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Reduction Of Fault Current By Using Short Circuit Analysis For Power System Network

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Abstract : The aim is to examine the short circuit analysis of the power system when a unsymmetrical and symmetrical fault is created at bus by using E-TAP software. At this juncture the short circuit analysis is carried out for 6 bus system. The fault is created at bus 1, 3 and 5 for 0.3 second. The lingering buses are kept as un faulted. The IEC 60909 standard is performed after running the load flow analysis with the help of short circuit study case editor. The 60909 standard is used for calculating the line to line, line to ground, line to line to ground and three phase fault. This study calculates AC component fault current, Dc component fault current, total fault current. The total fault current generated will be used for relay co ordination.

Keywords : E-TAP software; IEC 60909; Short Circuit stability

I. Introduction

Short circuit studies and analysis are important in power system because they provide data such as voltages and currents during and after various types of fault which are important while designing the protective schemes of power system. There are different types of faults in the power system it is broadly classified into symmetrical and unsymmetrical fault. Short Circuit analysis is required to ensure that existing and new equipment ratings are adequate to withstand the available short circuit energy available at each point in the electrical system. A Short Circuit Analysis will help to ensure that personnel and equipment are protected by establishing proper interrupting ratings of protective devices like circuit breaker and fuse.

Causes of unsymmetrical faults

Lightning, wind damage, trees falling across lines, vehicles colliding with towers, birds shorting lines. Other causes are due to breaking of one or two conductor or the action of fuses and other protective devices that may not open the three phases.

Benefits of Short Circuit Analysis

- Reduces the risk a facility could face and help avoid catastrophic losses
- Increases the safety and reliability of the power system and related equipment
- Evaluates the application of protective devices and equipment
- Identifies problem areas in the system
- Identifies recommended solutions to existing problems

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Need For Short Circuit Study

When heavy current flows through the circuit it has to be protected against the current by disconnecting the faulty section from healthy section by using circuit breaker. For proper choice of circuit breaker, protective relays the estimation of magnitude of fault current, short circuit study is essential. It is more important in order to design or develop the protective schemes for various parts of the system.

Applications of Short Circuit Analysis

- To select circuit breaker
- To obtain the ratings of switch gear
- For proper relay setting and coordination
- To select relays while line to ground fault is used for earth relays

The faults in the power system are classified as

- Symmetrical fault
- Unsymmetrical fault

Symmetrical Fault

The fault current in all the phases are equal. It is classified as

- Three phase fault

Unsymmetrical Fault

The fault current in all the phases are not equal. It is classified into three types

- Line to Line fault
- Line to ground fault
- Double line to ground fault

Three phase fault is least common after the fault the system remains symmetrical that is balanced. The remaining three faults are unsymmetrical that is unbalanced, after the fault voltages and currents are unbalanced.

II. Software

The software used for simulation is E-TAP (Electrical Transient Analysis Program). The designer and developer of ETAP is the “Operation Technology, Inc” (OTI). E-TAP is a fully graphical enterprise package that runs on microsoft windows 2003, 2008, XP, vista, and 7operating system. It is the most comprehensive analysis software for the design, simulation, operation, monitoring, control, optimization and automation of power systems. By using this

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software we can perform different analysis on a bus system, it includes load flow analysis, short circuit analysis, arc flash analysis, harmonic analysis and transient stability analysis etc. Transient stability studies includes identifying critical fault clearing time, checking generator rotor angle stability, preparing and testing load shedding schedule, evaluating relay setting.

III. Simulation Diagram

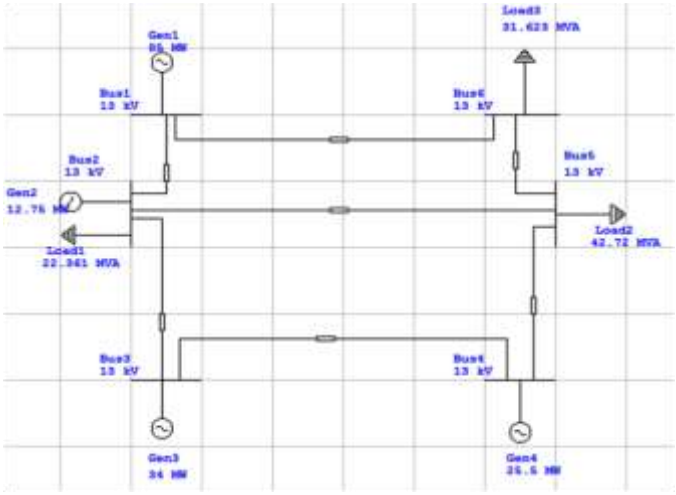

Fig. 1. Test System

3.1 Input Data

TABLE I. Transmission Line Parameters of 6 Bus System

Line	Bus Code	Resistance (p.u)	Reactance (p.u)
1	1-2	0.05	0.20
2	2-3	0.10	0.50
3	3-4	0.20	0.80
4	4-5	0.10	0.30
5	5-6	0.20	0.40
6	6-1	0.10	0.15
7	2-5	0.20	0.50

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TABLE II. Generator Data

Generator No	MVA	Bus type
Generator 1	100	Slack
Generator 2	15	PV
Generator 3	40	PV
Generator 4	30	PV

TABLE III. Load Data

Bus	MW	MVA
Bus 2	20	10
Bus 5	40	15
Bus 6	30	10

Table I consists of transmission line parameters that is resistance and reactance values of each lines represented in per unit. Table II consists of generator data's in MVA and type of bus connected to each generator. Table III consists of load data's that is amount of load connected to the bus in MW and MVA ratings.

