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NEC 2017 Code Changes in Wiring & Protection

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Wiring & Protection

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210.5(C)(1), Exception Identification for Ungrounded Conductors

- **Type of Change:** New

- **Change at a Glance:** A new exception was added for identifying each ungrounded conductor for existing installations where a voltage system(s) already exists and a different voltage system is being added.

- **Code Language:** 210.5 Identification for Branch Circuits.

(C) **Identification of Ungrounded Conductors.** Ungrounded conductors shall be identified in accordance with 210.5(C)(1) or (2), as applicable.

(l) **Branch Circuits Supplied from More Than One Nominal Voltage System.** Where the premises wiring system has branch circuits supplied from more than one nominal voltage system, each ungrounded conductor of a branch circuit shall be identified by phase or line and system at all termination, connection, and splice points in compliance with 210.5(C)(1)(a) and (b).

(a) **Means of Identification.** The means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means.

(b) **Posting of Identification Means.** The method utilized for conductors originating within 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. The label shall be of sufficient durability to withstand the environment involved and shall not be handwritten.

**Exception:** In existing installations where a voltage system(s) already exists and a different voltage system is being added, it shall be permissible to mark only the new system voltage. Existing unidentified systems shall not be required to be identified at each termination, connection, and splice point in compliance with
210.5(C)(1)(a) and (b). Labeling shall be required at each voltage system distribution equipment to identify that only one voltage system has been marked for a new system(s). The new system label(s) shall include the words “other unidentified systems exist on the premises.”

2014 NEC Requirement
Where the premises wiring system has branch circuits supplied from more than one nominal voltage system, each ungrounded conductor of a branch circuit be identified by phase or line and system at all termination, connection, and splice points. The means of identification for these different voltage systems can be by separate color coding, marking tape, tagging, or other approved means. These identification means must be documented in a manner that is readily available or permanently posted at each branch-circuit panelboard or similar branch-circuit distribution equipment.

2017 NEC Change
The previous identification requirements for branch circuits supplied from more than one nominal voltage system moved forward for the 2017 NEC with a new exception added for relief from identifying each ungrounded conductor for existing installations where a voltage system(s) already exists and a different voltage system is being added. A new requirement was also added concerning the durability and makeup of the labels.

Analysis of the Change:
In the 2002 edition of the NEC, 210.4(D) addressed the identification of multi-wire branch circuits where more than one nominal voltage system existed in the same building or premise. For the 2005 NEC, these requirements were shifted to 210.5(C), and revisions made this identification requirement mandatory for all branch circuits (not just multiwire branch circuits). For the 2017 NEC, a new exception was added for 210.5(C) that would make these branch circuit identification rules applicable only to the new system(s) of existing installations where a voltage system(s) already exists and a different voltage system is being added. Existing unidentified systems will not be required to be identified at each termination, connection, and splice point in compliance with 210.5(C)(1)(a) and (b) under this new exception.

In existing and older buildings, numerous systems exist that are supplied by more than one nominal voltage system and were installed prior to the adoption of the 2005 NEC [when 210.5(C) was first mandated]. These older systems were and are not identified at each termination, connection, and splice point. This new exception will allow existing unidentified installations to remain in place without requiring the addition of identification in compliance with 210.5. It is not practical to remove every existing device, luminaire, connection point, or to open every junction box cover of the old existing system to mark the existing branch circuit conductors. The majority of the enforcement community might have already offered this relief for these existing systems as the Code is not retroactive, but this new exception will make this allowance very clear.

This new exception also includes some labeling requirements for older existing unidentified installations that would require a label at each voltage system distribution equipment point to identify that only the added voltage system(s) have been marked or identified at each termination, connection, and splice point for a new system(s). This new label(s) will be required to include the words “Other Unidentified Systems Exist on the Premises.”

One other change that occurred was to add a requirement that the label for 210.5(C)(1)(b) be “sufficiently durable” and able to withstand the environment in which it is installed. This added text will also require that the marking on the label be legible and not handwritten. This text is very similar to existing language found at 110.21(B) for field-applied hazard markings and other locations throughout the Code.

First Revisions: FR 302
Second Revisions: 304, SCR 68
Public Inputs: PI 4496, PI 2712
Public Comments: PC 877

210.8
Measurements for GFCI Protection

210.8 Ground-Fault Circuit-Interrupter Protection for Personnel

- Type of Change: New

- Change at a Glance: New language added to clarify how measurements are to be determined for GFCI receptacle.

- Code Language: 210.8 Ground-Fault Circuit-Interrupter Protection for Personnel. Ground-fault circuit-interrupter protection for personnel shall be provided as required in 210.8(A) through (D) (E). The ground-fault circuit interrupter shall be installed in a readily accessible location.

Informational Note No. 1: See 215.9 for ground-fault circuit-interrupter protection for personnel

Informational Note No. 2: See 422.5(A) for GFCI requirements for appliances.

For the purposes of this section, when determining distance from receptacles the distance shall be measured as the shortest path the cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window.

- NEC Requirement
  No Code provisions existed at 210.8 giving clear-cut direction on the proper measurement technique to employ when determining the necessity of GFCI protection.

- 2017 NEC Change
  A new provision was added to the parent text of 210.8 to indicate that measurements from receptacles to objects (such as a sink) that would qualify for GFCI protection should be measured as the “shortest path” a cord of an appliance connected to a receptacle would take without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window.

Analysis of the Change:
How is the measurement supposed to be made when the Code gives a measurable dimension such as where receptacles are installed within 1.8 m (6 ft) of the outside edge of a sink they require GFCI protection? What path should the installer or enforcer take to determine this distance? Various interpretations have been offered for
accomplishing these measurements for as long as they have existed in the Code. New language added at 210.8 clarifies how these measurements are determined, and it applies to dwelling units and non-dwelling units alike. This “shortest path” measurement language is very similar to the existing text at 680.22(A)(5) for receptacle measurements around permanently installed swimming pools, which was the inspiration for this new text at 210.8.

During the 2014 NEC revision process, CMP-2 deliberated at length on how these GFCI measurements were to be made, but no clear guidance was mandated in the form of enforceable text. In a Panel Statement (see 2014 ROC 2-22), CMP 2 stated that the distance should be “the shortest path the cord of an appliance could take without penetrating a doorway, floor, etc.,” but no prescriptive requirements were brought forth. This deliberation was the genesis for several Public Inputs (PI), which resulted in this new requirement for the 2017 NEC.

Strict interpretation, along with commentary from CMP-2 during the 2017 NEC Code development process, indicate that this added text would alleviate the need for GFCI protection for receptacles installed inside a cabinet as the measurement to the sink would constitute “penetrating a cabinet door” to achieve this measurement. An example of this situation would be a receptacle for a cord-and-plug connected, under-the-counter garbage disposal installed under a kitchen sink. For further confirmation on this point, see the revisions at 210.8(A)(7) (dwelling units) and 210.8(B)(5) (non-dwelling units).

First Revision: FR 333  
Second Revision: SR 318  
Public Inputs: PI 2806, PI 2991, PI 2541, PI 1915, PI 1436

210.8(A)(7)  
*GFCI Protection at Sinks*

210.8(A)(7) **Ground-Fault Circuit-Interrupter Protection for Personnel**

- **Type of Change:** Revision
- **Change at a Glance:** Measurement criteria at dwelling unit sinks were revised for clarity in determination of which receptacles around these sinks would and would not require GFCI protection.
- **Code Language:** 210.8 Ground-Fault Circuit-Interrupter Protection for Personnel.
Ground-fault circuit-interrupter protection for personnel shall be provided as required in 210.8(A) through (D). The ground-fault circuit-interrupter shall be installed in a readily accessible location.

**Informational Note No. 1:** See 215.9 for ground-fault circuit-interrupter protection for personnel on feeders.

**Informational Note No. 2:** See 422.5(A) for GFCI requirements for appliances.

For the purposes of this section, when determining distance from receptacles, the distance shall be measured as the shortest path the cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window.

(A) **Dwelling Units.** All 125-volt, single-phase, 15- and 20-ampere receptacles installed in the locations specified in 210.8(A)(1) through (10) shall have ground-fault circuit-interrupter protection for personnel.

(7) Sinks — where receptacles are installed within 1.8 m (6 ft) of the outside top inside edge of the sink bowl.

- **2014 NEC Requirement**
  All 125-volt, single-phase, 15- and 20-ampere receptacles installed within 1.8 m (6 ft) of the “outside edge” of any dwelling unit sink (including the kitchen sink) required GFCI protection.

- **2017 NEC Change**
  All 125-volt, single-phase, 15- and 20-ampere receptacles installed within 1.8 m (6 ft) of the “top inside edge of the bowl” of any dwelling unit sink (including the kitchen sink) requires GFCI protection without the measurement piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window.

**Analysis of the Change:**
For the sixth straight *Code* cycle, the provisions of 210.8(A)(7) for GFCI protection within 1.8 m (6 ft) of dwelling unit sinks has experienced some form of revision to its content. Back in the 2002 *NEC*, this list item (7) only pertained to GFCI protection for receptacles located within 1.8 m (6 ft) of a wet bar sink and “intended to serve the countertop.” The 2005 *NEC* saw this requirement expanded to “Laundry, Utility, and Wet Bar Sinks” with the previous provision that the receptacle be “intended to serve the countertop” removed. For the 2011 *NEC*, the title was simplified to just “Sinks”, but excluded kitchen sinks as the GFCI provisions for kitchen sinks was covered at 210.8(A)(6) and this list item only required GFCI protection for receptacles that served a kitchen countertop and did not extend GFCI protection for such things as a receptacle under the kitchen sink for a garbage/waste disposer even though that disposer receptacle might be within 1.8 m (6 ft) of the outside edge of dwelling unit kitchen sink. Last *Code* cycle, this provision was expanded to all dwelling unit sinks (*including the kitchen sink*) by eliminating the phrase “located in areas other than kitchens” at 210.8(A)(7). This meant that all 125-volt, single-phase, 15- and 20-ampere receptacles installed within 1.8 m (6 ft) of any dwelling unit sink required GFCI protection. With literal interpretation, this 2014 *NEC* modification brought about some unintended circumstances such as mandated GFCI protection for a receptacle under the kitchen sink for a garbage/waste disposer.

For the 2017 *NEC*, revisions to this list item (7), along with an addition to the parent text of 210.8 will eliminate the necessity for GFCI protection for receptacles installed inside a cabinet (such as a receptacle for the garbage disposer) as the measurement to the sink would constitute “penetrating a cabinet door” in order to achieve this required 1.8 m (6 ft) measurement. This revision makes it clear that the measurement from the receptacle to the sink starts or begins at the “top inside edge of the bowl” of the sink rather than the “outside edge” of the sink. The outside edge of a sink is three dimensional and could include the bottom of the bowl, which apparently was an unintended interpretation. In today’s modern dwelling units, it is not difficult to find some unconventional sinks. This would include such things as a free-standing bowl that sits atop a countertop with no recess into the countertop at all. This revised text will help with consistent interpretation as to the method of measurement for these types of sinks. Again, literal interpretation of the previous text could have resulted in the 1.8 m (6 ft) measurement being addressed at the bottom of such a sink when only the “outside edge” of the sink was the driving factor.
This same revision occurred at 210.8(B)(5) for GFCI protection and measurements at a non-dwelling unit sink (see SR 322 and PC 599). Nothing previously stated concerning the measurement methodology at a dwelling unit sink would change for a sink at a commercial office break room or any other non-dwelling unit sink location.

Second Revision: SR 316
Public Inputs: PI 2991, PI 4478
Public Comments: PC 598

210.8(B)

Three-Phase GFCI Protection

210.8(B) Ground-Fault Circuit-Interrupter Protection for Personnel

- Type of Change: Revision

- Change at a Glance: The GFCI requirements for receptacles at commercial/industrial applications have been expanded to recognize ground faults other than 15 and 20A 125-volt applications only.

  Ground-fault circuit-interrupter protection for personnel shall be provided as required in 210.8(A) through (D), (E). The ground-fault circuit-interrupter shall be installed in a readily accessible location.

Informational Note No. 1: See 215.9 for ground-fault circuit-interrupter protection for personnel on feeders.

Informational Note No. 2: See 422.5(A) for GFCI requirements for appliances.

For the purposes of this section, when determining distance from receptacles, the distance shall be measured as the shortest path the cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window.

(B) Other Than Dwelling Units. All 125-volt, single-phase, 15 and 20 ampere receptacles rated 150 volts
to ground or less, 50 amperes or less; and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less, installed in the locations specified in 210.8(B)(1) through (10) shall have ground-fault circuit-interrupter protection for personnel.

- **2014 NEC Requirement**
  The GFCI requirements at “Other Than Dwelling Units” were limited to 125-volt, single-phase, 15- and 20-ampere receptacles.

- **2017 NEC Change**
  The GFCI requirements at “Other Than Dwelling Units” still include coverage of 125-volt, single-phase, 15- and 20-ampere receptacles. These requirements have been expanded to include all single-phase receptacles rated 150 volts to ground or less, 50 amperes or less; and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less.

**Analysis of the Change:**
Class A GFCI devices, which are designed to trip when the current to ground exceeds 4 to 6 mA (see UL 943, Standard for Ground-Fault Circuit Interrupters), have proven to be a reliable resource in reducing the number of injuries and fatalities due to electrical shock. They have saved numerous lives over the years, and they were introduced into the Code in the 1968 NEC. Class A GFCI devices have typically been associated with 125-volt, single-phase, 15- and 20-ampere applications, but what about the shock hazards and electrocutions involving higher currents and voltages, particularly in the workplace? Class A GFCI devices cannot be used where the electrical equipment employs 480 or 600 volts or is a three-phase system, yet the shock hazards of exist for these applications as well.

Revisions in the 2017 NEC at 210.8(B) have resulted in the expansion of GFCI protection for non-dwelling unit receptacles to include all single-phase receptacles rated 150 volts to ground or less, 50 amperes or less; and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less. These requirements have been expanded in recognition of the fact that shock hazards are not limited to 15- and 20-ampere, 125-volt receptacles alone at commercial/industrial applications. Receptacles of the higher voltage and current ratings in the locations identified in 210.8(B) present similar shock hazards as those of lower voltage and current ratings.

According to information published in IAEI magazine, from 2003 to 2009 there were 801 fatal workplace accidents caused by worker contact with electrical current. These figures do not include construction industry fatalities (see, Now That Industrial GFCIs are Here, Inspectors Have a Proactive Option for Shock Protections in the January-February 2014 issue). Statistics continue to show electrocutions as a significant cause of death in other than dwelling units. NFPA 70E (Standard for Electrical Safety in the Workplace), Annex K states that electrocutions are the fourth leading cause of industrial fatalities.

UL Standard 943C (Outline of Investigation for Special Purpose Ground-Fault Circuit-Interrupters) identifies protective devices designated as GFCI devices other than Class A GFCI devices. GFCI devices addressed by UL 943C are divided into three classes, Class C, D and E, based on voltage rating and the characteristics of the grounding circuit. Such devices operate at 20 mA or less to prevent fibrillation and require an equipment grounding conductor in the protected circuit with an internal means to monitor equipment grounding conductor continuity. Although the new classes of GFCI devices trip at higher current levels (20 mA instead of 6 mA), UL 943C calls these devices GFCIs and defines them as “a device intended for the protection of personnel.” The increase in personnel protection trip level of these new GFCI classes is based upon the availability of a reliable equipment grounding conductor in parallel with the body. During a ground fault condition, the equipment grounding conductor will shunt the fault current around the body and cause the device to trip. This action provides the “let-go” protection while the 20 mA threshold provides protection against fibrillation. These so-called “Industrial” GFCIs provide workers with vital protection against shock hazards and electrocution at a cost that is trivial compared to the enormous costs involved with a serious injury or a fatality.

It should be noted that provisions for an Equipment Ground-Fault Protective Device (EGFPD) and Special Purpose Ground-Fault Circuit Interrupter (SPGFCI) devices were proposed for the 2017 NEC but did not receive the necessary support from CMP-2 for inclusion in the requirements at 210.8(B). An EGFPD is a device that operates to disconnect
the electric circuit from the source of supply when ground-fault current exceeds the ground-fault pickup level marked on the device. An SPGFCI is a device intended for the protection of personnel that de-energizes a circuit or portion of a circuit within an established period when a current to ground exceeds the values established for a Class C, D, and E GFCI device.

First Revision: FR 347
Second Revision: SR 321
Public Inputs: PI 2192
Public Comments: PC 642, PC 819

210.8(B)(9) Non-Dwelling Unit Crawl Space

Type of Change: New

Change at a Glance: GFCI protection for receptacles in non-dwelling unit crawl spaces has been added.


Ground-fault circuit-interrupter protection for personnel shall be provided as required in 210.8(A) through (D) (E). The ground-fault circuit-interrupter shall be installed in a readily accessible location.

Informational Note No. 1: See 215.9 for ground-fault circuit-interrupter protection for personnel on feeders.

Informational Note No. 2: See 422.5(A) for GFCI requirements for appliances.

For the purposes of this section, when determining distance from receptacles, the distance shall be measured as the shortest path the cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window.
(B) Other Than Dwelling Units. All 125-volt, single-phase, 15- and 20-ampere receptacles rated 150 volts to ground or less, 50 amperes or less; and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less, installed in the locations specified in 210.8(B)(1) through (8) (10) shall have ground-fault circuit-interrupter protection for personnel.

(9) Crawl spaces — at or below grade level

- **2014 NEC Requirement**
  GFCI protection for personnel is required for all 125-volt, single-phase, 15- and 20-ampere receptacles installed in dwelling unit crawl spaces when that crawl space is at or below grade level. This requirement is located at 210.8(A)(4), which pertains to dwelling units only. No such requirement existed for receptacles installed in a non-dwelling unit crawl space.

