



PDHonline Course E428 (3 PDH)

Revisions for the 2014 National Electrical Code® - Part 1

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PDH Course E428

Revisions for the 2014 National Electrical Code®

Part 1

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Introduction

Part 1 of this 3-part series covers Code-wide changes through Article 240. 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.

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Four New Articles and New Informative Annex J**Article 393 – Low-Voltage Suspended Ceiling Power Distribution Systems**

New Article 393 provides rules for distribution of low voltage current through suspended ceiling grid designed for power distribution for the supply of luminaires, sensors, and other low power devices and equipment located within, on, or suspended below the ceiling grid. Equipment is supplied by Class 2 circuits using approved cables and connectors.

Article 646 – Modular Data Centers

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 users to applicable existing requirements in other articles.

Article 728 – Fire-Resistive Cable Systems

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.

Article 750 – Energy Management Systems

Article 750 – Energy Management Systems (EMS) 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 equipment 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.

Informative Annex J

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.

These new articles and Informative Annex J are covered in more detail within this textbook.

Lockable Disconnecting Means

Many sections of the *NEC* require a disconnecting means to be capable of being locked in the open position, sometimes as a requirement for permitting an exception to the rule. Further, the provisions for locking or adding a lock to the disconnecting means shall remain in place with or without the lock installed. This language has been inserted into new Section 110.25. Instead of re-writing this requirement in various sections throughout the Code, those sections now state that the disconnecting means shall be “lockable in accordance with 110.25.” Section 110.25 is covered in more detail within this textbook.

Requirements for DC Systems

Requirements for DC systems integrated throughout the *NEC* is a result of the *NEC* DC Task Force that was established to review the Code’s existing DC requirements and make recommendations in the form of proposals, where the *NEC* was deemed lacking in addressing new DC technologies. The increasing use of on-site generation and utilization of DC power from such sources as photovoltaic systems is one example of the need for expanded *NEC* coverage of DC systems. Electric vehicle charging, DC microgrids, and wind electric generation systems require *NEC* rules for safe installations. Some of the DC-related changes in the 2014 *NEC* are new Article 393 – Low-Voltage Suspended Ceiling Power Distribution Systems, revisions to Article 480 – Storage Batteries, revisions to Article 690 – PV Systems, switchboards and panelboards for DC systems in Article 408, and new sections to identify ungrounded branch-circuit and feeder conductors supplied from DC systems. This textbook analyzes several Code articles/sections related to DC systems.

Use of the Term *Switchgear* Incorporated throughout the *NEC*

The term *switchgear* has replaced *metal-enclosed power switchgear* in Article 100 and throughout the Code. The definition of *switchgear* is essentially the same as the former definition of metal-enclosed power switchgear. All switchgear subject to *NEC* requirements is metal enclosed. Switchgear rated 1000 V or less may be identified as “low-voltage power circuit breaker switchgear.” Switchgear rated over 1000 V may be identified as “metal-enclosed switchgear” or “metal-clad switchgear.”

Article 408 – Switchboards and Panelboards is re-titled “Switchboards, Switchgear, and Panelboards.” Article 490 – Equipment Over 1000 Volts, Nominal now uses the term *switchgear* in place of *metal-enclosed switchgear* and *metal-enclosed power switchgear*. Other places in the Code have replaced *metal-enclosed switchgear* with *switchgear*. Several Code sections add *switchgear* where switchboards are listed.

Voltage Threshold: Changed from “Over 600 Volts” to “Over 1000 Volts”

Some wind generating systems operate above the existing 600-V threshold (690 volts AC is common) and solar photovoltaic (PV) systems operate in a range of DC voltages up to and including 1000 V and higher. The “High Voltage Task Group” was appointed by the Technical Correlating Committee to review existing Code and submit new proposals to address the need for installation rules for circuits and systems operating at over 600 volts.

As a result of their work, several Code articles now address Over 1000 Volts in place of Over 600 Volts. Some articles retained the 600-V threshold, particularly where there were safety concerns.

This process will continue to evolve. Equipment must be manufactured and tested for the new voltage level. Changes may be needed to tools, electrical testers, and safety equipment, including safety clothing. Conductor insulations, equipment and terminal spacings, work space clearances, and more will be affected.

Article 690 – Solar Photovoltaic (PV) Systems and Article 694 – Wind Electric Systems are among the articles that contain requirements for systems operating over 1000 volts. UL currently lists PV cable and other equipment for operation over 600 volts.

Article 250 – Grounding and Bonding began to address grounding of systems and circuits of 1 kV and over in the 1981 edition of the *NEC*.

Coordination (Selective) [revised definition]

“Localization of an overcurrent condition to restrict outages to the circuit or equipment affected, accomplished by the ~~choice~~ selection and installation of overcurrent protective devices and their ratings or settings for the full range of available overcurrents, from overload to the maximum available fault current, and for the full range of overcurrent protective device opening times associated with those overcurrents.”

The revision makes it clear that selective coordination is the isolation of downstream overcurrent conditions over the complete range of available overcurrents and associated opening times.

Premises Wiring (System) [new Informational Note]

“Interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all their associated hardware, fittings, and wiring devices, both permanently and temporarily installed. This includes (a) wiring from the service point or power source to the outlets or (b) wiring from and including the power source to the outlets where there is no service point.”

“Such wiring does not include wiring internal to appliances, luminaires, motors, controllers, motor control centers, and similar equipment.”

“Informational Note: Power sources include, but are not limited to, interconnected or stand-alone batteries, solar photovoltaic systems, other distributed generation systems, or generators.”

The new Informational Note provides some examples of premises wiring systems. Not all premises wiring is supplied by a utility service, i.e., there may not be a service point. Portable generators and their associated wiring constitute premises wiring, unless used to serve installations not covered within the scope of the NEC in 90.2(B).

Readily Accessible [revised definition]

“Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to actions such as to use tools, to climb over or remove obstacles, or to resort to portable ladders, and so forth.”

Where a disconnecting means is required to be readily accessible, even the use of a simple screwdriver to access the disconnect renders the disconnect not readily accessible (only accessible). This can be the case in certain HVAC equipment where a built-in disconnect is located behind an access panel that requires a screwdriver to remove or open.

Retrofit Kit [new definition]

“A general term for a complete subassembly of parts and devices for field conversion of utilization equipment.”

The term “retrofit kit” is used in Article 410 – Luminaires, Lampholders, and Lamps, and in Article 600 – Electric Signs and Outline Lighting. For use within the scope of these articles, retrofit kits are required to be listed. With the move toward energy-efficient lighting, retrofit kits used to upgrade lighting sources (many to LED lighting) are increasingly popular.

Separately Derived System [revised definition]

“An electrical source, other than a service, having no direct connection(s) to circuit conductors of any other electrical source other than those established by grounding and bonding connections.”

Separately derived systems are not services. Only a utility company supplies power via a service. Grounding the neutral of a separately derived system (e.g., a transformer) in a building to metal water piping or structural steel in the vicinity of the separately derived system will nearly always form a connection to another system's grounded conductor. The electrode used (structural steel or metal water piping) to ground the separately derived system must qualify as a grounding electrode. The revised definition clarifies that a common grounding electrode conductor used to ground multiple separately derived systems, as permitted in 250.30(A)(6), does not disqualify the systems from being separately derived systems.

Arc-Flash Hazard Warning

Significance

Arc-flash hazard warning labels that are factory applied meet the marking requirements of this section.

Analysis

Electrical equipment such as switchboards, switchgear, panelboards, industrial control panels, meter socket enclosures, and motor control centers, that are in other than dwelling units, and are likely to require examination, adjustment, servicing, or maintenance while energized shall be marked to warn qualified persons of potential arc flash hazards. This Code revision permits equipment to be either field marked or factory marked. Many manufacturers are marking equipment with appropriate arc flash warning labels, so there is no need for field marking. The installer, though, is ultimately responsible for compliance with this section. The marking shall be located such that it is clearly visible to qualified persons who will examine or service the equipment. Also new in this Code edition is the requirement that the marking meet the provisions of 110.21(B), which is itself new to the 2014 *NEC*. According to Section 110.21(B), labels shall be permanently affixed to the equipment or wiring method, shall be of sufficient durability to withstand the environment, and shall adequately warn of the hazard using effective words and/or colors and/or symbols.

Like the 2011 *NEC*, the 2014 Code does not specify the content and details of the warning label, since this information is deemed related to workplace safety rather than installation, and thus, beyond the scope of the *NEC*. Informational Note No. 1 makes reference to NFPA 70E-2012, *Standard for Electrical Safety in the Workplace*, which provides guidance in determining the level of exposure, planning safe work practices, arc flash labeling, and selecting personal protective equipment (PPE). Informational Note No. 2 references ANZI Z535.4, *Product Safety Signs and Labels* for guidelines for the design of safety sign and labels.



This label meets both the 2014 *NEC* and NFPA 70E-2012 requirements.

Note: Factory marking of the information required by 70E is generally not feasible due to the variety of equipment applications.

Summary: Arc flash warning labels may be field or factory applied. Field-applied marking shall meet the requirements of new 110.21(B), which contains general requirements for field marking.

Application Question

Does the *NEC* require the available incident energy to be marked on electrical equipment?

Answer: No, but NFPA 70E does. Section 130.5(C) of 70E-2012 requires equipment to be field marked to specify either the available incident energy, in calories/cm², or the minimum arc rating of PPE, also expressed in calories/cm²; the nominal system voltage; and the arc flash boundary.

Field-Applied Markings

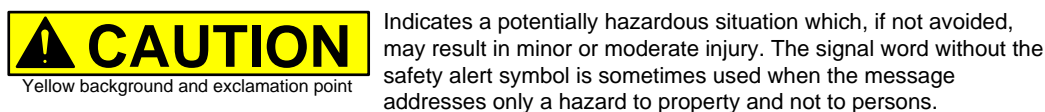
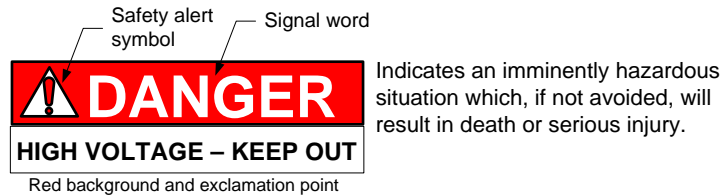
Significance

A new subsection has been added to 110.21 that contains requirements when implementing the DANGER, WARNING, and CAUTION markings required by the *NEC*.

