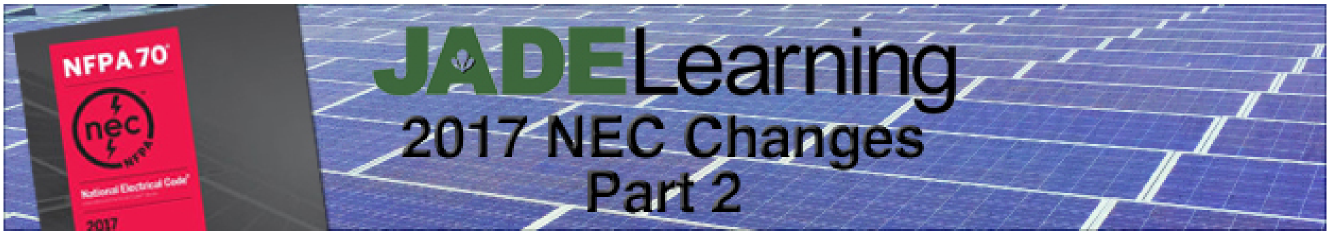


2017 NEC Changes Part 2 (Homestudy)

North Carolina Electrical License

This course will review some of the most important National Electrical Code changes from the 2017 NEC. Changes from Article 240 to Article 408 will be covered

Course# CEC.02354 4 Homestudy Credit Hours $55.00

This course is currently approved by the North Carolina State Board of Examiners of Electrical Contractors under course number CEC.02354.

Completion of this continuing education course will satisfy 4.000 credit hours of course credit type 'Homestudy' for Electrical license renewal in the state of North Carolina. Course credit type 'Homestudy'. Board issued approval date: 2/8/2017. Board issued expiration date: 6/30/2021.

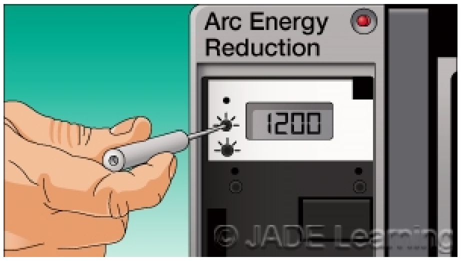
JADELearning

2017 NEC Changes Part 2 (Homestudy) - NC

Chapter 2

Question 1: 240.87 Arc Energy Reduction.

Question ID#: 1100.0



Setting the instantaneous trip setting of a circuit breaker below the available arcing current is a way to provide arc energy reduction.

Large electrical systems protected by circuit breakers with high trip settings have the potential for extreme arc fault events. Section 240.87 requires that these systems use some method that will limit these arcing fault levels.

Circuit breakers that have a continuous trip rating of 1200 A or higher, and circuit breakers that are adjustable to have their continuous trip rating set to 1200 A or higher, must be provided with some type of Arc Energy Reduction. The 2017 NEC has expanded the choices for how this Arc Energy Reduction can be accomplished.

One new way to reduce the hazards of an arc flash is to provide ***an instantaneous trip setting that is less than the available arcing current.*** Another new way to limit arc faults is to provide ***an instantaneous override that is less than the available arcing current.***

Under arc fault conditions, the longer the arc persists, the more dangerous it is to people and equipment. Reducing the amount of time that the faulted circuit is energized, will increase safety. Instantaneous trip settings for circuit breakers and instantaneous overrides that are set below the available arcing current are an effective way to reduce the arc energy because the circuit breaker will trip as soon as the instantaneous trip level is reached.

New Informational Note No. 3 explains how an instantaneous trip setting can reduce the clearing time of a circuit breaker: ***An instantaneous trip is a function that causes a circuit breaker to trip with no intentional delay when currents exceed the instantaneous trip setting or current level. If arcing currents are above the instantaneous trip level, the circuit breaker will trip in the minimum possible time.***

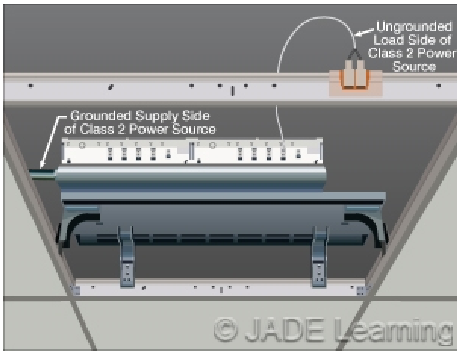
This code change will provide a safer installation by including an instantaneous trip function as a way to reduce arc energy by reducing the amount of time the arc is allowed to continue.

Question 1: Which of the following requires some form of Arc Energy Reduction?

A: 1000 A rated circuit breaker with adjustable instantaneous trip setting.
B: 1200 A rated circuit breaker with adjustable instantaneous trip setting.
C: 1000 A rated circuit breaker with continuous setting set to 1100 A.
D: Circuit breaker with maximum continuous current setting of 1100 A.

Question 2: 250.22 Circuits Not to Be Grounded.

Question ID#: 1101.0



Circuits on the load side of a class 2 power supply used for low-voltage power grid distribution systems are not to be grounded.

Article 250 covers requirements for grounding and bonding electrical installations. Section 250.22 covers circuits not to be grounded in particular. Class 2 load side circuits for suspended ceiling low-voltage power grid distribution systems are not to be grounded.

Low-Voltage Suspended Ceiling Power Distribution Systems are systems that support a finished lay-in ceiling and have busbars to distribute power to utilization equipment, such as LED luminaires, installed in the ceiling.Â The system is supplied by a Class 2 Power Supply.Â Article 393, Low-Voltage Suspended Ceiling Power Distribution Systems was new in the 2014 NEC.

The supply side of the class two power supply is grounded, usually by the equipment grounding conductor that feeds the Class 2 power supply.Â The load side of the Class 2 power supply is not to be grounded, and is a new list item that has been added to section 250.22, Circuits Not to Be Grounded.

Class 2 power supplies have isolating transformers and provide limited power outputs.Â Because of their limited power outputs, Class 2 power supplies and Class 2 circuits are not considered a shock or fire hazard.

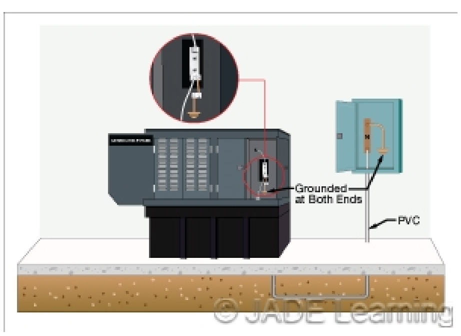
Class 2 load side circuits operate at a maximum of 30 volts ac or 60 volts dc.Â The maximum power output for Class 2 Power Sources is most commonly 100 VA.Â The output values for Class 2 power sources are given in Chapter 9, Tables 11(A) and 11(B).

Question 2: How is a Class 2 power supply for a Low-Voltage Suspended Ceiling Power Distribution System grounded?

A: The supply side of the Class 2 power supply is not to be grounded; the load side circuits shall be grounded.
B: The supply side shall be grounded; The load side circuits of the Class 2 power supply are not to be grounded.
C: Both the supply side and load side circuits of a Class 2 power supply are to be grounded.
D: Neither the supply side or the load side of Class 2 power circuits are to be grounded.

Question 3: 250.30(A)(1) Ex. No. 2. Grounded Systems. System Bonding Jumper.

Question ID#: 1102.0



A main bonding jumper can be installed at the source of a separately derived system, and at the first disconnecting means if it does not create a parallel path for normal neutral current.

Section 250.30 goes over grounding separately derived alternating-current systems.

If a building or structure is supplied by a feeder from an outdoor separately derived system, a system bonding jumper can be installed at the source of the separately derived system and at the first disconnecting means, if it does not create a parallel path for the grounded conductor.Â

The 2014 NEC said the system bonding jumper could be installed at an â€œoutdoor transformerâ€• and the first disconnecting means.Â The 2017 NEC has changed the wording from â€œoutdoor transformerâ€• to â€œoutdoor separately derived system.â€•

A â€œseparately derived systemâ€• is a broader term that could include generators, PV systems, wind generators or transformers.Â A separately derived system is defined in Article 100 as:

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

A transformer is always a separately derived system.Â A generator, PV or wind generator system may or may not be installed as a separately derived system.Â If a power source is a separately derived system, and it is installed outdoors, according to 250.30(A) Ex. No. 2, a system bonding jumper can be installed at the source and at the first disconnecting means, if it does not create a parallel path for current flowing on the grounded conductor.

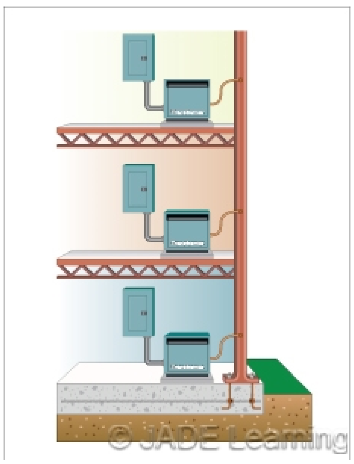
If this exception is used, then the grounded conductor is connected to the enclosure at the source of the separately derived system and at the first disconnecting means.Â A supply side bonding jumper is not installed between the source and the first disconnecting means.Â Fault current returning to the source of the separately derived system from circuits on the load side of the disconnecting means travels on the grounded conductor.

Question 3:   When can a system bonding jumper be installed at a separately derived system and the first disconnecting means?

A: When the separately derived system is installed indoors.
B: When the separately derived system is installed within 10 ft. of the disconnecting means.
C: When the installation does not create a parallel path for the grounded conductor.
D: When the grounded and ungrounded conductors are installed in metallic conduit.

Question 4:   250.30(A)(4) Grounded Systems. Grounding Electrode.

Question ID#: 1103.0



The grounding electrode system that is used for separately derived systems in a building must be the same grounding electrode system used for the building service.Â

Section 250.30 goes over grounding separately derived alternating-current systems.

Now the grounding electrode system used for a separately derived system must be the same grounding electrode system as used for the building or structure.Â The 2014 NEC said the grounding electrode for the separately derived system only had to be as near as practicable to, and in the same area as the grounding electrode connection to the system.Â Saying that the same grounding electrode system must be used for both a separately derived system and the building supply system is a much clearer statement of what is required.

