

Substation

A substation is a part of an electrical generation, transmission, and distribution system. Substations transform voltage from high to low, or the reverse, or perform any of several other important functions. Between the generating station and consumer, electric power may flow through several substations at different voltage levels. A substation may include transformers to change voltage levels between high transmission voltages and lower distribution voltages, or at the interconnection of two different transmission voltages.

Substations may be owned and operated by an electrical utility, or may be owned by a large industrial or commercial customer. Generally substations are unattended, relying on SCADA for remote supervision and control.

The word substation comes from the days before the distribution system became a grid. As central generation stations became larger, smaller generating plants were converted to distribution stations, receiving their energy supply from a larger plant instead of using their own generators. The first substations were connected to only one power station, where the generators were housed, and were subsidiaries of that power station.



Types of Sub Stations

The different types of substations mainly include Step-up Type Substation, Step-down Transformer, Distribution, Underground Distribution, Switchyard, Customer Substation, and System Station.

Classification of Substations by Nature of Duties

The classification of the substation by nature of functions is explained below in details.

Step-up or Primary Substations – Such types of substations generate low voltage like 3.3, 6.6, 11, or 33kV. This voltage is stepped up by the help of a step-up transformer for transmitting the power over large distances. It is located near the generating substation

Primary Grid Substations – This substation lowered the value of primary stepped up voltages. The output of the primary grid substation acts as the input of the secondary substations. The secondary substation is used for stepping down the input voltage to more lowered for further transmission.

Step-down or Distribution Substations – This substation is placed near the load centre where the primary distribution is stepped down for sub-transmission. The secondary distribution transformer feeds the consumer through the service line

Classification of Substations by Service Rendered

Transformer substations – In such type of substation transformers are installed for transforming the power from one voltage level to another level as per need.

Switching Substations – The substations use for switching the power line without disturbing the voltage is known as the switching substations. This type of substations is placed between the transmission line.

Converting Substations – In such types of substations, AC power converting into DC power or vice versa or it can convert high frequency to lower frequency or vice versa.

Classification of Substations by Operating Voltage

The substations, according to operating voltage, may be categorised as

High Voltage Substations (HV Substations) – Involving voltages between 11 KV and 66 KV.

Extra High Voltage Substations – Involving voltages between 132 kV and 400 KV.

Ultra High Voltage – Operating voltage above 400 KV.

Classifications of Substation by Importance

Grid Substations – This substation is used for transferring the bulk power from one point to another. If any fault occurs on the substation, then the continuity of whole of the supply is affected by it.

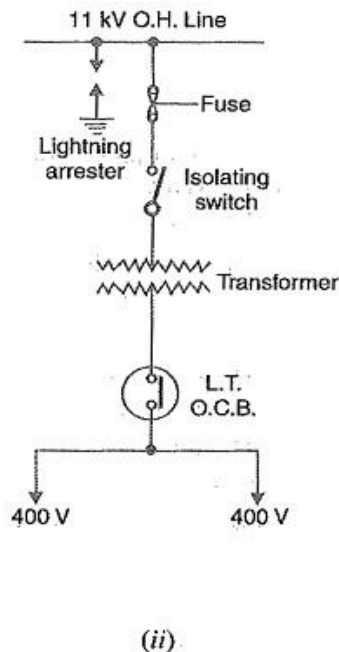
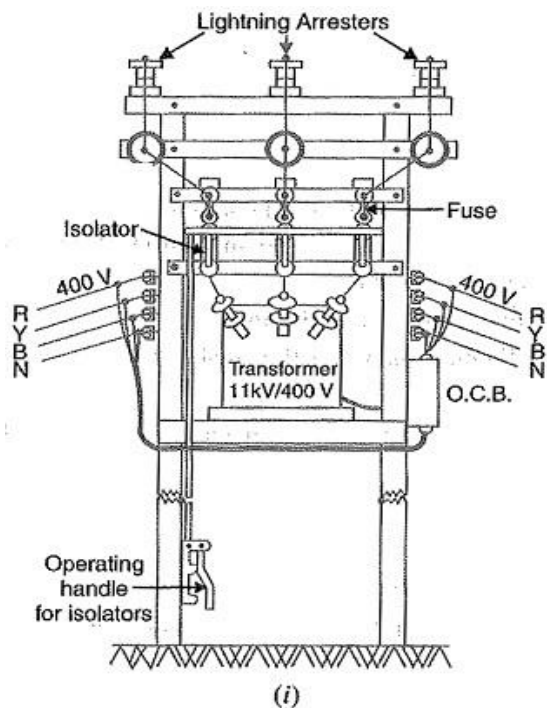
Town Substations – These substations step down the voltage at 33/11 kV for more distribution in the towns. If there is any fault occurs in this substation, then the supply of the whole town is blocked.

Classification of Substations by Design

Indoor Type Substations – In such type of substations, the apparatus is installed within the substation building. Such type of substations is usually for the voltage up to 11 KV but can be raised for the 33 KV or 66 KV when the surrounding air is polluted by dust, fumes or gasses, etc.

