PDHonline Course E356 (3 PDH)

Revisions for the 2011 National Electrical Code® - Part 2

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PDH Course E356

Revisions for the 2011 *National Electrical Code*®

Part 2

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Introduction

Part 2 of this 4-part series covers Article 250 through Article 314. The course covers only major Code changes, but provides depth of coverage.

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

Although there are many references to the 2011 *NEC*® throughout this document, the course and quiz can be completed without the need to refer to the *NEC*® itself. For further study on any Code section within this course, the 2011 *NEC*® should be consulted.

Alternating-Current Systems of 50 Volts to Less Than 1000 Volts Not Required to Be Grounded – Ground Detectors

Significance

When ungrounded systems are installed as permitted by Code, detectors are required to alert maintenance personnel that a phase conductor has become unintentionally grounded. A dangerous condition could result if a second ground-fault should occur before the first fault is cleared.

Analysis

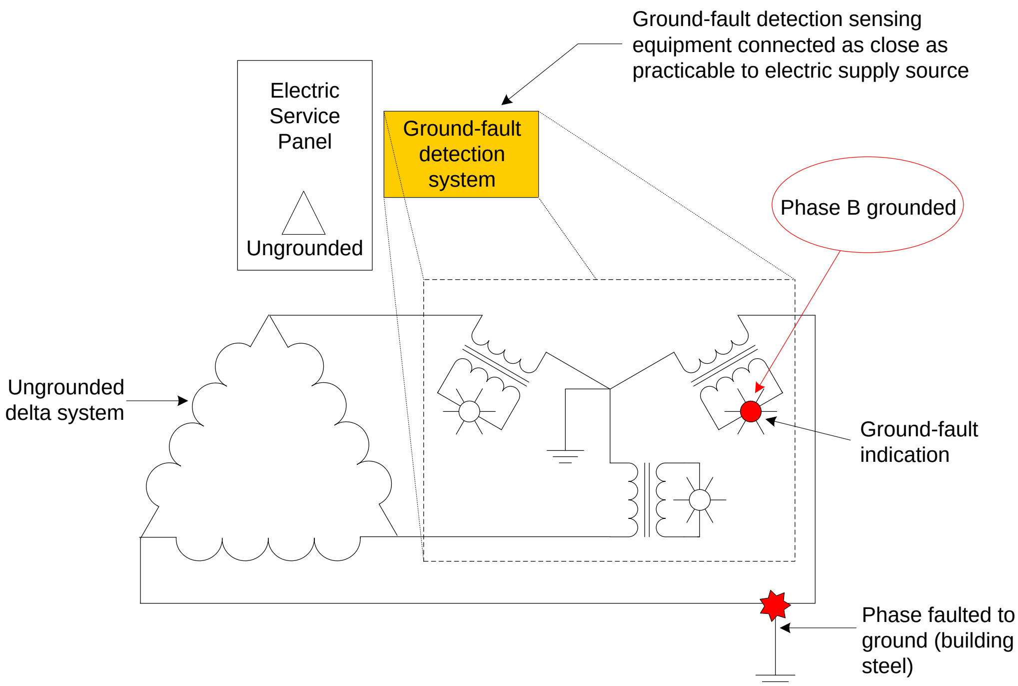
It is not uncommon for 3-phase, 3-wire, ungrounded delta-connected systems to be used where continuity of service is essential. Ungrounded 240- and 480-volt delta systems are among the systems in use that are permitted to be ungrounded. It is important that maintenance personnel locate and repair an accidental phase to ground before a second inadvertent ground fault from a different phase occurs. Ground detectors signal a visual indicator and/or an audible alarm providing notification that a ground fault has occurred, which otherwise could go unnoticed for an extended period of time. If a second ground fault should occur before the initial fault is cleared, destructive currents could result. The further the distance between the faults, the more likely the fault-current path back to the supply will not be a low-impedance path, perhaps passing through loose raceway connections and loose fittings.

The Code change specifies the connection location for the ground detector sensors. Only the sensor connection location is specified, not the location of system monitors. The sensors must be connected as near as practicable to the service for a utility supplied system, or to the source of a separately derived system. Previous Code editions permitted the sensors to be connected anywhere on the system. If there are several levels of the electrical distribution between the location where the sensing equipment is connected and the service equipment, the possibility of disabling the sensors due to the shutdown of certain feeders or branch circuits is increased.

Ground detectors are also required for high-impedance grounded neutral systems in Section 250.36. However, no connection location for the sensors is prescribed in the 2011 *NEC*.

Summary

Ungrounded systems operating between 120 volts and 1000 volts shall have ground detectors connected as near as practicable to the service equipment or to the source of a separately derived system.



Application Question

T F The ground-fault indication device must be located as close as practicable to the electrical service or to the source of a separately derived system.

Answer

False. The fault indication equipment may be located anywhere. It is the sensing equipment that must be *connected* near the electric supply source.

Alternating-Current Systems of 50 Volts to Less Than 1000 Volts Not Required to Be Grounded – Marking

Significance

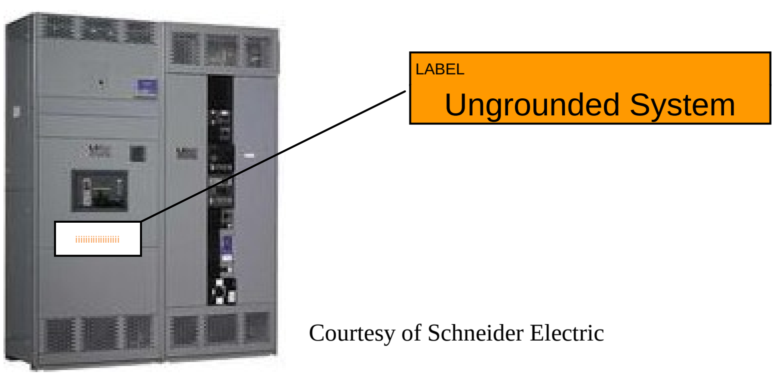
It is critical to the safety of maintenance electricians that they be able to readily identify the type of electrical system they are working on. A faulted ungrounded delta-connected system can be mistaken for a corner-grounded delta-connected system.

Analysis

A 3-phase, 3-wire, ungrounded delta system that has one phase faulted to ground will look the same to a voltage meter as a corner-grounded, 3-phase delta system of the same voltage. One might presume an ungrounded system with a phase to ground, when in fact, the system is a corner-grounded delta without the required marking of the grounded phase conductor, or perhaps the conductor identification goes unnoticed. The presence of ground detectors may be evidence that an ungrounded system exists, but a sure method of identification is necessary. A change in the 2011 *NEC* requires that ungrounded systems be legibly marked "Ungrounded System" at the source of a separately derived system or at the first disconnecting means of a service. The marking is not required on downstream distribution equipment.

Summary

Ungrounded systems shall be legibly marked "Ungrounded System" at the source of a separately derived system or at the first disconnecting means of a service.



Courtesy of Schneider Electric

Application Question

Is the field marking identifying ungrounded systems required for existing ungrounded systems?

Answer

No. Unlike certain other codes, the *NEC* is not retroactive. However, Sections 210.12(B) and 406.4(D) contain rules for updating equipment and devices with newer technology equipment, when certain dwelling unit circuits are modified and when receptacles are replaced.

Code Refresher

- ✓ Section 200.6 requires identification of all grounded circuit conductors. With some exceptions, the grounded conductor shall be identified by
  - a continuous white or gray outer finish
  - three continuous white stripes along its entire length on other than green insulation
  - a distinctive white or gray marking at its terminations, applied at the time of installation

  Identification of the grounded conductor is required throughout the system.

Grounding Separately Derived Alternating-Current Systems

Significance
This section has been reorganized to make it easier to apply the rules for installing separately derived systems. A new term is introduced and details for grounding and bonding separately derived systems have been added.

Analysis
This section has been re-written for clarity and user-friendliness. A new term, *supply-side bonding jumper*, is defined in 250.2: "Bonding Jumper, Supply-Side. A conductor installed on the supply side of a service or within a service equipment enclosure(s), or for a separately derived system, that ensures the required electrical conductivity between metal parts required to be electrically connected." The supply-side bonding jumper can be understood as a service equipment bonding jumper as opposed to a branch-circuit or feeder bonding jumper. The supply-side bonding jumper bonds the service equipment enclosure and metallic equipment upstream of the service disconnect. An equipment bonding jumper on the load side of a service bonds equipment supplied by a feeder or branch-circuit overcurrent device. For a separately derived system, the supply-side bonding jumper is used to bond metallic parts from the source of the separately derived system to and including the enclosure for the first disconnecting means. In this section, the new term replaces the term used by prior Code editions, *equipment bonding jumper*. When a transformer is the source of a separately derived system, the supply-side bonding jumper creates an effective ground-fault return path back to the secondary winding. If this jumper is a wire, it is sized using Table 250.66, based on the size of the derived ungrounded conductors. This procedure is different than sizing an equipment bonding jumper, which is sized using Table 250.122, based on the size of the overcurrent protective device.

Subsections 250.30(A)(1)(a) and (b) detail the two options for the location of the system bonding jumper, and thus, the location of the connection for the grounding electrode conductor. The system bonding jumper shall be located at the source of the separately derived system or at the first disconnecting means. The change also specifies that the system bonding jumper shall remain within the enclosure where it originates.

