PDHonline Course E430 (3 PDH)

Revisions for the 2014 National Electrical Code® - Part 3

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Revisions for the 2014 NEC®, Part 3

PDH Course E430

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Revisions for the 2014 National Electrical Code®
Part 3

Patrick S. Ouillette, P.E.

Introduction

Part 3 of this 3-part series covers Article 445 through Informative Annex J. The course covers only major Code changes, but provides depth of coverage.

The layout and the method of presentation will enable new Code users to navigate through the changes. Those well experienced in the Code will find depth in the coverage. Through the heading(s) at the beginning of each Code change addressed in the document, the reader will readily identify the section affected by the change and the specific subject being discussed. The Significance section serves as an introduction to the Code change under discussion. An Analysis of the Code change follows, with explanation as necessary to help the student understand the revision, its background, and the logic of the change. Graphics, photographs, examples, or calculations are used to illustrate the change and to enhance learning. The Summary is a brief re-statement of the highlights of the Code change. An Application Question, with Answer and key to the correct answer, is included at the end of each Code section studied for exercise in applying the change and to broaden learning. Many of the sections analyzed contain a Code Refresher that addresses existing Code requirements related to the change. The author attempts to tie the entire NEC® together through the study of the changes.

Although there are many references to the 2014 *NEC* throughout this document, the course and quiz can be completed without the need to refer to the *NEC* itself. For further study on any Code section within this course, the 2014 *NEC* should be consulted.

Marking

Significance

For safe utilization of generators, it is necessary to know whether or not the generator neutral is connected to the frame of the generator. A new section requires that this information be marked on the generator.

Analysis

Generators can be connected for use as separately derived systems or as non-separately derived systems. Generators are used as stand-alone systems for recreational and other purposes, for temporary power at construction sites, and for backup power supplying premises wiring for residences and small commercial properties. Different uses require different wiring connections, sometimes requiring the generator neutral to be bonded to the frame and sometimes requiring isolation between the generator neutral and generator frame.

Often, generators are connected by persons not trained in electrical wiring. This is especially true of portable generators. Adverse weather conditions, standing water, and flexible power cords that may be subject to physical damage are all potential hazards related to the use of small portable generators. GFCI protection is required in most instances and is critical to the safe utilization of electricity supplied by portable generators. (See new Section 445.20 and existing Section 590.6(A)(3) for GFCI requirements on portable generators 15 kW or smaller.) In order for GFCI receptacles to operate properly, the neutral of the generator must be connected (bonded) to the generator frame. However, it cannot be readily determined whether or not the generator neutral is connected to the frame of the generator, nor can the bonding or lack thereof be necessarily modified in the field. Generators that employ a floating neutral are inherently safe, since the neutral point of the generator winding is not connected to the generator frame or to earth. Thus, there is no conductive path through earth for current supplied from the generator.

Section 445.11 of the 2014 *NEC* requires the manufacturer to mark the generator denoting whether or not the generator neutral is bonded to the generator frame. If this connection is modified in the field, updated field marking is required that denotes whether or not the generator neutral is bonded to the frame of the generator. The location of any bonding connection is not required to be marked. In some cases, this connection is not accessible for field modification, nor is it required to be accessible.

This Code change seeks to address safety concerns mainly associated with the use of portable generators, but the change also applies to stationary generators.

Summary

Generator manufacturers are required to mark the generator to denote whether or not the neutral of the generator winding is connected to the frame of the generator. If this connection is modified in the field, updated field marking is required that denotes whether or not the generator neutral is bonded to the frame of the generator.

Application Question

T F The manufacturer's marking denoting whether or not the generator neutral is connected to the generator frame must include the location of any bonding connection.

Answer

False. The location of the bonding connection is not required to be marked. On some generators, the bonding connection is not intended to be accessible.

Courtesy of Robin America Inc.

Output panel of a Robin Subaru portable generator

Ground-Fault Circuit-Interrupter Protection for Receptacles on 15-kW or Smaller Portable Generators

Significance

A new rule addressing ground-fault circuit-interrupter (GFCI) protection for personnel on small portable generators differentiates between stand-alone generators and those that will be connected to grounded premises wiring systems.

Analysis

The 2014 *NEC* requires that all 125-volt, single-phase, 15- and 20-amp receptacles that are part of a 15-kW or smaller portable generator be provided with GFCI protection for personnel integral to the generator or receptacle, unless these receptacles are not available (switched off) when the generator's 125/250-volt receptacle is being used. If the generator does not have a 125/250-volt locking-type receptacle, this requirement shall not apply.

[If the generator was manufactured or remanufactured prior to January 1, 2015, listed cord sets or devices incorporating listed ground-fault circuit-interrupter protection for personnel identified for portable use shall be permitted.] The text in brackets is the essence of a Tentative Interim Amendment (TIA) 14-2, effective November 11, 2013. This action/section will be reevaluated as a proposal (public input) during the next Code cycle.

This new rule seeks to provide optimal safety by permitting, in some cases, the inherently safe "floating neutral" configuration frequently used for stand-alone systems. Where a generator is supplying 125/250-volt power to a building wiring system, the 125-volt, single-phase, 15- and 20-amp receptacles must be made unavailable or equipped with GFCI protection.

Many small portable generators are used by homeowners when utility power is lost, most commonly for outages due to storms. Often a flexible power cord is used as a patch cord to supply 120/240-volt power to the residence through a transfer switch that does not switch/break the neutral conductor. With this connection the generator neutral is now grounded (earthed) through the grounding electrode system of the utility service. Use of other receptacles on the generator without GFCI protection poses a hazard, since now a conductive path through earth has been established. The path can be traced from a point of contact with earth, to the grounding electrode system of the utility supplied service, to the service neutral, then back to the generator winding through the neutral conductor of the generator supply cord. The point of contact with earth could be a person standing on the ground operating a power tool where the metal frame of the tool has become accidentally energized. This makes a good case for the Code change.

The inherent safety of the floating neural system is based on the fact that the neutral point of the generator winding (or one side of a winding that is not center-tapped) is isolated from the frame of the generator and earth ground. Thus, if a person standing on the ground contacts an energized metal part of equipment supplied from the generator, there is no shock hazard due to the lack of a current path through earth back to the power source. It is important to know whether or not the neutral is connected to the frame of the generator so that the generator can be connected correctly for safe operation. A related change in Section 445.11 of the 2014 *NEC* requires the manufacturer to mark the generator denoting whether the generator winding is bonded to the generator frame.

This expands the 2011 Code change that required GFCI protection where these portable generators were used for temporary wiring, except that the GFCI requirements in 590.6(A)(3) also include 125-volt, 30-amp receptacles and 125/250-volt receptacles.

Summary

For generators manufactured beginning January 1, 2015, all 125-volt, single-phase, 15- and 20-amp receptacles that are part of 15-kW or smaller portable generators shall be provided with GFCI protection for personnel integral to the generator or receptacle, unless these receptacles are not available (switched off) when the generator's 125/250-volt receptacle is being used. This requirement shall not apply if the generator does not have a 125/250-volt locking-type receptacle.

125/250-volt locking-type receptacle

No GFCI protection is provided.

Receptacles cannot be switched off.

This generator is exempt from these new requirements ("grandfathered") because of the date of manufacture.

Application Question

T F Where a portable generator less than 15 kW is used for temporary power on a construction site, 125-volt, single-phase, 15- and 20-amp receptacles on the generator are not required to be GFCI protected. (The generator is not equipped with a 125/250-volt receptacle. The generator was manufactured after January 1, 2011.)

Answer

False. All 125-volt, single-phase, 15- and 20-amp receptacles that are part of 15-kW or smaller portable generators used for temporary power are required to be GFCI protected by Section 590.6(A)(3). Listed cord sets or devices incorporating listed GFCI protection identified for portable use are permitted for use with 15-kW or smaller portable generators manufactured or remanufactured prior to January 1, 2011. This section has not changed in the 2014 *NEC*. It is noteworthy that where the frame of a generator is bonded to the neutral and earthed with a suitable ground rod, a malfunctioning/failed GFCI receptacle on the generator will pose more of a safety hazard to persons than a floating neutral generator with non-GFCI receptacles. With a floating neutral generator, two faults (a fault on each side of the winding with one side faulted to the frame) are necessary for a shock hazard to be present, but the voltage might be 240 volts.

Grounding – Dry-Type Transformer Enclosures

Significance

The Code contains new requirements and guidance for the connection of grounding and bonding conductors within transformer enclosures.

Analysis

Occasionally, inspectors will see electrical connections made to the metal grille or grating at the bottom of transformer enclosures. The grille shown in the photograph below will not easily accommodate connections, but other grilles might. The Code change states that where separate equipment grounding conductors and supply-side bonding jumpers are installed, a terminal bar for the connection of all grounding and bonding conductors shall be secured inside the transformer enclosure. The terminal bar shall be bonded to the enclosure in accordance with 250.12 and shall not be installed on or over any vented portion of the enclosure. This will help to ensure proper transformer ventilation. Also, these metal grilles have not been evaluated as grounding and bonding equipment and are not suitable as a fault current path. The connections within the base of the transformer pictured are acceptable, since the metal grille is not used for connections and the connections are located suitably above the grille. Lug kits are available for these grounding and bonding connections. There is an exception for transformers with leads rather than terminals.

There are no electrical connections made to or on the metal grille, and ventilation is not hindered by electrical connections.

Bottom view of a dry-type transformer mounted on a wall and supported by brackets

Summary

Where separate equipment grounding conductors and supply-side bonding jumpers are installed, a terminal bar for the connection of all grounding and bonding conductors shall be secured inside the transformer enclosure. The terminal bar shall be bonded to the enclosure in accordance with 250.12 and shall not be installed on or over any vented portion of the enclosure.

Application Question: What are the requirements of 250.12?

Answer: Section 250.12, Clean Surfaces, requires nonconductive coatings (such as paint, lacquer, and enamel) to be removed from threads and other contact surfaces of equipment to be grounded to ensure good electrical continuity, unless the means of connection make it unnecessary to remove such coatings.

Marking – Source Marking

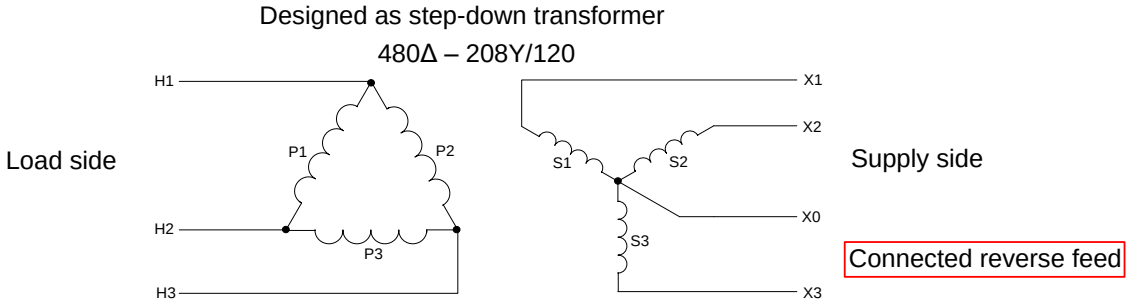
Significance

A new subsection has been added to 450.11 clarifying that it may be permissible to reverse feed (or back feed) a transformer.