Analysis

Various sections of the Code require field marking using one of these signal words: “DANGER”, “WARNING”, or “CAUTION.” This Code change seeks to provide consistency in the required marking by establishing the visual format, durability, and suitability criteria for these three types of markings. The marking/label shall adequately warn of the hazard using effective words and/or colors and/or symbols. The label shall be permanently affixed to the equipment or wiring method and shall be of sufficient durability to withstand the environment involved. Labels shall not be hand written, except where they are variable or could be subject to change. Informational Notes reference ANSI Z535.4-2011, *Product Safety Signs and Labels*, which provides guidelines for suitable font sizes, words, colors, symbols, and placement requirements for safety signs and labels.

The labels below are examples of safety labels that conform to ANSI Z535. Labels should include a description of the hazard, a way to avoid the hazard, and consequences if ignored (partly understood by having knowledge of the label’s meaning). The DANGER label below will probably satisfy most AHJs as compliant with 110.21(B) and 110.34(C). It would be better if it included the consequence, e.g., “Contact will cause electric shock or burn.”



Summary

Where DANGER, WARNING, or CAUTION labels are required by the *NEC*, field-applied labels shall be permanently affixed to the equipment or wiring method, shall be of sufficient durability to withstand the environment, and shall adequately warn of the hazard using effective words and/or colors and/or symbols.

Application Question: What safety label requirements are included in Article 110 that require signal words?

Answer: Sections 110.22(B) and (C), CAUTION (for series combination systems); 110.34(C), DANGER (for over 600 volts); and possibly 110.28(C), “conspicuous warning signs” (forbidding unqualified persons to enter rooms or locations containing exposed live parts).

Lockable Disconnecting Means

Significance

Several sections of the new Code require disconnects to be “lockable in accordance with 110.25.”

Analysis

Many sections of the *NEC* require disconnecting means to be lockable in the open position. Further, the provision for locking must remain in place with or without the lock installed. This facilitates lockout/tagout (LOTO). Instead of repeating the rules for a “lockable open” disconnecting means in various sections of the Code, the 2014 *NEC* places the provisions in Article 110. The 2014 Code adds an exception for cord-and-plug-connected equipment that might require the equipment to be locked off/open. There are products on the market designed to be placed over a cord plug and locked, thereby preventing use of the plug. The plug lock is stored on the cord while the equipment is energized. The exception recognizes that this provision for locking cannot remain in place. Some sections of the *NEC* permit a cord and plug to serve as the required disconnecting means, but do not require any cord-and-plug disconnecting means to be lockable open. However, OSHA regulations in 29 CFR 1910-147 do require certain cord-and-plug-connected equipment to be lockable open, except where the plug is under the exclusive control of the employee servicing the equipment.

Examples of Code sections that require disconnecting means to be “lockable in accordance with 110.25” are 430.102(B), Exception, for motor disconnecting means; and 422.31(B), for permanently connected appliances rated over 300 volt-amperes.



Courtesy of Brady Worldwide, Inc.

Summary

New 110.25 contains rules that must be complied with for a disconnecting means to qualify as lockable open. An exception recognizes that where the disconnecting means is permitted to be a plug for cord-and-plug-connected equipment, the provision for locking cannot remain in place.

This lockout kit contains locking devices and accessories for several sizes of single-pole and multi-pole circuit breakers.

Application Question

There is a simple metal locking device available that fits over a standard size single-pole breaker handle and uses a set screw to “lock” the breaker in the ON or OFF position. Does this device comply with 110.25?

Answer: No. The device may be useful to help ensure that certain circuit breakers remain ON or OFF, but the “locking” provision is not suitable, since it can be defeated with a simple screwdriver.

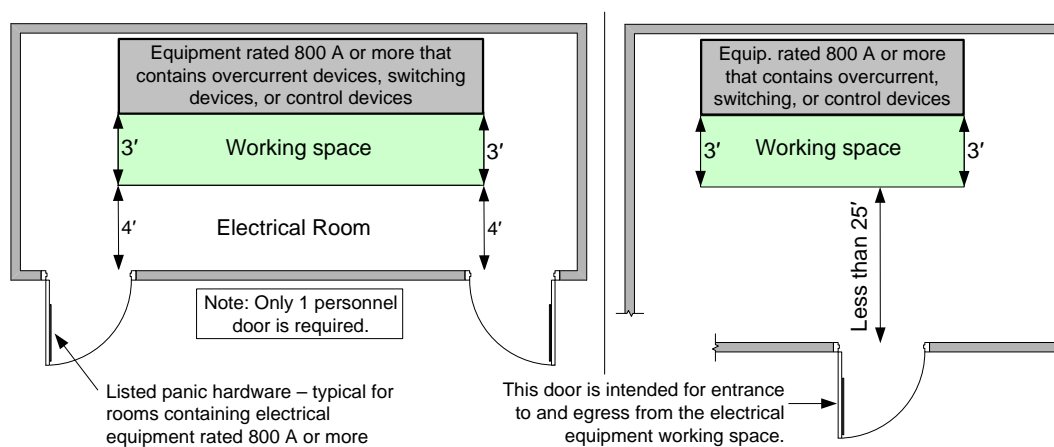
Spaces About Electrical Equipment – Entrance to and Egress from Working Space – Personnel Doors

Significance

The threshold at which listed panic hardware is required on egress doors from electrical equipment working spaces has been reduced from 1200 A to 800 A.

Analysis

Specifications for personnel doors intended for entrance to and egress from electrical equipment working spaces are only concerned with the safety of persons. The threshold of 1200 A relates to the number of personnel doors required, but equipment ratings less than 1200 A pose significant exposure to arc flash. Code-Making Panel 1 has chosen 800 A as the minimum equipment rating where egress doors within 25 feet of the working space require listed panic hardware to facilitate egress by persons who may have been injured while examining or working on equipment. The doors must open in the direction of travel. The 800-A rating is not cumulative. Two separate 400-A rated pieces of equipment will not trigger the requirement.



These doors must open in the direction of egress and must be equipped with listed panic hardware.

Summary

All doors intended for entrance to and egress from any room where electrical equipment rated 800 A or more is installed, and are less than 25' from the nearest edge of the working space, shall open in the direction of egress and be equipped with listed panic hardware.

Application Question

T F Rooms that are not dedicated electrical equipment rooms are exempt from the rules specifying the number of egress doors required and the specifications for the doors.

Answer: False. Any room where electrical equipment is installed must comply with working space and applicable egress door requirements. Any *area* where electrical equipment is installed must comply with applicable working space requirements.

Part II. 600 Volts, Nominal, or Less – Spaces About Electrical Equipment – Dedicated Equipment Space – Outdoor

Significance

Dedicated equipment space is now required for certain outdoor electrical equipment.

Analysis

Electrical distribution equipment is sometimes located outdoors, along with HVAC equipment, PV system inverters and disconnects, generator equipment and disconnecting means, etc. This may be especially true for slab-on-grade construction. It makes sense for large electric loads and electrical sources to be in close proximity, but proper design is necessary to ensure safe working space about all equipment. *Working space* in 110.26(A) is for the protection of the worker, while *dedicated equipment space* is to ensure future wiring access to the equipment and protection of electrical equipment from intrusion by non-electrical equipment. In the existing Code, rules for *working space* about electrical equipment include outdoor locations, but *dedicated equipment space* for outdoor locations is new in 2014. The space equal to the width and depth of the equipment and extending from grade to a height of 6 ft above the equipment shall be dedicated to the electrical installation. This permits unobstructed access for conduits and cables to be installed in and out of electrical panelboards and other equipment. No piping or other equipment foreign to the electrical installation is permitted in this space. Gas piping, water piping, refrigeration lines, compressed air lines, and phone and internet equipment are examples of foreign equipment that must not be installed above or below a panel or certain other electrical equipment in the dedicated space.



Service disconnect and branch circuit breakers (panelboard)

Summary

Dedicated equipment space shall be provided for switchboards, switchgear, panelboards, and motor control centers installed in outdoor locations. The space shall be equal to the width and depth of the

equipment and extend from grade to a height of 6 ft above the equipment.

Application Question

What are the *working space* and *dedicated equipment space* requirements for outdoor electrical equipment?

Answer

Per 110.26(E)(2)(a), the working clearance space includes the zone described in 110.26(A): 3-4 ft deep, depending on the voltage and other conditions; the greater of 30 in. or the width of the equipment; and the greater of 6½ ft or the height of the equipment. The dedicated equipment space for outdoor switchboards, switchgear, panelboards, and motor control centers (equipment that is likely to require future wiring access) is the space equal to the width and depth of the equipment and extending from grade to a height of 6 ft above the equipment.

Neutral Conductors – Multiple Circuits

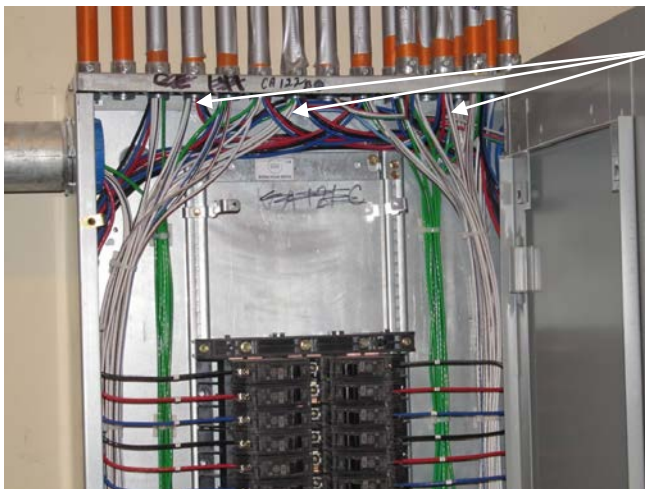
Significance

Neutral conductors are generally not protected by overcurrent devices. It is necessary to be able to correctly identify circuit conductor pairs (grounded and ungrounded conductors of the same circuit) when splicing and terminating conductors to prevent overloading and miswiring.