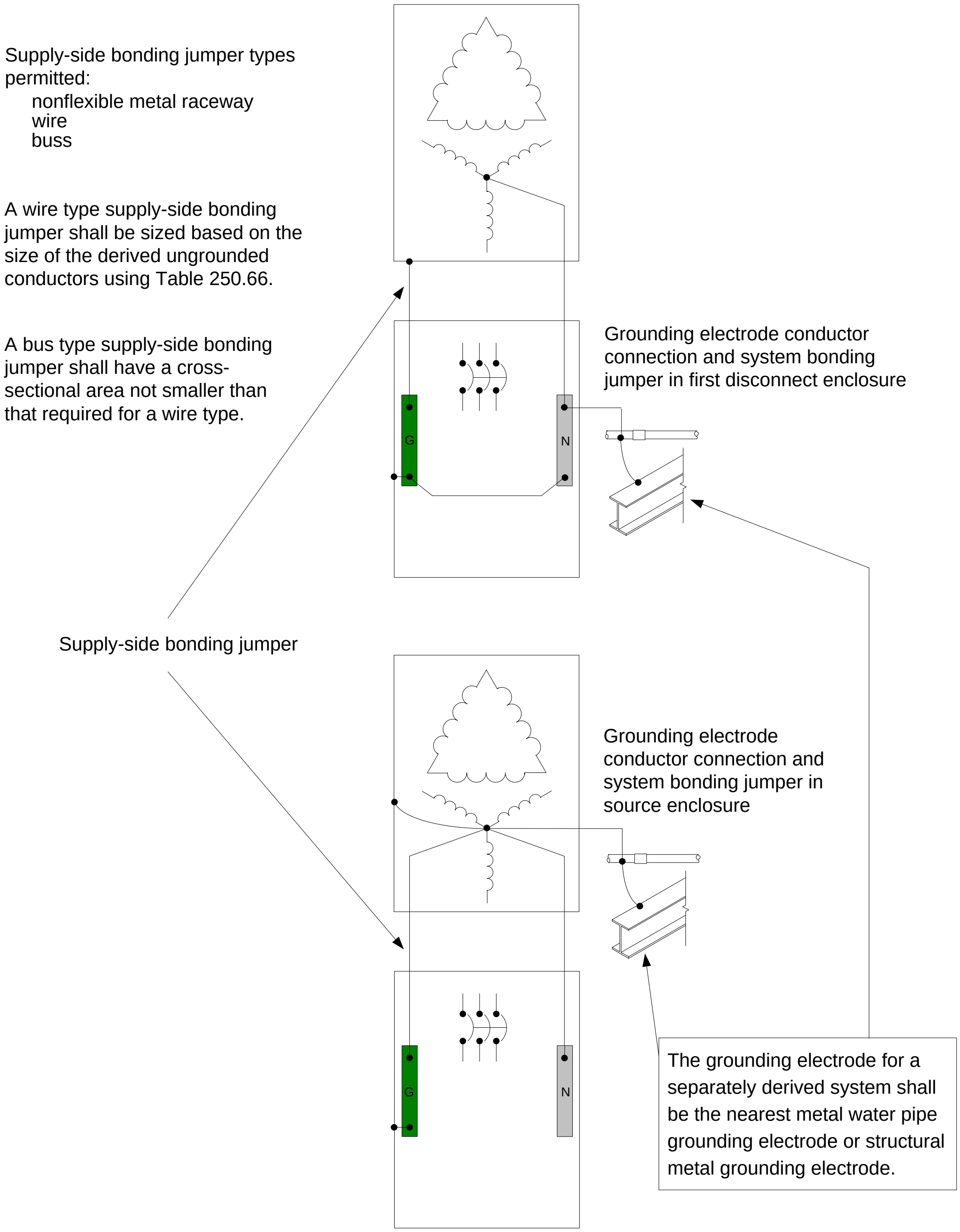
Summary
For a separately derived system, a *supply-side bonding jumper* is a bonding conductor installed on the supply side of the first disconnecting means, including within the enclosure of the first disconnecting means. The *system bonding jumper* shall be located at the source of the separately derived system or at the first disconnecting means, and shall remain within the enclosure where it originates.

Application Question
For a separately derived system, the supply-side bonding jumper shall be sized based on the size of the derived ungrounded conductors and Table __________.

A. 250.66
B. 250.122

Answer

A. The minimum size required for the supply-side bonding jumper is the same as the minimum size required for the grounding electrode conductor from Table 250.66.



Grounding and bonding connections for separately derived systems

✓ **Code Refresher**

Application of Code requirements to separately derived systems is one of the most misunderstood of all Code topics. A separately derived system is a premises wiring system whose power is derived from a source other than a service, and that has no direct electrical connection, including a solidly connected grounded circuit conductor, to supply conductors originating in another system. Sources that can qualify as separately derived systems include generators, wind turbines, batteries, transformers, and non–utility-connected photovoltaic systems. Grounding and bonding requirements for separately derived systems will become clear when one considers the fault clearing path for a ground fault occurring at any point on the line side of the first disconnecting means. A reliable low-impedance path must exist back to the source in order to safely clear a fault current. For either of the derived systems in the preceding drawing, you should be able to trace the ground-fault current path back to the transformer secondary winding, for a fault occurring anywhere within the source (transformer) enclosure or disconnecting means enclosure. When a fault occurs in the conductors on the line side of the first disconnecting means, the fault is cleared by the overcurrent device protecting the primary of the transformer.

There must not be parallel paths for the grounded conductor (neutral) current. Sometimes electricians are confused about whether to install a metal or nonmetallic raceway between the source and the first disconnect of a separately derived system. Using a metal raceway will not create a parallel neutral path as long as the system bonding jumper is installed in only one location as required by Code. However, this bonding jumper is permitted to be installed at both the source enclosure and the first disconnecting means enclosure if a nonmetallic raceway is used between the enclosures, e.g., PVC. Essentially, this means that the grounded conductor is permitted to bond the disconnect enclosure, and no other grounding or bonding conductor is required between the two enclosures.

The grounding electrode for separately derived systems shall be the nearest available metal water pipe or structural metal. It is not the intent of the *NEC* to require a grounding electrode conductor to be run back to the service grounding electrode connection for the building. Instead, a local electrode is used that is electrically connected to the service grounding electrode(s). The local electrode must qualify as a grounding electrode. For example, to use a water pipe to ground a separately derived system, the pipe must be in direct contact with the earth for 10′ or more. Also, the connection to the water pipe must be made within the first 5′ of piping entering a building. In industrial, commercial, and institutional buildings where it can be assured that only qualified persons will service the installation, the piping beyond 5′ from the entrance into the building is permitted as a conductor back to the portion of the electrode in contact with the earth. In order to use the piping beyond the first 5′ for a conductor, the entire length of the metal piping used as a conductor must be exposed. Remember that the *NEC* considers the wiring behind removable ceiling panels to be exposed.

The only *service* is the utility service. The term *service* is not used when discussing separately derived *systems*. A *main bonding jumper* is used in a service. A *system bonding jumper* is used in a separately derived *system*.

Grounding Separately Derived Alternating-Current Systems – Outdoor Source

Significance
An important change within the re-write of Section 250.30 is the inclusion of new subsection (C). This subsection contains rules for grounding the source of a separately derived system when the source of the system is outdoors. This is often the case.

Analysis
Separately derived systems are frequently installed outdoors. The most common sources for these systems are generators and transformers. Outdoor transformers used in a campus or other multi-building distribution system are sources of separately derived systems, when they are not part of the utility service. The requirements in this new subsection are intended to provide better protection from the effects of transients from lighting or power faults. For outdoor sources of separately derived systems, the new rule requires that a connection to a grounding electrode(s) be made at the source location. This is similar to the existing rule in Section 250.24(A)(2) for outdoor transformers that are part of the utility service. The grounding electrode must comply with Section 250.50. In addition, the installation must comply with all other provisions of Section 250.30 for grounding of separately derived ac systems.

There is an exception for impedance grounded systems. The grounding electrode conductor (GEC) connection for impedance grounded systems shall meet the requirements of 250.36, or 250.186 for systems over 1000 volts.

Connection to grounding electrode system

The generator above is connected as a separately derived grounded system. The generator neutral terminal is connected to a grounding electrode system.

Summary

For outdoor sources of separately derived systems, a grounding electrode connection shall be made at the source location to a grounding electrode(s).

Application Question

An outdoor pad-mount transformer is the source of a separately derived system. To comply with the 2011 *NEC*, an electrician connects a GEC from the source to a ground rod at the transformer location. Is the installation of a single ground rod Code compliant?

A. Yes
B. No
C. It depends on the resistance to earth of the driven rod.

Answer

C. A single ground rod must have a resistance to earth of 25 Ω or less, or be supplemented by an additional electrode. [250.53(A)(2)]

Grounding Electrodes – Electrodes Permitted for Grounding – Metal Frame of the Building or Structure

Significance

It is important to understand when the Code considers the metal frame of a building or structure a qualifying grounding electrode, and when the metal frame is merely a grounding electrode conductor (GEC) connecting to a grounding electrode. This Code change seeks to clarify the rules for using building steel as a grounding electrode.

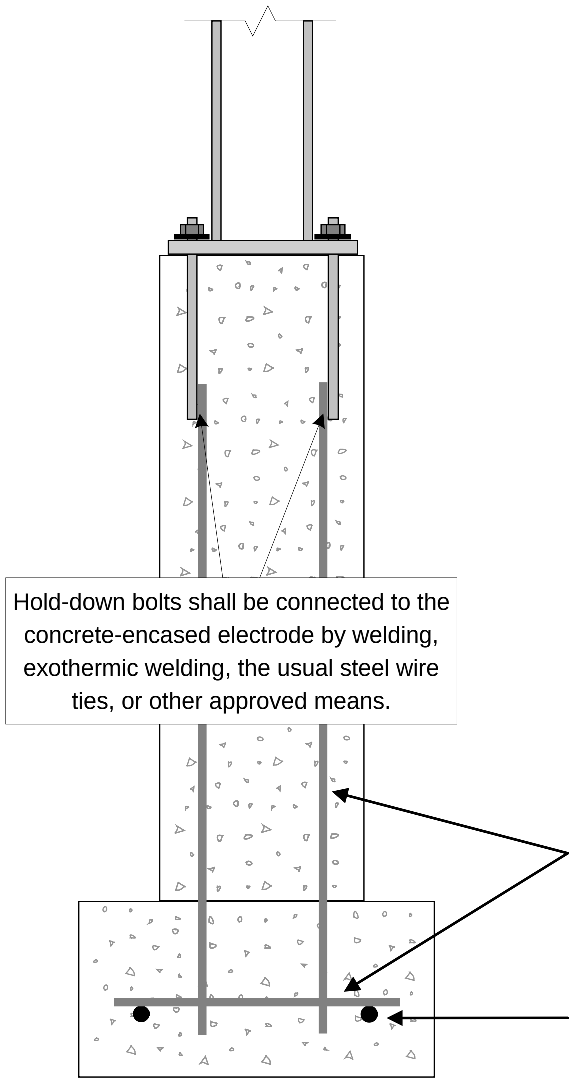
Analysis

Consider the instance where an 800-A service is grounded to building steel via a 2/0 copper grounding electrode conductor. This is a correct application from Table 250.66, assuming parallel ungrounded service-entrance conductors of 500 kcmil, with an equivalent conductor size of 1000 kcmil. However, for the building steel to qualify as a grounding electrode, the steel is connected to a pair of ground rods with a 6 AWG copper conductor running from building steel to each rod. Is the building steel a grounding electrode or is it part of the grounding electrode conductor? According to the 2008 *NEC*, this metal building frame qualifies as a grounding electrode, since the frame is connected to earth by one of the means permitted in 250.52(A)(2). The grounding path to earth beginning at the service grounded conductor consists of 2/0 copper, building steel, and 6 AWG copper! For the purpose of making the building frame qualify as a grounding electrode, the 2008 Code also permits building steel to be earthed (connected to earth) using a 4 AWG copper conductor for connection to a concrete-encased electrode, or a 2 AWG copper conductor for connection to a ground ring. Here also the 2/0 conductor in our example is larger than the conductor size required for connection from the steel to a concrete-encased electrode or ground ring.