Outdoor Substations – These substations are further subdivided into two categories

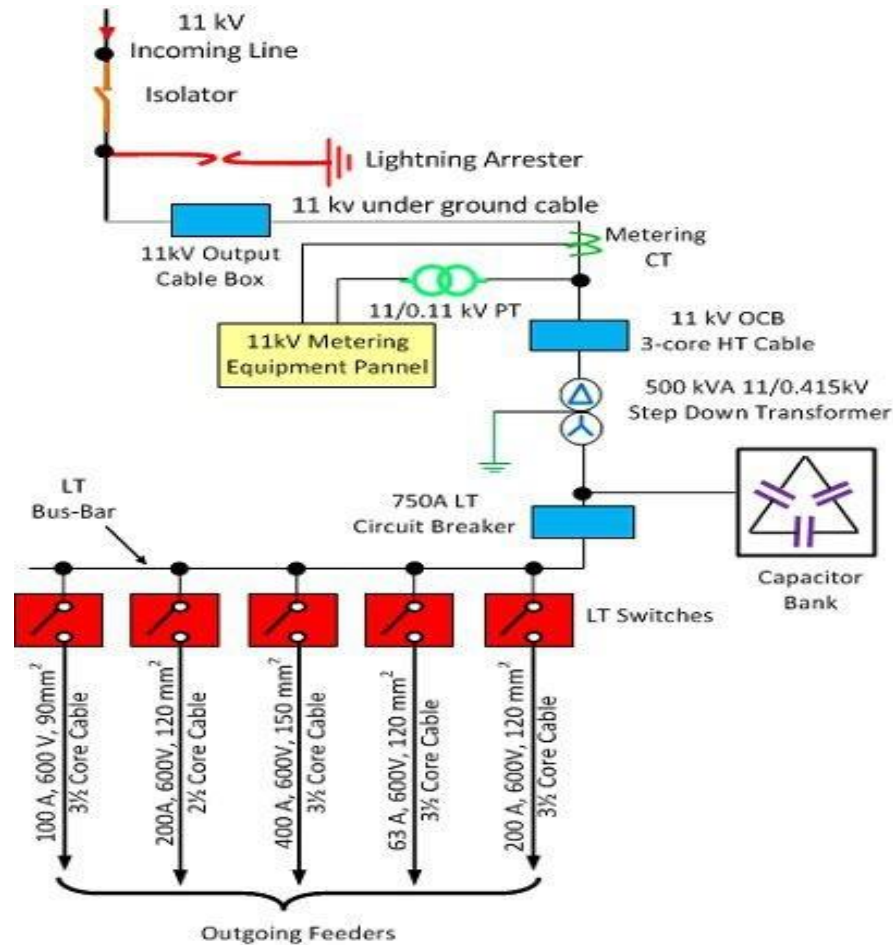
Pole Mounted Substations – Such Substations are erected for distributions of power in the localities. Single stout pole or H-pole and 4-pole structures with relevant platforms are operating for transformers of capacity up to 25 KVA, 125 KVA, and above 125KVA.



Foundation Mounted Substations – Such types of substations are used for mounting the transformers having capacity 33,000 volts or above.

Single Line Diagram of an Electrical Substation

The single line diagram of an 11 KV substation is shown in the figure below.



Key Diagram for 11/0.4kV Substation

Main Components of 11kV Substation

The working of the electrical equipment used in the substation is explained below in details.

1. Isolator – The isolator connects or disconnects the incoming circuit when the supply is already interrupted. It is also used for breaking the charging current of the transmission line. The isolator is placed on the supply side of the circuit breaker so that the circuit breaker is isolated from the live parts of the maintenance.
2. Lightning Arrester – The lightning arrester is a protective device which protects the system from lightning effects. It has two terminals one is high voltage and the other is the ground voltage. The high voltage terminal is connected to the transmission line and the ground terminal passes the high voltage surges to earth.
3. CT Metering – The metering CT measure and records the current when their secondary terminal is connected to the metering equipment panel.

4. Step-down Transformer – The step-down transformer converts the high voltage current into the low voltage current.
5. Capacitor Bank – The capacitor bank consists series or parallel connection of the capacitor. The main function of the capacitor bank is to improve the power factor of the line. It draws the leading current to the line by reducing the reactive component of the circuit.
6. Circuit Breaker – The circuit breaker interrupts the abnormal or faults current to flow through the line. It is the type of electrical switch which open or closes the contacts when the fault occurs in the system.

The outgoing feeder supplies the input power to the consumer end.

Selection and location of a site for an Electrical Substation

The following factor is considered while making site selection for a substation.

- Type of substation – The category of the substation is important for its location. For example, a step-up transformer is a point where power from various sources is pooled and step up for long distance transmission should be located as cool as possible to minimise the losses. Similarly, the step-down transformer should be located nearer to the load centre to reduce transmission losses, the cost of the distribution system and better reliability of supply.
- Availability of suitable and sufficient land – The land selected for a substation should be level and open from all sides. It should not be waterlogged particularly in the rainy season. The site selected for substation should be such that approach of transmission lines and their take off can be easily possible without any obstruction. The places nearer to airdrome, shooting practice ground, etc. should be avoided.
- Communication facility – Suitable communication facility is desirable at a proposed station, both during and after its construction. It is better, therefore, to select the site alongside the existing road to facilitate an easier and cheaper transportation.
- Atmospheric Pollution – The atmosphere around the ground factories produces metal corroding gas, air fumes, conductive dust, etc. And the area near the sea coast may be more humid and is harmful to the proper running of the power system. Thus, the substation should not be located near the factories or sea coast.
- Availability of Essential Facilities to the Staff – The site should be such where staff can be provided essential facilities like school, hospital, drinking water, housing, etc.
- Drainage Facility – The site selected for the proposed substations should have proper drainage arrangement or the possibility of making effective drainage, avoid pollution of air and growth of micro-organism and health