

Types of Substations (Part 1)

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- Course: Substation Engineering (DI04009011)
- Unit 1: Introduction
- Lecture 3

Agenda

- Basis of Classification
- Classification by Service Requirement
- Transformer Substations (Step-up, Step-down)
- Switching Substations
- Converting Substations
- Summary

Basis of Classification

- Substations can be classified in multiple ways:
- 1. According to Service Requirement (Function).
- 2. According to Constructional Features (Design/Location).
- 3. According to Operating Voltage.
- 4. According to Importance in the grid.

Classification by Service Requirement

- This classification focuses on the primary job the substation performs.
- Major Categories:
 - - Transformer Substations
 - - Switching Substations
 - - Converting Substations
 - - Power Factor Correction Substations

1. Transformer Substations

- The most common type of substation in the power system.
- Primary function: To transform voltage from one level to another.
- They utilize large power transformers.
- Can be further subdivided based on where they are in the grid.

Subtypes of Transformer Substations

Step-Up Substation (at Generating Station)



Primary Grid Substation (Extra High Voltage to High Voltage)



Secondary Substation (High Voltage to Medium Voltage)



Distribution Substation (Medium Voltage to Low Voltage)

Step-Up Substations

- Located directly adjacent to power generating plants.
- Generation voltage (11kV - 25kV) is stepped up for transmission.
- Transmission voltages can be 132kV, 220kV, 400kV, or 765kV.
- Essential for reducing I^2R transmission losses.

Primary Grid Substations

- Located at the end of long Extra High Voltage (EHV) transmission lines.
- Steps down EHV (e.g., 400kV) to High Voltage (HV) (e.g., 220kV or 132kV).
- Supplies power to the secondary transmission network.
- Handles bulk power transfer for entire regions.

Secondary Substations

- Located closer to load centers (cities, industrial zones).
- Steps down HV (e.g., 132kV) to primary distribution voltages (33kV or 11kV).
- Lines originating here feed distribution substations.
- Often seen on the outskirts of towns or cities.

Distribution Substations

- Located very close to the end consumers.
- Steps down 33kV or 11kV to utilization voltages (415V 3-phase / 240V 1-phase).
- Feeds direct service lines to homes and small businesses.
- Small footprint, often pole-mounted or in small enclosures.

Comparison of Transformer Substations

Type	Input Voltage	Output Voltage	Location
Step-Up	11-25kV	132-765kV	Generating Station
Primary	400kV+	132-220kV	Regional Hubs
Secondary	132kV	33-11kV	City Outskirts
Distribution	11-33kV	415V/240V	Neighborhoods

2. Switching Substations

- DO NOT contain power transformers for voltage change.
- Input voltage equals Output voltage.
- Used strictly for switching operations in the network.
- Routes power, connects multiple transmission lines, and isolates faults.

3. Converting Substations

- Used to change AC to DC, or DC to AC, or change the frequency.
- Examples: HVDC (High Voltage Direct Current) converter stations.
- Traction Substations for railways (convert 3-phase AC to single-phase AC or DC).
- Requires heavy power electronic equipment (thyristors, IGBTs).

Summary

- Substations are classified primarily by their service requirements.
- Transformer substations change voltage levels and are found throughout the grid.
- Switching substations route power without changing voltage.
- Converting substations alter AC/DC state or frequency.