The 2011 *NEC* specifies only two instances when building steel qualifies as a grounding electrode:

- When at least one structural metal member is in direct contact with the earth for 10 ft or more, with or without concrete encasement.
- When the hold-down bolts securing a structural steel column are connected to a concrete-encased electrode (copper wire or re-bar) that complies with 250.52(A)(3) located in the support footing or foundation. The hold-down bolts must be connected to the concrete-encased electrode by welding, exothermic welding, the commonly used steel tie wires, or by other approved means.

The concrete-encased electrode shall consist of at least 20 ft of minimum ½″ steel reinforcing rods or at least 20 ft of minimum 4 AWG copper conductor. Where building steel qualifies as a grounding electrode, the grounding electrode conductor shall be sized from Table 250.66, based on the size of the ungrounded service-entrance conductors.



This metal building frame qualifies as a grounding electrode because the hold-down bolts are connected to the footing reinforcing rods by the method prescribed in 250.52(A)(2)(2).

Summary

The metal frame of a building is considered a grounding electrode when at least 10 ft of a structural steel member is in direct contact with the earth, with or without concrete encasement, or when the hold-down bolts of a structural steel column are connected to a qualifying concrete-encased electrode.

Application Question

Assume building steel is connected to a concrete-encased electrode through steel reinforcing bars that connect to column hold-down bolts. For which electrode should the grounding electrode conductor be sized?

A. The metal frame of the building or structure
B. The concrete-encased electrode

Answer
The building steel qualifies as a grounding electrode. The GEC should be sized for connection to the metal frame of the building in accordance with Table 250.66.

More on Concrete-Encased Electrodes
The *National Electrical Code* permits grounding electrodes consisting of concrete-encased reinforcing rods or at least 20′ of bare copper not smaller than 4 AWG placed near the bottom of a foundation footing, or placed horizontally or vertically in a foundation wall. The concrete wall must be in contact with earth for the encased steel or copper to be an effective grounding means. This rules out any portion of the concrete electrode that is above grade. Also, that area of the concrete-encased electrode in contact with frozen ground or dry ground is less effective for grounding. Hence, the preferred location of reinforcing steel or bare copper is near the bottom of a support foundation footing. When a plastic barrier is placed between the concrete-encased steel or copper and earth, the installation does not qualify as a concrete-encased electrode. Other barriers and coatings may also prevent direct contact between concrete and earth.

Code Refresher

- ✓ The *NEC* permits a 6 AWG copper grounding electrode conductor for connection to a rod, pipe, or plate electrode regardless of the size of the ungrounded service conductors. This is due to the fact that the rod-to-earth contact resistance and the earth resistance will limit any current to earth to a level that can be safely carried by the 6 AWG copper. For certain size services, the minimum required size for GECs that are the sole connection to rod, pipe, or plate electrodes, concrete-encased electrodes, and ground rings is smaller than specified in Table 250.66. The GEC size specified in Table 250.66 shall not be reduced when the grounding electrode is a metal underground water pipe, the metal frame of a building, other listed electrodes (see the listing requirements), and other local metal underground systems or structures (e.g., well casings). The largest GEC required by the Code for any size service is 3/0 copper.

  Even though a 3/0 copper conductor is the largest GEC required by Code, there is no upper limit on the required size of the equipment grounding conductor. An equipment grounding conductor performs a different function than a grounding electrode conductor. Note that a 3/0 copper equipment grounding conductor is suitable for equipment supplied by a 1200-amp overcurrent device. For circuits of higher rating, a larger equipment grounding conductor is required in accordance with Table 250.122.

Grounding Electrode System Installation – Rod, Pipe, and Plate Electrodes – Supplemental Electrode Required

Significance

Section 250.56 in the 2008 *NEC* has been deleted in the 2011 *NEC*. Its rules have been placed into an expanded Section 250.53(A) in the 2011 Code. Section 250.53(A) contains rules for supplementing a rod, pipe, or plate electrode.

Analysis

According to the 2011 Code, a rod, pipe, or plate electrode that has a resistance to ground of more than 25 ohms must be supplemented by an additional electrode of a type specified in 250.52(A)(2) through (A)(8). This includes all types of electrodes specified in the Code except a metal underground water pipe, listed in (A)(1). The concern is that the metal water pipe might be replaced with a plastic water pipe.

The supplemental electrode shall be bonded to one of the following

- Rod, pipe, or plate electrode
- Grounding electrode conductor
- Grounded service-entrance conductor
- Nonflexible grounded service raceway
- Grounded service enclosure

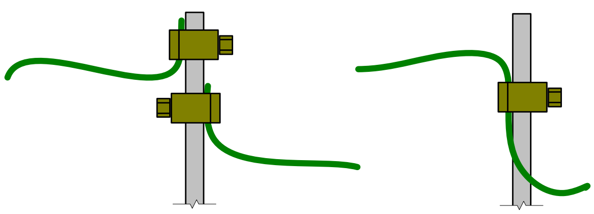
Also of significance in this section is the change in the Informational Note (formerly Fine Print Note). The related Fine Print Note in previous Code editions stated that the paralleling efficiency of rods longer than 2.5 m (8 ft) is improved by spacing greater than 1.8 m (6 ft). The revised Note states that the paralleling efficiency of rods is increased when the rods are spaced a distance of twice the length of the longest rod. Each ground rod has a sphere of influence that extends out from the rod a distance approximately equal to the length of the rod. Ground rods should be spaced so that their spheres of influence do not overlap. Manufacturers of listed rods recommend that spacing should be not less than twice the length of the rod. Section 110.3(B) requires equipment to be installed in accordance with the manufacturer’s instructions.

Summary

When a supplemental electrode is used to augment a rod, pipe, or plate electrode, the supplemental electrode shall be bonded to the rod, pipe, or plate electrode, the GEC, the grounded service-entrance conductor, the grounded service enclosure, or a nonflexible grounded service raceway.

Application Question

Does the Code permit “splicing” the GEC at a ground rod?



These connection methods comply with the NEC.

Answer
Yes. For a multiple rod installation, the GEC can run through a ground rod clamp unspliced, or it can be made continuous at a ground rod using approved clamps. For example, two conductors could connect to a ground rod, each with a separate clamp.

Code Refresher

- ✓ The *NEC* requires that, if practicable, rod, pipe, and plate electrodes be embedded below the permanent moisture level. It is also beneficial for electrodes to be placed below frost. Consider using a 10′ rod where frost is present. If the top end of a ground rod is not below grade, the exposed rod and grounding electrode conductor connection must be protected from physical damage. Remember that a ground rod must be in contact with earth for a minimum of 8′. [250.53(A)(1) and 250.53(G)]

Grounding Electrode Conductor Installation – Securing and Protection Against Physical Damage

Significance

Questions have arisen as to whether the installation of grounding electrode conductors on or through building framing members is an acceptable Code practice. This change clarifies that such installations are permitted by the *NEC*. Also, the permitted methods for protecting GECs from physical damage have been expanded.

Analysis

A revision in the 2011 Code clarifies that grounding electrode conductors are permitted to be installed on framing members of a building or run through framing members. This includes wood framing. Also, the 2011 Code recognizes an additional raceway, reinforced thermosetting resin conduit (RTRC), for the protection of grounding electrode conductors. Physical protection for a grounding electrode conductor can be accomplished by installing the GEC in

- Rigid metal conduit (RMC)
- Intermediate metal conduit (IMC)
- Rigid polyvinyl chloride conduit (PVC)
- Reinforced thermosetting resin conduit (RTRC)
- Electrical metallic tubing (EMT)
- Cable armor

Summary

Grounding electrode conductors are permitted to be installed on or through building framing members, including wood framing members.

Application Question

A grounding electrode conductor is enclosed in PVC and installed on building framing members. Rules for securing the PVC raceway are located in Article __________.

A. 250 – Grounding and Bonding
B. 300 – Wiring Methods
C. 352 – Rigid Polyvinyl Chloride Conduit: Type PVC

Answer

C. Securing shall be in accordance with Section 352.30. When a raceway is used to enclose a GEC, the installation shall comply with the requirements of the Code article for the specific raceway type.

Code Refresher

- ✓ Ferrous raceways enclosing GECs must be electrically continuous from the point of attachment to cabinets or equipment to the grounding electrode, or be made continuous by bonding each end of the raceway to the GEC. The bonding jumper for the raceway shall be the same size as, or larger than, the enclosed GEC (see Section 250.64(E)). When steel raceway enclosing a GEC is electrically continuous, the majority of current actually flows through the raceway. A GEC should not be installed in a ferrous raceway if it can be avoided. When a GEC is installed in a continuous ferrous raceway, the impedance of the grounding electrode conductor path is increased significantly over that of using the copper conductor alone. The increase in impedance when a steel conduit is used is about 40% for a 6 AWG copper conductor enclosed in a ¾″ conduit, to about 500% for a 3/0 copper conductor enclosed in a 1¼″ conduit. Since aluminum conduit is nonmagnetic, it will not adversely affect the impedance of the GEC path. An aluminum conduit enclosing a GEC is not required to be electrically continuous. Schedule 80 PVC conduit is a good choice when physical protection is needed for a grounding electrode conductor.

