Technology Brief 26
Inside a Power Generation Station

Many of the other Technology Briefs in this book are about small circuits with high component densities, such as Technology Brief 1 on Nano- and Microtechnology and Technology Brief 7 on Integrated Circuit Fabrication. In contrast, this Technology Brief is about *big* circuits used to support high-voltage and high-power systems. Household power sources provide 120—240 V. As seen in **Fig. 10-1**, the voltages in local distribution systems are on the order of *1–10 kV*, in transmission systems they are on the order of *10s of kV*, and in power generation stations they are on the order of *100s of kV*. As the power increases, the wires and electrical components must be physically larger to accommodate the heat generated by large currents passing through even small resistances. They must also be physically separated by greater distances, to prevent breakdown across the air gap between them.

High-power systems use many of the same electrical components as other electrical circuits, but the physical scale of high-power components is much bigger. Consider, for example, the very large ***iron-core inductor*** at the utility substation shown in **Fig. TF26-1**. Each of its three phases is connected via cables at the top. A bank of ***capacitors*** is shown in **Fig. TF26-2**. Both the capacitor and inductor are physically isolated from the ground below them in order to prevent them from arcing or shorting to the ground.

As noted in Section 10-2, 3-phase circuits are arranged in either a ***Y*** or a Δ ***configuration***. **Figure TF26-3** shows photos of inductors connected in both configurations.

Not only are the inductors and capacitors used in the distribution substations very large in size, but so is the power generator. As described in Section 10-1, 3-phase electrical power is generated by creating a rotating magnetic field (often with rotor coils) inside three ***stator coils***. **Figure TF26-4** shows one of the large stator coils for a coal-fired power ***generation station***. The sheer scale of the coils is evident from the fact that several technicians are working inside of it.

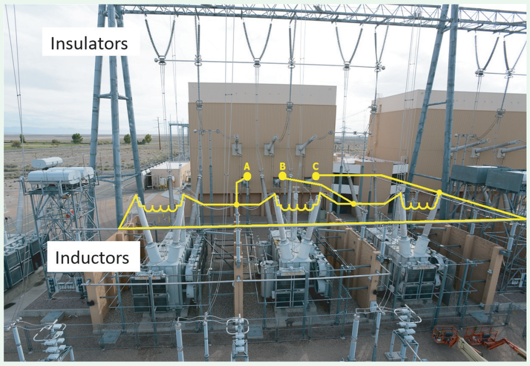
The large size theme also applies to electrical insulation, connections, and fuses used in high power applications. When connecting any electrical system, physical/mechanical connections are needed to hold the system together, and electrical connections to provide the appropriate paths for current. It is best practice to separate the mechanical connections from the electrical connections (similar to a smaller system where the electrical solder should not serve as the mechanical support). High-power systems use ceramic or glass insulator strings to electrically isolate the mechanical system that holds wires in place. These are seen and labeled in **Fig. TF26-3(a)**, and a close-up is shown in **Fig. TF26-5**.

Opening a switch in a high power system requires special care, as illustrated in **Fig. TF26-6**. A fuse for high voltage systems is shown in **Fig. TF26-7**. Unlike smaller fuses where the metal component is meant to melt away, this type of fuse snaps open when the current gets too high. This is useful when maintaining long transmission lines, for instance, because a maintainer can visually observe which fuse is open, indicating the location for repair.

High-power systems provide exciting jobs for electrical engineers. Unlike commercial products, where circuits are designed to be used in thousands or millions of identical devices, most power systems are built for a single individualized application.

Figure TF26-1: A large 50 MVAR (Mega-Volts-Amps Reactive) loading inductor.

Figure TF26-2: A bank of large capacitors for three phase power. (Note the 3 lines going in and out of each capacitor.



(a) Δ configuration

(b) Y configuration

Figure TF26-3: 3-phase Y and Δ inductor configurations in a 345 kV substation. (Photos courtesy of Intermountain Power Project.)

Figure TF26-4: Maintenance technicians working inside one of the generator coils at the Intermountain Power Project, a coal-fired power generation station. (Photo courtesy of Intermountain Power Project.)

Figure TF26-5: Cap and pin insulator string (the vertical string of discs) on a 275 kV suspension pylon.

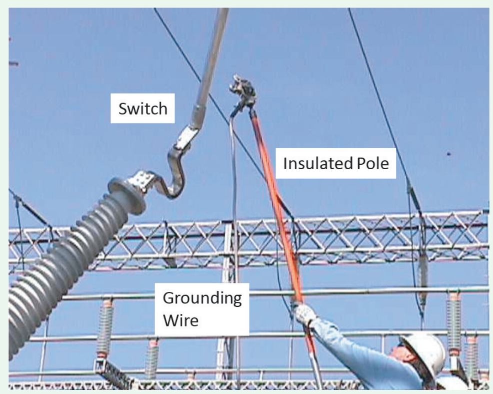


Figure TF26-6: Opening a switch using a fiberglass-insulated pole with a grounding wire. (Credit: IECACA.)

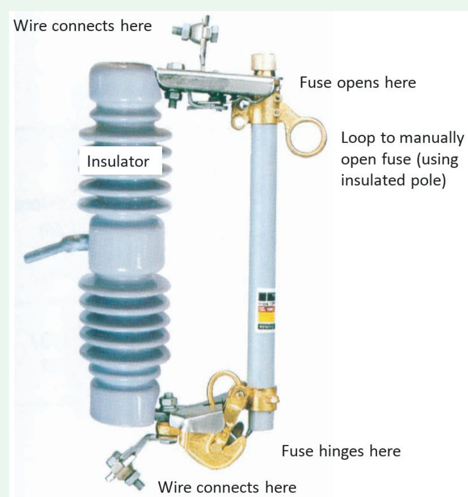


Figure TF26-7: Expulsion fuse cutout for 15 kV–27 kV.