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Using Graphical User Interface NEPLAN to Calculate the Transmission Lines Faults in Power System

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Abstract- A fault represents the structural network change equivalent caused by the addition of impedance at the place of Fault. The faulted network can be solved conveniently by graphical user interface NEPLAN. In this paper an example of a 3 bus system is taken with a fault at 50% from transmission line. The calculation for fault current is done in NEPLAN program created by input the same data at several methods and compared with the calculations.

Keywords- *Power System Fault Analysis, unsymmetrical Faults, Symmetrical faults, open circuit fault, short circuit fault and transient faults*

I. INTRODUCTION

In power system network, it is necessary to design the equipment as (circuit breaker, c.t, v.t, relay … etc.), to detect and control the network against any deferent fault occur, this called protection systems.

A fault in an electric power system can be defined as any abnormal condition of the system that involves the electrical failure of the equipment.

In fact, there are deferent types of fault occur in power system network effective at parts of the network (transformers, generators, transmission lines, bus bars, motors and the loads) if not treat it this faults can be caused damage in parts of network and due to economic losses.

The fault also involves in insulation failures and conducting path failures which results short circuit and open circuit of conductors.

Under normal operating conditions, the electric equipment into power system network operating at normal voltage and current ratings. Once the fault takes place in a circuit or device, voltage and current values deviates from their nominal ranges.

The faults in power system causes over current, under voltage, unbalance of the phases, reversed power and high voltage surges. This results in the interruption of the normal operation of the network, failure of equipment, electrical fires, etc.

In this paper, is devoted to types of fault in transmission line and mathematical analyses about it [2][1].

And devoted to abnormal system behavior under conditions of symmetrical and unsymmetrical fault in power system networks. Then we talk about transient and permanent faults [5][3]. Then using the NEPLAN software the procuration, discussion and conclusion the results.

II. TYPES OF FAULTS

Electrical faults in three-phase power system can be classified into 2 types, namely open circuit faults and short circuit faults. Further, these faults can be symmetrical faults or unsymmetrical faults. Let us discuss these faults in details.

A. Open Circuit Faults

These faults occur due to the failure of one or more conductors. The figure (1) below obtain types of open circuit faults for single, two and three phases (conductors).

The most common causes of these faults include: joint failures of cables, overhead lines, failure of one or more phase of circuit breaker and also due to melting of a fuse or conductor in one or more phases.

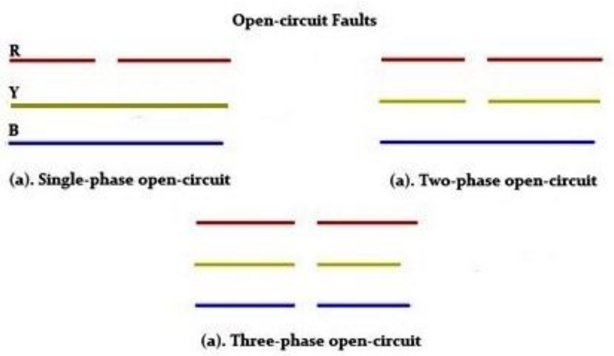

Figure 1. Types of open circuit Fault

Thus, single and two phase open conditions can produce the unbalance of the power system voltages and currents that causes great damage to the equipment.

Open circuit faults are representing as series faults. These are unsymmetrical faults or unbalanced faults except three phase open fault.

Open conductor fault is in series with the line. Line currents and series voltage between ends of the conductors are required to be determined. The set of series current and voltage at the fault are:

$$I_P = \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix}; V_P = \begin{bmatrix} V_{aa'} \\ V_{bb'} \\ V_{cc'} \end{bmatrix}$$

Symmetrical component of current and voltage are:

$$I_s = \begin{bmatrix} I_{a1} \\ I_{b2} \\ I_{c0} \end{bmatrix}; V_s = \begin{bmatrix} V_{aa'1} \\ V_{bb'2} \\ V_{cc'0} \end{bmatrix}$$