Also, the 2017 NEC has recognized that a grounding electrode connection to a metal water pipe or structural metal is not a connection to a grounding electrode.Â At the point where a grounding electrode conductor is connected to a water pipe or building steel, the water pipe and building steel is acting as an extension of the grounding electrode, but is not the actual grounding electrode.

What makes a water pipe a grounding electrode is the fact that it is in the ground for 10 ft. or more, 250.52(A)(1).Â What makes structural steel a grounding electrode is the fact that it is in contact with the earth vertically for 10 ft. or more, 250.52(A)(2).Â The section of the water pipe or building steel which is above ground is not a grounding electrode; it is an extension of the grounding electrode.
If the separately derived system is located outdoors, the connection to the grounding electrode system must be made at the source of the separately derived system.

Question 4:   A transformer is installed as a separately derived system in a building with a 277/480 service. How is the transformer connected to the grounding electrode?

A: The grounding electrode system for the transformer must be separate from the grounding electrode system for the service.
B: The transformer is not required to be connected to a grounding electrode.
C: The grounding electrode system for the transformer must be isolated from the grounding electrode system for the service.
D: The grounding electrode system for the transformer must be connected to the grounding electrode system for the building.

Question 5: 250.30(A)(6) Grounded Systems. Grounding Electrode Conductor, Multiple Separately Derived Systems.

Question ID#: 1104.0

Section 250.30 goes over grounding separately derived alternating-current systems.

Metal water piping that complies with 250.68(C)(1) is now permitted to serve as a common grounding electrode conductor for multiple separately derived systems. In order to qualify under 250.68(C)(1), the interior metal water piping must meet both of the following conditions:

1)Â Â The water pipe must be electrically continuous with an underground metal water pipe electrodeÂ ***AND***

2)Â Â The grounding electrode conductors from the separately derived systems must be connected to the metal water pipe within 5 ft. of where the pipe enters the building.

Interior metal water piping more than 5 ft. inside the building cannot be used as a grounding electrode conductor.

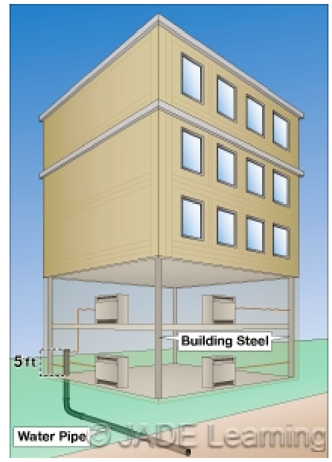
The metal structural frame of a building or structure is permitted to serve as a common grounding electrode conductor for multiple separately derived systems under any of the following conditions:

1)Â Â The metal structural frame is used as a conductor to interconnect electrodes that are part of the grounding electrode system, ***OR***

2)Â Â The metal structural frame is used as a grounding electrode conductor in accordance with 250.68(C)(2) ***OR***

3)Â Â The metal structural frame is connected to the grounding electrode system by a grounding electrode conductor not smaller than 3/0 AWG Cu or 250 kcmil Al.

The grounding electrode conductors from the separately derived systems may be connected to the metal structural frame of the building at any accessible point.



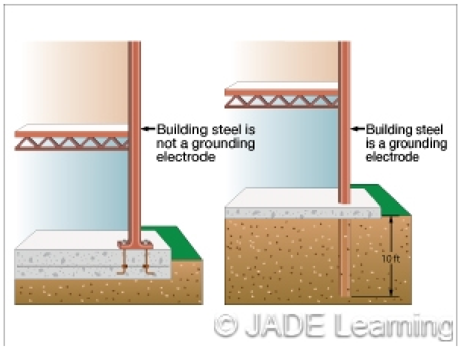
A metal underground water pipe may be used as a grounding electrode conductor if connected within the first 5 ft. of where the water pipe enters the building.

Question 5: Which one of the following can be used as a common grounding electrode conductor for five separately derived systems in a building?

A: 10 ft. of interior copper water pipe.
B: The steel cover of each separately derived system (transformer).
C: The building's metal structural frame.
D: Interior metal water pipe connected to an underground plastic water main.

Question 6: 250.52(A)(2) Electrodes Permitted for Grounding. Metal In-ground Support Structure(s).

Question ID#: 1105.0



A metal piling that is in contact with the earth for 10 ft. or more can be used as a grounding electrode.

Section 250.52 goes over grounding electrodes; section A is Electrodes Permitted for Grounding.

A metal in-ground support structure, such as a metal piling, installed in direct contact with the earth for 10 feet vertically or more qualifies as a grounding electrode. Concrete encasement is permitted, but a metal in-ground support structure is different from the concrete encased electrode covered by 250.52(A)(3).

In general, all grounding electrodes identified in 250.52(A)(1)-(7) that are present at a building must be bonded together to form the grounding electrode system ***(code reference 250.50)***. However, if there is more than one metal in-ground support structure, only one is required to be bonded to the grounding electrode system. In other words, if there are 20 metal pilings in direct contact with the earth for 10 vertical ft. or more, only one piling is required to be connected to the grounding electrode system.

Section 250.68(C)(2) permits the metal structural frame of a building to serve as a grounding electrode conductor to interconnect grounding electrodes that are part of the grounding electrode system. If there is no metallic connection between the metal structural frame and a metal in-ground support structure, a grounding electrode conductor sized in accordance with Table 250.66 must be installed and connected to at least one of the metal in-ground support structures.

Question 6: If 50 metal pilings are each driven to a depth of 65 ft. to support a building, how many pilings must be connected to the grounding electrode system?

A: 50 metal pilings.
B: 7 metal pilings.
C: 0 if there is no connection to the metal structural frame.
D: 1 metal piling.

Question 7: 250.52(B)(3) Grounding Electrodes. Not Permitted for Use as Grounding Electrodes.

Question ID#: 1106.0

The reinforcing steel of a swimming pool cannot be used as a grounding electrode.

In general, bonding all available electrodes together to form a single grounding electrode system for a building is a good idea, but there are some underground systems and structures, such as underground metal gas piping, that are not intended to be used as grounding electrodes (code reference 250.50). Swimming pool structures covered by 680.26(B)(1) and (B)(2) are also now included in the list of systems and materials in 250.52(B) that ***shall not be used as grounding electrodes***:

(1) Metal underground gas piping systems.

(2) Aluminum.

(3) The structures and structural reinforcing steel described in 680.26(B)(1) and (B)(2).

Article 680 requires metal parts of a swimming pool and the perimeter surfaces around the pool to be bonded together either by structural steel or by No. 8 bare solid copper conductors. This equipotential bonding protects people using the pool from electrical shock by reducing voltage gradients in the pool area. It is not intended to be used as a grounding electrode for the electrical service.

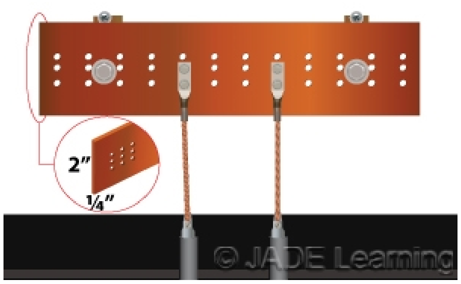
Using the bonding system of a swimming pool or similar structure as part of the grounding electrode system could introduce current from the electrical system into the earth near the swimming pool. In addition, lighting strikes or unintentional contact between high-voltage lines may result in temporary currents in the grounding electrode system. Any of these conditions could pose a life safety hazard if swimming pool structures are used as a grounding electrode for the electrical system.

Question 7: Which one of the following is permitted to be used as a grounding electrode?

A: An aluminum rod 10 ft. in length.
B: 10 ft. of underground metal water pipe.
C: Structural reinforcing steel in a concrete swimming pool.
D: 20 ft. of underground metal gas piping.

Question 8: 250.64 Grounding Electrode Conductor Installation.

Question ID#: 1107.0



Bonding jumpers from grounding electrodes can be connected to an aluminum or copper busbar.

Section 250.64 covers grounding electrode conductor installation. The rules for the installation and protection of grounding electrode conductors have been simplified.

A No. 6 AWG or larger copper or aluminum grounding electrode conductor is permitted to be run unprotected on the surface of a building unless exposed to physical damage. The grounding electrode conductor must be securely fastened in place and bare aluminum or copper clad aluminum conductors are not permitted to be used in direct contact with masonry or the earth.

Grounding electrode conductors, No. 6 AWG or larger that are exposed to physical damage and all grounding electrode conductors smaller than No. 6 AWG must be protected by cable armor or by rigid metal conduit (RMC), intermediate metal conduit (IMC), rigid PVC conduit, reinforced thermosetting resin conduit Type XW (RTRC-XW), or electrical metallic tubing (EMT).

Grounding electrode conductors and grounding electrode bonding jumpers in contact with the earth are not required to meet the cover requirements of Table 300.5, but are required to be buried or protected if exposed to damage. For example, a No. 6 AWG grounding electrode bonding jumper between two ground rods must be buried or protected to avoid damage from lawn mowers or other ordinary maintenance activities. A minimum burial depth is not stated.

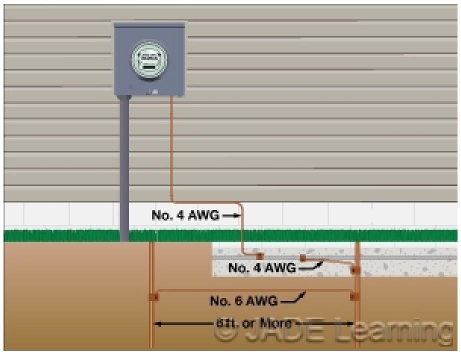
Bonding jumpers from grounding electrodes can be connected to an aluminum or copper busbar if the busbar is at least 1/4 in. thick x 2 in. wide and is long enough to accept the number of terminations necessary to connect all of the bonding jumpers in the installation. ***The busbar requirements mentioned belong to the code section, 250.64(D)(1), which pertains specifically to buildings or structures with multiple disconnecting means in separate enclosures.***

Question 8: A No. 6 AWG solid copper grounding electrode conductor from a residential service to a ground rod is exposed to physical damage and run on the building surface. Which one of the following provides acceptable physical protection?

A: Nonmetallic flexible conduit.
B: Rigid PVC conduit.
C: No protection required when run on building surface.
D: Electrical nonmetallic tubing (ENT).

