

# **SUBSTATION HIGH VOLTAGE COMPONENTS**

## **POWER PLANT SWITCHING STATION (SWITCHYARD)**

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# SUBSTATION

- ▶ **SUBSTATION** - A station in the power transmission system at which electric power is transformed to a conveniently used form. The station may consist of transformers, switches, circuit breakers and other auxiliary equipment. Its main function is to receive energy transmitted at high voltage from the generating station, by either step-up or step-down the voltage to a value appropriate for local use and provide facilities for switching. Substations have some additional functions. Its provide points where safety devices may be installed to disconnect circuits or equipment in the event of trouble.

*Some substation, such as power plant switchyard are simply switching stations where different connections can be made between various transmission lines.*

# Typical Components of a Power Plant Substation (Switchyard)

- **CONNECT**

- **CONNECT & DIS-CONNECT**

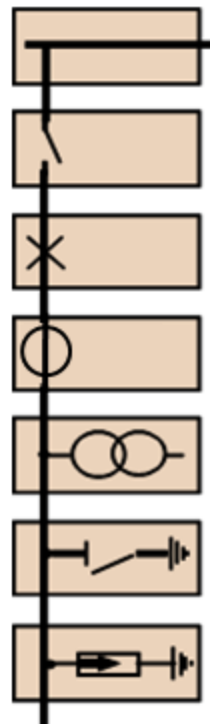
- **CONNECT, DIS-CONNECT & DETECT**

- **DETECT & TRANSFORM**

- **DETECT & TRANSFORM**

- **PROTECT & SAFETY**

- **PROTECT**



- **A - Busbar**

- **B - Disconnector**

- **C - Circuit Breaker**

- **D - Current Transformer**

- **E - Voltage Transformer**

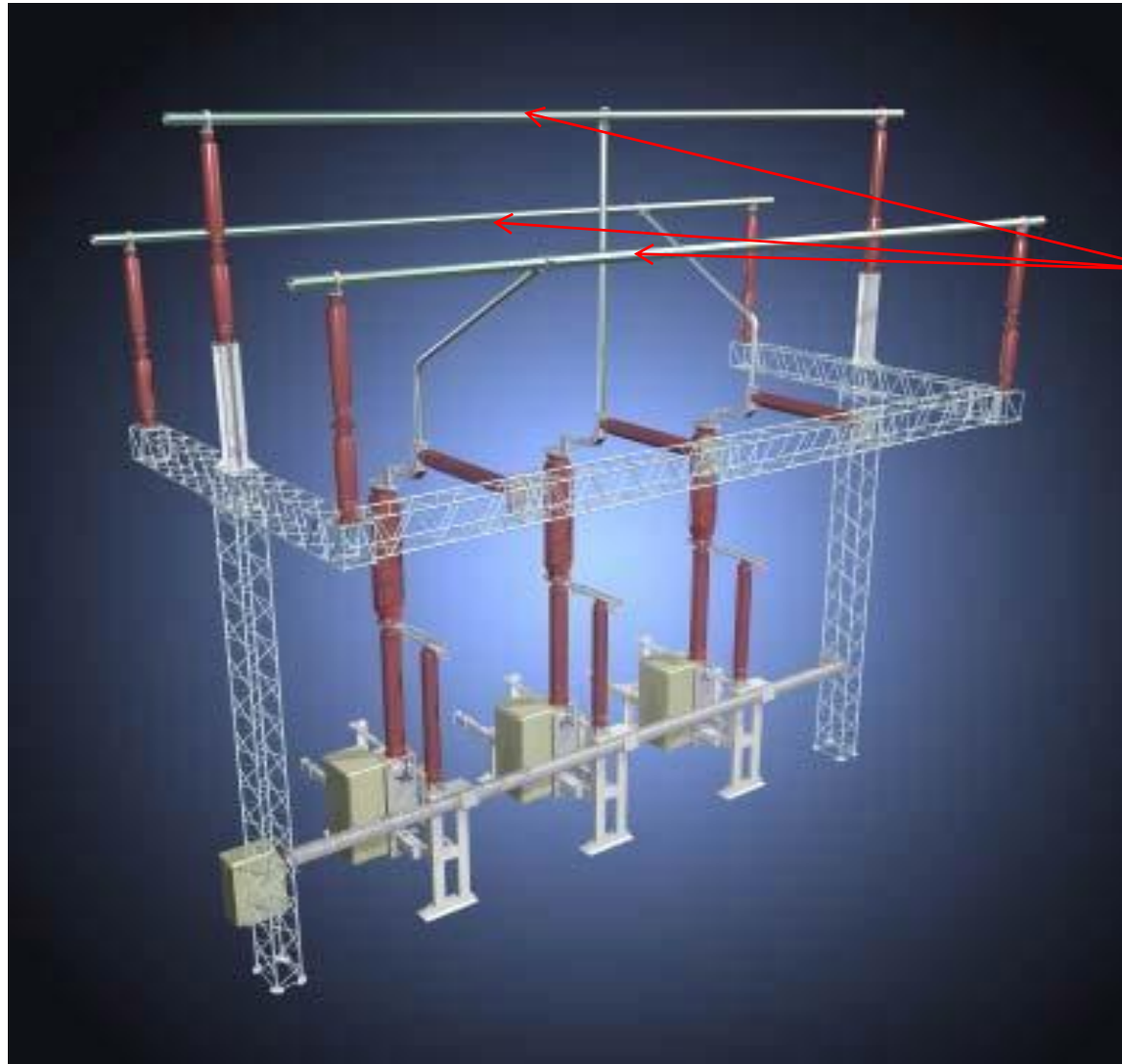
- **F - Earthing Switch**

- **G - Surge Arrester**

## A. BUSBAR

- ▶ **BUSBAR** (or *bus*, for short) - is a term we use for a main bar or conductor carrying an electric current to which many connection may be made.

Buses are merely convenient means of connecting switches and other equipment into various arrangements. The usual arrangement of connections in most substations permit working on almost any piece of equipment without interruption to incoming or outgoing feeders. In the switchyard or substation, buses are open to the air. Aluminum or copper conductors supported on porcelain insulators, carry the electric energy from point to point.