Case-1 When two conductor open- the current and voltage due to this fault are expressed as

Vaa' = 0 Ib = Ic = 0

In term of symmetrical components, we can write:

Vaa'1 + Vaa'2 + Vaa'0 = 0

Ia1 = Ia2 = Ia0 = 1 / 3 Ia

Case-2 One conductor open- the current and voltage due to this fault are expressed as

Vbb' = Vcc' = 0 Ia = 0

In term of symmetrical components, we can write:

Vaa'1 = Vaa'2 = Vaa'0 = 1 / 3 Vaa'

Ia1 + Ia2 + Ia0 = 0

1) Causes

Broken conductor of circuit breaker in one or more phases.

2) Effects

- Abnormal operation into the system
- Danger to the personnel and animals
- Exceeding the voltages in normal values in local parts of the network, which further leads to insulation failures and then developing of short circuit faults.
- If not remove open circuit fault as early as possible to reduce the greater damage.

B. Short Circuit Faults

A short circuit can be defined as an abnormal connection of very low impedance between two points of different potential, whether made intentionally or accidentally.

These are the most common and severe kind of faults, resulting in the flow of abnormal high currents through the equipment or transmission lines. If these faults are allowed to persist even for a short period, it leads to the extensive damage to the equipment.

Short circuit faults are also called as shunt faults. These faults are caused due to the insulation failure between phase conductors or between earth and phase conductors or both.

The various possible short circuit fault conditions include three phase to earth, three phase clear of earth, phase to phase, single phase to earth, two phase to earth and phase to phase plus single phase to earth as shown in figure (2).

The three phase fault clear of earth and three phase fault to earth are balanced or symmetrical short circuit faults while other remaining faults are unsymmetrical faults.

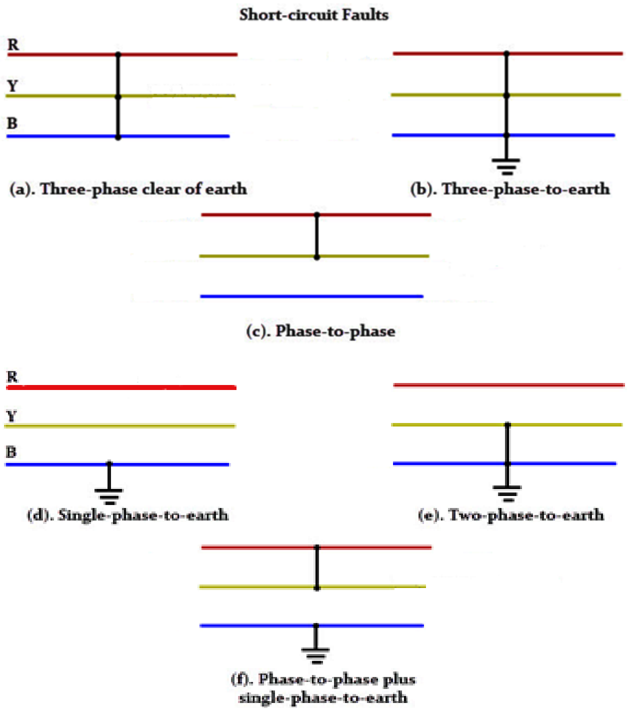

Figure 2. types of short circuit Fault

In shunt type fault also three category:

1) Single line to ground fault

In this type of fault at the fault point, the currents out of the power system and the line to line ground voltages are constrained as follows:

$$I_b = I_c = 0$$

$$V_a = Z^f I_a$$

The symmetrical components of the fault current are:

$$I_{a1} = I_{a2} = I_{a0} = 1/3I_a$$

$$V_{a1} + V_{a2} + V_{a0} = Z^f I_{a1}$$

2) Line to line fault

Line to line fault at any point in a power system then the currents and voltages at the fault can be expressed as:

$$I_a = 0, I_b = -I_c$$

$$V_b - V_c = I_b Z^f$$

3) Double line to ground fault

For this condition the currents and voltages at the fault are expressed:

$$I_a = 0, I_{a1} + I_{a2} + I_{a0} = 0$$

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

1) Causes

These may be due to internal or external effects

- Internal effects: breakdown of transmission lines or equipment, aging of insulation, deterioration of insulation in generator, transformer and other electrical equipment, improper installations and inadequate design.
- External effects: overloading of equipment, insulation failure due to lighting surges and mechanical damage by public.