- **2017 NEC Change**
  GFCI protection is now required for all single-phase receptacles rated 150 volts to ground or less, 50 amperes or less; and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less installed in non-dwelling unit crawl spaces.

**Analysis of the Change:**
The Code has mandated GFCI protection for all 125-volt, single-phase, 15- and 20-ampere receptacles installed in dwelling unit crawl spaces since the 1990 NEC. From that time until the present, no similar requirement existed for similar receptacles installed in a non-dwelling unit crawl space. That will change for the 2017 NEC with all single-phase receptacles rated 150 volts to ground or less, 50 amperes or less; and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less installed in non-dwelling unit crawl spaces now requiring GFCI protection.

It could be argued with a high degree of certainty that a receptacle outlet is not intelligent enough to know whether it is installed in a dwelling unit or a non-dwelling unit. If a hazard from a ground-fault condition exists, it would seem that both locations would need and warrant GFCI protection. It is interesting to look back at the substantiation for GFCI protection for dwelling unit crawl spaces. Part of this substantiation stated, “In its analysis of over 3,000 electric shock incidents for the period from 1976 and mid-1984, the Consumer Product Safety Commission (CPSC) had found approximately 312 deaths and 192 injuries involving consumer products in residential basements. In this study, 330 indepth investigative reports were examined to determine what products were involved and the location. Of the basement fatalities, 61.5% occurred in crawl spaces involving portable power tools, extension lights, and extension cords. Furthermore, the death rate in crawl spaces was very significant compared to the injury rate, accounting for 86.7% of the electric shock incidents” (see 1990 ROP 2-53 and 1990 ROC 2-649).

If a crawl space exists at a non-dwelling unit facility and that crawl space is at or below grade level, these same electrical shock hazards would exist. It is interesting to note that this non-dwelling unit crawl space GFCI requirement is not limited to 125-volt receptacles. Revisions of the parent text of 210.8(B) have resulted in the expansion of GFCI protection for non-dwelling unit receptacles that now will include all single-phase receptacles rated 150 volts to ground or less, 50 amperes or less; and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less. These requirements have been expanded to recognize the fact that shock hazards are not limited to 15- and 20-ampere, 125-volt receptacles alone at commercial/industrial applications.

First Revisions: FR 347
Second Revisions: SR 322, SCR 117
Public Inputs: PI 564
Public Comments: PC 2702, PC 988

**210.8(B)(10)**

*GFCI Protection for Receptacles in Non-Dwelling Unit Unfinished Basements*
210.8(B)(10) Ground-Fault Circuit-Interrupter Protection for Personnel.

- **Type of Change:** New

- **Change at a Glance:** GFCI protection has been added for receptacles installed in non-dwelling unit unfinished basements.

- **Code Language:** 210.8 Ground-Fault Circuit-Interrupter Protection for Personnel.
  Ground-fault circuit-interrupter protection for personnel shall be provided as required in 210.8(A) through (E). The ground-fault circuit-interrupter shall be installed in a readily accessible location.

**Informational Note No. 1:** See 215.9 for ground-fault circuit-interrupter protection for personnel on feeders.

**Informational Note No. 2:** See 422.5(A) for GFCI requirements for appliances.

For the purposes of this section, when determining distance from receptacles, the distance shall be measured as the shortest path the cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window.

(B) Other Than Dwelling Units. All 125-volt, single-phase, 15- and 20-ampere receptacles rated 150 volts to ground or less, 50 amperes or less; and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less, installed in the locations specified in 210.8(B)(1) through (D)(10) shall have ground-fault circuit-interrupter protection for personnel. (10) Unfinished portions or areas of the basement not intended as habitable rooms

- **2014 NEC Requirement**
  125-volt, single-phase, 15- and 20-ampere receptacles installed in dwelling unit unfinished basements require GFCI protection. An exception exists for a receptacle supplying only a permanently installed burglar or fire alarm system installed in a dwelling unit unfinished basement. This GFCI requirement for unfinished basements did not apply to non-dwelling unit unfinished basements.

- **2017 NEC Change**
  GFCI protection for receptacles installed in unfinished basements has been expanded to include commercial
applications as well as dwelling units. Revisions to the parent text at 210.8(B) has expanded the receptacles involved to those that are rated 150 volts to ground or less, 50 amperes or less; and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less.

Analysis of the Change:
If GFCI protection is warranted for receptacles installed in a dwelling unit unfinished basement, why would anyone not want that same protection for a receptacle located in a non-dwelling unit facility? The same shock hazards exist in an unfinished basement of a commercial building as they do in an unfinished basement of a dwelling unit. GFCI protection for unfinished basements was first introduced in the 1987 NEC. This GFCI requirement was only applicable to dwelling unit unfinished basements and remained related to dwelling units only until this change in the 2017 NEC.

It should be noted that the text at 210.8(A)(5) for GFCI requirement for receptacles in dwelling unit unfinished basements has been revised to match this new text for non-dwelling unit unfinished basements in such a way as to eliminate the need for a definition of an unfinished basement. Also worth noting is the change to the voltage and ampere ratings of the receptacles covered by the GFCI requirements of 210.8(B). In previous editions of the Code, these GFCI requirements only applied to 125-volt, single-phase, 15- and 20-ampere receptacles. Revisions to the parent text at 210.8(B) has expanded the receptacles covered to those that are rated 150 volts to ground or less, 50 amperes or less; and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less.

First Revisions: FR 347
Second Revisions: SR 322
Public Inputs: PI 564
Public Comments: PC 358, PC 988

210.8(E)

GFCI Protection for Lighting Outlets in Crawl Spaces

210.8(E) Ground-Fault Circuit-Interrupter Protection for Personnel

- **Type of Change:** New

- **Change at a Glance:** GFCI protection for lighting outlets in crawl spaces has been added.
**Code Language: 210.8 Ground-Fault Circuit-Interrupter Protection for Personnel.**

Ground-fault circuit-interrupter protection for personnel shall be provided as required in 210.8(A) through (D) (E). The ground-fault circuit-interrupter shall be installed in a readily accessible location.

**Informational Note No. 1:** See 215.9 for ground-fault circuit-interrupter protection for personnel on feeders.

**Informational Note No. 2:** See 422.5(A) for GFCI requirements for appliances.

For the purposes of this section, when determining distance from receptacles, the distance shall be measured as the shortest path the cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window.

(E) **Crawl Space Lighting Outlets.** GFCI protection shall be provided for lighting outlets not exceeding 120 volts installed in crawl spaces.

**2014 NEC Requirement**

GFCI protection for lighting outlets is mandated for luminaires in shower stalls of recreational vehicles (RVs) [551.53(B)] and for park trailers [552.54(B)]. If temporary lighting outlets at construction sites are powered through a receptacle outlet, 590.6(A) would require GFCI protection. There are seven specific requirements for GFCI protection of lighting outlets and luminaires in Article 680 for swimming pools and similar installations. Receptacle outlets are required to be GFCI-protected by provisions at 210.8(A)(4).

**2017 NEC Change**

In addition to the GFCI requirements for lighting outlets of the previous Code, GFCI protection is now required for lighting outlets not exceeding 120 volts in crawl spaces where space is at or below grade level.

**Analysis of the Change:**

A new requirement was added at 210.8(E) establishing GFCI protection for lighting outlets not exceeding 120 volts installed in crawl spaces where that space is located at or below grade level. This new GFCI requirement for lighting outlets was justified due to the fatality of a worker in a crawl space. The incandescent light bulb of a keyless lampholder was accidentally broken, and the worker was electrocuted upon unintentional contact with the live, exposed parts of the broken light bulb. The number of open-bulb keyless or pull chain lampholders installed in crawl spaces is countless, and they are frequently damaged in this same manner.

This crawl space lighting outlet GFCI provision was originally proposed for 210.70(C), which deals with required lighting outlets in attics and underfloor spaces, utility rooms, and basements. The original public input called for the crawl space lighting outlet to be “protected from physical damage” or be GFCI-protected. CMP-2 indicated that “physical protection does not provide the appropriate shock protection” and decided to place the requirement for GFCI protection in 210.8(E). While this crawl space lighting outlet GFCI requirement has merit, this requirement might be relocated in a future Code cycle to Article 410 where protection of luminaires, lampholders, and lamps are addressed. Regardless of its location, GFCI protection for these typically bare, exposed, open bulbs is a small price to pay compared to the cost of an injury or fatality to a human being.

Since this new GFCI requirement for crawl space lighting outlets is located at 210.8(E), it will apply to all crawl spaces, dwelling unit and non-dwelling units alike.

First Revision: FR 347
Second Revision: SR 317
Public Input: PI 564
Public Comments: PC 2702, PC 988
210.11(C)(4) Garage Branch Circuit(s)

**Type of Change:** New

**Change at a Glance:** New requirement added for minimum rated 120-volt, 20-ampere branch circuit for dwelling unit garage receptacles.

**Code Language: 210.11 Branch Circuits Required.**
Branch circuits for lighting and for appliances, including motor-operated appliances, shall be provided to supply the loads calculated in accordance with 220.10. In addition, branch circuits shall be provided for specific loads not covered by 220.10 where required elsewhere in this Code and for dwelling unit loads as specified in 210.11(C).

(C) Dwelling Units.
(4) Garage Branch Circuits. In addition to the number of branch circuits required by other parts of this section, at least one 120-volt, 20-ampere branch circuit shall be installed to supply receptacle outlets in attached garages and in detached garages with electric power. This circuit shall have no other outlets.

*Exception: This circuit shall be permitted to supply readily accessible outdoor receptacle outlets.*

**2014 NEC Requirement**
The branch circuit supplying receptacle outlets in dwelling unit garages could be a 120-volt, 15- or 20-ampere rated branch circuit. The branch circuit supplying this receptacle(s) could not supply outlets outside of the garage as indicated by 210.52(G)(1).

**2017 NEC Change**
The branch circuit supplying receptacle outlets in dwelling unit garages is now required to be a 120-volt, 20-ampere rated branch circuit. The garage receptacle outlet branch circuit is still prohibited from serving other outlets with the exception of readily accessible receptacles located outdoors.

**Analysis of the Change:**
A new requirement, which was added to the required branch circuits for dwelling units, calls for at least one dedicated branch circuit for garage receptacle outlets only. This 120-volt branch circuit must have a minimum rating of 20 amperes. An exception was also added to allow readily accessible outdoor receptacle outlets to be supplied from the branch circuit as well. Many of the appliances and tools used in today’s dwelling unit garages are rated at 12 to 16 amperes or higher and demand, at least, a 20-ampere rated branch circuit. A 15-ampere rated branch circuit in the modern dwelling unit garage is typically not sufficient for these loads. While most residential electricians might already be installing 20-ampere rated branch circuits in dwelling unit garages, the NEC did not require or demand this 20-ampere rated branch circuit previous to this 2017 NEC change. A small, portable, 120-volt, 1 horsepower air compressor drawing 16 amperes would be an example of a tool requiring 20-ampere rated branch circuit.

This requirement was originally proposed at 210.52(G)(1) for dwelling unit garage receptacle outlets, not the branch circuit supplying these receptacle outlets. 210.11(C)(4) is a more appropriate location for this requirement as 210.11(C) deals with required branch circuits for dwelling units. Lighting outlets in the dwelling unit garage are still required to be supplied by general lighting circuits and are not allowed to be supplied from this newly required 20-ampere rated receptacle outlet branch circuit. The thought process here is to protect the illumination of the garage area in the event of an outage on the 20-ampere rated receptacle outlet branch circuit. The added exception will allow readily accessible receptacles located outdoors to be supplied from this garage branch circuit.

First Revision: FR 330
Second Revision: SR 324
Public Input: PI 1010, PI 2722
Public Comments: PC 952, PC 954

210.12(C)
AFCI Protection in Guest Rooms and Guest Suites

210.12(C) Arc-Fault Circuit-Interrupter Protection

- **Type of Change:** New

- **Change at a Glance:** New provisions added requiring AFCI protection for guest rooms/guest suites of hotels/motels.

- **Code Language:** 210.12 Arc-Fault Circuit-Interrupter Protection.
  Arc-fault circuit-interrupter protection shall be provided as required in 210.12(A) (B), and (C), and (D). The arc-fault circuit interrupter shall be installed in a readily accessible location.  
  (C) Guest Rooms and Guest Suites. All 120-volt, single-phase, 15-and 20-ampere branch circuits
supplying outlets and devices installed in guest rooms and guest suites of hotels and motels shall be protected by any of the means described in 210.12(A)(1) through (6).

■ 2014 NEC Requirement

Rules exist at 210.18 requiring guest rooms and guest suites that are provided with “permanent provisions for cooking” to have branch circuits installed to meet the rules for dwelling units. This provision would mean that the AFCI requirements of 210.12 would apply to a hotel and motel guest room/guest suite if this room-suite were furnished with “permanent provisions for cooking.” No AFCI requirements existed for guest rooms and guest suites of hotels and motels lacking “permanent provisions for cooking.”

■ 2017 NEC Change

New provisions were added at 210.12(C) requiring AFCI protection for all 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets and devices installed in guest rooms and guest suites of hotels and motels, regardless of the existence of “permanent provisions for cooking” or not.

Analysis of the Change:

AFCI technology that can help save lives and avoid property damage from fire-related events has been expanded to include guest rooms and guest suites of hotels and motels. Previous editions of the Code would extend AFCI protection to these guest quarters with a qualifying condition that “permanent provisions for cooking” must be a part of these accommodations (see 210.17, was 210.18). This new AFCI requirement does not depend on cooking provisions in order to be enforceable. The same or similar threats imposed by arcing events exist in hotel or motel guest occupancies as exist in dwelling units. In numerous cases, guest rooms and guest suites are used in the same basic fashion as school dormitories, and dormitories are already afforded the safety measures of AFCI protection.

The evolution and expansion of AFCI protection play a major role in protecting the lives and property of homeowners and their families. These families deserve the same protection while occupying a hotel room away from their home. AFCI technology is the next generation of product safety in the protection of electrical circuits. While working smoke detectors, fire extinguishers, and other safety measures provide some life-saving help, these measures are only useful after a fire has already ignited. An AFCI circuit breaker or device detects dangerous electrical conditions (arcing events) and shuts the branch circuit off before an electrical fire can ignite.

The previous requirements of 210.12 were rearranged to accommodate this new requirement for guest rooms and guest suites. Requirements at 210.12(C) for AFCI protection for dormitory units were moved to 210.12(B), and the requirements at 210.12(B) for branch circuit extensions and modifications were moved to new 210.12(D).

First Revision: FR 352
Second Revision: SR 328
Public Inputs: PI 1453
Public Comments: PC 683, PC 818

210.17

Electric Vehicle Branch Circuit
**210.17 Electric Vehicle Branch Circuit**

- **Type of Change:** Deletion and Relocation

- **Change at a Glance:** The requirement for an individual branch circuit for electric vehicle outlets has been relocated from 210.17 to 625.40.

- **Code Language:** 210.17 Electric Vehicle Branch Circuit.
  
  An outlet(s) installed for the purpose of charging electric vehicles shall be supplied by a separate branch circuit. This circuit shall have no other outlets.

- **Informational Note:** See 625.2 for the definition of Electric Vehicle.

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**625.40 Electric Vehicle Branch Circuit.** An outlet(s) installed for the purpose of charging electric vehicles shall be supplied by a separate individual branch circuit. Each circuit shall have no other outlets.

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**2014 NEC Requirement**

There was no requirement for an outlet to be installed for charging of an electric vehicle. If an outlet(s) for the purpose of charging electric vehicles was installed, the requirements of 210.17 would require the outlet(s) to be supplied by a “separate” branch circuit. This circuit may have no other outlets.

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**2017 NEC Change**

The requirement for a separate branch circuit for electric vehicle outlets was relocated to 625.40, the article for electric vehicle charging systems. During this relocation, the requirement for a “separate” branch circuit was changed to an “individual” branch circuit. There is still no requirement for an outlet to be installed specifically for the purpose of charging of an electric vehicle.

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**Analysis of the Change:**

During the 2014 NEC Code revision process, a new requirement was added at 210.17 providing for a “separate” branch circuit for circuits that supply electric vehicle charging (EV) systems. Without this “separate” branch circuit with no other outlets, combining an EV charging load with older and traditional wiring methods (particularly at dwelling units) was challenging at best. Charging an electric vehicle by simply plugging into an existing 120-volt receptacle outlet that is more than likely supplied from a general lighting circuit can and will overload the existing general purpose branch circuit. In relocating this EV branch circuit requirement to Article 625 (Electric Vehicle Charging Systems), it was noted by the submitter that this requirement did not belong in NEC Chapter 2 as Article 210 deals with general provisions for branch circuits, and it more appropriately belongs in NEC Chapter 6, which is specific to special equipment.

At its previous location at 210.17, the Code language used referred to the need for a “separate” branch circuit. This
term is not defined anywhere in the Code and, in particular, not in Article 100. The one and only Code cycle that this term was used, it caused confusion among installers and inspectors alike as to what constituted a “separate” branch circuit. At its present location at 625.40, this branch circuit was renamed as an “individual” branch circuit. This term that is defined in Article 100 and is intended to supply only one piece of utilization equipment, which fits with the last sentence of the requirement (“...circuit shall have no other outlets”). The previous 210.17 text was also unclear as to whether multiple outlets on one branch circuit could be installed, as long as the outlets are only intended for EV charging systems, or if each EV charging outlet had to have a single (individual) branch circuit supplying it and no other outlets. The new text at 625.40 makes it clear that the latter is intended.

It should be noted that neither the previous 210.17 requirement or this relocated requirement demand that an outlet for the specific and sole purpose of charging EV equipment must be installed. This requirement simply states that where such EV charging outlets are installed (by choice), each of these EV charging outlets must be supplied by an individual branch circuit with no other outlets. This new provision for EV charging will go a long way to ensuring that EV charging can be performed safely and effectively without overloading an existing branch circuit.

