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Improving the Power Transmission and Distribution in Nigeria Using Global Positional System and Geographical Information System

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Abstract: Power system transmission is the bulk transfer of electrical energy from the generating station to electrical substations located near demand centres and this comprises generation, transmission and distribution. These electrical power transmission and distribution are exposed to different fault. These faults sometimes are difficult to locate and if indentified using manual tracing, it took days or months to ratify such fault. The users of electricity in Nigeria are sometimes thrown into total black out within the period such fault occurred. This has led to loss of properties and income for those that use the power in the industrials and companies. Global positioning system (GPS) and geographical information systems (GIS) have been suggest to be installed with relay in power system transmission and distribution for easy identification and location of faults as being used in developed countries. Whenever GPS and GIS locates these faults, GOS satellite sends a signal to the GPS receiver which will turn record the time instantly corresponding to when the initial travelling wave generated by faults arrives at the bus bars. This is a high speed protection that offers high accuracy in fault location. The protection scheme monitors the network to which it is connected and not limited to individual unit plant or feeder.

Key words: Power system · Transmission · Distribution · Faults · Protection Global positioning system · Geographical information systems · Relay · Circuit breaker

INTRODUCTION

Electric power system comprise of power generation, transmission and distribution of electric energy. Transmission lines are used to transmit or transport this electric power over a distance. In transmission station, the maximum generation voltage from the generating station in developed country is 11kV while it is about 11kV [1-4]. The transmission system of these voltages is divided into two, the primary transmission and the secondary transmission. Hence, the amount of the amount that has to be transmitted through lines is very large and if transmitted at that rate, the lines current and power loss would be very large. These voltages were stepped up to a higher voltage with a step up transformers situated at the substation near generating station. In some countries, they have their transmission voltage as 400kV, 220kV, 200kV, 132kV and 110kV etc. The high voltage transmission lines transmit electrical power from generating station to main receiving end substation. In these stations, the voltage is stepped down to a lower value of 66kV, or 33kV. Furthermore at the secondary substation, the voltage is stepped down again to 33kV or 11kV with the power being fed to the primary distribution substation. In the distribution station, these voltages were finally stepped down to usable voltage of values 110V, 240V, 400V and 415V depending on the country [1-4].

In Nigeria, distribution companies are used to distribute power in town by three phase four-wire system. The phase donations were red, yellow and blue phases with the fourth wire as neutral line. Each of the phases is connected to the neutral to the consumers. The rapid growth of electric power system for years has resulted in increased number of lines in operation. Lines are exposed to faults as a result of lightening, faulty equipment, overloading, human error ageing of transformers lines and its support. For safe and predictable operation, the components of the transmission systems are controlled with generator, switches, circuit breaker and loads [5-7].

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When electric faults manifest in mechanical damage, it must be repaired to return the line to service. The restoration can be expedited if the faults location is either known or be estimated with a reasonable accuracy. Faults if allowed without immediate attention can cause short to long term power outage for consumers and may result to loss of economy and properties [5-7].

The line of high voltage transmission system are usually composed of wire of copper, aluminium, or copper-clad or aluminium-clad steel which are suspended from tall towers steel by string of porcelains insulators by the use of clad steel wires and high towers. In some areas, high voltage line are suspended by tall wooden pole and spaced more closed together. For lower voltage distribution lines, wooden or concrete poles are generally used. In developed countries, insulted underground cables are used for distribution of electricity [1-4].

Causes of Fault in Power Transmission and Distribution System: The rapid growths of electric power system over few decades have resulted in large increase of the number of lines in operation and their total length. Urbanization and increased in industries have resulted in increase in utilization of electricity and hence has contributed in increase in production and transmission and distribution of electricity. These transmission lines are exposed to faults ranging from lightening, short circuits, faulty equipments, improper operation and handling of the system, overloading, falling of trees and knocking down of poles by vehicle, harsh wind and heavy down pores resulting to felling of poles and wrong connection of electricity etc. [5-7].

Power System Protection: Power system protection deals with the protection of electrical power system from faults through isolating of faulted parts from the rest of the electrical network. The aim of the protection scheme is to keep the transmission system stable by isolating only the components that has faults whereas leaving as much of the network as possible in operation. Thus, in securing the power transmission system, the protection schemes adopted must be very reliable, efficient and pragmatic to deliver. To achieve this there is need to use global positioning system and geographical information system [8,9,10].