2) Effects

- Arcing faults can be lead to fire and explosion in equipment as transformers and circuit breakers.
- Abnormal currents cause in equipment to get overheated, which is further leads to reduction of life insulation.
- The operating voltages of the system can go down or up their acceptance values that creates harmful effect to the service rendered by the network.
- The power flow is severely restricted or even completely blocked as long as the short circuit fault persists.

III. SYMMETRICAL AND UNSYMMETRICAL FAULTS

From discussed above the faults are mainly classified into open and short circuit faults and again these can be symmetrical or unsymmetrical faults.

A. Symmetrical Faults

Symmetrical fault is also called as balanced fault. This fault occurs when all the three phases are simultaneously short circuited.

These faults rarely occur in practice as compared with unsymmetrical faults. Two kinds of symmetrical faults include line to line to line (L-L-L) and line to line to line to ground (L-L-L-G) as shown in figure (3) below.

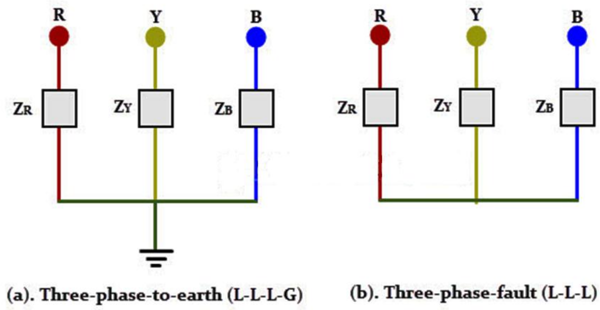

Figure 3. symmetrical Fault

A rough occurrence of symmetrical faults is in the range of 2 to 5% of the total system faults. However, if these faults occur, they cause a very severe damage to the equipment even though the system remains in balanced condition. The analysis of these faults is required for selecting the rupturing capacity of the circuit breakers, choosing set-phase relays and other protective switchgear. These faults are analyzed on per phase basis using bus impedance matrix or Thevenins's theorem.

B. Unsymmetrical Faults

The most common faults that occur in the power system network are unsymmetrical faults. This kind of fault gives rise to unsymmetrical fault currents (having different magnitudes with unequal phase displacement). These faults are also called as unbalanced faults as it causes unbalanced currents in the system.

Up to the above discussion, unsymmetrical faults include both open circuit faults (single and two phase open condition) and short circuit faults (excluding L-L-L-G and L-L-L).

The figure below shows the three types of symmetrical faults occurred due to the short circuit conditions, namely phase or line to ground (L-G) fault, phase to phase (L-L) fault and double line to ground (L-L-G) fault as shown in figure (4):

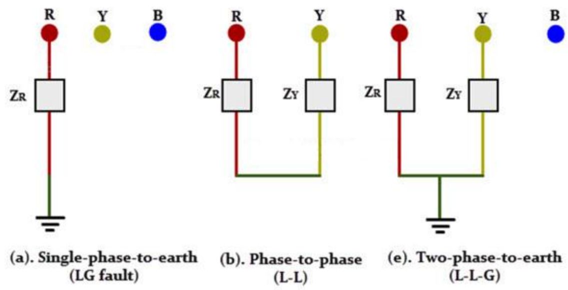

Figure 4. Unsymmetrical Fault

A single line-to-ground (L-G) fault is one of the most common faults and experiences show that 70-80 percent of the faults that occur in power system are of this type. This forms a short circuit path between the line and ground. These are very less severe faults compared to other faults.

