

TRANSMISSION AND DISTRIBUTION

Basic Overview:

Transmission and distribution (T&D) are the two key stages of delivering electricity from generation sources to consumers. Transmission involves moving large amounts of electricity at high voltages over long distances, often across regions or states, to substations. Distribution then takes over, stepping down the voltage to lower levels suitable for local use and delivering it to individual homes and businesses.

1. Transmission:

- **Purpose:**

Transports electricity from power plants to substations located closer to load centers (areas with high demand).

- **Voltage:**

Operates at very high voltages (e.g., 115 kV and above) to minimize energy losses over long distances.

- **Infrastructure:**

Utilizes large, high-capacity transmission lines supported by towers or poles, often interconnected to form a grid.

- **Key Components:**

Substations, transformers (step-up), transmission lines.

2. Distribution:

- **Purpose:**

Distributes electricity from substations to end-users (residential, commercial, and industrial customers).

- **Voltage:**

Operates at lower voltages than transmission (e.g., 2.4 kV to 34.5 kV) for safe and efficient delivery to consumers.

- **Infrastructure:**

Employs a network of distribution lines, including feeders, distributors, and service mains, which can be overhead or underground.

- **Key Components:**

Substations (step-down), transformers (step-down), distribution lines, meters.

In essence: Transmission is the "highway" for moving electricity over long distances, while distribution is the "local roads" that deliver electricity to individual homes and

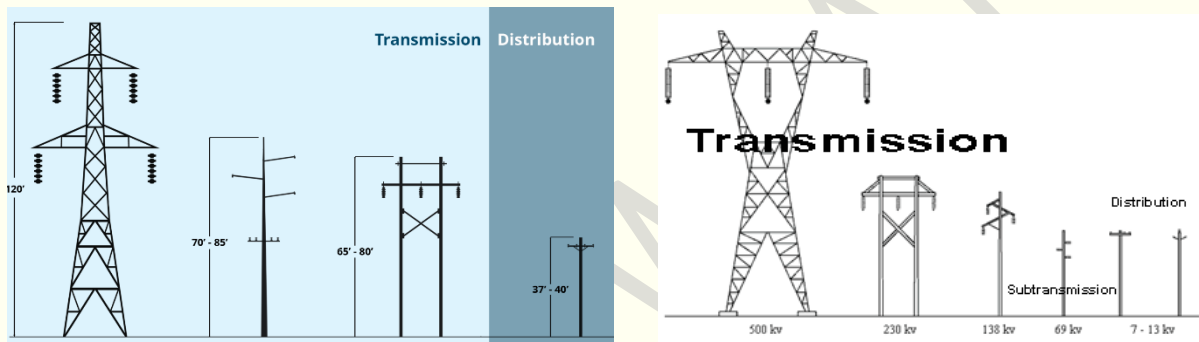
businesses. The combined transmission and distribution network is often referred to as the electrical grid.

Let us dive deep into the topic to develop an in-depth understanding:

SECTION 1: BASICS OF TRANSMISSION AND DISTRIBUTION

1. What is the difference between transmission and distribution systems?

- Transmission refers to bulk power transfer from generating stations to substations.
- Distribution refers to delivering electricity from substations to end users.



2. Explain Transmission and Distribution systems.

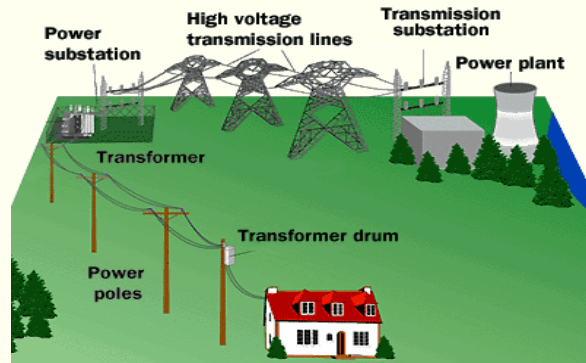
- Transmission: Transfers electrical energy over long distances. Systems include DC, single-phase AC, two-phase AC, and three-phase AC.
- Distribution: Supplies power locally. Systems include:
 - AC Distribution: Primary and Secondary
 - DC Distribution: 2-wire and 3-wire systems

3. Why is alternating current used for transmission?

- AC can be easily stepped up/down using transformers.
- Power stations naturally produce AC via rotating turbines.
- AC transmission equipment is cheaper, and AC faults are easier to interrupt due to natural current zero.

