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STUDY OF VARIOUS TRANSFORMER FAILURES, CAUSES AND IMPACT

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***Abstract*—**Investigation of transformers, the flaws that most regularly happen, the reasons for these deficiencies and their effect is led and talked about in this paper. The transformers that were pondered were wander down transformers (11kv-220v) used by WAPDA available for use divisions. Information about the transformer dissatisfaction all through the past 5 years was accumulated from PESCO for two ranges of Chhattisgarh. The vital region was the metropolitan scope of University Town and the second was the suburb locale. Exhaustive information mining was done to examine the reason for disappointments.

***Keywords*—**Transformers, Faults, Failures, Causes, PriorityNumber, power distribution

1. INTRODUCTION

Transformers are electrical gadgets utilized for vitality exchange by electromagnetic enlistment between at least two circuits. Like every single electrical gadget blames additionally occur in the transformers which cause disappointments. One disappointment can bring about numerous issues. A basic blame at the disseminating end can bring about pass out of energy to the entire range. The blame can likewise be extremely perilous as the transformers contain large amount of oil in direct contact with high voltage segments. This expands the danger of flame and blasts because of disappointments [1].

Distinctive deficiencies are brought about by various reasons, which all impacts affect the power framework. In this paper probably the most generally happening disappointments are talked about with their causes and effects. This critical procedure of venturing up and venturing down of voltage and current is finished by Transformers introduce at both closures of the power transmission and dissemination [2].

To dodge real line misfortunes in influence transmission over long separations the voltage is venture up to 11kv and the current is venture down as the influence is transmitted to various parts of the nation by long transmission lines.

The misfortunes are numerically spoken to by Eq. 1:

$$\text{Losses} = I.I.R \quad (1)$$

Where I is current and R is the resistance. Longer the transmission-line more is the resistance. Consequently the voltage is kept high and the current is kept low.

2. POWER DISTRIBUTION SYSTEM

To Power is produced for customer use. From when power is produced this is transmitted through of transmission lines by means of networks and then appropriated to the customer. Control circulation framework is the last and most essential connection in electricity inventory network and most noticeable piece of the electricity division, as indicated by Power Grid Corporation of India Limited current dispersion misfortunes is around 30%.

Appropriation misfortunes can be brought about by robbery of electricity, low metering levels and poor money related soundness of utilities with ease recuperation, which generally causes influence quality issues and increment to electricity supply. The vitality misfortunes happen during the time spent this providing electricity to customers because of specialized and business misfortunes. The specialized misfortunes are because of vitality disseminated in the conductors and to hardware utilized for the transmission, change, sub transmission and appropriation of influence.

The essential Power disseminations systems are electrical circuits with three-stage wire (three stages), associated at conveyance substation and are generally implicit classes of voltage of 11KV and 33KV. The levels of voltage: 11 KV and 33 KV are institutionalized by law; and different levels happen and keep on operating regularly. Essential Power appropriation systems are introduced with dissemination transformers, settled on posts, whose capacity is to bring down the voltage level to the essential side voltage level [3].

The auxiliary power dissemination systems are electrical circuits with three-stage four wires (three stages and impartial), regularly work at voltages (stage - stage/stage - nonpartisan) 11KV/440 volts, 11KV/230 volts. These systems are associated buyers, and including living arrangements, shops, bread kitchens, et cetera, and furthermore the installations for road lighting. These systems serve the large utilization focuses (namely, to population and large industry, into others) [4].

3. CLASSIFICATION

A power transformer like numerous electronic gadgets faces numerous disappointments. MIL-STD-1629A standard is utilized to characterize diverse flaws that happen. It is the most normally utilized standard utilized all through the world for as long as 30 years.

Each blame is initially arranged into three classes which are further subcategorized.

The principal classification the issues are characterized are on the premise of seriousness of the blame. The greater the blame the more separate it is. Table-I demonstrates this arrangement [5].