First Revisions: FR 353, FR 3371
Public Inputs: PI 3601, PI 3604, PI 810, PI 3307

210.52(A)(2)(1)
Receptacle Wall Space

210.52(A)(2)(1) Dwelling Unit Receptacle Outlets

- **Type of Change:** Revision

- **Change at a Glance:** Fixed cabinets “that do not have countertops or similar work surfaces” was added as an item that will constitute a break in a wall space for receptacle spacing requirements at dwelling units.

- **Code Language: 210.52 Dwelling Unit Receptacle Outlets**
  This section provides requirements for 125-volt, 15-and 20-ampere receptacle outlets.
  (Remainder of text unchanged.)

  (A) **General Provisions.** In every kitchen, family room, dining room, living room, parlor, library, den,
sunroom, bedroom, recreation room, or similar room or area of dwelling units, receptacle outlets shall be installed in accordance with the general provisions specified in 210.52(A)(1) through (A)(4).

(2) **Wall Space.** As used in this section, a wall space shall include the following:

(1) Any space 600 mm (2 ft) or more in width (including space measured around corners) and unbroken along the floor line by doorways and similar openings, fireplaces, and fixed cabinets that do not have countertops or similar work surfaces

(2) The space occupied by fixed panels in exterior walls, excluding sliding panels

(3) The space afforded by fixed room dividers, such as freestanding bar-type counters or railings

- **2014 NEC Requirement**
  All “fixed cabinets,” regardless of their dimension or size, with or without countertop or work surfaces were considered as items (along with doorways and fireplaces) that would not be counted as “wall space” and would establish a break in that wall space as far as receptacle spacing and location were concerned.

- **2017 NEC Change**
  Only “fixed cabinets that do not have countertops or similar work surfaces” are now considered as an item (along with doorways and fireplaces) that would not be counted as “wall space” concerning receptacle spacing and location requirements.

**Analysis of the Change:**
When it comes to determining just how many general-use wall receptacle outlets are needed in a dwelling unit, the Code language found at 210.52(A)(1) through (A)(4) provides requirements and guidance. For spacing of these required receptacles, 210.52(A)(1) states that receptacles are to be located so that “no point measured horizontally along the floor line of any wall space is more than 1.8 m (6 ft) from a receptacle outlet.” What is considered “wall space” and what is not? To answer that question, the provisions of 210.52(A)(2) step forward. During the 2011 NEC revision process, 210.52(A)(2)(1) was revised by adding the term “fixed cabinets” to a list of things that actually would break up a “wall space” that was 600 mm (2 ft) or more in width. These items also include doorways and fireplaces. In reading the substantiation for adding the term “fixed cabinets,” it was quite clear that the cabinets referred to were large cabinets, such as kitchen cabinets. Receptacle placement and spacing for kitchen cabinets and countertops have their set of rules at 210.52(C). The term “fixed cabinets” was added to ensure that the requirements for “1.8 m (6 ft) from a receptacle outlet” wall spacing were not applied to large pantry-type cabinets occupying the space from the floor to the ceiling (with no countertop) in a kitchen area.

In a literal reading or interpretation of this 2011 NEC revision, any and all “fixed cabinets” (not just kitchen cabinets) were now subject to having no receptacle outlets required in, on, or above them. This requirement would include any fixed cabinet at any height in any room not counting as “wall space.” This rule presented a problem for enforcement at such things as cabinets in a home office, library, or family room where the cabinets may be only 900 mm (36 in.) tall. In some of these areas, these cabinets are installed around the majority of the room. As previously written, there was no Code requirement the AHJ could fall back on to require any receptacle outlets for the “wall space” these cabinets consumed. This situation resulted in rooms, other than kitchens, with fixed cabinets and cabinet countertops occupying a substantial length of wall space with no required receptacle outlets serving these countertop areas.

This revision for the 2017 NEC at 210.52(A)(2)(1) will eliminate this problem by separating “fixed cabinets,” such as kitchen pantry-type cabinets (but not limited to kitchen cabinets), that do not have countertops or similar work surfaces from short desk-type cabinets with countertops that are clearly intended as work surfaces. This change will ensure that receptacle outlets are required and installed along with these desk-type fixed cabinets that need receptacle outlets for such things as laptop computers, printers, televisions, etc. These fixed desk-type cabinets will be under the same “no point more than 1.8 m (6 ft) from a receptacle outlet” rules as the other walls of that particular room.

First Revisions: FR 324
210.52(B)(1), Ex. No. 2
Appliance Branch Circuit

210.52 Dwelling Unit Receptacle Outlets

- **Type of Change:** Revision

- **Change at a Glance:** An individual branch circuit supplying a receptacle outlet for any specific appliance (not just the refrigerator) at a dwelling unit is allowed to be rated 15-ampere or greater.

- **Code Language:** 210.52 Dwelling Unit Receptacle Outlets
  This section provides requirements for 125-volt, 15-and 20-ampere receptacle outlets.
  (Remainder of text unchanged.)

(B) Small Appliances
(1) **Receptacle Outlets Served.** In the kitchen, pantry, breakfast room, dining room, or similar area of a dwelling unit, the two or more 20-ampere small-appliance branch circuits required by 210.11(C)(1) shall serve all wall and floor receptacle outlets covered by 210.52(A), all countertop outlets covered by 210.52(C), and receptacle outlets for refrigeration equipment.

*Exception No. 1:* In addition to the required receptacles specified by 210.52, switched receptacles supplied from a general-purpose branch circuit as defined in 210.70(A)(1), Exception No. 1, shall be permitted.

*Exception No. 2:* The receptacle outlet for refrigeration equipment in addition to the required receptacles specified by 210.52, a receptacle outlet to serve a specific appliance shall be permitted to be supplied from an individual branch circuit rated 15 amperes or greater.
2014 NEC Requirement
Dwelling unit refrigeration equipment was permitted by exception to be supplied from an individual branch circuit rated 15 amperes or greater rather than from one of the 20-ampere rated small-appliance branch circuits. This “smaller than 20 amperes” permission was not afforded to any other kitchen appliance.

2017 NEC Change
Any specific dwelling unit kitchen appliance is permitted by exception to be supplied from an individual branch circuit rated 15 amperes or greater rather than from one of the 20-ampere rated small-appliance branch circuits.

Analysis of the Change:
The receptacle outlets in dwelling unit kitchens, pantries, breakfast rooms, dining rooms, or similar areas are required to be supplied by the required 20-ampere small-appliance branch circuits. It comes as a surprise for many individuals that 210.52(B)(1) also demands that the receptacle outlet serving the refrigeration equipment be supplied from one of the two or more 20-ampere small-appliance branch circuits as well.

Beginning with the 1996 NEC, an exception to this main rule has allowed the refrigeration equipment to be supplied by its own individual branch circuit rated 15 amperes or greater rather than one of the 20-ampere small-appliance branch circuits. Some users of the Code have recently begun to ask why this exception is exclusive to just the refrigerator. Why can’t this exception be applied to other dwelling unit kitchen appliances such as the garbage disposal, dishwasher, and permanently installed microwave? Currently, these appliances are installed on individual branch circuits and cord-and-plug connected in the kitchen area routinely, with the refrigerator being the only permitted non-small appliance permitted to be supplied by a branch circuit smaller than a 20-ampere branch circuit.

This exception was originally instituted for the refrigeration equipment to allow an individual branch circuit (rated as small as 15 amperes) and to allow this appliance load to be removed from the small appliance branch circuits, as the refrigeration is not a small appliance. It is interesting to note that the original proposal (see NFPA 70 A95 ROP 2-257) was seeking an individual branch circuit used to supply “a specific appliance such as a refrigerator or freezer” not the refrigerator alone.

For the 2017 NEC, a revision to Exception No. 2 of 210.52(B)(1) will recognize that an individual branch circuit supplied specifically for any single appliance is allowed to be rated at 15-ampere or greater. Apparently, this was happening on a fairly regular basis with the seeming permission coming from 210.22, which states that an individual branch circuit is permitted to supply any load for which it is rated, but in no case shall the load exceed the branch-circuit amperage rating. This revision will help weave these two rules together.
210.52(C)(3) Dwelling Unit Receptacle Outlets

- **Type of Change:** Revision

- **Change at a Glance:** The measurement point for peninsular countertops has been changed from the “connecting edge” to the “connected perpendicular wall.”

- **Code Language: 210.52 Dwelling Unit Receptacle Outlets**
  This section provides requirements for 125-volt, 15- and 20-ampere receptacle outlets.
  (Remainder of text unchanged.)

  **(C) Countertops and Work Surfaces.** In kitchens, pantries, breakfast rooms, dining rooms, and similar areas of dwelling units, receptacle outlets for countertop and work surface spaces shall be installed in accordance with 210.52(C)(1) through (C)(5).

  **(3) Peninsular Countertop Spaces.** At least one receptacle outlet shall be installed at each peninsular countertop long dimension space with a long dimension of 600 mm (24 in.) or greater and a short dimension of 300 mm (12 in.) or greater. A peninsular countertop is measured from the connecting edge connected perpendicular wall.

  **2014 NEC Requirement**
  At least one receptacle outlet must be installed at each peninsular countertop with a long dimension of 600 mm (24 in.) or greater and a short dimension of 300 mm (12 in.) or greater. These measurements were measured from the “connecting edge.”

  **2017 NEC Change**
  At least one receptacle outlet is still required at each peninsular countertop with a long dimension of 600 mm (24 in.) or greater and a short dimension of 300 mm (12 in.) or greater, but the measurement is now measured from the “connected perpendicular wall.”

**Analysis of the Change:**
The requirements at 210.52(C)(3) speak to the placement and measurement for required receptacle outlet(s) at dwelling unit kitchen peninsular countertop spaces. At least one receptacle outlet is required to be installed at each peninsular countertop with a long dimension of 600 mm (24 in.) or greater and a short dimension of 300 mm (12 in.) or...
greater. Since its inception in the 1993 edition of the NEC, this measurement has always been measured from the “connecting edge” where the peninsular countertop mates with the base kitchen countertop. This will no longer be true beginning with the 2017 NEC as these measurements will now be measured from the “connected perpendicular wall.”

The change was not intended to create language that reduces the coverage of receptacle outlets serving these peninsular countertops, but rather to better define how the long dimension of the peninsular countertop is measured. The final language at 210.52(C)(3) allows a receptacle outlet at the connecting wall (which serves the base countertop) to serve the peninsular countertop as well. When measured from the connecting edge rather than the wall, this requirement previously demanded at least one receptacle outlet be placed somewhere at or on the peninsular countertop itself. This revision will allow relief from the burden of trying to figure out a solution to the placement of the required receptacle outlet at a peninsular countertop without any supporting cabinets installed under the peninsular countertop. Some peninsular countertops are installed and resemble a permanently installed kitchen table more than the traditional cabinet-style countertops.

In the original proposed language accepted at the 2017 NEC First Draft stage, a receptacle outlet in a wall countertop space was only permitted to serve as the receptacle for a peninsular countertop space where the spaces were continuous and the wall receptacle was located within 1.8 m (6 ft) of the outside edge of the peninsular countertop. This 1.8 m (6 ft) restriction was removed at the 2017 NEC Second Draft stage allowing the wall receptacle outlet to serve the base countertop as well as all of the peninsular countertop, regardless of the length of the peninsular countertop.

Some will argue that this revision achieved the opposite effect than was intended as the number of required receptacle outlets to serve kitchen peninsular countertops has been reduced rather than maintained. No doubt this issue will be revisited again in future Code revision cycles.

First Revisions: FR 356
Second Revisions: SR 309
Public Inputs: PI 3605
Public Comments: PC 572

210.52(G)
Receptacle for Basements, Garages, and Accessory Buildings

![Diagram of 210.52(G)]

210.52(G) Dwelling Unit Receptacle Outlets
Type of Change: Revision

Change at a Glance: Receptacle requirements for dwelling unit garages, basements, and accessory buildings expanded to two-family dwellings (not just one-family dwellings).

Code Language: 210.52 Dwelling Unit Receptacle Outlets
This section provides requirements for 125-volt, 15- and 20-ampere receptacle outlets.

(Remainder of text unchanged.)

(G) Basements, Garages, and Accessory Buildings. For a one- and two-family dwellings, at least one receptacle outlet shall be installed in the areas specified in 210.52(G)(1) through (3). These receptacles shall be in addition to receptacles required for specific equipment.

2014 NEC Requirement
At least one receptacle outlet is required to be installed in each attached garage and detached garage with electric power, each separate unfinished portion of a basement, and each accessory building with electric power. This requirement applied to one-family dwellings only.

2017 NEC Change
The same one receptacle outlet requirement still applies to qualifying basements, garages, and accessory buildings, but this requirement has been extended to two-family dwellings as well as one-family dwellings.

Analysis of the Change:
At least one 125-volt, 15- or 20-ampere receptacle outlet has been required to be installed in each garage and unfinished basement since the 1978 NEC. Detached garages were added to this provision in the 1987 NEC and accessory buildings with electric power were added in the 2011 NEC. Historically, this requirement has applied to one-family dwellings. Without a close look at the text at 210.52(G), some users of the Code would assume that this receptacle outlet rule would and has applied to both one- and two-family dwellings alike.

For the 2017 NEC, this same level of electrical safety has been extended to two-family dwellings as it has been for one-family dwellings for the past 10 Code cycles. The purpose of this rule is to help prevent the use of extension cords as a substitute for permanent wiring, which often occurs when receptacle outlets are not readily available. When extension cords are used as a substitute for permanent wiring, they are often stretched through doorways, windows, and similar openings. This frequently leads to damaged cords and the creation of an electrical hazard. The same potential for creating a hazard occurs at a two-family dwelling as it does for a one-family dwelling.

First Revisions: FR 310
Public Inputs: PI 96

210.52(G)(1)

Dwelling Unit Garages
210.52(G)(1) Dwelling Unit Receptacle Outlets

- **Type of Change:** Revision

- **Change at a Glance:** At least one receptacle outlet is required to be installed “in each vehicle bay” and not more than 1.7 m (5 1/2 ft) above the floor in dwelling unit garages.

- **Code Language: 210.52 Dwelling Unit Receptacle Outlets**

  This section provides requirements for 125-volt, 15- and 20-ampere receptacle outlets.

  (Remainder of text unchanged.)

(G) Basements, Garages, and Accessory Buildings. For one- and two-family dwellings, at least one receptacle outlet shall be installed in the areas specified in 210.52(G)(1) through (3). These receptacles shall be in addition to receptacles required for specific equipment.

(1) Garages. In each attached garage and in each detached garage with electric power, at least one receptacle outlet shall be installed for in each car space vehicle bay and not more than 1.7 m (5 1/2 ft) above the floor.

2014 NEC Requirement

In each attached garage and in each detached garage with electric power, at least one receptacle outlet was required to be installed “for each car space.” The branch circuit supplying these receptacle(s) could not supply outlets outside of the garage.

2017 NEC Change

In each attached garage and in each detached garage with electric power, at least one receptacle outlet is required to be installed “in each vehicle bay and not more than 1.7 m (5 1/2 ft) above the floor.” The branch circuit supplying these receptacle(s) cannot serve outlets outside of the garage with the exception of readily accessible receptacles located outdoors. This latter requirement concerning the branch circuit supplying the garage is now located at 210.11(C)(4).

Analysis of the Change:

When it comes to the required number of receptacle outlets required in a dwelling unit garage, at least one 125-volt, 15- or 20-ampere receptacle outlet has been required to be installed in each garage beginning in the 1978 NEC. To
ensure that both attached and detached type garages were covered by this requirement, detached garages were specifically added to this provision in the 1987 NEC. This minimum of one required receptacle outlet remained in place until the 2014 NEC when the Code language was revised to require at least one receptacle outlet to be installed “for each car space.”

This 2014 NEC revision was created due to the increased activities in dwelling unit garages as well as the possibility of the existence of electric vehicle (EV) charging equipment in a modern day garage. This 2014 NEC change was also intended to require a minimum of three receptacle outlets in a three-car garage, four receptacle outlets in a four-car garage, etc. The verbatim language “for each car space” brought about a wide variety of interpretations. With a literal interpretation, it was not a stretch to determine that one receptacle outlet placed between two “car spaces” could be “for each car space.” Some would argue that a receptacle outlet in the ceiling for a garage door opener could be “for” that particular “car space.” The parent text at 210.52(G) which states that “these receptacles shall be in addition to receptacles required for specific equipment” would eliminate receptacle outlets specific to such things as a garage door opener from serving as this required receptacle outlet “for” or in each vehicle space.

For these and other reasons, the 2017 NEC text at 210.52(G)(1) was further revised by changing the requirement for at least one receptacle outlet to be installed “for each car space” to “in each vehicle bay and not more than 1.7 m (5½ ft) above the floor.” The change from “for” to “in” each vehicle bay will eliminate the interpretation of one receptacle outlet being shared by two adjacent spaces. The term “car space” was changed to “vehicle bay” to recognize the fact that other vehicles such as pickup trucks, sports utility vehicles, tractors, and so forth could be parked in a dwelling unit garage as well as a car. The “not more than 1.7 m (5½ ft) above the floor” requirement removes all doubt concerning the receptacle outlet installed in the ceiling specifically for a garage door opener serving double-duty and also serving as the required receptacle outlet “in each vehicle bay.” This requirement and the revision as a whole is intended to ensure that a receptacle outlet is reasonably close to where it is needed in the garage area and to diminish or eliminate the use of an extension cord in a garage as fixed or permanent wiring, which of course is a violation of previous 400.8(1) [now 400.12(1)].

