Review of 3 Phase Transmission Line Faults Analysis

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Abstract- *In addition to an overview of various types of fault and prevention techniques, this paper introduces introductory advanced techniques used in 3- phase transmission line fault concurrence. The paper represents a solution to currently demand of electricity or power is increasing day by day this results in transmitting more power by increasing the transmission line capacity from one place to the other place. But during the transmission, some faults occur in the system, such as L- L fault, 1L- G fault, and 2L- G fault. These faults affect the power system outfit which is connected to it.*

Keywords- 3-Phase Transmission Line, Electricity, L-L Fault, 1L-G Fault, 2L-G Fault

I. INTRODUCTION

Fault occurrence in power systems could end in losing their stability and cause severe damages in faulted devices or adjacent healthy devices. Also, the stability proposition is charged as an important factor in energy operation and planning of power systems. also, during the motor starting period, it draws an outsized current from the system, leads to drop of system and poses disturbances to the traditional operation of other loads. Various studies have shown that anywhere from 70%, to as high as 90%, of faults on utmost overhead lines are transient. A transient fault, like an insulator flashover, may be a fault which is cleared by the immediate tripping of 1 or more circuit breakers to isolate the fault, and which does not reoccur when the road isre-energized. Faults tend to be less transient at lower, distribution voltages and more transient at higher, sub transmission and transmission voltages. Lightning is that the commonest explanation for flash faults, incompletely performing from insulator flashover from the high transient voltages induced by the lightning. Other possible causes are swinging lines and temporary contact with foreign objects. therefore, transient faults are often cleared by shortly de-energizing the line, so as to permit the fault to clear. Auto reclosing can also restore service to the road. The remaining 10- 30 of faults are semi permanent or endless in nature. a little branch falling onto the road can cause a semi-permanent fault. during this case, still, an immediated e-energizing of the road and subsequent auto reclosing does not clear the fault. rather, a coordinated time-delayed trip would allow the branch to be burned down without damage to the system. Semi-permanent faults of this sort are likely to be most prevalent in largely wooded areas and may be substantially controlled by aggressive line clearance programs. Permanent faults are people who will not clear upon tripping and reclosing. An example of a permanent fault on an overhead line is a broken line causing a phase to open, or a broken pole causing the phases to short together. Faults on underground lines should be considered endless. Cable faults should be cleared without auto reclosing and therefore the damaged cable repaired before service is restored There could also be exceptions to the present, as in the case of circuits composed of both underground lines and overhead lines. This de-energizes the road long enough for the fault source to pass and thus the fault arc to deenergize, also automatically recloses the road to revive service. therefore, auto reclosing can significantly reduce the outage time thanks to faults and provide a better level of service continuity to the customer. Furthermore, successful high- speed reclosing auto reclosing. On transmission circuits are often a serious factor when attempting to maintain system stability. For those faults that are permanent, auto reclosing will reclose the circuit into a fault that has not been cleared, which can have adverse effects on system stability.in this paper, the discussed part will be nature of faults, their causes, and prevention methods.

II. NATURE OF FAULT

The faults are classified as,

- Symmetrical fault
- Unsymmetrical fault

1. *Symmetrical fault*

In such sorts of faults, all the phases are short-circuited to every other and often to earth. Such fault is balanced within the sense that the systems remain symmetrical, or we'll say the lines are displaced by an equal angle (i.e. 120° in three phase line). this type of fault is very severe but this fault occurs rarely.

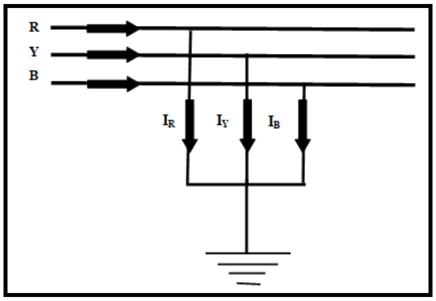

Diagram Of Symmetrical Fault

2. Unsymmetrical fault

Unsymmetrical faults involve only one or two phases. In unsymmetrical faults the three phase lines become unstable. similar types of faults occur between line-to- ground or between lines. An unsymmetrical series fault is between two phases or in phase-to- ground, whereas an unsymmetrical shunt fault is unstable in the line impedances. Shunt fault in the three- phase system can be classified as

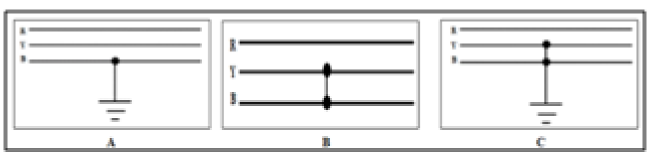

Diagram of Unsymmetrical fault

A. Single Line to Ground Faults (LG Fault)

Single line to ground fault is the most commonly occurring fault (60 % to 75 % of occurrence). This fault will occur when any single line is in contact with the ground.

only phase **r** is connected to ground at the fault, phase y and b are open circuited and carries no current; i.e fault current is I_r and $I_y = 0$, $I_b = 0$. The voltage at the fault point F is $V_r = Z_f I_r$.

