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A STUDY ON IMPACT ANALYSIS OF POWER QUALITY PROBLEMS OF TRANSFORMERS DISTRIBUION FALIURE

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ABSTRACT

This paper focuses around distribution transformer failure. The Transformer is a static machine which moves energy starting with one electrical circuit then onto the next by electromagnetic induction. Distribution transformer is a most significant part of the electrical framework for giving continuous capacity to the shoppers and it ought to be profoundly dependable and proficient. Distribution transformer failure investigation is done to discover distribution transformer failure modes and causes, failure examination is led on 330 failed 11KV/433V distribution transformers of different limits from 2010-2015 Transformer failure investigation is led in two sections. In initial segment to direct failure examination on distribution transformers IEEE standard Guide for Failure Investigation, Documentation and Analysis for Power Transformer and Shunt Reactors alongside are utilized.

KEY WORDS: Distribution, transformer, power, consumer, failure.

I. INTRODUCTION

For various reasons a move is occurring, or expected to happen in future, from huge scope power generation units towards little scope generation associated with distribution organizations. The expression "distributed generation" (DG) or "distributed energy resources" (DER) is being utilized to allude to this little scope generation. The current circumstance is alluded to as "unified generation". Distributed energy resources have favorable circumstances over unified generation in various applications, for instance less expensive absolute energy bills on account of joined warmth and-power; saving money on fossil fuel if there should arise an occurrence of renewable energy sources, improvement of nearby dependability in the event of frail or untrustworthy public grids, conceding of distribution framework interest if there should be an occurrence of intensely loaded grids, costs security in the event of high unpredictability in power costs. Regardless of what the application, the mix of sources of electrical energy at distribution level will have impacts on plan and activity of the distribution framework. A much-examined sway is the normal disintegration of

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power quality because of the huge scope organization of distributed energy resources. Then again, the current power quality may adverse affect the distributed energy resources. This paper presents the connection between power quality and distributed energy in an efficient manner the qualification among voltage and current quality is a basic one, and applies this to DER. In transmission and distribution frameworks, transformer empowerment is a genuinely normal activity. In any case, such an activity may trigger issues, for example, voltage and current unsettling influences. The transformer itself is an indispensable and costly part of the power flexibly framework. Truly, transformer stimulation and its related transients have been examined in different power framework investigates. Despite the fact that transformer empowerment issues in transmission and distribution networks are notable for quite a while, the issues are turning out to be increasingly pervasive. This is because of two central point: (I) the power markets have prompted an expanded number of members with continuous changes in the organization geography, and (ii) the rising pattern around the world towards the utilization of clean renewable energy (wind, sunlight based, and so forth) through distributed generation with characteristically serious level of irregularity. Transformer stimulation has offered ascend to numerous instances of genuine power framework issues.

II. VOLTAGE SAGS AND SWELLS

Voltage sags – or dips which are something very similar – are brief decreases in voltage, commonly enduring from a cycle to a second or in this way, or many milliseconds to several milliseconds. Voltage swells are brief expansions in voltage throughout a similar time range. Longer times of low or high voltage are alluded to as "under voltage" or "overvoltage". Voltage sags are brought about by unexpected expansions in loads, for example, short circuits or blames, motors turning over, or electric radiators turning on, or they are brought about by sudden expansions in source impedance, commonly brought about by a free association. Voltage swells are quite often brought about by an unexpected decrease in load on a circuit with a poor or harmed voltage regulator, in spite of the fact that they can likewise be brought about by a harmed or free unbiased association. Voltage sags are the most well-known power aggravation. At an ordinary mechanical site, it isn't unordinary to see a few sags for each year at the administration entrance, and unmistakably more at gear terminals. Voltage sags can show up from the utility; notwithstanding, as a rule, the majority of sags are produced inside a building. For instance, in private wiring, the most widely recognized reason for voltage sags

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is the beginning current drawn by refrigerator and cooling motors. Sags don't by and large upset incandescent or fluorescent lighting. Motors or warmers However, some electronic hardware needs adequate inside energy storage and, therefore, can't ride through sags in the gracefully voltage. Hardware might have the option to ride through exceptionally concise, profound sags, or it might have the option to ride through longer however shallower sags.

