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Research Paper

Review on Transmission Lines Faults & Diagnostic Method Approaches

Engineering

KEYWORDS : ASC, Faults, Fuzzy Logic, Impedance Method, Transmission Lines, Insulators, Wavelet Method

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ABSTRACT

One of the crucial components of Power Systems is Transmission Line. Faults in these lines are cause of concern. This paper proposes a overview study on different types of transmission lines and their faults. Factors responsible for the faults and line fault pattern detection methods are extensively discussed. Various fault preventive strategies and their implementation is also emphasized lucidly.

Introduction
Transmission lines are lines with sharing same voltage and current with their specific length.

These lines forms the backbone of the power systems, fails many a times which leads to massive damage to system & loss to the electrical energy. In recent years, the demand of electric power has turned exorbitant. In order to meet this demand, several electrical companies have had to improve the efficiency of their transmission lines to a great extent. The efficiency of a system depends mainly on continuity in service which could be achieved by eliminating faults in the transmission system. It has been observed that about 80% of the faults on transmission lines are transient in nature. Several studies are being conducted on national and international levels to develop various protection strategies and equipments of transmission lines. In order to facilitate rapid detection and removal of disturbance, various fault detection techniques have also been procured over these years.

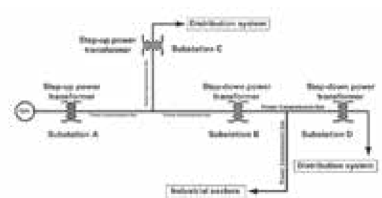

Fig.1 General Scheme of a Power System Layout.

Insulations:
Electrical Insulators is a component which is used in electrical system for the prevention of unwanted flow of current to the earth from its supporting points. The **insulator** plays a very vital role in the electrical system. **Insulator** behaves like a very high resistive path through which practically no current can flow.

Faults:
The nature of a fault could be defined as any abnormal condition, which results in a reduction in the basic insulation strength between phase conductors, or between phase conductors and earth or any earthed screens surrounding the conductors. Practically, a reduction is not regarded as a fault until is it is detectable, i.e. until it results either in an abrupt increase in current or in a reduction of the impedance between conductors, or between conductors and earth, to a value which is below even the lowest load impedance normal to the circuit.

Types of Faults:
Faults can be classified into several types based on different parameters. Some of the major faults are:

- Phase to Ground Fault
- Phase to Phase Fault
- Phase-Phase to Ground Fault
- Three Phase Fault

Other faults of electricity are not of major important. But they still are considered for the power system operation, they are:

- Open circuit Faults
- I nter turn Faults
- Random Faults

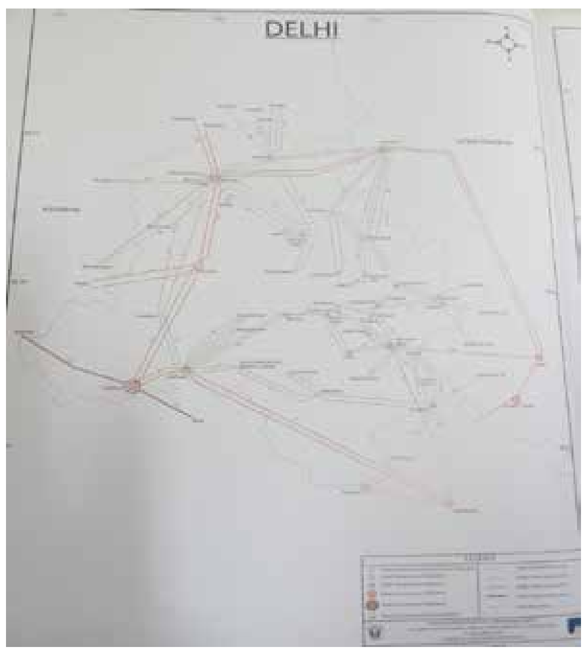

Fig.2 Transmission Line Map from the Power System Atlas.

FACTORS AFFECTING TRANSMISSION LINE FAULTS
The transmission lines which are exposed in the air to the environment fall prey to various types of failures. These factors are

Lightning factors:
It has been observed that more than half of the faults in the over head transmission lines are caused due to lightning. Frequency in the River Delta region, in the spring and summers is very high. Thunder and lightning cause transmission line failure, causing the accident trip of the substation, the cause of the accident is basically because of the lightning overvoltage resulting in short circuit this led to the failure of the lines.

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Over line Icing factors:
Transmission Line Icing is caused occurs in the winter or in regions with extremely low temperature. The formation of ice cover is because of cold weather, air and humidity and when ice cover is formed the overall weight of the transmission line increases which led to the failure of the line.

Wind Related Factors: Transmission lines which are mostly situated around rickety terrains and those areas which receive strong wind currents are prone to transmission line partial flashover.

External damage factor:
These factors are random factors which cause faults like falling of trees, activity of birds, collisions of vehicles with poles and such reasons which could not be accounted elaborately but they do cause faults.

Pollution Related Factors:
Pollution is one of the major causes of flashover in the insulators. The pollutants present in the environment settle down on the surface of conductor such that when it comes in contact with humidity, rain or dew forms a mixture. When this layer dries up form a dry band which facilitates passage of currents that generates conditions of short circuit. This happens as a result of decrease of the resistance of the insulator surface.