Analysis

Perhaps the most common polyphase transformer in use is a step-down, 480-volt, delta-connected primary to a 208/120-volt, wye-connected secondary. A 3-phase transformer that steps up from 208-V to 480-V may not be as readily available as the common step-down transformer. Section 450.11(B) permits a transformer to be supplied at the marked secondary voltage provided the installation is in accordance with the manufacturer's instructions.

When a transformer is reverse fed, there are several factors that must be considered. A transformer is constructed for either a step-up or step-down function, having its primary and secondary winding impedances specifically designed for the purpose. When a secondary winding is supplied (becomes the primary), the value of the magnetizing inrush current will be very high, and an overcurrent protective device that will not trip upon energization must be sized in accordance with 450.3. Where primary taps and compensating windings are present, tap adjustments must be considered. Transformer grounding is also a concern. The neutral point of the wye-connected primary must not be grounded and must not be bonded to the transformer enclosure. A fan cooled transformer (general-purpose specialty transformer) cannot be reverse fed due to UL regulations.



Summary

A transformer is permitted to be supplied at the marked secondary voltage (reverse fed) provided the installation is in accordance with the manufacturer's instructions.

Application Question

Should the neutral point of the wye connection for the reverse fed transformer in the diagram above be grounded as a separately derived system?

Answer

No. The wye-connected supply side is not a separately derived system. The delta-connected side does constitute a separately derived system. The delta should be corner grounded (B phase).

Article 480 – Storage Batteries

Significance

Changes to this article involve accessibility to battery terminals, working space about battery systems, egress from battery rooms, and illumination of spaces containing battery systems.

Analysis

New subsection 480.8(C) requires that the terminals of all cells or multi-cell units be readily accessible for readings, inspection, and cleaning where required by the equipment design. One side of transparent battery containers shall be readily accessible for inspection of the internal components.

Subsection 480.9(C) has been expanded to provide side clearance for cell containers. For battery racks, a minimum clearance of 1 in. is required between containers and any wall or structure on the side not requiring maintenance. New subsection (D) has been added to address working space around top terminal batteries. Where top terminal batteries are installed on tiered racks, working space in accordance with the battery manufacturer's instructions shall be provided between the highest point on a cell and the ceiling or battery row above. As in the previous Code, working spaces about battery systems shall also comply with 110.26.

Courtesy of ACRAN Spill Containment Inc.

New subsection 480.9(E) requires that personnel doors intended for entrance to, and egress from, designated battery rooms open in the direction of egress and be equipped with listed panic hardware.

Illumination requirements are set forth in new subsection 480.9(G). Illumination shall be provided for working spaces containing battery systems. The lighting outlets are not permitted to be controlled by automatic means only. If the work space is illuminated by an adjacent light source, additional lighting outlets shall not be required. The location of luminaires shall not:

(1) Expose personnel to energized battery components while performing maintenance on the luminaires in the battery space; or
(2) Create a hazard to the battery upon failure of a luminaire.

Summary

The terminals of all cells shall be readily accessible. A minimum side clearance of 1 in. shall be maintained between a cell container and any wall or structure. Top terminal batteries require vertical working space in accordance with the battery manufacturer's instructions. Doors in battery rooms shall open in the direction of egress and be equipped with listed panic hardware. Illumination shall be provided for working spaces containing battery systems, with specific rules for locating luminaires.

General Care Areas – Patient Bed Location – Patient Bed Location Receptacles

Significance

Several changes have been made in the 2014 *NEC* to harmonize with NFPA 99, *Health Care Facilities Code*. One significant change is the increase in required receptacles at patient bed locations.

Analysis

The number of required receptacles at patient bed locations in general care areas has increased from four to eight "hospital grade" receptacles. As in the previous Code, the receptacles are permitted to be of the single, duplex, or quadruplex type, or any combination of the three. Also, to harmonize with NFPA 99, the term *emergency system* is no longer used in Article 517. Instead of being considered branches of the emergency system, the life safety branch and the critical branch are branches of the essential electrical system.

One or more branch circuits supplying patient bed locations in general care areas shall be from the normal system and one or more branch circuits shall be from the *critical branch* (rather than from the *emergency system*). The receptacles or cover plates of receptacles supplied from the critical branch(s) shall have a distinctive color or marking so as to be readily identifiable and shall also indicate the panelboard and branch circuit number supplying them. This is an existing requirement for patient bed locations in critical care areas.

Summary

The minimum number of receptacles required at patient bed locations in general care areas has been increased from four to eight.

Application Question

T F A patient bed location with four duplex receptacles satisfies the *NEC* requirement in 517.18 for the minimum number of required receptacles.

Answer

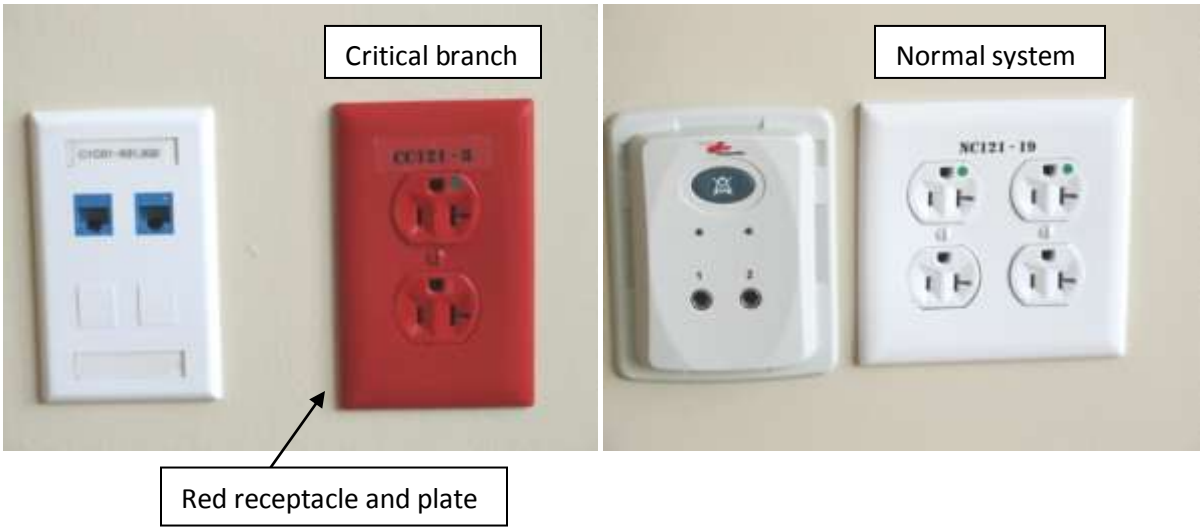
True. A receptacle is a contact device. A duplex receptacle consists of two contact devices. See the definition of *receptacle* in Article 100.

Code Refresher

- ✓ 517.13 – Redundant grounding is required in patient care areas of health care facilities. To accomplish this, the wiring method must be a metal raceway system or a cable having a metallic armor or sheath that qualifies as an equipment grounding conductor in accordance with 250.118. The redundant grounding requirement applies also to patient care areas in nursing homes, clinics, medical and dental exam rooms, therapy areas, and similar rooms or areas where electrical equipment is used in the treatment of patients. An example of where the requirement does not apply is a physiologist's office where counseling is given.

Patient Bed Location

General Care Areas: Minimum of eight receptacles required
Critical Care Areas: Minimum of fourteen receptacles required



For patient bed locations in general care areas, the receptacles or cover plates of receptacles supplied from the critical branch(s) shall have a distinctive color or marking so as to be readily identifiable and shall also indicate the panelboard and branch circuit number supplying them. This is an existing requirement for patient bed locations in critical care areas.

Critical Care Areas – Patient Bed Location Branch Circuits – Patient Bed Location Receptacles

Significance

In order to harmonize with NFPA 99, *Health Care Facilities Code*, the number of required receptacles at patient bed locations in critical care areas has been increased from eight to fourteen.

Analysis

As stated in the analysis of changes to 517.18, the term *emergency system* is no longer used in Article 517. The three branches of the essential electrical system are the equipment branch, the life safety branch, and the critical branch.

One or more branch circuits supplying patient bed locations in critical care areas shall be from the normal system and one or more branch circuits shall be from the critical branch. The receptacles must be listed "hospital grade" and so identified.

The minimum number of receptacles required at patient bed locations in critical care areas has increased from eight to fourteen. At least one of the receptacles shall be connected to either:

1) A normal system branch circuit, or
2) A critical branch circuit supplied by a different transfer switch than the other receptacles at the same patient bed location.

The receptacles are permitted to be of the single, duplex, or quadruplex type, or any combination of the three.

Summary

The minimum number of receptacles required at patient bed locations in critical care areas has increased from eight to fourteen.

Application Question

T F All receptacles at a patient bed location in a critical care area are permitted to be supplied from the critical branch to enhance reliability of electric supply.

Answer

True, with conditions. All receptacles are permitted to be supplied from the critical branch, provided that at least one circuit is supplied from a different transfer switch than the other receptacles. If all circuits are supplied from the same transfer switch, there is more potential hazard than where the circuits are supplied from the normal system and the critical branch. If all receptacles are supplied from the critical branch and connected to the same transfer switch, a malfunction of the transfer switch (e.g., not reconnecting to normal power after a generator test) will leave the bed location with no power.

Critical Care Areas – Operating Room Receptacles

Significance

This is a new subsection that contains requirements for operating room receptacles. It is intended to coordinate *NEC* requirements with requirements of NFPA 99.

Analysis

This new section requires that there be a minimum of thirty-six receptacles in operating rooms of health care facilities. As is the case for patient bed locations, the receptacles are permitted to be of the single, duplex, or quadruplex type, or any combination of the three.

At least twelve of the receptacles shall be supplied from either:

1) The normal system branch circuit required in 517.19(A), or
2) A critical branch circuit supplied from a different transfer switch than the other receptacles at the same location.

The receptacles shall be listed "hospital grade" and be so identified. The grounding terminal of each receptacle shall be connected to the reference grounding point by an insulated copper equipment grounding conductor. The reference grounding point is the ground bus of the panelboard or isolated power system panel supplying the patient care space (*patient care area* in the 2011 *NEC*).

Summary

Each operating room shall be equipped with a minimum of thirty-six receptacles, at least twelve of which shall be supplied from a normal circuit or a critical circuit connected to a different transfer switch than the other receptacles at the same location.

Application Question

T F At least twelve operating room receptacles must be connected to a normal circuit.

Answer

False. In lieu of one or more normal circuits, all operating room receptacles are permitted to be connected to the critical branch, provided that at least twelve are supplied from a separate transfer switch than the other receptacles at the same location.

Code Refresher

- ✓ The requirement for "hospital grade" receptacles in general care and critical care areas is not retroactive. They are required to be installed when receptacles are being replaced in locations where the present Code mandates hospital grade receptacles, and where there is a modification of building use or renovation of a health care facility.