Analysis

Where conduit raceways are used to enclose home-run conductors run into a panel, or where wireways are used near panels to transition from a cable wiring method to conduit to run into a panel, it is not uncommon to find more than one neutral/grounded conductor in a conduit with several ungrounded conductors. This Code revision requires that grounded circuit conductors be identified or grouped in enclosures to correspond with the ungrounded conductor(s) of the same circuit. This can be accomplished by using wire markers, cable ties, or similar means in at least one location within the enclosure (all enclosures). There are two exceptions. Identifying or grouping is not required where: (1) the branch-circuit or feeder conductors enter from a cable or raceway unique to that circuit so that the conductor association is obvious, and (2) branch-circuit conductors pass through a box or conduit body without a loop as described in 314.16(B)(1) or without a splice or termination. Some contractors have established the practice of using number labels to identify neutral conductors. Certainly this is an acceptable means of identification.

This change will facilitate maintenance and troubleshooting and will help to prevent overloading of neutral conductors. Note that there is a separate existing requirement for grouping or identifying all conductors of a multiwire circuit in 210.4(D), which was new in the 2008 *NEC*.



Multiple neutral/grounded conductors in the same raceway

Summary

Where there is more than one grounded conductor within an enclosure, the grounded conductors shall be matched with their corresponding ungrounded conductors by marking, grouping, or other effective means, unless the conductor association is obvious or where conductors pass directly through the enclosure.

Application Question

T F This new requirement for grounded conductor identification/association applies only where there is more than one voltage system within a building.

Answer

False. Neutral identification where the premises wiring is supplied by more than one voltage system is a separate requirement in 200.6(D) for branch circuits and in 215.12(A) for feeders.

Identification for Branch Circuits – Identification of Ungrounded Conductors – Branch Circuits Supplied from Direct-Current Systems

Significance

Where AC and DC circuits exist together in premises wiring, identification of circuit conductors of different systems is necessary for safety and is generally accepted wiring practice.

Analysis

Thomas Alva Edison's argument for DC over Nikola Tesla's AC remains inferior, but a resurgence in popularity of DC systems is occurring with the use of photovoltaic (PV) systems, microgrids, low-voltage suspended ceiling power distribution systems (new Article 393), Article 411 lighting, etc. DC circuits can be used in premises wiring directly from sources without conversion power loss. The 2014 *NEC* has included rules to identify DC branch circuits.

The new identification rules apply to ungrounded DC circuit conductors operating at more than 50 volts. Sizes 4 AWG and larger conductors shall be identified by polarity at all termination, connection, and splice points by marking tape, tagging, or other approved means. Ungrounded conductors sizes 6 AWG and smaller shall also be identified by polarity at all termination, connection, and splice points. The identification means shall be as follows:

Positive Polarity, Sizes 6 AWG or Smaller

- A continuous red outer finish
- A continuous red stripe along the length of the conductor on other than green, white, gray, or black insulation
- Imprinted plus signs (+) or the word POSITIVE or POS marked on an insulation color other than green, white, gray, or black at intervals not exceeding 24 inches in accordance with 310.120(B)



Negative Polarity, Sizes 6 AWG or Smaller

- A continuous black outer finish
- A continuous black stripe along the length of the conductor on an insulation color other than green, white, gray, or red
- Imprinted minus signs (–) or the word Negative or NEG marked on other than green, white, gray, or black insulation at intervals not exceeding 24 inches in accordance with 310.120(B)



The identification means employed for conductors originating in each branch-circuit panelboard or similar branch-circuit distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each branch-circuit panelboard or similar branch-circuit distribution equipment. This posting requirement is the same as existing 210.5(C)(1)(b) for AC branch circuits.

Previously, the rule in 210.5(C)(1) could have been used by the AHJ to apply to DC circuits, where more than one voltage system existed. New subsection (2) provides specific rules for DC circuits as one of the voltage systems, or where only DC circuits exist in premises wiring. In many instances, the DC circuits will be installed in existing buildings with an AC utility supply system.

This new requirement for identifying ungrounded DC conductors is also applied to feeders supplied from direct-current systems in 215.12(C)(2). It has not been applied in Article 690, since Article 690 already has established rules for identifying and marking of PV cables and raceways.

Summary

Ungrounded branch-circuit and feeder conductors supplied from DC panelboards or similar distribution equipment shall be identified by polarity at all termination, connection, and splice points. Sizes 4 AWG and larger conductors shall be identified by marking tape, tagging, or other approved means. Ungrounded positive polarity conductors of sizes 6 AWG and smaller shall be identified by a continuous red outer finish; a continuous red stripe on insulation other than green, white, gray, or black; or imprinted plus (+) signs or the word POSITIVE. Ungrounded negative polarity conductors of sizes 6 AWG and smaller shall be identified by a continuous black outer finish; a continuous black stripe on insulation other than green, white, gray, or red; or imprinted minus (–) signs or the word NEGATIVE. The identification means shall be documented in a manner that is readily available or shall be posted at each panelboard or distribution equipment.

Application Question

What means of identification is required for the *grounded* conductor of a DC circuit?

Answer

For both DC branch circuits and feeders, this new identification requirement applies only to the ungrounded conductors. The requirement contains specific marking for both positive and negative polarities, but in both cases ungrounded conductors. The grounded conductor of a DC circuit is subject to the general rules for identifying grounded conductors in 200.6. Also relevant, new Section 250.167 (covered separately in this text) requires ground-fault detection systems for ungrounded DC systems and permits ground-fault detection for grounded DC systems. Section 250.167(C) requires marking to indicate the grounding type employed, i.e., ungrounded, negative or positive polarity grounded, resistance grounded, or mid-point grounded.

Code Refresher Question

Is there a *neutral* conductor in a 2-wire DC circuit (positive and negative polarity) that is not “earthed” at any point?

Answer

No, regardless of whether the circuit has either polarity connected to earth. A conductor connected to earth is a *grounded* conductor. A 3-wire, DC system contains a neutral point (at its mid-point).

Ground-Fault Circuit-Interrupter Protection for Personnel – Dwelling Units – Bathtubs or shower stalls

Significance

The new Code mandates expanded use of ground-fault circuit-interrupters (GFCIs) in dwelling units.

Analysis

All 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed within 6 ft of the outside edge of a bathtub or shower stall shall be GFCI protected. This change recognizes that not all bathtubs and showers are installed in rooms that qualify as *bathrooms* per the *NEC* definition. Where bathtubs or showers are installed in rooms or areas that require AFCI protection, both AFCI and GFCI protection are required for a receptacle within 6 ft of the tub or shower.

These areas may have tile or other conductive floors that, when wet, increase the hazard of using receptacles located in the area that are not GFCI protected. Note that this change resembles existing 680.71, which requires GFCI protection for receptacles located within 6 ft horizontally of the inside walls of a hydromassage bathtub.



Summary

In dwelling units, all 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed within 6 ft of the outside edge of a bathtub or shower stall shall be GFCI protected. Not all bathtubs and shower stalls are located in bathrooms, where GFCI protection is already required.

Application Question

Does this Code change apply to guest rooms and guest suites?

Courtesy of Interiorholic.com

Answer

The new GFCI requirement does not apply to guest rooms and guest suites unless they qualify as dwelling units.

Code Refresher

- ✓ According to the *NEC*, a *bathroom* is an area that includes a basin and one or more of the following: a toilet, a urinal, a tub, a shower, a bidet, or similar plumbing fixtures.
- ✓ According to the *NEC*, a *dwelling unit* is a single unit, providing complete and independent living facilities for one or more persons, including permanent provisions for living, sleeping, cooking, and sanitation.

Ground-Fault Circuit-Interrupter Protection for Personnel – Dwelling Units – Laundry areas

Significance

Dwelling unit laundry rooms or areas have been added to the list where ground-fault circuit-interrupters (GFCIs) are required.

Analysis

All 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed in dwelling unit laundry rooms or areas shall be GFCI protected. These circuits will also require AFCI protection (see the change in 210.12(A)). The requirement includes all such receptacles in laundry areas, not just the receptacle that supplies a clothes washer. According to existing Section 210.11(C)(2), at least one 20-ampere branch circuit shall be provided to supply the laundry receptacle outlet(s) required by 210.52(F). This circuit shall have no other outlets. Section 210.52(F) requires that, in dwelling units, at least one receptacle outlet be installed in areas designated for the installation of laundry equipment, unless an exception applies. Laundry equipment includes clothes washers, gas clothes dryers (the 120-volt pilot, etc.), clothes irons/flatirons, etc. The principal reason for the change is that laundry areas involve electrical appliances and water, with a resulting increased risk of electric shock.



Courtesy of decorpad.com

Summary

All 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed in dwelling unit laundry rooms or areas shall be GFCI protected.

Application Question

Where the laundry equipment and provisions are located in an area rather than a room, how is the border determined between laundry receptacles and receptacles that are not considered in the laundry area?

Answer

This will be up to the AHJ. It seems reasonable that receptacles intended for and located to serve laundry related equipment would require GFCI protection.

Code Refresher

- ✓ Appliance receptacle outlets installed in dwellings for specific appliances, such as laundry equipment, shall be installed within 6 ft of the intended location of the appliance. [210.50(C)]
- ✓ A load of not less than 1500 volt-amperes shall be included for each 20-A laundry branch circuit installed in a dwelling. [220.52(B)]
- ✓ The load for household electric clothes dryers installed in dwellings shall be either 5000 watts (VA) or the nameplate rating, whichever is larger. [220.54]

Ground-Fault Circuit-Interrupter Protection for Personnel – Other Than Dwelling

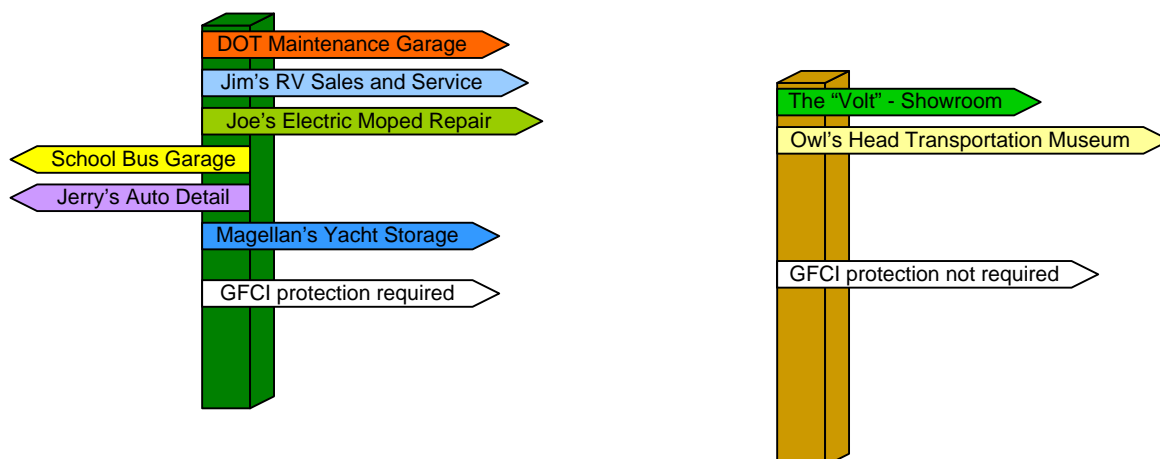
Units – Garages, service bays, and similar areas other than vehicle exhibition halls and showrooms

Significance

This Code change expands the requirement for GFCI-protected receptacles to most types of non-dwelling garages whether or not electrical hand tools or other electrical equipment are to be used.