Metallic	• Mining handling processes • Mineral handling processes
Coal	• Coal mining • Coal handling plants/thermal plants • Coal burning/brick kilns areas
Volcanic ash	• Volcanic activity areas
Defecation	• Roosts of birds areas.
Chemical	• Wide variety of chemical/ process industries, oil refineries...
Smog	• Automobile emissions at highways crossing • Diesel engine emissions at railway crossing / yards
Smoke	• Wild fire • Industrial burning • Agriculture burning

Contaminant	Source of pollution
Salt	• Coastal areas • Salt Industries • High ways with deposit of snow where salt is used to melt the snow
Cement	• Cement Plant • Construction sites • Rock quarries
Earth	• Plowed fields • Earth moving on construction projects
Fertilizers	• Fertiliser plants • Frequent use of fertilizers in cultivated fields

FAULT DETECTION METHOD:
I. Impedance-Based Methods:
The impedance-based fault location methods compares most often pre-known line parameters to the impedance measured in the case of fault. Based on this comparison the fault location can be estimated. The line parameters can either be calculated or measured on the transmission line after installation. Often, a representation based on symmetrical components is selected because it can be difficult and time consuming to obtain all components in the series impedance matrix of the line.

Several assumptions are made for most impedance-based fault location algorithms.

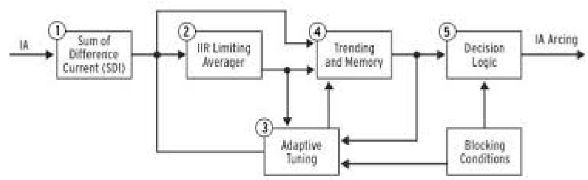

Fig.3 The Flow diagram of Impedance Fault Detection Method.
The most common are:
1. The fault loop impedance is linear dependent on the fault location.

2. A sequence representation of the line can be used with no errors or the full series impedance matrix is available and represents the entire line.

3. The fundamental voltage and current phasors can be determined at either one or both cable ends.

4. The influence of the fault resistance, system loading and short circuit power can be eliminated.

The simplest online travelling wave-based method is a single-terminal method. The method relies only on detecting the first and second wave from the fault location as the effective surge impedance of the substation is assumed to be different from the one of the line, such that an incoming wave is rejected back towards the fault.

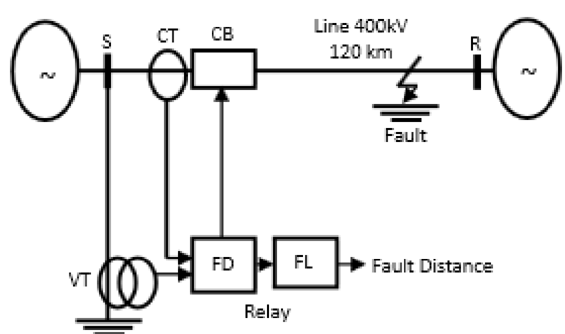

Fig.4 Standard 400KV Transmission line Layout with Fault Detection.
It is also assumed that the fault arc is not extinguished at the fault location so the surge impedance is close to zero, and the wave is almost completely reflected back towards the fault locator terminal. If the arrival instance of the first and second waves at the fault location is captured and the wave velocity is known, the fault location can be estimated as :

$$x = (v_n \cdot \tau_d) / 2$$

where vn is the velocity of a wave of mode n, and τd is the time difference between the arrival instance of the two first waves from the fault for a mode n wave.

2.) Fuzzy Logic Approach:

In power systems to solve uncertain problems that usually occur due to variation of power system parameters fuzzy logic are used. In this fuzzy set theory is brought to operation without specific knowledge or know how. These algorithms are fairly accurate only under the few assumptions of fault resistance, fault distance and line length. In a fuzzy neutral network a neutral network is brought under operation on the basis of fuzzy rule based system from input/output data. Wang et al., (1998), proposed three different neuro-fuzzy networks in series to classify the fault in transmission line protection using both designer's experiences and sample data sets. A distance relaying scheme based on FNN is proposed by Dash et al., (2000) in which the fuzzy view point is utilized to simplify the model.

4.) Wavelet Approach:

The post fault voltage and current related components are needed to be extracted as quickly and as accurately possible. In conventional signal processing techniques had an disadvantage of long discrimination time and errors in impedance calculations. Wavelet transform has the ability to perform local analysis of relaying signals without losing time and frequency information. So the best method for protection of parallel transmissions by decomposing fault current signals using wavelet and by comparing the magnitude of line currents in the corresponding phases. The ability of wavelets to decompose the signal into different frequency bands using multi resolution analysis (MRA) allows detecting and classifying faults as well as extracting the voltage and current fundamental phasors needed to calculate the impedance to the fault point in distance protection (Osman et al., 2004) and with filtering algorithms proposed by Kleber M.Silva et al., (2010), fast relay operating times are obtained. .The capabilities of wavelets are affected owing to the existence of noises riding high on the signal and the problem lies in identification of the most suitable wavelet family that is more approximate for use in estimating fault location. Most of the wavelet based techniques employ multi-level wavelet decomposition, which requires multi-level filtering followed by complex computation

Conclusions

Fault detection in power system will be detected by many approaches. It can be seen in the previous section. The fault detection in system must fast when fault occurred in the transmission line, transformer, or anywhere in the electricity system. This paper proposes some of the detection approaches used in the last and the present. Also, it can be used for one

part of articles for developing their researches. The paper also gives a detailed explanation of causes of different types of faults as well as the protection measures used in the present century

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