An Overview of the Power System below the Short Circuit Fault State

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ABSTARCT: ***A fault is any situation in an electric system that causes the electric functioning to be interrupted. An excessive flow of current, which happens when the system's insulation breaks at many points, or when a conducting item comes into touch with the live point, causing a short circuit, may cause a failure. When the operating system fails, an open circuit fault occurs. This article examines fault situations, types of faults in power systems, fault remedies, and short circuit modeling using MATLAB software. This article looks at the voltage drop in a short circuit and how it affects the appliances that are connected to the power source. The relay is a sensor component in the circuit that detects excessive current or abnormal current flow and provides a tripping signal to the circuit breaker, which disconnects the defective line from the healthy line. However, effective functioning of all components requires a time delay, which may result in severe power system issues.***

KEYWORDS: Circuit, Electrical Power, Fault Prevention, Lightning, Power Source.

1. INTRODUCTION

The electrical power system is vast, complicated, and dispersed over a wide geographic region. For every power station, many electrical components and devices work simultaneously for high efficiency, but grid efficiency suffers when abnormal activity occurs in the grid or in a device, and that abnormal activity is referred to as a fault in the circuit. A fault in the circuit can be caused by an excessive flow of current in a short circuit condition or by a decrease in voltage level. A generator, transformer, transmission lines, and load make up the electrical power system. A fault in a circuit is a disruption or failure that prevents the circuit from functioning normally[1].

1.1Cause of power system fault:

i) Lightning:

Lightning has an impact on power line performance because transient high voltages may induce flashover on the power line's electrical equipment. Because the likelihood of a direct hit rises with tower height in a given area, high voltage (HV) lines may be more vulnerable to direct strikes than medium voltage (MV) or low voltage (LV) lines. The lightning voltage is very high, and it may burn or damage the insulation of electrical system devices or equipment. As a result of the lighting equipment breaking and ceasing to function, other sections of the station that rely on it will be impacted, resulting in a reduction in the efficiency of the power system as a result of the lightning fault[2].

ii) Human error:

Human mistakes are also responsible for abnormalities in current or electrical problems due to poor material selection, operating equipment without maintenance, neglecting conductive or metallic parts after service, and switching the circuit while it is under repair [3].

iii) Weather condition

Weather conditions like as lightning, strong winds, or the deposition of salt or other undesirable materials on transmission lines and conductors increase their resistivity and reduce their conductivity, resulting in a fault and a disruption of normal operation [4].

iv) Line breaks due to excessive loading:

When the load on the electrical grid reaches its maximum value, the line breaks and the delivery of electric current ceases[5].

v) Equipment Failure:

Equipment failure is one of the reasons why faults occur in power systems; due to the ageing effect of the equipment, as well as a lack of maintenance of the device, faults occur; in transformers, oil should be changed on a regular basis and refined oil should be used so that impurity efficiency does not become an issue; insulation failure of cable and winding due to which a large amount of current is drawn[6].

vi) Smoke of air:

Ionization of air refers to the charge particles present in the air; when charge particles begin to move in the air due to smoke particles, they surround the conductor and insulation, attracting their charge particles into the atmosphere, causing sparking and insulators to lose their insulation capacity, causing sparking.

1.2 Types of fault:

*A***)** *Power system fault types:*

i) Open circuit fault

ii) Short circuit fault

B) Open circuit fault types;

i) One conductor

ii) Two conductor open

iii) Three conductor open

C) Short circuit fault types:

i) Symmetrical fault

ii) Unsymmetrical fault

D) *Symmetrical fault types:*

i) Three phase short circuit fault (LLL)

ii) Three phase to ground fault (LLLG)

E) *Unsymmetrical fault types:*

i) Single line to ground fault (LG)

ii) Double line to ground fault (LLG)

iii) Line to line fault (LL)

F) In power system there are basically two types of fault:

i) Symmetrical or Balanced fault

ii) Asymmetrical or Unbalanced fault

G) Most of the faults in the power system are unbalanced three phase faults so on the basis of this fault can further classified as:

a) Series fault
b) Shunt fault
c) Simultaneous fault

H) Series faults:

Represent the open conductor and this happens when unbalanced series impedance present in the line. Series type of fault is basically unbalanced in the system. Suppose we have used Fuse / Breaker to protect the circuit. If one or two phases open while the third phase remains in circuit, such a fault is called a Series Fault. Notice that Series Fault may also occur in case of one or two Broken Conductor.

Series faults are characterized by increases of voltage and frequency and fall in current of the faulted phase.

Shunt fault is the basic fault occur in the line, in this fault current increases voltage and frequency decreases, shunt fault is further classified as:

i. Line to ground fault
ii. Line to line fault
iii. Double line to ground fault
iv. Three phase fault

I) *Line to ground fault*:

This fault occurs in the line when any phase touches the ground directly or indirectly (by ice, tree,wind), mostly fault comes under this category.