Analysis

The garages covered by this rule are nondwelling garages not within the scope of Article 511, Commercial Garages, for which GFCI protection for certain receptacles is already a requirement. Article 511 covers areas used for service and repair operations in connection with self-propelled vehicles in which volatile flammable liquids or flammable gases are used for fuel or power. A *flammable liquid* is any liquid that has a closed-cup flashpoint below 100°F (37.8°C). Garages for the service and repair of diesel-fueled vehicles are not within the scope of Article 511, since diesel fuel has a flash point above 100°F.



This Code change applies to nondwelling unit garages (including diesel garages), service bays, and similar areas whether or not electrical diagnostic equipment, electrical hand tools, or portable lighting equipment are to be used. The diagram above shows examples of garages where the rule applies. The Code specifically exempts vehicle showrooms and exhibition halls from the GFCI requirement. See 555.19(B)(1) for GFCI requirements for Magellan's Yacht Storage.

Summary

All 125-volt, single-phase, 15- and 20-ampere receptacles installed in nondwelling garages, service bays, and similar areas shall have GFCI protection for personnel. Vehicle showrooms and exhibition halls are exempt from the GFCI requirement.

Application Question

Does the *NEC* define *garage*?

Answer

Yes, in Article 100: "A building or portion of a building in which one or more self-propelled vehicles can be kept for use, sale, storage, rental, repair, exhibition, or demonstration purposes."

Ground-Fault Circuit-Interrupter Protection for Personnel – Kitchen Dishwasher Branch Circuit

Significance

At some point it seems likely that whole-house GFCI and AFCI will be the norm. The change in 210.8(D) is one of the instances where the 2014 Code requires both GFCI and AFCI protection. AFCI protection is required for the entire circuit; GFCI protection is required for the appliance.

Analysis

GFCI protection shall be provided for outlets that supply dishwashers installed in dwelling unit locations. GFCI devices have proven effective in reducing shock hazards and are particularly important where an electric appliance or equipment is used within reach of grounded surfaces or objects, such as metal sinks or other grounded metal appliances in kitchens. This Code change is not placed within subsection (A) of 210.8, since it address *outlets* rather than receptacles. The new requirement applies to both cord-and-plug connected and hard-wired dishwashers. A new AFCI requirement for kitchen circuits (including the DW circuit) is covered in Section 210.12(A).

An AFCI can be used in conjunction with GFCI protection to provide both arcing fault protection and 5 mA ground-fault protection for persons. One way to provide both types of protection is to use an AFCI circuit breaker and a GFCI receptacle. AFCIs that incorporate 5 mA GFCI protection into the same package should become available in the near future. Both AFCI and GFCI devices must be installed in readily accessible locations.

Visit www.AFCISafety.org for a wealth of information on arc-fault circuit interrupters and use of AFCI and GFCI on the same circuit.



Summary

Dishwashers in dwelling units shall be GFCI protected.

Application Question

Where would you locate a GFCI receptacle that serves the dishwasher in a dwelling?

Answer

Since the GFCI receptacle must be readily accessible, a standard receptacle could be located behind the dishwasher (a common practice) connected downstream from a dead-front/blank face GFCI receptacle located on the wall above the kitchen countertop.

Code Refresher

- ✓ For cord-and-plug-connected appliances, an accessible plug and receptacle is permitted to serve as the required disconnecting means. [422.33(A)]

Arc-Fault Circuit-Interrupter Protection – Dwelling Units

Significance

Whole-house protection from the effects of electric arc faults has been the goal of many entities, including the Consumer Products Safety Commission (CPSC). With expanded arc-fault circuit-interrupter (AFCI) requirements in the 2014 *NEC*, we're almost there.

Analysis

The requirement for AFCI protection for 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets or devices in dwelling units has been expanded to include all such circuits in kitchens and laundry areas. Many dishwasher fires have been reported, so the dishwasher circuit is a reasonable addition to the AFCI requirement. Kitchen appliance circuits, circuits for food waste disposers, lighting circuits, etc. are included in the expanded protection. The AFCI protection for the applicable laundry circuit(s) includes circuits that supply lighting and receptacle outlets in laundry rooms or laundry areas. The only 120-volt, 15- and 20-ampere branch circuits that are exempt from AFCI protection are those that supply outlets in bathrooms, garages, outdoors, and basements, except for basement rooms included in the list of rooms or areas in 210.12(A) requiring AFCI protection (e.g., laundry outlets in a basement require AFCI protection). Foyers are rooms or areas similar to hallways and should be wired to comply with the AFCI requirement.

The 2014 *NEC* requires all AFCI devices to be installed in a *readily accessible* location. This will facilitate resetting and testing. Testing should be performed monthly. An AFCI (or GFCI) receptacle installed beneath a kitchen sink, on or near the back wall of the sink cabinet to supply a food waste disposer, may not, in the judgment of the AHJ, meet the definition of *readily accessible*, “Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to climb over or remove obstacles....” AFCI circuit breakers are readily accessible by compliance with existing 240.24(A), which requires overcurrent devices to be readily accessible. This provision for ready access applies to all subsections of 210.12, including new subsection (C), Dormitory Units.

The 2014 *NEC* presents six options/methods for accomplishing AFCI protection. The methods can be viewed as a *systems* approach to compliance. The combinations of prescribed devices and wiring methods are deemed to provide AFCI protection equal to that of combination-type AFCIs, detecting and mitigating both series and parallel arc faults.

Outlet branch-circuit (OBC) type AFCIs are becoming available. These receptacles along with combination-type and branch/feeder type AFCI circuit breakers are the AFCI components used in the systems approach to AFCI protection of branch circuits. These three devices are pictured on the following page, emphasizing the marking of the AFCI type.

Each of the six options for AFCI protection is described on subsequent pages. Following the description, the system is shown in pictorial form to assist in understanding the details of the requirements.



Siemens Q115AFC 15-amp,
1 pole, 120-volt combination-
type AFCI



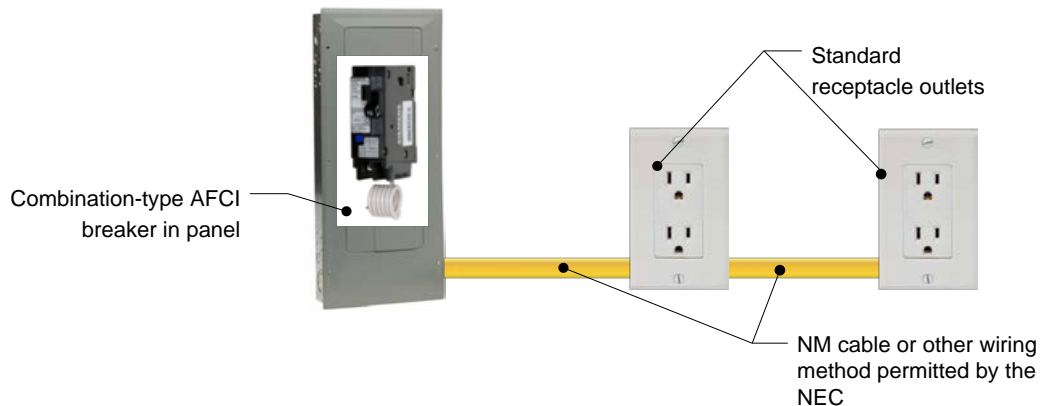
Siemens Q115AF 15-amp, 1 pole,
120-volt branch/feeder AFCI



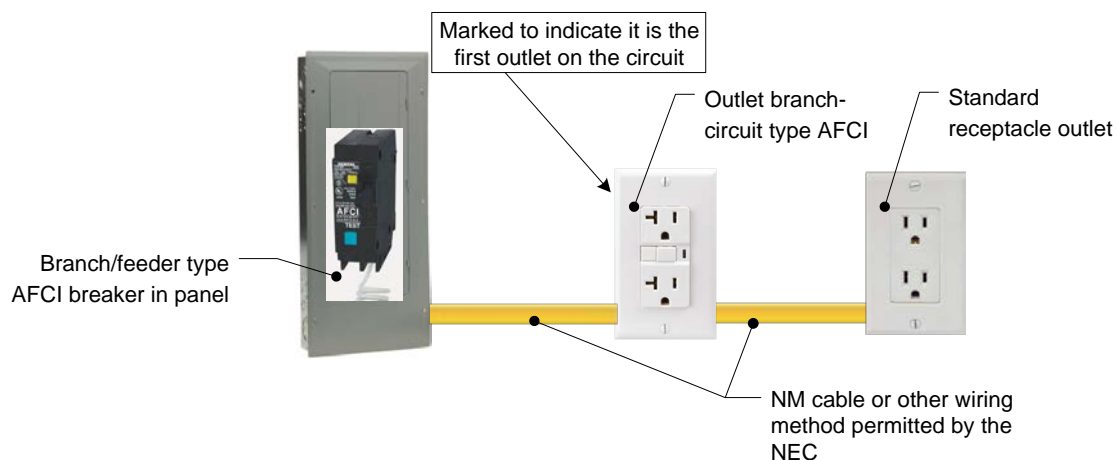
Leviton AFTR1 SmartlockPro®, 15-amp, 125-volt
outlet branch-circuit AFCI receptacle

