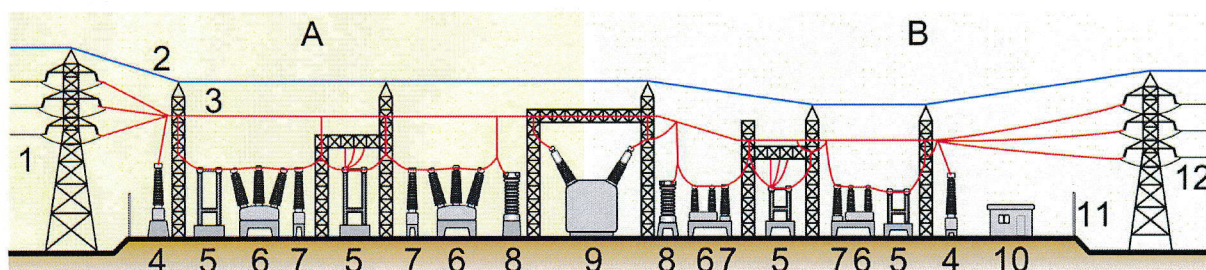


A



Electrical Sub-stations



Elements of a substation

A: Primary power lines' side B: Secondary power lines' side

1. Primary power lines
2. Ground wire
3. Overhead lines
4. Transformer for measurement of electric voltage
5. Disconnect switch
6. Circuit breaker
7. Current transformer
8. Lightning arrester
9. Main transformer
10. Control building
11. Security fence
12. Secondary power lines

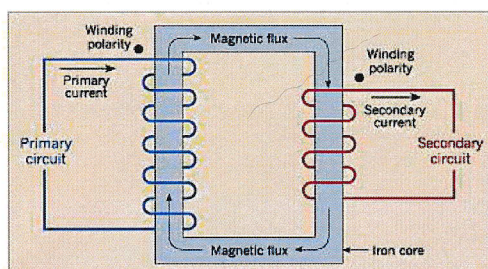
About Electrical Substations

NCEA Assessed

Electrical sub stations is a key factor in the electrical transmission and distribution system. Electrical substations allow us to turn parts of the lines off and change voltage between two lines. Substations are typically found near urban areas where high voltage transmission lines need to be transformed to a lower voltage which is able to be used by consumers. Multiple components are used to do this including transformers.

Transformers involve two wires coiled around a single metal square. A higher voltage goes through one of the coils and through magnetic influx a lower electric charge is created in the second coil.

Substations have strict safety features which stop the public accessing and vandalizing electrical components. If a member of the public were to enter the site they could potentially get injured or killed from electrical current or arcing, damaging parts of the substation itself. Below is a diagram of how transformers work:



Types

Transmission

The role of electrical substations differ as there are two main types. The first is the Transmission Substation. This system typically connects high voltage (transmission) lines to high voltage electrical switches. These are called switching stations. This feature is used when a section of power lines need to have maintenance performed - this is important as safety is a large concern while working on transmission lines. Transmission substations also regulate voltage keeping it constant throughout both lines.

Distribution

Distribution substations are used to transform high voltages to usable low voltages. This is because it would be uneconomical to supply consumers with such high amounts of power. Distribution substations are also used to isolate power lines and can be used Transformers are used in this process.



Collector

Collector substations are often used when collecting electricity from sources which do not provide constant electrical flow (eg: wind power, thermal power). These substations regulate the electrical output flow .

Switching station

Switching substations are typically small and work at a single voltage. They do not incorporate any transformers and are often just made up of electrical switches. These are usually found near power stations.

Types of Insulation

There are three main types of electrical insulation used in substations. Some substations are left bare and are insulated by the surrounding air. The space of air between components increase the insulation. Medium-voltage stations may be insulated by metal and may not have any wires exposed at all. Gas insulation is used for high voltage stations. Wires and components are built into canisters which are filled with pressurized gas - sulfur hexafluoride. This requires less space than other insulations, such as air.

Redundancy Definition:

In engineering redundancy is defined as the duplication of critical components or functions of a system with the intention of increasing reliability of the system, usually in the form of a backup or fail-safe.

This means that the entire system will continue to operate even will one or more components malfunctioning.

Redundancy of Substations

There are typically duplicate components of the same type within substations. In important substations a ring bus or double bus is installed. These stop failures of one component affecting the others. They also allow parts of the substation to be de-energized to allow for maintenance. These components are important as they mean the entire system will not shut down, although the entire system would be shut down while maintenance is performed due to safety reasons.



Electrical transformer with surge arresters on top

Reliability Definitions

- The idea that an item is fit for a purpose with respect to time.
- The capacity of a designed, produced, or maintained item to perform as required over time
- The capacity of a population of designed, produced or maintained items to perform as required over specified time
- The resistance to failure of an item over time
- The probability of an item to perform a required function under stated conditions for a specified period of time
- The durability of an object

Reliability of Substations



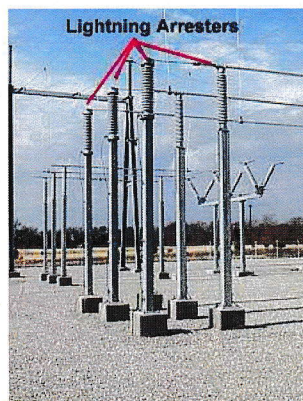
Reliability is a large factor in the design process of electrical sub-stations. For instance, substations are designed to accommodate a lightning arrestor (image below) which earth lightning which would otherwise strike components and equipment damaging them severely. Similarly, surge protectors protect subsystems and components from high voltage electrical spikes. Power surges are caused by multiple reasons, some of which are power outages, switching, short circuits and equipment malfunctions. Surge protectors work by directing electrical spikes to the earth while reducing it to a safe voltage.

Surge arrestors are typically made of many metal oxide varistors. Varistors reduce the voltage until it reaches a safe level, this is when it is drawn to earth and grounded. If it is not at a safe level the electricity will flow through the soil damaging components and injuring personnel.

These protective components of substations protect equipment such as breakers and transformers. These components are important to protect as they are both expensive and time costly to replace.



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