- ✓ When used outside, aluminum or copper-clad aluminum GECs shall not be terminated within 450 mm (18 in.) of the earth. [250.64(A)]

Grounding Electrode Conductor Installation – Continuous

Significance

Except for grounding of separately derived systems, grounding electrode conductors must be continuous, without a splice or joint. This change specifies methods for connecting sections of water piping or members of building steel, that are not considered a splice or joint.

Analysis

The *NEC* permits metal water piping and structural metal to be used as a grounding electrode conductor, or as a bonding conductor to interconnect electrodes that are part of the grounding electrode system. This permission is reinforced by a revision to Section 250.68(C) in 2011. Previous editions of the Code only cover the continuity of wire-type or busbar grounding electrode conductors. The expanded list of permitted splices or connections is as follows:

- Irreversible compression-type connectors listed as grounding and bonding equipment, or exothermic welding for wire-type GECs
- Sections of busbars connected together
- Bolted, riveted, or welded connections of structural metal building frames
- Threaded, welded, brazed, soldered, or bolted-flange connections of metal water piping

Connections made by any of these methods are not considered a splice or joint, and will preserve the *continuous* characteristic of the metallic system.

Summary

Bolted, riveted, or welded connections of structural metal building frames, or threaded, welded, brazed, soldered, or bolted-flange connections of metal water piping, are not considered a splice or joint.

Application Question

T F If members of a structural metal building frame are bolted together, the building frame cannot serve as a grounding electrode conductor according to the *NEC*.

Answer

False. Bolted connections are not considered a splice or joint. The steel is considered continuous and is permitted to serve as a GEC. [250.64(C)(3)]

Code Refresher

- ✓ When metal underground water piping is used as a grounding electrode, continuity of the grounding path shall not rely on water meters or filtering devices and similar equipment. [250.53(D)(1)]

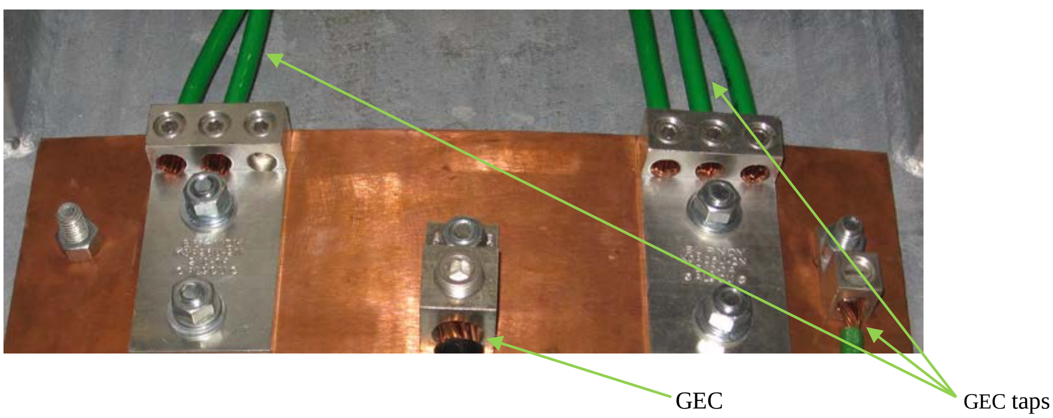
Grounding Electrode Conductor Installation – Service with Multiple Disconnecting Means Enclosures – Common Grounding Electrode Conductor and Taps

Significance

A practical method for connecting grounding electrode conductor taps to a common grounding electrode conductor is included in a revision to Section 250.64(D)(1).

Analysis

In lieu of using separate GECs for grounding a service that consists of multiple disconnecting means, GEC taps from each enclosure can be used to connect to a common grounding electrode conductor. The tap conductors shall extend to the inside of each enclosure. The tap conductors shall be connected to the GEC by exothermic welding or with connectors listed as grounding and bonding equipment. A third method permitted in the 2011 Code for making the tap connections to the GEC uses a busbar for termination of the taps. The copper or aluminum busbar shall be at least 6 mm x 50 mm (1/4 in. x 2 in.), securely fastened, and installed in an accessible location. Connections to the busbar shall be made by listed connectors or by exothermic welding. This busbar method of connection is already permitted in Sections 250.30(A)(4) and 250.64(F) for grounding multiple separately derived systems and for interconnecting grounding electrodes respectively. Section 250.30(A)(4) is modified in the 2011 Code and re-numbered 250.30(A)(6).



Summary

Grounding electrode conductor taps from multiple service enclosures are permitted to be connected to a busbar that connects to the grounding electrode system.

Application Question

The busbar method for connecting GEC taps to a common grounding electrode is used to ground a service consisting of multiple service disconnect enclosures. Is it permissible to use this busbar to also interconnect grounding electrodes?

Answer

Yes. This installation meets all the provisions of 250.64(F)(3) for interconnecting grounding electrodes.

Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes – Metallic Water Pipe and Structural Metal

Significance

This new Code section clarifies that metal water piping and building steel are permitted to serve as grounding electrode conductors, or as bonding conductors to interconnect grounding electrodes that are part of the grounding electrode system. The new section sets forth the conditions for compliance for this common field practice.

Analysis

Section 250.68(C) is new and contains rules for using interior metal water piping and the metal frame of buildings as GECs, or as bonding conductors to interconnect grounding electrodes. The portion of this section that applies to water piping is revised language relocated from Section 250.52(A)(1), Exception in the 2008 *NEC*. As it relates to building steel, this section is different than revised Section 250.52(A)(2), which contains the requirements for building steel to qualify as a *grounding electrode*. Section 250.68(C) contains requirements for qualifying building steel as a *grounding electrode conductor*.

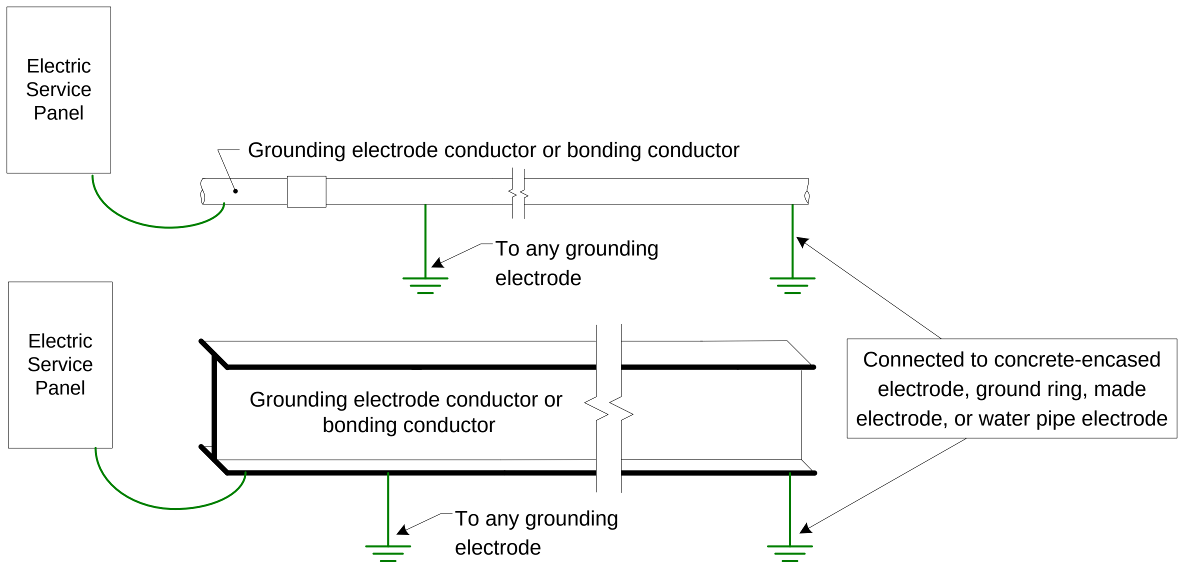
For residential applications, only the first 1.52 m (5 ft) of interior metal water piping, measured from the point of entrance of the water service into the building, is permitted to be used as part of the grounding electrode system or as a conductor to interconnect electrodes that are part of the grounding electrode system. In industrial, commercial, and institutional occupancies, there is no length restriction as long as the entire length of water piping that is used as a conductor remains exposed, except for short sections of piping that pass perpendicularly through walls, floors, or ceilings. Also, there must be assurance that only qualified persons will service the installation.

The structural metal frame of a building is permitted to be used as a GEC, or as a bonding conductor to interconnect electrodes that are part of the grounding electrode system, when the metal frame itself qualifies as a grounding electrode in accordance with 250.52(A)(2), or when the metal frame is connected to one or more of the following electrodes:

- Concrete-encased electrode [250.52(A)(3)]
- Ground ring [250.52(A)(4)]
- Rod and pipe electrodes [250.52(A)(5)]
- Plate electrodes [250.52(A)(7)]
- Other approved means of establishing a connection to earth [250.68(C)(2)(c)]

The use of structural steel and metal water piping as a GEC is not a new concept. This practice has been used for many years for grounding separately derived systems.

This change prompted a revision to Section 250.64(C), which deems several methods for connecting structural steel and water piping as "continuous" rather than spliced.



Metal water piping and structural steel used as a bonding conductor or GEC in non-residential occupancies

Summary

For other than residential applications, interior metal water piping is permitted as a GEC, or as a bonding conductor for interconnecting electrodes that are part of the grounding electrode system, if the piping remains exposed and only qualified persons service the installation. Only the first 5′ of piping entering the building can be used for this purpose in dwellings.

The structural metal frame of a building is permitted to be used as a GEC, or as a bonding conductor for interconnecting electrodes that are part of the grounding electrode system, when the metal frame is a qualified grounding electrode, or when the metal frame is connected to a concrete-encased electrode, ground ring, rod, pipe, or plate electrode.

Application Question

In a building for commercial use, 100′ of interior metal water piping is used as a GEC. Qualified persons will service the installation. The piping is hidden behind removable tiles of a suspended ceiling. Is the installation compliant with the 2011 *NEC*?