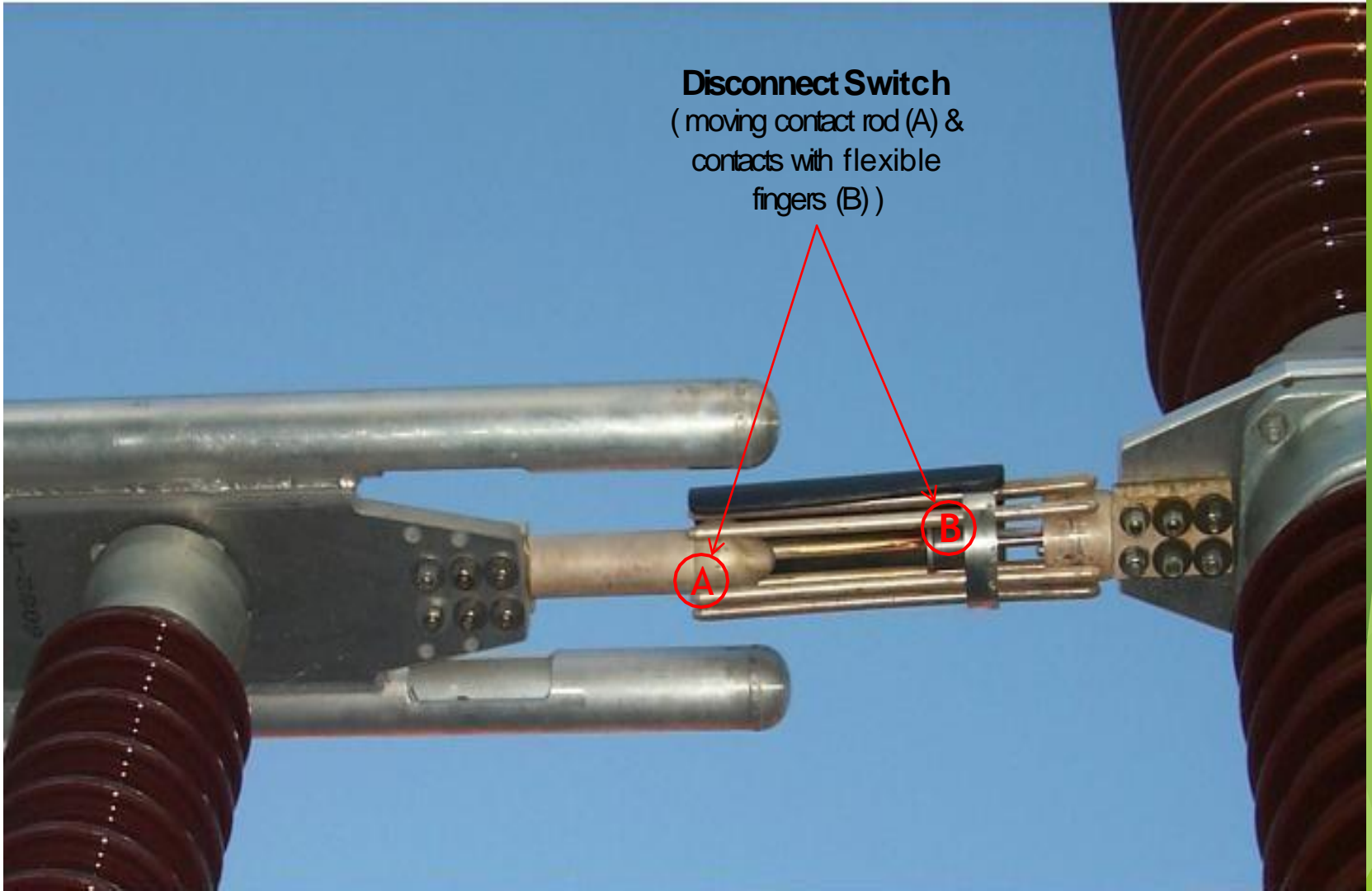


**Busbars**  
(long heavy  
tube type)

## B. DISCONNECTS

- ▶ **DISCONNECT** - is an easily removed piece of the actual conductor of a circuit. The purpose of disconnects is to isolate equipment. Disconnects are not used to interrupt circuits; they are no-load devices. A typical use of disconnects is to isolate a circuit breaker by installing one disconnect on either side of the circuit breaker (in series with the breaker). Operation of disconnects is one of the most important and responsible jobs of a power plant operator. One error in isolation of equipment, or the accidental grounding of line equipment, can be a fatal mistake.