Question 9: 250.66 Size of Alternating-Current Grounding Electrode Conductor.

Question ID#: 1108.0



<u>The bonding jumper between two grounding electrodes of the same type does not have to be bigger than the grounding electrode conductor size from Table 250.66.</u>

Section & Table 250.66 deal with the sizing of Grounding Electrode Conductors (GEC) for AC electrical systems. This section was revised to clarify that the special rules that apply for sizing grounding electrode conductor(s), when they connect to the three specific types of electrodes that are sized outside of Table(250.66), also apply to bonding jumpers that connect to those same electrodes. Connections to rods, pipes, or plate electrodes, concrete-encased electrodes, and ground rings are all permitted to be made with GEC sizes that may be smaller than the size required from Table 250.66, for ***<u>other</u>*** types of electrodes.

If a conductor makes the connection between two electrodes, but does not go back to the service equipment (or wherever the connection to the electrical service is), that particular conductor is called a "Bonding Jumper." And if the conductor extends from the service equipment (or similar) to an electrode, that conductor is then called a "Grounding Electrode Conductor." The revision to the Code for this Code cycle now makes it clear that both types of conductors are covered by the same rules.

Another change in this Code-section clarifies when you need to install a larger conductor. Section 250.66(A) says if a GEC or bonding jumper only connects to rods, pipes, or plates as grounding electrodes, then it is not required to be larger than 6 AWG copper no matter how large the service ampacity. That No. 6 AWG size limit for a GEC connected to that type of electrode, is one of those special sizing rules outside of Table 250.66. These driven grounds (rods, pipes and plates) are required to move electrical current through the soil of the earth whenever they are called upon to function, and no matter how big the conductor is, the earth is still going to limit current flow because it is a poor conductor, this is why the GEC attached to this type of electrode is not required to increase as the service size increases.

If the GEC only connects to concrete-encased electrodes, it is not required to be larger than 4 AWG copper, and if it only connects to ground rings, it is not required to be larger than the conductor that is used to build the grounding ring(s). These rules apply regardless of the size that would otherwise be required from Table 250.66.

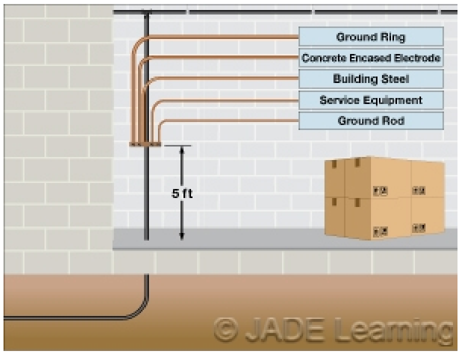
<u>However</u>, if the conductor or conductors making a connection to one of these types of electrodes also extends to another type of electrode that requires a larger size bonding jumper or GEC, then that larger size must be used throughout the conductor, all the way back to the service. In other words, if a GEC extends from a piece of service equipment to a ground rod, a No 6 AWG is just fine for the GEC. But if a bonding jumper then connects that ground rod to a concrete-encased electrode that requires a No. 4 AWG Grounding Electrode Conductor, then you must not only use a No. 4 AWG between the ground rod and concrete-encased electrode, but you must also use a No. 4 AWG between the service equipment and the ground rod, as the No. 6 AWG that is normally permitted becomes undersized for the last electrode that you just installed on the end of that wire. Remember, when the electrodes are all wired in series, or in other words they are all ***<u>daisy-chained together</u>***, all conductors used to string them together must be able to meet the sizing requirements for all electrodes depending on that wire.

Question 9: In which of these situations, is the connection to a ground rod required to be larger than 6 AWG copper?

A: When it connects to more than one ground rod.
B: When the service conductors are larger than 2/0 cu.
C: When the ground rods are larger than the minimum size required.
D: When the connection extends to other electrodes that require larger sizes.

Question 10: 250.68(C) Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes. Grounding Electrode Conductor Connections.

Question ID#: 1109.0



The first 5 ft. of metal water piping inside the building may be used to interconnect other electrodes.

Section 250.68 covers the connecting of grounding electrode conductors (GEC) & bonding jumpers, to grounding electrodes in contact with the earth. Also covered, is when it is appropriate to use components such as building steel, water pipe or rebar as a means of interconnection (meaning as a bonding jumper) between electrodes, or as an extension from an approved buried electrodes, so as to provide a place for other conductors to connect. Often, all or part of these items are not considered grounding electrodes (as defined in Article 100) because they do not make a direct 10' connection to earth.

For example, metal water piping on the inside of a building is not itself an electrode because it is not buried in the earth. However, up to 5 ft. of the interior metal piping, measured from the point of entrance into the building, may be used to extend the connection to that portion of the water piping that does meet the requirement for an electrode by being buried in the earth. The first 5 ft. of metal water piping inside the building may also be used to interconnect other electrodes. Interior metal piping that is more than 5 ft. from the point of entrance to the building is not permitted to extend the connection to a buried electrode and is not permitted for interconnecting electrodes.

Similarly, the metal frame of a building is usually not permitted as an electrode because it is usually not in direct contact with the earth for 10 ft. or more. But the metal frame IS permitted in 2017 to be used as a conductor to interconnect other electrodes to one another (meaning it can serve as a bonding jumper) when that frame is not connected to earth. Or, when the frame IS connected to earth, by way of a hold down bolt attached to concrete-encased rebar, the frame may serve as a grounding electrode conductor (GEC).

The metal frame of a building, when connected to a concrete-encased electrode through the hold-down bolts in the concrete, is now considered a Grounding Electrode Conductor. The connection of the hold-down bolts to the concrete-encased electrode may be made by welding, exothermic welding, by the usual steel tie wires, or by other means approved by the AHJ. Previously, the metal structural frame of a building was considered to be an actual grounding electrode if it was connected by hold-down bolts to the concrete-encased electrode. But now, this connection to the earth by way of a hold down bolt, only permits the frame to be called a grounding electrode conductor. This change allows the metal frame to continue to be used, but it will only be a conductor, not an electrode. There is a means in which the metal frame can be an actual electrode in 2017, it requires that at least one steel pillar of the frame extend 10' vertically into the Earth.

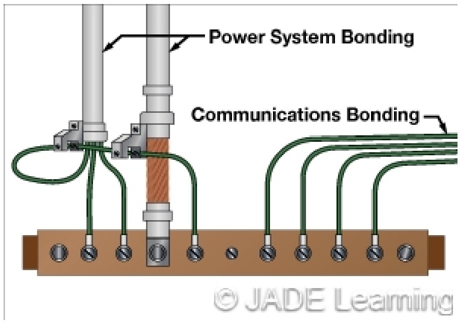
The third part of this section permits the use of a separate section of rebar to extend the connection from the rebar that forms a concrete-encased electrode to an accessible location above grade. A grounding electrode conductor or bonding jumper may be connected to the separate section of rebar at the above-grade location. The location of the connection must not be subject to corrosion and the rebar extension must not be exposed to earth without corrosion protection. In accordance with 250.52(A)(3), the rebar extension may be connected to the rebar electrode using ordinary steel tie wires.

Question 10: A metal building frame connected to concrete-encased rebar by way of an approved hold-down bolt, is considered:

A: A grounding electrode.
B: A grounding electrode conductor.
C: An equipment grounding conductor.
D: A main bonding jumper.

Question 11: 250.94 Bonding for Communication Systems.

Question ID#: 1110.0



The same busbar can be used for power system and communication system bonding.

Section 250.94 addresses bonding for communication systems. Communications systems can now be bonded to the electrical system by connecting the communications conductors to a busbar.Â Â Communication systems can also still be bonded by using an intersystem bonding termination device (IBT).Â A new exception allows the intersystem bonding termination and the busbar to be omitted at a structure if communications systems are not likely to be used.

If a busbar is used to bond the communication system as allowed by 250.94(B) instead of an IBT, the busbar must be at least Â¼ in thick and 2 in. wide and long enough for at least three communication system connections in addition to the length needed for any other terminations. The busbar must be securely fastened and accessible.Â Unlike the IBT that is required to be specifically listed as grounding and bonding equipment, the busbar itself is not required to be listed, but connections to the communications bonding jumpers must be made by listed connectors. The requirements for this busbar are equivalent to those for a busbar used to interconnect bonding jumpers and grounding electrode conductors for the power system, except that exothermic welding is also allowed for the connections of the grounding electrode system.Â Since the requirements are essentially the same, and both are required to be accessible but not readily accessible, the same busbar could be used for both power system and communication system bonding.

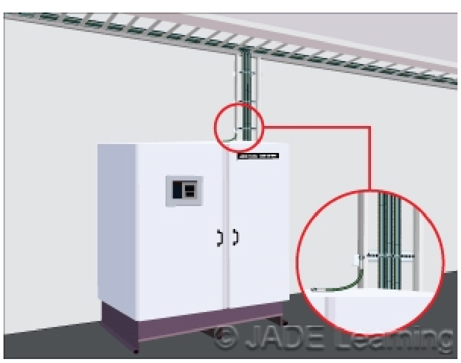
The new exception allows the busbar or intersystem bonding termination at a building to be omitted if communications systems are not likely to be installed at the structure For example, a service to a separate structure that is only used for a sign or a storage building and where there would be no telephone, CATV, antenna, or other communication system, neither the IBT nor the busbar would be required.Â

Question 11: Which of the following is a requirement for a busbar used for communications intersystem bonding terminations?

A: The busbar must be listed.
B: The busbar may only be used for communications bonding.
C: The busbar must be long enough for three communications bonding terminations in addition to any other terminations.
D: The busbar must be readily accessible.

Question 12: 250.122(F) Size of Equipment Grounding Conductors. Conductors in Parallel.

Question ID#: 1111.0



A raceway, gutter, or cable tray can be used as the equipment grounding conductor for multiconductor cables installed in parallel. This eliminates the need to install a wire-type equipment grounding conductor.

Section 250.122 of the NEC covers the sizing of equipment grounding conductors (EGC). 250.122(F) covers EGCs specifically installed to serve conductors in parallel, and it is divided into two subsections to clarify the difference between sizing EGCs run with individual conductors installed in parallel, versus sizing EGCs for multi-conductor cables installed in parallel.