A line to line fault occur when a live conductor get in contact with other live conductor. Heavy winds are the major cause for this fault during which swinging of overhead conductors may touch together. These are less severe faults and its occurrence range may be between 15-20%.

In double line to ground faults, two lines come into the contact with each other as well as with ground. These are severe faults and the occurrence these faults is about 10% when compared with total system faults.

Unsymmetrical faults are analyzed using methods of unsymmetrical components in order to determine the voltage and currents in all parts of the system. The analysis of these faults is more difficult compared to symmetrical faults.

This analysis is necessary for determining the size of a circuit breaker for largest short circuit current. The greater current usually occurs for either L-G or L-L fault.

IV. TRANSIENT & PERMANENT FAULTS

A transient fault is a fault that is no longer present if power is disconnected for a short time. Many faults in overhead power lines are transient in nature. At the occurrence of a fault power system protection operates to isolate area of the fault.

Transient faults are faults which do not cause damage the insulation permanently and allow the circuit to be safely re-energized after a short period of time.

A typical example would be an insulator flashover following a lightning strike, which would be successfully cleared on opening of the circuit breaker, which could then be automatically reclosed.

Transient faults occur on outdoor equipment where air is the main insulating medium.

Permanent faults, as the name implies, are the result of permanent damage to the insulation. In this case, the equipment has to be repaired and reclosing must not be entertained. A transient fault will then clear and the power line can be returned to service.

V. WORK AND RESULT

In this paper, we used a graphical user interface NEPLAN. This program is simulate power system analyses (load flow) after draw the network and input data in load flow section, go two shot circuit section and chose the line and/or bus whose fault information can get it and can chose any method to solve the problem, of course, after input all data can be scarcity and get a result. Also can chose type of fault as 3 phases, single phase, two conductors … etc.

NEPLAN software gives a real result it's excellent about it. In this work, draw a simple power system network and input data as scarcity in several method and several types of fault and compared the result whose get it.

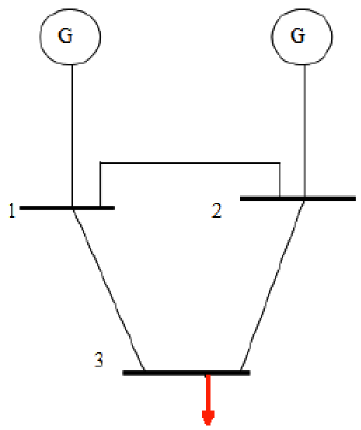

TABLE I. SOFTWARE DATA INPUT IN NEPLAN

Slack	Generator	Load	Line 1 -2	Line 1-3	Line 2-3	Busses
100KV	400 MW	400 MW	R = 25	R= 30	R = 32	400 KV
	200 MVAR	200 MVAR	X = 40	X = 20	X = 64	
Cos(pai)=1			FAULT at 50%			
Vr = 20						
Sr MVA=80						
Xdsat=1						

After draw the network as figure 5 and inter the software data from table 1 in network drawing in NEPLAN in section load flow and get a result, chose any method to calculate the fault as shown in (group figures) below:

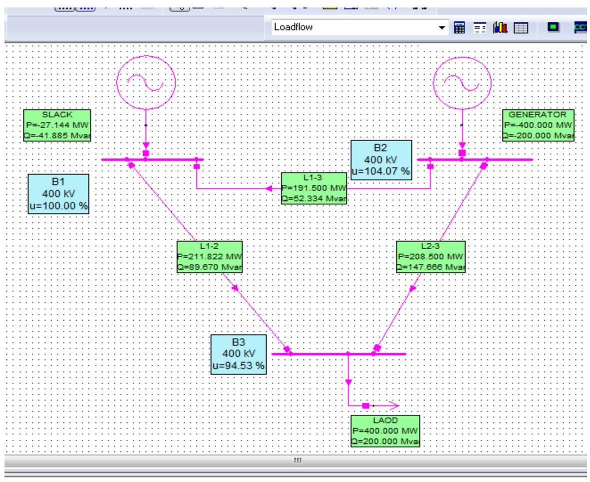

Figure 5. input data in load flow section

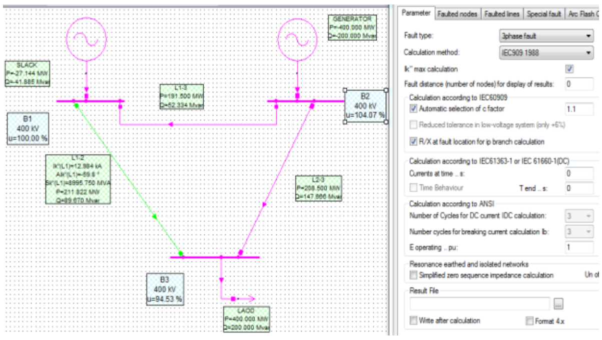

Figure 6. 3 phase fault in IEC909 1988 method

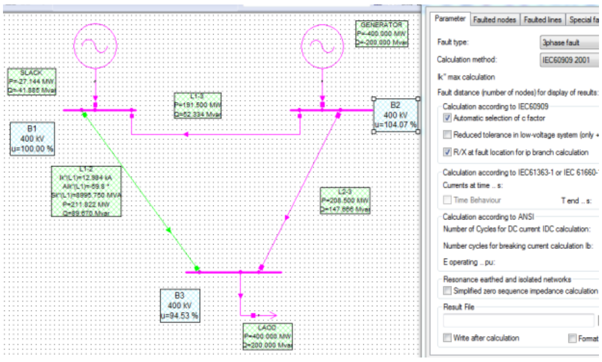

Figure 7. 3 phase fault in IEC60909, 2001 method

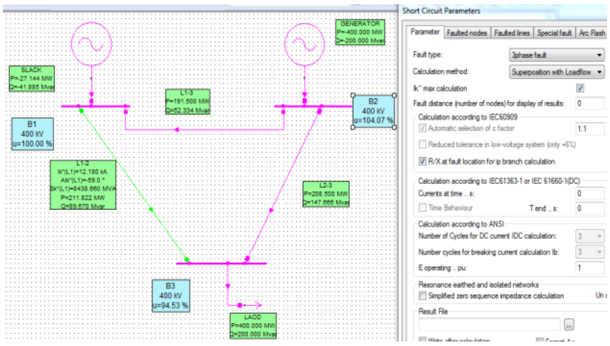

Figure 8. 3 phase fault in superposition with load flow method

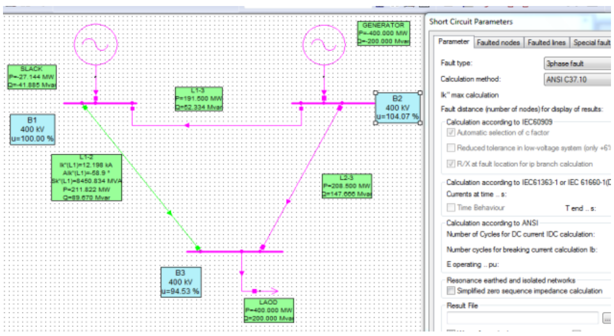

Figure 9. 3 phase fault in ANSI C37.10 method

TABLE II. COMPARE BY THE FAULT CURRENTS ABOUT SEVERAL METHODS IN NEPLAN SOFTWARE

IEC909 1988 method	IEC60909 2001 method	superposition with loadflow method	ANSI C37.10 method
12.984 KA	12.984 KA	12.180 KA	12.198 KA

VI. DISCUSSION

Can see the current fault is very high about 12 KA this result depend to values of input data in network.

And this high current cause damage in transmission line and so in other equipment.

VII. CONCLUSION

In this paper a power system with faulted transmission line is analyzed. The calculations are done by using the graphical user interface NEPLAN and used several methods to get the result. All these results are found nearly equal, so this type of methods in NEPLAN is very useful for solving lengthy calculations of the faulted transmission lines on a power system.

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