**Disconnect Switch**  
( moving contact rod (A) &  
contacts with flexible  
fingers (B) )

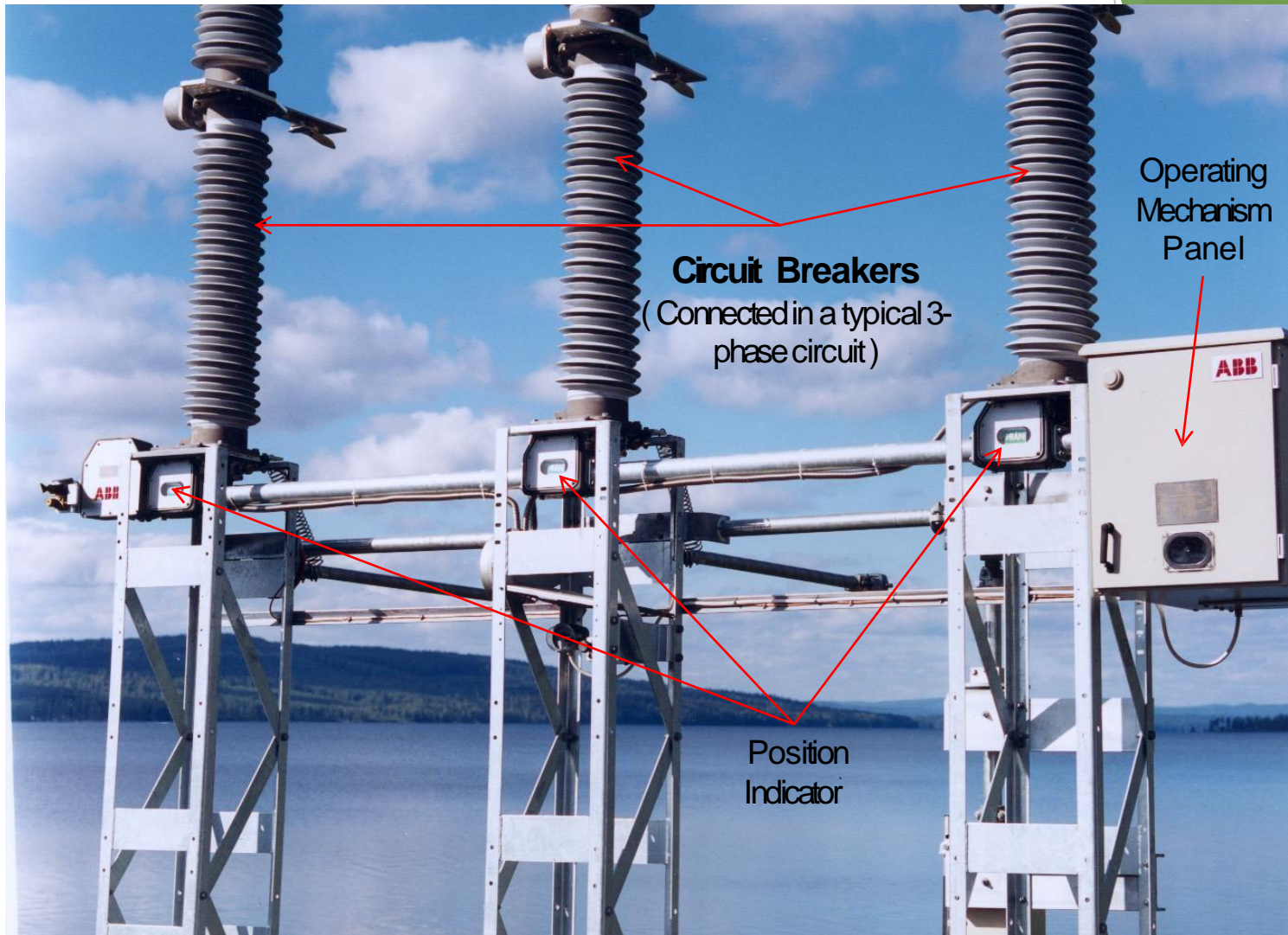


## C. CIRCUIT BREAKER

- ▶ **CIRCUIT BREAKER** - is used to interrupt circuits while current is flowing through them. The making and breaking of contacts in a Oil type circuit breaker are done under oil, this oil serves to quench the arc when the circuit is opened. The operation of the breaker is very rapid when opening. As with the transformer, the high voltage connections are made through bushings. Circuit breakers of this type are usually arranged for remote electrical control from a suitably located switchboard.

Some recently developed circuit breakers have no oil, but put out the arc by a blast of compressed air; these are called air circuit breakers. Another type encloses the contacts in a vacuum or a gas (sulfur hexafluoride, SF<sub>6</sub>) which tends to self maintain the arc.





## Circuit Breakers

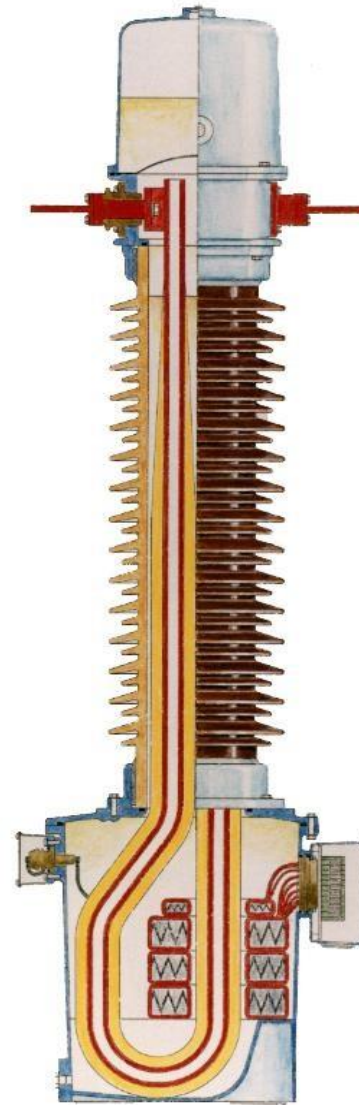
( Connected in a typical 3-phase circuit )