TABLE I SEVERITY CLASSIFICATION FOR POWER TRANSFORMERS

Value	Description	Criteria
1	Category IV (Minor)	Primary function can be done but urgent repair needed
2	Category III (Marginal)	Reduction in ability to primary function
3	Category II(Critical)	Causes a loss of primary function
4	Category I (Catastrophic)	Product becomes inappropriate

The second category the faults are classified are on the basis of the occurrence of the fault. The more frequent the fault occurs the more sever it is. Table-II shows this classification[6].

TABLE II OCCURRENCE CLASSIFICATION FOR POWER TRANSFORMERS

Value	Description	Criteria
1	Level E (Extremely unlikely)	Probability of occurrence less than 0.001
2	Level D (Remote)	Probability of occurrence more than 0.001and less than 0.01
3	Level C (occasional)	Probability of occurrence more than 0.01and less than 0.1
4	Level B (Reasonably Probable)	Probability of occurrence more than 0.1and less than 0.2
5	Level A (Frequent)	Probability of occurrence more than 0.2

The Third category the faults are classified are on the basis of the detection of the fault after it has occurred. This is an important part as after the fault is detected it can be repaired. Table-III shows this classification [7].

TABLE III DETECTION CLASSIFICATION FOR POWER TRANSFORMERS

Value	Detection	Criteria
1	Level F	Good Identification
2	Level E	Fair Identification
3	Level D	Good detection and rough Identification
4	Level C	Fair detection
5	Level B	Rough detection
6	Level A	Complementary test

A numerical esteem called Priority Number (PN) is doled out to each blame which relies on upon the blame an incentive from the over three tables. This number chooses the move should have been made after the blame happens. PN is ascertained by Eq. 2

PN = Severity * Occurrence * Detection (2)

The base number of PN for any blame is 1 and the most extreme is 120. The PN is additionally used to figure the likelihood of the blame going to happen before it does, so that required activity should be possible to forestall it before it happens

4. FAILURES, CAUSES & IMPACT

Deficiencies may happen in various parts and segments of the transformer because of mechanical, electrical or warm anxiety brought about because of various conditions. The absolute most ordinarily happening disappointments of the transformer and their causes are recorded underneath.

1. Winding failure

Windings are an essential piece of a transformer. In dispersion side transformers there are ordinarily two windings. One on the essential side and the second on the optional side.

High voltage/low current streams in the essential side twisting and through electromagnetic enlistment voltage is ventured down and current ventured up in the optional side winding. These windings withstand dielectric, warm and mechanical worry amid this procedure. The flaws that happen in the twisting are because of these burdens [8]. This causes the breaking of the windings or the wear out. The winding flaw PN number is for the most part between 6 to 30.

Dielectric flaws happen in the twisting because of swing to-turn protection breakdown. These are the protection between the turns of the winding. Protection breakdown normally happen because of high present and voltage which are high over the appraised values. The breakdown of the protection brings about the flashover of the winding turns and cause hamper. Two purposes behind the high appraising are Lightning motivation assault with no lightning arresters [9].

2. Fault voltages

- The windings are more often than not of copper. Because of the copper line resistance warm misfortunes happen. These warm misfortunes make hotspots in the twisting because of terrible or absence of upkeep. This after some time causes wear and tear and the decline of the physical quality up to the point of breaking of the winding.

- Mechanical issues are the bending, relaxing or uprooting of the windings. These outcomes in the decline of the performance of the transformer and the tearing of the swing to-turn proportion. The primary reasons that cause this blame are the despicable repair, awful support, consumption, producing insufficiencies, vibration and mechanical development inside the transformer.

3. Bushing Failure

Brambles are protecting gadgets that protect a high voltage electrical channel to go through an earth conveyor. In transformers it gives a present way through the tank divider. Inside the transformer paper encasings are utilized which are encompassed by oil that gives facilitate protection. Bushing disappointment as a rule happens after some time. Hedges disappointment PN number is between 24 to 48. A portion of the principle explanations behind bushing disappointment are examined beneath.

- Loosening of conductors is brought about by transformer vibrations which bring about overheating. This warmth harm the protecting paper and the oil utilized.
- Sudden high blame voltages causes' halfway release (breakdown of strong/fluid electrical encasings) which harm the hedges and causes its degeneration and finish breakdown inside hours.
- Seal breaking of shrubberies occur because of entrance of water, maturing or exorbitant dielectric misfortunes. Because of this blame center disappointment of the transformer happens.
- Not supplanting of old oil over long time or its insufficiency because of spillage causes inside over-glimmering.

