

# Why Selective Coordination is Mandatory

## -- It Fills the Reliability "Hole" --

The NEC<sup>®</sup> has mandatory selective coordination requirements for the following systems.

Emergency Systems- Article 700

– 700.27

Legally Required Standby Systems- Article 701

– 701.18

Critical Operations Power Systems- Article 708

– 708.54

Healthcare Article 517

– 517.26 Required for Essential Electrical Systems

(In addition, selective coordination is required in elevator circuits (620.62), which is not discussed in depth in this paper.)

Notice, these requirements are not in NEC<sup>®</sup> Chapters 1 through 4, such as Articles 210 for Branch Circuits, 215 for Feeders, or 240 for Overcurrent Protection. Chapter 1 through 4 requirements pertain generally to all premise electrical installations. Instead, these selective coordination requirements are in Chapters 5 and 7 that are under special occupancies and special conditions, respectively. Specific attention is given to these systems in the NEC<sup>®</sup> and they have some unique requirements. Articles 700, 701, 708, and 517 are for circuits and systems that are intended to deliver reliable power for loads that are vital to life safety, public safety, or national security. Reliability for these systems in the above articles has a higher priority than the reliability for the normal systems covered by Chapters 1 through 4.

Reviewing portions of the scopes of these Articles provides further insight.

### **Article 700 Emergency Systems**

*"700.1 Scope. The provisions of this article apply to the electrical safety of the installation, operation, and maintenance..."* The inclusion of operation and maintenance indicates that reliability of these systems is very important. For these systems, installation requirements alone are not sufficient. These systems must operate when needed so this Article includes operational and maintenance requirements. Why? The following statement from the scope is clear: *"Essential for safety of human life"*. For instance in times of emergency, these loads are critical to evacuate a mass of people from a building.

### **Article 708 Critical Operations Power Systems (COPS)**

*"708.1 Scope. FPN No. 1: Critical operations power systems are generally installed in vital infrastructure facilities that, if destroyed or incapacitated, would disrupt national security, the economy, public health or safety; and where enhanced electrical infrastructure for continuity of operation has been deemed necessary by governmental authority."* Due to recent events such as 9/11 and Hurricane Katrina, Homeland Security requested that NFPA develop electrical requirements for systems that are vital to public safety and national security. The newly created Article 708 (COPS) includes requirements, such as selective coordination, that are minimum requirements for electrical systems that are important for public safety and national security.

Articles 700, 701, 708, and 517 are unique in that they have more restrictive minimum requirements (versus the general requirements for normal systems) in order for these systems to provide more reliable power for vital loads. Selective coordination is one of the requirements that support higher reliability. To make the point, here are just a few of the more restrictive minimum requirements in Article 700:

- Periodic testing, maintenance, and record retention

- Alternate power sources
- Wiring from emergency source to emergency loads separate from all other wiring
- Special fire protection for wiring
- Wiring location to avoid outage due to physical damage during fires, floods, vandalism, etc.
- Automatic transfer switches (ATS) with sophisticated sensors, monitors, & control
- Separate ATSs and load segmenting (emergency, legally required standby, & optional standby) with sophisticated load shedding, if required

Article 708 (COPS) also has a similar list of restrictive requirements with the intent of providing a reliable power system.

Why have these special, more restrictive requirements? The reason these articles for special systems exist is that the electrical industry, the standard making bodies, the technical code panel members, and Homeland security feel special rules are needed to ensure minimum requirements for delivering reliable power for designated vital loads. To better understand why we have more restrictive requirements, focus on the loads that are being served by these special systems. There are a few vital loads that pertain to life safety, public safety and national security. For instance, 700.1 Scope FPN states

*“FPN No. 3: Emergency systems are generally installed in places of assembly where artificial illumination is required for safe exiting and for panic control in buildings subject to occupancy by large numbers of persons, such as hotels, theaters, sports arenas, health care facilities, and similar institutions. Emergency systems may also provide power for such functions as ventilation where essential to maintain life, fire detection and alarm systems, elevators, fire pumps, public safety communications systems, industrial processes where current interruption would produce serious life safety or health hazards, and similar functions.”*

The requirements for these systems are intended to increase the system reliability to deliver power and thereby increase the availability of these vital loads during emergencies, disasters, and the like.