The change provides for an alternative method of providing an EGC for multiconductor cables when they are installed in parallel within a single raceway, auxiliary gutter or cable tray. It also clarifies that sizing EGCs according to Table 250.122 applies only to wire-type equipment grounding conductors. Metal raceways, cable trays, and auxiliary gutters that meet applicable requirements are now recognized as equipment grounding conductors on their own, without wire-type equipment grounding conductors being installed.

A wire-type EGC is sized from T250.122 on the basis of the overcurrent protection device for that feeder or branch circuit. This size remains constant whether the installation is in a single raceway or cable tray utilizing one EGC. Or the installation is in multiple raceways with multiple EGCs. Also, new Code-language has been added that says that metallic raceways or auxiliary gutters that meet the requirements of 250.118, or cable trays that meet the requirements of 392.10(B)(1)(c) are permitted to be used as the EGC with or without the addition of an EGC of the wir- type.

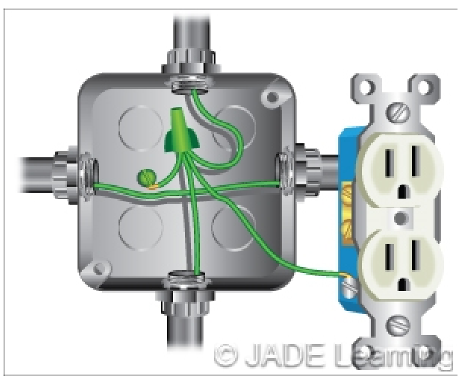
Similar requirements are in place for multiconductor cables as well, meaning the EGC must be sized per T250.122 for multiconductor cables. The difference with multiconductor cables is that the size of the EGC is typically predetermined by the cable manufacturer based on the anticipated rating of an overcurrent device for a ***single cable***. For that reason, when multiconductor cables are run together in parallel, the EGCs in the multiconductor cables are often insufficient, being smaller than the size required in Table 250.122. The new Code-change provides the electrician with two new options for providing a sufficiently sized EGC when the included EGCs within multiconductor cables grouped together in parallel, might otherwise be too small. First, if the multiconductor cables are paralleled in a single raceway, auxiliary gutter, or cable tray, a single EGC is permitted to be combined with the EGCs that are factory installed within the multiconductor cables. The separate EGC must be sized on the basis of Table 250.122, run with the multiconductor cables, and connected to all the EGCs in the multiconductor cables. The second option available is- if multiconductor cables are installed singly or in parallel in metal raceways or auxiliary gutters that meet the requirements of 250.118, or in cable trays that meet the requirements of 392.60(B), the raceway, gutter, or cable tray may be used as the EGC and no additional EGC of the wire-type is even required. The EGCs in each multiconductor cable are still required to be connected together, but they will not be required to meet the sizing requirements of Table 250.122.

Question 12:   When are the EGCs in multiconductor cables, when installed in parallel and in a single nonmetallic raceway, permitted to be sized smaller than the minimum EGC specified in Table 250.122?

A: When the multiconductor cables are installed in parallel.
B: When the EGCs in the paralleled multiconductor cables are connected together with a single EGC that is sized from Table 250.122.
C: When the raceway does not provide an EGC.
D: When the overcurrent device includes Ground Fault Protection for Equipment.

Question 13:   250.148 Continuity and Attachment of Equipment Grounding Conductors to Boxes.

Question ID#: 1112.0



All equipment grounding conductors must be bonded together, with devices that are suitable for the use.

Section 250.148 covers continuity and attachment of equipment grounding conductors to boxes. The wording of NEC Section 250.148 has been revised for clarity, but no changes have been made to the content.

When circuit conductors are spliced or terminated in a box, all of the equipment grounding conductors in the box must be bonded together. Â In addition, an equipment bonding jumper must be installed from the equipment grounds that are now bonded together, to a metal box, when metal is used.

Like in previous editions, an exception permits an isolated equipment grounding conductor connected to an isolated ground receptacle or simply passing through the box to not be connected to other equipment grounding conductors or to the box.

The wording of Section 250.148 in the 2014 NEC was unclear to some readers who interpreted the rule as only requiring equipment grounding conductors from the same circuit to be bonded together. The revised wording now makes it clear that all equipment grounding conductors must be bonded together, with the exception of isolated equipment grounding conductors.

It should be noted that when the circuit conductors pass through a box without being spliced or terminated, the equipment grounding conductors may also pass through unspliced or terminated. This does not do away with the requirement that the metal boxes must be grounded by some means, such as the use of a metal raceway system.

The connection to the box must be accomplished with devices that are â€œ***suitable for the use.***â€• Typical suitable devices include machine screws and grounding clips.Â Examples of devices that are not suitable include sheet metal screws or screws already being used to attach the box cover.Â

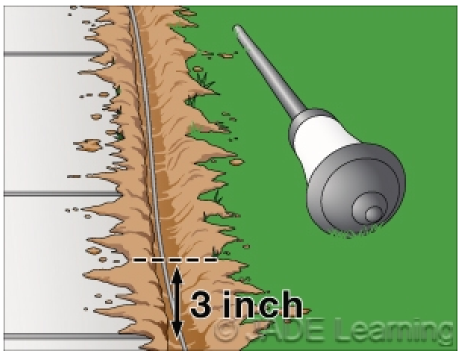
Question 13: Select the one statement that is true regarding a non-metallic box containing three sets of circuit conductors, each one having its own equipment grounding conductor. The ungrounded circuit conductors are all spliced within the box.

A: All equipment grounding conductors must be bonded together.
B: Equipment grounding conductors of different circuits are not required to be bonded together.
C: Because the box is non-metallic, none of the equipment grounding conductors need to be bonded to any other equipment grounding conductors.
D: All equipment grounding conductors must be bonded together and to the box.

Chapter 3

Question 14: Table 300.5 Minimum Cover Requirements, 0 to 1000 Volts, Nominal, Burial in Inches.

Question ID#: 1113.0



The wiring for low-voltage lighting systems can be buried less than 6 inches deep if the manufacturer of the low-voltage lighting system specifies a lessor depth is permitted in their installation instructions.

Table 300.5 provides the minimum cover requirements for circuits rated 1000 volts or less. Two footnotes were added to Table 300.5. The new footnotes apply to cover requirements for irrigation and low voltage lighting systems (30 volts or less) as noted in the top row of Column 5 of the table. They modify and expand the general requirement in Column 5 that requires a minimum cover of 6 inches for low voltage lighting circuits.

Footnote "a" now allows a cover of less than 6 inches "where specified in the installation instructions of a listed low-voltage lighting system". This change was necessary because some manufacturers of low voltage lighting systems provide cables with their systems that are listed for a burial depth of less than 6 inches. NEC Section 411.4 now requires low voltage lighting systems to be listed systems or assembled from listed component parts. If the manufacturer provided cables that were not listed for direct burial or listed for a burial depth of less than 6 inches there was a conflict. Without the new allowance the installer of the system could not satisfy both 110.3(B) "Listed or labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling," and the cover requirement of 6 inches given in Table 300.5. The new footnote now allows the installer to satisfy all requirements of the NEC for burial depth that apply to low voltage lighting systems.

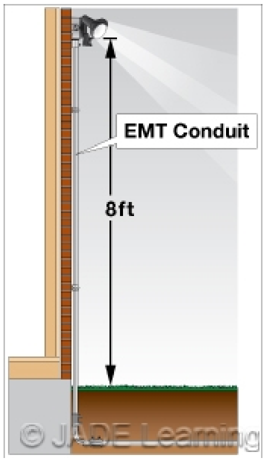
Footnote "b" was added to clarify that the 6 inch minimum cover requirement may also be used for "pool, spa, and fountain lighting installed in a nonmetallic raceway, limited to not more than 30 volts where part of a listed low-voltage lighting system." Since the heading of Column 5 did not state it could be used for pool, spa, and fountain wiring it was unclear if it applied to those areas. Some AHJ's were requiring a burial depth of 18 inches based on the cover requirements for nonmetallic raceways in Column 3. It is important to note that low voltage circuits supplying pool, spa, and fountain lighting must be installed in a nonmetallic raceway and must be part of a listed low voltage lighting system (not an assembly of components) The requirements for low voltage luminaires in Article 680, Swimming Pools, Fountains, and Similar Installations also apply.

Question 14: Which one of the following would allow for low-voltage lighting circuits to be covered by less than 6 inches?

A: If the system is rated 30 volts or less.
B: If the system is installed in residential areas.
C: If the system is listed for less than 6 inches of cover.
D: If the system is wired in UF cable.

Question 15: 300.5(D)(4) Protection from Damage. Enclosure or Raceway Damage.

Question ID#: 1114.0



EMT can now be used to protect conductors from physical damage.

EMT has been added to the list of approved raceways for protecting direct-buried conductors and cables emerging from grade. EMT provides an acceptable degree of protection in locations that are not subject to severe physical damage. For example, EMT should not be used next to a parking space where it may be subject to vehicle impact. Additional corrosion protection may also be required where EMT is used in direct contact with the earth.

Direct buried conductors and cables, such as Type UF cable, emerging from the earth must be protected to a point at least 8 ft. above grade. The EMT or other approved raceway must also extend below grade to a depth of 18 in. or the depth required by Table 300.5, whichever is less. For example, a GFCI protected residential branch circuit protected at 20 amperes or less only requires protection to a depth of 12 inches in most locations so the physical protection need only extend 12 inches below grade. Where 24 inches of cover is required, such as in a commercial parking lot, the physical protection must extend at least 18 inches below finished grade. A bushing or terminal fitting is required where the underground conductors emerge from the conduit to protect the cable from damage.

Supplementary corrosion protection may be required where the EMT is in direct contact with the earth. Soil conditions vary widely, wet or acidic soils may cause rapid corrosion of galvanized steel EMT. Â EMT is permitted for use in direct contact with the earth when corrosion protection is suitable for the conditions. According to the UL Whitebook, listed steel EMT installed in direct contact with the earth generally requires supplementary corrosion protection. Steel EMT is especially subject to corrosion where emerging from concrete underground or where emerging from concrete into salt air environments. Aluminum EMT in direct contact with the earth or in concrete always requires supplementary corrosion protection in accordance with 358.10(B)(2).

