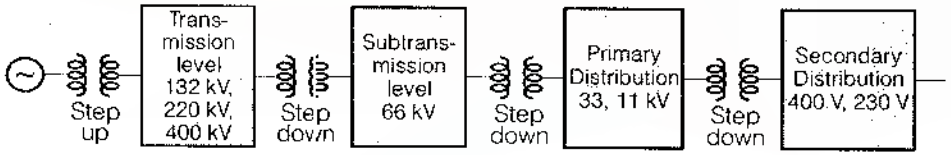
# Supply System

# 1

## Basic Structure of Power System

Electrical energy generated at generating stations by synchronous generator. The generating voltages are generally 11 kV and 33 kV. This voltage is then stepped up by step up transformer upto 132 kV, 220 kV, 400 kV for transmission over long distances. Again this high voltages are brought down to subtransmission level i.e. 66 kV to supply large consumer and further stepped down for primary distribution i.e. 33 kV, 11 kV. For secondary distribution level voltage is brought down to 400 V for 3 $\phi$ and 230 V for 1 $\phi$ for residential and commercial used.




**Note:**

- Generating stations are interconnected by the lines.
- Transmission lines, when interconnected with each other, becomes transmission networks.
- The combined transmission and distribution network is known as the "power grid".

## Effect of System Voltage on Transmission of Power

- Power loss in the line is inversely proportional to the system voltage and power factor both.
- Percentage voltage drop in resistance decreases with the increase in the system voltage.
- Weight of the conductor material for the line will decreases with the increase in supply voltage and power factor.
- Efficiency of transmission, increases with the increase of supply voltage and power factor.
- Higher supply voltages also enhances the system stability.
- The problems encountered with high voltages are the insulation of the equipment, corona, radio and television interference.
- The voltage level of a system is therefore governed by the amount of power to be transmitted and the length of the line.

## Voltage Level

(a) Low voltage → 230 V (1$\phi$), 400 V (3$\phi$)

(b) High voltage → 11 kV, 33 kV

(c) Extra high voltage: 66 kV, 132 kV, 220 kV.

(d) Modern EHV: 400 kV

(e) Ultra high voltage: 765 kV and above.

## Conductor Used for Transmission Line

- Copper conductor
- ACSR (Aluminium conductor steel reinforced).
- ACAR (Aluminium conductor alloy reinforced).
- AAAR (All Aluminium alloy reinforced).
- Expanded ACSR conductor: Normally used for EHV lines.

## Types of Conductor

- Solid conductor: It has high skin effect.
- Hollow conductor: Preferred under heavy current i.e. more than 1000 Amp.
- Stranded conductor.
- Composite standard conductor: used for voltage $\leq$ 220 kV.
- Bundle conductor: Used for voltage > 275 kV.

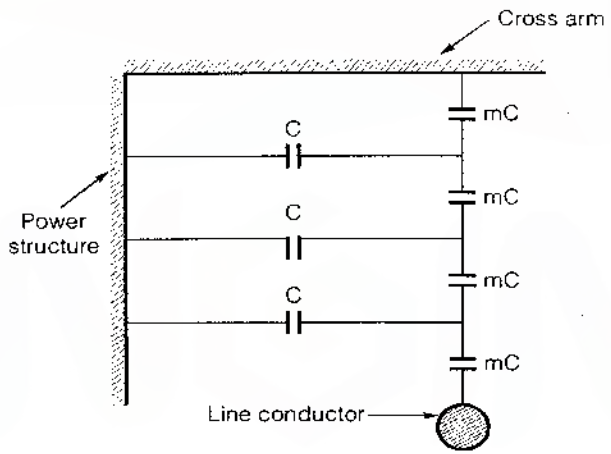
## Advantage of Bundle Conductor

- Self distance (GMR) increased without change in mutual distance.
- Voltage gradient reduced so corona loss reduce.
- It reduces the interference with near by communication line.

- Inductance (L) of transmission line reduces and capacitance (C) increases.
- Surge impedance i.e. $Z_s = \sqrt{\frac{L}{C}}$ decreases.
- Power system stability increases.

## Insulators

Over head line insulators provide the required insulation to the line conductors from each other and from the supporting structures electrically. Most commonly used materials are porcelain and toughened glass.




where, C : Capacitance between metal part of the insulator and tower structure

mC : Capacitance of each insulator disc.

$$mC > C$$

**Note:**

The stress experienced by the disc near the power conductor is more than the stress experience by the disc near the cross-arm.

## String Efficiency

$$\text{String efficiency} = \frac{\text{Voltage across the whole string}}{n \times (\text{Voltage across the unit adjacent to line conductor})}$$

where, $n$ = Number of insulator discs in the string

**Note:**

As the number of disc increases string efficiency decreases.

### Methods of Equilising Potential Across Each Disc

- Increase the length of cross arm.
- Capacitance grading or grading of units.
- Use of grading rings or static shielding.

### Types of Insulator

(a) **Pin type insulator:** Pin type insulator operate satisfactory upto 25 kV.

(b) **Multipine type insulator:** Operates upto 33 kV

(c) **Suspension type insulator:** A suspension insulator is designed to operate at 11 kV.

(d) **Strain type insulator:** Strain type insulator mechanically strong. It is used when direction of transmission line changes across river crossing and at the dead end of the transmission line.

(e) **Shackle type:** Shackle type insulator are used in low tension cable. These insulator can be operated either horizontally or vertically.

■■■■