Answer

Yes. The definition of exposed (as applied to wiring methods) in Article 100 considers wiring behind panels designed to allow access as exposed.

Code Refresher

- ✓ If available, metal water piping or structural metal shall be used to ground separately derived systems. [250.30(A)(4)] The metal water piping or structural metal must qualify as a grounding electrode as specified in 250.52(A)(1) or 250.52(A)(2) respectively. The metal water pipe electrode specified in 250.52(A)(1) is a metal *underground* water pipe. Thus, when connected to metal water piping, the separately derived system is grounded to a grounding electrode—the metal water piping in contact with the earth.

Use of Equipment Grounding Conductors

Significance

This is a new section in the 2011 *National Electrical Code*. It is intended to clarify the separate functions of grounding electrode conductors and equipment grounding conductors and to ensure these conductors are correctly used.

Analysis

New Section 250.121 simply states that an equipment grounding conductor shall not be used as a grounding electrode conductor. The functions of equipment grounding conductors and grounding electrode conductors are entirely separate and distinct. An equipment grounding conductor (EGC) is used to connect non–current-carrying metal parts of equipment to the system grounded conductor at the service or to the grounding electrode conductor, or both. In the case of an ungrounded system, the EGC connects metal parts to the grounding electrode conductor. In grounded systems, the EGC connects to both the system grounded conductor and grounding electrode conductor. The EGC functions to reduce the shock hazard at equipment, limiting the voltage to ground by connecting the equipment frame to ground. Also, for a grounded system, the EGC facilitates the operation of the overcurrent protective device by providing a low-impedance path back to the power source.

The purpose of a grounding electrode conductor is to connect the system grounded conductor to the grounding electrode(s). For an ungrounded system, the GEC connects the metal enclosures of service equipment to the grounding electrode(s). The GEC connects the system neutral and metal parts of equipment to earth in order to maintain the equipment at earth potential and to dissipate over-voltages into the earth.

Equipment grounding conductors and grounding electrode conductors are sized differently and have different installation requirements. EGCs are normally not current-carrying conductors, while GECs often carry current as a parallel conductor with the grounded service conductor.

Summary

An equipment grounding conductor shall not be used as a grounding electrode conductor.

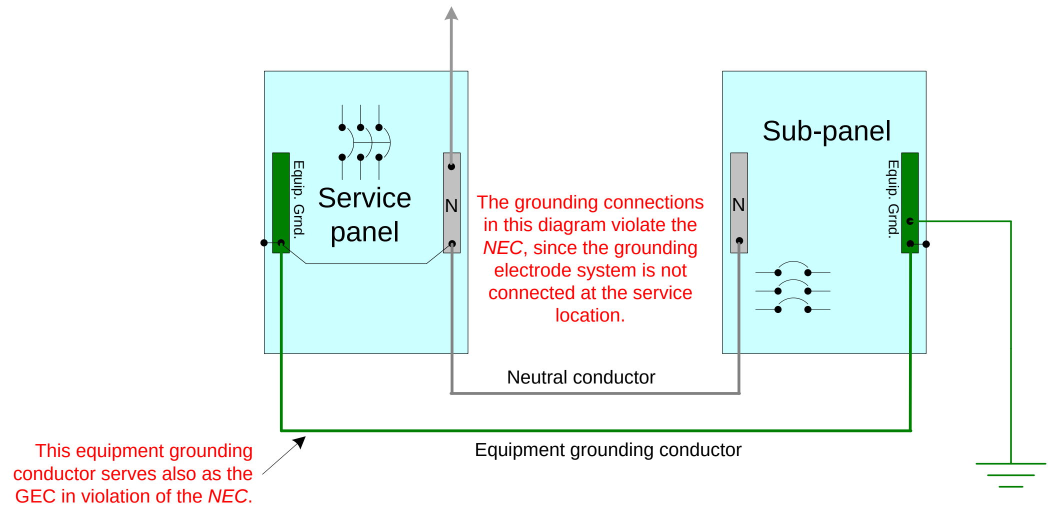
Application Question

Which of the following is considered an effective ground-fault current path?

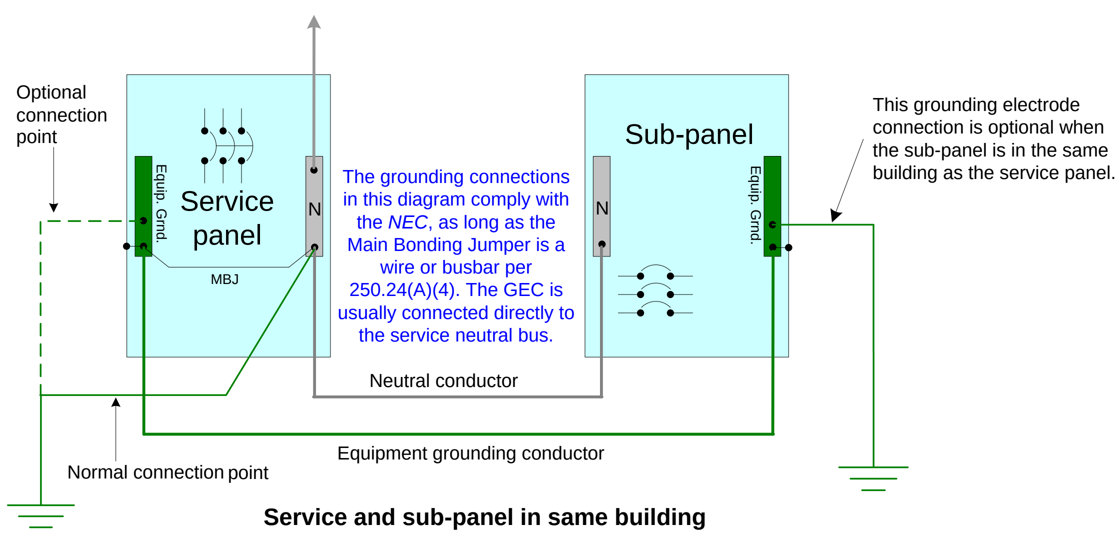
A. The path from a ground fault through the EGC, through the GEC to the grounding electrode(s)
B. The path from a ground fault through the EGC, back to the source of the supply

Answer

B. An effective ground-fault current path must be a low-impedance path capable of carrying fault current back to the source of supply. This facilitates the operation of the overcurrent protective device, or ground-fault detectors on high-impedance grounded systems (see 250.4(A)(5)).



Service and sub-panel in same building or in separate buildings



Service and sub-panel in same building or in separate buildings

Grounding of Systems and Circuits of over 1 kV – Grounding of Equipment

Significance

The existing *NEC* rules for sizing equipment grounding conductors for applications over 600 volts are inadequate for some applications. The 2011 *NEC* includes expanded requirements for sizing EGCs for over 600/1000 volts.

Analysis

The rules for grounding equipment in circuits over 600/1000 volts are expanded in Section 250.190. Retained from the 2008 Code, equipment grounding conductors that are not an integral part of a cable assembly must be a minimum of 6 AWG copper or 4 AWG aluminum. New rules specify the types and sizing of equipment grounding conductors permitted.

A metallic insulation shield encircling a current-carrying conductor(s) is permitted as the equipment grounding conductor, if the metallic shield is rated for the clearing time of the ground-fault-current protective device operation without damaging the metallic shield. Metallic tape and drain wire insulation shields are not permitted as equipment grounding conductors on solidly grounded systems. On solidly grounded systems, fault current is not limited by a grounding impedance as in impedance grounded systems. On ungrounded systems, ground faults are monitored and cleared without the flow of heavy fault current.

The existing *NEC* rules do not provide guidance for sizing equipment grounding conductors for circuits protected by overcurrent relays and current transformers, as permitted in 240.100(A). The new rule states that equipment grounding conductors shall be sized in accordance with Table 250.122, based on the current rating of the fuse or setting of the overcurrent protective relay. Remember that the overcurrent rating of a medium-voltage circuit breaker is the combination of the current transformer ratio and the current pickup setting of the protective relay.

When a grounding electrode conductor connects non–current-carrying metal parts to ground, the grounding electrode conductor shall be sized in accordance with Table 250.66, based on the size of the ungrounded service, feeder, or branch-circuit conductors supplying the equipment. The GEC must not be smaller than 6 AWG copper or 4 AWG aluminum.

Summary

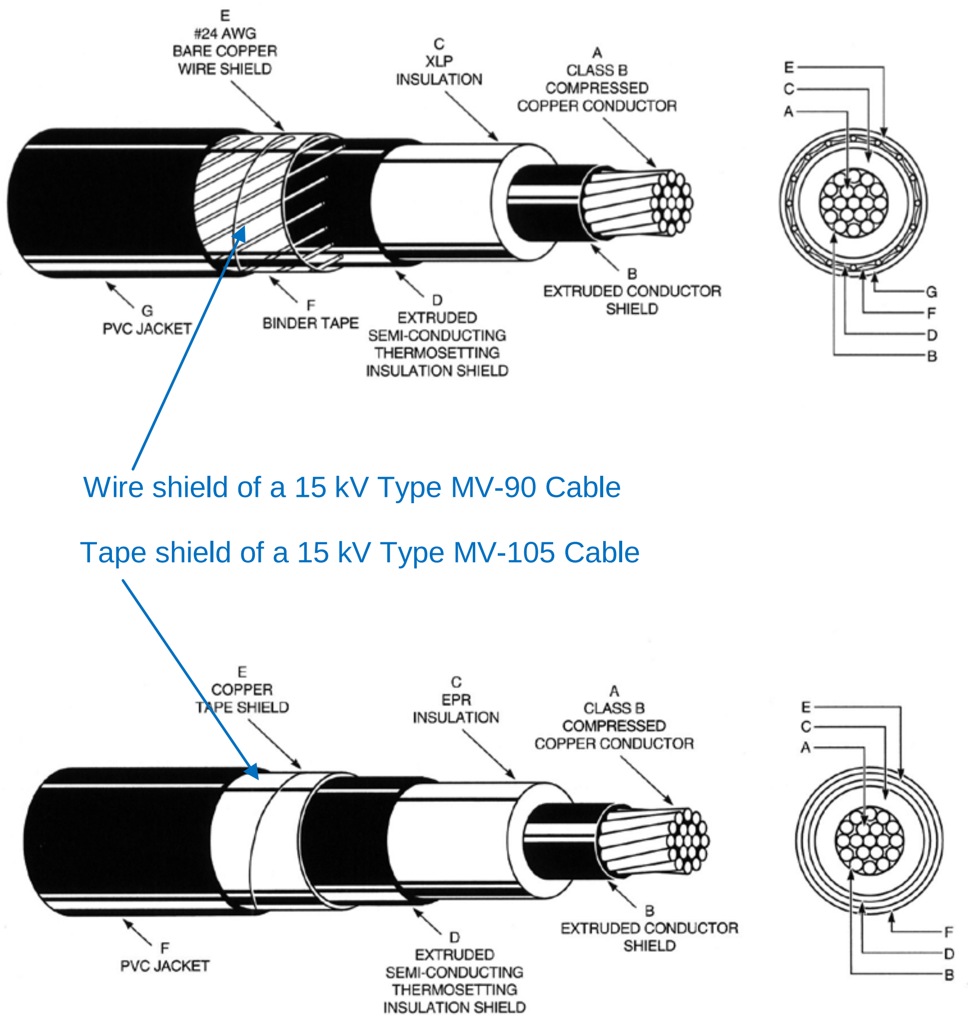
Metallic tape insulation shields and drain wire insulation shields are not permitted as equipment grounding conductors on solidly grounded systems. Equipment grounding conductors shall be sized in accordance with Table 250.122, based on the current rating of the fuse or setting of the overcurrent protective relay.