*J) Line to line fault***:**

When one phase of the transmission line touches the other phase this occurs because of the high wind. *Double line to ground fault* When two phases come in contact with ground due to falling of a tree causes this fault

*K) Three phase fault***:**

In this case, failure of equipment, falling of tower or even line breaking and touches the remaining phase cause three phase fault.

*L) Effect of fault***:**

Fault may lead to fire breakout that results in loss of property, loss in efficiency, damaging of the equipments, there are lots of effect of fault some of them given below:

i) Over current flow: This condition occurs when current starts flowing through the lowest impedance path, because of the lowest impedance huge amount of current flows through the equipment which can damage the equipment.

ii) Danger to operating personnel: Fault occurrence can cause death to the person, seriousness of the fault depends upon the current voltage at the fault location.

iii) Loss of equipment: Due to short circuit fault excessive amount of current starts flowing through the equipment results in equipment/components being burnt completely due to this improper working of equipment.

iv) Disturbed interconnected circuit: Fault not only destroys the connected equipment but also harms the interconnected location and devices.

v) *Electrical Fires*-Short circuit current causes flashover and sparks due to ionization of the air produces excessive amounts of heat which burns the transmission line and its components.

M) How we can reduce short circuit current:

To reduce the short circuit current in power systems we should increase the inductive reactance at the fault location this can be done by either increasing the inductance of the circuit or by removing the circuit equipment from the fault path.

i. Reactors
ii. Current limiting device[7]

All-power-system protection is a field of electrical power engineering that deals with the isolation of faulty components from the rest of the electrical network in order to safeguard electrical power systems from faults. A protection scheme's goal is to maintain the power system stable by isolating just the components that are failing while keeping as much of the network as feasible operational. As a result, protection systems must take a pragmatic and pessimistic approach to resolving system flaws. Protection devices are the equipment that are used to safeguard power systems from failures.

a. The inference engine coordinates and manages all aspects of the knowledge-based system, including the processing of knowledge-based rules, reasoning, and communication with the user, other programs, and databases.

b. The outcome of the graphical analysis is a graphical analysis of the simulation findings.

c. The outcome of the graphical analysis is a graphical analysis of the simulation results.

d. The Generic Relay may be structured using the user interface, which enables you to input and modify rules. It also enables the user to follow the inference engine's reports, findings, and conclusions.

e. The protection design output shows the specifications and configurations of the Generic Relay, which are the result of this knowledge-based system [8].

Fault analysis can reduce the probability of failure in the power system which results in long life of the equipment used in the power system. There has been very much research paper published about fault analysis in which there is discussion about what is fault and how we can reduce the fault also how we can increase the efficiency of the power system. In book title "Power Systems Modelling and Fault Analysis" by Nasser Tleis there he explained about the fault, remedies and impact of the fault on the efficiency of device or power system.

2. REVIEW OF LITERATURE

A. Shuaibu studies Fault analysis is an important consideration in power system planning, protection equipment selection, and overall system reliability assessment. To adjust and set the protective devices so we can detect any fault and isolate the faulty portion of the system. In faulty condition excessive amount of current starts flowing through the device because heating effect Due to which insulation of the power systems burnt and device behaving improperly, so by fault analysis minimize that abnormal current and can increase the efficiency[9].

Power System Analysis 2nd Edition by arthurr bergen and vijay vittal he explained by calculation how we can increase the efficiency of the power system. Limiting short-circuit currents in medium-voltage applications by Terence Hazel Senior Member IEEE Schneider Electric 38050 Grenoble France in which short circuit current reduction method is given. Power systems analysis book in which method to find out the short circuit current at the fault location is given [10]

3. DISCUSSION

The electrical power infrastructure is massive, complicated, and sprawled over a wide region. In order for a power plant to attain high efficiency, several electrical components and devices must work simultaneously. However, grid efficiency is reduced when abnormal activity occurs in the grid or in a device, which is referred to as a fault in the circuit. A circuit failure may be caused by an increase in current flow in a short circuit or a decrease in voltage level. A generator, transformer, transmission lines, and load make up the electrical power system. A circuit fault is a disruption or failure in the circuit that prevents it from functioning correctly. As previously stated, short circuit current is high due to the low impedance. Until the circuit is completely burnt up, a huge amount of current in Kilo Amperes is unstoppable.