4. Tap Changer Failure

The tap changer work in the transformer is to control the voltage level. This is finished by either including or expelling turns from the optional transformer winding. It is the most complex piece of the transformer and furthermore an essential one. Indeed, even the littlest blame outcomes in the wrong power yield [10]. The PN number is for the most part between 28 to 52. Some blame and causes are

- In Run-Through blame the tap changer requires some serious energy and after a postpone changes the turn proportion. The principle explanation behind it is the transfer in charge of the tap change has buildup flux as a result of dirtied oil, accordingly setting aside opportunity to change. The other explanation behind gone through blame is the spring getting to be distinctly delicate after some time.

- Lack of support causes the pole association between the tap and the engine driver of the tap changer to be not synchronous. In view of this the tap changer is not in the position where it should be.

- Old capacitors or wore out capacitor in the engine makes the tap changer neglect to control its course development.

- Regular utilization of the tap changer causes the spring in it to gradually get to be distinctly delicate after some time and afterward at last break. In light of this the tap changer is not ready to change the turn proportion of the winding.

- Breakdown of the engine in the tap changer in view of over voltage or miss-utilize likewise makes the tap changer neglect to change the turn proportion of the winding.

5. Core failure

The transformers have covered steel centers in the center encompassed by the transformer windings. The capacity of the center is to think the attractive flux. Blame in the center straightforwardly influences the transformer windings, bringing on deficiencies in them. The centers of the transformers are covered to diminish whirlpool current. The cover of the center can get to be abandoned by poor upkeep, old oil or erosion. The breakdown of the littlest piece of the cover brings about

increment of warm warmth because of vortex current . The impacts of this over warming are

- The over-warming achieves the center surface which is in direct contact with the windings. Accordingly of this the windings are harmed by the warmth.
- This warm additionally harms the oil in the transformers bringing about the arrival of a gas from the oil that harms different parts of the transformer.
- The PN number of the center disappointment is regularly 6.

6. Tank Failures

The capacity of the tank in the transformer is to be a holder for the oil utilized as a part of it. The oil in the tank is utilized for protection and cooling. The tank can likewise be utilized as a support for different supplies of the transformer. The PN number for the disappointment is 18.

The blame in the tank happens because of natural anxiety, erosion, high dampness and sun radiation [11] bringing about a spillage or splits in the tank dividers. From these spillages and breaks oil slick from the tank bringing about the diminishment of oil.

- The lessening in oil level outcomes in the decrease of protection in the transformer and influencing the windings.
- The oil is likewise utilized for cooling purposes so the diminishment of oil causes over-warming with harms diverse parts of the transformer.

7. Protection system Failure

The fundamental capacity of the insurance framework is to shield the transformer from flaws by first identifying the blame and afterward settling it as quick as could reasonably be expected. In the event that it can't settle the blame, it disconnects it with the goal that it may not harm the transformer.

Assurance frameworks incorporate the Buchholz security, weight help valve hardware, surge insurance and Sudden Pressure Relays [12].

This is the most happening disappointment with a PN between 22 to 64.

- Buchholz assurance is a defensive gadget that is touchy to dielectric

blames in the transformer. Overheating of the transfer happens as a result of gathering of gasses after some time, which decreases its affectability to dielectric deficiencies. Low level oil because of spillage causes the Buchholz assurance to come energetically regardless of the possibility that there is not a blame which is not required and misuse of vitality.

- Pressure alleviation valve hardware shields the transformer from detonating because of gas weight. The gas weight is created because of overheating of oil. Weight alleviation valve hardware gradually lessens the weight of the gasses. Blame in this hardware principally happens because of the spring init getting to be distinctly delicate after some time bringing about the hardware not having the capacity to diminish weight rapidly. This hardware likewise falls flat when gas weight increments rapidly as this is just ready to discharge weight gradually.
- Surge defender shields the transformer from over voltage by permitting particular size of voltage to go to transformer and for the rest backup course of action is found. Disappointment in surge insurance causes high voltage to go to the windings which gets to be distinctly harmed as a result of it. Dampness, warmth and consumption are the principle reasons of the disappointment of surge assurance as it causes overheating and short out in it.
- Sudden Pressure Relays shields the transformers from exploding from sudden exponential increment of gas weight If it neglects to discharge the sudden weight the transformer explodes. Transfer flops because of dampness and dampness influencing its inward hardware.