The symmetrical component of the fault current in phase "r" at the fault point can be written as below

we put a,b,c instead of r,y,b in equations.

$$I_{a0} = \frac{1}{3}(I_a + I_b + I_c) = \frac{1}{3} I_a$$

$$I_{a1} = \frac{1}{3}(I_a + \alpha I_b + \alpha^2 I_c) = \frac{1}{3} I_a$$

$$I_{a2} = \frac{1}{3}(I_a + \alpha^2 I_b + \alpha I_c) = \frac{1}{3} I_a$$

$$I_{a0} = I_{a1} = I_{a2} = \frac{1}{3} I_a \qquad \mathbf{1}$$

In the case of a L-G fault, the sequence currents are same. The sequence voltage at the fault point is determined by the equations,

$$\mathbf{Va0} = E\boldsymbol{a}\mathbf{0} - \boldsymbol{Za}0\boldsymbol{Ia}\mathbf{0} \qquad \mathbf{2}$$

$$\mathbf{Va1} = E\boldsymbol{a}1 - \boldsymbol{Za}1\boldsymbol{Ia}1 \qquad \mathbf{3}$$

$$\mathbf{Va2} = E\boldsymbol{a}2 - \boldsymbol{Za}2\boldsymbol{Ia}2 \qquad \mathbf{4}$$

The current sequence is given by eq.

$$I_{a0} = I_{a1} = I_{a2} = \frac{V_f}{[3Z_f + (Z_{a0} + Z_{a1} + Z_{a2})]} \qquad \mathbf{5}$$

B. Line To Line Fault (LL Fault)

Double line fault occurs when two lines are got short-circuited. This type of fault occurrence ranges from 5% to 15%. The symmetrical component sofa fault current in phase 'r' at the fault point can be divided in to three components. The zero-sequence component of current at phase a is,

we put a,b,c instead of r,y,b in equations.

$$I_{a0} = \frac{1}{3}(0 + I_b - I_b) \qquad \mathbf{1}$$

$$I_{a1} = \frac{1}{3}(\alpha - \alpha^2) I_b \qquad \mathbf{2}$$

The negative sequence component of lineis given by the eq.

$$I_{a2} = \frac{1}{3}(\alpha - \alpha^2) \qquad \mathbf{3}$$

Therefore, we get

$I_{a0}=0$ and $\mathbf{Ia1} = -\mathbf{Ia2}$

Expressing Va, Vb and Vc regarding voltages at the fault point are found by the relations given by

$(\boldsymbol{Va}\mathbf{0} + \alpha^2 \boldsymbol{Va}\mathbf{1} + \alpha \boldsymbol{Va}\mathbf{2}) - (\boldsymbol{Va}\mathbf{0} + \alpha \boldsymbol{Va}\mathbf{1} + \alpha^2 \boldsymbol{Va}\mathbf{2}) = \boldsymbol{Zf}(\boldsymbol{Ia}\mathbf{0} + \alpha^2 \boldsymbol{Ia}\mathbf{1} + \alpha \boldsymbol{Ia}\mathbf{2})$

$$\boldsymbol{Va}\mathbf{1} - \boldsymbol{Va}\mathbf{2} = \boldsymbol{Zf}\boldsymbol{Ia}\mathbf{1} \qquad \mathbf{4}$$

$$\mathbf{Va0} = -\boldsymbol{Za}\mathbf{0}\boldsymbol{Ia}\mathbf{0} \qquad \mathbf{7}$$

$$\mathbf{Va1} = -\boldsymbol{Vf} - \boldsymbol{Za}\mathbf{1}\boldsymbol{Ia}\mathbf{1} \qquad \mathbf{8}$$

$$\mathbf{Va2} = -\boldsymbol{Za}\mathbf{2}\boldsymbol{Ia}\mathbf{2} \qquad \mathbf{9}$$

$$I_f = \frac{(\alpha^2 - \alpha)V_f}{Z_{a1} + Z_{a2} + Z_{a3}} \qquad 10$$

From equation (1) it is clear that the line-to-line fault the zero-sequence component ofcurrent Ia0 is equal to zero. Equation (4) shows that the positive-sequence component ofcurrentis opposite inphase to the negative-sequencecomponent of current