Application Question

Is a concentric neutral conductor of a medium-voltage power cable permitted for equipment grounding?

Answer

Yes. A concentric neutral is neither a metallic tape or drain wire type shield. It can be used for equipment grounding if rated for the clearing time of the ground-fault-current protective device. The concentric neutral of medium-voltage cables functions as a shield, providing a uniform electric field within the conductor insulation.



Medium-Voltage Power Cables

Courtesy of Southwire Company

Grounding of Systems and Circuits of over 1 kV – Grounding System at Alternating-Current Substations

Significance

This is a new Code section containing requirements for grounding alternating-current substations not under the exclusive control of an electric utility.

Analysis

Privately owned electric generation is increasingly coming on line. Wind generation farms with turbines of 1.5 – 6 megawatts are becoming popular. The output voltage of these turbines is stepped up to some medium voltage (commonly 34.5 kV), then connected at a substation to a transformer that steps up to the transmission line voltage. Generally, the transmission line is owned by a public utility, and must comply with the *National Electrical Safety Code* (*NESC*). Electrical safety requirements for the privately owned substation are within the scope of the *National Electrical Code*. This new *NEC* section requires the grounding system for ac substations to be installed in accordance with Part III of Article 250. Part III covers the Grounding Electrode System and Grounding Electrode Conductor. Substation grounding according to ANSI/IEEE 80-2000, *IEEE Guide for Safety in AC Substation Grounding*, will ensure compliance with *NEC* Article 250, Part III.

Summary

The grounding system for ac substations, not under the exclusive control of an electric utility, shall be in accordance with Part III of Article 250.

Application Question

Are the electrodes specified in Part III of Article 250 adequate for substation grounding?

Answer

Some of the electrode types might be adequate, but the *NEC* does not require the resistance to ground of a grounding electrode system to be measured. The more effective electrodes described in 250.52(A), metal underground water piping, structural building steel, concrete-encased electrodes, and metal well casings, will probably not be available. Even if available, these electrodes would be inadequate in many cases. It is very unlikely that a low ground resistance (1 – 3 ohms) can be achieved by following the minimum requirements in the *NEC*. A ground grid constructed according to ANSI/IEEE Std. 80-2000 will perform well. The *National Electrical Code* will undoubtedly broaden its coverage of installations over 600 volts in future editions.

Protection against Physical Damage – Cables, Raceways, or Boxes Installed in or Under Roof Decking

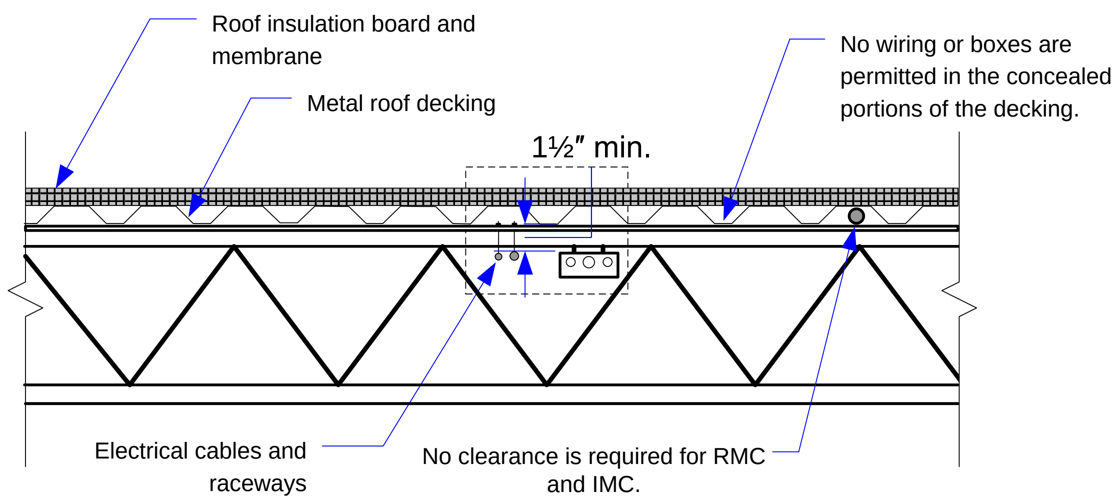
Significance

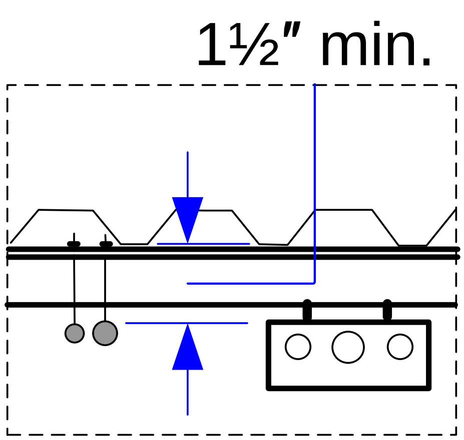
This section was introduced as a new section in the 2008 Code to address protection for wiring installed below metal roof decking. It has been revised in the 2011 *NEC*.

Analysis

This section requires clearances for cables, raceways, and boxes installed below metal roof decking. Wiring systems have been damaged by fasteners driven into metal roof decking to secure roofing material in place during roof replacements. A minimum clearance of 1½″ is required between the lowest part of the metal decking and the top of a cable, raceway, or box. Also, wiring shall not be installed in the concealed portions of the metal decking.

Rigid metal conduit and intermediate metal conduit are not required to comply with 300.4(E).





Summary

A minimum clearance of 1½″ is required between the lowest part of the metal decking and the top of a cable, raceway, or box. Wiring shall not be installed in the concealed portions of the metal decking. Rigid metal conduit and intermediate metal conduit are not required to comply with 300.4(E).

Application Question

T F Boxes may be secured directly to the underside of metal roof decking.

Answer

False. The 1½″ clearance is required for cables, raceways, and boxes.

Protection against Physical Damage – Structural Joints

Significance
Raceway wiring methods at construction control joints must be installed such that the wiring system is protected against structure expansion, contraction, or deflection.

Analysis
This new subsection is intended to address damage that has been caused to raceways improperly installed in structural construction joints. Construction joints can experience shear and lateral loading due to gravity, expansion and contraction, and movement of the structure. The new rule requires that a listed expansion/deflection fitting be used where a raceway crosses a construction joint intended for expansion, contraction, or deflection in buildings, bridges, parking garages, or other structures. Design architects or engineers will identify all structural joints for a building or structure on construction drawings. Means other than the use of a listed expansion/deflection fitting that are judged suitable by the AHJ are also permitted.

Section 300.7(B) of the existing Code contains rules intended to compensate for thermal expansion and contraction. Section 300.5(J) contains rules for protecting wiring and equipment from earth movement.

A listed expansion/deflection fitting for rigid conduit

Courtesy of Cooper Crouse-Hinds

Summary
A listed expansion/deflection fitting or other approved means shall be used where a raceway crosses a structural control joint intended for expansion, contraction, or deflection in buildings, bridges, parking garages, and other structures.

Application Question
Is a wireway considered a raceway?

Answer
Yes. The definition of *raceway* in Article 100 includes wireways.

Underground Installations – Underground Cables Under Buildings

Significance

The general rule in 300.5(C) requires all wiring under buildings to be installed in raceways. The new Code permits two wiring methods under buildings without being enclosed in a raceway.

Analysis

Two exceptions have been added to 300.5(C) that permit mineral-insulated, metal-sheathed cable (Type MI) and metal-clad cable (Type MC) to be installed under a building without being enclosed in a raceway. According to new Exception No. 1, Type MI cable without installation in a raceway is permitted under a building where embedded in concrete, fill, or other masonry in accordance with 332.10(6) or where suitably protected against physical damage and corrosive conditions in accordance with 332.10(10). Section 332.10 of the existing *NEC* already permits the use of Type MI cable under the conditions stated in the new exception. However, Type MI cable has not previously been permitted under a building without being enclosed in a raceway.

According to new Exception No. 2, Type MC cable listed for direct burial or concrete encasement may be used under a building without being installed in a raceway in accordance with 330.10(A)(5). Also, MC cable may be installed in a wet location under a building without being enclosed in a raceway, provided the cable covering is impervious to moisture in accordance with 330.10(A)(11). These conditions of installation are already permitted by Code, except for the permission to install MC cable under a building without being enclosed in a raceway.

