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Different Methods And Fault Impact Analysis On Radial Feeder Based Distribution System-A Review

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Abstract: This paper investigates and focus on fault current method for fault analysis in radial feeder based distribution system and check its performance under both normal and abnormal operating conditions. There are different traditional and analytical method for fault analysis but fault current method is used in our project. Radial feeders radiate form distribution substation in one end only and provide electrical power to consumer. Due to simplicity and cost effectiveness in rural and urban area radial feeder are used. Radial means one source and different load are connected through these concern feeders. But they face challenges such as voltage drops, power failure at consumer side, load imbalances. At peak power demand loads are increasing from consumer side hence reliability issues during faulty condition.

This Project deals with design and implementation of over current relay (OCR) simulation models in PSCAD/EMTDC or Power word simulator (PWS) software and analyze the system's response to various load conditions, fault occurrence. After over current relay logic design successfully done in software the key focus of these project are maintain voltage level, required current and provide continuous electrical power to consumer side and maintain system reliability in distribution network. This research contributes to the development of more reliable and efficient distribution networks, ensuring improved service continuity for consumers.

Keywords: Distribution system, Radial feeder, Overcurrent Relay, PWS.

I. INTRODUCTION

Radial feeder systems are essential for distributing electricity efficiently from substations to consumers at various area. But when any fault occur on feeder line then power get interrupted to that concern feeder. While at normal operating conditions for especially radial feeder by maintaining stable voltage and accommodating typical load demands, they can face significant challenges during abnormal situations such as faults or sudden load changes. In parallel feeder fault occur at one feeder line than load shifting principle shift load to healthy feeder and continuity of electrical power is maintained at consumer side. In ring types feeder if any fault occur or during maintained of particular feeder line get separate with the help isolator and circuit breaker as compare to radial, parallel feeder ring types feeder are more reliable. The aims to assess the performance of radial feeders under both normal and abnormal conditions, focusing on key indicators like voltage stability, load capacity, and fault tolerance. The insights gained will contribute to optimizing system design and enhancing reliability in modern electrical distribution networks.

II. DISTRIBUTION SYSTEM

The major component of distribution is feeder, distributor and service main line. In a distribution system there are various types of feeder such as radial, parallel, ring type and inter connected feeder all these refers to a set of electrical conductors that carry electricity from a distribution substation to various distribution points or step down transformers. Voltage range of feeder is 11kV in primary distribution system and current throughout same in feeder. The feeder's primary role is to deliver power to different areas, such as residential neighborhoods, commercial districts, or industrial zones. A distributor refers to the part of the distribution network that carries electricity from distribution transformers (pole mounted substation) to the final consumers, such as homes and businesses. Distributors operate at lower voltage levels compared to feeders distributer having tapping with the help tapping

provide essential power deliver to individual customers. Service mains line in a distribution system, refer to the conductors and associated equipment that connect the distribution network directly to the consumer's premises. Design of service main line is important factor in distribution system because most of factor affecting on it such as protection, load demand and distance of consumer energy meter. Essentially, service mains provide the final link in the electricity supply chain, delivering power from the distribution system to individual customers, such as homes and businesses.

III. DIFFERENT RADIAL FEEDER FAULT ANALYSIS METHOD

There are different traditional and advanced methods for fault analysis in radial feeder based distribution system as fellows.

1. **Fault Current Method** (Used In Our Project)

The fault current method is a technique used in electrical power system to analyze and calculate the short-circuit currents that occur during fault time period in electrical power systems. In our project design instantaneous over current relay for different symmetrical and unsymmetrical fault and in that set predefined value and if fault occur in system this fault get sense by over current relay (OCR) and protect system. Power Systems Computer Aided Design (PSCAD) software is used for simulation. The purpose of fault current methods is choose and design protective system, relay time system to set relay protection settings for proper detection and response to faults. Following steps involved in our project.

I. **Radial feeder distribution system model:** Creating a model in PSCAD simulation software including three phase source, four buses, step down (33kV/11kV) transformers, feeder line radiate one end only and loads. Every component having impedance values. All real time data collected form actual side visit at Bhendali 33 kV/11kV substation, Nashik.

II. **Identify fault types:** identify different fault types (e.g., L-G, LL-G, LLL-G, LL). Each type of fault in system has different fault current and voltage drop.

III. **Calculate fault currents at different fault (Symmetrical and Unsymmetrical)**

- Per Unit System: Use the per unit calculation system to simplify fault calculations after fault in system. Checked PU voltage of all buses this involves normalizing voltages, currents, and impedances to a common base.
- Impedance Calculation: Calculate the total impedance seen by the fault current. This includes contributions from generators, transformers, and transmission.

IV. **Simulation and Testing:** In many create different cases and check performance of system under normal and abnormal operating condition using PSCAD simulation software tools and verify result before and after fault in system. Power word simulator is used to power flow study in radial feeder based distribution system.

