# Fault power engineering wikipedia

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Failures may occur in each part, such as insulation failure, fallen or broken transmission lines, incorrect operation of circuit breakers, short circuits and open circuits. Protection devices are installed with the aims of protection of assets and ensuring continued supply of energy.

Switchgear is a combination of electrical disconnect switches, fuses or circuit breakers used to control, protect and isolate electrical equipment. Switches are safe to open under normal load current (some switches are not safe to operate under normal or abnormal conditions), while protective devices are safe to open under fault current. Very important equipment may have completely redundant and independent protective systems, while a minor branch distribution line may have very simple low-cost protection.[1]

Protection of the transmission and distribution system serves two functions: protection of the plant and protection of the public (including employees). At a basic level, protection disconnects equipment that experiences an overload or a short to earth. Some items in substations such as transformers might require additional protection based on temperature or gas pressure, among others.

In a power plant, the protective relays are intended to prevent damage to alternators or to the transformers in case of abnormal conditions of operation, due to internal failures, as well as insulating failures or regulation malfunctions. Such failures are unusual, so the protective relays have to operate very rarely. If a protective relay fails to detect a fault, the resulting damage to the alternator or to the transformer might require costly equipment repairs or replacement, as well as income loss from the inability to produce and sell energy.

The objective of protection is to remove only the affected portion of plant and nothing else. A circuit breaker or protection relay may fail to operate. In important systems, a failure of primary protection will usually result in the operation of back-up protection. Remote back-up protection will generally remove both the affected and unaffected items of plant to clear the fault. Local back-up protection will remove the affected items of the plant to clear the fault.

The bulk system which is a large interconnected electrical system including transmission and control system is experiencing new cybersecurity threats every day. ("Electric Grid Cybersecurity," 2019). Most of these attacks are aiming the control systems in the grids. These control systems are connected to the internet and makes it easier for hackers to attack them. These attacks can cause damage to equipment and limit the utility professionals ability to control the system.

Protective device coordination is the process of determining the "best fit" timing of current interruption when abnormal electrical conditions occur. The goal is to minimize an outage to the greatest extent possible. Historically, protective device coordination was done on translucent log-log paper. Modern methods normally include detailed computer based analysis and reporting.

There are two aspects of reliable operation of protection systems: dependability and security.[8] Dependability is the ability of the protection system to operate when called upon to remove a faulted element from the power system. Security is the ability of the protection system to restrain itself from operating during an external fault. Choosing the appropriate balance between security and dependability in designing the protection system requires engineering judgement and varies on a case-by-case basis.