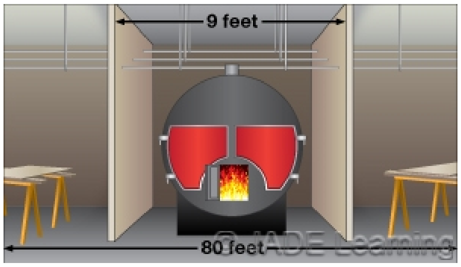
Supplementary corrosion protection may be provided by bitumastic coatings, zinc-rich paints or other approved methods. Special tapes and shrink wraps are also available. The authority having jurisdiction has the final say in the type of supplementary corrosion protection required based on local conditions.Â

Question 15: Type UF cable is installed in EMT on the side of a wooden light pole. How far above grade must the EMT extend?

A: 18 in.
B: 3 ft.
C: 8 ft.
D: 10 ft.

Question 16: 310.15(A)(2) Ex. Ampacities For Conductors Rated 0 - 2000 Volts. Selection of Ampacity.

Question ID#: 1115.0



If 10 feet, or 10% of the total conductor length pass through an area with temperatures above 86Â°F, the ampacity of all of the conductors in the circuit must be adjusted for the hot ambient temperature.

The ambient temperature surrounding a conductor can affect the ampacity of the conductor. In general, as the ambient temperature goes up, the ampacity of a conductor goes down. The ampacity values for conductors in Table 310.15(B)(16) are based on an ambient temperature of 30'C (86'F). For ambient temperatures other than 86'F, the conductor ampacities in the table must be adjusted using the temperature correction factors in Table 310.15(B)(2)(a).

There is an exception under 310.15(A)(2) to the general rule. The exception applies to a circuit that passes through multiple ambient temperatures. The general rule is that if a circuit passes through multiple ambient temperatures, the entire circuit ampacity must be reduced based on the highest ambient temperature it passes through. However, if the length of conductor exposed to the higher ambient temperature is limited in its length, it is not required to be reduced based on that higher temperature.

The exception addresses situations where the part of the circuit passing through the higher ambient is so short that it will have little effect on the current carrying capacity of the conductors making up the circuit. The 2014 NEC said that this exception only applied to ***"adjacent portions of a circuit"***, the 2017 NEC has replaced that phrase with ***"total portions of the circuit".*** It is the total portion of the circuit passing through the high ambient temp that must be considered now, and not just the adjacent portions of the circuit. These conductors may pass through several different ambient temperature zones, that are above 86'F. In this case, the total length of circuit exposed to the different ambient temperature zones (above 86'F) must not exceed 10 feet, or 10% of the entire length of the circuit. If the sum of the different exposed areas of the circuit add up to a length greater than 10' or greater than 10% of the circuit length, then the entire circuit ampacity must be derated based on the highest temperature zone that the circuit passes through.

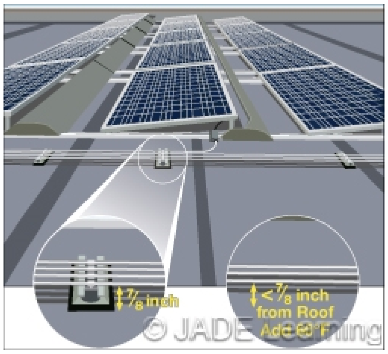
Example: A circuit is 80 feet long. Nine feet of that circuit passes through a higher ambient temperature than the rest of the circuit. The ampacity of all of the circuit conductors would have to be based on that higher ambient temperature. Even though less than 10 feet of the circuit passes through the higher temperature, the 10% rule found in the exception, still has been exceeded. 10% of 80 ft. is 8 ft. (80 ft. x 0.10 = 8 ft.). Therefore the entire circuit ampacity must be derated based on the higher temperature zone that the 9 ft. portion of the circuit conductors is exposed to.

Question 16: A conduit run is 75 feet in length. Part of it runs through a higher ambient temperature than the rest of the run. The ampacity of the entire length of conductors would have to be based on the higher ambient temperature, if the portion of the circuit passing through the higher ambient temperature is any greater than ____________ feet in length. (Your math here should be based on 75 feet)

A: 3.
B: 5.
C: 7 1/2.
D: 7.

Question 17: 310.15(B)(3)(c) Tables. Adjustment Factors. Raceways and Cables Exposed to Sunlight on Rooftops.

Question ID#: 1116.0



The method used to make a temperature correction adjustment to the ampacity of conductors installed on a rooftop has been changed.

Studies have shown that the heat build-up in conductors within raceways and cables exposed to direct sunlight on rooftops is not as damaging to conductor insulation as once thought. Table 310.15(B)(3)(c) that required additional ambient temperature adjustment based on the distance above the rooftop has been removed from the NEC. A new simplified method for adjusting conductor ampacities where cables or raceways are installed on or above rooftops exposed to direct sunlight.

Specifically, the 2017 NEC requires that raceways and cables be installed a minimum distance of 7/8 of an inch above the rooftop. The distance is measured from the roof surface to the bottom of the raceway or cable. If the cables or raceways meet the 7/8 of an inch requirement, it is not required to include a temperature adder when calculating the allowable ampacity of the installed conductors.

Where it is not possible to maintain a minimum distance of 7/8 of an inch above the roof surface, the ambient temperature must be increased by 33Â°C (60Â°F) for ampacity adjustment purposes.

Example: Three No. 4 copper THW conductors are installed in a raceway outdoors directly on a rooftop exposed to direct sunlight. The ambient outdoor temperature maximum is 98Â° F. Because the raceway is directly on the rooftop, 60Â°F must be added to the 98Â°F ambient for derating purposes. (98Â° + 60Â° = 158Â°) The derating factor from Table 310.15(B)(2)(a) for 158Â°F is 33%.

The ampacity of a No. 4 copper THW from table 310.15(B)(16) is 85 Amps. (85 Amps x .33 = 28 Amps). The ampacity of the No. 4 copper THW conductors under those conditions of use is 28 amps.

If the raceway was installed with a clearance of at least 7/8 of an inch above the rooftop the derating factor would be based on an ambient of 98Â°F with no 60Â°F increase required. The ampacity adjustment factor from table 310.15(B)(2)(a) would be 88%. 85 Amps x .88 = 74.8 Amps.

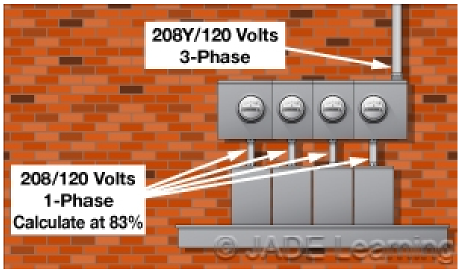
The elimination of Table 310.15(B)(3)(c) results in a much simpler process for determining conductor ampacity in raceways and cables on rooftops. There should be few instances where the 7/8 inch distance from a raceway or cable to the roof surface cannot be maintained.

Question 17: Unless 33'C is added to the ambient temperature for ampacity adjustment, the NEC requires that raceways on rooftops exposed to direct sunlight be raised a minimum of ____ above the rooftop.

A: 3 inches.
B: 1/2 inch.
C: 4 inches.
D: 7/8 inch.

Question 18: 310.15(B)(7) Tables. Single-Phase Dwelling Services and Feeders.

Question ID#: 1117.0



If a single-phase dwelling feeder is supplied by a 120/208 3-phase system, the single-phase ungrounded conductors can be calculated at 83% of the dwelling load.

The conductor size for ungrounded single-phase dwelling services and feeders that are supplied by a three-wire feeder from a 208Y/120 volt, three phase system, can now be calculated at 83% of the dwelling load, just like services and feeders supplied by a 240/120-volt system. In order to qualify for this reduced conductor sizing, the service or feeder must carry 100% of the load for the dwelling and the service or feeder must be rated between 100 and 400 amperes.

This change can be widely applied when installing feeders to individual apartments in an apartment complex that is supplied by a 208Y/120-volt system. In the 2014 NEC, a feeder consisting of two ungrounded conductors and the neutral supplying a single apartment from a three-phase, 208Y/120-volt system would have to be selected from Table 310.15(B)(16). Under the 2014 rules, the minimum size for 75'C rated aluminum ungrounded conductors supplying a dwelling with a total connected load of 100 amperes was a No. 1 AWG. In the 2017 NEC, the ampacity of the two ungrounded feeder conductors can be adjusted to 83% of the calculated load on the dwelling unit. The minimum ampacity of a feeder rated 100 Amps is 83 Amps (100 X 0.83 = 83 Amps). A 75'C rated No. 2 AWG aluminum conductor can be used for the ungrounded conductors. A 200 Amp feeder that carries the entire load of a dwelling unit could be installed using conductors with an ampacity of only 166 Amps. (200 x .83 = 166).

If the feeder is supplied from a 208Y/120 Volt system the grounded conductor is not allowed to be smaller than the ungrounded conductors like it is for a 240/120 volt feeder. With a 240/120 volt system the currents on line "A" and line "B" are 180 degrees out of phase. If the current on line "A" is 75 amps and the current on line "B" is 75 amps, the neutral current will be 0 amps. With a single phase feeder taken from a 208Y/120 Volt system the currents on line "A" and "B" are 120 degrees out of phase. If the current on line "A" is 75 amps and the current on line "B" is 75 amps, the neutral current will also be 75 amps. Therefore, reducing the neutral beyond the reduction of 83%, is not allowed when that neutral is part of a feeder taken from a 208Y/120 Volt system.

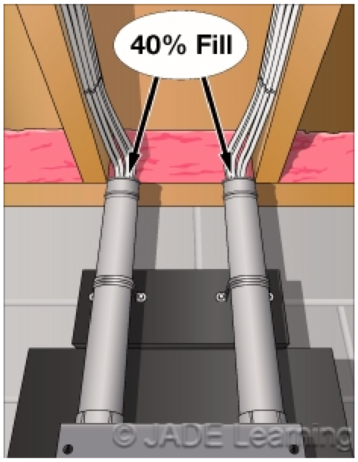
When performing calculations, don't forget NEC 220.5(B) that says it is permissible to round up to the nearest whole number any fraction(s) greater than .5. You can then omit fractions that are less.

Question 18:   A 208Y/120-volt three-wire feeder serves an individual apartment unit inside a multi-unit building. The individual apartment unit is equipped with a 100 amp load center and its feeder carries 100% of the load for that individual apartment unit. What is the minimum ampacity rating allowed for the feeder conductors serving that individual apartment?