These are the options for providing AFCI protection:

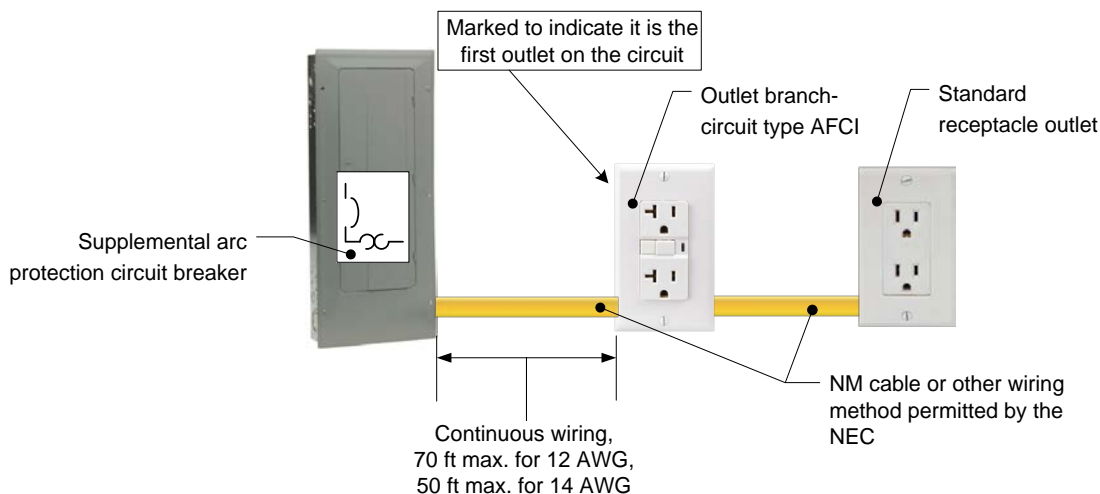
- (1) A listed combination-type AFCI installed to provide protection for the entire branch circuit. There are no additional requirements when this method is used. The system is pictured below.



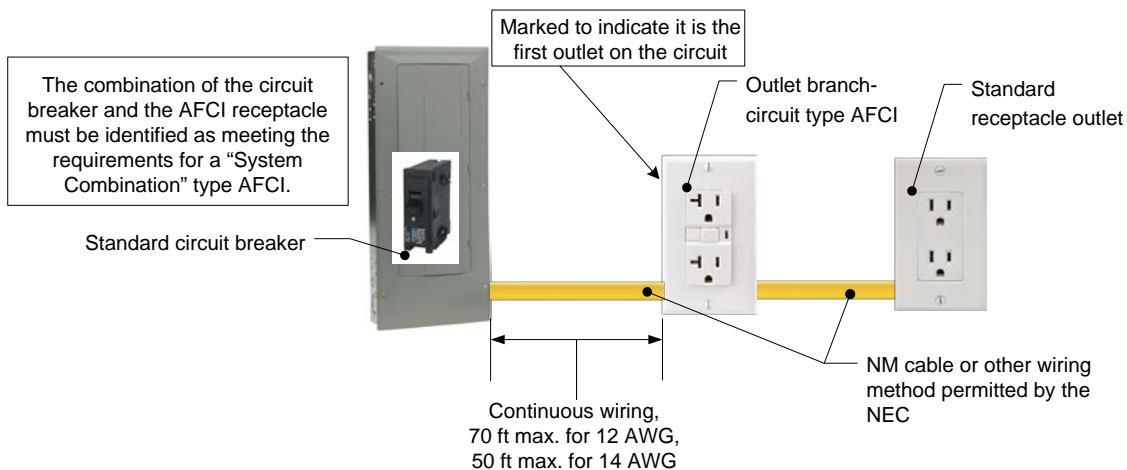
- (2) A listed branch/feeder type AFCI installed at the origin of the branch circuit in combination with a listed outlet branch-circuit (OBC) type AFCI installed at the first outlet box on the circuit. The first outlet box in the circuit shall be marked to indicate that it is the first outlet of the circuit. The system is pictured below.



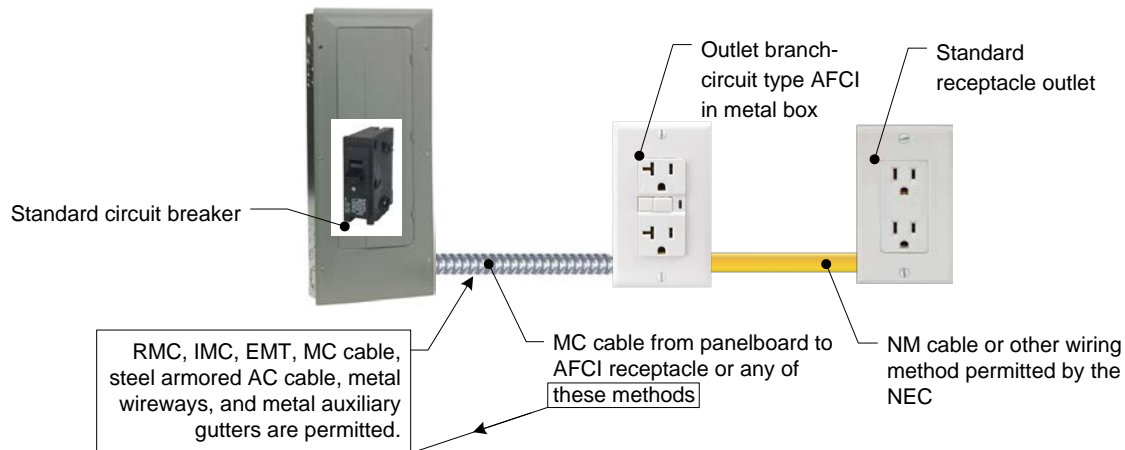
- (3) A listed supplemental arc protection circuit breaker installed at the origin of the branch circuit in combination with a listed outlet branch-circuit (OBC) type AFCI installed at the first outlet box on the circuit, provided the following conditions are met: (a) the branch circuit wiring is continuous from the overcurrent device to the OBC type AFCI, (b) the maximum length of the branch circuit wiring from the overcurrent device to the AFCI device does not exceed 50 ft for a 14 AWG conductor or 70 ft for a 12 AWG conductor, and (c) the first outlet box in the circuit is marked to indicate that it is the first outlet of the circuit. The supplemental arc protection circuit breaker concept is being developed by the circuit breaker industry specifically for this application, based on selected requirements from UL 1699, *Standard for Arc-Fault Circuit-Interrupters*. The system is pictured below.



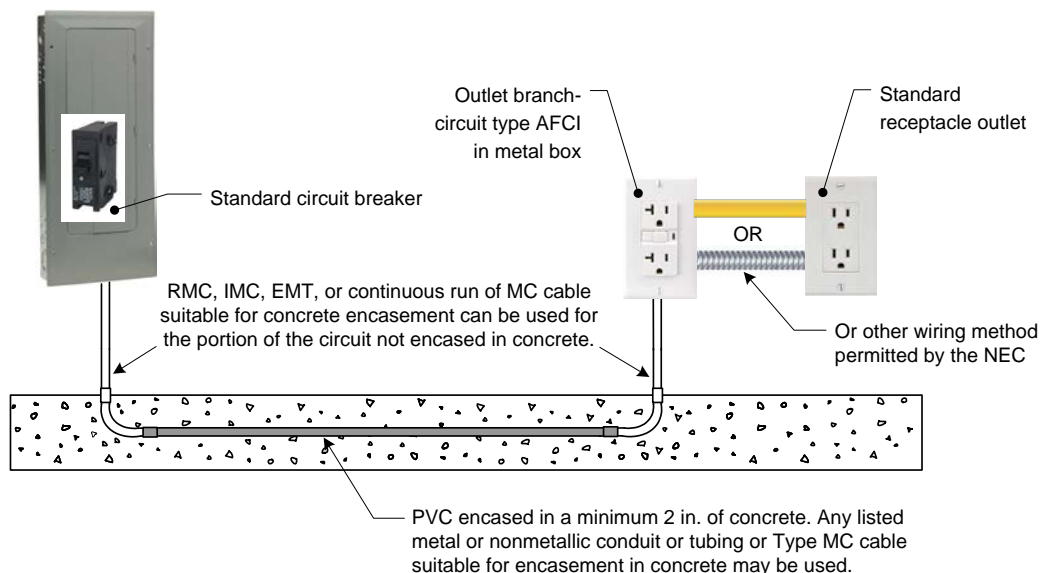
(4) A listed branch-circuit overcurrent protective device (e.g., a standard circuit breaker) installed at the origin of the branch circuit in combination with a listed outlet branch-circuit (OBC) type AFCI installed at the first outlet box on the circuit, provided the following conditions are met: (a) the branch-circuit wiring is continuous from the overcurrent device to the OBC type AFCI, (b) the maximum length of the branch-circuit wiring from the overcurrent device to the AFCI device does not exceed 50 ft for a 14 AWG conductor or 70 ft for a 12 AWG conductor, (c) the first outlet box in the circuit is marked to indicate that it is the first outlet of the circuit, and (d) the combination of the branch-circuit overcurrent device and the AFCI receptacle is identified as meeting the requirements for a “System Combination” type AFCI and is listed as such. This option introduces the concept of certifying a branch-circuit overcurrent device and OBC type AFCI in specific system combinations that have been tested and certified to comply with UL 1699 using a new outline of investigation. After this outline is developed, it will be published as UL Subject 1699C. The system is pictured below.