III. RESEARCH METHODOLOGY

Distribution transformer failure analysis is done to discover distribution transformer failure modes and causes, failure analysis is directed on 330 failed 11KV/433V distribution transformers of different limits from 2010-2015 Transformer failure analysis is led in two sections. In initial segment to lead failure analysis on distribution transformers IEEE standard Guide for Failure Investigation, Documentation and Analysis for Power Transformer and Shunt Reactors alongside are utilized. It gives a methodology to perform failure analysis on transformers to discover the most reasonable justification of transformer failure. In view of this technique a factual analysis is introduced to recognize reasons for failure and level of transformer failure. In second part Transformer Failure Modes Effect and Criticality Analysis (FMECA) is introduced to recognize transformer failure modes, reasons for failure of transformer segments and its nearby and end effects by appointing a danger priority number (RPN) in light of seriousness, event and recognition of failure to discover most basic segments of transformer and compensatory arrangements are prescribed to spare the transformer from failure to decrease the failure rate.

3.1 Preparation for Information Gathering

Before directing the onsite investigation, records identified with the history of the state of the transformer must be gathered this will stand extremely supportive during the onsite examination, which may incorporate:

3.2 Routine inspection reports

- Maintenance work records including reports on past problems
- Historical DGA results
- Historical oil test results
- Transformer name plate ratings
- Factory test data reports
- Loading data at the time of failure
- List of faults or switching events in the system just prior to failure

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3.3 Onsite Inspection

Onsite inspection comprises of looking at the outside conditions around the failed transformer and thorough assessment of transformer. A speedy onsite inspection of a failed transformer is important to gather the indispensable information which might be pulverized during restoration of supply

3.4 Transformer Conditions

Investigations are done/performed on following obvious abnormalities in the transformer for example principle tank for swelling, breaks, releases, indication of overheating, oil slick or fire, oil level in fundamental tank, oil level in conservator, harm to radiators, harm to conservator and bushings for releases, broken porcelain, openings in covers and following and so on At the point when no obvious harm is found remotely, at that point following stage is to direct symptomatic testing of transformer.

3.5 Diagnostic Testing

In outer assessment of transformer, when there is no noticeable harm is discovered, at that point demonstrative tests are directed to discover deficiency and to give sign of fix. Test information is recorded cautiously and a few tests are deciphered together to analyze an issue. Tests of protecting oil for testing must be taken prior to opening the transformer for inspection. Following tests are led on transformer.

IV. DATA ANALYSIS

Transformer failure analysis is directed according to approach examined in past area. In the wake of gathering information from on-site and off-site, it is thoroughly concentrated before arriving at any resolution for reporting cause and effects. The distribution associated in distribution framework may flop because of mechanical harm and electrical failure. The energy from the power framework can make both happen. Therefore appropriate consideration has been taken during reporting cause and effects. It has more than 8 million consumer base comprising of domestic, commercial, industrial and agriculture loads isolated in four zones. The consumers are taken care of through distribution network of HT/LT (11KV/.4KV) line of roughly 214868/149668 CKT. KM length and around 7.5 lakhs of distribution transformers the transformer failure rate is above 15% which is a tremendous misfortune to the organization. According to IEEE Standard 57.100-1999 the life of fluid submerged transformer is 20.55 years. So enormous number of distribution transformers are flopping rashly. In this work a city base sub division is chosen and a failure analysis in did on failed transformers from 2010 to 2015 to discover the reason for failure of distribution

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transformers. Information gathered on Transformer failure for one zone of PSPCL comprising four quantities of circles named as C1, C2, C3 and C4 for the years 2010 to 2015 given in Table 1.

Table 1 Transformers failed during 2010-2015

Circle	Year	2010	2011	2012	2013	2014	2015
C1	DT Damaged	1992	2259	2474	2689	2745	2829
	DT Installed	11894	13389	14564	15198	15491	15721
	Percentage Damaged	16.75	16.87	16.99	17.69	17.72	18.00
C2	DT Damaged	3017	3184	3265	3418	3615	3721
	DT Installed	17895	18502	18612	19254	20015	20274
	Percentage Damaged	16.86	17.21	17.54	17.75	18.06	18.35
C3	DT Damaged	3424	4019	4389	4633	4979	5310
	DT Installed	21923	23987	25567	26112	27721	28725
	Percentage Damaged	15.62	16.75	17.17	17.74	17.96	18.49
C4	DT Damaged	1825	2367	2701	3417	3892	4387
	DT Installed	10984	13826	14989	17890	20258	22108
	Percentage Damaged	16.62	17.12	18.02	19.1	19.21	19.84

Yearly number of failure of distribution transformers of one west zone comprising of four circles (for example C1, C2, C3, and C4) is given by Table 1. According to Table 1 number of new transformers is added each year, likewise transformer failures are expanding each year and

