Nature and causes of fault in power system

Any fault in electrical apparatus is nothing but the defect in its electrical circuit which makes current path directed from its intended path. Normally due to breaking of conductors or failure of insulation, these faults occur. The other reasons for occurance of fault include mechanical failure, accidents, excessive internal and external stresses. The impedance of the path in the fault is low and the fault currents are comparatively large. The reduction of the insulation is not considered as a fault until its show some effects such as excessive current flow or reduction of impedance between conductors or between conductors and earth.

- When a fault occurs on a system, the voltages of the three phases become unbalanced. As the fault currents are large, the apparatus may get damaged. The flow of power is diverted towards the fault which affects the supply to the neighbouring zone.
- A power system consists of generators, transformers, switchgear, transmission and distribution circuits. There is always a possibility in such a large network that some fault will occur in some part of the system. The maximum possibility of fault occurrence is on transmission lines due to their greater lengths and exposure to atmospheric conditions.

- The fault can not be totally eliminated from the system but their occurrence can be minimised by improving system design, quality of the equipment and maintenance.
- The faults can be classified according to causes their incidence to :

1. The breakdown may occur at normal voltage due to deterioration of insulation.
2. The breakdown may also occur due to damage on account of unpredictable causes which include perching of birds, accidental short circuiting by snakes, kite strings, three branches etc.
3. The breakdown may occur at abnormal voltages due to switching surges or surges caused by lighting.

The AC faults can also be classified as :

1. single line to ground fault.
2. double line to ground fault
3. three phase fault

that may occur in the system due to unbalance in current and voltage, over voltages, reversal of power, power swings, under frequency, temperature rise and instability.

- It may be necessary to know the frequency of the fault ocurrance on various parts of the system which help in designing suitable protection circuit. Following table gives us an idea as to how the faults are distributed in the various parts of the system.

Table 1

	Equipment	% of total faults
1)	Overhead lines	50
2)	Switchgear	15
3)	Transformer	12
4)	Cables	10
5)	Miscellaneous	8
6)	Control equipment	3
7)	CTs and PTs	2

- It can be seen from the above table that maximum number of faults are occurring on overhead lines.
- In case of three phase system we have :

1. the breakdown of insulation between one of the phases and earth is known as line to ground fault.
2. In line to line fault, there is insulation breakdown between either of two phases.
3. While the insulation breakdown between two phases and earth forms double line to ground fault.
4. The breakdown of insulation between three phases is nothing but three phase fault.

Following table gives occurrence of these faults.

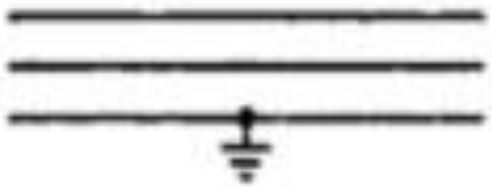
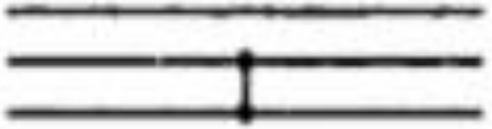
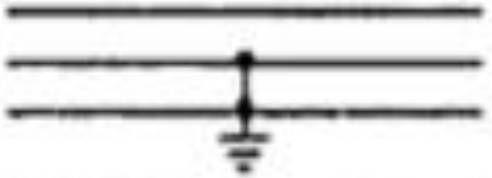
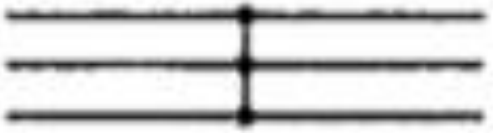
Type of Fault	Representation	% occurance
1) Line to Graound (L-G		85
2) Line to Line (L-L)		8
3) Line to Line to Ground (L-L-G)		5
4) Line to Line to Line (L-L-L)		2 or Less

Table 2 Type of faults and % of occurrence

Sub-transient – transient and steady state cases

- It can be seen from the above table that most of the faults are line to ground faults in case of overhead lines. A large number of these faults are transitory in nature. the word transitory refers to the fault which remains for short duration of time. The fault current varies with time. For example if a twig falls across a line and across arm and burns itself out or just falls down then the fault is transient as it vanishes after few cycles. During first one to three cycles, the fault current is very high but later on decreases very rapidly.

- This zone in which the current is very high but decreases very rapidly is called 'sub transient' state. After these first few cycles, the rate of current decreases is slower. This zone is called 'transient' state. This state remains for several cycles. After the transient state is over, steady state is reached. During the steady state, the rms values of short circuit current remains constant. The circuit breaker operates during transient state.