A: 100 Amps.
B: 80 Amps.
C: 125 Amps.
D: 83 Amps.

Question 19: 312.5(C) Exception. Cabinets, Cutout Boxes, and Meter Socket Enclosures. Cables.

Question ID#: 1118.0



Conduit installed above a cabinet used to protect conductors entering the cabinet cannot be filled to more than 40% of its square inch area.

If a non-flexible raceway extends above a surface mounted enclosure, such as when a conduit above a cabinet is used to protect NM cables entering the cabinet, the fill percentages in Table 1 of Chapter 9 will apply. The fill percentages in Table 1 of Chapter 9 are 40% for more than 2 conductors, 31% for 2 conductors, and 53% for 1 conductor.

A sentence has been added to the exception under Section 312.5(C) that makes it clear that the fill percentages in Table 1, Chapter 9 will apply, even though the conduit used to protect the cables is not a complete conduit or tubing system.

There was a conflict between 312.5(C) and Note 2 to Table 1 in Chapter 9. Note 2 said the fill percentages in Table 1 only applied to complete conduit or tubing systems and did not apply to sections of conduit and tubing installed only to protect exposed wiring from physical damage. For example, where direct buried Type UF cables emerge from grade, physical protection is required to a height of 8 ft.

The exception to Section 312.5 describes a situation where cables with entirely nonmetallic sheaths, such as Type NM or UF cables, enter an enclosure through a non-flexible raceway. The cable sheath is not secured to the enclosure by a connector as is typically required. The exception includes 7 conditions that must be met. The length of the raceway must not be less than 18 in. or more than 10 ft. The raceway is also not permitted to penetrate a structural ceiling. Since the raceway(s) are not a complete conduit system and provide physical protection for the nonmetallic cables there was disagreement over whether Note 2 applied.

A new sentence added to condition 7 in the exception to 312.5(C) resolves the conflict with Note 2. The last sentence in condition 7 states, "***Note 2 to the tables in Chapter 9 does not apply"***. This means the fill percentages in Table 1, Chapter 9 must be used when nonmetallic cables enter a surface mounted enclosure through nonflexible raceways

For example, if the inside area of a conduit installed above an enclosure was 1.5 square inches, and there were more than 2 cables, the cables pulled into the conduit could not take up more than .6 sq. in. (1.5 sq. in x 40% = .6 sq. in.).

Question 19: When using an 8 foot raceway to protect NM cables coming out of the top of a cabinet, which of the following is true?

A: No maximum fill percentage applies.
B: The fill is limited to the percentages given in Table 1 of Chapter 9.
C: A 60 percent fill is allowed.
D: Note 2 for the tables in Chapter 9 applies.

Question 20: Table 312.6(A) Minimum Wire-Bending Space at Terminals and Minimum Width of Wiring Gutters.

Question ID#: 1119.0

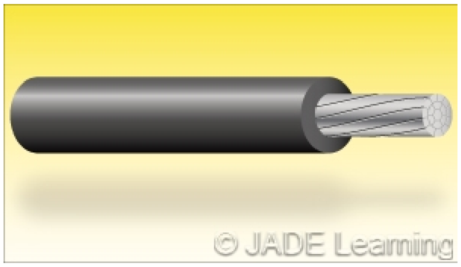


Table 312.6(A) includes wire bending space for compact stranded aluminum conductors.

A new column addressing ***Compact Stranded AA-8000 Aluminum Alloy conductors*** has been added to NEC Table 312.6(A).

Table 312.6(A) gives the minimum wire bending space needed for conductors that enter/exit an enclosure through a wall NOT opposite the terminals where they terminate.

(Note: When conductors enter/exit an enclosure through a wall that IS opposite the terminals where they terminate, that means the wires can essentially travel in a straight line, exiting the knockout without having to be bent to any major degree.)

Example of Table 312.6(A)

For example, standard 400 kcmil copper conductors enter through a knockout at the BOTTOM of a panelboard, but they terminate onto a main breaker located at the TOP of the interior of the panelboard. Since the conductors enter the bottom of the box and have to be bent to go around the panel "guts" to reach the circuit breaker terminals at the top, Table 312.6(A) applies. This is a scenario where the 400 kcmil conductors do not enter/exit the panelboard through a wall opposite of the circuit breaker terminals where they are landed.

NOTE: You will find that the bending spaces listed in Table 312.6(A) ***for a wall NOT opposite the terminals*** is LESS than the spaces listed in Table 312.6(B) ***where the wall IS opposite the terminals.***

This is because less space is needed to bend the wiring (to send elsewhere for termination in the enclosure) to a near 90 degree angle as soon as it enters the enclosure, versus immediately terminating the wires onto lugs/screws located on the same side where the wires just entered the enclosure.

New Column in the 2017 NEC

The newly added column for Compact Stranded AA-8000 Aluminum Alloy Conductors has been added to Table 312.6(A) and it provides a reduced wire-bending space where compact stranded aluminum conductors are used, versus all other conductors listed in the Table. You will notice the minimum wire-bending space for a 400 kcmil compact aluminum conductor from the new column is 5 inches, instead of the 6 inches required for other 400 kcmil conductors. Table 312.6(A) in the 2014 NEC made no distinction between these compact aluminum conductors and other conductors.

The wire bending space(s) listed in the new column are less than those for equivalent size wires in the rest of the Table because of the increased flexibility of these specific conductors. For example, a 3/0 copper conductor that leaves the enclosure through a wall NOT opposite the terminal and having only one wire per terminal requires a wire bending space of 4 inches but a 3/0 Compact Stranded AA-8000 Aluminum Alloy conductor requires only 3 1/2 inches. (See Table 312.6(A)). The wire bending space is measured in the direction that the wire leaves the terminal.

Table 312.6(A) also gives minimum wiring "gutter" widths. The new column for compact aluminum conductors does not apply to the minimum width of the wiring gutter within the enclosure. A new Note 2 clarifies that the minimum width of wiring gutters must adhere to the "***all other conductor values***" from the Table no matter what the conductor is made of.

Table 312.6(B)

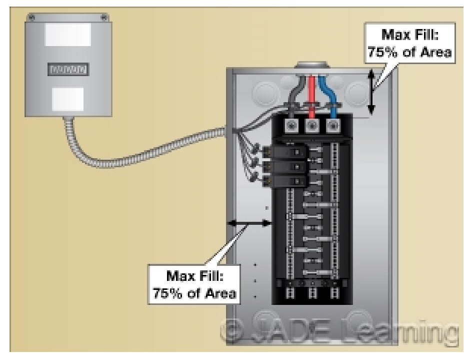
The other Table in 312.6, Table 312.6(B), applies to when the conductor enters/exits the enclosure through a wall that IS opposite the terminal. The 2014 NEC already had a separate column for Compact Stranded AA-8000 Aluminum Alloy Conductors in Table 312.6(B). This change brings Table 312.6(A) into alignment with Table 312.6(B).

Question 20: How much wire-bending space is needed when a 250 kcmil Compact Stranded AA-8000 Aluminum Alloy conductor enters/exits the enclosure through a wall NOT opposite the terminal where the wire terminates? (Note: There is only one wire per terminal).

A: 4 inches.
B: 4 1/2 inches.
C: 3 1/2 inches.
D: 5 inches.

Question 21: 312.8 Switch and Overcurrent Device Enclosures.

Question ID#: 1120.0



Power monitoring equipment can be installed in cabinets, cutout boxes, and meter sockets. Conductors, splices, taps, and equipment cannot take up more than 75% of the wiring space.

NEC Section 312.8 has been expanded to include the minimum space requirements for ***"Power Monitoring Equipment".*** The 2014 NEC addressed space requirements for "***Splices, Taps, and Feed-Through Conductors"*** but not power monitoring equipment.

The space requirements in this Section have been broken down into two new paragraphs. NEC Section 312.8(A) and (B). Section 312.8(A) covers space requirements for ***"Splices, Taps, and Feed-Through Conductors"*** - these are the same as they were in the 2014 NEC, they are simply in a separate paragraph.

NEC Section 312.8(A)

The requirements in 312.8(A) for using space inside switch and overcurrent device enclosures for electrical splices, taps, and feed-through conductors are:

(1) The total of all conductors installed at any cross section of the wiring space does not exceed 40 percent of the cross-sectional area of that space.

(2) The total area of all conductors, splices, and taps installed at any cross section of the wiring space does not exceed 75 percent of the cross-sectional area of that space.

(3) A warning label complying with 110.21(B) is applied to the enclosure that identifies the closest disconnecting means for any feed-through conductors.

NEC Section 312.8(B)

NEC Section 312.8(B) provides the wiring space requirements for "***Power Monitoring Equipment".*** There are two conditions that must be met if power monitoring equipment is to be installed inside enclosures meant for switches or overcurrent devices.

The first condition given in 312.8(B) states that the ***"power monitoring equipment is identified as a field installable accessory as part of the listed equipment, or is a listed kit evaluated for field installation in switch or overcurrent device enclosures".*** The second condition given in 312.8(B)(2) is that not more than 75% of the cross sectional area of the space may be taken up by the sum total of ***"conductors, splices, taps, and equipment".***

It is very important that the power monitoring equipment meet these two conditions. Unlisted equipment or kits have not been tested or evaluated by a third-party testing agency. If the equipment overheats or fails, conductors within the same wiring space may be damaged. In all cases the total area of the power monitoring equipment plus any other conductors, splices, or taps must not exceed 75% of the cross-sectional area of the wire gutter space within the enclosure.

Question 21: Power Monitoring Equipment may be installed inside enclosures meant for switches and overcurrent devices provided the equipment meets which one of the following requirements?

A: Must be UL Listed.
B: Must be factory installed.
C: Must be a listed kit evaluated for field installation.
D: Must be marked with its short circuit current rating.

Question 22: 314.16(A) Number of Conductors in Outlet, Device, Junction Boxes, and Conduit Bodies. Box Volume Calculations.

Question ID#: 1121.0

Section 314.16(A) of the NEC now requires the volume taken up by barriers installed in a box to be considered when doing a box fill calculation. Barriers are typically installed to separate circuits of different voltages. Installing a barrier in a box leaves less volume for other wiring components in the box but the added space for the barrier was not considered before.

The volume taken up by barriers installed in a box must be included when calculating box fill.