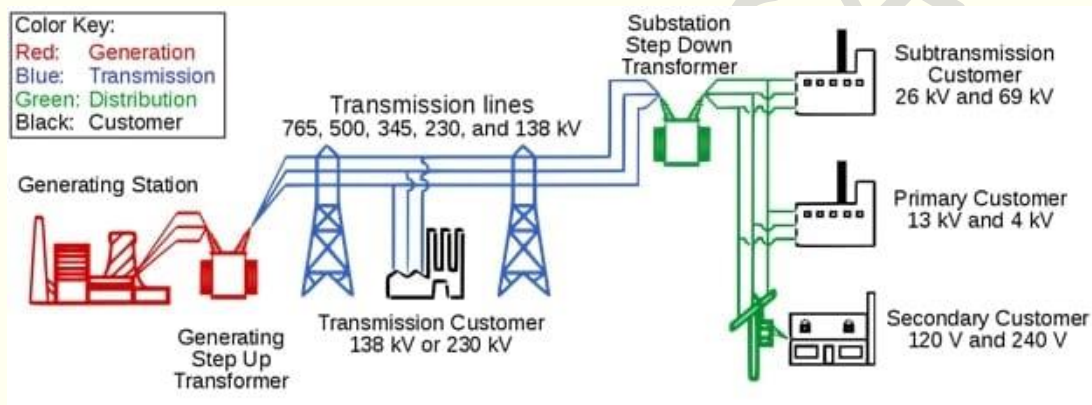
4. Why is voltage stepped up before transmission?

- Reduces conductor size
- Increases efficiency
- Decreases line drop



5. What are standard transmission and distribution voltages?

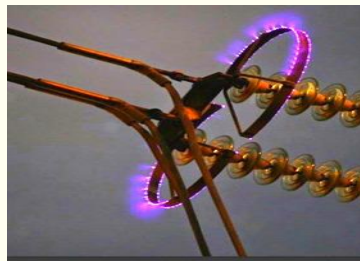
- Primary Transmission: 66 kV, 132 kV, 220 kV, 400 kV
- Secondary Transmission: 33 kV
- Primary Distribution: 11 kV (3-phase, 3-wire)
- Secondary Distribution: 400 V (line-to-line), 230 V (line-to-neutral)



SECTION 2: KEY TRANSMISSION CONCEPTS

6. What is corona?

- A violet glow, hissing noise, and ozone formation on overhead lines due to ionization



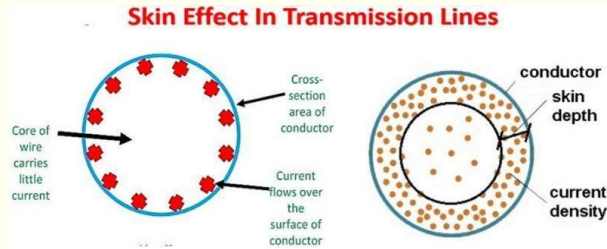
of air.

7. Is corona more in AC or DC?

- Corona is higher in AC due to the presence of supply frequency in the loss formula.

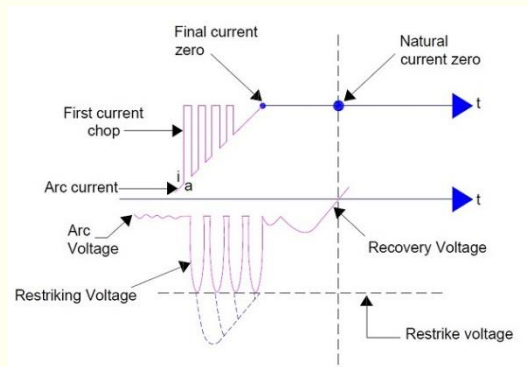
8. What is skin effect?

- AC tends to concentrate near the surface of a conductor.



9. What is current chopping?

- Premature arc interruption before current naturally reaches zero. It causes voltage oscillations.



10. Which breaker uses current chopping?

- Vacuum circuit breakers.

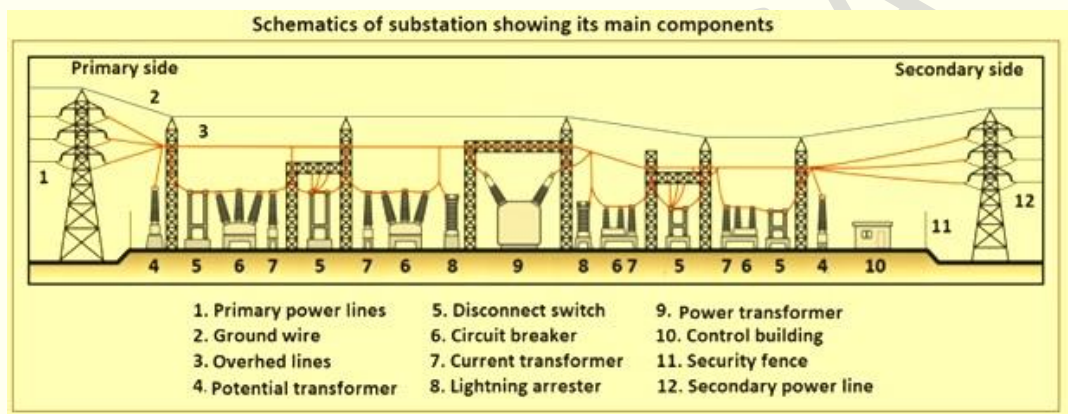
11. What are the faults in a three-phase line?

