

CRITICAL OPERATIONS POWER SYSTEMS
NEC 2008, Article 708
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Over the last several years, the US has been challenged by both natural and human caused events that have made many people re-think the safety and reliability of our infrastructures and facilities. This prompted the US government to create the Department of Homeland Security in 2002 to implement plans and actions to maintain a safe environment in the US. In addition, the National Fire Protection Association (NFPA) established a task force (CMP-20) to review the existing codes and determine changes that could be added to increase the reliability, safety, and functionality of facilities. This task force met in August 2005 to review current NFPA 70-2005 National Electrical Code (NEC), and other NFPA documents, such as; NFPA 1600-2004 Standard on Disaster/Emergency Management, NFPA 110-2005 Standard for Emergency and Standby Power Systems, and NFPA 111-2005 Standard on Stored Electrical Energy Emergency and Standby Power Systems.

During the period of time that this task force was in place, Hurricane Katrina hit Louisiana. This natural disaster provided significant input to this committee because of the failure of communication systems, facilities, and other infrastructures that were not able to handle the masses of people that had been forced to evacuate their homes and businesses.

Article 708, Critical Operations Power Systems (COPS) was added to the NFPA 70-2008 (NEC) code to provide facilities with a higher level of protection from disasters. This was the code making authority's first attempt to create building design requirements that were significantly more capable of sustaining operations during these types of disasters.

This paper discusses Article 700, Emergency Systems, Article 517, Health Care Facilities, and finally Article 708, COPS, and provides some of the additional requirements of each Article.

EMERGENCY SYSTEMS
Article 700

Article 700 is intended to establish guidelines for the maintenance of power and controls when a normal power source has been interrupted in certain safety-related systems. When this situation occurs, these systems are required to automatically transfer power to a secondary power source within 10 seconds or less. The secondary power source must have the capacity and rating required to provide emergency power for a minimum of 1-1/2 – 2 hours, depending upon the backup

power source. The following are approved sources of alternate power: storage batteries, generator set, uninterruptible power supplies, separate service, or fuel cell system.

In most facilities, automatic transfer switches (ATS) will be required to provide a means of separating the emergency and normal loads. The ATS's must have the capability of automatic selective load pickup to ensure that adequate power is available to (1) emergency systems, (2) legally required standby systems, and (3) optional standby or normal systems in that order of priority. The emergency branch circuits shall only supply equipment and illumination classified as emergency; such as exit signs, egress lighting, and fire alarm systems. The transfer equipment shall be designed and installed to prevent inadvertent interconnection of normal and emergency power sources unless it has been designed for parallel operation, and then it must also meet the requirements of Article 705.

When the primary service disconnect is more than 150 volts to ground, fed by a solidly grounded wye system, and the service entrance protective device is rated 1000 amps or larger, the disconnect is required to have one level of ground fault protection. This device must be capable of limiting the ground fault current to a maximum of 1200 amps.

Legally required and optional standby circuits shall not originate from the same vertical section of a switchboard, panelboard enclosure, or individual disconnect as the emergency circuits. Wiring for the emergency systems shall be kept entirely independent of all other wiring, with the exception of where two sources of power come together in the same device, such as a transfer switch.

HEALTHCARE FACILITIES

Article 517

Article 517 provides additional requirements above Article 700 because the primary function of these facilities is to provide care to human beings.

When a health care facility is classified with critical care areas, the alternate sources of power shall be: an on-site generator driven by a prime mover located on the premises, another generating unit located on the premises, an external utility service where the normal source of power is an on site generator unit, or a battery system located on the premises. In most states, the alternate power source requires a minimum of 24 hours of on-site fuel supply. However, where the site falls under Seismic Codes C, D, E or F, it requires 96 hours of on-site fuel supply. Careful consideration should be given to the location of the components of the essential electrical system to minimize the potential for interruptions caused by natural forces. Generator accessories including equipment such as transfer fuel pumps, electrically

operated louvers, and other generator accessories essential for the generator operation, shall be automatically connected to the alternate power source.

In a hospital facility, the electrical system must be split into normal and emergency loads through the use of automatic transfer switches. Additionally, the emergency loads should be broken down into three categories: Life safety branch, Critical branch, and Equipment branch. Life safety branch is intended to provide adequate power needs to maintain safety to patients and personnel, and meet the criteria of Article 700. Critical branch is intended to provide power needs to areas and functions related specifically to patient care. Equipment branch is intended to provide power to primarily 3-phase power equipment. The ATS equipment must have the capability of selective pickup and shedding of nonessential loads such that the generating equipment will be able to carry the emergency loads without overloading the equipment.

When the service entrance primary over-current device has ground fault protection, all next level feeder devices, downstream toward the load, must also have ground fault protection. The additional level of ground fault shall not be on the load side of an essential electrical system transfer switch or be between the on site generator and the essential electrical system transfer switch. This system shall be fully selective such that the feeder device, not the service device, opens first on all ground faults. There also must be a minimum of 6 cycles separation between the ground fault tripping bands of the service device and the ground fault tripping bands of the feeder device.

Life safety and critical branch circuit wiring must be kept independent of all other wiring and equipment. It shall be protected by one of the following wiring methods: non-flexible metal raceways, type MI cable, or schedule 80 rigid nonmetallic conduit, encased in a minimum of 2 inches of concrete, listed flexible metal raceways and metal sheathed cable assemblies and flexible power cords for appliances and other utilization equipment.