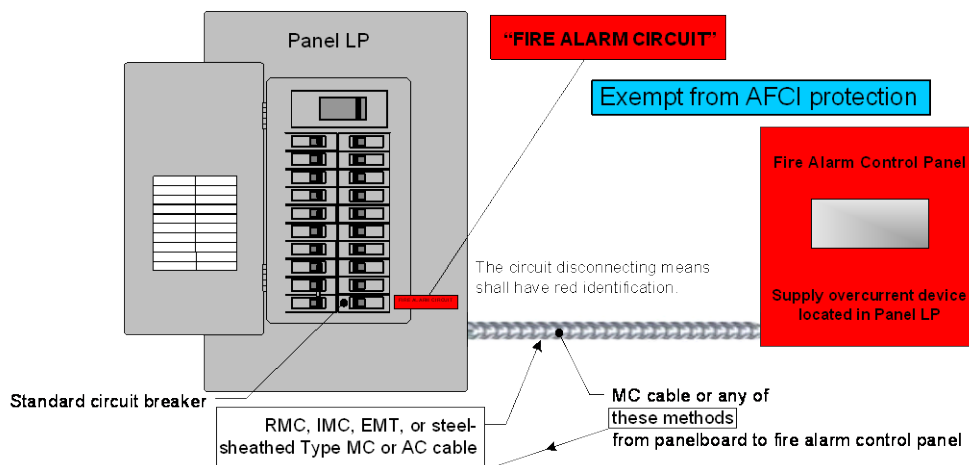
(5) Where RMC, IMC, EMT, Type MC cable, or steel armored Type AC cables meeting the requirements of 250.118 for equipment grounding conductors, metal wireways, metal auxiliary gutters, and metal outlet and junction boxes are installed for the portion of the branch circuit between the overcurrent protective device and the first outlet, it shall be permitted to install a listed OBC type AFCI device at the first outlet to provide protection for the remaining portion of the branch circuit. Metal wireways or large junction boxes installed above panels are a convenient way to transition from horizontally run branch circuits to vertical raceways between the panels and the wireway or junction box(s) located above the panels. As such, they become part of the raceway system for the branch circuits. The system is pictured below.



(6) Where a listed metal or nonmetallic conduit or tubing or Type MC cable is encased in not less than 2 in. of concrete for the portion of the branch circuit between the branch circuit overcurrent device and the first outlet, it shall be permitted to install a listed OBC type AFCI device at the first outlet to provide protection for the remaining portion of the branch circuit. The system is pictured below.



Exception Where an individual branch circuit for a fire alarm system installed in accordance with 760.41(B) or 760.121(B) is installed in RMC, IMC, EMT, or steel-sheathed Type AC or MC cable meeting the equipment grounding requirements in 250.118, with metal outlet and junction boxes, AFCI protection shall be permitted to be omitted. Sections 760.41(B) for non-power-limited fire alarm circuits and 760.121(B) for power-limited fire alarm circuits state that the fire alarm branch circuit shall not be supplied through AFCI or GFCI devices. Single- and multiple-station smoke alarms in dwellings powered by circuits that are protected by GFCI or AFCI devices shall have a secondary power source [see 29.6.3(5) of NFPA 72-2013, *National Fire Alarm and Signaling Code*].



Summary: The requirement for AFCI protection for 120-volt, single-phase, 15- and 20-ampere branch circuits in dwelling units has been expanded to include all such circuits in kitchens and laundry areas. The only branch circuits that are exempt from AFCI protection are those that supply outlets or devices in bathrooms, garages, outdoors, and basements, except for basement rooms included in the list of rooms or areas in 210.12(A) requiring AFCI protection (e.g., laundry outlets in a basement require AFCI protection). The 2014 *NEC* requires all AFCI devices to be installed in a *readily accessible* location to facilitate resetting and testing. The 2014 Code presents six options/methods for accomplishing AFCI protection. The methods can be viewed as a *systems* approach to compliance. The most common methods for providing AFCI protection for branch circuits will likely be by use of combination-type AFCI circuit breakers, or by combining standard circuit breakers with outlet branch-circuit type AFCIs (AFCI receptacles) as a systems approach to branch circuit AFCI protection. A circuit breaker that provides both AFCI and GFCI protection could be available soon and find wide use in light of 2014 *NEC* changes and expected future changes. Panelboards that contain neutral busbars to directly supply the neutral to these devices are already on the market (e.g., plug-on neutral loadcenters).

Application Question: When using a standard circuit breaker in combination with an OBC type AFCI to provide AFCI protection for a branch circuit installed in wood framing members, what wiring method(s) are permitted to be used between the overcurrent device and the first outlet?

Answer: RMC, IMC, EMT, Type MC cable, steel armored Type AC cable meeting the requirements of 250.118, metal wireways, metal auxiliary gutters, and metal outlet and junction boxes can be installed for the portion of the branch circuit between the circuit breaker and the first outlet (AFCI receptacle) to provide AFCI protection for the branch circuit.

Arc-Fault Circuit-Interrupter Protection – Branch Circuit Extensions or Modifications — Dwelling Units

Significance

A new exception has been added to this subsection that will help to clarify when AFCI requirements are applicable to circuit extensions or modifications to existing wiring.

Analysis

The new exception states that the AFCI requirement is not applicable for dwelling unit branch circuit extensions, where the circuit extension is not more than 6' in length and no additional outlets or devices are added to the circuit. When an existing panel is replaced or upgraded, the branch-circuit wiring is not always long enough to connect to the panel overcurrent devices. The exception will allow existing branch circuits to be spliced and extended up to 6' in cable length without requiring AFCI protection for the branch circuits. This will accommodate panels being moved out of clothes closets and bathrooms, service panels (during service upgrades) being moved closer to where the service-entrance conductors penetrate the outside wall of a building, panels being moved to readily accessible locations, and other situations.

The existing AFCI requirement remains the same. In any of the areas specified in 210.12(A), where branch-circuit wiring is extended, modified, or replaced, the branch circuit shall be protected by either

- A listed combination-type AFCI located at the origin of the branch circuit, or
- A listed outlet branch-circuit type AFCI device located at the first receptacle outlet of the existing branch circuit.

This subsection applies also to kitchens and laundry rooms or areas, since these rooms have been added to the list in 210.12(A). The AFCI devices must meet the new requirement at the beginning of 210.12 for ready access.

Summary

AFCI requirements are not applicable to dwelling unit branch circuit extensions, where the circuit extension is not more than 6' in length and no additional outlets or devices are added to the existing branch circuit.

Application Question

Statistics show that the majority of electrical fires occur in older homes. How does this exception promote enhanced safety of older circuits that would be better protected by AFCI devices?

Answer

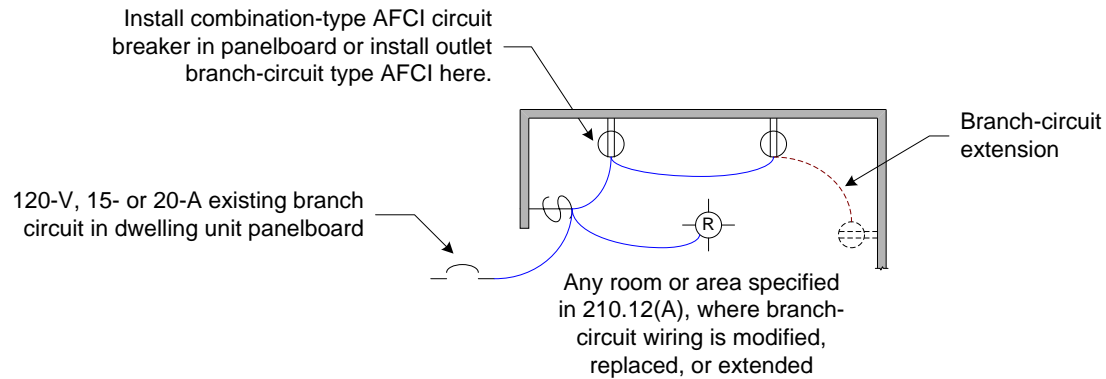
It doesn't. However, it does encourage other safety enhancements like moving panels to Code-compliant locations, upgrading from fuses to circuit breakers, or increasing the size of an overloaded service (all of which may require circuit extensions), without necessitating the extra cost of AFCI devices. For some, particularly in hard economic times, this extra cost could be a deterrent from making a service or panel upgrade, or from moving a panel. Note that the exception does not apply to circuit modifications or replacements—only short extensions of existing branch circuits, where no outlets or devices are added.

Technical Update

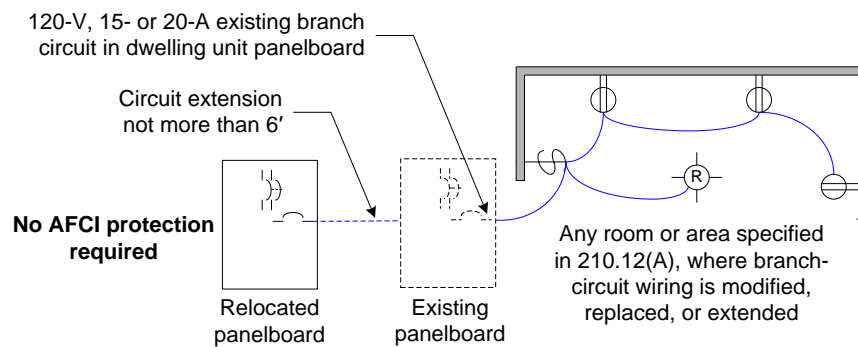
You may be wondering how an AFCI receptacle installed at the first receptacle outlet on an existing circuit compares with a combination-type AFCI circuit breaker in terms of protection of the entire branch circuit. Outlet branch-circuit (OBC) type AFCIs provide both upstream and downstream protection from series arc faults, but provide only downstream protection from parallel arc faults. So, how is the “home run” (that portion of a circuit from the overcurrent device to the first outlet) protected against parallel arcing faults?

Studies have shown that the home run portion of a circuit is, on average, approximately 35% of the total branch circuit length. The magnetic trip (instantaneous) function of a conventional circuit breaker will usually clear a parallel arcing fault in the portion of the circuit from the circuit breaker to the AFCI receptacle. This is contingent on the available fault current at the panel being high enough (approximately 500 A), the instantaneous trip value of the circuit breaker being low enough (less than 200 A), and a low conductor impedance from the circuit breaker to the location of the fault. The conductor impedance depends on the conductor length, size, and material. These parameters were used in writing some of the options in 210.12(A). The home run of a circuit is generally less vulnerable to a fault, being enclosed by construction and not containing splices or cord extensions. The home run conductors are continuous from the circuit breaker to the AFCI device, except perhaps for a switch outlet in an existing branch circuit that could be between the circuit breaker and the AFCI receptacle.

