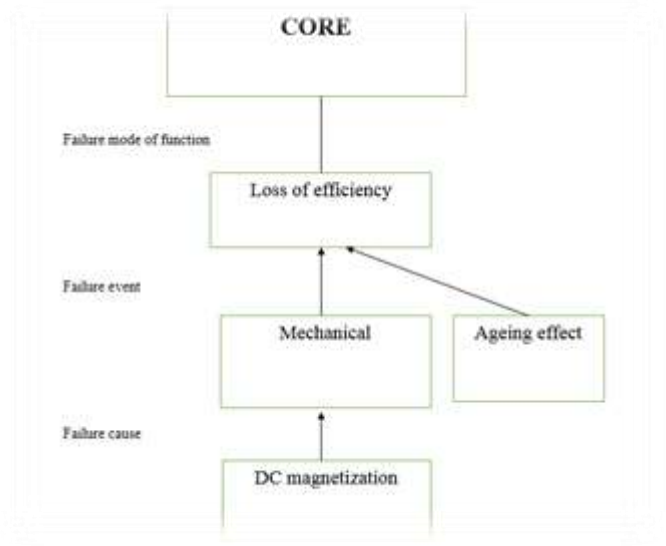

## III. CIRCLE DATA ANALYSIS

So for more analysis we have taken sample from the different circle from the engineers for finding main cause of transformer failure. From the failure reported, the leading cause of transformer failures is Low voltage & internal faults, so we can say main cause to be “insulation failure”. So from data obtained we have created fault tree which easily explains the cause of failure. From the failure reported, the leading cause of transformer failures is Low voltage & internal faults, so we can say main cause to be “insulation failure”. So from data obtained we have created fault tree which easily explains the cause of failure. [4]



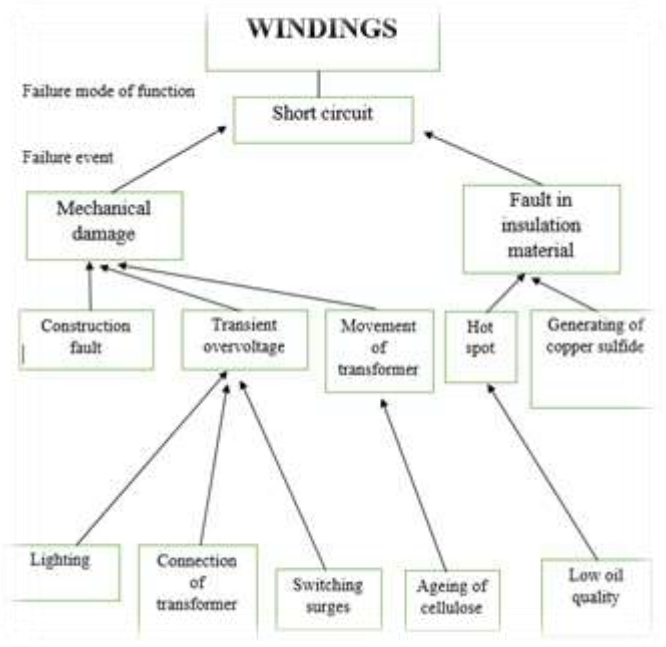

## IV. FAULT TREE FOR CORE

The core’s function is to carry magnetic flux. The failure mode of this function is a reduction of transformer efficiency or ageing. The cause can be a mechanical fault in the core, due to DC magnetism or displacement of core steel during the construction. Figure shows a fault tree for core. [4]