More on Health Care Facilities

In addition to the *NEC,* some of the other standards that designers of health care facilities will need to consult are NFPA 72, *National Fire Alarm Code*; NFPA 99, *Health Care Facilities Code*; NFPA 101, *Life Safety Code*; and NFPA 110, *Standard for Emergency and Standby Power Systems*. Important design information concerning classification of essential electrical systems can be found in NFPA 99 and NFPA 110.

Essential Electrical Systems for Hospitals – Coordination

Significance

Selective coordination of overcurrent protective devices serving essential electrical systems in hospitals is no longer required. Instead, *coordination* is required.

Analysis

Selective coordination involves the selection and application of overcurrent protective devices, for the full range of overcurrents and opening times, such that only the upstream overcurrent device closest to a fault or overload condition will open. This minimizes interruption of power and localizes the outage.

Section 517.26 requires that the life safety branch meet the requirements of Article 700 – Emergency Systems, except as amended by Article 517. Section 700.28 requires that emergency system overcurrent devices be selectively coordinated with all supply-side overcurrent protective devices. Section 517.30(G) effectively amends this requirement.

As a result of the Task Group 2014 NEC/2012 NFPA 99 Correlation efforts, selective coordination of overcurrent devices for hospital essential electrical systems has undergone a significant change. Rather than a fully coordinated system, overcurrent protective devices serving the essential electrical system shall be coordinated for the period of time that a fault's duration extends beyond 0.1 second. This coordination does not cover the full range of overcurrent conditions. The 0.1 second at 60 Hz is equivalent to six cycles. Faster clearing times can be accomplished, particularly with the use of fuses. This could be seen as a relaxation of standards, since many systems have been successfully coordinated at 100% (total coordination). Total coordination is synonymous with selective coordination. Other systems in the Code still require selective coordination rather than coordination.

By exception, coordination is not required between transformer primary and secondary overcurrent protective devices, where there is only one overcurrent device or set of overcurrent protective devices on the transformer secondary. A second exception to the rule is where overcurrent devices of the same ampere rating are connected in series.

In the 2014 *NEC*, the essential electrical system does not consist of an emergency system and an equipment system. Instead, the essential electrical system consists of three branches: the life safety branch, the critical branch, and the equipment branch (equipment *system* in the 2011 *NEC*). The life safety branch and the critical branch are no longer referred to as components of an emergency system. Since the equipment branch is part of the essential electrical system, this new Code section requires coordination of the overcurrent protection for the equipment branch also.

Summary

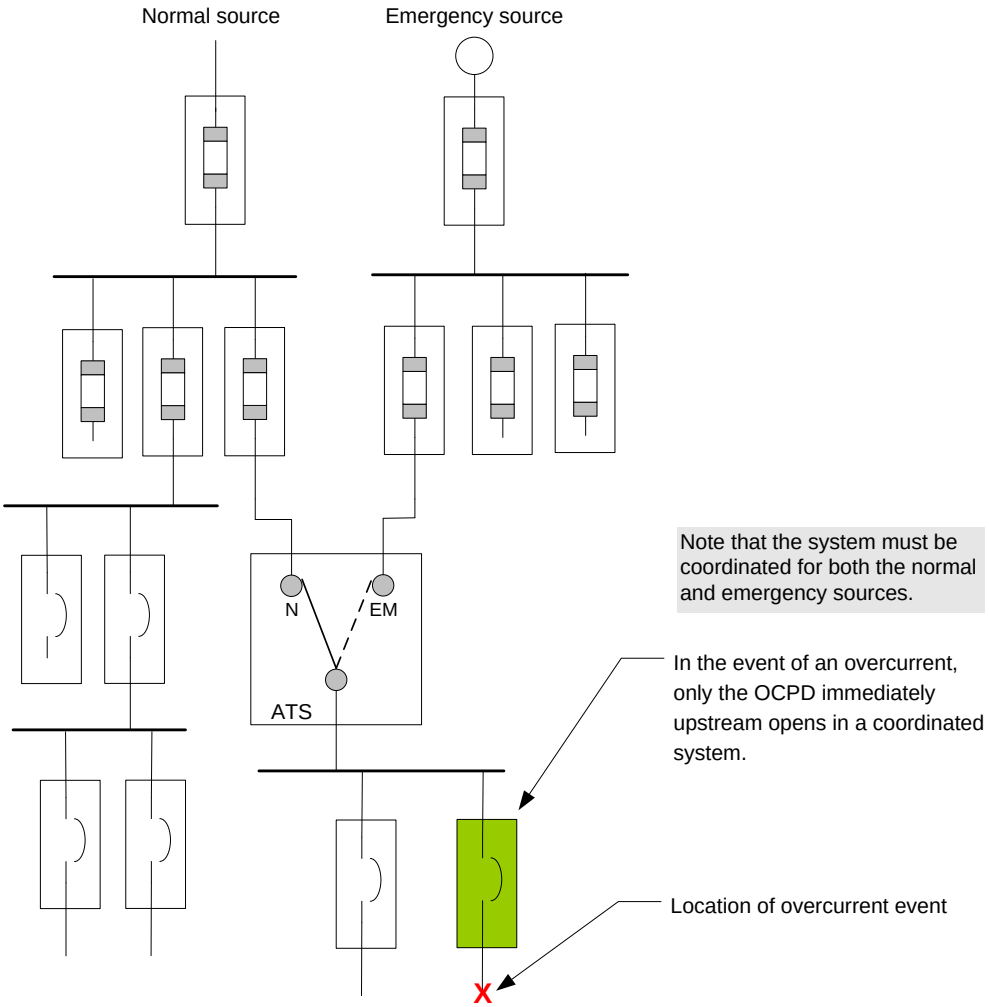
Overcurrent protective devices serving the essential electrical system in hospitals shall be coordinated for the period of time that a fault's duration extends beyond 0.1 second.

Application Question

T F The coordination of overcurrent protective devices required in this section is applicable to essential circuits only when supplied by the emergency source.

Answer

False. Coordination between overcurrent protective devices must be accomplished for both the normal and emergency power sources. The essential branches for which coordination is required are supplied by both the normal and emergency sources.



For essential electrical systems in hospitals, coordination of overcurrent protective devices is required after 0.1 second of the onset of an overcurrent.

Code Refresher

- ✓ 517.17 – Where a second level of ground-fault protection of equipment (GFPE) is applied as required in 517.17(B), the *selectivity* required by 517.17(C) must be considered in the overall coordination of overcurrent protective devices for essential electrical systems. The GFPE coordination must be *fully* selective. The requirement for the next level of GFPE protection is not based on the feeder circuit rating, since the function of the device is to provide selectivity between the feeder and service overcurrent protective devices.

547.5(F) Wiring Methods – Separate Equipment Grounding Conductor
555.15(B) Grounding – Type of Equipment Grounding Conductor

Significance
The long-standing prohibition against aluminum equipment grounding conductors for wiring in and about agricultural buildings and marinas and boatyards has been lifted.

Analysis
The requirement for a copper equipment grounding conductor (EGC) for wiring in and about agricultural buildings first appeared in the 1987 *NEC*. The intent was to improve the longevity of EGCs in the harsh, corrosive, and often wet locations associated with many agricultural buildings. Metal raceways were not permitted to serve as the required EGC. Interestingly, in Section 310.14 of the same Code edition, the *NEC* first required aluminum conductors to be constructed of an AA-8000 series electrical grade aluminum alloy. Along with improved testing of termination equipment for aluminum conductors, the modified properties of aluminum building wire have enabled good performance of aluminum wiring in agricultural settings. Analysis of the conductor's exposure to common corrosive gases found in agricultural settings has shown that aluminum conductors generally perform well and are suitable for these environments.

Note: Aluminum EGCs shall not be terminated within 18" of the earth [250.120(B)].

Both copper and aluminum equipment grounding conductors are permitted for agricultural buildings and marinas.

Article 555 covers wiring and equipment in and about public and private facilities for docking, repair, storage, and fueling of small watercraft (not exceeding 300 tons). Private facilities associated with a single-family dwelling are not within the scope of this article. For about a half century, copper EGCs have been required for circuits in and about marinas and boatyards. However, decades of aluminum wire use for phase and neutral conductors exposed to the corrosive conditions associated with these locations has shown satisfactory operation in both fresh and salt water environments. An aluminum conductor exposed to air will become coated with a nonconductive film of aluminum oxide that will serve to slow or inhibit corrosion. Terminations are important, particularly where cables are attached to floating (movable) piers.

Summary: Aluminum EGCs are now permitted for wiring in and about agricultural buildings and marinas and boatyards. Where installed underground in agricultural locations, the EGC shall be insulated or covered. In marinas and boatyards, the EGC shall be insulated.

Application Question: Are aluminum or other metal raceways now permitted as EGCs?

Answer: No. For Article 547 and Article 555 locations, wire-type EGCs are required.

Part VI. Recreational Vehicle Parks – Type Receptacles Provided

Significance

Additional 30-ampere, 125-volt receptacles at recreational vehicle sites are now required. This change will enhance safety by reducing the use of adapter cords.

Analysis

Existing Code requires at least 20% of electrified sites to be equipped with a 50-ampere, 125/250-volt receptacle. The 2014 *NEC* requires that these 50-A sites also be equipped with a 30-ampere, 125-volt receptacle. The revised receptacle provisions/distribution can be summarized as follows:

- All sites with electric power shall be equipped with at least one 20-A, 125-V receptacle.
- At least 70% of sites with electric power shall be equipped with a 20-A, 125-V receptacle and a 30-A, 125-V receptacle.
- At least 20% of sites with electric power shall be equipped with a 20-A, 125-V receptacle; a 30-A, 125-V receptacle; and a 50-A, 125/250-V receptacle.
- Any electrified site may provide additional receptacles of any of the three types specified.
- Tent sites with 15- or 20-A receptacles need not be included in the percentage distribution.

The recreational vehicle (RV) power panel below meets the requirements for the minimum 20% of sites equipped with 30- and 50-A receptacles—and the requirements for any site. Note the 30-A, 125-V configuration is a specific purpose configuration for travel trailers (NEMA TT-30R).

Summary

Every RV site equipped with a 50-A, 125/250-V receptacle shall also provide a 30-A, 125-V receptacle.

Application Question

Plans for a new RV park include 25 dedicated tent sites, 10 sites with a 20-A, 125-V receptacle. There will be 100 additional RV sites, 90 of which will be electrified. What are the minimum requirements in terms of receptacle types at the sites?

Answer

The dedicated tent sites are not considered in the percentage distribution of receptacle types. All 90 electrified sites shall have a 20-A, 125-V receptacle. At least 18 sites shall be provided with a 20-A and a 30-A, 125-V receptacle, along with a 50-A, 125/250-V receptacle. At least 63 sites shall be provided with a 20-A and a 30-A, 125-volt receptacle. These 63 sites may or may not also provide a 50-A receptacle. So, only 45 more sites equipped with 30-A are required (63 – 18 = 45).

