

Transmission Line Components

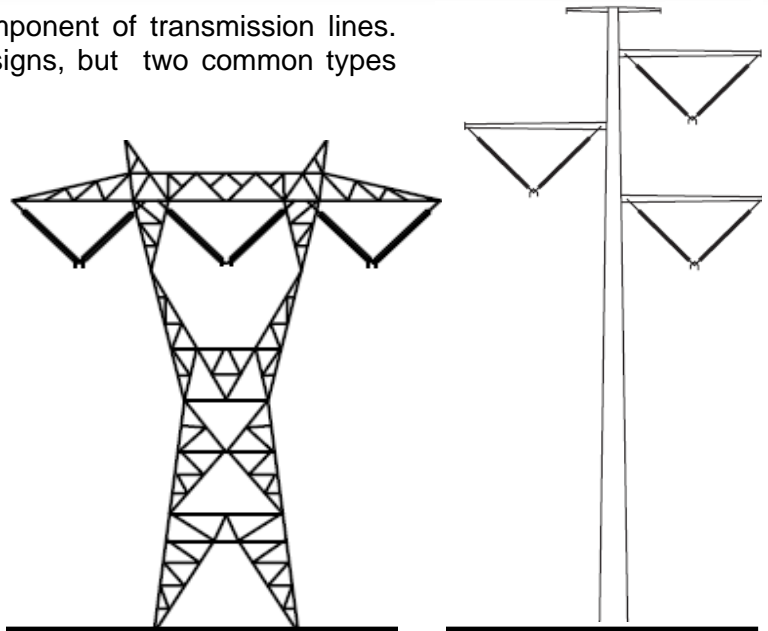


A variety of components are required to successfully deliver electricity from generating stations to local residential and commercial areas. The primary components include the transmission structures, conductors, insulators, and ground wires.

Transmission structures are the most visible component of transmission lines. Transmission structures come in many different designs, but two common types are:

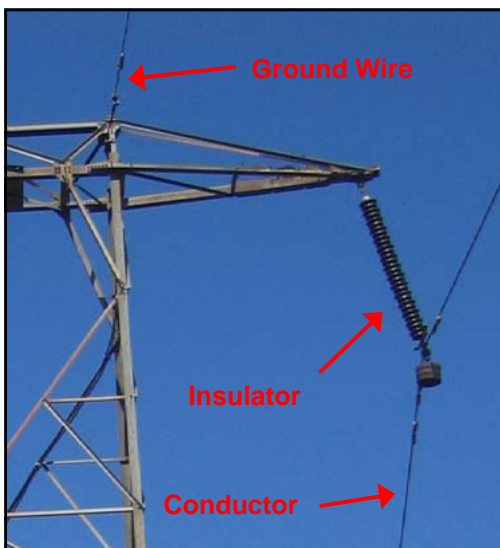
- **Lattice Steel Towers (LST)**, which consist of a steel framework of many structural components that are bolted or welded together.
- **Tubular Steel Poles (TSP)**, which are hollow steel poles fabricated either as one piece or as several pieces fitted together.

Conductors – “wires” – are comprised of materials that readily conduct electric current. Conductors used in transmission lines are usually aluminum placed over a steel core for reinforcement. Transmission line conductors are not insulated – insulation is provided by air.



500-kV single-circuit LST

500-kV single-circuit TSP



Top of lattice steel tower illustrating suspension insulator, ground wire and conductor. Note that the ground wire is higher on the tower than the conductor.

Conductors are connected to towers via **insulators** which support the conductors on the tower. They must withstand normal operating voltage and surges due to switching and lightning. Insulators have commonly been comprised of porcelain or toughened glass, which needs routine cleaning to eliminate dust build-up that can lead to insulator flashover and noise. Newer insulators are composed of polymer or silicon, which are lightweight and resistant to shattering. There are two common types of insulators:

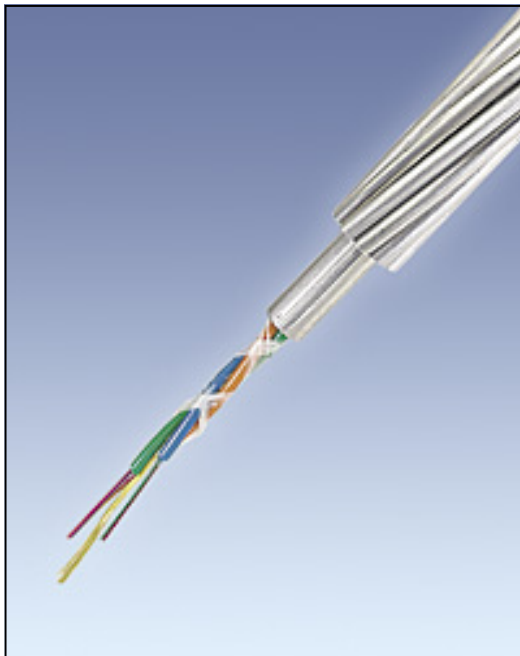
- **Horizontal post-type** supports the conductor to the side of the structure.
- **Suspension-type** suspends the conductor below the structure (see photos).

A **circuit** is made up of three **phases** (for alternating current). Towers can carry one or more circuits, depending on design (e.g., single-circuit vs. double-circuit towers).

- For voltages up to 200 kV, a phase is typically a single conductor (a total of 3 wires per circuit).
- For voltages over 200 kV, **bundled conductors** are often used to increase the current-carrying capability of the line and reduce power loss. Bundled conductors consist of two or more conductor cables connected by non-conducting spacers. 220-kV and 500-kV lines usually have two conductors per phase (six wires total in a circuit).



A transmission line composed of single-circuit lattice steel towers (LST). Note the three sets of bundled conductors (wires) which combine to make one circuit. The two triangular structures at the top of each tower support the ground wires (two per tower in this photo).



Source: www.afltele.com

Direct current (DC) circuits have two **poles** – one for positive current and one for negative current. Electricity is rarely transported as DC in the United States because transformers cannot change the voltage of DC current.

Voltage in a phase conductor is not constant – surges can happen, and fluctuations occur due to demand at any given time. A 500-kV line can accommodate up to and slightly above 500 kV, but usually carries lower voltages.

Ground wires (also called shield or earth wires) are strung along the tops of the towers to protect the system from lightning strikes. High-voltage systems usually have two ground wires.

Transmission systems must have reliable **communications** for control of the lines and substations. For example, substations have built-in mechanisms to detect problems and shut down line sections. Communication lines can be attached to the transmission towers or installed in separate locations, such as nearby streets. The ground wire sometimes incorporates a fiber optic communication line.

The photo above illustrates a ground wire with optic fibers incorporated in the core. Fiber optic communication lines can also be wrapped around the outside of a ground wire. This is usually done as a retrofit to existing lines.