Power Protection Scheme: The power system protection scheme usually comprise of five components mainly: current and voltage transformer to step down the high voltage and current of the electrical power to convenient levels for the relay with circuit breaker to open and close the system based on the relay and auto reclose command, batteries to provide power in case of power disconnection in the system, communication channel to allow analysis of current and voltage at remove terminals of a line and to allow remote typing of equipment and protection relay to sense the faults and initiates a trip or disconnection. The three classes of protection device are protective relay control, the tripping of the circuit breakers surrounding the faulted parts of the network and the automatic operation such as auto reclosing or system restart. In distribution systems fuses are connected for sensing and disconnecting faults. Failure may occur in each part such as installation failure, fallen of or broken transmission lines, incorrect operation of breaker, short circuit and open circuit. Thus protective devices are installed with the aim of protecting asset and ensuring continued supply of energy [8-10].

In Nigeria, research has shown that the transmission and distribution of electricity is a nightmare, sometimes faults can develop in a particular feeder, transformer and transmission or distribution lines and it may last days, months and years without Electricity Distribution Company having any knowledge. They can only have knowledge of the fault if the consumers in such area reports to the company.

Types of Transmission System Protection: In power plant, the protective relay are intended to prevent damage to the attenuator or the transformer in case of normal condition of operation due to internal failure as well as insulating failure or regulation malfunctions. If the protective relay fails to detect a fault, the resulting damage to the alternator or the transformer might require costly equipment repairs or replacement as well as loss of income because of inability to produce and sell energy [8-10].

High voltage transmission network protection and distribution serves two functions: protection of the plant and protection of the users including employees at basic levels. Protection also serves to disconnect the equipment which experiences an overload or a short to earth. In substation, transformer might require additional protection based on temperature and pressure gases etc [8-10].

Overload and backup for distance over current –overload protection require a current transformer which simply measures the current in a circuit. Two types of overload protection exist: instantaneous over current and time over current.

Earth fault (ground faults) also requires current transformer and sensor as in a balance three phase circuit. Three phase current are usually balanced and hence in magnitude. If one or two phases become connected to the earth, their magnitude will increase very high and will create current imbalance. If the imbalance exceeds the pre-determined value, a circuit breaker will break.

Distance impedance protection (i.e. relay) detects both voltage and current. Faults occurring on a circuit will create impact in the voltage level. If the ratio of voltage to current measured at relay terminals (i.e. impedance) is within a pre-determined level, the breaker will operate. Since the operating characteristics are based on the line, then when fault is noticed on the line, the impedance setting in the relay is compared to the apparent impedance to the line from the relay terminals to the fault. It is easy to determine and locate fault within a zone of protection when the transmission line length is short, i.e. less than 100miles but it becomes more difficult to actualize in long line distances. In such case, the best choice of protection is current differential protection. A circuit breaker or protection relay may fail to operate, a back-up protection is provided. Remote back-up protection will generally remove the affected and unaffected items of the plant to velar the faults. In low voltage network, fuses or low voltage circuit breakers are installed to remove both overload and earth faults. These protection schemes sometimes fail and the power supply in a particular area are affected and it results to black out. These last for some days or months or years before such faults are ratified [8-10].

To indentify a particular fault last for some days using manual checking or conventional method of identification, sometimes it throws the user into total black out in Nigeria. Hence, the use of global positioning system and geographical information system is necessary to easy off the identification and location of such fault for quick ratification. In Nigeria, when fault occur or when there is a cut on distribution line, there is always an indication in the feeder that fed the particular region. Every feeder has a particular where it feeds in transmission station which were labelled feeder 1, 2, 3, 4 etc. But in developed countries, the transmission systems are been protected from fault by global positioning of system or geographical information system.