Code Refresher

- ✓ 551.73 – Electrical service and feeder loads shall be based on 9600 VA per site equipped with a 50-A receptacle, 3600 VA for sites with both 20- and 30-A receptacles, and 2400 VA for sites with only a 20-A receptacle. The load for tent sites equipped with only a 20-A receptacle shall be 600 VA/site. The demand factors in Table 551.73(A) shall apply.
- ✓ 551.73(D) – The minimum ampacity for feeder conductors for RV sites is 30 A.

General – Termination(s) at Devices – Support

Significance

This change seeks to align with OSHA regulations. It will afford a greater level of safety in the construction environment where temporary electrical power is used.

Analysis

It is not uncommon to find feeder and branch-circuit cables on the ground or on the floor at constructions sites. These environments are often wet. Cables on walking surfaces pose a tripping hazard and are not afforded suitable protection from damage. Language added to 590.4(J) states that cable assemblies and flexible cords and cables installed as branch circuits or feeders shall not be installed on the floor or on the ground. Extensions cords are exempt from this requirement, since these cords are designed and suitable for this purpose. GFCI protection is provided where extension cords are used.

A separate change in subsection (I) pertains to flexible cords and cables entering enclosures containing devices that require termination. The cords and cables shall be secured to boxes with fittings "listed for connecting flexible cords and cables to boxes…." The previous language was "fittings designed for the purpose," which is essentially the definition of *identified*. A *listed* fitting will provide a higher degree of suitability. This will help to prevent any connector that will "fit" on a cable from being used. The connector/fitting should keep the cable secured and protected. This will keep terminations tight and reduce the possibility of having exposed conductors or short circuits caused by damaged conductors.

Temporary Power Distribution System
Courtesy of Hubbell Incorporated
Hubbell Wiring Device – Kellems

OSHA-Approved Lighting String
Courtesy of Precision Lighting

Feeder and branch-circuit cables used for temporary wiring are not permitted on floors or on the ground.

Summary

For temporary wiring installations, cable assemblies and flexible cords and cables installed as branch circuits or feeders shall not be installed on the floor or on the ground. Flexible cords and cables entering enclosures containing devices that require termination shall be secured to the boxes with fittings listed for connecting flexible cords and cables to boxes.

Application Question

Is a remodeling project where temporary wiring is used subject to the rules in Article 590?

Answer

Yes. This article applies to temporary electrical installations used during the period of construction, remodeling, maintenance, repair, or demolition of buildings, structures, equipment, or similar activities.

Disconnects – Location – At Point of Entry to a Sign Enclosure

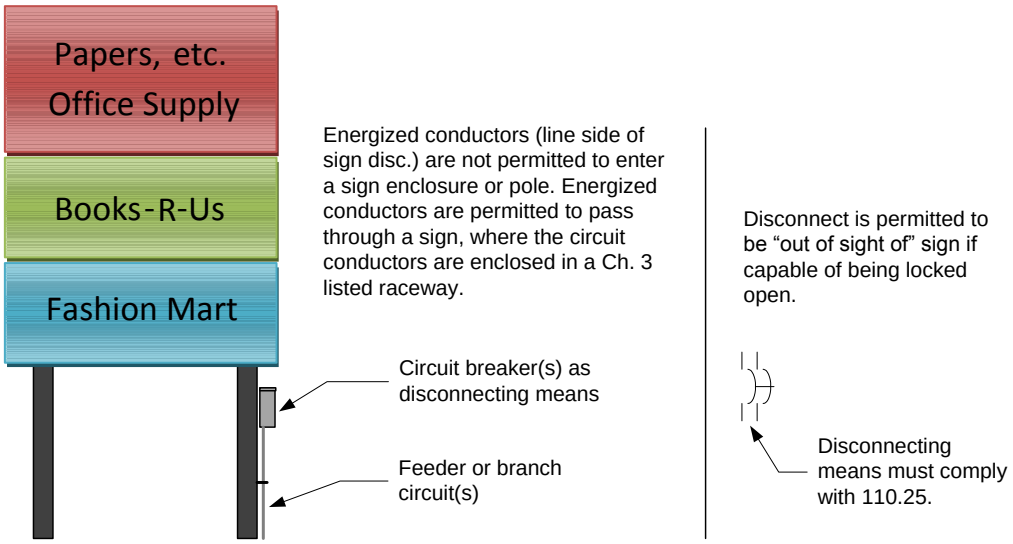
Significance

This change will reduce the risk of persons contacting energized conductors within a sign.

Analysis

As with the existing Code, the 2014 *NEC* permits the disconnecting means for a sign (or outline lighting) to be at the sign, within sight of the sign, or out of sight of the sign if lockable in the off position. Some signs have the disconnecting means mounted on the sign enclosure or support pole. Where the disconnecting means is at the sign, a new subsection requires the disconnect to be located at the point where the supply circuit(s) enters the sign enclosure or pole. Conductors on the line side of the disconnecting means are not permitted to enter the sign enclosure or pole to run to an internal disconnect switch or to an externally operable switch. An exception allows circuit conductors to pass through a sign without complying with the disconnect requirement, where the circuit conductors are enclosed in a Chapter 3 listed raceway.

This rule applies to all types of electric sign and outline lighting installations (conductors, equipment, and field wiring) within the scope of Article 600. Article 600 covers the use of traditional lighting sources, neon tubing, and light-emitting diodes (LEDs). The rule applies to signs installed on buildings, poles, and other structures, and includes portable signs.



Summary

Where a sign disconnecting means is at the sign, the disconnect shall be located at the point where the feeder or branch circuit(s) enters the sign enclosure or pole and shall disconnect all wiring where it enters the enclosure of the sign or pole. A disconnect at the point conductors enter a sign is not required for conductors enclosed in a Chapter 3 listed raceway that passes through the sign.

Application Question: Are the supply conductors for a sign permitted to emerge from the ground inside of the sign pole?

Answer: This is permissible only where the required disconnect is located other than at the sign.

Modular Data Centers

Significance

Existing Article 645 – Information Technology Equipment is not applicable to equipment that does not meet all of the conditions listed in 645.4. Generally, Modular Data Centers (MDCs) are factory wired. The unique construction and broad range of sizes and types of MDCs requires clear direction for the application of existing *Code* rules and new requirements for safe electrical installation of MDCs.

Analysis

Many MDCs are not considered ITE rooms, which, among other reasons, set these data centers outside the scope of Article 645. Modular Data Centers, sometimes referred to as Containerized Data Centers, are prefabricated equipment enclosures or structures that contain information technology equipment (ITE) and related power, UPS (uninterruptible power supply) systems, HVAC (heating, ventilation, and air-conditioning) systems, monitoring equipment, etc. All equipment can be located within the same module or related equipment may be located in an adjacent separate module or structure. MDCs are intended for fixed installation either indoors or outdoors.

An approved disconnecting means in accordance with 645.10 is required for disconnection of the IT equipment. A similar approved disconnecting means is required to disconnect HVAC equipment serving the MDC, which shall also cause all required fire/smoke dampers to close. For MDCs that are listed and labeled, only compliance with Sections 646.5 through 646.9 is required, in addition to the requirement for disconnecting means (see 646.4). Otherwise, all provisions of the article must be complied with, including specific requirements for illumination, emergency illumination, receptacles, work space, egress, and other requirements.

Much of the article directs the *Code* user to applicable sections of existing articles for application in MDCs. Flexible power cords are not permitted for connection to external power sources but may be used for connection between modules. Generally, working space requirements must be in accordance with 110.26, with some less restrictive rules for working space about IT equipment where the voltage of live parts exposed for servicing is limited to 30 volts rms or 60 volts dc.

Summary

New Article 646 – Modular Data Centers contains requirements for prefabricated structures or enclosures that house IT equipment and related systems such as power, back-up power, HVAC, and others. The article contains specific new requirements and directs *Code* uses to applicable existing requirements in other articles.

Application Question

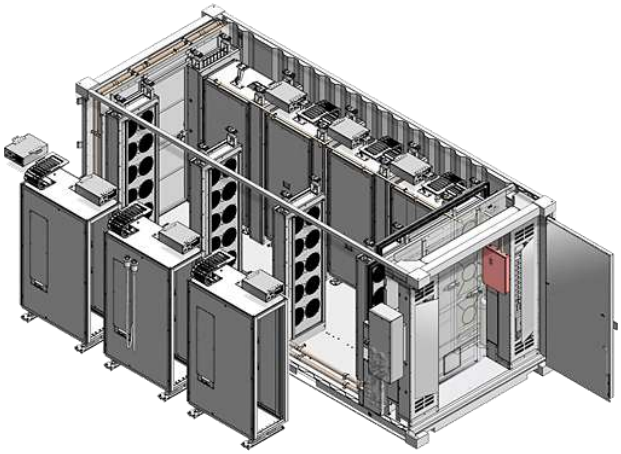
T F The portability of MDCs requires that flexible power cables be used for service or feeder conductors to supply MDCs from external power sources.

Answer

False. Flexible power cables are not permitted for this use. However, where not subject to physical damage, extra-hard usage cords may be run between MDC enclosures, e.g., from an ITE enclosure to an adjacent enclosure housing HVAC equipment for the ITE. MDCs are intended for fixed installation rather than as portable equipment.

Indoor MDC

Courtesy of Mainline Computer Products, Inc.



Cut view of portable data center inside shipping container

- 20’ x 8’ shipping container
- 7 racks (6 racks with a total of 240 rack units available for servers)

Courtesy of Sun Microsystems, Inc. and Data Center Professionals.net

Electric service for outdoor (container) MDC

Courtesy of Sun Microsystems, Inc. and PRWeb

Part II. Permanently Installed Pools – Lighting, Receptacles, and Equipment – Luminaires, Lighting Outlets, and Ceiling-Suspended (Paddle) Fans – Low-Voltage Luminaires

Significance

This new subsection permits qualifying low-voltage luminaires (e.g., site lighting) to be installed around pools less than 5 ft from the inside walls of the pool.

Analysis

In previous Codes, no luminaire could be installed within 5 ft horizontally of the inside walls of a pool unless the luminaire was located significantly above the surface of the maximum water level (5 ft to 12 ft above the water level, depending on the installation). Article 411 lighting systems (30 volts maximum or connected to a Class 2 power source) could not be installed within 10 ft of pools, unless permitted by Article 680 [see 411.4(B)]. The *low voltage contact limit* introduced in the 2011 *NEC* in 680.2 is key to this new permission. The contact limit replaced the long standing 15-volt AC threshold because of the need to address new technology luminaires operating on DC and nonsinusoidal wave forms. The AC and DC voltage limits establish a safe voltage level for circuit operation. Qualifying luminaires must have a voltage rating in accordance with the low voltage contact limit in 680.2 and be supplied from a power source meeting the isolation requirements for swimming pool lighting in 680.23(A)(2). Low-voltage landscape lighting power units complying with UL 1838 that are marked "For Use with Submersible Fixtures" meet the isolation requirements in 680.23(A)(2) and comply with the low voltage contact limit.