8. Cooling system failure

Cooling framework lessens the warmth created in transformers because of copper and iron misfortunes. The cooling framework contains cooling fans, oil pumps and water-

cooled warm exchangers. The disappointment in the cooling framework causes the warmth to develop in the transformer which impact distinctive parts of the transformer and furthermore causes more gas weight to be worked inside which may bring about the transformer to blow [13]. The PN is between 26 to 48. A portion of the fundamental explanations behind disappointment are talked about beneath.

- One of the main motivations of cooling framework disappointment is break in the oil/water channels. This causes the diminishment in the liquids which brings about low warmth trade which is bad for the transformer. Spillage happens in view of ecological anxiety, consumption, high dampness and sun radiation.

- Some disappointment happens because of blame in the cooling fans which surge in cool air into the tanks for cooling reason. The fans make flaws due to poor upkeep, over utilize or engine destroy.

- Cooling framework can perform wrong because of awful indoor regulators which measure the warmth in the transformer. Defective indoor regulators indicate wrong temperature making the cooling framework work as needs be and not in the way required.

5. CONCLUSION

A single distribution transformer has a wide range of parts which work in correspondence with each other. All these distinctive parts have diverse faults which cause distinctive failures. Some are more serious than other, some happen all the more much of the time while some are difficult to identify. One thing that is clear is that a single fault has influence on that particular segment as well as on numerous others in the transformer in this way a greater disappointment happens in the transformer from a little fault. Indeed, even the littlest fault must not be overlooked.

REFERENCES

[1] A. Franzén, and S. Karlsson, "Failure modes and effects analysis of transformers," Royal Institute of Technology, KTH School of ElectricalEngineering, Stockholm, Sweden, January 2007.

[2] Mohsen Akbari, P. Khazaee&Sabetghadam, P. Karimifard "Failure Modes and Effects Analysis (FMEA) for Power Transformers" PowerTransmission & Distribution Research Center Niroo Research Institute (NRI) Tehran, Iran. 28th international power system conference, iran, November2013.

[3] CIGRE Working Group A2.18, No. 227, Guide for LIFE Management Techniques for Power Transformer, June 2003.

[4] William H. Bartley, "Failure analysis of Transformer", The HartfordSteam Boiler Inspection & Insurance, 2003

[5] Viktor Sokolov& Boris Vanin, "Evaluation and identification of typical defects and failure modes of 110-775kv bushing".

[6] J.H. Harlow, Electric Power Transformer Engineering, 2004.

[7] M. F. Cabanas, F. Pedrayes, M. G. Melero, C. H. Rojas G. A. Orcajo, J. M. Cano & J. G. Norniella, "INSULATION FAULT DIAGNOSIS INHIGH VOLTAGE POWER TRANSFORMERS BY MEANS OF LEAKAGE FLUX ANALYSIS", Progress In Electromagnetics Research, Vol. 114, 211{234, 2011.

[8] Carlsson Å., Power Transformer Design Fundamentals. ABB Transformers, ABB, Ludvika, August 2000.

[9] Michel Duval, "A review of faults detectible by gas in oil analysis in transformers", DEIS, IREQ, Canada.

[10] M. Gumede& G. Frederick d'Almaine, "Surge Arrester Faults and Their Causes at EThekwini Electricity", Durban University ofTechnology/Power Engineering, Durban, South Africa, International Journal of Electrical Energy, Vol. 2, No. 1, March 2014

[11] http://en.wikipedia.org/wiki/Transformer

[12] J. Jagers, and S. Tenbohlen, "Differences approaches for the acquisition of reliability statistics," CIGRE, pp. 1-7, 2009.

[13] http://en.wikipedia.org/wiki/Electricity_sector_in_Pakista