Each metal barrier not marked with its volume must be considered to take up 8.2 cm3 (1/2 in3) of volume and each nonmetallic barrier not marked with its volume must be considered to take up 16.4 cm3 (1.0 in3) of volume. The volume taken up by the barriers must be divided equally between each of the resulting spaces.

Example 1: A square box has a volume of 30.3 in3. A metal barrier inserted into the box creates two equal separate spaces. The volume of each space would be one half of the original 30.3 in3 minus one half of the 1/2 in3 volume taken up by the barrier.
30.3 in3 Ã· 2 = 15.15 in3   15.15 in3 - .25 in3 = ***14.9 in3***

Each section of the box has 14.9 in3 of usable volume. The box fill calculation would then be performed for each box section by deducting the volume allowances required by 314.16(B) from the 14.9 in3 box volume. For example, each No. 14 AWG conductor entering the box would require a volume of 2 in3.

Example 2: A three gang box has 42 in3 of volume. Two nonmetallic dividers are installed to create three separate spaces. The volume of one of the outside spaces is 1/3 of the 42 in3 volume minus 1/2 of the volume taken up by one of the dividers. 1/3 x 42 in3 = 14 in3   14 in3 - .5 in3 = ***13.5 in3***

The volume of the middle space is 1/3 of the 42 in3 volume minus the volume taken up by one whole divider (1/2 of a divider on each side).

1/3 x 42 in3 = 14 in3   14 in3 - 1.0 in3 = ***13 in3***

If the barrier to be installed is marked with its volume in cubic inches (in3) the volume marked on the barrier must be used.

Question 22: How much volume must be considered for a metal barrier not marked with its volume?

A: 1/2 in³.
B: 1.0 in³.
C: 1/4 in³.
D: 3/4 in³.

Question 23: 314.17(B) Conductors Entering Boxes, Conduit Bodies, or Fittings. Metal Boxes and Conduit Bodies.

Question ID#: 1122.0

The sheaths of nonmetallic cable must extend at least 1/4 inch into a metal box and beyond any cable clamp.

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The sheaths of nonmetallic-sheathed cable and multiconductor type UF cable entering a metal box or conduit body must extend at least 1/4 inch into the box and beyond any cable clamp. This requirement has been clear in previous editions of the NEC for nonmetallic boxes and conduit bodies but there was no requirement for the cable sheath to extend beyond the cable clamp in metal boxes or conduit bodies. This change will assure that the insulated conductors in cables are protected from damage caused by the cable clamp where the conductors enter metal boxes. Extending the sheath past the clamp will also make it easier to confirm that the cable is properly installed within the clamp.

When installing nonmetallic-sheathed cable into a metal box the cable is required to be secured to the box. This ensures that individual conductors are not pushed out of the box when a receptacle or other device is installed. Cables are typically secured by using a cable clamp which is located inside the box or a cable connector which is located outside the box. The new wording in 314.17(B) now makes it clear that the sheath must extend not only a minimum of 1/4 inch into the box but also beyond the cable clamp if one is used.

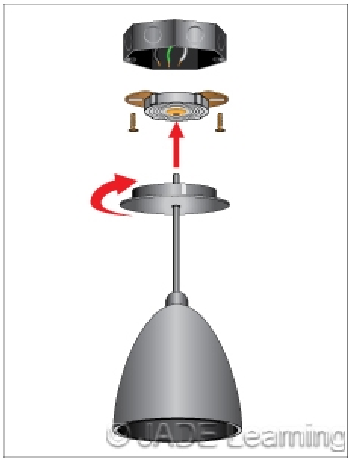
Nonmetallic sheathed cable installed in a nonmetallic box must also be secured to the box as a general rule. There is one exception for single gang nonmetallic boxes that are not larger than 4 inches by 2 1/4 inches. If the cable is securely fastened within 8 inches of the box it is not required to be secured to the box. The 8 inch distance is measured along the cable sheath. The sheath of the cable must still extend at least 1/4 inch into the box.

Question 23: How far into the box must the sheath of Nonmetallic Sheathed Cable extend when entering a metal box with cable clamps inside the box?

A: at least Â½ inch beyond the cable clamp.Â
B: at least 3/8 inch into the box and beyond the cable clamp.
C: at least 1/8 inch into the box.
D: at least Â¼ inch into the box and beyond the cable clamp.

Question 24: 314.27(E) Outlet Boxes. Separable Attachment Fittings.

Question ID#: 1123.0



A separable attachment fitting is a listed assembly that allows electrical utilization equipment to quickly connect to a contact device.

A new type of connection is now permitted at outlet boxes. These "Separable Attachment Fittings" are a pin and sleeve type connection that can be used to attach luminaires or ceiling fans to outlet boxes. The mounting support for the luminaire is installed in the ceiling outlet box, and then a mating attachment fitting is made into the luminaire or fan assembly. The luminaire or fan is then attached to the outlet box with a twist-locking mechanism that ensures both adequate support, as well as a firm connection to the electrical connection portion. A ***listed*** (such as UL) locking support and mounting receptacle (electrical connection) must be used with compatible attachment fittings to ensure the equipment is securely supported.

The "listed" combination of receptacle and separable attachment fitting must be identified for use (such as a label or etching), and must installed within the weight limits of the listing for that assembly. Also, be aware that if the supporting receptacle is installed inside of the outlet box, it along with the conductors must be included in the box fill calculation for that outlet box. (See NEC 314 for Additional Box Fill Calculation Information)

The definition of a "receptacle" in Article 100 has been revised to recognize the type of receptacle used with these twist-locking luminaire and fan fittings. A receptacle is a contact device installed at the outlet for the connection of an attachment plug, ***or for the direct connection of electrical utilization equipment designed to mate with the corresponding contact device.***

The new way of attaching luminaires or ceiling fans to ceiling boxes with separable attachment fittings will simplify the final trim out. With the receptacle wired into the outlet box, the luminaire or fan can be installed quickly and easily. Connecting luminaires in this manner will also enable maintenance staff to quickly replace a luminaire when needed. With the increasing use of light weight LED luminaires, the use of separable attachment fittings will also likely increase.

Question 24: Which of the following is a requirement for a Separable Attachment Fittings used with a box to support a luminaire?

A: Separable attachment fittings must be approved for at least 50 pounds.
B: Separable attachment fittings must be of the locking type.
C: Separable attachment fittings may not be used in dwelling units.
D: Separable attachment fittings may be used with metallic boxes only.

Question 25: 314.28(A)(3) Pull and Junction Boxes and Conduit Bodies. Minimum Size. Smaller Dimensions.

Question ID#: 1124.0

Listed boxes or listed conduit bodies used for conductors sized No. 6 and smaller are required to have adequate internal volume.Â Listed boxes or listed conduit bodies used for conductors sized No. 4 and larger are required by 314.28(A)(1) and (2) to be selected based on the size of the conduit used and whether a straight pull or angle pull is made. Section 314.28(A)(1) requires that the length of a box or conduit body in a straight pull be not less than eight times the trade size of the largest raceway. For example, if a 2 inch trade size raceway is used with a C-type conduit body in a straight pull the minimum width of the conduit body is 16 inches (8 X 2 in. = 16 in.) Listed boxes or conduit bodies with smaller internal dimensions than are normally required are permitted if they are permanently marked for the maximum number and maximum size of the conductors.

The total cross-sectional area of a conduit body can be used to determine the size and combinations of conductors that are permitted in the conduit body or box.

For example, a listed 3 inch conduit body is marked with a maximum capacity of five, 300 kcmil conductors. The dimensions of the conduit body have been evaluated by the testing laboratory and found to meet the necessary wire-bending space for this combination of conductors. Â What if a different combination of conductors is needed?Â Will the same 3 inch conduit body be acceptable for six, 250 kcmil conductors?

The 2017 NEC provides a way to determine a different combination of conductors than what is marked on the box or conduit body. Different sizes and combinations of conductors can be used if the total cross-sectional area of the fill does not exceed the total cross-sectional area of the conductor combination that is marked on the conduit body or box.Â An informational note says the product standards are based on conductors with Type XHHW insulation unless otherwise specified.

In Chapter 9 Table 5, the cross-sectional area on a 300 kcmil XHHW conductor is 0.4536 in2. The area of five, 300 kcmil XHHW conductors is 2.268 sq.in2 (5 X 0.4536 = 2.268).Â Any combination of conductors with a total cross-sectional area no greater than 2.268 in2 permitted. The area of a single 250 kcmil XHHW conductor is 0.3904 in2. If six, 250 kcmil conductors are installed the total cross-sectional area for all conductors is 2.3424 in2.
The total cross-sectional area of the six 250 kcmil conductors is greater than the cross-sectional area of the five 300 kcmil conductors. A larger conduit body is required.

Another example: Determine if a conduit body marked as suitable for three 4/0 conductors will work for four, 2/0 THHN conductors.

Calculate the total area of the three 4/0 conductors. Per the new informational note the calculation is based on Type XHHW Insulation.

From Table 5 Ch. 9 â€“ a 4/0 XHHW has an area of 0.3197 in2
3 x 0.3197 = 0.9591 in2
From Table 5 Ch. 9 - a 2/0 THHN has an area of 0.2223 in2
4 x 0.2223 = 0.8892 in2
Therefore, the conduit body could be used for three, 4/0 XHHW or four, 2/0 THHN conductors.

Question 25: A 3 inch conduit body is marked as being suitable for three 1/0 conductors. Those markings are based on what insulation type?

A: TW.
B: THW.
C: THHN.
D: XHHW.

Question 26: 320.6 Armored Cable: Type AC. Listing Requirements.

Question ID#: 1125.0

Type AC cable and the fittings for AC cable must be listed.

New NEC Section 320.6 now requires Type AC Armored Cable and associated fittings to be listed. Although Type AC cable and fittings manufactured in the United States were typically listed and labeled, previous editions of the NEC had no specific listing requirement for Type AC Cable or its associated fittings.

Several other types of cable wiring methods are also required to be listed in the 2017 NEC and AC cable is just one of them. Other popular cable wiring methods that are now required to be listed include MC Cable, NM Cable, SE Cable and UF Cable.

Past editions of the NEC required certain wiring methods to be listed but not the fittings associated with them. The 2017 NEC now requires that all cable wiring methods and the fittings associated with them are to be listed, except for Integrated Gas Spacer Cable.