Operating  
Mechanism  
Panel

Position  
Indicator

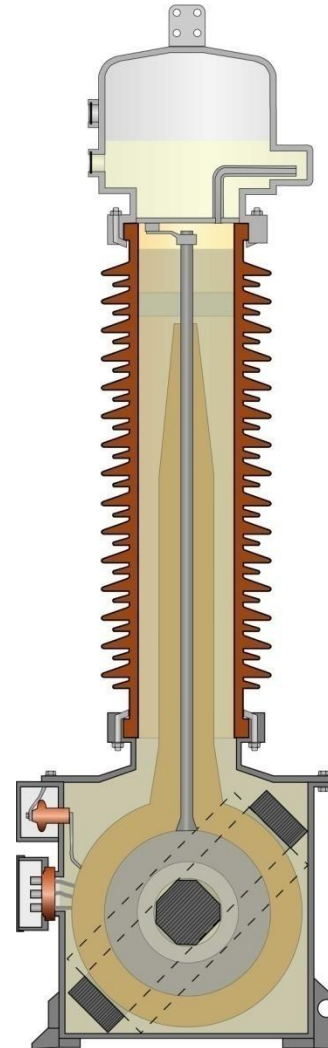
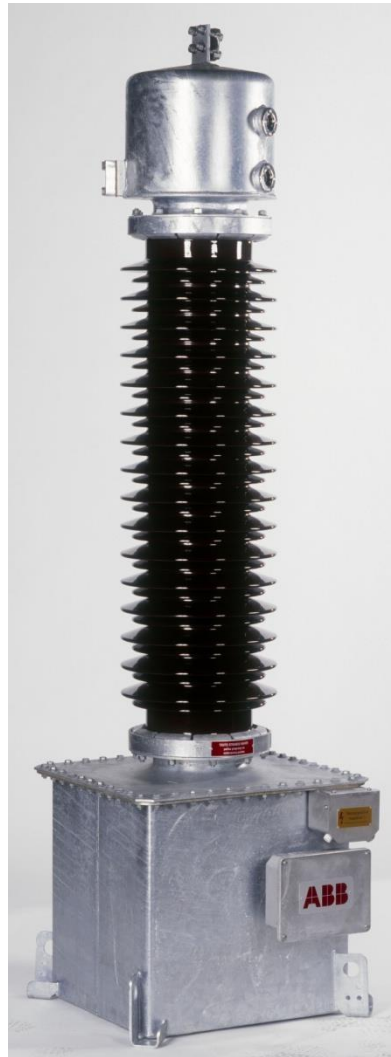
## D. CURRENT TRANSFORMER

- ▶ **CURRENT TRANSFORMER** - Current transformer are used with ammeters, watt meters, power-factor meters, watt-hour meters, compensators, protective and regulating relays and the trip coil of circuit breakers. One current transformer can be used to operate several instruments, provided that the combined burden does not exceed that for which the transformer is designed and compensated. The current transformer is connected directly in series with the line.



## E. VOLTAGE TRANSFORMER

- ▶ **VOLTAGE TRANSFORMER** - also known as potential transformer, are used with volt-meters, wattmeters, watt-hour meters, power-factor meters, frequency meters, synchroscopes and synchronizing apparatus, protective and regulating relays and the no-voltage and over-voltage trip coils of automatic circuit breakers. One transformer can be used for a number of instruments at the same time if the total current taken by the instrument does not exceed that for which the transformer is designed and compensated. The ordinary voltage transformer is connected across the line, and the magnetic flux in the core depends upon the primary voltage