2. **Voltage Drop Method**

In voltage drop method technique particularly finding the voltage drops across each components in circuit. This method is especially useful for complex circuits, including those with multiple resistors, inductors, and capacitors.

3. **Impendence Method**

The impedance method technique used in particularly used in the context of AC (alternating current) systems. It involves representing circuit elements with their impedance values instead of resistance or reactance alone. This method is particularly useful for analyzing the behavior of circuits under various frequency conditions.

4. **Wavelet Transform Method**

Wavelet transform (WT) is a signal processing technique used to detect faults in systems by analyzing the frequency and time content of non-stationary signals. It's often used in place of Short Time Fourier Transform because WT can automatically adjust its window size to the signal's dynamics.

5. **Artificial Neural Network Method**

Artificial Neural Networks (ANNs) in radial feeder fault analysis are computational models that detect, classify, and locate faults in electrical distribution systems by processing real-time and historical data.

6. **Support Vector Machine**

Support vector machine (SVM) is a computational learning method that can be used to detect faults in system and monitor the health condition of machine.

7. **Frequency Domain Analysis**

Frequency domain analysis in radial feeder based distribution system fault analysis is a method used to detect and diagnose electrical faults by examining the frequency components of voltage and current signals in system.

8. **Time Domain Analysis**

Time-frequency analysis (TFA) is a signal processing technique that studies a signal in both time and frequency domains simultaneously.

IV. PROBLEM STATEMENT

In electrical distribution systems, radial feeders are commonly used to deliver electrical power from substations to consumers. Radial feeders radiate form distribution substation one end only. If anyone fault occurs in radial feeder-based distribution system due to that fault continuity power get interrupted to consumer's side.

V. OBJECTIVE OF PROJECT

1. Behaviour of radial feeder during normal and abnormal operating condition.
2. Determine of short circuit current value after fault in feeder line.
3. RMS voltages of four buses during normal and abnormal operating condition.
4. Different symmetrical/unsymmetrical fault impact evaluation on feeder line.
5. Design of overcurrent relay (OCR) logic for different fault in PS-CAD/EMTDC.
6. Power flow study in radial feeder based distribution system using power word simulator.(PWS)

VI. LITERATURE SURVEY

Literature Survey No.1

Title of paper: - Practical Evaluation of Overcurrent Protective Relay Performance in Power Distribution System
Journal/Conference Name: -2024 IEEE 4th International Maghreb Meeting of the Conference on Sciences and Techniques of Automatic Control and Computer Engineering (MI-STA).
Publisher/Vol/Page No.: - Mohamed.D.Hamouda IEEE Xplore: 30 July 2024.

What is given in the paper	Methodology	How is it useful for our project
Analysis and practical evaluation of overcurrent protective relays performance and its implementation.	Using Advance test system (CMC Test System) and different Software for simulation Measurements and data collection	Optimize relay time setting and uptime evaluation concept by relay logic.

Literature Survey No.2

Title of paper: - Investigation on overcurrent relay setting and performance using PS-CAD software.
Journal/Conference Name: Journal of Engineering and Technology (JET)
Publisher/Vol/Page No.: - ISSN: 2180-3811, EISSN: 2289-814X JET [Vol.12 No 1], 2021.

What is given in the paper	Methodology	How is it useful for our project
Overcurrent relay modelling and simulation. Analysis (study) of overcurrent relay setting and performance.	Using PS-CAD software for simulation and analysis of overcurrent relay. Relay setting in distance relay, OCR, differential relay its calculation method.	To reduce the faults (short circuit on consumer side) we can use overcurrent relay in distribution side.

Literature Survey No.3

Title of paper: - Simulation and Hardware Implementation of Over-current Relay Used for Transmission Lines.
Journal/Conference Name: - IEEE International Conference on Trends in Electronics and Informatics (ICOEI 2019)
Publisher/Vol/Page No.: - 978-1-5386-9439-8/19/$31.00 ©2019 IEEE

What is given in the paper	Methodology	How is it useful for our project
Simulation of over-current relay and implementation of over-current relay logic in Arduino UNO micro-controller	The performance of this module of overcurrent relay module is designed and simulation by using MATLAB simulation.	Working of overcurrent protection relay and logic used in design OCR for transmission line when faults occur in transmission line.

Literature Survey No.4

Title of paper: -Overcurrent Relay Coordination in Radial Distribution System.
Journal/Conference Name: -International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Publisher/Vol/Page No.: -Volume 12, Issue 1, December 2021 ISSN (Online) 2581-9429

What is given in the paper	Methodology	How is it useful for our project
To prevent the damage of system, setting the coordination of overcurrent relay with the Radial distribution system.	Relay coordination strategy used Relay modelling to design the overcurrent relay use MATLAB simulation.	Arrangement of overcurrent relay in distribution system and its location in radial system. Power flow and minimize the faults.