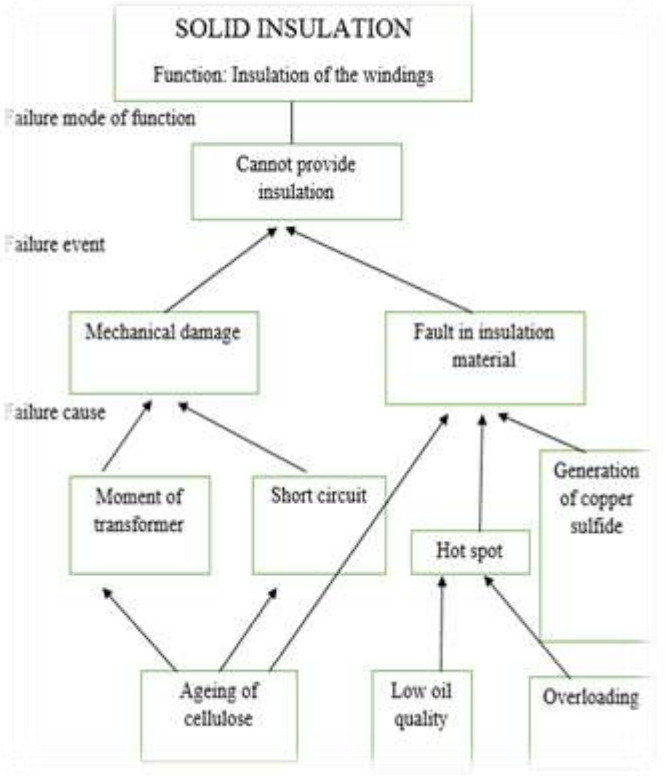

V. FAULT TREE FOR WINDINGS

The windings belong to the active part of a transformer, and their function is to carry current. The windings are arranged as cylindrical shells around the core limb, where each strand is wrapped with insulation paper. Copper is today the primary choice as winding material. In addition to dielectric stresses and thermal requirements the winding have to withstand mechanical forces that may cause windings replacement. Such forces can appear during short circuits, lightning's, etc. [4]




VI. FAULT TREE FOR INSULATION FAILURE

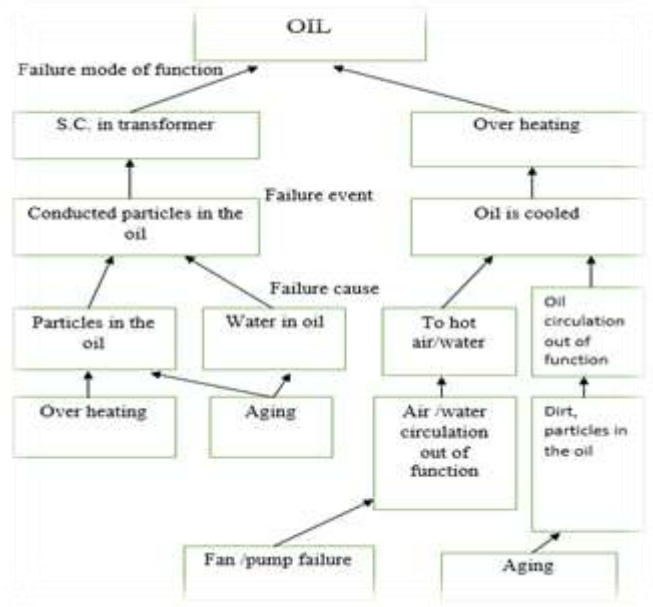
The solid insulation in transformer is cellulose based products such as press board and paper. Its function is to provide dielectric and mechanical isolation to the windings. Cellulose consists of long chains of glucose rings. When degradation of the cellulose occurs these chains get shorter. Degree of polymerization is average number of these rings in the chain and indicates the condition of the paper. New paper has an average DP number of 1200-1400. A DP no longer withstand short circuit and other mechanical strength and may solid insulation is the weakest link in the transformer insulation system, due to degradation of the cellulose is irreversible and it is often not economically defensible to replace it. The aging of cellulose is accelerated by water, oxygen, and heat. [4]