CRITICAL OPERATIONS POWER SYSTEMS (COPS) Article 708

Article 708 is the most stringent of the three Articles in many categories. This Article provides an additional level of protection for the electrical equipment and wiring such that in the event of a natural or human created disaster, this facility will still function while other facilities may fail.

COPS systems are generally installed in vital facilities that, if destroyed or incapacitated, would disrupt national security, the economy, public health and/or safety. The local Authority Having Jurisdiction (AHJ) has the authority to require a designated area or all of the facility to meet these new requirements. If only a

designated area in the facility is required to meet this section of the code, it is referred to as the Designated Critical Operations Area (DCOA).

As a part of the additional requirements for this section of the NEC, a risk assessment shall be performed to identify the hazards and rank their likelihood of occurrence. At a minimum, the assessment should include naturally occurring hazards and human caused events. Based on the risk assessment, a plan should be developed and implemented to mitigate the potential hazards. A facility with a COPS area shall also have a documented emergency operations plan.

The COPS alternate power source shall have the capacity and rating to run full load continuously for a minimum period of 72 hours. The alternate power source can be a generator, uninterruptible power supply, or a fuel cell system. It must have selective load pickup and shedding capabilities as needed to ensure power to (1) the COPS and emergency circuits, (2) the legally required standby circuits, and (3) the optional standby circuits, in that order of priority. If the DCOA is fed by a single generator source, a means for connecting a portable generator shall also be provided. Fuel transfer pumps for prime mover type generators must be connected to the COPS branch distribution equipment. The on-site fuel supply shall be secured and protected according to the risk assessment plan. Additionally, all sources of power shall be grounded as a separately derived source according to Article 250.30.

It is required for the emergency systems to be commissioned so that baseline test results are created. Additional tests must be conducted on a regular basis and these tests' results should be documented. There should be a means for testing all the critical circuits under the maximum anticipated load conditions. The local AHJ can set the maximum testing intervals.

The COPS system circuits must be supplied by dedicated automatic transfer equipment. All other loads, including other emergency loads not designated as COPS, must be supplied through additional ATS's, so that the loads are separated.

When the primary service disconnecting means has ground fault, a second level of ground fault protection must be provided. This is similar to the Article 517 requirements. The ground fault protection shall be fully selective with a minimum of 6 cycles of separation between the service and feeder ground tripping bands. All COPS over current devices shall be selectively coordinated.

COPS branch circuit distribution equipment must be located within the same DCOA that it supplies. The feeder and branch circuit over current devices shall be accessible only to authorized personnel. Surge protection (TVSS) shall be provided at all facility distribution voltage levels. (code 708.20(D))

All feeder and branch circuit wiring for the COPS systems must be permanently marked so they can be easily identified. They shall also be kept entirely independent of all other wiring and equipment. The circuit wiring must be protected by one of the

following methods: rigid metal conduit, intermediate metal conduit, or Type MI cable, encased in a minimum of 2 inches of concrete with schedule 40 or 80 conduit, reinforced thermosetting resin conduit (RTRC), electrical metallic conduit (EMT), flexible nonmetallic or jacketed metallic raceways, or jacketed metallic cable assemblies listed for installation in concrete.

Feeder cables shall meet one of the following conditions; be a listed electrical protective system with a minimum of 1 hour fire rating, be protected by a minimum of 1 hour fire rated assembly, be embedded in a minimum of 2 inches of concrete, or be a cable listed to maintain integrity for a minimum of 1 hour.

When the COPS feeders are installed in an area that is below the 100-year flood plain, they shall be listed for use in wet locations. (708.10 (3) The feeder distribution equipment must be located in spaces with a 2-hour fire rating and also be located above the 100-year flood plain. (708.11 (B)

Riser communication cables shall be a 2 hour fire resistive cable or in a 2 hour protective system. Control, monitoring and power wiring to HVAC systems shall be a 2 hour fire resistive cable or in a 2 hour protective system.

CONCLUSION

Article 700 insures that a facility has an alternate source of power that must be available within 10 seconds or less when the normal power source has been interrupted. The alternate power source must provide power and controls so human life is not at risk, and provides adequate time to orderly vacate the facility, which is normally 1-1/2 hours.

Article 517 enhances several requirements. The electrical system must be split into three branches of power: life safety, critical, and normal. The life safety branch is intended to provide adequate power for the safety of patients and personnel. The alternate power source must be capable of running continuously for either 24 or 96 hours, depending on the local codes and Seismic rating for that area.

Article 708, new to the 2008 NEC, has enhanced the local AHJ's ability to ensure uniform enforcement for critical facilities. These facilities can have either a designated area or the entire building considered as part of the COPS system. This Article requires that the alternate power source have a minimum of 72 hours of full load capacity. It also requires TVSS protection be included in all COPS equipment. And finally, it provides additional protection from fire and water damage for COPS equipment, power wiring, and communication cables by considering the 100-year flood plain.

REFERENCES

Critical Operations Power Systems, IAEI Article, by Timothy Owens NFPA CMP-20 Task Member
NFPA 70-2008 National Electrical Code Handbook
NFPA 99-2005 Standard For Health Care Facilities
NFPA 110-2005 Standard for Emergency and Standby Power Systems
Homeland Security Website <http://www.dhs.gov/index.shtm>