Introduction
Coordination of overcurrent protective devices is one essential key to maintaining electrical distribution system reliability and integrity. However, how many electrical distribution systems are coordinated? To answer this question, the first step is to define what is coordination (or selective coordination).

Per the 2002 NEC, coordination is defined in 240.2 as: “The proper localization of a fault condition to restrict outages to the equipment affected, accomplished by the choice of selective fault-protective devices.” Thus, if the overcurrent protective devices are coordinated, only the overcurrent device closest to the fault opens and the remainder of the system is unaffected.

Coordination – Circuit Breakers
The ability of overcurrent protective devices to be coordinated typically depends upon the type of device, short-circuit operation characteristics, and the available fault current.

Mechanical devices that incorporate an instantaneous trip, such as molded case circuit breakers, can experience a lack of coordination at relatively low fault current levels. The instantaneous trip for a molded case circuit breaker is typically a maximum of 10 times the ampere rating of the circuit breaker and this setting is typically what limits coordination with downstream devices. For instance, a 100A molded case circuit breaker typically cannot be coordinated with an upstream 400A molded case circuit breaker at fault current levels of 4,000A or above (figure below).

With circuit breakers that incorporate an instantaneous trip, checking for a potential lack of coordination can be easy. If the fault current is above the upstream instantaneous setting (usually 10 times), a coordination issue most likely exists.

Mechanical devices that do not require an instantaneous trip, such as low voltage power circuit breakers, can be coordinated provided the circuit breaker short-time delay setting is selected such that the downstream device is able to clear the fault condition before the short-time delay setting is reached. However, the application of short-time delay with power circuit breakers can adversely affect the protection of equipment and arc flash hazard (by greatly increasing the fault clearing time).

Coordination - Fuses
Current-limiting fuses, of the same manufacturer, can be easily coordinated without investigating time-current curves provided coordination ratios are followed. For instance, the Bussmann® LOW-PEAK™ series of fuses can achieve coordination provided a ratio of 2:1 or higher is maintained for fault currents up to the marked interrupting rating. In addition, arc flash hazard may be greatly reduced with the application of current-limiting fuses.

Coordination Studies
Coordination studies are needed to verify the ability of overcurrent protective devices to properly coordinate. Coordination studies can be completed by hand or by using software programs. Regardless of the method used, the study must be used to analyze the overcurrent protective device characteristics, identify coordination issues, determine the potential consequences, and identify solutions. However, the studies focus only on the time-current curves and settings for the overcurrent devices, they do not identify and solve coordination issues and potential hazards. It is also important to realize that time-current curves cannot always determine coordination in the short-circuit region (below .01 seconds), often testing is the only method to determine coordination in this region.

A lack of coordination can be a serious hazard in installations such as hospitals, public and government buildings, sporting facilities, emergency systems, and potentially hazardous manufacturing processes. Often the owner is unaware of this potential problem since they assume that the system is coordinated. Would they accept a lack of coordination and possible hazards?

Standard Requirements
The NEC® and other standards, such as NFPA 99, have requirements for coordination. NEC 620.62 requires coordination for multiple elevators fed from a single feeder. NFPA 99 requires coordination in patient care areas of health care facilities.

Conclusions
Coordination is a critical element to proper operation of electrical distribution systems. The selected overcurrent protective devices and the available fault current affect the system coordination. To avoid coordination issues and potential hazards, the overcurrent device time-current curves must be analyzed. A fusible electrical distribution system and adhering to fuse selectivity ratios is an easy way to assure a coordinated electrical distribution system.

For more information see the Tech Spec 22 Supplement at: http://www.bussmann.com/apen/pubs/tsdirect.asp.