C. Double Line to Ground Fault (LLG Fault)

Double line to ground fault occurs when two lines are short-circuited and are in contact with the ground. This type of fault occurrence ranges from 15% to 25% of the occurrence The current & voltage to ground conditions the fault is expressed as

$$I_{a1} = I_{a2} = I_{a0} = 0 \qquad 1$$

$$V_b = V_c = Z^f(I_b + I_c) = 3Z^f I_{a0} \qquad 2$$

$$V_{a0} = V_{a1} + 3Z^f I_{a0} \qquad 3$$

in terms of thevenin theorem we can write

$$I_{a1} = \frac{E_a}{Z_1 + Z_2 \parallel (Z_0 + 3Z^f)} \qquad 4$$

Now we finally get the euation,

$$I_{a1} = \frac{E_a}{Z_1 + Z_2(Z_0 + 3Z^f)/(Z_2 + Z_0 + 3Z^f)} \qquad 3$$

III. CAUSES OF FAULTS

There are several causes for the occurrence of a fault in the power system. Some of the causes of faults are

1) overvoltage due to switching surges
2) Severe lightning strokes
3) Aging of conductor
4) Heavy wind, rain, and snowfall
5) Falling trees on the transmission line
6) Excessive internal and external stresses on the conductors
7) High changes in atmospheric temperatures
8) Accident of vehicle with towers or poles of transmission line
9) Perching of birds on the lines
10) Accidental short circuit due to string

IV. PREVENTION METHOD

A. Preventive measures against lightning

There are a few preventive measures that can be taken to lessen the chance of being struck by lightning. When thunderstorms are forecasted, it is best to stay indoors and avoid contact with any conductive materials like metal or water. If you must go outside, try to stay in an open area away from trees or other tall objects. And always remember, when thunder roars, go indoors.

B. Prevention measures for tower collapse accidents

To prevent these accidents, it is necessary to take some specific measures. Firstly, it is important to conduct a comprehensive risk assessment of the transmission line. This will help identify potential risks and hazards associated with the line. Secondly, regular maintenance and inspection of the transmission line should be carried out. This will help ensure that the line is in good condition and does not pose any risks. Thirdly, effective communication and coordination between different agencies involved in the operation of the transmission line are essential. This will help ensure that everyone is aware of the potential risks and knows what to do in case of an accident. Finally, it is also important to have an emergency response plan in place in case of an accident. This will help ensure that everyone knows what to do in case of an emergency situation.

C. Measures to avoid pollution of overhead transmission line

There are a few things that can be done to prevent pollution flashovers on overhead transmission lines. First, the conductors should be regularly cleaned and inspected for corrosion. Second, the insulators should be checked for cracks or other damage. Third, the ground wire should be checked for proper connections. Finally, if there is any vegetation near the line, it should be trimmed back to prevent it from coming into contact with the line.

D. Measure to avoid Dropping or disconnection of overhead transmission lines

There are a few different ways to help prevent drooping or disconnection of overhead transmission lines. One way is to use guy wires, which are cables that provide extra support to the main line. Another method is to use surge arresters, which are devices that help protect the line from sudden voltage surges. Finally, regular maintenance and inspection of the lines can help identify potential problems before they cause an outage

V. CONCLUSION

Studies and researches regarding 3 phase transmission line faults and a prevention option may overcome large damages in power system. Using these methods overcome of these faults and increase the life of equipment connected to the transmission line is possible. And also, disturbance of power supply to the consumer is also reduce

REFERENCES

[1] Whakilahemedshakil, Midhant Rahman “Fault Analysis on Three Phase Transmission Lines and its Detection” in researchgate, aprril 2022
[2] Aditya Sharma, Himanshu Sharma, Md Irfan Ahmed, “Arduino Based Overhead Cable Fault Detection’ B.Tech Student, Electrical Engineering Department Career Point University, Kota, Rajasthan, Kota, India, 2017.
[3] Tarang Thakur,” Three Phase Faults Analysis of Power System”, Maharaja Agrasen Institute of Technology, 2016.
[4] Manju, Sooraj Maharana, Chandrakant Sharma”Fault Analysis of Transmission Line Approach to MATLAB Simulation.” Taraksh Journal of Web Services Volume 1 Issue 1, 2014.
[5] Raunak Kumar “These Phase Transmission Lines Fault Detection Classification and Location” IJSR, 201