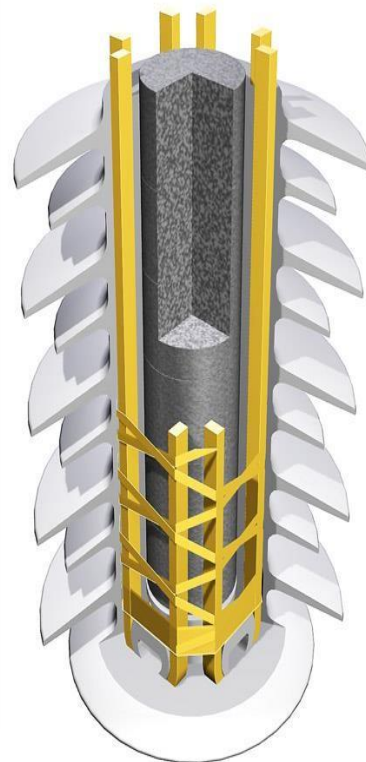


## F. EARTHING SWITCH

- ▶ **EARTHING SWITCH** - also known as ground disconnect, which used to connects the equipment to a grid of electrical conductors buried in the earth on the station property. It is intended to protect people working on the grounded equipment. It does this by completing a circuit path, thereby reducing the voltage difference between the equipment and its surroundings. For safety reasons, it is important that ground disconnects and all associated connections have good contact and low resistance. It is also important that the protective ground not be accidentally remove, that is why all the earthing switches, disconnect switches and circuit breakers are all interlocked to each other and proper/correct sequencing must be followed.