Code Making Panels (CMPs) decide whether an item is a requirement or a design consideration. Requirements are in the body of the NEC<sup>®</sup> under a Chapter, Article and Section.

A design consideration or an unenforceable point of interest is a Fine Print Note (FPN). Code Making Panels make the decision as to whether an important criterion is worthy either as an informative FPN or as an NEC<sup>®</sup> requirement. Until 2005, selective coordination was a FPN in Articles 700 and 701. During the 2005 NEC<sup>®</sup> cycle, Code Making Panel 13 made the decision to convert selective coordination from a Fine Print Note (design consideration) to a Section requirement written in mandatory performance language in order to ensure the outcome the technical panel deemed necessary. The Code Panel decided that selective coordination as a FPN was not sufficient. Our society was changing, our culture was changing, and our building systems have evolved to a greater dependency on electricity. It was time to make selective coordination a requirement. Their panel statement included: *“The panel agrees that selective coordination of emergency system overcurrent devices with the supply side overcurrent devices will provide for a more reliable emergency system.”*

Let's take a closer look at what may have prompted CMP 13 to change selective coordination from a FPN to a requirement (700.27 and 701.18) during the 2005 NEC<sup>®</sup> cycle and then for CMP 20 to include selective coordination as a requirement (708.54) for Critical Operations Power Systems in the new Article 708 for 2008 NEC<sup>®</sup>. The very first requirement in the NEC<sup>®</sup> is a good place to start. This requirement is the root of every requirement in the NEC<sup>®</sup>:

*“90.1 Purpose. (A) Practical Safeguarding. The purpose of this Code is the practical safeguarding of persons and property from hazards arising from the use of electricity.”*

A hazard would exist if power were not supplied to the loads that are vital to assist a mass of people while exiting a building in an emergency. The NEC® has detailed requirements to address this hazard. Selective coordination is one of the requirements that ensure reliability for these special systems. This is one of those examples where the NEC® requirement is putting an emphasis on protecting people, similar to GFCIs.

Let’s dig a little deeper into the rationale to make selective coordination a requirement. Until the 2005 NEC®, there was a **“hole”** in the requirements of Article 700 and 701; a performance issue that reduced the reliability of these systems was not addressed. As already discussed, these Articles have many special requirements that are intended to keep the power flowing to a few vital loads. An emergency system could have redundant power sources, automatic transfer switches with load shedding, location of wiring to minimize outages from floods, special fire protection provisions, no ground fault protection on the alternate source (for selective coordination purposes), testing, maintenance, etc., and yet the whole or part could unnecessarily be left without power because the overcurrent protection was not selectively coordinated. These requirements for high reliability systems had a missing piece that could negate the intended reliability for these special systems. This had to be fixed. The 2005 NEC® remedied that **“hole”** by inclusion of the selective coordination requirements for Articles 700 and 701 and indirectly 517 for healthcare essential electric systems.

The substantiation for the original 2005 NEC® proposal for Section 700.27 provides the reasons.

For better understanding, this substantiation is separated into three segments below.

The **Need** is illustrated by the fact that there were already many existing special requirements with the intent of ensuring more reliable emergency power systems:

*“This article specifically mandates that the emergency circuits be separated from the normal circuits as shown in [Section] 700.9(B) and that the wiring be specifically located to minimize system hazards as shown in [Section] 700.9(C), all of which reduce the probability of faults, or failures to the system so it will be operational when called upon. With the interaction of this Article for emergency lighting for egress, it is imperative that the lighting system remain operational in an emergency. Failure of one component must not result in a condition where a means of egress will be in total darkness as shown in [Section] 700.16”...* The principle is that these and other requirements are in Article 700 to ensure reliability of the system to deliver power during emergencies.