Summary

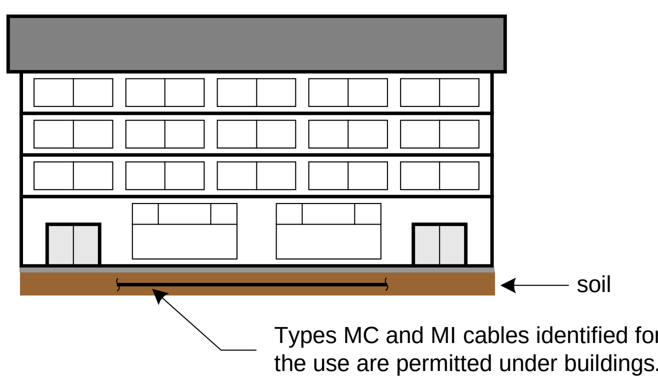
Type MC cable and Type MI cable are permitted to be installed under a building without being enclosed in a raceway, provided that all other applicable conditions of use are followed in accordance with 330.10 and 332.10 respectively.

Application Question

T F Type MC cable installed under a building without being enclosed in a raceway is considered an *accessible* wiring method.

Answer

False. According to the *NEC's* definition, an *accessible* wiring method is, "Capable of being removed or exposed without damaging the building structure or finish or not permanently closed in by the structure or finish of the building." Raceway wiring methods are accessible.



Securing and Supporting – Secured in Place – Non-Fire-Rated Assemblies

Significance
The requirement for identification of independent support wires in fire-rated ceiling assemblies now applies also to non–fire-rated assemblies.

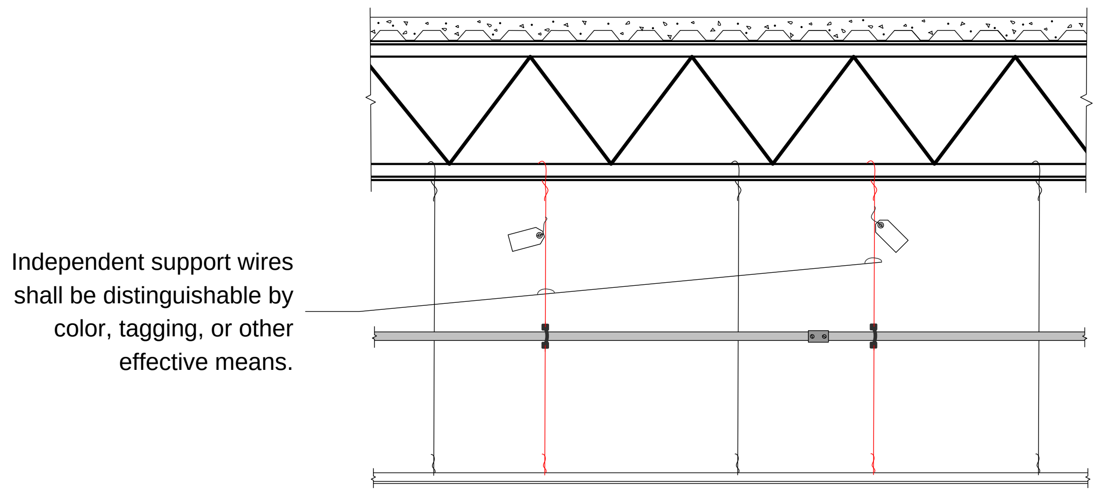
Analysis
Wiring located within the cavity of a floor–ceiling or roof–ceiling assembly cannot be secured to ceiling support wires, unless guidance is received from the manufacturer of the ceiling assembly. If support wires are used as the wiring support method and the manufacturer of the ceiling assembly does not permit using the ceiling support wires, then additional support wires must be installed that are independent of the ceiling support system. In previous Code editions, these independent support wires were required to be identified where used in fire-rated ceiling cavities. The change in this section requires this identification for support wires in non–fire-rated ceilings as well. The independent support wires shall be distinguishable from the ceiling support wires by color, tagging, or other effective means.

The independent support wires shall provide *secure* support, meaning that the wiring method shall be prevented from horizontal movement. This is particularly important where a metallic raceway is used and the raceway serves as the equipment grounding conductor. The independent support wires must be secured at the top and bottom. The wires can be secured at the bottom to the metal ceiling grid. The support wires *support* the weight of the wiring method.

This new requirement will assist the AHJ and alert electric equipment installers in the future to the availability of a wiring method support system. Wiring can be supported by other means above a suspended ceiling such as by the structural ceiling or by structural framing members.

Summary
Where independent support wires are used to support wiring in cavities above suspended ceilings, the support wires shall be distinguishable from the ceiling support wires by color, tagging, or other effective means.

Application Question
T F It is permissible to support boxes from the ceiling support grid and from ceiling support wires.



Wiring in fire-rated and non–fire-rated ceiling cavities cannot be supported by the ceiling support system. An independent means of support is required.

Answer

True. Generally, the wiring method cannot be supported by, or secured to, the ceiling grid or ceiling support wires, but boxes not larger than 100 in.^{3} can.

Wiring in Ducts Not Used for Air Handling, Fabricated Ducts for Environmental Air, and Other Spaces for Environmental Air (Plenums)

Significance

The permitted use of cable tray support systems in air-handling spaces has been clarified. Code terminology has changed with regard to systems used to transport environmental air.

Analysis

A common use of the space above a suspended ceiling is as a plenum for return air. The term *plenum* is now used differently in the *NEC* to align with NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, and other mechanical codes. This will help avoid confusion in enforcement due to inconsistent labeling of products for use in air-handling spaces. In the new Code, *plenum* is synonymous with Other Spaces for Environmental Air. Also, the 2011 *NEC* removes *plenum* from the heading of 300.22(B) to clarify that this subsection applies only to ducts specifically fabricated to transport environmental air.

Section 300.22 subsection (C) has been expanded to include rules for using cable tray support systems in other spaces for environmental air (plenums). Open metal cable trays may be used in plenums to support wiring methods that are permitted in plenums. Metal cable trays with solid sides and bottom that include a solid metal cover may be used in plenums to support the many wiring methods listed in Table 392.10(A), and specified in 392.10(B) for qualified industrial establishments.

Electrical equipment with a metal enclosure and associated wiring material suitable for the ambient temperature is permitted in other spaces for environmental air (plenums) unless prohibited elsewhere in the *NEC*. Also, electrical equipment with a nonmetallic enclosure listed for use within an air-handling space and having adequate fire-resistant and low-smoke-producing characteristics is permitted in plenums.

Remember that cable tray is not a wiring method but a support system for wiring methods.

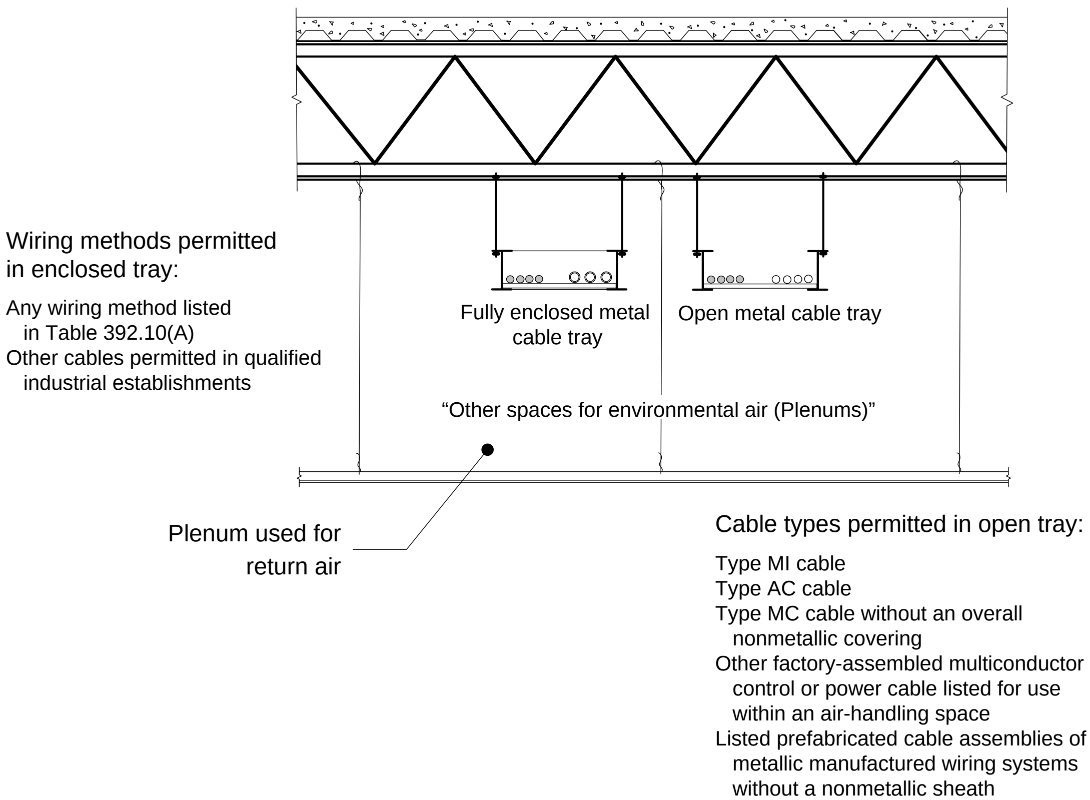
Summary

In the new Code, *plenum* is synonymous with Other Spaces for Environmental Air. Section 300.22 subsection (C) has been expanded to include rules for using cable tray support systems in other spaces for environmental air (plenums).

Application Question

The space above a suspended ceiling used for return air is considered a __________ by the *NEC*.

A. duct
B. plenum
C. duct or plenum



Answer

B. Plenum

Article 310, Tables

Significance
All tables located in Article 310 have been renumbered in the 2011 *NEC*.

Analysis
Article 310 has been reorganized in the 2011 Code in an effort to comply with the *NEC Style Manual* and to provide consistency with other articles in Chapter 3 of the *NEC*. The *Style Manual* dictates that all tables be referenced in the text of the *NEC* and that they be numbered according to the section in which they are referenced. This has resulted in the renumbering of all tables within Article 310. Familiar Table 310.16 is now Table 310.15(B)(16), since the reference to the table is in 310.15(B). The “16” at the end of the new table designation identifies it with former Table 310.16. Thus, former Tables 310.16 through 310.21 are now numbered 310.15(B)(16) through 310.15(B)(21).