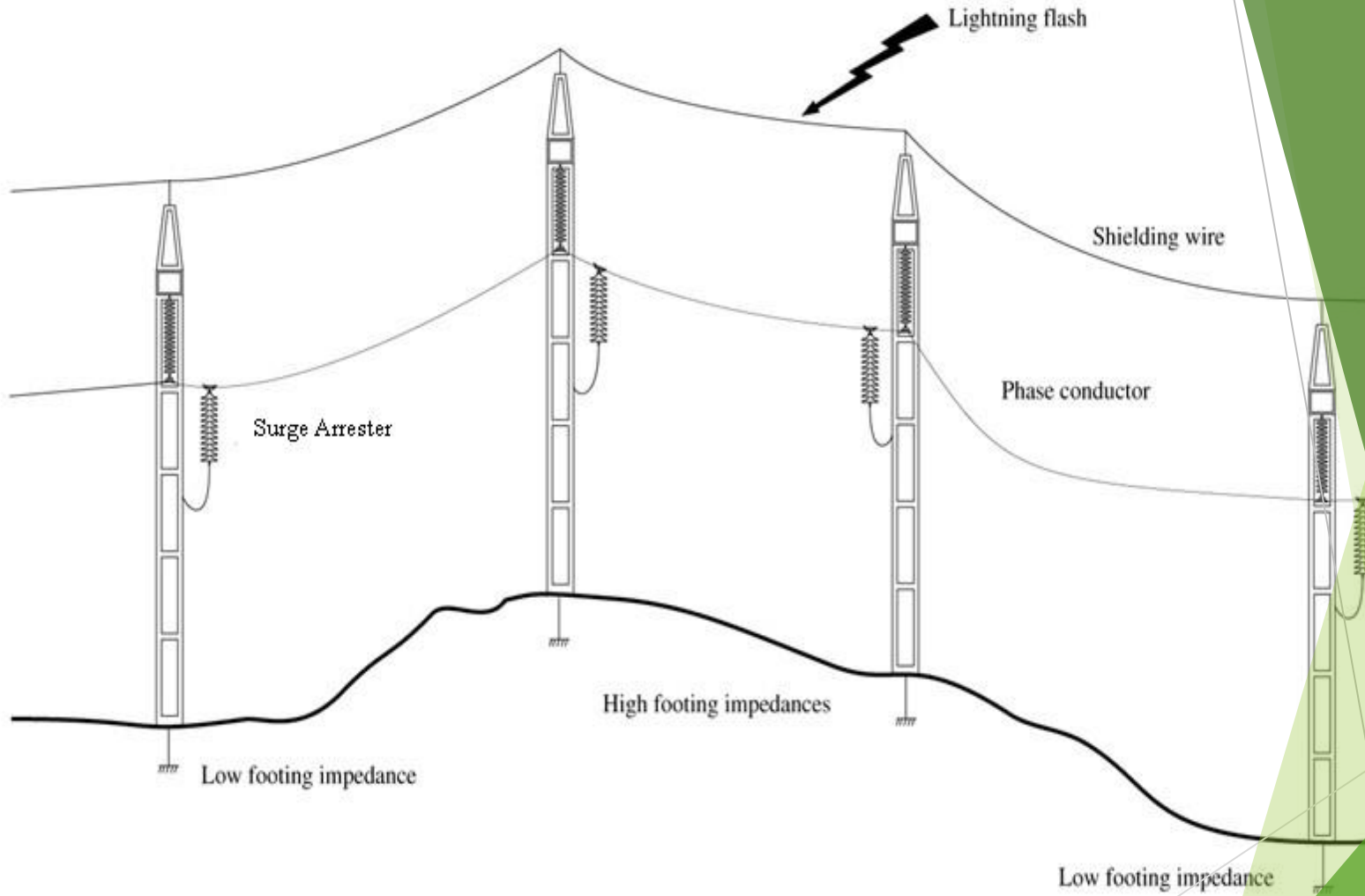
# G. SURGE ARRESTOR

- **SURGE ARRESTOR** - are devices used to provide the necessary path to ground for such surges, yet prevent any power current from following the surge. An ideal arrester must therefore have the following properties:
  1. Ability to remove the surge energy from the line in a min. time.
  2. High resistive to flow of power current.
  3. A valve action automatically allowing surge to pass and then closing up so as not to permit power current to flow to ground.
  4. Always ready to perform.
  5. Performance such that no system disturbances are introduced by its operation.
  6. Economically feasible





- ▶ **OVERHEAD GROUND WIRE** - by a ground wire is meant a wire, generally of steel, supported from the top of transmission-line towers and solidly grounded at each tower. It is considered a preventive device, but it does not entirely prevent the formation of travelling waves on a line. Furthermore, those lines which are not equipped with ground wires will be subjected to disturbances which produce surges that must be allowed to escaped to ground, or the apparatus connected to the line must be strong enough to reflect or absorb these surges until they are entirely damped out.



# PREVENTIVE MAINTENANCE

- **BUSBARS & OVERHEAD GROUND WIRE**

*At least once a year*

- Visual Inspection & Examination of all wiring connectors.
- Check Insulator , clean or apply HVIC if necessary.
- Check the physical condition of bus (cables or bars)
- For ground wire, check or test the grounding system.

- **DISCONNECT & EARTHING SWITCHES**

*At least once a month*

- Visual Inspection.
- Check heating resistor located at its control panel for proper functioning.

*At least once a year*

