

Subject : Basic electrical engineering

Question : Describe the basic fundamental of standard transmission and distribution of Voltage. Also briefly discuss the concept of grid.

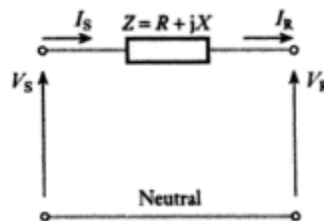
Answer :

Standard Transmission and Distribution of Voltage:

Power system analysis is required for different purposes. These include:

- System design and control to maintain consumer voltage at statutory levels. (Effected by conductor sizing and transformer tap changer position.)
- Fault calculations to ensure that the maximum fault current can be interrupted by circuit breakers or fuses and that large fault currents cause the minimum of damage to the power system.
- Design of protection systems to ensure faulty circuits are switched off rapidly (<20 ms) to prevent damage and to ensure that only the faulty circuit is switched off to minimise supply disruption.
- System design and control to maintain frequency within ± 0.5 percent.
- To ensure sufficient generation is available to meet the expected demand - load forecasting.
- To ensure that loads are supplied by the most efficient arrangement of generators - load scheduling.

We shall consider the first two of these topics - the calculation of voltage drops and the calculation of fault currents in supply networks.



Consider the equivalent circuit of figure 5.2 used to represent a single phase of a balanced three phase system. V_S and V_R are phase to neutral voltages. Since there are no parallel branches, the current at the sending end (I_S) and that at the receiving end (I_R) are the same.

Hence two circuit equations are,

$$V_S = V_R + ZI_R$$

$$I_S = I_R$$

The current is calculated from the three phase power delivered:

$$P = 3V_R I_R \cos \phi$$

Grid

An electrical grid is an interconnection of generation, transmission, and distribution networks used to supply electricity from the generating stations to the consumers. Connection of a load to grid system improves the reliability of service. Grid is a term used for electricity network to support any or some of the operations viz, generation of electricity; transmission of electricity to long distances and distribution and control of electricity.

Electricity generation and consumption must be balanced across the entire grid. Excess of electricity in one state can be shared with shortage of electricity in another state through national-level electrical grid connection. Electricity can be sold or purchased as per requirement by the state electricity supply authorities. A central authority is usually designated to develop protocols and facilitate communication for maintaining a stable grid. Any large failure in one part of the grid has to be compensated quickly to avoid cascading effect of large-scale power failure. When we say that a particular load of an industry or a township is connected to the grid, it means that the load is connected to several supply sources through long transmission lines.

This enables the possibility of getting supply from whichever source is available. In India, we have national grid connections to share the electricity resource between different State Electricity Boards. Some countries have gone for international grid connection so as to share electricity among the neighbouring countries. It is always advantageous to have the opportunity to buy and sell power to and from the neighbouring states or neighbouring countries. This improves reliability of service.

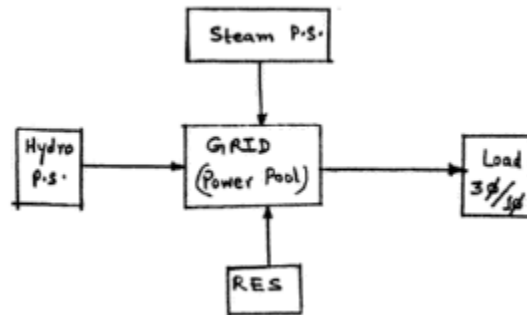
In India, State Electricity Boards are responsible for generation, transmission, and distribution of electricity in their respective states. Central Government has also set up public sector undertakings such as National Thermal Power Corporation (NTPC), National Hydro Power Corporation (NHPC), Damodar Valley Corporation (DVC), Bhakra Beas Management Board (BBMB) and Nuclear Power Corporation (NPC) to plan and operate power stations and associated transmission networks. Power Grid Corporation of India was set up to for planning and operation of extra high voltage transmission system in India.

The Central Electricity Regulatory Commission (CERC) amongst other activities, regulate interstate transmission of energy through the national grid. Power Grid Corporation of India has developed a grid code for facilitate maintenance of reliable regional grid and facilitate trading of electricity.

Concept of Grid

The grid is a power pool from where electrical energy can be extracted easily. The grid consists of large number of a.c. generators operating in cohesion without going out of step. That is, they work in synchronism. Thus, the frequency of supply of each generator remains same. The grids can be interconnected to form a national grid. The national grid can be interconnected to other nation grid to form international grid. The grid helps in power security and its reliability at the same time. If one generator fails to operate then the other generator supply power to the

grid thus the power failure is avoided. The grid can get power from both the steam power plants and hydro power plants. Thus in case the steam power plant is generating less power than the power obtained from hydro power plants is used accordingly thus maintaining continuity of supply. The grid concept will be clear from the fig.

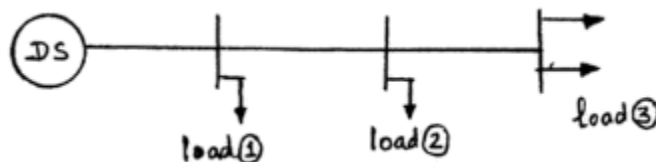


Power Grid Block diagram

The grid failure is considered as major failure which result in power failure over larger part and it can lead to completed failure of power supply. The grid failure is mainly due to the frequency mismatching of various generators which lead to sub synchronous resonance which leads to major disturbances in the power system network and hence power delivery. The grid may consist of hundreds of a.c generators or even more.

Possible causes of grid failure are

- a. Failure of backup protection system
- b. Mismatching of frequency of generators
- c. Sub synchronous resonance (SSR)
- d. Speed governor failure
- e. Sudden change of load
- f. Increase in the power angle of alternator i.e., $\delta > 90^\circ$.



Radial distribution system

The radial distribution system is shown in Fig. It has the disadvantage that if there is a fault in the T.L. then the power gets totally disrupted causes discontinuities of electric supply to the consumers.