This revision also included the relocation of the requirement that the “branch circuit supplying these receptacle(s) shall not supply outlets outside of the garage” from this section of the Code. This branch circuit requirement was relocated to new 210.11(C)(4) which pertains to required branch circuits for dwelling units. The requirement under discussion here at 210.52(G)(1) relates to dwelling unit garage receptacle outlets, not the branch circuit supplying these receptacle outlets. Closer examination of the new requirements for the branch circuit supplying the garage at 210.11(C)(4) will still find a requirement that this branch circuit serve no other outlets, but with an exception allowing readily accessible receptacles located outdoors to be supplied by this garage branch circuit.

As a side note, lighting outlets in the dwelling unit garage are still required to be supplied by general lighting circuits and not allowed to be supplied from this newly required 20 ampere rated receptacle outlet branch circuit of 210.11(C) ((4) to protect the illumination of the garage area in the event of an outage on the 20-ampere rated receptacle outlet branch circuit.

First Revisions: FR 317
Second Revisions: SR 326
Public Inputs: PI 1431, PI 1572, PI 705, PI 839, PI 4303, PI 3608, PI 4691, PI 2655, PI 2905, PI 365, PI 366
Public Comments: PC 929, PC 954, PC 1549

210.64

Receptacle at Electrical Service Areas
210.64 Electrical Service Areas

- **Type of Change**: Revision

- **Change at a Glance**: The required receptacle outlets at electrical service equipment must be installed in an accessible location within 7.5 m (25 ft) of indoor electrical service equipment.

- **Code Language**: 210.64 Electrical Service Areas.

  At least one 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed in an accessible location within 7.5 m (25 ft) of the indoor electrical service equipment. The required receptacle outlet shall be located within the same room or area as the service equipment.

  **Exception No. 1**: The receptacle outlet shall not be required to be installed in one-and-two-family dwellings.

  **Exception No. 2**: Where the service voltage is greater than 120 volts to ground, a receptacle outlet shall not be required for services dedicated to equipment covered in Articles 675 and 682.

- **2014 NEC Requirement**

  At least one 125-volt, single-phase, 15- or 20-ampere receptacle outlet was required to be installed within 15 m (50 ft) of the electrical service area. This service area receptacle outlet is not required at one- and two-family dwellings by exception.

- **2017 NEC Change**

  At least one 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet is still required to be installed at the electrical service equipment. The maximum distance this receptacle outlet can be located from the electrical service has been shortened to 7.5 m (25 ft) and limited to indoor service equipment only. This required receptacle outlet is now required to be installed in an accessible location and must be located within the same room or area as the service equipment. This requirement is still not applicable to one- and two-family dwellings. A new exception was also added allowing services dedicated to equipment covered in Articles 675 and 682 to be exempt from this requirement when the service voltage is greater than 120 volts to ground.

**Analysis of the Change:**

For the 2014 *NEC Code* cycle, a new provision was added in Article 210 requiring, at least one 125-volt, single-phase, 15- or 20-ampere receptacle outlet to be installed within 15 m (50 ft) of all electrical service areas (other than
one- and two-family dwellings). The substantiation for this change indicated that there is sometimes a need for connecting portable electrical data acquisition equipment for the qualitative analysis of the electrical service system, and test equipment is frequently needed for monitoring and servicing electrical equipment in service areas as well. This service area receptacle outlet requirement was revised for the 2017 NEC.

The first revision requires this service area receptacle outlet to be installed in an accessible location, within the same room or area as the service equipment. Part of the rationale for requiring this receptacle outlet in the first place was to eliminate extension cords from being run across the floor of the electrical equipment room, and down a hallway into an adjoining room when a receptacle was not provided in the electrical service area. With the previous text at 210.64, the rules for a service area receptacle outlet could be literally accomplished with a receptacle outlet located in the next room, down and across the hallway from the electrical service area by employing an extension cord as long as the receptacle outlet was “installed within 15 m (50 ft) of the electrical service equipment.”

The second revision was to reduce the maximum distance between the required receptacle outlet and the electrical service equipment to 7.5 m (25 ft) rather than the previous 15 m (50 ft). This 7.5 m (25 ft) distance is consistent with 210.63, which is a similar receptacle outlet requirement for heating, air-conditioning, and refrigeration equipment. The measurement of 15 m (50 ft) is typically associated with visibility, such as “within sight”, while this requirement (like 210.63) pertains to servicing of equipment. Part of the substantiation for this 2017 NEC revision indicated that the typical length of an electrical worker’s service truck extension cord is 7.5 m (25 ft) versus 15 m (50 ft).

The third revision was to limit this service area receptacle outlet requirement to only “indoor” service equipment (other than one- and two-family dwellings). Revising the text to specify only indoor locations provides a reasonable solution to unintended consequences from the language introduced in the 2014 NEC. Much of the discussion during the 2014 NEC revision cycle was related to indoor locations where monitoring equipment would be used and with the proliferation of cordless tools, vehicle power inverters, and mobile generators; the need for this outlet seems marginal in outdoor locations.

The final revision to 210.64 added a second exception pertaining to service equipment that is dedicated to equipment covered in Articles 675 (Electrically Driven or Controlled Irrigation Machines) and 682 (Natural and Artificially Made Bodies of Water) where the service voltage is greater than 120 volts to ground. These unique and mostly discrete, stand-alone pumping facilities often receive their power source from metered utility distribution systems of 480 or 600 volts grounded or ungrounded systems. These remote services typically serve only these irrigation loads. These loads could be items such as an irrigation pump or center pivot irrigation machine for a farm or ranch, or equipment for an industrial facility settling pond pumping system. Without this exception, these 480- or 600-volt services would require something like the installation of a step-down transformer for the sole purpose of supporting a 120-volt receptacle outlet, which seems excessive. These installations are normally installed and serviced by qualified persons using portable power generators, or battery powered electrical tools. Once again, remember that the service area receptacle outlet is now required for indoor installations only. The exempted services are often mounted on poles in fields, where they are unsupervised for long stretches of time.

As requested by one public input, CMP-2 chose not to include agricultural buildings in this exception as these buildings are normally associated with 120/240 volt services and GFCI protected receptacle outlets are required by 547.5(G).

Public Inputs: PI 437, PI 1439, PI 840, PI 3344, PI 3611, PI 443, PI 483, PI 653, PI 1309, PI 4750, PI 4038

First Revisions: FR 323

210.70(C)

Lighting Outlet(s) All Occupancies
210.70(C) Lighting Outlets Required

- **Type of Change:** Revision

- **Change at a Glance:** Lighting outlet requirements for storage or equipment spaces added for non-dwelling unit utility rooms and basements.

- **Code Language: 210.70 Lighting Outlets Required.**
  Lighting outlets shall be installed where specified in 210.70(A), (B), and (C).

  - **(C) Other Than Dwelling Units All Occupancies.** For attics and underfloor spaces containing equipment requiring servicing, such as heating, air-conditioning, and refrigeration equipment, utility rooms, and basements, at least one lighting outlet containing a switch or controlled by a wall switch shall be installed in such where these spaces are used for storage or contain equipment requiring servicing. At least one point of control shall be at the usual point of entry to these spaces. The lighting outlet shall be provided at or near the equipment requiring servicing.

- **2014 NEC Requirement**
  For dwelling unit attics, underfloor spaces, utility rooms, and basements, at least one lighting outlet containing a switch or controlled by a wall switch must be installed where these spaces are used for storage or contain equipment requiring servicing. This requirement is found at 210.70(A)(3). For other than dwelling units, this lighting requirement only applied to attics and underfloor spaces (not utility rooms and basements). This non-dwelling unit lighting requirement is located at 210.70(C). Both of these Code sections require at least one point of control to be located at the “usual point of entry” to these spaces with the lighting outlet(s) itself located “at or near the equipment requiring servicing.”

- **2017 NEC Change**
  The title of 210.70(C) was changed from “Other Than Dwelling Units” to “All Occupancies” and the text at this provision was revised to mirror the Code text at 210.70(A)(3) for dwelling units. This lighting outlet requirement for storage or equipment spaces now applies to dwelling units as well as non-dwelling unit attics, underfloor spaces, utility rooms, and basements.

**Analysis of the Change:**
A switched lighting outlet has been required to be installed in dwelling unit attics, underfloor spaces, utility rooms, and basements beginning with the 1975 *NEC*. A switched lighting outlet has been a requirement for non-dwelling unit
attics and underfloor spaces since the 1990 edition of the Code. Non-dwelling unit utility rooms and basements have not been subject to a required lighting outlet until a revision to 210.70(C) for the 2017 NEC.

A utility room or basement located at other than a dwelling unit often contains or has the ability to contain the very same electrical equipment as non-dwelling unit attics or an underfloor space. However, the non-dwelling unit utility room or basement was not required to have any lighting outlet provided for servicing of the equipment until this revision. The same types of hazards that can exist due to the lack of illumination exist in all attics, underfloor spaces, utility rooms, and basements whether these areas are located in a dwelling unit or other than a dwelling unit. Illumination is needed for the safety of a homeowner as well as for service personnel in all locations where there is storage or electrical equipment requiring servicing. The revised wording at 210.70(C) for all occupancies is the same as the text found in 210.70(A)(3) for dwelling units.

In the revised text in the First Draft of 2017 NEC, 210.70(C) contained language calling for a lighting outlet installed in a crawl space to be protected from physical damage or be provided with GFCI protection. This requirement for GFCI protection was more appropriate for the GFCI requirements found at 210.8 and was moved to new 210.8(E). This location at 210.70 is for required lighting outlets and, therefore, addresses the luminaire itself or GFCI protection. The option of protection from physical damage was removed from 210.8(E) since physical protection does not provide the appropriate shock protection.

First Revisions: FR 315
Second Revisions: SR 311
Public Inputs: PI 150, PI 3099
Public Comments: PC 985

210.71
Receptacle Outlets in Meeting Rooms

210.71 Meeting Rooms

■ Type of Change: New

■ Change at a Glance: Receptacle outlet requirements were added for non-dwelling unit meeting rooms.
■ Code Language: **210.71 Meeting Rooms.**

(A) **General.** Each meeting room of not more than 93 m² (1000 ft²) in other than dwelling units shall have outlets for nonlocking-type, 125-volt, 15- or 20-ampere receptacles. The outlets shall be installed in accordance with 210.71(B). Where a room or space is provided with movable partition(s), each room size shall be determined with the partition in the position that results in the smallest size meeting room.

**Informational Note No. 1:** For the purposes of this section, meeting rooms are typically designed or intended for the gathering of seated occupants for such purposes as conferences, deliberations, or similar purposes, where portable electronic equipment such as computers, projectors, or similar equipment is likely to be used.

**Informational Note No. 2:** Examples of rooms that are not meeting rooms include auditoriums, schoolrooms, and coffee shops.

(B) **Receptacle Outlets Required.** The total number of receptacle outlets, including floor outlets and receptacle outlets in fixed furniture, shall not be less than as determined in (1) and (2). These receptacle outlets shall be permitted to be located as determined by the designer or building owner.

1. **Receptacle Outlets in Fixed Walls.** Receptacle outlets shall be installed in accordance with 210.52(A)(1) through (A)(4).

2. **Floor Receptacle Outlets.** A meeting room that is at least 3.7 m (12 ft) wide and that has a floor area of at least 20 m² (215 ft²) shall have at least one receptacle outlet located in the floor at a distance not less than 1.8 m (6 ft) from any fixed wall for each 20 m² (215 ft²) or major portion of floor space.

**Informational Note No. 1:** See Section 314.27(B) for floor boxes used for receptacles located in the floor.

**Informational Note No. 2:** See Article 518 for assembly occupancies designed for 100 or more persons.

■ **2014 NEC Requirement**

The 2014 NEC and previous editions of the Code have provisions for the location and wall spacing of nonlocking-type, 125-volt, 15- or 20-ampere receptacles, but these provisions were only binding at dwelling units [see 210.52(A)(1) through (A)(4)]. There were no such receptacle outlet spacing requirements at “other than a dwelling unit.”

■ **2017 NEC Change**

New provisions were added at 210.71 with minimum provisions for receptacle outlets placement and wall spacing requirements in non-dwelling unit meeting rooms such as those found at hotels and convention centers. See NEC text for complete requirements and specifics.

**Analysis of the Change:**

To emphasize the receptacle outlet spacing requirements specific to dwelling units, the instructor conducting a residential electrical training class will often ask the attendees, “How many receptacle outlets does the Code require us to supply for this beautiful meeting room of this fine-looking hotel facility that we are meeting in today?” The answer, of course, was “Zero!”

The answer to that question is about to change with the new requirements introduced at 210.71 for the 2017 NEC. For certain sized non-dwelling unit meeting rooms, receptacle outlets will be required to be provided and spaced apart similar to a dwelling unit and the wall spacing rules of 210.52(A)(1) through (A)(4) [see complete Code text at 210.71 for specifics]. Meeting rooms with a floor area greater than 93 m² (1000 ft²) will not be subject to these rules,
unless they can be partitioned into smaller rooms meeting that threshold.

In some cases, floor receptacles will be required to be installed to meet the needs of the present and future meeting room occupants. A meeting room that is at least 3.7 m (12 ft) wide and has a floor area of 20 m² (215 ft²) must be provided with one floor receptacle outlet located not less than 1.8 m (6 ft) from any fixed wall for each 20 m² (215 ft²) or major portion of floor space. These required floor receptacle outlet(s), located away from fixed walls, will minimize the need for extension cords and multi-outlet devices to facilitate the use of equipment (such as a projector) in the middle of the meeting room. We have all witnessed the current practice of providing an extension cord—usually plugged into a wall receptacle outlet and taped to the carpet—to provide power for such things as laptops, phone chargers, and projectors that are used in areas several feet away from the available wall receptacles.

Without this new requirement, there was previously no Code requirement to provide receptacle outlets in meeting rooms of commercial or non-dwelling occupancies. The fact that 125-volt, 15- or 20-ampere receptacle outlets are installed in meeting rooms at all is due, in part, to building owners and designers recognizing the need for access to electrical power for a multitude of different types of portable equipment. From a design standpoint, you rarely encounter a meeting room with no receptacle outlets; but, under previous editions of the Code, a Code-compliant project could have resulted in a hotel meeting room with no receptacle outlets whatsoever.

A close look at 210.50(B) reveals that a receptacle outlet is to be installed wherever flexible cords with attachment plugs are used. Since it would be virtually impossible to use these meeting rooms in the fashion that they are typically used and not resort to some form of flexible cords with an attachment plug, it would follow that there is a need for some minimum requirement for receptacle outlets in these gathering places. Receptacle outlets are needed in meeting rooms to provide electrical power for such things as booth displays, coffee pots, heating of catered food, and other electrical/electronic equipment such as laptop computers, phone chargers, and projectors. There is also a great need to provide electrical power at moveable partitions in the form of floor receptacle outlets to help prevent the use of portable extension cords in these areas.

It should be noted that in a meeting room or space provided with movable partition(s), each room size will be determined by the partition in the position that results in the “smallest size meeting room.” If a meeting area were equipped with a movable partition and that partition (when opened or in place) would divide the space into two equal spaces, this would result in two separate meeting rooms. Each side would be treated as a separate meeting room. If each side of these two spaces is each at least 3.7 m (12 ft) wide and have a floor area of at least 20 m² (215 ft²), this would require at least one floor-receptacle outlet located on both sides of this partition.

While the placement of receptacle outlets may be best left to the designer, the decision on whether or not to provide receptacle outlets is a safety issue and belongs in the NEC. These new provisions have language that will leave the placement of receptacle outlets up to the designer or building owner while also including minimum provisions for receptacle outlets in meeting rooms, in the same way that 210.60 does for guest rooms or guest suites in hotels, motels, sleeping rooms in dormitories, and similar occupancies.

First Revisions: FR 7517
Second Revisions: SR 329
Public Inputs: PI 2872
Public Comments: PC 762, PC 1188, PC 1761, PC 828

215.2(A)(1)(a), Ex. No. 2

*Feeder Rating and Size*
210.7 Minimum Rating and Size

- **Type of Change:** New

- **Change at a Glance:** A new exception allows a portion of a feeder that is not connected directly to load terminations to have an allowable ampacity not less than the sum of the continuous load plus the noncontinuous load (rather than the noncontinuous load plus 125 percent of the continuous load). It also clarifies when correction factors are to be applied.

- **Code Language:** 215.2 Minimum Rating and Size.

(A) **Feeders Not More Than 600 Volts.**

(1) **General.** Feeder conductors shall have an ampacity not less than required to supply the load as calculated in Parts III, IV, and V of Article 220. Conductors shall be sized to carry not less than the larger of 215.2(A)(1)(a) or (b).

(a) Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the minimum feeder conductor size shall have an allowable ampacity not less than the noncontinuous load plus 125 percent of the continuous load.

**Exception No. 1:** If the assembly, including the overcurrent devices protecting the feeder(s), is listed for operation at 100 percent of its rating, the allowable ampacity of the feeder conductors shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

**Exception No. 2:** Where a portion of a feeder is connected at both its supply and load ends to separately installed pressure connections as covered in 10.14(C)(2), it shall be permitted to have an allowable ampacity not less than the sum of the continuous load plus the noncontinuous load. No portion of a feeder installed under the provisions of this exception shall extend into an enclosure containing either the feeder supply or the feeder load terminations, as covered in 10.14(C)(1).

**Exception No. 3:** Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the continuous and noncontinuous load.

(b) The minimum feeder conductor size shall have an allowable ampacity not less than the maximum load to be served after the application of any adjustment or correction factors.