Global Positioning System (GPS): This is a satellite based navigation system that is made up of networks of 24 satellite placed in orbit which works 24 hours a day in all weather conditions. GPS technology allows precise determination of location of velocity, direction and time. Global positioning system is time spaced based radio positioning system that provide time and three dimensional position and velocity information to suitably equipped user anywhere on the earth. GPS will enable the users to determine their 3 dimensional position, velocity and time by combining GPS with current and computer mapping techniques for easy and efficient operation. In global positioning system, the relay contains a full transient detection system together with communication unit which is connected to the power line through the high voltage coupling capacitor of the capacitive transformer. The relays are installed at each bus bar in transmission network and once fault is detected, the relay will rip off while GPS instantly record the time corresponding to when the initial travelling wave generated by the fault areas at the bus bar and also send a message to GPS receiver showing there is a fault in power line [11-15].

The global positioning systems has its ability to provide synchronization with an accuracy of microsecond over the wide area provides an ideal tool for performing time tagging of the fault transient. Relays are installed at each bus bar for protection of network and tripping of circuit breakers associated with that network. Each of the relays records the arrival of the signal generated by the fault. These relays compares the fault transient arrival time recorded at its sight with those send by other relays and determine whether the fault is within the protective zone. Then tripping the appropriate instruction is send to the relevant local circuit breaker and the actual location where the faults occurs. This can be clearly indentified at each relay location by the global positioning system or program information system [11-14].

Geographical Information System: This is a computerized data management system used to capture, store, manage, analyze and display spatial information. System software use relational database management technologies to assign a series of attributes to each spatial feature. GIS provide the capability to combine with various data into a composite data layer that may become a base layer in database.

Geographical information system allows user to synthesize or combine different layers of information to indentify distribution pattern that may otherwise not be obvious. This system provides rapid data access and multi-dimensional analysis and geographical output capabilities that can result in more effective resources management decisions [11-14].

CONCLUSION

In power protection of transmission system, the global positioning system or geographical information system and relays should be installed at key points in power system network. In this scheme, appropriate tripping instruction are given to the relay once faults occurred and the actual location area where the faults occurs can be clearly indentified at each relay location once a signal is sent to GPS receiver. This method will help to indentify fault and ratify it as quick as possible. The Electricity Distribution Company in Nigeria should embrace this scheme to improve its power transmission and distribution which nothing to write home about. This is a high speed protection that offers high accuracy in fault location. The protection scheme monitors the network to which it is connected and not limited to individual unit plant or feeder.

REFERENCES

1. Nweke, F.U., 2008. Workshop process and practice, Electronics and Electrical Installation. Frinwek publisher, Abakaliki Ebonyi State.
2. Gupta, B.R., 2001. Principles of Electrical Engineering, 3rd Revised and Enlarged edition. Rajendra Ravindra Printer, New Delhi.
3. Theraja, B.L. and A.K. Theraja, 1997. A Textbook of Electrical Technology 25th edition. Chad & Company Ltd, Ram Nagar, New Delhi.
4. Gioglo Rizzoni, 2004. Principles and Applications of electrical Engineering 7th edition, McGraw Inc.
5. Sachdeve, M.S. and R. Aggananwal, 1998. A technique for estimating transmission line fault location from digital impedance relaying measurement, IEEE Trans Power Delivery, 3(1)
6. Schader, M.S., 1979. Computer relaying IEEE tutorial curse text Pub 79 EHO 148-7-PWR
7. Jiarig, J.A., *et al.,* 2000. An adaptive P.M.U. based fault detection and location for transmission lines part1; Theory and algorithm. IEEE Trans Power Transmission lines.
8. Girgis, A.A., *et al,* 1992. Fault location in transmission line using two or three terminal lines. IEEE Trans Power Delivery, pp: 7.
9. Dong X., *etal* (2009). Fault classification and faulted phase selection based on the initial current travelling wave. IEEE Trans Power Delivery Vol. 29(2)
10. Kacha, K.V. and R. Aaron, 1984. Travelling wave protection of transmission lines. Electrical power system Research, 8(1).
11. BO, 2000. Positional protection of transmission system using global positioning system. IEEE Trans. Pattern annual March Intel., 11(7): 1989.
12. ESRI. 2011. Geographical information software and data management.
13. Gale, P.F., *et al.,* 1993. Fault location based on travelling wave, IEEE Trans power Delivery.
14. Gil Crest, G.B., *et al.,* 1972. High speed distance relaying using a digital computer part of system description. IEEE Trans Power Apparatus and System. Vol pAS-91(3).
15. Rockeffeler, G.D., 1969. Fault protection with a digital computer. IEEE Tans Power App and System, 8(9).