This part of the substantiation identifies the existing **Hole** that should be rectified to ensure a more reliable system:

*“Selectively coordinated overcurrent protective devices will provide a system that will support all these requirements and principles. With properly selected overcurrent protective devices, a fault in the emergency system will be localized to the overcurrent protective device nearest the fault, allowing the remainder of the system to be functional”...*

This part proposes that the **Solution** is to convert from a Fine Print Note design consideration to a requirement:

*“Due to the critical nature of the emergency system uptime, selective coordination must be mandated for emergency systems. This can be accomplished by both fuses and circuit breakers*

*based on the system design and the selection of the appropriate overcurrent protective devices.”*

It was not a fuse or circuit breaker issue; since either technology can provide selective coordination. What was needed was the mandate to design the electrical distribution system so that the fuses and circuit breakers would provide selective coordination. Without this as a requirement, electrical distribution systems are designed and installed without any regard to how the overcurrent protective devices interact and this can negatively impact the system reliability for delivering power to these vital loads.

The Code Making Panel action was to accept this proposal in Principle and in Part. The panel deleted the Fine Print Note and rewrote and accepted the following requirement text with a vote of 13 to 1.

**700.27 Coordination.** *“Emergency system(s) overcurrent devices shall be selectively coordinated with all supply side overcurrent protective devices.”* It is important to note the panel expressly used the word “all”.

The Code Panel 13 statement provides the panel’s reasoning: ***“The panel agrees that selective coordination of emergency system overcurrent devices with the supply side overcurrent devices will provide for a more reliable emergency system...”*** The take away from the panel action is that selective coordination equals reliability. Acceptance of this requirement plugged the “hole” that had previously existed.

In the comment stage, this new reliability requirement was challenged but was not overturned. Some people incorrectly characterized this as a circuit breaker versus fuse issue. At the NFPA Annual Meeting a motion was brought forth to delete this requirement for the 2005 NEC®. The same comments, both pro and con, that were brought up in the proposal and comment stages were discussed. After the discussion, the motion to delete this new requirement failed by a hand vote. So in the 2005 NEC®, selective coordination was required in emergency and legally required standby systems. In addition, since selective coordination was required in 700.27, it was required in healthcare essential electrical systems.

The selective coordination requirements expanded in the 2008 NEC®. A new Article 708, Critical Operations Power Systems, was developed by the newly created Code Panel 20 and the message carried through. The COPS scope encompasses electrical systems designated for national security and public safety. Is there a need for these systems to deliver reliable power? Absolutely, there is a need. If there is a need for reliable power, then there is a need for selective coordination. CMP20 included a requirement for selective coordination in Article 708:

**708.54 Selective Coordination** *“Critical operations power system(s) overcurrent devices shall be selectively coordinated with all supply side overcurrent protective devices.”*

Also, in the 2008 NEC® cycle, the selective coordination requirements in 700.27 (emergency systems), 701.18 (legally required standby systems), & 620.62 (elevator circuits) were challenged. In the proposal and comment stages, there were plenty of pro and con submittals. All rationale was presented, debated, and discussed in this Code cycle. All selective coordination requirements were retained with 700.27 and 701.18 adding two clarifying exceptions. Neither exception reduced life-safety because no additional parts of the electrical system would be shut down unnecessarily.

To understand the support for these requirements by the national industry experts on the technical committee, the following is official voting in the 2008 NEC® comment stage:

- Panel 12 voted unanimously (**11–0**) to retain the requirement for selective coordination in elevator circuits (620.62)
- Panel 13 voted **11–2** to add exceptions to 700.27 and 701.18 for two devices of the same ampere rating in series and single devices on the primary and secondary of a transformer
- Panel 20 voted **16–0** (three times) and **15–1** (one time) to reject all attempts to reduce or eliminate this key life safety requirement (708.54)

During the 2008 NEC® proposal stage, CMP 13 reaffirmed the selective coordination and communicated several key positions in their statement. In this case, the panel statement clearly communicates the panel action and position. Proposal 13-135 proposed the elimination of the selective coordination requirement from 700.27 and moving the language back to a fine print note. This proposal was rejected 9 to 4.

**Panel Statement:** *“This proposal removes the selective coordination requirement from the mandatory text and places it in a non-mandatory FPN. The requirement for selective coordination for emergency system overcurrent devices should **remain in the mandatory text. Selective coordination increases the reliability of the emergency system.** The current wording of the NEC® is adequate. **The instantaneous portion of the time-current curve is no less important than the long time portion. Selective coordination is achievable with the equipment available now.**”*

Special note: some people are still advocating lessening or diluting the requirement to wording similar to “for times greater than 0.1 seconds”. This would only provide selective coordination for overloads, would not cover most ground faults or arcing faults, and would definitely not cover high level short circuit currents. It certainly would reduce the reliability of these power systems. CMP 13 considered all these type proposals and by their above statement, clearly stated that the selective coordination requirement is for all levels of overcurrent, irrespective of the operating time of an overcurrent device.