Qualifying low-voltage lighting is permitted to be located within 5 ft of the inside walls of a pool.

Summary

Listed low-voltage luminaires not requiring grounding and not exceeding the low voltage contact limit shall be permitted to be located less than 5 ft from the inside walls of a pool. The luminaires shall be supplied by a listed transformer or power supply of the isolated winding type or that incorporates a system of double insulation between the primary and secondary windings in accordance with 680.23(A)(2).

Application Question: What is the low voltage contact limit set forth in 680.2?

Answer: A voltage not exceeding the following values:

(1) 15 volts (RMS) for sinusoidal ac
(2) 21.2 volts peak for nonsinusoidal ac
(3) 30 volts for continuous dc
(4) 12.4 volts peak for dc that is interrupted at a rate of 10 to 200 Hz

Part IV. Spas and Hot Tubs – Outdoor Installations – (B) Bonding – (C) Interior Wiring to Outdoor Installations

Significance

This change appropriately exempts certain outdoor spas and hot tubs from the perimeter bonding requirement. The change began as a Tentative Interim Amendment (TIA 11-1) to the 2011 *NEC* issued by the Standards Council on March 1, 2011 with an effective date of March 21, 2011.

Analysis

A TIA is tentative because it has not been processed through the entire standards-making process. It is interim because it is only effective until the next edition of the Code (2014). It automatically becomes a proposal for the 2014 *NEC*. The interim amendment exempted outdoor installations of listed self-contained hot tubs and spas from the requirement for equipotential bonding of perimeter surfaces in 680.26(B)(2), provided the installation met certain requirements. The amendment has been revised and accepted into the 2014 *NEC*. Equipotential bonding of perimeter surfaces shall not be required where all of the following conditions apply:

(1) The spa or hot tub shall be listed as a self-contained spa for aboveground use.
(2) The spa or hot tub shall not be identified as suitable only for indoor use.
(3) The installation shall be located on or above grade and comply with the manufacturer's instructions.
(4) The top rim of the spa or hot tub shall be at least 28 in. above all perimeter surfaces that are within 30 in. horizontally from the spa or hot tub. The height of nonconductive external steps for access to the spa or tub shall not affect the rim height measurement.

The revision will provide relief for homeowners and guidance for contactors and inspectors where a spa or hot tub is intended to be installed at an outdoor location, such as on a stone patio or other finished surface, where it is not feasible to install perimeter bonding. The change recognizes the different safety needs of permanently installed, custom spas or hot tubs and listed self-contained portable units. This is in harmony with existing Code that exempts storable pools and listed self-contained spas or hot tubs installed indoors from the perimeter bonding requirement.

Outdoor installations of self-contained spas or hot tubs where perimeter bonding is not required for listed units

Summary

Perimeter equipotential bonding is not required for self-contained spas or hot tubs that are indoor/outdoor rated and listed according to UL 1563 standards.

Also, 680.42(C) now permits any Chapter 3 wiring method (with a min. 12 AWG copper EGC that is insulated or within an overall jacket) to be used in the interior of any dwelling unit or associated building for the supply to an outdoor spa or hot tub. Previously, this was only permitted for one-family dwellings. Specific wiring methods are still required for underwater luminaires.

Application Question: Is equipot. bonding of perimeter surfaces required for in-ground spas?
Answer: Yes. An in-ground spa does not meet the conditions in 680.42(B).

Rapid Shutdown of PV Systems on Buildings

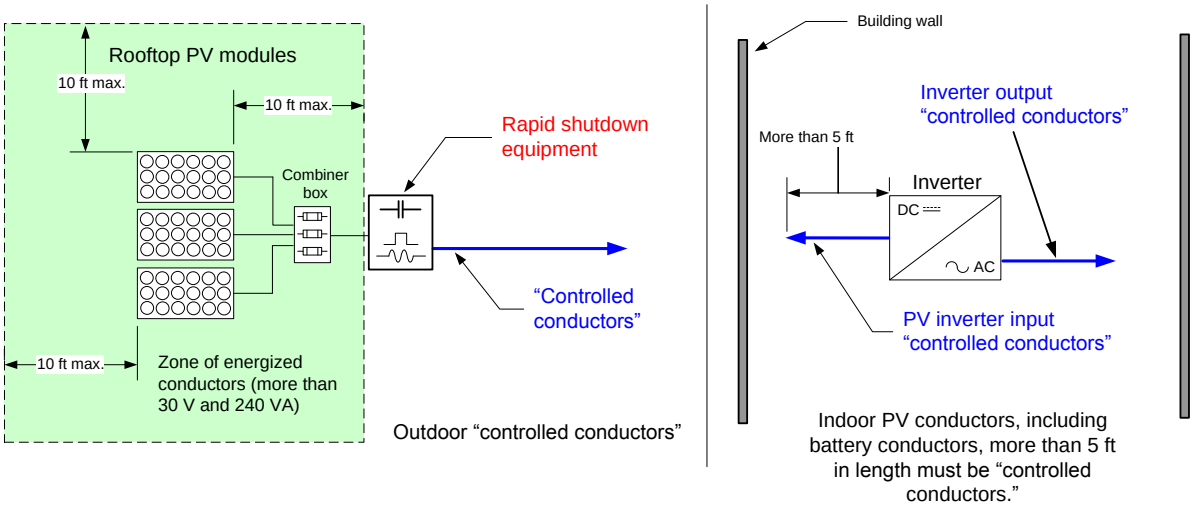
Significance

Provisions are now required for the rapid shutdown of PV circuits for the safety of first responders/firefighters.

Analysis

The Code seeks to establish safe circuits ("controlled conductors" that are touch safe) for the portion of conductors more than 10 ft from a PV array and for conductors that are more than 5 ft in length installed inside of buildings and associated with PV systems. This applies to all PV output conductors, inverter inputs, inverter outputs, and energy storage (battery) circuits. The controlled conductors shall be limited to not more than 30 volts and 240 volt-amperes within 10 seconds of rapid shutdown initiation. The 10 seconds will allow dc-side capacitor banks to discharge by means other than contactors and shunt-trip devices. The rapid shutdown equipment/hardware shall be listed and identified as suitable for the purpose.

Voltage and power shall be measured between any two conductors and between any conductor and ground. The rapid shutdown initiation methods shall be labeled in accordance with 690.56(B), which requires a permanent plaque or directory showing the location of the service disconnect and the PV system disconnect if not installed at the same location. Ideally, the service disconnect and the required PV system disconnect would be located outdoors adjacent to one another.



This new *NEC* section does not contain prescriptive requirements. Existing section 690.13 requires the PV disconnecting means to be installed at a readily accessible location on the outside of a building or inside nearest the point of entrance of the system conductors. The diagram below shows the required PV system disconnect adjacent to the service disconnect.

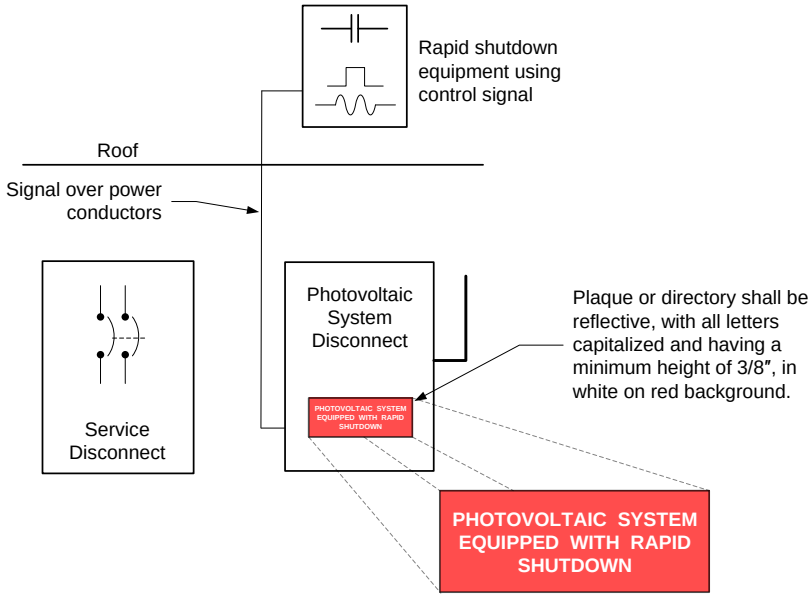
Some methods of accomplishing the emergency shutdown currently exist and other solutions will evolve within the solar industry. Modules with micro-inverters are an easy solution, since modules will shut down on loss of utility power. For systems that use an inverter for a string or array, loss of utility power will shut down the inverter output, but source circuits will remain

energized. The required readily accessible PV system disconnect will not shut down dc output circuits on roofs; rather, the modules will continue to generate power during daylight hours. "Power optimizers" could be used on each module and would limit module output to 1 volt upon loss of a signal from the inverter. Also, tenKsolar's RAIS® Wave system can electronically control output at the module level when a disconnect is opened.

New section 690.56(C) requires that buildings with both a utility service and a PV system have a permanent plaque or directory including the following wording:

PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN

The plaque or directory shall be reflective, with all letters capitalized and a minimum of 3/8 in. high, in white on red background.



Summary

Rapid shutdown of PV circuits is required for the portion of conductors more than 10 ft from a PV array and for conductors that are more than 5 ft in length installed inside of buildings and associated with PV systems. This applies to all PV output conductors, inverter inputs, inverter outputs, and energy storage (battery) circuits. The "controlled conductors" shall be limited to not more than 30 volts and 240 volt-amperes within 10 seconds of rapid shutdown initiation. The rapid shutdown equipment/hardware shall be listed and identified as suitable for the purpose.

Application Question

T F PV system conductors within a building must be controlled conductors via rapid shutdown equipment if the conductors are longer than 5 ft from the point where the conductors penetrate the exterior wall.

Answer

True. However, the point of penetration of the outside wall is not significant. All indoor PV system related conductors more than 5 ft in length must be controlled conductors. This includes PV related conductors originating and terminating within the building, e.g., battery conductors.

Wind Electric Systems

Significance

The scope of Article 694 has changed and a new section has been added containing requirements for turbine shutdown.

Analysis

Article 694, Small Wind Electric Systems, was introduced in the 2011 *NEC* and contained installation requirements for wind generators up to and including 100 kW. This article now covers wind generators of any size that are within the scope of the *NEC* in 90.2, hence the change in the title of the article.

New Section 694.23 requires wind turbines to have a readily accessible manual shutdown button or switch. Operation of the switch shall result in a parked turbine state that shall either stop the turbine rotor or allow limited rotor speed combined with a means to de-energize the turbine output. A manual shutdown button or switch is not required for turbines with a swept area of less than 538 ft^2. The shutdown procedure shall be defined and posted at the location of a shutdown means and at the location of the turbine controller or disconnect, if the location is different.

Portion of foundation, and structure grounding for a 3 MW wind turbine

View of climbing tower inside a 3 MW wind turbine structure

All 125-V, 15- or 20-A receptacles installed for maintenance of a wind turbine are required to have 5-mA GFCI protection. Outdoor receptacles already require GFCI protection by 210.8(B), but this requirement will cover receptacles in towers and accessory buildings related to wind generators.