In existing NM cable installations, the AFCI receptacle option cannot be guaranteed to provide equivalent protection to that of a combination-type AFCI installed at the origin of the circuit. Only the options in 210.12(A) provide combination-type AFCI protection or its equivalent. Note that options (5) and (6) of 210.12(A) require more robust protection for the home run than Type NM cable affords.



Section 210.12(B), general rule, 2011 and 2014 *NEC*



Section 210.12(B), Exception, 2014 *NEC*

Arc-Fault Circuit-Interrupter Protection – Dormitory Units

Significance

A new subsection has been added to the requirement for AFCI protection of certain branch circuits.

Analysis

This new subsection addresses AFCI protection for certain branch circuits in dormitory units. All 120-volt, single-phase, 15- and 20-ampere circuits installed to supply outlets in dormitory unit living rooms, bedrooms, hallways, closets, and similar rooms now require AFCI protection using any of the methods in (1) through (6) of 210.12(A). In a typical dormitory room, all branch circuits will require AFCI protection.

Some living facilities for students at colleges and other institutions are apartments rather than dormitories. They qualify as dwelling units per the definition of *dwelling unit* and must be wired as such. As used in this subsection, dormitory unit does not envision a bathroom or cooking provisions within the dormitory unit (compartment). A portable microwave oven does not constitute permanent provisions for cooking.



The AFCI protection requirement now includes dormitory units.

Summary

All 120-volt, single-phase, 15- and 20-ampere circuits installed to supply outlets in dormitory unit living rooms, bedrooms, hallways, closets, and similar rooms require AFCI protection using any of the methods in (1) through (6) of 210.12(A).

Application Question

Does this new AFCI requirement apply to modification, extension, or replacement of branch circuit wiring in existing dormitory units?

Answer: No. It applies only to newly installed branch circuits that require AFCI protection.

Code Refresher

- ✓ Receptacle placement in dormitory units is permitted to accommodate permanent furniture layout, but the quantity of receptacles installed must be in accordance with 210.52(A) for dwelling units. At least two receptacle outlets shall be readily accessible. Where a receptacle is installed behind a bed, the receptacle shall be located to prevent the bed from contacting any attachment plug that may be inserted or the receptacle shall be provided with a suitable guard. [210.60]

Ground-Fault Protection of Equipment

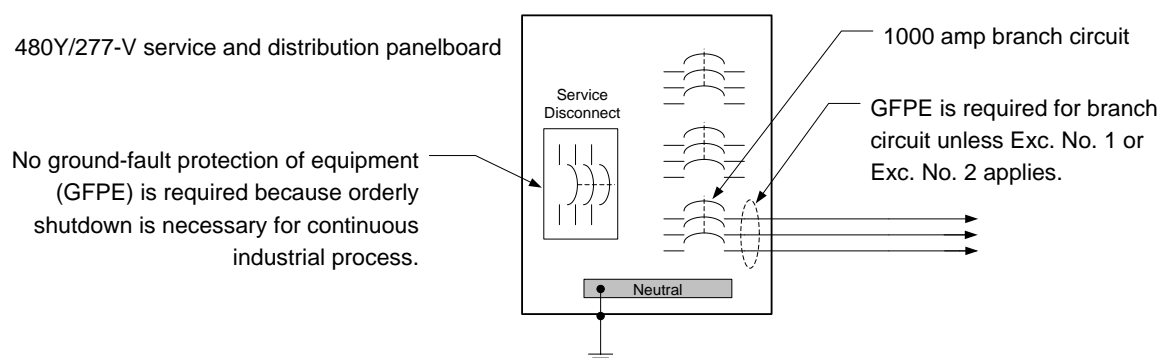
Significance

This new section will not find wide use but is significant because it involves an expansion of the ground-fault protection of equipment (GFPE) requirement.

Analysis

New Section 210.13 requires that each branch circuit disconnect rated 1000 A or more and installed on solidly grounded wye electrical systems operating at more than 150 volts to ground, but not exceeding 600 volts phase-to-phase, be provided with GFPE in accordance with the provisions of 230.95. This protection is designed to limit damage to conductors and equipment when a fault occurs. Each ground-fault protection system must be performance tested and documented in accordance with the requirements in 230.95(C). A 1000 amp branch circuit is rare, but could exist in industrial settings.

The new section includes an informational note and two exceptions that are essentially the same as follows Section 215.10, which address GFPE for feeders. The informational note reminds Code users that 517.17 must be considered for buildings that contain health care occupancies. Exception No. 1 addresses a continuous industrial process where a nonorderly shutdown will introduce additional or increased hazards. Exception No. 2 waives the GFPE requirement where GFPE is installed on the supply side of the branch circuit and on the load side of any transformer that supplies the branch circuit.



Summary

Each branch circuit disconnect rated 1000 A or more and installed on solidly grounded wye electrical systems operating at more than 150 volts to ground, but not exceeding 600 volts phase-to-phase, shall be provided with ground-fault protection of equipment.

Application Question

T F A GFPE device will protect persons from shock hazard.

Answer

False. A 5 mA-trip GFCI (Class A) device is designed to protect persons from electric shock. GFPE devices are available that trip at ground faults of 30 mA and higher.

Part I. General Provisions – Electric Vehicle Branch Circuit

Significance

This is a new section providing rules for branch circuits for electric vehicle charging equipment.

Analysis

An outlet(s) installed to supply electric vehicle charging equipment shall be supplied from a separate branch circuit. This branch circuit shall not supply any other outlets (other than electric vehicle charging equipment). This is not the same as requiring an *individual branch circuit*, which by definition can supply only one utilization equipment. Note that this new section does not fall within Part III. Required Outlets; therefore, a receptacle for electric vehicle charging equipment is not required to be installed.

The charging equipment is considered a continuous load. The load must be calculated at 125% of the rated load. This can be a significant load and could affect the adequacy of an existing service. There is a related change in 625.41, which states that where an automatic load management system is used, the maximum electric vehicle supply equipment load on a service and feeder shall be the maximum load permitted by the automatic load management system.

Article 625 – Electric Vehicle Charging System has undergone a total re-write. The most significant changes are more detailed rules pertaining to supply cords and receptacles for electric vehicle charging equipment and cords between the charging equipment and the vehicle.



Courtesy of Leviton Manufacturing Co., Inc.

Cord-connected electric vehicle charging station
16-A, 240-V, 3.8 kW output

Summary

If an outlet(s) is installed to supply electric vehicle charging equipment, it shall be supplied by a separate circuit that has no other outlets. The load shall be 125% of the rated load or the maximum permitted by an automatic load management system.

Application Question

T F A receptacle for the connection of electric vehicle charging equipment is required to be installed for all new dwellings.

Answer

False. It is not a required outlet.

**Conductors—Minimum Ampacity and Size – Branch Circuits Not More Than 600 Volts
Minimum Rating and Size – Feeders Not More Than 600 Volts****Significance**

These revisions are intended to provide clarity on sizing conductors that supply continuous loads.

Analysis

The existing Code language in 210.19(A)(1) for branch circuits and 215.2(A)(1) for feeders has caused confusion in their application. Code users have found it difficult to interpret the Code rules for wire sizing, where continuous loads and adjustment or correction factors are involved.

The 2014 revision to these sections attempts to clarify the application of these rules. Two separate calculations are specified, and conductors are sized based on the larger of the two resulting conductor sizes, where the separate calculations result in different conductor sizes. Conductors shall be not smaller than the larger of the sizes calculated in accordance with subsections (a) or (b) of 210.19(A)(1) or 215.2(A)(1) as applicable.

- (a) Where a branch circuit or feeder supplies continuous loads or a combination of continuous and noncontinuous loads, the minimum conductor size shall have an ampacity not less than the noncontinuous load plus 125 percent of the continuous load.
- (b) The minimum branch-circuit or feeder conductor size shall have an ampacity not less than the maximum load to be served after the application of any adjustment or correction factors.

Example

A 3-phase, 4-wire feeder supplies a continuous, nonlinear lighting load of 60 amperes. The feeder circuit conductors are installed in EMT. The conductors that will be used are rated 90°C. Terminations are rated 75°C. What size aluminum conductors are required to supply the load?

Calculations based on subsection (a):

$$60 \times 1.25 = 75 \text{ A (minimum required conductor ampacity)}$$

From Table 310.15(B)(16): A 3 AWG aluminum conductor is permitted (75 A, 75°C column).

Calculations based on subsection (b):

The second paragraph of Section 310.15(B) permits applying adjustment or correction factors to the table ampacity listed for the conductor insulation, provided the adjusted or corrected ampacity does not exceed the ampacity listed for the temperature rating of the terminations in accordance with 110.14(C).

From Table 310.15(B)(3)(a): Adjustment for four current-carrying conductors = 80% or 0.80

From Table 310.15(B)(16): The 90°C ampacity for a 3 AWG aluminum conductor is 85 A.

$$85 \text{ A} \times 0.80 = 68 \text{ A (adjusted ampacity for a 3 AWG aluminum conductor rated 90°C)}$$

#3 Al conductors rated 75°C or 90°C are permitted, since the adjusted ampacity is at least 60 A.

Summary

There is a change in the method of sizing branch-circuit and feeder conductors where a portion of the load, or the entire load, is continuous, and adjustment or correction factors, or both, are required to be considered.

Dwelling Unit Receptacle Outlets – Outdoor Outlets – One-Family and Two-Family Dwellings – Multifamily Dwellings

Significance

This change now permits an interpretation of Code that some electrical inspectors have already been using for locating the required outdoor receptacles at dwellings.

Analysis

Rather than “accessible while standing at grade level” the required outdoor receptacles for dwelling units are now permitted to be “readily accessible from grade.” In the 2011 *NEC*, in order for a receptacle located on a deck or open porch with steps to grade to serve as one of the required outdoor receptacles, the receptacle had to be located near enough to the edge of the deck or porch to be reached while standing at grade level. The 2014 Code allows a receptacle that is *readily accessible* from grade and located on a deck or porch to serve a twofold purpose: as one of the required outdoor receptacles, and as the required receptacle for decks and porches in 210.52(E)(3). Where a deck or porch exists, most outdoor receptacle use will be for electrical equipment on the deck or porch. Where a deck or porch is covered (damp location), this new permission will enable safer use of outdoor outlets by avoiding locating a receptacle in a wet location. Of course, additional outlets accessible while standing at grade level can be installed.