[(3) Informational Notes unchanged]
**Exception No. 1:** If the assembly, including the overcurrent devices protecting the feeder(s), is listed for operation at 100 percent of its rating, the allowable ampacity of the feeder conductors shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

**Exception No. 2:** Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the continuous and noncontinuous load.

- **2014 NEC Requirement**

  215.2(A)(1) stated that a feeder had to be sized based on the larger of two separately required calculations or conditions. 215.2(A)(1)(a) requires the feeder conductors to have an allowable ampacity of not less than the noncontinuous load plus 125 percent of the continuous load. The conditions described at 215.2(A)(1)(b) requires the feeder conductors to have an allowable ampacity not less than the maximum load to be served after the application of any adjustment or correction factors. Two exceptions existed allowing the feeder conductors to be sized at not less than the sum of the continuous load plus the noncontinuous load, but these exceptions appeared after 215.2(A)(1)(b), which created confusion as to their application.

- **2017 NEC Change**

  The previous exceptions to 215.2(A)(1)(b) have been relocated after 215.2(A)(1)(a). This relocation clarifies that these exceptions apply to the main rule that the feeder conductors must have an allowable ampacity of not less than the noncontinuous load plus 125 percent of the continuous load. A new exception was also added that allows a portion of a feeder that is connected at both its supply and load ends to separately installed pressure connections to have an allowable ampacity not less than the sum of the continuous load plus the noncontinuous load (rather than the noncontinuous load plus 125 percent of the continuous load).

**Analysis of the Change:**

For the 2017 NEC, the previous exceptions that appeared after 215.2(A)(1)(b) have been moved to follow 215.2(A)(1)(a) to clarify that these exceptions apply to the requirement that the feeder conductors must have an allowable ampacity of not less than the noncontinuous load plus 125 percent of the continuous load. In a literal reading of 2014 NEC, the location of the exceptions after 215.2(A)(1)(b) could have implied that the user did not have to consider ampacity adjustment or temperature correction factors when using these exceptions. By placing the existing exceptions after 215.2(A)(1)(a), it clarified that these are exceptions to the requirements found in item (a), not item (b).

A new 215.2(A)(1)(a), Ex. No. 2 allows a portion of a feeder that is connected at both its supply and load ends to separately installed pressure connections to have an allowable ampacity not less than the sum of the continuous load plus the noncontinuous load. This is allowable since the 125% rule for continuous loads is necessary for temperature-sensitive equipment like circuit breakers, not for separately installed connectors. This provision is technically appropriate and has been done in the past, but was inadvertently prohibited due to the recent restructuring of the requirements at 215.2(A)(1). This new exception also includes language that omits that portion of the feeder that extends into an enclosure containing either the feeder supply or the feeder load terminations, as covered in 110.14(C)(1). Without this new exception, 215.2(A)(1)(a) would seem to be in conflict with 110.14(C)(2), which states that separately installed pressure connectors must be used with conductors at the amperages not exceeding the ampacity at the listed and identified temperature rating of the connector.

The key to making correct conductor selection decisions is to remember that the end of a conductor is different from its middle. Special rules apply to calculating conductor sizes based on how the terminations are expected to function. Entirely different rules aim at assuring that conductors, over their length, do not overheat under current loading and conditions of use. Sometimes it is the termination requirements that produce the largest conductor, and sometimes the adjustment and correction factor requirements prevent conductor overheating. These two separate calculations must be performed, and then one makes a comparison to determine the proper size of a conductor. In a cost-saving effort, it has become relatively commonplace for installers to place pull boxes at both ends of long feeder-conductor installations and reduce the size of the feeder conductors in the middle of this run. This procedure leaves and arrives at overcurrent devices with feeder conductors sized to accommodate the effects of continuous loading on those devices while complying with the provisions of 110.14(C)(1). This method leaves the middle of this run of feeders sized in accordance with the ampacity requirements for the conductor and to provide wiring that will accommodate the maximum current in amperes, whether or not any portion of that current is continuous, that will not exceed its temperature rating under the conditions of use. Splicing devices rated for full conductor temperatures are readily available.
available and clearly permitted in the middle of runs by 110.14(C)(2). This new exception will encompass this type of installation and allow it to be Code-compliant.

This concept has a precedent in the Code in the form of previous Ex. No 2 [now 215.2(A)(1)(a), Ex. No. 3], which allows grounded conductors to use this procedure provided they do not arrive at or depart from an overcurrent device.

First Revisions: FR 337
Public Inputs: PI 3612, PI 4680

Article 220 and 220.1
Branch-Circuit, Feeder, and Service Load Calculations

Article 220 and 220.1 Branch-Circuit, Feeder, and Service Load Calculations

■ Type of Change: Revision

■ Change at a Glance: The Title and Scope of Article 220 were revised to enhance clarity of what is covered by the article.

■ Code Language: Article 220 Branch-Circuit, Feeder, and Service Load Calculations

220.1 Scope. This article provides requirements for calculating branch-circuit, feeder, and service loads. Part I provides for general requirements for calculation methods. Part II provides calculation methods for branch-circuit loads. Parts III and IV provide calculation methods for feeder and service loads. Part V provides calculation methods for farm loads.

Informational Note No. 1: See examples in Informative Annex D.

Informational Note No. 2: See Figure 220.1 for information on the organization of Article 220.

■ 2014 NEC Requirement

The title of Article 220 was “Branch Circuit, Feeder, and Service Calculations.” The scope of the article indicated that Parts III and IV provide calculation methods for “feeders and services.” The scope went on to state that Part V provided calculation methods for “farms.”
**2017 NEC Change**

The title of Article 220 was changed to “Branch Circuit, Feeder, and Service ‘Load’ Calculations.” Parts of the scope of the article were changed to clarify that Parts III and IV provide calculation methods for “feeder and service loads.” Text concerning Part V was revised to clarify that this part of the article covers calculation methods for “farm loads.”

**Analysis of the Change:**

The title and scope statement for Article 220 have been revised to enhance the clarity of the article. The word “Load” was added to the title of the article and the word “loads” was added a couple of times in the scope. These revisions will help make it clear that the place for calculating loads is Article 220 and the place for determining branch circuit and feeder conductor sizes is Articles 210 and 215. Titles and scope statements for all articles should clearly describe in general terms what the article covers and include sufficient details to indicate the range or limits of what is covered by the article.

The title of Article 220 is now “Branch Circuit, Feeder, and Service ‘Load’ Calculations.” What differentiates Article 220 from Articles 210, 215, and 230 is the fact that Article 220 substantially addresses loads. This is confirmed by the titles of Parts II, III, and IV of Article 220, all of which contain the word “load.”

First Revisions: FR 343, FR 342
Public Inputs: PI 695

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**225.30(F)**

*Multiple Feeders in One- or Two-Family Dwellings*

Feeders are generally limited to one feeder on the load side of the service equipment per building or structure [see permissive conditions at 225.30]

Multiple feeders are now allowed to enter a one- or two-family dwelling under certain restrictions that include the feeder disconnects at the building served must be grouped

**225.30(F) Number of Supplies. (Outside Branch Circuits and Feeders)**

- **Type of Change:** New

- **Change at a Glance:** Multiple feeders are now allowed to enter a one- or two-family dwelling under certain restrictions, which include that the feeder disconnects at the building served must be grouped.

- **Code Language:** 225.30 Number of Supplies. (Outside Branch Circuits and Feeders)
A building or other structure that is served by a branch circuit or feeder on the load side of a service disconnecting means shall be supplied by only one feeder or branch circuit unless permitted in 225.30(A) through (E) (F). For the purpose of this section, a multiwire branch circuit shall be considered a single circuit.

Where a branch circuit or feeder originates in these additional buildings or other structures, only one feeder or branch circuit shall be permitted to supply power back to the original building or structure, unless permitted in 225.30(A) through (E) (F).

(F) One- or Two-Family Dwelling Unit(s). For a one- or two-family dwelling unit(s) with multiple feeders, it shall be permissible to install not more than six disconnects grouped at one location where the feeders enter the building, provided the feeder conductors originate at the same switchboard, panelboard, or overcurrent protective device location.

■ 2014 NEC Requirement
A building or structure is generally required to be served by only one feeder or branch circuit on the load side of the service equipment in accordance with the parent text of 225.30. Several “conditions” are described at 225.30(A) through (E) that would allow more than one feeder or branch circuit to serve a building or structure.

■ 2017 NEC Change
A new first level subdivision (F) was added to 225.30 that will allow multiple feeders at one- or two-family dwelling unit(s) with not more than six grouped disconnecting means. These feeder conductor(s) are to originate at the same switchboard, panelboard, or overcurrent protective device location.

Analysis of the Change:
Similar to the service requirements of 230.2, feeders are generally limited to one feeder on the load side of the service equipment per building or structure. As with services, several “conditions” exist at the subsections of 225.30 that will allow more than one feeder or branch circuit in a particular building or structure as long as the multiple feeders (or branch circuits) meet the described conditions. Some of these conditions for allowing an additional feeder or branch circuit would include such things as additional feeders or branch circuits for a fire pump, emergency systems, legally required standby systems, optional standby systems, buildings that are “sufficiently large” making two or more supplies necessary, and feeders of different characteristics (different voltages, phases, etc.).

In order to permit more than one feeder to a one- or two-family dwelling unit(s), a new 225.30(F) was added to the 2017 NEC. This new first level subdivision allows multiple feeders at one- or two-family dwelling unit(s) with not more than six disconnects grouped at one location where the feeders enter the building. These feeder conductor(s) are to originate at the same switchboard, panelboard, or overcurrent protective device location.

Custom dwelling units are getting larger and larger. The increased size of services and feeders to one- or two-family dwelling unit(s) has made the necessity of permitting more than one feeder to supply a dwelling unit a must. The well-established requirement to group the disconnects for these feeders in one location and limit the number of disconnects to a maximum of six will address any safety concerns involved. This new multiple feeder allowance for dwelling units will incorporate a provision for feeders that is already a common installation method used for services.

An example of a situation where this new multiple feeder provision for dwelling units will apply is a common installation of pedestal-type meterbases with service disconnects mounted on a built structure away for the main building. The service disconnects are either an integral part of the meterbase assembly or located directly adjacent to the meterbase assembly. Multiple individual feeders are then installed from these service disconnects to a large dwelling unit directly to panel-boards that includes a single main disconnect. Under the previous requirements at 225.30(A) through (E) and the 2014 NEC, this installation would not be allowed even though this would be a Code-compliant installation if this installation involved service conductors rather than feeders. The new provisions of 225.30(F) will make this situation described above a Code-compliant installation for feeders as well.
230.24(B)(5) Clearance for Overhead Service Conductors

230.24(B)(5) Clearances

- **Type of Change:** New

- **Change at a Glance:** New vertical clearance of 7.5 m (24.5 ft) added for overhead service conductors installed over railroad tracks.

- **Code Language:** 230.24 Clearances.
  Overhead service conductors shall not be readily accessible and shall comply with 230.24(A) through (E) for services not over 1000 volts, nominal.

  **(B) Vertical Clearance for Overhead Service Conductors.** Overhead service conductors, where not in excess of 600 volts, nominal, shall have the following minimum clearance from final grade:

1. 3.0 m (10 ft) — at the electrical service entrance to buildings, also at the lowest point of the drip loop of the building electrical entrance, and above areas or sidewalks accessible only to pedestrians, measured from final grade or other accessible surface only for overhead service conductors supported on and cabled together with a grounded bare messenger where the voltage does not exceed 150 volts to ground

2. 3.7 m (12 ft) — over residential property and driveways, and those commercial areas not subject to truck traffic where the voltage does not exceed 300 volts to ground

3. 4.5 m (15 ft) — for those areas listed in the 3.7 m (12 ft) classification where the voltage exceeds 300 volts to ground

4. 5.5 m (18 ft) — over public streets, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land such as cultivated, grazing, forest, and orchard
7.5 m (24.5 ft) over tracks of railroads

2014 NEC Requirement
Article 230 for services had no requirements pertaining to vertical clearances for overhead service conductors installed above the tracks of a railroad. Similar requirements did and still exist at 225.18(5) for a clearance of 7.5 m (24.5 ft) for outside overhead branch circuits and feeders installed over railroad tracks.

2017 NEC Change
A new vertical clearance of 7.5 m (24.5 ft) was added at 230.24(B)(5) for overhead service conductors installed over the tracks of a railroad. This will coordinate with the same requirement for outside overhead branch circuits and feeders in Article 225.

Analysis of the Change:
Overhead service conductors (not exceeding 600 volts) must be installed with a minimum vertical clearance from final grade as prescribed at 230.24(B). This subsection describes vertical clearances above such things as sidewalks accessible to pedestrians, residential property and driveways, commercial areas not subject to truck traffic, and public streets, alleys, roads, and parking areas subject to truck traffic. For the 2017 NEC, a vertical clearance for overhead service conductors of 7.5 m (24.5 ft) above the tracks of a railroad was added to 230.42(B).

This will bring this vertical clearance requirement for overhead service conductors in line with the existing clearance requirements for outside overhead branch circuits and feeders found at 225.18. This same railroad track clearance requirement was added at 225.18 for outside overhead branch circuits and feeders during the 2011 NEC revision cycle. The vertical clearance requirements for overhead service conductors should be at least equal to the same requirements for outside overhead branch circuits and feeders. At a minimum, it seemed strange to have specified height requirements for outside overhead branch circuits and feeders above a railroad track and not have any such requirement for overhead service conductors in the NEC.

This new provision for overhead service conductors will bring some enforceability for a minimum clearance where these service conductors are installed over rail track spurs or other railway systems on private property areas that are under the control of the NEC. The 7.5 m (24.5 ft) clearance requirement is derived from and matches vertical clearance requirements found in ANSI Standard C2, National Electrical Safety Code (NESC) published by the Institute of Electrical and Electronics Engineers (IEEE).

230.29
Supports over Buildings

First Revisions: FR 929
Public Inputs: PI 2974
230.29 Branch-Circuit Receptacle Requirements

■ Type of Change: New

■ Change at a Glance: New requirement added for bonding of metal overhead service support structures over buildings.

Service conductors passing over a roof shall be securely supported by substantial structures. For a grounded system, where the substantial structure is metal, it shall be bonded by means of a bonding jumper and listed connector to the grounded overhead service conductor. The bonding jumper shall be of the same conductor size and material as the grounded overhead service conductor, and in no case smaller than mandated in 250.102(C)(1) based on the size of the ungrounded service conductors. Where practicable, such supports shall be independent of the building.

■ 2014 NEC Requirement
Bonding of equipment for services (raceways, cable trays, auxiliary gutters, etc.) is found at 250.92(A). This bonding requirement did not include substantial support structures for overhead service conductors installed over a roof of a building.

■ 2017 NEC Change
Metal support structures that support overhead service conductors installed over a roof are now required to be bonded to the grounded overhead service conductor.

Analysis of the Change:
New requirements were added to 230.29 requiring metal support structures that support overhead service conductors passing over a roof to be bonded to the grounded overhead service conductor. These metal structures; sometimes referred to as a “roof jack” in the field, should be adequately bonded to limit a potential shock hazard.

The Code contains bonding requirements pertaining to “equipment for services” at 250.92(A), but this provision covers “normally non-current-carrying metal parts of equipment” such as “all raceways, cable trays, cablebus framework, auxiliary gutters, or service cable armor or sheath that enclose, contain, or support service conductors.” This subsection goes on to require “all enclosures containing service conductors, including meter fittings, boxes, or the like, interposed in the service raceway or armor” to be bonded together. As thorough as this list of service related items required to be bonded is, the “substantial metal structures” described here at 230.29 does not seem to fit into any of these categories. These substantial support structures are not a raceway, as it does not act as a channel for
conductors; it is simply an auxiliary or supplemental support for the overhead service conductors. This new requirement will add clear direction to installers and enforcers alike for the bonding of these structural metal supports.

The bonding jumper used to accomplish this bonding is based on the size of the ungrounded service conductors. This bonding and sizing requirement is very similar to the bonding requirements for bonding of a ferrous metallic raceway used to chase or enclose a grounding electrode conductor found at 250.64(E).

Table 240.6(A)  
**Standard Ampere Ratings for Fuses and Inverse Time Circuit Breakers**

<table>
<thead>
<tr>
<th>Type of Change: New</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change at a Glance: New Table 240.6(A) added for “Standard Ampacity Ratings for Fuses and Inverse Time Circuit Breakers.”</td>
</tr>
<tr>
<td>Code Language: 240.6 Standard Ampere Ratings.</td>
</tr>
</tbody>
</table>

(A) Fuses and Fixed-Trip Circuit Breakers. The standard ampere ratings for fuses and inverse time circuit breakers shall be considered 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, 200, 225, 250, 300, 350, 400, 450, 500, 600, 700, 800, 1000, 1200, 1600, 2000, 2500, 3000, 4000, 5000, and 6000 amperes as shown in Table 240.6(A). Additional standard ampere ratings for fuses shall be 1, 3, 6, 10, and 601. The use of fuses and inverse time circuit breakers with nonstandard ampere ratings shall be permitted.

Table 240.6(A) Standard Ampere Ratings for Fuses and Inverse Time Circuit Breakers

(See NEC and illustration provided for complete table)
The standard ampere ratings for fuses and inverse time circuit breakers were contained at 240.6(A) in a sentence format.

- **2017 NEC Change**
  The standard ampere ratings for fuses and inverse time circuit breakers have been revised to be included in a list format located at new Table 240.6(A).

**Analysis of the Change:**
The information pertaining to the standard ampere ratings for fuses and inverse time circuit breakers has been reformatted into a table format for clarity and usability. A new Table 240.6(A) was formed from the list of standard ampere ratings that have appeared in a single sentence for decades in previous editions of the NEC.

This continues a concentrated effort by many of the Code Making Panels to streamline and make the Code more “user friendly” whenever possible. Converting a long list of items previously addressed in long sentences or paragraphs is one way to accomplish this goal. This revision to “list format” style has a long precedence in the NEC. An example would be the revisions that occurred at 250.8(A) for permitted connection methods for equipment grounding conductors, grounding electrode conductors, and bonding jumpers to metal enclosures. Another example would be the list format at 404.2(C) for locations where a grounded conductor would not be required at switch locations.