- Phase-to-earth
- Phase-to-phase
- Phase-to-phase-to-earth
- Three-phase
- Three-phase-to-earth
- Phase-to-pilot
- Pilot-to-earth

SECTION 3: EQUIPMENT USED IN TRANSMISSION & SUBSTATIONS

12. What are the components of a substation?

- Primary & secondary power lines
- Ground wire
- Overhead lines
- Voltage measurement transformer
- Disconnect switch
- Circuit breaker
- Current transformer
- Lightning arrester
- Main transformer
- Control building
- Security fence



13. What is a substation?

- An assembly of equipment used to alter voltage, AC/DC, frequency, or power factor.

14. What is a bus bar?

- A copper/aluminium strip conducting electricity inside substations.

15. What is a lightning arrester?

- A protective device that shields insulation from lightning damage.

16. What is a wave trap (Line trap)?

- Blocks high-frequency signals from entering substations; diverts them to telecom panels.

SECTION 4: PROTECTIVE DEVICES

17. What is a relay and a fuse?

- Relay: A switch for control, not designed for fault current.

- Fuse: Melts under fault to disconnect the circuit.

18. Explain the working principle of relay and circuit breaker.

- Relay: Uses electromagnetic attraction/induction to operate.
- Circuit breaker: Opens under fault using stored mechanical energy; extinguishes arc in vacuum, air, gas, or oil.

19. What is an IDMT relay?

- Inverse Definite Minimum Time relay; time inversely proportional to fault current.

SECTION 5: POWER SYSTEM COMMUNICATION AND CONTROL

20. What is PLCC?

- Power Line Carrier Communication: Transmits data and voice over power lines.

21. What is SCADA?

- Supervisory Control and Data Acquisition: Monitors and controls industrial and power systems remotely.

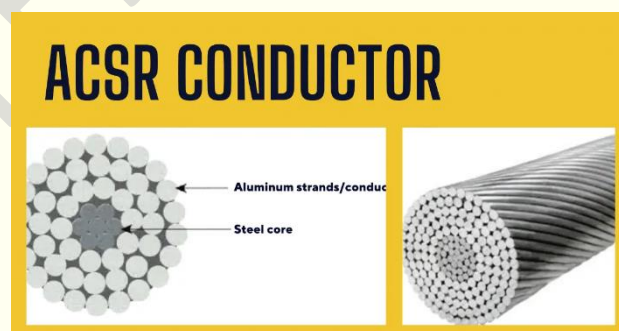
22. What is a diversity factor?

- $\text{Ratio} = \frac{\text{Sum of individual max demand}}{\text{Max demand on power station}}$

SECTION 6: CONDUCTORS AND CABLES

23. What is ACSR? Where is it used?

- Aluminium Conductor Steel Reinforced; used in transmission and distribution.



24. What is grading of cables?

- Ensuring uniform electrostatic stress in cable dielectric.

25. What materials are used in transmission cables?

- Rubber, Varnished cambric, Impregnated paper, PVC, Vulcanized rubber.

26. Which is preferred: underground or overhead cables?

- Overhead for high voltage due to lower cost; underground for low voltage/local use.

SECTION 7: POWER SYSTEM QUALITY AND SUPPLY

27. What happens when power factor is leading?

- Reduces heat loss, reduces cable size, lowers transformer overheating.

28. What is 3-phase supply?

- A polyphase system with 3 currents out of phase by 120° , used worldwide.

29. Why do we need protection against lightning?

- Prevents damage to equipment (e.g., generators, transformers) from direct or indirect lightning strikes.

SECTION 8: MISCELLANEOUS

30. What is arc formation?

- When contacts in a breaker open under fault, high temperature ionizes the air, forming an arc.

31. What is the approximate power generation capacity in India?

- State Sector: 83,563.65 MW
- Central Sector: 56,572.63 MW
- Private Sector: 42,553.34 MW
- **Total: 1,82,689.62 MW**