A turbine support pole or tower is permitted to be used as a raceway if evaluated as part of the listing of the wind turbine or otherwise listed or evaluated for the purpose.

Summary

Article 694 now covers all wind generators within the scope of the *NEC*—no longer limited to 100 kW or smaller. Provisions for manual shutdown are now required.

Application Question

A privately owned wind farm consisting of 1.6 MW turbines connects to the grid and sells energy to electric utilities. Is the installation covered by the *NEC*?

Answer

The field wiring for the turbines/structures, and perhaps the substation, is within the jurisdiction of the *NEC*. There will be an agreed to point of demarcation where the utility jurisdiction begins.

Surge Protection

Significance

Implementation of this rule could prevent damage to emergency power controls and critical electronic loads, thereby enhancing the reliability of emergency systems.

Analysis

This new section applies to emergency systems, which are legally required systems that automatically supply power to designated loads upon loss of normal power. The rule requires a listed surge-protective device (SPD) to be installed in or on all switchboards and panelboards supplying emergency systems. The intent of this rule is to enhance the reliability of emergency systems by mitigating potential damage from surges to electronic control and communications systems and sensitive loads. SPDs are currently required for power sources of Critical Operations Power Systems (COPS) in 708.20(D).

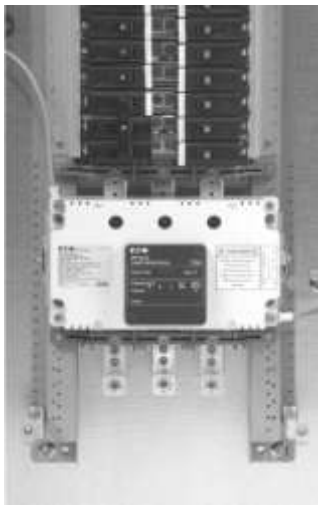


Photo shows SPD mounted directly to the panelboard's busbars.

SPD Series, Courtesy of Eaton Corporation
www.eaton.com/consultants

Section 700.8 does not specify the level of protection required, but guidelines for protection are available through several sources. One source is ANSI/IEEE C62.41, IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits. The consulting and specifying engineering community through the American Institute of Architects (AIA) has produced a MasterSpec document related to SPDs for low-voltage electrical power circuits. It references a protection level of 250 kA at service entrance locations. Section 4.18 of NFPA 780, *Standard for the Installation of Lightning Protection Systems*, contains prescriptive requirements for surge protection systems installed for electrical and communications systems, including protection levels. According to Section 4.18.3.1.2 of NFPA 780, SPDs at the service entrance shall have an I_{max} rating of at least 40 kA 8/20 µs per phase or a nominal discharge current (I_n) rating of at least 20 kA 8/20 µs per phase for the protection of electrical power circuits. The 8/20 µs terminology is a reference to the Combination Wave generator described in IEEE C62.41.2 used to simulate lightning induced transient activity. The combination wave is characterized by short duration, high-frequency 8-by-20 µs (maximum current in 8 µs and 50% of maximum after 20 µs) current and 1.2-by-50 µs voltage waveforms.

Summary

A listed SPD shall be installed in or on all emergency systems switchboards and panelboards.

Application Question: What Type of SPD is required for protection?

Answer

Section 700.8 does not specify the Type or level of protection. Consult Article 285, Surge-Protective Devices (SPDs), 1000 Volts or Less, for requirements on the use and installation of SPDs. The article contains rules for Type 1, Type 2, Type 3, and Type 4 SPDs, based on UL 1449.

Part IV. Emergency System Circuits for Lighting and Power – Emergency Illumination

Significance
Emergency illumination is now required in certain electrical rooms.

Analysis
Emergency systems are installed where electrical systems are essential for the safety of human life. They are required in certain occupancies to illuminate means of egress or critical task areas and to supply power for life-support equipment, critical alarm systems, fire pumps, elevators, etc. Emergency systems are installed in high occupant load buildings such as places of assembly, shopping malls, institutional facilities, and where life-support equipment is used such as in hospitals. Where an emergency system is installed, emergency illumination must be provided in the area of the disconnecting means required in 225.31 (a main disconnect in a separate building supplied by a feeder or branch circuit) and 230.70 (a service disconnect). The rule is applicable where the service disconnect or main disconnecting means is installed indoors. The purpose of the change is to enhance the safety of persons working on electrical equipment and to aid first responders in disconnecting building power. Unit equipment (rechargeable battery and lamps) is limited to the supply of power for illumination, including back-up power for exit lighting. The Code does not appear to consider unit equipment a "system." Section 700.12 states that "...The supply system for emergency purposes...shall be one or more of the types of systems described in 700.12(A) through (E)." Unit equipment is addressed in 700.12(F). Frequently, unit equipment supplies the entire emergency load. The AHJ will determine where this requirement is applicable.

Emergency lighting symbols

Electrical service equipment room

Summary
Where an emergency system is installed, emergency illumination must be provided in the area of the disconnecting means required in 225.31 (a main disconnect in a separate building supplied by a feeder or branch circuit) and 230.70 (a service disconnect). The rule is applicable where the service disconnect or main disconnecting means is installed indoors.

Application Question
Does the requirement apply to each of multiple electrical rooms in a large facility?

Answer
No. The rule only applies to the electrical room where the service (or main) disconnect for the normal supply is located.

Fire-Resistive Cable Systems

Significance

This new article provides details for the installation of fire-resistive cable systems. Proper installation of these systems is necessary to ensure continued operation of critical circuits during a fire.

Analysis

Article 728 covers the installation of fire-resistive conductors and cables (e.g., circuit integrity [CI] cable) and other components of fire-resistive cable systems. The purpose of the new rules is to enhance the survivability of critical circuits to ensure continued operation for a specified period of time under specified fire conditions. Fire-resistive cable systems are part of Electrical Circuit Protective Systems, UL Category FHIT.

The components of fire-resistive cable systems are tested and listed as a system and shall not be interchangeable between systems. Installation of these systems is very detailed and must follow the instructions provided in the listing as well as applicable *NEC* provisions. Installation requirements in this article and in the listing apply to systems installed outside the fire-rated rooms that they serve, such as electrical or fire pump rooms. Fire-resistive cable systems shall be secured to the structure in accordance with the listing and manufacturer's installation instructions. The fire rating of the wall or ceiling on which the system is installed shall be equal to or greater than the fire rating of the system. Where a fire-resistive system is listed for installation in a raceway, the raceway, couplings, and connectors must be listed as part of the fire-resistive system. Pulling lubricants used in the installation of fire-resistive cables within raceways shall be listed for the system. Unless specifically stated in the design, all components of Electrical Circuit Protective Systems (UL Category FHIT) such as raceways, couplings, connectors, boxes, conduit bodies, etc. that come in contact with fire-resistive cables shall have an interior coating free of zinc.

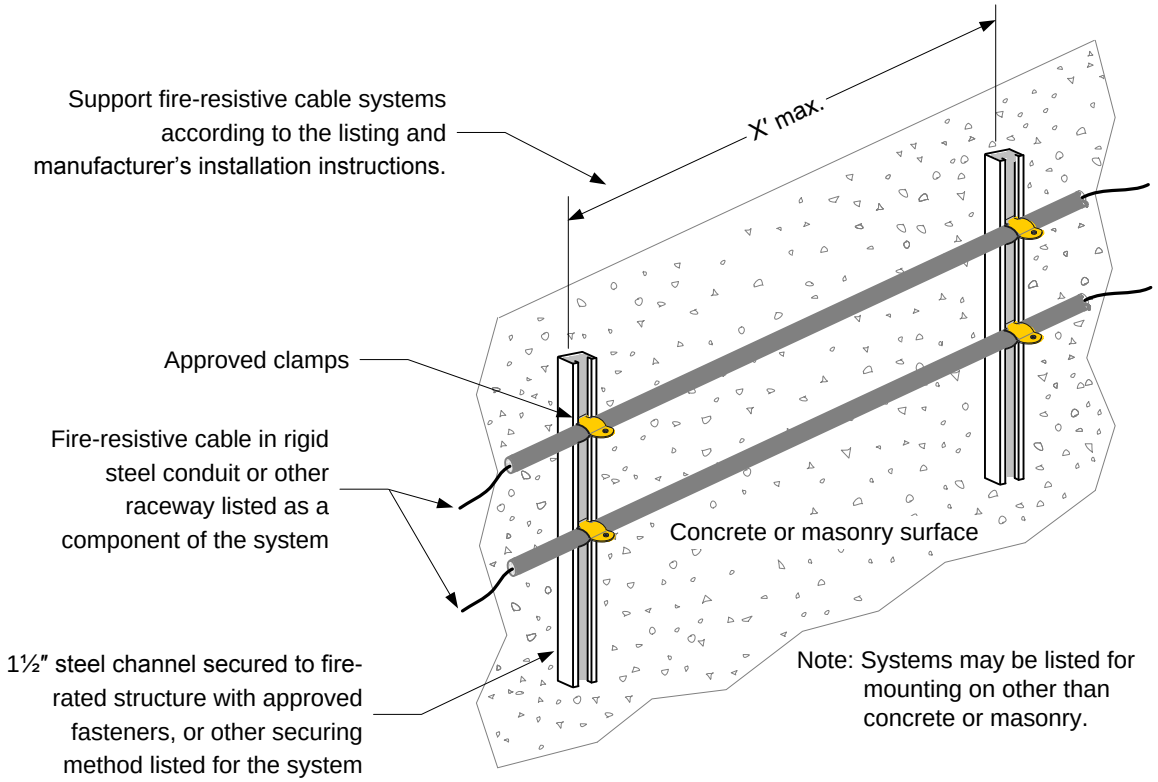
Support for fire-resistive cable systems is important to the survivability of the systems and is more robust than *NEC* support requirements for other wiring methods. Fire-resistive systems shall be supported in accordance with the listing and manufacturer's installation instructions.

If an equipment grounding conductor is required within a raceway system, it shall consist of the same fire-rated cable described in the system, unless alternative equipment grounding conductors are listed for use with the system. An alternative equipment grounding conductor shall be marked with the system number. System cables and conductors shall be marked with the suffix "–FRR" (Fire-Resistive Rating), along with the circuit integrity duration in hours and the system identifier.

Summary

New Article 728 – Fire-Resistive Cable Systems contains detailed requirements for installation of fire-resistive cable systems. Its purpose is to enhance the survivability of critical circuits to ensure continued operation for a specified period of time under fire conditions. The components of fire-resistive cable systems are tested and listed as a system and shall not be interchangeable between systems.

The systems must be installed in accordance with this Code and all instructions included in the listing. Robust securing and supporting of fire-resistive cable systems shall be in accordance with the listing and manufacturer's instructions. Fire-resistive cable systems are part of Electrical Circuit Protective Systems, UL Category FHIT.



Electrical Circuit Integrity System
(constructed with fire-resistive cable)
System No. XXXX Fire Rating – X Hr.