This revision to the text at 240.6(A) and the accompanying new Table 240.6(A) will be another step in the direction toward a more “user friendly” NEC format.

First Revisions: FR 2703  
Public Inputs: PI 1056, PI 1441

**240.67**

*Arc Energy Reduction*

All single-phase receptacles (150 volts to ground or less, 50 amperes or less) and three-phase receptacles (150 volts to ground or less, 100 amperes or less) installed in non-dwelling unit crawl spaces requires GFCI protection.

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**Type of Change:** New

**Change at a Glance:** New arc energy reduction requirements have been added for fuses rated 1200 amperes or higher.
- **Code Language: 240.67 Arc Energy Reduction.**
  Where fuses rated 1200 amperes or higher are installed, 240.67(A) and (B) shall apply. This requirement shall become effective January 1, 2020.

  (A) **Documentation.** Documentation shall be available to those authorized to design, install, operate, or inspect the installation as to the location of the fuses.

  (B) **Method to Reduce Clearing Time.** A fuse shall have a clearing time of 0.07 seconds or less at the available arcing current, or one of the following shall be provided:

  1. Differential relaying
  2. Energy-reducing maintenance switching with local status indicator
  3. Energy-reducing active arc flash mitigation system
  4. An approved equivalent means

  **Informational Note No. 1:** An energy-reducing maintenance switch allows a worker to set a disconnect switch to reduce the clearing time while the worker is working within an arc-flash boundary as defined in NFPA 70E-2015, *Standard for Electrical Safety in the Workplace*, and then to set the disconnect switch back to a normal setting after the potentially hazardous work is complete.

  **Informational Note No. 2:** An energy-reducing active arc flash mitigation system helps in reducing arcing duration in the electrical distribution system. No change in the disconnect switch or the settings of other devices is required during maintenance when a worker is working within an arc flash boundary as defined in NFPA 70E-2015, *Standard for Electrical Safety in the Workplace*.

  **Informational Note No. 3:** IEEE 1584, *IEEE Guide for Performing Arc Flash Hazard Calculations*, is one of the available methods that provides guidance in determining arcing current.

- **2014 NEC Requirement**
  Arc energy reduction requirements for circuit breakers rated 1200 amperes or greater are located at 240.87. There are five methods to reduce clearing times to achieve the goal of arc energy reduction identified at this location; these requirements are only related to circuit breaker overcurrent protective devices. The 2014 NEC has no similar arc energy reduction requirements for fuse-type overcurrent devices.

- **2017 NEC Change**
  Comparable methods of incident energy reduction as that of 240.87 have been introduced into the 2017 NEC at 240.67 for fuses rated at 1200 amperes and greater.

**Analysis of the Change:**
The benefits of arc energy reduction of incident energy for circuit breakers rated 1200 amperes and greater have been recognized and implemented by the requirements at 240.87, which were incorporated into the *Code* in the 2011 NEC. Those same methods of incident energy reduction have been introduced into the 2017 NEC at 240.67 for fuses rated at 1200 amperes and greater.

Arc energy reduction is designed to limit the arc-flash energy to which an electrical worker or maintenance personnel could be exposed when working on the load side of an overcurrent device that is rated or can be adjusted to 1200 amperes or higher. These industry-proven methods reduce arc-flash injuries by reducing the amount of time a fault will be permitted to persist in the electrical system. The incident energy in an arcing event is directly proportional to the time frame for such an event. The installation requirements of 240.87 for circuit breakers and the new requirements at 240.67 for fuses provide a means to reduce the level of incident energy.

The new requirements added at 240.67 were patterned after the requirements in 240.87, but modified to accommodate their application with fuses. This new arc energy reduction requirement for fuses has been properly located in Part VI of Article 240, which is titled, “Cartridge Fuses and Fuseholders.” The numbering sequence of 240.67 was selected to parallel the numbering of 240.87. Circuit breakers utilizing zone-selective interlocking (ZSI) applications to meet the
requirements of 240.87 can take up to 0.07 seconds to open the circuit. With that in mind, a maximum fuse opening time of 0.07 seconds was also selected in the parent text of 240.67(B) to provide equivalent protection for a fuse as that provided by a circuit breaker with zone selective interlocking.

This new requirement has a future effective date of January 1, 2020, due in part to the contained requirements for “energy-reducing maintenance switching with local status indicator.” A maintenance-type switch for fusible switches is not readily available at this time, and this future effective date will allow the manufacturers time to develop such a device. This future date is also needed to allow manufacturers time to get equipment listed and to allow the electrical industry to respond with feasible solutions, and to ensure there is ample availability of devices from multiple manufacturers that meet this requirement.

First Revisions: FR 2707
Second Revisions: SR 2702
Public Input: PI 3293
Public Comments: PC 1365, PC 575, PC 614

250.22(6)

Circuits Not to Be Grounded

Type of Change: New

Change at a Glance: Class 2 load-side circuits for suspended ceiling low-voltage power grid distribution systems were added to the list of circuits not to be grounded.

Code Language: 250.22 Circuits Not to Be Grounded.
The following circuits shall not be grounded:
(1) Circuits for electric cranes operating over combustible fibers in Class III locations, as provided in 503.155
(2) Circuits in health care facilities as provided in 517.61 and 517.160
(3) Circuits for equipment within electrolytic cell working zone as provided in Article 668
(4) Secondary circuits of lighting systems as provided in 411.6(A)
(5) Secondary circuits of lighting systems as provided in 680.23(A)(2)
(6) Class 2 load side circuits for suspended ceiling low-voltage power grid distribution systems as provided in 393.60(B)
(6) Class 2 load-side circuits for suspended ceiling low-voltage power grid distribution systems as provided in 393.60(B).

■ **2014 NEC Requirement**

There were five circuits that were not to be grounded identified at 250.22(1) through (5). Included in new Article 393 was a requirement that stated Class 2 load-side circuits for suspended ceiling low-voltage power grid distribution systems were not to be grounded, which is stipulated at 393.60(B).

■ **2017 NEC Change**

A new List Item (6) was added to 250.22 for circuits not to be grounded with the addition of Class 2 load-side circuits for suspended ceiling low-voltage power grid distribution systems as provided in 393.60(B).

**Analysis of the Change:**

In Article 250, alternating-current (ac) systems are divided into three categories: (1) ac systems that are required to be grounded (see 250.20), (2) ac systems (50 volts to 1000 volts) that are not required to be grounded (see 250.21), and (3) ac systems that are prohibited from being grounded (see 250.22). The previous edition of the Code identified five circuits that were not to be grounded at 250.22(1) through (5). For the 2017 NEC, a new List Item (6) was added to the list of circuits not to be grounded with the addition of Class 2 load-side circuits for suspended ceiling low-voltage power grid distribution systems.

Low-voltage suspended ceiling power distribution systems are defined as “a system that serves as a support for a finished ceiling surface and consists of a busbar and busbar support system to distribute power to utilization equipment supplied by a Class 2 power supply” (see 393.2). These systems were added to the 2014 NEC at Article 393 to address low-voltage Class 2 supplied equipment (lighting and power) connected to ceiling grids, floors, and walls built for this purpose. The article addresses equipment with characteristics similar to track lighting, but that also includes the wiring and power supply requirements while providing the specific requirements for the safe installation of low-voltage, power-limited power distribution that provides power to lighting and non-lighting loads.

Adding these low-voltage systems to the list of circuits not to be grounded was a natural step since the relevant article stipulates that the “Class 2 load-side circuits for suspended ceiling low-voltage power grid distribution systems shall not be grounded.” This requirement is located at 393.60(B). The supply side of these Class 2 power sources is to be grounded by connection to an equipment grounding conductor in accordance with the applicable requirements in Part IV of Article 250 [see 393.60(A)]. The ungrounded nature of the load side of this low-voltage system helps ensure safety similar to other identified low-voltage systems not to be grounded at 250.22.

First Revisions: FR 1208
Second Revisions: SR 1203
Public Inputs: PI 1444
Public Comments: PC 1558, PC 1767

**250.30(A)(4) and (A)(5)**

*Grounding Separately Derived Systems*
250.30(A)(4) and (A)(5) Grounding Separately Derived Alternating-Current Systems

- **Type of Change:** Revision

- **Change at a Glance:** The use of metal water piping or building steel as the first options as a grounding electrode system for a separately derived system has been removed.

- **Code Language:** 250.30 Grounding Separately Derived Alternating-Current Systems.
In addition to complying with 250.30(A) for grounded systems, or as provided in 250.30(B) for ungrounded systems, separately derived systems shall comply with 250.20, 250.21, 250.22, or 250.26, as applicable. Multiple separately derived systems that are connected in parallel shall be installed in accordance with 250.30.

(A) **Grounded Systems.** A separately derived ac system that is grounded shall comply with 250.30(A)(1) through (A)(8). Except as otherwise permitted in this article, a grounded conductor shall not be connected to normally non-current-carrying metal parts of equipment, be connected to equipment grounding conductors, or be reconnected to ground on the load side of the system bonding jumper.

**Informational Note:** See 250.32 for connections at separate buildings or structures and 250.142 for use of the grounded circuit conductor for grounding equipment.

**Exception:** Impedance grounded neutral system grounding connections shall be made as specified in 250.36 or 250.187, as applicable.

(4) **Grounding Electrode.** The building or structure grounding electrode system shall be used as the grounding electrode for the separately derived system. If located outdoors, the grounding electrode shall be in accordance with 250.30(C), as near as practicable to, and preferably in the same area as, the grounding electrode conductor connection to the system. The grounding electrode shall be the nearest of one of the following:

1. Metal water pipe grounding electrode as specified in 250.52(A)(1)
2. Structural metal grounding electrode as specified in 250.52(A)(2)

**Exception No. 1:** Any of the other electrodes identified in 250.52(A) shall be used if the electrodes specified by 250.30(A)(4) are not available.

**Exception No. 2 to (4) and (2):** If a separately derived system originates in equipment that is listed and identified equipment as suitable for use as service equipment, the grounding electrode used for the service or
feeder equipment shall be permitted to be used as the grounding electrode for the separately derived system.

Informational Note No. 1: See 250.104(D) for bonding requirements for interior metal water piping in the area served by separately derived systems.

Informational Note No. 2: See 250.50 and 250.58 for requirements for bonding all electrodes together if located at the same building or structure.

(5) Grounding Electrode Conductor, Single Separately Derived System. A grounding electrode conductor for a single separately derived system shall be sized in accordance with 250.66 for the derived ungrounded conductors. It shall be used to connect the grounded conductor of the derived system to the grounding electrode as specified in accordance with 250.30(A)(4), or as permitted in 250.68(C)(1) and (2). This connection shall be made at the same point on the separately derived system where the system bonding jumper is connected.

[See NEC text for Exception No. 1, 2, and 3 to 250.30(A)(5)]

■ 2014 NEC Requirement
In order to establish a grounding electrode system for a separately derived system, the 2014 NEC called for the nearest of either a metal water pipe grounding electrode as identified at 250.52(A)(1) or a structural metal frame of the building or structure as described at 250.52(A)(2) to be utilized. If these two grounding electrodes were not available, 250.30(A) (4), Ex. No. 1 allowed “any of the other electrodes specified in 250.52(A)” to be used as a grounding electrode for a separately derived system. These grounding electrodes had to be located “as near as practicable and preferably in the same area” as the grounding electrode conductor connection to the separately derived system.

■ 2017 NEC Change
For the 2017 NEC, any of the building or structure grounding electrode(s) that are present can now be used as the grounding electrode(s) for a separately derived system. The grounding electrode(s) for the separately derived system do not have to be located near the grounding electrode conductor connection. The metal water piping and the structural metal frame as covered in 250.68(C)(1) and (2) have been recognized as conductors to extend the grounding electrode connection at 250.30(A)(5).

Analysis of the Change:
Since the 1971 edition of the NEC, specific requirements have applied to the allowable choices regarding which grounding electrode(s) must be used for a separately derived system. The first requirement concerned the grounding electrode’s location as it had to be “as near as practicable and preferably in the same area” as the grounding electrode conductor connection to the separately derived system. The second requirement was with the type of grounding electrode utilized, which had to be the nearest of either a metal water pipe grounding electrode [within 1.5 m (5 ft) from the point of entry to the building] as specified in 250.52(A)(1), or a structural metal frame grounding electrode of the building or structure as specified in 250.52(A)(2). Whichever of these two grounding electrodes was closest to the grounding electrode conductor connection to the separately derived system would determine which grounding electrode must be used. If neither of the two grounding electrodes described at 250.30(A)(4)(1) or (2) (metal water pipe or structural metal) was “available” for use, an exception would allow any of the other electrodes specified in 250.52(A) to be used as a grounding electrode for a separately derived system.

For the 2017 NEC, the hierarchy of preferences as to which grounding electrodes to use for a separately derived system has been removed. The building or structure grounding electrode system (whatever is present and regardless of its nearness) can now be used as the grounding electrode(s) for the separately derived system. The revisions to 250.30(A)(4) better describe a grounding electrode system for a separately derived system and don’t limit the grounding electrode choices. The revisions to 250.30(A)(5) include the conductors that are suitable to extend the grounding electrode connection and recognize the fact that the metal water piping and the structural metal frame as covered in 250.68(C)(1) and (2) are not grounding electrodes but are conductors extending the grounding electrode connection.
These revisions also allowed previous 250.30(A)(4), Exception No. 1 to be deleted as those previous options allowing any of the grounding electrodes described at 250.52(A) to be used “if metal water piping and the structural metal framing are not available” to be used were incorporated into the main text of 250.30(A) (4). Editorial changes were made to the former Exception No. 2 of 250.30(A)(4) (now the only exception) to make it more technically accurate.

First Revisions: FR 1219, FR 1214
Second Revisions: SR 1210, SR 1205
Public Inputs: PI 572, PI 3471
PC: PC 1561, PC 1768, PC 1571, PC 1769

250.30(A)(6)(a)

Common GE Conductor

250.30(A)(6)(a) Grounding Separately Derived Alternating-Current Systems

- **Type of Change:** New and Revision

- **Change at a Glance:** A metal water pipe was added to the methods of achieving a common grounding electrode conductor permitted for multiple separately derived systems.

- **Code Language:** 250.30 Grounding Separately Derived Alternating-Current Systems

  In addition to complying with 250.30(A) for grounded systems, or as provided in 250.30(B) for ungrounded systems, separately derived systems shall comply with 250.20, 250.21, 250.22, or 250.26, as applicable. Multiple separately derived systems that are connected in parallel shall be installed in accordance with 250.30.

  (A) **Grounded Systems.** A separately derived ac system that is grounded shall comply with 250.30(A)(1) through (A)(8). Except as otherwise permitted in this article, a grounded conductor shall not be connected to normally non-current-carrying metal parts of equipment, be connected to equipment grounding conductors, or be reconnected to ground on the load side of the system bonding jumper.

  **Informational Note:** See 250.32 for connections at separate buildings or structures and 250.142 for use of the grounded circuit conductor for grounding equipment.
Exception: Impedance grounded neutral system grounding connections shall be made as specified in 250.36 or 250.187, as applicable.

(6) Grounding Electrode Conductor, Multiple Separately Derived Systems. A common grounding electrode conductor for multiple separately derived systems shall be permitted. If installed, the common grounding electrode conductor shall be used to connect the grounded conductor of the separately derived systems to the grounding electrode as specified in 250.30(A)(4). A grounding electrode conductor tap shall then be installed from each separately derived system to the common grounding electrode conductor. Each tap conductor shall connect the grounded conductor of the separately derived system to the common grounding electrode conductor. This connection shall be made at the same point on the separately derived system where the system bonding jumper is connected.

Exception No. 1: (No change—see NEC for complete text)

Exception No. 2: (No change—see NEC for complete text)
(a) Common Grounding Electrode Conductor. The common grounding electrode conductor shall be permitted to be one of the following:
(1) A conductor of the wire type not smaller than 3/0 AWG copper or 250 kcmil aluminum
(2) A metal water pipe that complies with 250.68(C)(1)
(3) The metal structural frame of the building or structure that complies with 250.52(A)(2) 250.68(C)(2) or is connected to the grounding electrode system by a conductor that shall not be smaller than 3/0 AWG copper or 250 kcmil aluminum

2014 NEC Requirement
A common grounding electrode conductor for multiple separately derived systems was permitted to be either one of the following: (1) a wire-type conductor (not smaller than 3/0 AWG copper or 250 kcmil aluminum) or (2) the metal frame of a building or structure that conforms to 250.52(A)(2) or the metal frame of a building or structure that is connected by a bonding jumper (not smaller than 3/0 AWG copper or 250 kcmil aluminum) to the grounding electrode system.

2017 NEC Change
A metal water pipe that complies with 250.68(C)(1) was added to the allowable methods for a common grounding electrode conductor for multiple separately derived systems. Revisions were also made to the provisions of a metal structural frame of a building or structure qualifying as a common grounding electrode conductor for multiple separately derived systems.

Analysis of the Change:
Whenever a building or structure employs multiple separately derived systems, a common grounding electrode conductor is permitted to be utilized for connection of the grounded conductor of the separately derived systems to the grounding electrode(s) described at 250.30(A)(4). If installed, a grounding electrode conductor tap would be installed from each separately derived system to the common grounding electrode conductor. The tap conductors, in turn, would connect the grounded conductor of each of the separately derived systems to the common grounding electrode conductor with the connection required to be made at the same point on the separately derived system where the system bonding jumper is connected.