VII. METHODOLOGY

Our project will focus on detailed analysis and design of radial feeders, specifically examining the behavior during faults with respect to current relay settings. It will begin with an in-depth study of existing fault analysis techniques and the operational principles of radial feeder systems, incorporating insights gathered from various substations. The project will also explore manual and automated load shifting methods within the distribution system. Data will be collected from a 33/11 kV distribution substation to validate the results related to our analysis of current relay performance in the radial feeder.

VIII. SYSTEM ARCHITECTURE

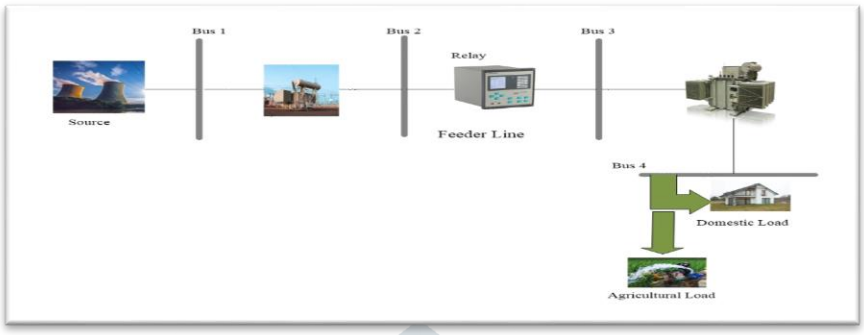

Fig. 1 System Architecture of Radial Feeders Based Distribution System

IX. BLOCK DIAGRAM

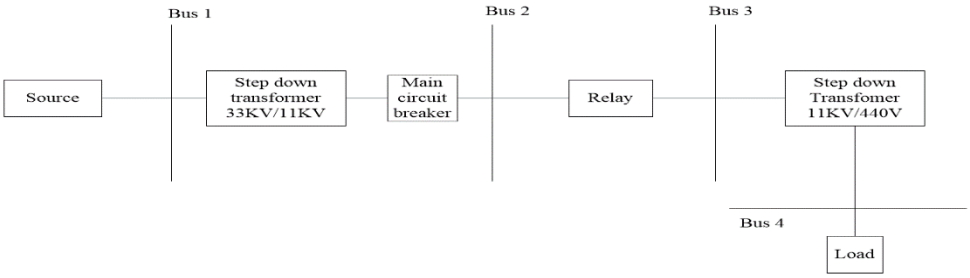

Fig. 2 Simple Single Radial Feeders

X. SYSTEM UNDER STUDY

Below fig.3 represent that four bus radial feeder distribution system radiate form distribution substation one end only. Three phase RMS meter connected to all four buses this meter shows PU voltage during normal and faulty operating condition. Rating of source side transformer is 33 kV/11kV (step down transformer) load is connected to bus 4 with help of distributer and service main line. Length of feeder 4 KM form distribution system.

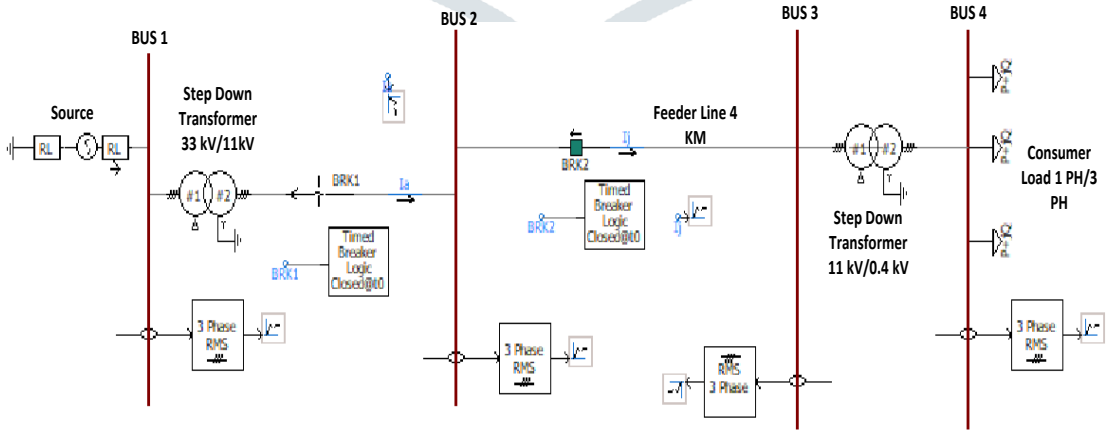

Fig. 3 Simulation of Four Bus Radial Feeder in PSCAD

XI. CONCLUSION

We have successfully define objective and methodology of our project. Architecture and simulation is ready in first module. In next module will verify result the of radial feeder based distribution system in PSCAD software and power flow analysis using power word simulator. This study demonstrates that while radial feeder-based distribution systems are efficient but they face challenges like voltage fluctuation, power interruption and reliability issues during peak and faulty conditions.

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