IV. Load Flow Analysis

The study of various methods of solution to power system network is referred to as load flow study. The information obtained from the load flow study is magnitude and phase of bus voltages, real and reactive power flow in each line and line losses. The buses of power system can be classified as

- Load bus or PQ bus
- Generator bus or PV bus
- Slack bus or swing bus

Load bus

Real and reactive power of bus is precise. The voltage is to vary within the limit.

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Swing bus

The magnitude and phase of bus voltage is precise. The swing bus is the reference bus for load flow solution. One of the generator bus is selected as swing bus. It is used to account transmission line losses.

For load flow analysis gauss seidel, newton raphson and fast decoupled methods are used. In this paper newton raphson method is used because it is faster, more reliable, results are accurate, requires less number of iterations. The first generator connected to the bus is kept as slack bus. Initially load flow analysis had to be performed to determine the power consumed by each loads.

V. Simulation Result and Discussion

The short circuit study is analyzed for 6 bus system. For initial load flow solution newton raphson method is used. The maximum number of iteration is 3, the solution precision for initial load flow is 0.000001, the time increment for integration steps is 0.001, the total simulation time will be 5 seconds and the plot time step will be of 10.

The symmetrical and unsymmetrical fault is created at bus 1, 3 and 5 for 0.3 second and with the help of short circuit study case editor. The IEC 60909 study is run in order to determine AC symmetrical short circuit current (I''_k), peak short circuit current (i_p), steady state short circuit current (I_k).

The I"k is th rms value of symmetrical short circuit current determined by

$$I\forall\kappa = \frac{c.U_n}{\sqrt{3}Z\kappa}$$

Where

Z_k = equivalent impedance at fault location

C = voltage factor

The peak current can be calculated by

$$Ip = \sqrt{2}*k*I''_k$$

Where

K is function of X/R ratio. X/R ratio depends on method selected for calculation using study case editor toolbar. method A for uniform X/R ratio, method B for meshed network and method c for non meshed network.

The standard IEC 61363 is used to perform three phase fault. This study is used to determine DC offset, short circuit current envelope, AC component in percentage for total short circuit current at faulted buses.

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The total fault current at different buses that is bus 1, 3 and 5 are shown in figure 2.

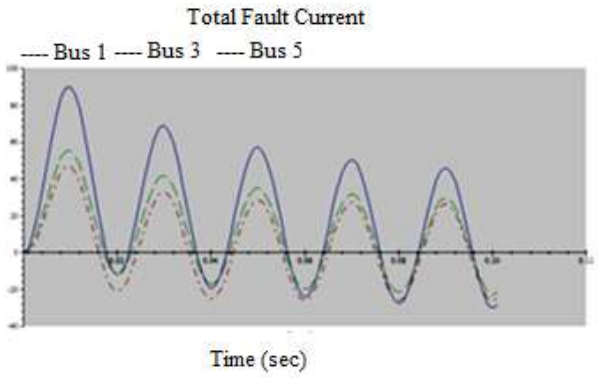

Fig. 2. Total Fault Current at Different Buses

TABLE IV. Short Circuit Analysis Result

Bus ID	Three Phase Fault			Line to Ground Fault		
	I''_K	i_p	I_k	I''_K	i_p	I_k
1	38.02	96.07	38.02	50.8	128.45	50.8
3	23.92	58.34	23.92	36.3	88.591	36.3
5	23.08	49.81	23.08	35	75.448	35

Line to Line			Line to Line to Ground		
I''_K	i_p	I_k	I''_K	i_p	I_k
35.38	89.4	35.38	46.83	118	46.8
25.21	61.5	25.21	30.54	74.5	30.5
24.52	52.9	24.52	29.8	64.3	29.8

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Table IV shows symmetrical and unsymmetrical fault current consists of symmetrical short circuit current (I"k), peak short circuit current (ip).

VI. Conclusion

Thus the short circuit analysis for 6 bus system has been enhanced by creating symmetrical and un symmetrical faults on bus 1, 3 and 5. By using the IEC 60909 study the total fault current is generated for buses 1, 3 and 5 and that generated fault current will be used for relay co ordination. Depending upon the uses the fault current can be reduced by increasing the line impedances and length of the line.

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