This “common grounding electrode conductor” approach for multiple separately derived systems has been allowed by the Code since the 2002 edition of the NEC. For the previous edition of the Code, this common grounding electrode conductor was permitted to be either a wire-type conductor (not smaller than 3/0 AWG copper or 250 kcmil aluminum), the metal frame of a building or structure that qualified as a grounding electrode in conjunction with 250.52(A)(2), or the metal frame of a building or structure that is connected by a bonding jumper (not smaller than 3/0 AWG copper or 250 kcmil aluminum) to the grounding electrode system.

For the 2017 NEC, along with revisions to the metal structural frame of a building or structure provisions, a metal
water pipe was added to the allowable methods of achieving the “common grounding electrode conductor” for multiple separately derived systems. For this metal water pipe to qualify as a common grounding electrode conductor, it must meet the conditions of 250.68(C)(1). This section of the Code allows a metal water pipe to be used as a conductor to interconnect electrodes that are part of the grounding electrode system as long as the connection is made to an interior metal water pipe that is electrically continuous with a metal underground water pipe electrode and is within the first 1.52 m (5 ft) from the point of entrance to the building (see exception for industrial, commercial, and institutional buildings with only qualified persons servicing the installation).

The use of a metal structural frame of a building or structure as a common grounding electrode conductor for multiple separately derived systems was revised by adding the word “structural” to the reference to give a better description to this method. The Code reference of 250.52(A)(2) was changed to 250.68(C)(2) as 250.52(A)(2) pertains to the conditions a metal structural framing member must meet to qualify as a grounding electrode. The revised Code reference of 250.68(C)(2) relates to a metal structural frame of a building or structure being used as a conductor to interconnect electrodes that are part of the grounding electrode system, which is what is being discussed here at 250.30(A)(6).

First Revisions: FR 1218
Second Revisions: SR 1206
Public Inputs: PI 3472
Public Comments: PC 364, PC 740, PC 1574, PC 1770, PC 321

250.52(A)(2)
Metal In-Ground Support Structures

250.52(A)(2) Grounding Electrodes

- **Type of Change:** Revision

- **Change at a Glance:** The title of a “Metal Frame of a Building” grounding electrode renamed “Metal In-Ground Support Structure.” Conditions for this grounding electrode revised.

- **Code Language:** 250.52 Grounding Electrodes.

  (A) Electrodes Permitted for Grounding.
(2) **Metal Frame of the Building or In-Ground Support Structure(s).** The metal frame of the building or structure that is connected to the earth by one or more of the following methods:

1. At least one or more structural metal in-ground support structure(s) member that is in direct contact with the earth vertically for 3.0 m (10 ft) or more, with or without concrete encasement. If multiple metal in-ground support structures are present at a building or a structure, it shall be permissible to bond only one into the grounding electrode system.

2. Hold-down bolts securing the structural steel column that are connected to a concrete-encased electrode that complies with 250.52(A)(3) and is located in the support footing or foundation. The hold-down bolts shall be connected to the concrete-encased electrode by welding, exothermic welding, the usual steel tie wires, or other approved means.

**Informational Note:** Metal in-ground support structures include, but are not limited to, pilings, casings, and other structural metal.

- **2014 NEC Requirement**

  Two items or objects were identified at 250.52(A)(2) as meeting the requirements or conditions necessary to qualify as a metal frame of a building or structure-type grounding electrode. Those two items were (1) at least one structural metal member in direct contact with the earth for 3.0 m (10 ft) or more, with or without concrete encasement, and (2) a structural metal member connected to a concrete-encased electrode by hold-down bolts securing the structural steel column to the concrete-encased electrode. The hold-down bolts had to be connected to the concrete-encased electrode by welding, exothermic welding, the usual steel tie wires, or other approved means.

- **2017 NEC Change**

  The title of 250.52(A)(2) was changed from “Metal Frame of a Building” to “Metal In-Ground Support Structure.” Only one item remains that would qualify as a “metal in-ground support structure” grounding electrode: an in-ground support structure that is in direct contact with the earth vertically for 3.0 m (10 ft) or more, with or without concrete encasement.

**Analysis of the Change:**

Grounding electrodes must “qualify” or meet specific conditions to be considered a grounding electrode. These “qualifications” or conditions for grounding electrodes can be found at 250.52(A). For the fourth time in the last five Code cycles, revisions, and/or deletions, were made to the descriptive language of 250.52(A)(2) pertaining to a metal frame of a building or structure as a permitted grounding electrode.

For this Code cycle, the title of 250.52(A)(2) was even changed from “Metal Frame of a Building” to “Metal In-Ground Support Structure.” This new title is more in line with the definition of a grounding electrode in Article 100, which is “a conducting object through which a direct connection to earth is established.” A “metal frame of building or structure” typically does not extend into the ground making a “direct connection to earth.” Metal or concrete reinforced pilings or similar objects are driven into the earth, or a hole is bored, and the structural support placed into the hole. Often, concrete is poured around the metal piling at or near the surface of the earth. Typically, the metal or concrete piling is capped where a transition is made from the piling to the metal frame of the building. For correct application of this definition, the structural metal members of a building or structure need to be the conducting object with a direct connection to the earth.

Theoretically, a “metal frame of a building or structure” that is above ground in the manner specified above cannot be a grounding electrode by the pure definition of a grounding electrode. Even if a metal structural member is driven into the ground and extends above the ground for any length, technically, a transition from grounding electrode to grounding electrode conductor is made at the point of emergence from the earth. This metal structural member may function as a grounding electrode conductor by providing a conductive path to the grounding electrode as recognized by 250.68(C)(2).

It should also be noted that the previous condition of a metal structural member connected to a concrete-encased electrode through the hold-down bolts, etc., qualifying as a grounding electrode has not been deleted. Rather, it has
been relocated to 250.68(C)(2) (Grounding Electrode Connections) as it is no longer appropriate for 250.52(A)(2) (Electrodes Permitted for Grounding) but adds clarity to 250.68(C)(2) and should be preserved as a permitted connection method.

Included in the 2005 NEC at 250.52(A)(2) were four items (with specific conditions) that were considered to qualify as a “metal frame of the building or structure” grounding electrode. With this 2017 NEC revision, there is only one object that would qualify as a “metal in-ground support structure” grounding electrode. An in-ground support structure that is in direct contact with the earth vertically for 3.0 m (10 ft) or more, with or without concrete encasement, is the lone qualifying survivor at 250.52(A)(2).

First Revisions: FR 1217
Public Inputs: PI 3311

250.52(B)(3)
Not Permitted for Use as Grounding Electrodes

250.52(B)(3) Grounding Electrodes

■ Type of Change: New

■ Change at a Glance: In-ground swimming pool structures are not permitted to be used as a grounding electrode.


(B) Not Permitted for Use as Grounding Electrodes. The following systems and materials shall not be used as grounding electrodes:
(1) Metal underground gas piping systems
(2) Aluminum
(3) The structures and structural reinforcing steel described in 680.26B (1) and (B)(2)

Informational Note: See 250.104(B) for bonding requirements of gas piping.

■ 2014 NEC Requirement
There were two items described at 250.52(B) that were prohibited from being used as a grounding electrode. The first item is a metal underground gas piping system, and the second item is an aluminum electrode.

2017 NEC Change
A third item was added to the list of objects that are prohibited from being used as a grounding electrode defined at 250.52(B). The structures and structural reinforcing steel of an in-ground swimming pool as described in 680.26(B)(1) and (B)(2) are now prohibited from being used as a grounding electrode, as well as the two items identified in the previous edition of the Code.

Analysis of the Change:
Detached buildings or structures with electrical power from a feeder—such as detached garages, workshops, etc.—require that a grounding electrode system be established and installed in accordance with the requirements of 250.32(A). Occasionally, these detached structures are located near in-ground permanently installed swimming pools. When this situation occurs, it has been documented that the electrical installer will sometimes run a grounding electrode conductor from the electrical subpanel at the detached structure to the reinforcing steel of the conductive pool shell (belly steel) or to the structural steel of the perimeter surfaces (deck steel) with the intent to identify the pool reinforcing steel as an "other local metal underground system or structure" as described at 250.52(A)(8). Unfortunately, this action is sometimes at the request of the local AHJ. This action would make the swimming pool in question (and its inhabitants) a "super-target" for any stray currents or ground-fault current introduced on this grounding electrode system, and could potentially introduce safety hazards to the occupants of the pool during events such as lightning-induced stray currents.

For the 2017 NEC, language was added at 250.52(B) to prohibit the use of the structures and structural reinforcing steel of an in-ground swimming pool as described in 680.26(B)(1) and (B)(2) from being used as a grounding electrode in the manner described above. CMP-5 determined that it was never the intent of the NEC to use a pool bonding grid as a grounding electrode. Adding the additional requirement to prohibit the use of the metal components of an in-ground swimming pool is an important clarification to point out the difference between grounding and bonding. The equipotential bonding requirements of 680.26 are to reduce voltage gradients (difference of voltage potential between two conducting objects), and not to create a grounding electrode system for a building or structure.

This point is further illustrated in the current language at 680.26(B), which states in part that "an 8 AWG or larger solid copper bonding conductor provided to reduce voltage gradients in the pool area shall not be required to be extended or attached to remote panelboards, service equipment, or electrodes."

250.66(A), (B), and (C)
Size of GECs
250.66(A), (B), and (C) Size of Alternating-Current Grounding Electrode Conductor

- **Type of Change:** Revision

- **Change at a Glance:** The “sole connection” language for sizing of grounding electrode conductors for connection to specific grounding electrodes has been removed and revised.

- **Code Language: 250.66 Size of Alternating-Current Grounding Electrode Conductor.**

  The size of the grounding electrode conductor at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s), or at a separately derived system of a grounded or ungrounded ac system shall not be less than given in Table 250.66, except as permitted in 250.66(A) through (C).

  (A) **Connections to a Rod, Pipe, or Plate Electrode(s).** Where the grounding electrode conductor or bonding jumper is connected to a single or multiple rod, pipe, or plate electrode(s), or any combination thereof, as permitted described in 250.52(A)(5) or (A)(7), that portion of the conductor that is the sole connection to the grounding electrode(s) does not extend on to other types of electrodes that require a larger size conductor, the grounding electrode conductor shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum wire.

  (B) **Connections to Concrete-Encased Electrodes.** Where the grounding electrode conductor or bonding jumper is connected to a single or multiple concrete-encased electrode(s) as permitted described in 250.52(A)(3), that portion of the conductor that is the sole connection to the grounding electrode(s) does not extend on to other types of electrodes that require a larger size conductor, the grounding electrode conductor shall not be required to be larger than 4 AWG copper wire.

  (C) **Connections to Ground Rings.** Where the grounding electrode conductor or bonding jumper is connected to a ground ring as permitted described in 250.52(A)(4), that portion of the conductor that is the sole connection to the grounding electrode does not extend on to other types of electrodes that require a larger size conductor, the grounding electrode conductor shall not be required to be larger than the conductor used for the ground ring.

- **2014 NEC Requirement**

  Grounding electrode conductors are required to be sized using Table 250.66 based on the size of the largest ungrounded service-entrance conductor or equivalent area for parallel conductors. A grounding electrode conductor with its sole connection to a rod, pipe, or plate electrode never had to be larger than a 6 AWG copper conductor or a 4 AWG aluminum conductor, regardless of the size of the ungrounded service-entrance.
conectors. A grounding electrode conductor with its sole connection to a concrete-encased electrode never had to be larger than a 4 AWG copper conductor. A grounding electrode conductor with its sole connection to a ground ring never had to be larger than the conductor used for the ground ring (2 AWG copper). Language was added to 250.66(A) and (B) to clarify that the “sole connection” provisions of these subsections pertain to the types of electrodes in these subsections, and the “sole connection” sizing provisions are still relevant even if more than one of the specified types of electrodes involved were present.

■ **2017 NEC Change**

The sizing requirements of 250.66(A), (B), and (C) are still the same as the previous edition of the Code, but the “sole connection” requirements in all three subsections was replaced with language indicating that a grounding electrode conductor that does not extend to other types of electrodes requiring a larger size conductor still qualifies for the smaller size conductors (instead of the size spelled out in Table 250.66).

**Analysis of the Change:**

To size a grounding electrode conductor properly, a visit to Table 250.66 is in order. Grounding electrode conductors are required to be a minimum size of 8 AWG copper (6 AWG aluminum or copper-clad aluminum) and need not be larger than 3/0 AWG copper (250 kcmil aluminum or copper-clad aluminum). The size of the grounding electrode conductor is typically based upon the size of the largest ungrounded service-entrance conductors; or if installed in parallel, the circular mil area of one set of parallel conductors added together and treated as a single conductor for sizing purposes.

What amounts to a three-part exception to the general rule for sizing grounding electrode conductors from Table 250.66 is provided in the text at 250.66(A) through (C). In the past, this Code language has permitted a grounding electrode conductor to be sized not larger than 6 AWG copper or 4 AWG aluminum when connected to a rod, pipe or plate electrode, and not larger than 4 AWG copper when connected to a concrete-encased grounding electrode as long as it was the “sole connection” to that grounding electrode. This section went on to permit a grounding electrode conductor connected to a ground ring to be sized no larger than the ground ring conductor, where that portion of the grounding electrode conductor is the “sole connection” to the ground ring.

This “sole connection” language has been in the Code since the 1965 NEC. Last Code cycle, explanatory-type language and plural text were added to 250.66(A) and (B) to clarify that the “sole connection” provisions of these subsections pertain to the types of electrodes in these subsections. The “sole connection” sizing provisions were not forfeited if more than one of the specified types of electrodes involved are present. The term “sole connection” apparently caused confusion in the electrical community as to the intended application of these provisions, even after the clarifications in the 2014 NEC.

For the 2017 NEC, the term sole connection was completely removed from 250.66(A), (B), and (C). The term was replaced with text that makes it clear that the action of “daisy chaining” grounding electrodes with properly sized bonding jumpers to form a grounding electrode system is an acceptable practice, as long as any downstream grounding electrode would not require a larger grounding electrode conductor or bonding jumper. The phrase “or bonding jumper” was added to subdivisions A, B, and C to use the correct terminology when “daisy chaining” occurs past the first grounding electrode in the chain of multiple electrodes.

First Revisions: FR 1227
Second Revisions: SR 1215
Public Inputs: PI 4196, PI 1407
Public Comments: PC 489, PC 1600, PC 1774

**250.94(A) and (B)**

*Intersystem Bonding Terminations*
250.94(A) and (B) Bonding for Communication Systems

- **Type of Change:** Revision and New

- **Change at a Glance:** The title of this section was renamed “Bonding for Communication Systems” and a new 250.94(B) was added titled “Other Means” allowing an alternate connection option to be made on a common bus bar.

- **Code Language:** 250.94 Bonding for Other Communication Systems.

Communications system bonding terminations shall be connected in accordance with (A) or (B).

**(A) The Intersystem Bonding Termination Device.** An intersystem bonding termination (IBT) for connecting intersystem bonding conductors required for other systems shall be provided external to enclosures at the service equipment or metering equipment enclosure and at the disconnecting means for any additional buildings or structures. The intersystem bonding termination shall comply with the following: (Remainder of 250.94(A) unchanged. See NEC for complete text.)
(B) Other Means. Connections to an aluminum or copper busbar not less than 6 mm thick × 50 mm wide (1/4 in. thick × 2 in. wide) and of sufficient length to accommodate at least three terminations for communication systems in addition to other connections. The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector. If aluminum busbars are used, the installation shall also comply with 250.64(A).

Exception to (A) and (B): Means for connecting intersystem bonding conductors are not required where communications systems are not likely to be used.

Informational Note: The use of an IBT can reduce electrical noise on communication systems.

2014 NEC Requirement
The section was titled, “Bonding for Other Systems.” An intersystem bonding termination for connecting only intersystem bonding conductors was required to be provided external to enclosures at the service equipment or metering equipment enclosure and at the disconnecting means for any additional buildings or structures. The intersystem bonding termination has six conditions that must be met to qualify as an intersystem bonding termination. This rule has one exception for existing buildings or structures.

2017 NEC Change
The title of the section was changed to “Bonding for Communication Systems.” The existing text for the intersystem bonding termination was placed under List Item (A) and titled, “The Intersystem Bonding Termination Device.” The six conditions that must be met to qualify as an intersystem bonding termination have not changed, and the one exception for existing buildings or structures remains the same. A new 250.94(B) was added titled, “Other Means,” which permits intersystem bonding connections to an aluminum or copper busbar that will accommodate at least three terminations for communication systems as well as “other connections.” A new exception was added for 250.94(A) and (B) offering relief from an intersystem bonding connection means “where communications systems are not likely to be used.”

Analysis of the Change:
An accessible point for bonding of intersystem bonding conductors for “other systems” such as telephone and cable television has been required for dwelling units since the 1981 NEC. The bonding of these intersystem bonding conductors was required for all types of occupancies beginning with the 1990 NEC. Part of the substantiation for this change in the 1990 NEC, which was simply to delete “for dwelling units,” indicated that “The accessibility for intersystem bonding is needed at all services. Small business buildings and multi-unit commercial buildings should not be exempted from this requirement.” An intersystem bonding termination point has been required since the 2008 NEC.

Intersystem bonding—which is accomplished by connection of a communication grounding conductor to the power system grounding electrode system—is an important safety measure to prevent occurrences of difference of voltages potentials between the communication system and power system. The intersystem bonding termination is for bonding of intersystem bonding conductors only. Previous proposals that also sought to allow other bonding conductors, such as a bonding jumper for bonding of metal gas piping, to terminate on the intersystem bonding termination have been rejected in past Code cycles. For the 2017 NEC, to further emphasize the fact that the intersystem bonding termination is for bonding of intersystem bonding conductors only, CMP-5 chose to change the title of 250.94 from “Bonding for Other Systems” to “Bonding for Communication Systems.”