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showing the expanding pattern of failure. Which demonstrate enormous resource misfortune to the organization every year, is worth of crores of rupees? To discover the main driver of such a high failure of transformer one city sub division is chosen and failure analysis is completed consistently from 2010 to 2015 on 330 failed transformers during this time, are additionally appeared in Table 2. It shows absolute number of transformers fizzled during the year, complete number of transformers and rate failure rate are additionally appeared. It shows that huge number of transformers is flopping rashly coming about immense loss of resources and loss of income because of supply failure to the utility

Table 2 Transformers failed in City Subdivision during 2010-2015

Year	DT Damaged	DT Installed	Percentage Damaged
2010	40	250	16.33
2011	45	270	17.22
2012	52	285	17.48
2013	67	353	18.64
2014	68	361	19.01
2015	76	382	19.48

4.1 Transformer Failed after Installation

Distribution transformer age is viewed as 20.55 years according to IEEE standard C57.125; however transformers are flopping very before finishing their administration age. Figure 1 gives the life of failed transformers in years after establishment. It shows that the greater part of transformer dissected for failure are failed rashly, for example 19 transformers fizzled in the wake of finishing the age of 0-4years, 134 following 5-10 years, 124 following 10-15 years and 36 following 15-20 years.

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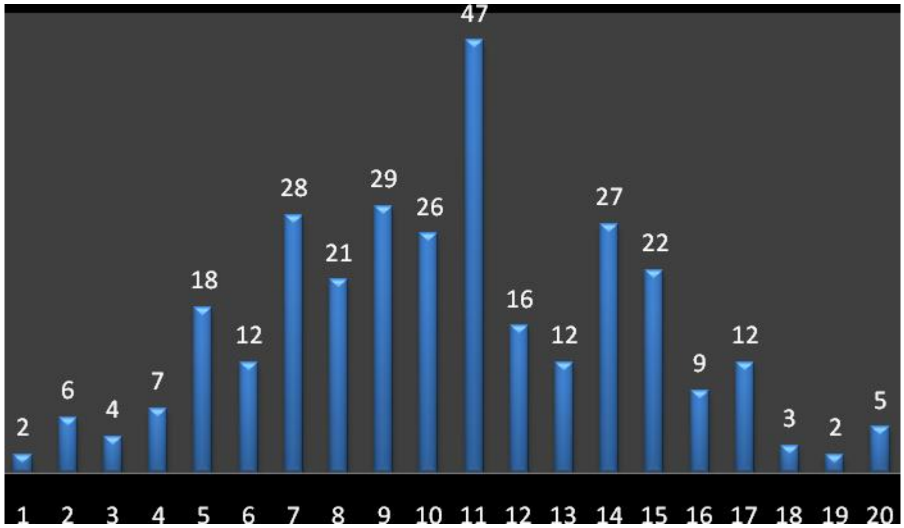

Figure 1 Number of Transformers failed after years of installation

4.2 Transformer 'Failure Modes Effect and Criticality Analysis' (FMECA)

To lead FMECA transformer failure information of 330 number of transformer of different limits is utilized for analysis of failure modes, failure causes, their effects and computation of danger priority numbers. FMECA is executed in parts. The initial segment performs the failure modes and effect analysis (FMEA) and the second part failure modes according to the seriousness and likelihood of event are characterized for the Criticality Analysis (CA). FMECA methodology is spoken to in Figure 2. Framework Definition: to direct FMECA initial step is to characterize a framework. The framework is characterized as transformer and its components and different capacities. Distinguishing proof of Failure Modes: failure modes are the manners by which a failure is watched, depicts the way, the failure happens and its effect on hardware activity. Transformer failure modes are recognized based on failure investigation led by zeroing in on component failure. Assurance the Causes of Failure: Causes of failure are the cycles, deformities, glitch or different cycles which are the purpose behind failure or which can start the cycle which may prompts failure. The different reasons for failure of transformer components and their recurrence of failure are researched by directing the failure analysis on 330 number of transformer from 2010-2015. Failure Effects Assessment: The effect of a failure mode upon the activity, capacity or status of a framework that decides the effect of transformer component failure on the transformer. Climate the

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component failure causes transformer failure or the component will be supplanted