If we increase the insulating resistance of the power line and control the voltage supply, the chances of generating significant amounts of current are low. People are protected from step potential and touch potential by connecting the stay back line to ground at the transmission line's curvature point, as well as attaching guy resistance at all accessible places. Regular testing of power system equipment is required. The North grid collapsed in 2002 due to power system equipment failure, grid collapse when system equipment failed, and the above-mentioned cause was also due to fog/pollution. Fog misting the power line and dust caked on it because the electrical system to collapse or blackout, resulting in short circuits. To address this problem, we might install a moisture sensor that detects the moisture level in the power line and sends a signal to the SER when the moisture level rises over a particular level. So that the problem does not harm the electrical system, the maintenance team may wipe or remove the moisture.

Because transient high voltages may produce flashover on the power line's electrical equipment, lightning has an effect on power line performance. High voltage (HV) lines may be more susceptible to direct hits than medium voltage (MV) or low voltage (LV) lines since the probability of a direct impact increases with tower height in a given region. Lightning has a very high voltage, which may burn or destroy the insulation of electrical system components and equipment. Other parts of the station that depend on the lighting equipment will be affected as a consequence of the lighting equipment failing and ceasing to operate, resulting in a decrease in the efficiency of the power system as a result of the lightning fault.

All-power-system protection is a field of electrical power engineering that deals with the isolation of faulty components from the rest of the electrical network in order to safeguard electrical power systems from faults. A protection scheme's goal is to maintain the power system stable by isolating just the components that are failing while keeping as much of the network as feasible operational. As a result, protection systems must take a pragmatic and pessimistic approach to resolving system flaws. Protection devices are the equipment that are used to safeguard power systems from failures.

4. CONCLUSION

The analysis of the power system under short circuit circumstances was carried out, and various types of faults in power systems were addressed. The most frequent fault in power system grid is short circuit fault, which destroys the grid and reduces the system's efficiency. We looked at the causes of short circuit faults and how to prevent them, as well as the variables that influence short circuit faults. There are several recommendations in this study that demonstrate how increasing the grid's impedance and voltage level may improve or reduce short circuit current. The problems resulting from power system contingencies and their impact on protective relay settings were discussed in this article. The suggested solution is to combine all traditional protective relays and functionalities into a single Generic Relay. With the inclusion of a knowledge base, the whole protection system transforms into an intelligent relay capable of resetting limits in reaction to events. The article explains how to program the generic relay and the knowledge base using an Object-Oriented approach. The whole system was tested on a test power system, demonstrating that such a method is viable and practical, and that it may be used to build future protection systems. Implementation of solid state relays with zero voltage switching is discussed in this article. Modern power system protection relies on relays to detect and isolate several kinds of faults in the power circuit. Relays are chosen based on their power, voltage, and current ratings, as well as the impact of external variables.

REFERENCES

[1] I. Journal, F. Technological, R. H. Maisuriya, D. K. Patel, and N. G. Polytechnic, “Simulation of Short Circuit Condition and Fault,” pp. 135–139, 2018.

[2] J. S., “Types of Faults,” 2006.

[3] X. Miao, Y. Chan, R. Qiu, and J. Chen, “Research on Early detection and identification of short circuit fault based on terminal voltage in low voltage distribution system,” 2017. doi: 10.1109/ICPRE.2016.7871206.

[4] C. J. Mozina, “Improvements in protection and commissioning of digital transformer relays at medium voltage industrial facilities,” 2011. doi: 10.1109/PPIC.2011.5982883.

[5] P. Pozzobon, “Transient and steady-state short-circuit currents in rectifiers for DC traction supply,” *IEEE Trans. Veh. Technol.*, 1998, doi: 10.1109/25.728534.

[6] S. Hänninen and M. Lehtonen, “Characteristics of earth faults in electrical distribution networks with high impedance earthing,” *Electr. Power Syst. Res.*, 1998, doi: 10.1016/s0378-7796(97)01193-0.

[7] A. Prasad, J. Belwin Edward, and K. Ravi, “A review on fault classification methodologies in power transmission systems: Part—I,” *J. Electr. Syst. Inf. Technol.*, 2018, doi: 10.1016/j.jesit.2017.01.004.

[8] M. A. S. Duro, P. Kaufmann, F. C. P. Bertoni, E. C. N. Rodrigues, and J. P. Filho, “Long-Term Power Transmission Failures in Southeastern Brazil and the Geophysical Environment,” *Surveys in Geophysics*. 2012. doi: 10.1007/s10712-012-9191-1.

[9] A. Shuaibu, “An Analytical Study of Power System under the Foult Conditons using different Methods of Fault Analysis,” *Front. Electr. Electron. Eng. INDIA*, 2015.

[10] P. Bunnoon, “Fault Detection Approaches to Power System: State-of-the-Art Article Reviews for Searching a New Approach in the Future,” *Int. J. Electr. Comput. Eng.*, 2013, doi: 10.11591/ijece.v3i4.3195.