- Clean contacts of disconnectors as well as earthing switches and apply electrical contact grease , if necessary.

- Check disconnectors and earthing switches, joints and bearings of the operating linkages for deformed bearing points.
- Check flexible connections of earthing switches.
- Check all screwed joints for tight fit.
- Clean insulators if necessary, when an excessive amount of dirt has accumulated.
- Carry-out the maintenance of operating mechanism.

## • VOLTAGE TRANSFORMER

*At least once a month*

- Inspect the voltage divider to be sure that no oil leak or serious accumulation of soot, dust or salt composite is present.
- Inspect the intermediate voltage transformer and check the minimum permissible oil level.

*At least once a year*

- Check all screwed joints & contact for tight fit.
- Clean insulators if necessary, when an excessive amount of dirt has accumulated.

## CURRENT TRANSFORMER

*At least once a month*

- Visual Inspection to check oil level and defects or possible oil leaks.

*At least once a year*

- Check all screwed joints & contact for tight fit.
- Clean insulators if necessary, when an excessive amount of dirt has accumulated.
- Check primary and secondary connectors and conduct necessary tightening.

*Note: Never open a secondary winding of a CT while on service.*

- SURGE ARRESTOR

*At least once a year*

- Visual Inspection & Examination of all wiring connectors.
- Check Insulator and metal circular ring, clean or apply HVIC if necessary.
- Check the physical condition of bus (cables or bars)

- For ground wire, check or test the grounding system.

Note: Arrestors should never be touched unless completely disconnected from all live lines and equipment and effectively connected to ground at the line side of the arrestor.