Application Question

T F Rigid steel conduit is the only acceptable raceway for use as a component of a fire-resistive cable system.

Answer

False. Generally, raceways of a listed system are rigid steel. However, other conduit or raceways might be listed as part of the system. Remember that all components of a system must be listed as part of that system and be installed according to the listing and manufacturer's instructions. The steel channel and rigid steel conduit in the drawing above must be listed as components of the electrical circuit integrity system.

Energy Management Systems

Significance

With widespread use of energy management systems (EMS) for monitoring and controlling loads, it is important that the *NEC* restrict automatic control of loads where shutdown could cause personal injury, or property damage or loss.

Analysis

Smart Grid and other load monitoring and control technologies are increasingly being used to improve energy efficiency, reliability, and economics of electricity use. The purpose of new Article 750 – Energy Management Systems is to restrict the use of automatic control of loads where injury could result, e.g., stopping a fan that is exhausting air from a hazardous (classified) area, or shutting down a moving walkway while in use.

Load shedding is already permitted in existing *Code* language for ensuring reliable operation of fire pumps and emergency systems, Articles 695 and 700 respectively. New Section 750.20 prohibits an energy management system from overriding any control necessary for ensuring continuity of alternate power sources for fire pumps, health care facilities, emergency systems, legally required standby systems, and critical operations power systems (COPS). Section 750.30 further restricts operations of energy management systems as follows:

(A) Load Shedding Controls. An energy management system shall not override load shedding controls that ensure the minimum electrical capacity for:
(1) Fire pumps
(2) Emergency systems
(3) Legally required standby systems
(4) Critical operations power systems (COPS)

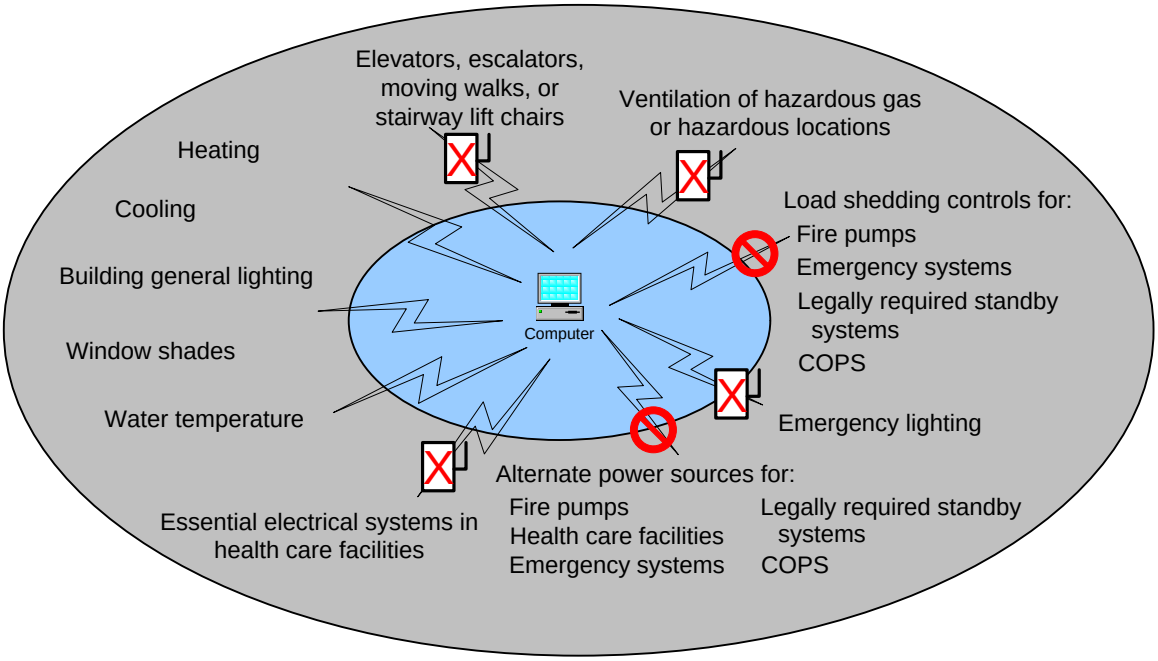
(B) Disconnection of Power. An energy management system shall not be permitted to cause disconnection of power to:
(1) Elevators, escalators, moving walks, or stairway lift chairs
(2) Positive mechanical ventilation for hazardous (classified) locations
(3) Ventilation used to exhaust hazardous gas or reclassify an area
(4) Circuits supplying emergency lighting
(5) Essential electrical systems in health care facilities

(C) Capacity of Branch Circuit, Feeder, or Service. An energy management system shall not cause a branch circuit, feeder, or service to be overloaded at any time.

When an energy management system is used to control power through a remote means, a directory identifying the controlled device(s) or circuit(s) shall be posted on the enclosure of the controller, disconnect, or branch circuit overcurrent device.

Summary

Article 750 – Energy Management Systems contains rules that prohibit energy management systems from overriding load shedding controls that are in place to ensure minimum capacity requirements for fire pumps, emergency systems, and other required standby and critical power systems. An EMS shall not be permitted to disconnect power to circuits supplying emergency lighting, essential electrical systems in health care facilities, ventilation exhausting hazardous gas, or power to elevators, moving walks and similar equipment. An EMS may not cause any service, feeder, or branch circuit to become overloaded. Also, an EMS is prohibited from overriding any control necessary for ensuring continuity of alternate power sources for critical loads.



Energy Management System

= Control of loads not permitted to be overridden by EMS

= EMS not permitted to cause disconnection of these loads

Application Question

Is an energy management system permitted to monitor and control indoor temperature, ventilation fan speeds, and lighting levels and modes for general lighting at multiple campuses of a university system?

Answer

Yes. This is an application of SCADA (supervisory control and data acquisition), computer monitoring and controlling of heating, ventilation, and air conditioning (HVAC) systems, and energy consumption. None of these functions is restricted by Article 750, assuming no hazards are introduced.

Part V. Installation Methods Within Buildings – Raceways and Cable Routing Assemblies for Optical Fiber Cables

Significance

Additional rules for the installation of Cable Routing Assemblies have been included in the 2014 *NEC*.

Analysis

Cable Routing Assemblies are widely used for cable support/management in data centers. They are commonly used for optical fiber, data, and communications cables. The definition for cable routing assembly has been relocated from 770.2 to Article 100, since the term is used in more than one Code article. Use of these assemblies has been expanded to include Class 2 and Class 3 circuit cables in Article 725, and power-limited fire alarm (PLFA) cables in Article 760. Its definition has been revised to reflect the extended application. A Cable Routing Assembly is a single channel or connected multiple channels, as well as associated fittings, forming a structural system used to support and route communications cables, optical fiber cables, data cables associated with information technology and communications equipment, Class 2 and Class 3 cables, and power-limited fire alarm cables.

Subsections 770.110(C)(1) and (2) contain requirements for horizontal and vertical support for cable routing assemblies. Generally, horizontal support is required at intervals not exceeding 3 ft; vertical support is required at intervals not exceeding 4 ft. See also .110(C) in 800, 820, and 830.

Listing requirements have been included in the new Code for plenum cable routing assemblies in 800.182(A). New Table 800.154(c) matches the application of listed cable routing assemblies in buildings with the cable routing assembly type: plenum, riser, and general-purpose.

Courtesy of Leviton Manufacturing Co., Inc.

Fiber Raceway System is UL 2024A listed for riser-rated telecommunications applications.

Summary

Cable routing assemblies are permitted to be used to support and route communications cables, optical fiber cables, data cables associated with information technology and communications equipment, Class 2 and Class 3 cables, and power-limited fire alarm cables. New Table 800.154(c) matches the application of cable routing assemblies in buildings with the cable routing assembly type: plenum, riser, and general-purpose. Installations must comply with horizontal and vertical support requirements.

Application Question: Does the *NEC* consider a cable routing assembly a *raceway*?

Answer

A raceway is an enclosed channel of metallic or nonmetallic material designed for holding wires, cables, or busbars. Cable routing assemblies that are enclosed could be considered raceways.

Article 800 – Communications Circuits

Significance

There are several changes to Article 800 that are important for those who work with low-energy circuits. Other changes within this article have been addressed in the analysis of other sections in this book.

Communications raceways as innerduct

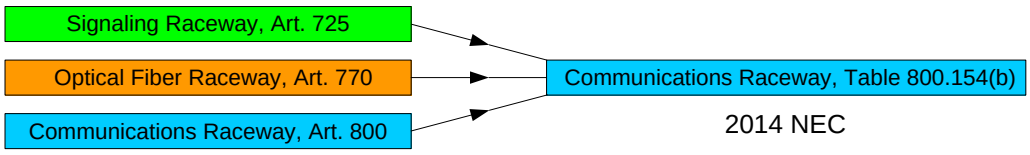
Courtesy of Innerduct.com

800.12 Innerduct. Definition: *Innerduct* is a nonmetallic raceway placed within a larger raceway.

Listed plenum communications raceway, riser communications raceway, and general-purpose communications raceway are permitted to be installed as innerduct in any type of listed raceway permitted in Chapter 3. The communications raceway shall be selected in accordance with the provisions of Table 800.154(b).

Communications Raceways

Signaling raceways and optical fiber raceways are no longer mentioned in the *NEC*, as these raceways are now *communications raceways*. Applications of communications raceways in buildings are shown in Table 800.154(b). The table lists the applications that are permitted for each of the raceway types: plenum communications raceway, riser communications raceway, and general-purpose communications raceway. This change is reflected in the revised definition of *communications raceway*, relocated to Article 100.



800.179(G) Circuit Integrity (CI) Cable or Electrical Circuit Protective Systems

Cables that are used for survivability of critical circuits under fire conductions can be tested and listed as "CI" cable or they can be tested as part of an electrical circuit protective system (UL Category FHIT) as outlined in new Article 728. Circuit integrity (CI) cables shall only be installed in free air. Fire-resistive cables that are a part of an electrical circuit protective system shall be identified with the protective system number on the product and installed in accordance with the listing of the protective system. A similar change has been made in Article 725.179(F) and Article 760.179(G).

Type FPLR-CI (Power-limited fire alarm riser cable – Circuit Integrity)

For use without conduit in fire alarm systems

Courtesy of Draka Cableteq USA

Informative Annex J – ADA Standards for Accessible Design

Significance

Selected provisions of the 2010 ADA Standards for Accessible Design are included in new Informative Annex J to assist Code users in considering electrical design constraints in buildings required to comply with the ADA Standard.

Analysis

The 2010 ADA Standards set minimum requirements for newly designed and constructed or altered State and local government facilities, public accommodations, and commercial facilities to be readily accessible to and usable by individuals with disabilities. Annex J includes provisions from Section 307, Protruding Objects (protruding into the *circulation path*), and Section 308, Reach Ranges. For placement of switches, receptacles, and other operable parts, consult Section 309 of the Standard, Operable Parts.