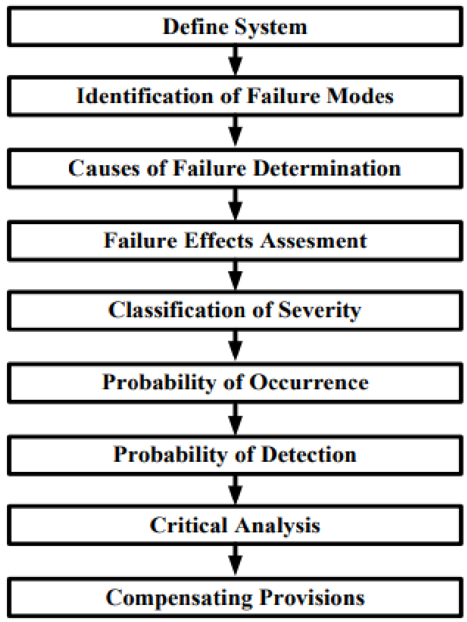

Figure 2 Failure modes effects and criticality analysis (FMECA) methodology

4.2.1 Risk Priority Number (RPN) Evaluation

In FMECA a numerical value called Risk Priority Numbers (RPN) is assigned to each risk

$$RPN = (Severity) * (Occurrence) * (Detection)$$

connected failure by using severity, occurrence and detection.

Severity is the proportion of the severity of the likely effect of the failure. Event is the proportion of the probability that the failure will happen. Discovery is the proportion of the probability that the difficult will be identified. Contingent on the estimations of these three factors, high qualities RPN can be focused to keep away from the failure in future.

Table 3 Severity, occurrence and detection classification for transformer

Ranking	Severity	Occurrence	Detection
1	No effect	Failure Unlikely	Almost certain

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2	Very minor	Low	Very high
3	Minor	Low	high
4	Very low	Moderate	Moderate high
5	Low	Moderate	Moderate
6	Moderate	Moderate : Occasional failures	Low
7	High	High	Very low
8	Very high	High: Repeated Failures	Remote
9	Hazardous with warning	Very high	Very remote
10	Hazardous without warning	Very high: Unavoidable Failure	Absolutely uncertain

4.2.2 Transformer Failure Modes

A transformer can flop because of mix of electrical, mechanical or thermal modes and it is consistently hard to discover a particular mode of failure. The greater part of the transformers falls flat due failure of protection. So the transformer may bomb electrically because of failure of protection which might be outcome from electrical, mechanical or thermal stress.

4.2.3 Critical Analysis of Distribution Transformer Failure

Basic analysis can be performed by positioning the failure modes of transformer components as an aggregate effect of severity, event and identification. In FMECA a mathematical worth called Risk Priority Numbers (RPN) is allocated to each hazard associated failure by utilizing severity, occurrence and detection.

V. RESULTS AND DISCUSSION

FMECA is led on 330 no of failed transformers. It incorporates transformer failure mode, reasons for failure, nearby effect which portrays the

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effect of each failure on transformer components, last effect alludes to the results of conceivable failure on entire transformer, a compensatory arrangement or prescribed activity are given to forestall these failures in future and at last a critical analysis is completed by allocating a Risk Priority Numbers (RPN) to every failure mode. FMECA of transformer components is recorded for proof that distinguishes transformer components failure modes, its reason for failure, effect of component failure regarding nearby and end effects, the (RPN) in light of severity, likelihood of event and likelihood of identification of the apparent multitude of components failure which may disturb the unwavering quality of supply framework. Danger Priority Numbers (RPN) demonstrates the criticality of the components, most elevated RPN shows most noteworthy critical component. Protection failure has the most noteworthy RPN followed by winding failure showing major failure. Transformer protection fundamentally flops because of Oxidation, Moisture, High acridity, Hot spot on account of overloading or low amount of oil and generation of CuSO4. To spare the transformer from failure it is prescribed to lead Dissolved Gas Analysis (DGA), substance analysis of oil routinely and take out any oil leakage right away. Transformer windings might be flopped because of assembling deserts, transient overvoltage, helping, short circuit and defective associations. It is the most awful failure requires prompt substitution of transformer. To spare the transformer from failure state of the transformer has been surveyed at ordinary span by directing DC obstruction, SFRA, Turn ratio testing of the winding

VI. CONCLUSION

The transformer failure analysis directed on 330 failed transformers during 2010 - 2015 according to IEEE standard to discover reasons for failure of distribution transformer. The factual analysis shows that the transformer failure rate is expanding each year and transformers are bombing rashly before finishing its normal existence of 20.55 years, which brings about poor unwavering quality and financial misfortune to the utility regarding fix and substitution of distribution transformers. Protection failure is recognized as major reason for failure of transformer. Failure Modes, Effects and Critical Analysis (FMECA) of distribution transformer components are introduced to recognize potential failure modes and reasons for failure and its nearby and last effect by ascertaining Risk Priority Numbers (RPN) according to severity, event to distinguish the critical components of transformer inclined to failure and preventive upkeep is prescribed to lessen the pace of transformer failure.

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