A new subsection (B) titled, “Other Means,” was also added to 250.94. The alternate connection option allows connections to be made on a common bus bar with other bonding jumpers. This method is often used in commercial or multi-family mixed-use buildings. Even though the previous language was not restricted to just dwelling units and worked well for a dwelling unit, it did not take into account how a commercial or industrial building may bond the communication systems and other systems. Many commercial buildings commonly utilize a common grounding terminal bar for the connection of multiple electrodes and bonding of other systems, such as water piping systems, building steel, and internal antenna systems—to name a few. These common bus bars also allow easy connection of the other systems, such as communication, satellite dish systems, and network-powered broadband systems. This new “other means” of terminating other systems allows the installer to terminate other bonding conductors for bonding all
systems, including such things as corrugated stainless steel tubing (CSST) gas piping, which is still prohibited to be terminated on the intersystem bonding termination device.

A new exception to 250.94(A) and (B) was also added to give relief from providing a means for connecting intersystem bonding conductors where communications systems are not likely to be used. This exception would include such things as outhouses, chicken coops or garden sheds.

First Revisions: FR 1215
Public Input: PI 702, PI 2889

250.102
*Grounded Conductors, Bonding Conductors, and Jumpers*

![Diagram](image)

**250.102** Grounded Conductors, Bonding Conductors, and Jumpers

- **Type of Change:** Revision
- **Change at a Glance:** Title changed to “Grounded Conductors, Bonding Conductors, and Jumpers” which more clearly reflects what this section covers.
- **Code Language:** 250.102 *Grounded Conductors, Bonding Conductors, and Jumpers.*
  - **(A) Material. Bonding jumpers** shall be of copper, aluminum, copper-clad aluminum, or other corrosion-resistant material. A bonding jumper shall be a wire, bus, screw, or similar suitable conductor.
  - **(B) Attachment.** (Text unchanged, see NEC for complete text.)
  - **(C) Size — Supply-Side Bonding Jumper.**
    - **(1) Size for Supply Conductors in a Single Raceway or Cable.** The supply-side bonding jumper shall not be smaller than specified in Table 250.102(C)(1).
    - **(2) Size for Parallel Conductor Installations in Two or More Raceways or Cables.** (Text unchanged, see NEC for complete text.)
(D) **Size — Equipment Bonding Jumper on Load Side of an Overcurrent Device.** (Text unchanged, see NEC for complete text.)

(E) **Installation.**

1. **Inside a Raceway or an Enclosure.** (Text unchanged, see NEC for complete text.)
2. **Outside a Raceway or an Enclosure.** (Text unchanged, see NEC for complete text.)
3. **Protection.** (Text unchanged, see NEC for complete text.)

**2014 NEC Requirement**

To size a grounded conductor, the main bonding jumper, a system bonding jumper or a supply-side bonding jumper for an alternating-current (ac) systems, use 250.102 and Table 205.102(C)(1). The title of 250.102 previously referenced bonding conductors and jumpers. No mention of sizing of a grounded conductor existed other than in the title of Table 205.102(C)(1).

**2017 NEC Change**

“Grounded Conductor” was added to the title of 250.102 to reflect more accurately what the section addresses.

**Analysis of the Change:**

The Code requires that the provisions of 250.102 and Table 205.102(C)(1) be utilized for proper sizing of a grounded conductor, main bonding jumper, system bonding jumper, or a supply-side bonding jumper for an alternating-current (ac) systems. Table 205.102(C)(1) was new for the 2014 NEC. Before this table, the correct table to use for sizing a grounded conductor or a bonding jumper was Table 250.66.

For the 2017 NEC, 250.102 added “Grounded Conductor” to the title of this section, which was “Bonding Conductors and Jumpers,” to more accurately reflect the items covered in this section. This change harmonizes the title with the content of the section.

Another clarification to this section was to explicitly add “aluminum and copper-clad aluminum” to the choices of material acceptable for bonding jumpers. This harmonized the language with that found in 250.62 and other locations recognizing aluminum and copper-clad aluminum as corrosion-resistant materials. Previously, users of the Code were sometimes left wondering whether aluminum and copper-clad aluminum were considered corrosion-resistant materials.

The previous title of 250.102(C)(2) was “Size for Parallel Conductor Installations in Two or More Raceways.” This heading was revised by adding “or Cables” at the end of the title. Two or more raceways or cables are clearly referenced in the body of this text for sizing supply-side bonding jumpers, and the rules contained within apply to both raceways and cables. This addition to the title helps avoid any misinterpretation, as a cable is not the same as a raceway.

First Revisions: FR 7509
Second Revisions: SR 1219
Public Inputs: PI 4186, PI 1236, PI 2778, PI 1390, PI 4540
Public Comments: PC 1778, PC 1634

**250.122(F)**

*EGCs Installed in Parallel*
250.122(F) Size of Equipment Grounding Conductors

- **Type of Change:** Revision and New

- **Change at a Glance:** Revision and new text added to clarify how to size and install equipment grounding conductors when installed in parallel in a single or multiple raceways, multiconductor cable, auxiliary gutter, or cable tray.

- **Code Language:** 250.122 Size of Equipment Grounding Conductors. (F) Conductors in Parallel. Where conductors are installed in parallel as permitted in 310.10(H), the equipment grounding conductors, where used, shall be installed in parallel in accordance with (1) or (2): each raceway or cable.

(1) **Conductor Installations in Raceways, Auxiliary Gutters, or Cable Trays.**

(a) **Single Raceway or Cable Tray.** If where conductors are installed in parallel as permitted in 310.10(H), a single wire-type conductor shall be permitted as the equipment grounding conductor shall be permissibl. Each wire-type equipment grounding conductor shall be sized in accordance with 250.122, based on the overcurrent protective device for the feeder or branch circuit. Wire-type equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c). Metal raceways or auxiliary gutters in accordance with 250.118 or cable trays complying with 392.60(B) shall be permitted as the equipment grounding conductor.

(b) **Multiple Raceways.** If conductors are installed in parallel in multiple raceways, wire-type equipment grounding conductors, where used, shall be installed in parallel in each raceway. The equipment grounding conductor installed in each raceway shall be sized in compliance with 250.122 based on the overcurrent protective device for the feeder or branch circuit. Metal raceways or auxiliary gutters in accordance with 250.118 or cable trays complying with 392.60(B) shall be permitted as the equipment grounding conductor.

(2) **Multiconductor Cables**

(a) If multiconductor cables are installed in parallel, the equipment grounding conductor(s) in each cable shall be connected in parallel. Except as provided in 250.122(F)(2)(b) for raceway or cable tray installations, the equipment grounding conductor in each multiconductor cable shall be sized in accordance with 250.122 based on the overcurrent protective device for the feeder or branch circuit.

(b) If multiconductor cables are installed in parallel in the same raceway, auxiliary gutter, or cable tray, a single equipment grounding conductor that is sized in accordance with 250.122 shall be permitted in combination with the equipment grounding conductors provided within the multiconductor cables and shall all...
be connected together. Equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c). Cable trays complying with 392.60(B), metal raceways in accordance with 250.118, or auxiliary gutters, shall be permitted as the equipment grounding conductor.

- **2014 NEC Requirement**

  The requirements for installing equipment grounding conductors in parallel were (and are) covered by 250.122(F). These requirements were combined into one paragraph and addressed where equipment grounding conductors were installed in parallel in multiple raceways or cables and the same raceway, cable, or cable tray. These equipment grounding conductors were to be sized in compliance with 250.122.

- **2017 NEC Change**

  In addition to the existing rules for equipment grounding conductors installed in parallel in multiple raceways or cables and the same raceway, cable, or cable tray, these rules for parallel installations were revised to allow equipment grounding conductors installed as part of a multiconductor cable to be used in combination with a separate equipment grounding conductor in a raceway, cable tray or auxiliary gutter. The requirements for 250.122(F) have been expanded into two separate Second Level Subdivisions (1) and (2) with third level subdivisions for each.

**Analysis of the Change:**

Conductors are permitted to be installed in parallel according to the rules of 310.10(H). When conductors are installed in parallel in separate raceways or cables, the equipment grounding conductor must be in parallel as well. Section 250.122(F) covers the requirements for installing equipment grounding conductors in parallel. For the 2017 *NEC*, these rules for parallel installations were expanded to cover equipment grounding conductors installed as part of a multiconductor cable in combination with a separate equipment grounding conductor when installed in raceways, auxiliary gutters, or cable trays. While the previous text of 250.122(F) was a single, long paragraph, it has now been expanded into two separate second-level subdivisions with third-level subdivisions for each.

This revised text separates individual equipment grounding conductors installed in raceways or cable trays from multiconductor cables. The requirements are further separated for single or multiple raceways. The revisions also recognize standard multiconductor cables installed in a raceway, auxiliary gutter, or cable tray, and permits them to be installed even though the internal equipment grounding conductors of the multiconductor cable may or may not be sized less than that required by Table 250.122 for the entire raceway, auxiliary gutter, or cable tray. This can occur if the raceway, auxiliary gutter, or cable tray is suitable as the equipment grounding conductor or where a fully sized wire-type equipment grounding conductor is provided in the raceway, auxiliary gutter, or cable tray.

It is now permissible to provide an additional equipment grounding conductor in the same raceway, auxiliary gutter, or cable tray as long as all equipment grounding conductors are bonded together to create a safe condition. A ground fault in a single cable would then not create an unsafe condition as the additional equipment grounding conductor is installed. A safe installation is still maintained by the presence of a full-sized equipment grounding conductor for the raceway, auxiliary gutter, or cable tray. Running a separate equipment grounding conductor in the raceway, auxiliary gutter, or cable tray will provide an adequate fault-current path while allowing the use of commercially available cable wiring methods.

First Revisions: FR 1246
Second Revisions: SR 1225, SR 1226, SR 1224
Public Input: PI 1315, PI 330, PI 3521, PI 3329, PI 4103
Public Comments: PC 901, PC 1783

**250.148**

*Continuity and Attachment of EGC to Boxes*
250.148 Continuity and Attachment of Equipment Grounding Conductors to Boxes

- **Type of Change:** Revision

- **Change at a Glance:** Revision to clarify that all equipment grounding conductors associated with any and all circuits in the box must be connected together and to the box and not just each equipment grounding conductors of each associated circuit.

- **Code Language:** 250.148 Continuity and Attachment of Equipment Grounding Conductors to Boxes.

Where if circuit conductors are spliced within a box, or terminated on equipment within or supported by a box, any all equipment grounding conductor(s) associated with any of those circuit conductors shall be connected within the box or to the box with devices suitable for the use in accordance with 250.8 and 250.148(A) through (E).

*Exception:* The equipment grounding conductor permitted in 250.146(D) shall not be required to be connected to the other equipment grounding conductors or to the box.

- **2014 NEC Requirement**
  Direction was given at 250.148 for the splicing together or connection of equipment grounding conductors for continuity within a box or enclosure. It was unclear if this meant splicing together all of the present equipment grounding conductors regardless of the circuit conductors they were associated with or just the equipment grounding conductors for the same circuit with which the equipment grounding conductors are associated.

- **2017 NEC Change**
  Clear directions in 250.148 specify that all of the equipment grounding conductors present in a box or enclosure are required to be connected, regardless of the circuit with which they are associated. The existing exception to 250.148 still applies, giving relief to the equipment grounding conductor of an isolated ground circuit for an isolated ground receptacle not being required to be connected to the other equipment grounding conductors or the box.

**Analysis of the Change:**
An equipment bonding jumper is typically required to connect the grounding terminal of a grounding-type receptacle to both a grounded metal box and the supply equipment grounding conductor(s) (EGC). Where one or more EGCs enters
a box, they are typically required to be spliced or joined inside the box with suitable devices (listed grounding screws, listed grounding clips, etc.) to bond the box and to connect to the device with a bonding jumper [see 250.146(A) through (D) for exceptions to this general rule].

In situations where the circuit conductors (ungrounded branch-circuit conductors, feeder conductors, etc.) are spliced or terminated on devices or equipment in a metal box, the EGCs installed with these circuit conductors are required to be connected to the metal box by listed devices. The removal of a receptacle or other devices or equipment installed in or on the metal box is not permitted to interrupt or break the continuity of the EGC connections to other equipment or devices that are supplied from the same box where EGCs are connected, or to interrupt or break the continuity of the EGC connections downstream. EGCs installed in nonmetallic boxes are required to provide a means of connecting EGCs to receptacles, switches, luminaires, and other equipment installed in or supplied from the nonmetallic box.

If these boxes happen to contain two or more different branch circuits of feeders, it has been argued whether or not it is required to splice or join all the EGCs together in the box, or just the EGCs from each circuit being required to be spliced or joined. In other words, are we allowed to co-mingle EGCs from different circuits together? Changes to 250.148 in the 2017 NEC went a long way in answering these question. The revised language at 250.148 clearly indicates that all of the EGCs present in a box are required to be connected regardless of the circuit with which they are associated.

The requirements of 250.148 are frequently misunderstood and misinterpreted to mean that where multiple circuits are present in a box, the EGCs for each circuit are to be connected, but not connected to the EGCs of other circuits that are present. The word “any” was changed to “all” as in “...all equipment grounding conductor(s) associated with “any of” those circuit conductors shall be connected within the box...” in the Code text. This change makes it definite that all of the EGCs present in the box are required to be connected together.

A reference to 250.8 was also added to provide guidance on terminating an EGC or bonding jumper to a metal box or enclosure. Section 250.8 is titled, “Connection of Grounding and Bonding Equipment” and gives eight specific list items on permitted methods to properly connect grounding and bonding conductors to metal enclosures.

First Revisions: FR 1237
Public Inputs: PI 1331
Second Revisions: SR 1227
Public Comments: PC 1667, PC 1784

250.187(B)

Impedance Grounded Neutral Systems
250.187(B) Impedance Grounded Neutral Systems

- **Type of Change**: Revision

- **Change at a Glance**: Neutral conductor for an impedance grounded neutral system over 1000 volts must be insulated to the maximum neutral voltage rather than the same insulation as the phase conductors.

- **Code Language**: 250.187 Impedance Grounded Neutral Systems.

  Impedance grounded neutral systems in which a grounding impedance, usually a resistor, limits the ground-fault current shall be permitted where all of the following conditions are met:
  1. The conditions of maintenance and supervision ensure that only qualified persons service the installation.
  2. Ground detectors are installed on the system.
  3. Line-to-neutral loads are not served.

  Impedance grounded neutral systems shall comply with the provisions of 250.187(A) through (D).

- **(B) Identified and Insulated.** The neutral conductor of an impedance grounded neutral system shall be identified, as well as fully insulated with the same insulation as the phase conductors, shall comply with both of the following:
  1. The neutral conductor shall be identified.
  2. The neutral conductor shall be insulated for the maximum neutral voltage.

  **Informational Note**: The maximum neutral voltage in a three-phase wye system is 57.7 percent of the phase-to-phase voltage.

- **2014 NEC Requirement**

  The neutral conductor of an impedance grounded neutral system was to be identified, as well as fully insulated with the same insulation as the phase conductors.

- **2017 NEC Change**

  The neutral conductor of an impedance grounded neutral system still must be identified, but it must be insulated to the maximum neutral voltage rather than fully insulated with the same insulation as the phase conductors.
Analysis of the Change:

NEC 250.180 indicates that where systems or circuits of over 1000 volts are grounded, they must comply with Article 250, but specifically the rules in Part X of Article 250 (Grounding of Systems and Circuits of Over 1000 Volts). The requirements of Part X of Article 250 supplement or modify other rules in Article 250. Many medium-voltage systems in the 2.4 to 15 kV range are either low-resistance grounded or are high-resistance grounded. The only difference between low- and high-resistance grounding is the value of the resistor that, in turn, controls the amount of ground-fault current permitted during a ground-fault event. The other common method is to solidly ground the system, especially if it is exposed to lightning.

Medium voltage systems above 15 kV are typically either solidly grounded or ungrounded. For the ungrounded system, even though there is not an effective ground provided, there is still a relationship to earth through the surge (lightning) arresters installed where outdoor lines are open and commonly subjected to lightning surges and transient over-voltages.

Grounding may be achieved through solid connections to earth or connection through a grounding impedance, typically a resistor, purposely installed in the equipment-grounding path at the source. The choice depends on available ground-fault current, the size of the system, tolerance for outages, and tolerance for damage from ground faults. It is common in industrial systems to ground the neutral of systems rated 2400 volts and above through a resistor. Impedance grounded neutral systems must be installed in accordance with 250.187. Impedance grounded neutral systems can be accomplished by reactance grounding, low-resistance grounding, or high-resistance grounding.

For the 2017 NEC, revisions to 250.187 call for the neutral conductor for impedance grounded neutral systems to be insulated to the maximum neutral voltage. Prior to this change, this neutral conductor had to be “fully insulated with the same insulation as the phase conductors.” According to the substantiation for this revision to the neutral conductor insulation, it is not necessary to provide the same insulation for the neutral conductor as for the phase conductors. The maximum voltage on the neutral conductor in a three-phase impedance grounded neutral system is 57.7% of the phase-to-phase voltage or 2400 volts for a 4160-volt system. The 57.7% of the phase-to-phase voltage is true for a three-phase wye system only. The 57.7% would not hold true for a system such as a three-phase delta system operated with an impedance grounded neutral system.

There is no hazard or disadvantage from a different insulation rating on the neutral conductor. The requirements of 300.3(C) prevent routing conductors with different insulation ratings in the same raceway or cable tray section. This revision will allow proper use of system components, such as 2400-volt grounding transformers, that are designed for use with unshielded conductors.

Revisions also reformatted 250.187 into a list format to provide a clearer statement for enforcement and improved clarity. A new informational note was added to clarify the magnitude of the neutral voltage.

First Revision: FR 7525
Second Revision: SR 1229
Public Inputs: PI 1798
Public Comments: PC 1404