VII. FAULT TREE FOR OIL INSULATION DETERIORATION

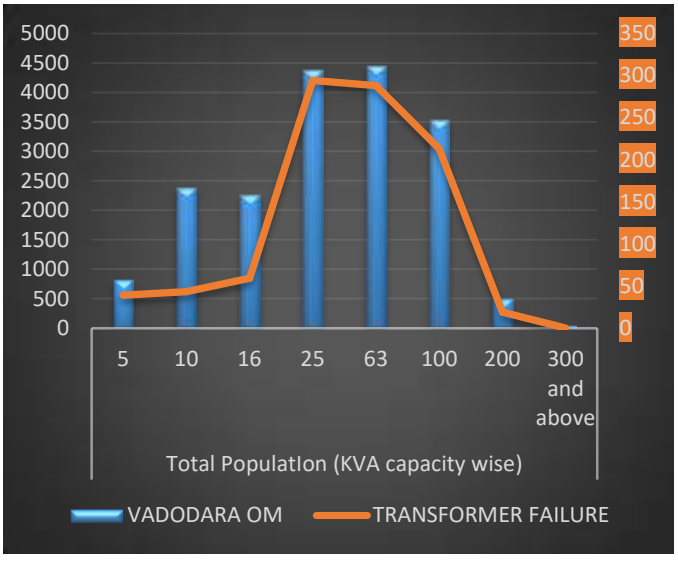
The transformer oil is highly refined product from mineral crude oil and consists of hydrocarbon composition of which the most common are paraffin, naphthene and aromatic oils. The oil serves as both cooling medium and part of the insulation system. The quality of oil greatly affects the insulation and cooling properties of the transformer. The major causes of oil deterioration are due to moisture and oxygen couple with heat.

Another function of the oil is to impregnate the cellulose and isolate between the different parts in the transformer. If the isolation fails there is a short circuit. A short circuit can appear if there is conducted particles present in oil e.g. water, metal.




## VIII. CAPACITY WISE FAILURE ANALYSIS

This failure analysis is essential as generally less than 100 KVA capacity transformers are used in rural areas where the problem of theft is more, load unbalancing, inadequate protection system, theft of unearthing wire or not proper earthing, improper maintenance, etc. which shows that failure rate is more in transformer capacity less than 100 KVA and transformer capacity more than 100 KVA are mainly used in urban and industrial areas so the failure rate is less for it. So from the data obtained we have found out the failure rate in rural, urban and industrial.




## IX. LOAD WISE FAILURE ANALYSIS

The feeder is separated into total of five category:

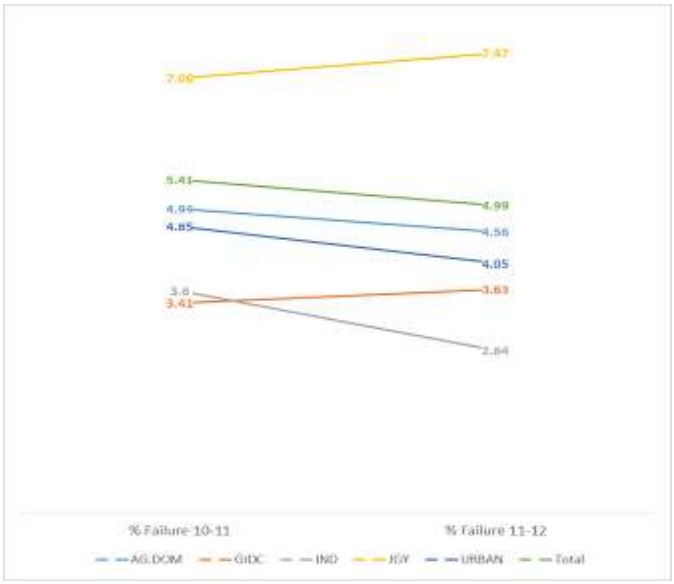
AG.DOM: This feeder is used to supply power to agriculture domestic consumer in rural areas.

GIDC: This feeder is used to supply power to the Gujarat small & medium sized industries.

IND: This feeder is used to supply power to medium and large industries.

JGY: This feeder is used to supply power to agriculture load. The power supplied by this feeder is only 8 hours per day.

URBAN: This feeder is used to supply power to urban residential and commercial loads.




## X. CONCLUSION

From the field survey done we can concluded that there should be proper maintenance strategy is required to be put in place in Distribution company for rural area, as they are mainly remote areas which leads to lack of maintenance as well as negligence is seen from engineers side, is required to be addressed.

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