Temperature correction factors are no longer included with each table for Tables 310.15(B)(16) through (B)(20). Instead the correction factors are listed in new Tables 310.15(B)(2)(a) and (B)(2)(b) for ambient temperatures based on 30°C and 40°C respectively.

Tables 310.67 through 310.86 have been renumbered Tables 310.60(C)(67) through 310.60(C)(86) to reflect the reference in 310.60(C) to ampacity tables for conductors rated 2001 to 35,000 volts. New Table 310.60(C)(4) is permitted to be used for ambient temperature correction for conductors rated 2001 to 35,000 volts.

Former Table 310.13(A), Conductor Applications and Insulations Rated 600 Volts, is now Table 310.104(A).

2008 *NEC* and before		**2011 *NEC***
Table 310.16	→	**Table 310.15(B)(16)**

Summary
All tables within Article 310 have been renumbered and ambient temperature correction factors are now listed in a separate table(s). Familiar ampacity Table 310.16 is now Table 310.15(B)(16).

Example
Determine the ampacity of three 8AWG, current-carrying, THWN copper conductors installed in a metal raceway in an ambient temperature of 95°F.

From Table 310.15(B)(16), 75°C column for copper conductors:
8 AWG = 50 amps in an ambient temperature of 86°F.
From Table 310.15(B)(2)(a), for an ambient temperature in the range 87-95°F and conductor temperature rating of 75°C, the correction factor is 0.94.

The corrected ampacity is 47 A (50 x 0.94).

Ampacities for Conductors Rated 0-2000 Volts – Tables

Significance

This revision provides an important clarification for calculating the adjusted and/or corrected ampacity of a conductor.

Analysis

Section 110.14(C), Temperature Limitations, requires that the temperature rating used to select the ampacity of a conductor not exceed the lowest temperature rating of any circuit component: any connected termination, conductor, or device. For example, for a conductor that is rated 90°C terminating at a circuit breaker whose terminals are rated 75°C, the ampacity of the conductor must not exceed the ampacity that corresponds to the conductor's 75°C rating. The temperature rating of load connections must also be considered. The revision in 310.15(B) clarifies that the conductor ampacity corresponding to the conductor's temperature rating may be used when applying adjustment and/or correction factors, provided the final ampacity does not exceed the ampacity for the lowest temperature rating of any component of the circuit. The term *adjustment* refers to the adjusted ampacity as a result of derating for more than three current-carrying conductors in a raceway or cable. The term *correction* refers to the corrected ampacity for a conductor used in an ambient temperature different than what the ampacity table is based on.

Example

Type XHHW-2 aluminum, 250 kcmil conductors are used for a 120/240-V, 3-wire, single-phase feeder circuit enclosed in a raceway. Parallel conductors are used. The load is balanced, so there are four current-carrying conductors within the raceway. The feeder circuit breaker and the load are equipped with connection terminals rated 75°C. What is the ampacity of the conductors?

From Table 310.15(B)(16), formerly Table 310.16:

- XHHW-2 conductors have a temperature rating of 90°C.
- Select the ampacity from the 90°C column for aluminum conductors (230 amps).
- Since Table 310.15(B)(16) is based on not more than 3 current-carrying conductors, the conductor ampacity must be adjusted in accordance with Table 310.15(B)(3)(a).

From Table 310.15(B)(3)(a):

- For 4-6 current-carrying conductors in the same raceway, the adjusted ampacity is 80% of the ampacity from Table 310.15(B)(16).
- Adjusted ampacity = 230 x 0.8 = 184 A
- ✓ The adjusted ampacity cannot be greater than the ampacity that corresponds to the 75°C rating for 250 kcmil aluminum, 205 A. So, 184 A is the final ampacity.

Summary

Adjustment and correction factors are permitted to be applied to the ampacity of a conductor at its temperature rating, provided the final ampacity does not exceed the ampacity that corresponds to the lowest temperature rating of any component in the circuit.

Ampacities for Conductors Rated 0-2000 Volts – Tables

Significance

Some of the ampacity values in frequently used Table 310.15(B)(16) have changed.

Analysis

The change in some of the ampacity values is the result of an effort to harmonize the *National Electrical Code* with the *Canadian Electrical Code (CEC)*. The proposal was generated by the Ampacity Harmonization Task Group, which consists of Canadian and U.S. members. The ampacity values are calculated from an equation defined in IEEE Std. 835-1994, *IEEE Standard Power Cable Ampacity Tables* and other standards. Proposals have also been submitted to revise the *CEC* to agree with the rounded calculated values of ampacity. The ampacities that have changed are indicated in partial Table 310.15(B)(16) below. For every revised ampacity value the difference is 5 amperes, either above or below the previous ampacity. There are no changes in the 75°C column for either copper or aluminum conductors. Note that the 60°C ampacity of 14 AWG and 12 AWG copper conductors has decreased by 5 amps from the 2008 *NEC* values. Since 240.4(D) limits the overcurrent protective devices to 15- and 20-A for 14 and 12 AWG copper respectively, the revision will not have a significant impact on general wiring. However, for specific conductor applications like motor circuits and other applications described in Table 240.4(G) conductor sizes will be affected.

Table 310.15(B)(16), in part Not more than 3 current-carrying conductors in cable, raceway, or directly buried in earth, based on an ambient temperature of 30°C

Size AWG or kcmil	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM		
14	~~20~~ 15					
12	~~25~~ 20			~~20~~ 15		
8				~~30~~ 35		
6						~~60~~ 55
3			~~110~~ 115			
1			~~150~~ 145			
300				~~190~~ 195		~~255~~ 260
600	~~355~~ 350					
700				~~310~~ 315		~~420~~ 425
800						~~450~~ 445
1500	~~520~~ 525					
2000	~~560~~ 555					

Summary

Changes have been made to some of the ampacity values in Table 310.15(B)(16).

Application Question

What is the ampacity of a 1 AWG copper conductor rated 90°C based on an ambient temperature of 30°C, where 3 conductors are installed in a raceway?

Answer

The table values can be used without adjustment or correction, since not more than 3 current-carrying conductors are installed in the raceway and the ambient temperature of the application is the ambient temperature that the table is based on. The ampacity is 145 amps. However, the conductor cannot be used at this ampacity unless all circuit components and terminations are rated for 90°C.

Outlet Boxes – Boxes at Ceiling-Suspended (Paddle) Fan Outlets

Significance

There are occasions where installation of a listed ceiling-suspended (paddle) fan box is required in the 2011 Code even if a luminaire is installed on the box instead of a paddle fan.

Analysis

It is a common practice for electricians to install ceiling boxes in bedrooms and other locations supplied with two switched conductors run from a 2-gang switch box. Often the initial contract does not include paddle fans and the electrician installs luminaires on theses boxes with one of the switched conductors capped off. According to new Section 314.27(C), where "spare," separately switched, ungrounded conductors are installed in a ceiling box that is in a location appropriate for a paddle fan, the box at this location shall be listed for sole support of a ceiling-suspended (paddle) fan. This ensures that a paddle fan installed on this box at a future date by a person not familiar with fan support requirements will be safely installed.

The rule applies only if a "spare" conductor is present at the ceiling box, presumably for the separate control of a paddle fan and light kit. The rule only applies to dwellings. The new requirement does not prohibit spare conductors in a ceiling box located too close to a wall for the installation of a paddle fan, e.g., for the supply of track lighting.

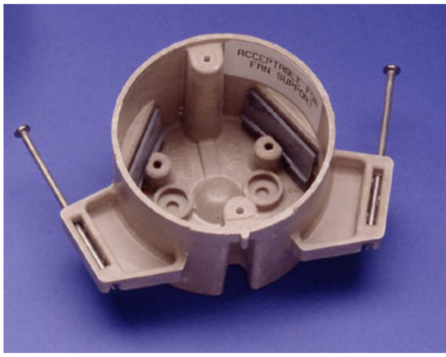
Summary

In dwelling units, where spare, separately switched, ungrounded conductors are provided at a ceiling outlet box mounted in a location acceptable for the installation of a paddle fan, the outlet box or outlet box system shall be listed for sole support of a ceiling-suspended (paddle) fan.

For cathedral ceiling

For suspended ceiling

Paddle fan boxes
Courtesy of Arlington Industries, Inc.



Nail-mount box

For old work applications

L-shaped for mounting to joist

Paddle fan boxes
Courtesy of Allied Moulded Products, Inc.

Application Question

An electrician installs a 14/2 with Ground NM cable from a switch location to a ceiling outlet box in the center of a bedroom. Is a listed paddle fan box required?

Answer

No. Even though the location of the box is suitable for a paddle fan, there are no “spare” switch-leg conductors in the box.

Code Refresher

- ✓ The general requirements for paddle fan support are repeated in Article 422 – Appliances. Section 422.18 requires that a paddle fan be supported independently of an outlet box, or by a listed outlet box or outlet box system identified for the use, and installed in accordance with 314.27(C). This section did not change in the 2011 *NEC*.

Pull and Junction Boxes and Conduit Bodies – Power Distribution Blocks

Significance
Power distribution blocks are now permitted in pull and junction boxes.

Analysis
Power distribution blocks are already permitted in metal wireways. The rules for installation in pull and junction boxes are similar to the rules for installation of power distribution blocks in wireways in 376.56(B). Power distribution blocks shall be permitted in pull and junction boxes over 1650 cm^3 (100 $in.^3$) for connections of conductors where the installation complies with the following:

- The power distribution blocks shall be listed.
- In addition to the overall size requirement in the first sentence of 314.28(A)(2), power distribution blocks shall be installed in a box with dimensions not smaller than specified in the installation instructions for the power distribution block.
- The wire bending space at the terminals of power distribution blocks shall comply with 312.6.
- The power distribution blocks shall not have uninsulated live parts exposed, whether or not the box cover is installed.
- Where the pull or junction box is also used for through conductors, the through conductors shall be arranged so as not to obstruct the power distribution block terminals.


Courtesy of ILSCO

Summary
Power distribution blocks are now permitted to be installed in pull and junction boxes, following the provisions of 314.28(E).

Application Question
Does the permission to install power distribution blocks in pull and junction boxes apply to both metal and nonmetallic boxes?

Answer
Yes. However, power distribution blocks are permitted in metal wireways but not in nonmetallic wireways.