According to Section 309.3 – Height, operable parts shall be placed within one or more of the reach ranges specified in 308. Where forward reach is unobstructed, high forward reach shall be 48 in. maximum and low forward reach shall be 15 in. minimum above finish floor or ground. Where the high forward reach is obstructed by an intrusion of more than 20 in., such as over a bathroom sink, the high forward reach shall be 44 in. max. Where a clear floor space allows side approach to an *element*, and the reach is unobstructed, the high reach shall be 48 in. maximum and the low reach shall be 15 in. minimum. If the side reach is obstructed, the high reach maximum is either 46 in. or 48 in., depending on the depth of the obstruction.

Remember that an Informational Annex is not a mandatory part of the *NEC*, but is included for informational purposes only.

The ADA Standard in its entirety should always be consulted. It can be viewed at: http://www.ada.gov/2010ADAstandards_index.htm

Summary

The 2014 *NEC* includes Informational Annex J, ADA Standards for Accessible Design, to assist Code users in considering electrical design constraints for electrical and other building systems in buildings required to comply with ADA, e.g., requirements for switch and receptacle heights.

Application Question

To be ADA compliant, a wall receptacle should be located not lower than _____ inches above finish floor or ground to the lowest part of a duplex receptacle.

A. 12
B. 15
C. 18
D. 24

Answer: B. The 15 in. lower limit for the receptacle height applies to both unobstructed front approach and unobstructed side approach.

110.24(A) Available Fault Current – Field Marking

A new Informational Note has been added to remind Code users that the required available fault current marking is related to compliance with Sections 110.9 and 110.10 to ensure suitable interrupting ratings and fault clearing ability of equipment. This fault current value is not intended to be used for arc lash hazard analysis as required in NFPA 70E-2012, *Standard for Electrical Safety in the Workplace*.

210.4(D) Multiwire Branch Circuits – Grouping

The general rule requires that the ungrounded and grounded circuit conductors of each multiwire branch circuit be grouped using cable ties or similar means in at least one location within the panelboard or other point of origin of the circuit. The requirement does not apply where the conductors enter the panel through a cable or raceway unique to the circuit so that the conductor association is obvious. The exception to the grouping requirement has been expanded to exempt the requirement where conductors are identified at their terminations with numbered wire markers corresponding to the appropriate circuit number.

210.8(A)(7) Ground-Fault Circuit-Interrupter Protection for Personnel – Dwelling Units – Sinks

A receptacle located within 6 ft of the outside edge of a kitchen sink (or any other sink) in a dwelling unit must have GFCI protection. A Code clarification calls attention to the fact that this includes a receptacle within a cabinet, perhaps for the supply of a waste disposer. This under-cabinet receptacle also requires AFCI protection of its supply circuit because of a 2014 change in 210.12(A).

314.15 Boxes and Conduit Bodies – Damp or Wet Locations

This change will help to prevent degradation over time of metal boxes in outdoor locations from moisture condensation. Approved drainage openings not larger than ¼ in. shall be permitted to be installed in the field in boxes or conduit bodies listed for use in damp or wet locations. Larger opening are permitted for field installation of listed drain fittings in accordance with the manufacturer's instructions. The provision also applies to nonmetallic boxes and conduit bodies. A vague version of this new permission is in Section 110.12(A) of the existing Code, where unused openings in equipment enclosures are permitted where "intended for the operation of the equipment."

314.25 Covers and Canopies

A new sentence has been added to this section. Screws used for the purpose of attaching covers, faceplates, lampholders, luminaire canopies, or other equipment to boxes shall be machine screws matching the thread gauge or size that is integral to the box or be in accordance with the manufacturer's instructions. Use of screws not designed for the purpose, such as drywall screws, is prohibited.

330.30(B) Metal-Clad Cable: Type MC – Securing and Supporting – Securing

A provision has been added to this section to address securing of vertical installations of listed MC cable of sizes 250 kcmil and larger. In vertical installations, listed MC cables with ungrounded conductors of 250 kcmil and larger shall be permitted to be secured at intervals not exceeding 10 ft. This provision recognizes the internal integral conductor support for large-size MC cables that are used for vertical runs in high rise construction. The general rule requires the securing of MC cables at intervals not exceeding 6 ft.

376.56(B)(1) and (B)(5) Metal Wireways – Power Distribution Blocks – Installation and Conductors

This change pertains to listed power distribution blocks installed in metal wireways on the line side of service equipment. Distribution blocks installed ahead of service equipment shall be listed for the purpose. A new subsection (5) requires conductors in wireways to be arranged so that the terminals of power distribution blocks remain unobstructed after installation.

400.7(A)(11) Flexible Cords and Cables – Uses Permitted

This new permission for flexible cord and cable usage in subsection (11) is primarily intended to address listed equipment assemblies for wall installation of flat-screen televisions. A flush wall inlet is installed on a wall at typical receptacle height. A chapter 3 wiring method in the wall connects this inlet to a single receptacle outlet above, and higher up on the wall, located behind the television. The new permission allows a flexible cord listed as part of the assembly to connect the receptacle inlet to an adjacent existing wall receptacle (used like a patch cord).

406.4(D) Replacements

Where receptacles are replaced in locations that require GFCI protection or AFCI protection for the branch circuit according to current Code, GFCI or AFCI receptacles installed must be *readily accessible*.

406.5(E) and (F) Receptacle Mounting – Receptacles in Countertops and Similar Work Surfaces – Receptacles in Seating Areas and Other Similar Surfaces

Receptacles in countertop surfaces are not permitted to be installed in a face-up position unless listed for the propose. This rule now applies to all occupancies, not just to dwelling units. New subsection (F) prohibits mounting of receptacles in a face-up position in seating areas and other similar surfaces unless the receptacle is any of the following:

(1) Part of an assembly listed as a furniture power distribution unit, if cord-and-plug connected
(2) Part of an assembly listed either as household furnishings or as commercial furnishings
(3) Listed either as a receptacle assembly for countertop applications or as a GFCI receptacle assembly for countertop applications
(4) Installed in a listed floor box

This change is intended to prohibit the practice of installing receptacles face-up in benches and seating areas in public locations, such as airports, for laptop or electronic device charging. The

change should prevent equipment damage from spillage and prevent physical damage to the receptacle that could expose persons to live parts.

408.3(F) Switchboard, Switchgear, or Panelboard Identification

Three new subsections have been added that require field marking for: high-impedance grounded neutral AC systems, ungrounded DC systems, and resistively grounded DC systems. Marking for each system shall include the word "CAUTION" followed by the type of system and the voltage between conductors, and, where applicable, the voltage to ground.

422.5 Appliances – Ground-Fault Circuit-Interrupter (GFCI) Protection

This is a new section that requires all devices that provide GFCI protection (5 mA) required in this article, 422 – Appliances, to be *readily accessible*. Article 422 requires GFCI protection for tire inflation and automotive vacuum machines, high-pressure spray washers (integral, factory installed), vending machines, and electric drinking fountains. Dishwashers installed in dwelling unit locations are required by 210.8(D) in the 2014 *NEC* to be provided with GFCI protection. A receptacle in a dwelling unit serving a waste disposer shall be GFCI protected if installed within 6 ft of the outside edge of a sink, even where located below the sink in a cabinet.

514.3(C) Motor Fuel Dispensing Stations in Boatyards and Marinas

Rules for wiring motor fuel dispensing stations at marinas and boatyards, formerly located in Section 555.21, are relocated to new Section 514.3(C). There are no changes to the rules. Class I, Division 1 or 2 locations are specified for closed construction (floating piers) and open construction (fixed piers). Exceptions apply to the classification for closed construction where documentation is provided in accordance with 500.4(A). Both exceptions require "documented air space."

- ✓ Code Refresher
  500.4(A) Documentation – Areas designated as hazardous (classified) locations shall be properly documented. The documentation shall be available to those authorized to design, install, inspect, maintain, or operate electrical equipment at the location. The best documentation is a plan/drawing prepared by a qualified design professional showing the details, dimensions, boundaries, etc. of the classified areas.

Article 516 – Spray Application, Dipping, Coating, <u>and Printing Processes Using Flammable or Combustible Materials</u>

Including the revised title, this article has undergone a substantial rewrite in order to correlate the article with the 2011 editions of NFPA 33, *Standard for Spray Application Using Flammable and Combustible Materials* and NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*. Several new figures are included within the article to aid in the understanding of the rules.

All of the existing definitions have been revised and new definitions have been added for *flash-off area*, *limited finishing workstation*, *resin application area*, and *unenclosed spray area*. There is revised language for enclosed spray booths or rooms to clarify the area classification of any

recirculation path in a recirculating spray booth, and to clarify that the interior of a fresh air supply plenum in a non-recirculating spray booth is an unclassified area. Rules concerning illumination of classified spray areas have been updated with detailed requirements extracted from NFPA 33.

680.25(A)(1) Permanently Installed Pools – Feeders

This section specifies certain wiring methods acceptable for feeders supplying panelboards that supply branch circuits for pool equipment. In the existing Code, an exception to the eight specified wiring methods permits existing feeders to be run in flexible metal conduit (FMC) or be an approved cable assembly that contains an equipment grounding conductor (not required to be insulated). This exception has been deleted in the 2014 *NEC*. The only feeder for pool equipment panelboards that is permissible without an insulated equipment grounding conductor is an existing feeder complying with the provisions of 250.32(B). An example is an existing outbuilding supplied by a feeder that does not contain an equipment grounding conductor.

690.47(D) Additional Auxiliary Electrodes for Array Grounding

New Section 690.47(D) was inadvertently removed from the 2011 *NEC*. It has been included in the 2014 *NEC* as it appeared in the 2008 Code. The only changes from the 2008 language are the inclusion of the term *auxiliary* in the title of the subsection and the requirement for the grounding electrode to be installed in accordance with 250.52 and 250.54. A grounding electrode shall be installed at the location of all ground- and pole-mounted PV arrays and as close as practicable to the location of roof-mounted arrays. The electrode(s) shall be connected directly to the array frame(s) or structure. The structure of a pole- or ground-mounted array is permitted to serve as the required auxiliary electrode if it qualifies as a grounding electrode in accordance with 250.52. The purpose of the auxiliary electrode(s) is to provide a degree of protection from surges caused by indirect lightning strikes. NFPA 780, *Standard for the Installation of Lightning Protection Systems*, should be consulted where lightning protection is required.

700.19 Emergency System Circuits for Lighting and Power – Multiwire Branch Circuits

This is a new section in the 2014 Code that is intended to enhance the reliability of critical circuits. In the new Code, a branch circuit that serves emergency lighting and power loads shall not be part of a multiwire branch circuit.

702.7(C) Optional Standby Systems – Signs – Power Inlet

This new subsection requires a warning sign where a power inlet is available for temporary connection to a portable generator. The sign shall be placed near the inlet and shall indicate the configuration of the transfer switch of the premises wiring. The sign shall display one of the following:

WARNING: FOR CONNECTION OF A SEPARATELY DERIVED (BONDED NEUTRAL) SYETEM ONLY

WARNING: FOR CONNECTION OF A NONSEPARATELY DERIVED (FLOATING NEUTRAL) SYETEM ONLY