The rule is essentially the same for multifamily dwellings. For each unit at grade level and provided with individual exterior entrance/egress, at least one receptacle *readily accessible* from grade and not more than 6½ ft above grade level is required.

Summary

The required outdoor receptacles for one-family dwellings, each grade-level unit of two-family dwellings, and for each grade-level unit of multifamily dwellings with individual exterior entrance/egress, the required outdoor receptacle outlet(s) shall be *readily accessible* from grade and not more than 6½ ft above grade level.

Application Question: If one of the required outdoor receptacles is on a deck or porch with steps to grade, is there a maximum height or number of steps that would make this deck or porch receptacle not qualified to serve as a required outdoor receptacle?

Answer: The Code substantiation suggested “not up more than a few steps.” The receptacle cannot be more than 6½ ft above grade level. One interpretation is that the receptacle cannot be more than 6½ ft above the level of the deck or porch walking surface as in 210.52(E)(3).

Dwelling Unit Receptacle Outlets – Outdoor Outlets – Balconies, Decks, and Porches

Significance

The new Code allows flexibility in locating outdoor receptacles to serve holiday lighting and other loads at small decorative balconies, decks, and porches.

Analysis

In the 2011 *NEC*, a receptacle was required to be located within the perimeter of a dwelling unit balcony, deck, or porch, where this area was accessible from inside the dwelling unit. For small decorative balconies, it proved difficult to locate the receptacle within the perimeter of the balcony, since doors often spanned most or all of the available exterior wall space. This change permits the required 125-volt, 15- or 20-ampere receptacle to be installed at a location that is *accessible* from the balcony, deck, or porch. As in the previous Code, the receptacle cannot be located more than 6½ ft above the balcony, deck, or porch walking surface.

This subsection also has been revised to apply only to decks and porches that are *attached* to the dwelling unit.

Receptacle accessible from balcony



Summary

Balconies, decks, and porches that are accessible from inside the dwelling unit shall have at least one receptacle outlet *accessible* from the balcony, deck, or porch. The receptacle outlet shall not be located more than 6½ ft above the walking surface of the balcony, deck, or porch.

Application Question

Besides the requirements in this section, what other rules apply to an outdoor receptacle for a balcony, deck, or porch of a dwelling unit?

Answer

The receptacle must be GFCI protected [210.8(A)(3)], tamper resistant [406.12(A)], be a listed weather-resistant (WR) type, and be equipped with a weatherproof enclosure suitable for either a damp or wet location, whichever is the case [406.9(A) and (B)(1)].

Dwelling Unit Receptacle Outlets – Basements, Garages, and Accessory Buildings – Garages

Significance

Most new single-family dwellings include 2- or 3-car garages. This has prompted a change to the receptacle requirement for residential garages.

Analysis

The rule requiring only one receptacle for a single-family garage, in addition to any receptacles required for specific equipment, is outdated. Garage space has become larger and has seen uses in addition to vehicle parking, such as recreational vehicle storage, workshops, home hobbies, etc. If only one receptacle is available in a multicar garage, odds are good that extension cords will be needed for car cleaning and other maintenance, and for a host of do-it-yourself projects. The 2014 Code requires at least one receptacle for each car space/lane. Each required receptacle should be placed to conveniently serve a vehicle space. The circuit(s) for this receptacle(s) is not permitted to supply outlets outside of the garage. This rule will also help to accommodate the increase in use of electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs). A Level 1 EV charger is supplied from a standard 125-volt receptacle (16 A maximum on a 20-A circuit). If it is known that the garage will be used for an electric vehicle, a separate branch circuit for charging should be installed in accordance with new Section 210.17.



This 3-car garage requires a minimum of three receptacles, in addition to any receptacles required for specific equipment.

Summary

For a single-family dwelling attached garage, or a detached garage with electric power, at least one receptacle outlet shall be installed for each car space, in addition to any receptacles provided for specific equipment. The branch circuit(s) supplying this receptacle(s) shall not supply *outlets* outside of the garage.

Application Question

Can the circuit supplying the receptacles for car spaces also serve garage lighting?

Answer

Yes. It can supply lighting outlets within the garage. It is not clear whether lighting and receptacle outlets on the outdoor side of the exterior garage wall can be supplied.

Part III. Required Outlets – Electrical Service Areas

Significance

A convenience receptacle is required at electrical service areas.

Analysis

This is a new section in 2014 that requires at least one 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet to be installed within 50 ft of the electrical service equipment. The outlet is not required in one- and two-family dwellings. The purpose is to accommodate electrical data acquisition and other test equipment and to facilitate maintenance, without the need to run extension cords into adjacent rooms or areas. The rule is not limited to indoor installations of service equipment.



Indoor service equipment room

Outdoor service equipment



The electrical equipment in a separate building supplied from another building is not service equipment and is not subject to the new requirement. The separate building might contain an electric room where a feeder enters the building, but the rule pertains only to an electric room that contains the electrical service. A feeder electrical entrance into a building is covered in Art. 225.

New Section 210.64 is similar to the existing requirement in 210.63, which requires a convenience receptacle located on the same level and within 25 ft of heating, air-conditioning, and refrigeration (HVAC) equipment.

Summary

For other than one- and two-family dwellings, at least one 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed within 50 ft of the electrical service equipment to accommodate electrical data acquisition and other test equipment and to facilitate maintenance.

Application Question

Does the required receptacle have to be located in the electrical service room?

Answer

Interestingly no. Most electrical rooms do not measure 50 ft in any direction! Ask the AHJ.

Part II. Branch-Circuit Load Calculations – Lighting Load for Specified Occupancies – Exception

Significance

The 2014 *NEC* has made provisions to permit the lower general lighting load allowance specified by energy codes. States must adopt specified model energy codes or their equivalent.

Analysis

Two popular model energy codes, ASHRAE/IES 90.1-2010, *Energy Standard for Buildings Except Low-Rise Residential Buildings* and IECC 2012, *International Energy Conservation Code* contain standards for energy reduction and efficiency, including standards for lighting. A key concept of energy codes is the limit that is set on lighting power density (LPD, measured in watts/ft²). Automatic lighting controls are also a major component of energy codes. The LPD values have decreased over the years with implementation of increasingly efficient lighting technologies. Smaller electrical services will result in cost savings and reduced levels of fault current and arc flash energy; smaller transformers will reduce the amount of lost energy.

Section 220.12 specifies the minimum lighting load for specified occupancies. Where a municipality has adopted an energy code, the lighting load allowed by that energy code will be significantly less than that permitted in the *NEC*. For instance, the typical energy code LPD for offices is .9 W/ft², 1.4 W/ft² for retail occupancies, and .6 W/ft² for warehouse buildings.

Example: Retail store lighting load calculation: 40 ft x 60 ft = 2400 ft² total floor area

NEC 2400 x 3 VA = 7200 VA

Energy code 2400 x 1.4 W/ft² = 3360 W, a 53% reduction from the *NEC* value

The *NEC* contains a new exception that permits use of the lighting load value determined in accordance with an adopted energy code provided that:

1. A power monitoring system is installed that will provide continuous information regarding the total general lighting load of the building,
2. The power monitoring system is set with alarm values to alert the building owner or manager if the lighting load exceeds the values set by the energy code, and
3. The demand factors in 220.42 are not applied to the general lighting load.

Summary

The general lighting load is permitted to be calculated according to the adopted energy code in lieu of the values specified in 220.12 of the *NEC*, where the load is continuously monitored and the building manager will be alerted if the load exceeds the value set by the energy code. The demand factors in 220.42 are not permitted to be applied to the general lighting load.

Application Question

For a 1000 ft² office, what is the difference in the lighting load allowance between the *NEC* and typical energy codes?

Answer

2600 VA. (1000 x 3.5) – (1000 x .9) = 3500 – 900 = 2600 VA.

Part VII. Circuit Breakers – Arc Energy Reduction

Significance

Section 240.87 was introduced in the 2011 Code and has been revised in the 2014 Code cycle. It contains rules for reducing incident energy caused by arcing fault currents.

Analysis

Where the highest continuous current trip setting for which an overcurrent device installed in a breaker is rated (or can be adjusted to) is 1200 amps or higher, one of the means listed below shall be provided to reduce clearing time. Documentation as to the location of the circuit breaker shall be available to those authorized to design, install, operate, or inspect the installation.

1. Zone-selective interlocking – Upstream and downstream circuit breakers communicate with each other and determine whether the upstream breaker should trip without intentional delay or after a preset time delay, depending on the location of the fault.
2. Differential relaying – The current flowing into the upstream breaker is compared with the current flowing out of the downstream breaker. Under normal conditions, the difference is zero. A fault between the upstream and downstream breakers will result in a difference current that will reach the level of a preset setting and cause the upstream breaker to trip without delay.
3. Energy-reducing maintenance switching with local status indicator – A worker can set the trip unit to “no intentional delay” whenever working within the flash protection boundary, and then back to the normal setting when finished.
4. Energy-reducing active arc flash mitigation system (a new option in the 2014 Code) – Helps in reducing arcing duration in the electrical distribution system. No change in the circuit breaker or the settings of other devices is required during maintenance when a worker is working within an arc flash boundary. (Arc Flash Boundary is defined in NFPA 70E, *Standard for Electrical Safety in the Workplace*.)
5. An approved equivalent means – This allows for new technology and innovation.



Digitrip 520MC, Model 5ARMLSIG trip unit for a Magnum DS Power Circuit Breaker
Courtesy of Eaton Corporation and BREAKER OUTLET Circuit Breakers

“Maintenance Mode”

“Arc Flash Reduction Setting”

Summary

Where the highest continuous current trip setting for which an overcurrent device installed in a breaker is rated (or can be adjusted to) is 1200 amps or higher, an approved means shall be employed to reduce clearing time.

Application Question

Does an instantaneous trip function in a circuit breaker meet the requirements in this section?

Answer

Yes. However, this is not clear in the actual text of the *NEC*. It seems the intent is for this rule to apply only where the breaker is (1) intentionally delayed under short-circuit conditions, and (2) does not have an instantaneous trip function, and (3) does not have an instantaneous override, or the instantaneous override is set higher than the potential arcing current.