During the 2008 NEC® comment stage, Code Making Panel 20 reaffirmed the selective coordination requirement based on system reliability. Comment 20-13, proposed the deletion of the 708.54 selective coordination requirement. This comment was rejected 16 to 0.

**Panel Statement:** *“**The overriding theme of Article 585 (renumbered to 708) is to keep the power on for vital loads. Selective coordination is obviously essential for the continuity of service required in critical operations power systems. Selective coordination increases the reliability of the COPS system.**”*

Inevitably, costs are discussed even though the first requirement in the NEC®, 90.1, tells us the NEC® is concerned about safety, even if not efficient or convenient. For designing and installing selectively coordinated overcurrent protective devices, the cost may not necessarily be greater. That depends on the design. It is important to keep in mind that the requirements in the whole of Articles 700, 701, 517, and 708 result in extra work and cost. An alternate power source with additional electrical distribution gear, automatic transfer switches, sophisticated sensors, monitoring, control, and other provisions cost more and take additional engineering effort. These systems also require extra time and money to test, maintain, and retain records. The extra cost is expected in order to provide more reliability for these special systems compared to normal systems. For mission critical business operations, such as data servers, financial applications, and communication industry centers, electrical distribution system design and equipment selection for selective coordination is the norm. No less should be expected for the few important loads that are critical for life safety. If we routinely provide selectively coordinated systems to protect our vital business interests, why shouldn't we do it to protect our people?

## Summarizing

Selective coordination for elevator circuits has been a requirement since the 1993 NEC<sup>®</sup> and the industry has adjusted to compliance. For two NEC<sup>®</sup> cycles, opposition to the 700.27 and 701.18 requirements has vigorously worked on removing or diluting these selective coordination requirements. However, during this time the requirements have been reaffirmed and expanded with Article 708, COPS, in the 2008 NEC<sup>®</sup>. Now three Code Making Panels have inserted selective coordination requirements in four Articles of the NEC<sup>®</sup>. These Articles provide the minimum requirements for these special systems essential for life safety, public safety and national security. We obtain insight as to why selective coordination is a requirement by studying their panel statements. The panels' statements make clear these are special systems where reliability is of utmost importance and selective coordination increases the system reliability to deliver power to these few vital loads.

In our modern buildings, there is a greater dependence on electricity and the NEC<sup>®</sup> requirements must adjust to this greater dependency and complexity. This is evidenced by Homeland Security approaching NFPA and requesting that the NEC<sup>®</sup> include requirements for Critical Operations Power Systems. The reliability of electrical systems supplying vital loads must be greater than that of the systems supplying power to normal loads. Hence, that is the reason for having Articles 700, 701, 708, and 517. People's health and safety as well as possibly national security and public safety rely on the power to these vital loads, even under adverse conditions such as fires, earthquakes, hurricanes, and man-made catastrophes. Selective coordination of all the overcurrent protective devices for the circuits supplying these loads adds another assurance of reliability: it fills the "hole".

Last, a quote from an Oct 2007 EC&M article sums it up well. James S. Nasby is engineering director for Master Control Systems, Inc. and was the NEMA representative on Code panel 13 for the 2005 and 2008 NEC<sup>®</sup> cycle. "In response, Nasby asks detractors (of selective coordination requirements) to list the essential emergency systems they'd want to risk going offline. He says it's difficult to calculate risk when it's your family on the top floor of a high-rise hotel. 'Typically, no building owners will install anymore emergency services than are required, and what is required for that building is important' Nasby says. 'You don't want to lose lights in the stairwell or the emergency elevators, and you don't want a fault on one of these services to take out anything else. There can be exceptions, but typically faults are localized. The premise of distribution systems is that a fault on one circuit doesn't propagate upstream – and that's what this is asking for.'"

More materials on selective coordination are available on [www.CooperBussmann.com](http://www.CooperBussmann.com)

