

Electric Power Stations

Course content:

- Introduction to power stations.
- Types of generating power stations:
- Loads and load curves.
- Power plant economies:
 - Tariffs and power factor improvements.
- Selection of plants.
- Coordination
- New energy sources:
 - Solar – wind – wave -
- Parallel operation of alternators.
- Major electrical equipment in power plants.
- System interconnections.

Introduction to power stations

Definitions

Operational requirements of power plant design

Limitations of power plant design

Definitions:

Power station or power plant: It is responsible for providing large scale electric power generation in a **safe**, **reliable** and **efficient** way.

Generating voltage levels: 6.6,11,15, 20, 22, 24 kV

Substation: It is a step-up transformer station, used to raise the generated voltage to transmission level.

Safety: Concerns personnel, equipment and environment.

Reliability: Assessment is performed during design process, concerning all system's operating configurations, and all station running modes. It involves indices relevant to failure, repair and maintenance.

Efficiency: Concerns fuel consumption, start-up procedures and running modes.

Operational requirements of power plant design :

-A single fault (in the plant or any where in its grid connection), will not cause the loss of more than a generating unit.

- Capable to be started in the absence of external grid supplies; smaller generating units (in the order of 5% of a main unit rating) is installed to supply essential equipment, starting requirements and frequency support.

- Meets voltage and frequency limits set by the system:

(Regular: 49.5 – 51 Hz, Less than 15 minutes: 49.5 – 47)

- Recognize acceptable voltage variations of connected HV system:

Voltage at any level is maintained via transformer's tap position to allow for operation within limits of the available operating condition.

Limitations of power plant design:

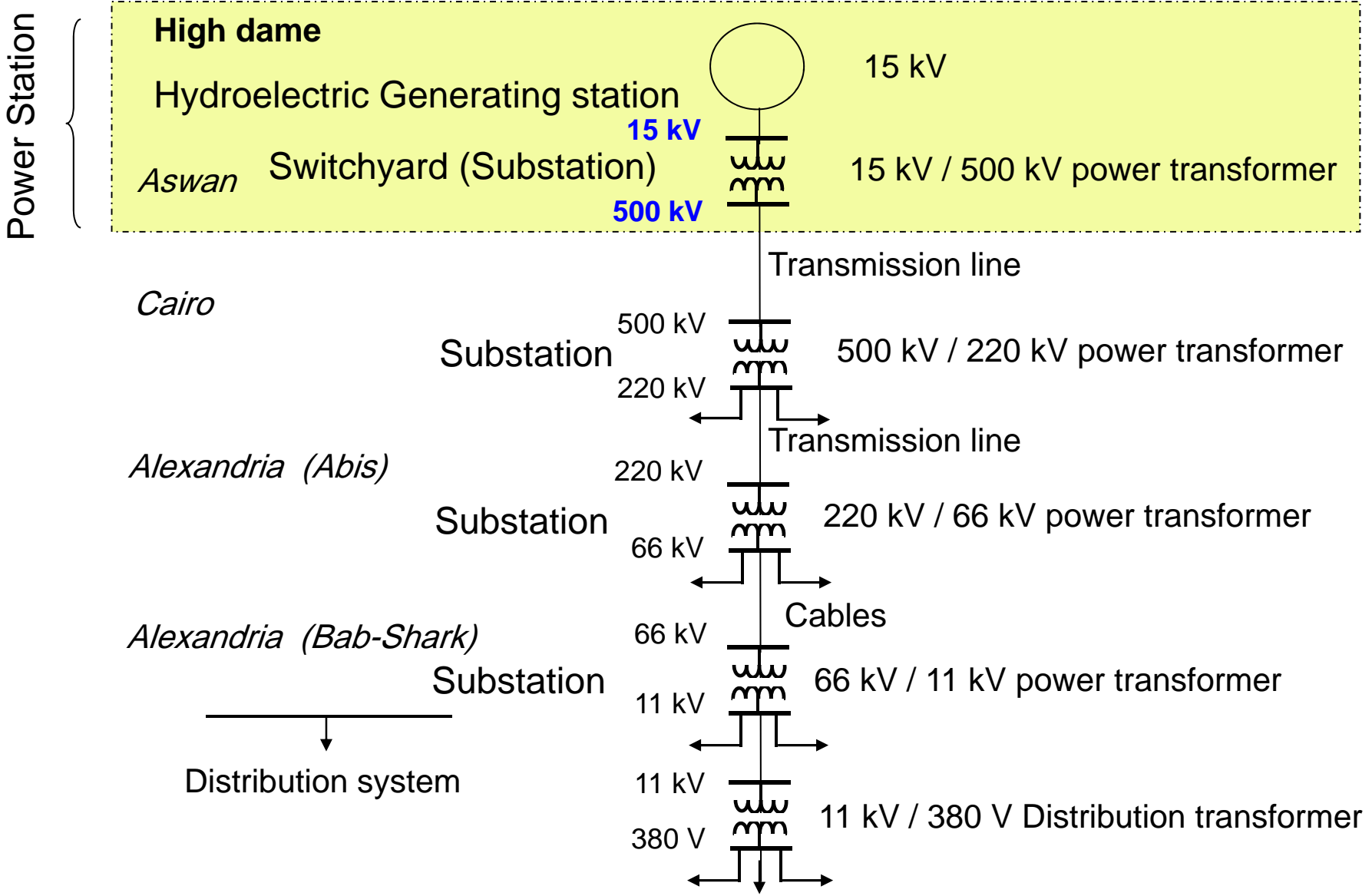
Switchgear current rating: The primary auxiliaries system voltage is mainly determined by the largest available electric drive (boiler feed pumps).

- **Switchgear short-circuit rating:** The fault level is mainly limited by impedance of supply transformer. Level is normally within switchgear's rating for single source, nevertheless, other limiting factors for parallel sources include direct on-line starting of large motors and the required system's voltage profile. Extreme cases may require connecting short-able inductors between switchboards.

- **Large electric motors:** Difficult to start direct on-line; creating trade-off between the former need to higher transformer's impedance for low fault level, and the consequent large voltage drop associated with starting such motors. In case of failure to compromise, starting techniques or transfer of supply without paralleling is adopted.

- **System performance calculations:** Prior data gathering (actual – typical –estimated)

Example of an AC power system including Generation, Substations, transmission, primary distribution and secondary distribution phases: (Egypt)



Generating stations

Generating stations are classified according to the *form of energy* converted into electrical energy :

(i) *Steam* power stations

(ii) *Hydroelectric* power stations

(iii) *Diesel* power stations

(iv) *Gas* power stations

(v) *Nuclear* power stations

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