Listed products have been tested by a third-party testing agency and found to comply with designated product standards. The testing agency publishes a list of products that have met the standards. Listed products will also usually be marked with a label. The means of identifying listed products vary based on the testing agency and the type of product. Small products may have the listing information provided on the box or container. Type AC cable is typically identified by a manufacturer's tag on the cable roll or reel.

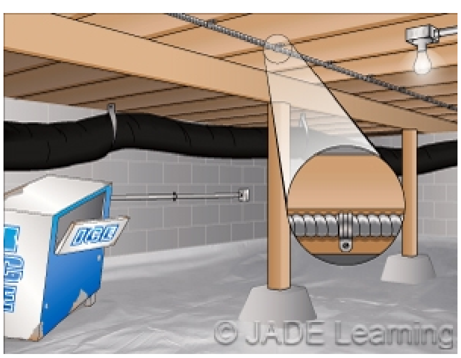
Part of the listing requirements for AC Cable is that the appropriate types of fittings are used with the cable. It is a common code violation to use a fitting suitable for one type of cable with a cable of another type. For example, a cable clamp listed for use with NM cable only should not be used with Type AC cable. In addition NEC Section 110.3(b) requires that equipment must be installed and used in accordance with any instructions included in its listing or labeling if it has been listed.

Question 26: When must Type AC Cable be listed?

A: Only when used in dwelling units.
B: Only when used in non-dwelling units.
C: When used in any occupancy.
D: When used for direct burial.

Question 27: 330.15 Metal-Clad Cable: Type MC. Exposed Work.

Question ID#: 1126.0



Exposed runs of MC Cable must closely follow the surface of the building finish or of running boards.

New section, 330.15 describes the requirements for protecting Metal Clad Cable (MC) when the cable is installed as an exposed wiring method. The requirements given in the new section are identical to those in NEC section 320.15 for Armored Cable (AC).

Existing section 330.10(4) allows MC Cable to be used as an exposed wiring method, but existing section 330.12(1) does not allow it to be installed where ***"*** subject to physical damage***".***

The new section now gives more specific requirements for installing MC Cable when it is exposed, just as NEC Section 320.15 gives specific requirements for installing AC Cable when it is exposed. Since AC Cable and MC Cable are very similar cable wiring methods it is reasonable that they would both have the same protection requirements when installed exposed.

Exposed runs of MC Cable must ***closely follow the surface of the building finish or of running boards.*** Exposed runs may be located on the underside of joists.

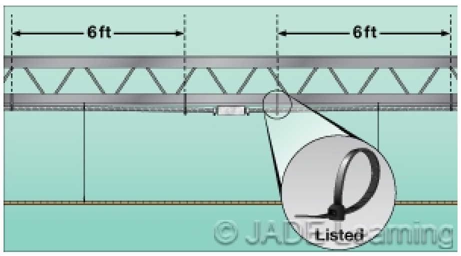
There is no minimum size given for Type MC cable installed on joists, but the cable must be supported at each joist and protected from physical damage. Type MC cable installed in accessible attics or roof spaces must still meet the requirements in 320.23 for Type AC cables.

Question 27:   MC Cable run exposed on the underside of floor joists must be supported:

A: Every 4 1/2 feet.
B: Every 24 inches.
C: At every joist.
D: Every other joist.

Question 28:   330.30(A) Metal-Clad Cable: Type MC. Securing and Supporting. General.

Question ID#: 1127.0



Cable ties used to support MC cable must be listed and identified for securement and support.

Cable ties used to support MC Cable must now be ***listed and identified for securement and support***.

While the 2014 NEC did allow the use of cable ties to secure and support MC Cable, there was no requirement that they be listed for that purpose. Many of the cable ties available today are not listed and are of very low quality. Some of them can be broken or pulled apart with little force. The requirement that they be listed and identified will assure that cable ties of adequate strength and design will be installed. In most applications Type MC cable must be supported and secured at intervals not exceeding 6 ft. MC cables containing not more than four No. 10 AWG conductors must be secured within 12 inches of every box, cabinet, fitting, or cable termination. If cable ties are used they must be listed and identified for securement and support.

Listed means that the cable ties have been tested and found to comply with the appropriate standards. The cable ties will also have to be identified to indicate they are suitable for securing and supporting cable assemblies. This could be by molded printing on the cable tie or other means that indicate the cable tie can be used for cable support. The same listed and identified requirement has been added to NEC Article 334.30 for securing and supporting Nonmetallic-Sheathed Cable. Only cable ties that are listed and identified may be used for supporting NM Cable.

Nonmetallic cable ties used to secure Type MC cable in an above ceiling space that is used as a plenum or other spaces used for environmental air must be also be listed as having low smoke and heat release properties in accordance with section 300.22(C).

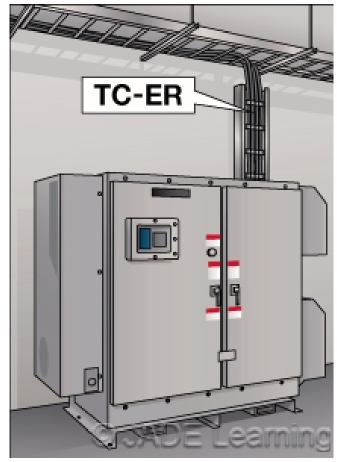
Other methods allowed for securing and supporting MC Cable include staples, straps, hangers, similar fittings, and other approved means. There are a variety of support devices available which are made specifically for the support of cables. Other types of support devices may be used if they are "approved***".***

Question 28:   MC Cable may be supported with cable ties provided the cable ties are:

A: Labeled.
B: Plenum Rated.
C: Listed and identified.
D: Listed.

Question 29: 336.10 Power and Control Tray Cable: Type TC. Uses Permitted.

Question ID#: 1128.0



The permitted uses for Type TC cable have been revised.

Extensive revisions and additions were made to section 336.10 which lists the uses permitted for Type TC Cable.

Type TC cable is a factory assembly of two or more insulated conductors, with or without associated bare or covered grounding conductors, under a nonmetallic jacket. Type TC cable and associated fittings must be listed. Type TC cable may be used for power, lighting, control, and signaling circuits.

Here is a summary of the changes to 336.10:

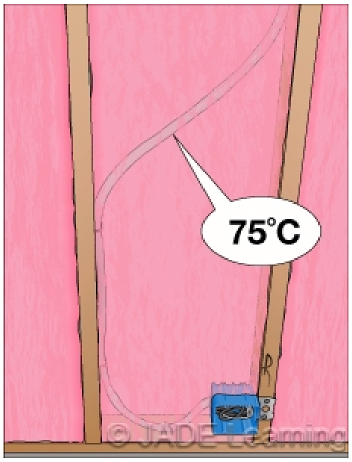
- Type TC cable can be used in cable trays where there is a gap between sections of not more than 1 ft. It is not unusual for there to sections of cable tray separated by short gaps. Type TC cable is permitted to be unsupported where the gap between sections is no more than 1 ft.
- Type TC-ER (ER is for "exposed run") cable can be used in industrial locations between a cable tray and the utilization equipment if continuously supported and secured at intervals of no more than 6 ft. and an equipment grounding conductor is included in the cable. Where an equipment grounding conductor is not provided, one of the insulated conductors within the cable must be permanently identified as an equipment grounding conductor at the time of installation.
- Type TC-ER cable can be used without continuous support to transition between cable trays or between cable trays and utilization equipment for up to 6 ft. if the cable is mechanically supported where exiting the cable tray.
- In one- and two-family dwelling units Type TC-ER cable that contains both power and control conductors can be pulled through structural members if identified for the purpose. Type TC cable was previously not allowed for use in one- and two-family dwelling units even though it met or exceeded the standard test used when evaluating Type NM and SE cables. Since TC Cable is available with more conductor configurations than Type NM cable it is useful for control and power wiring in some heat pump installations. Wiring optional stand-by generators and transfer switches is another application for Type TC cable at one- and two-family dwellings.
- Type TC cable can be direct buried where identified for such use.
- Type TC cable can be used in hazardous locations if permitted by other articles in the NEC.

Question 29: When installing Type TC Tray Cable in cable tray, the cable tray itself may have discontinuous sections up to ______ .

A: 12 inches.
B: 3 feet.
C: 20 inches.
D: 2 feet.

Question 30: 338.10(B)(4) Service-Entrance Cable: Types SE and USE. Uses Permitted. Branch Circuits or Feeders. Installation Methods for Branch Circuits and Feeders.

Question ID#: 1129.0



Conductors sized No. 8 AWG and larger can be used at the 75^{â—¦}C rating, even when installed in thermal insulation.

The 2014 NEC required the ampacity of all sizes of Type SE (service-entrance) cable to comply with the 60Â° C temperature rating when installed in thermal insulation. The 60Â°C ampacity was required even where equipment terminals were rated 75Â°C. Limiting the ampacity to the 60Â° C temperature rating is now required only where the conductor size of Type SE cable is No.10 AWG or smaller and the cable is installed in thermal insulation.

This change will permit No. 8 AWG and larger Type SE cable to be used at the75o C ampacity it is typically rated for, even when used in thermal insulation provided equipment terminals are rated 75'C. Type SE Cable with conductor sizes No. 10 AWG and smaller will still have their ampacity based on the 60Â° temperature rating, just as Non-Metallic Sheathed Cable must have its' ampacity based on the 60Â° temperature rating. Type SE cables with No. 10 AWG or smaller conductors is not typically encountered in residential applications.

It should be noted that the NEC requires Non-Metallic Sheathed Cable to be rated for 90Â° C, but the ampacity is limited to that of the 60Â°C temperature rating for all sizes of NM cable. The 90'C rating for the individual conductors in Type NM cables was introduced in the 1984 NEC. NM cables with these conductors are identified by a -B on the cable sheath (Type NM-B).

The individual conductors in most SE cables currently manufactured are also 90'C rated conductors, but the ampacity is limited by the temperature rating of the equipment terminals. If the equipment terminations are rated 75'C then the allowable ampacity of the conductor can be based on the 75'C rating even when the SE cable is installed in thermal insulation.

If the 75Â°C rating of SE cable can be used, then a 4/0 AL cable can be used to supply a 180 amp load, even if the SE cable is installed in thermal insulation. In the 2014 NEC if a 4/0 aluminum cable was run in thermal insulation it could only supply a 150 amp load and had to be protected by a 150 amp overcurrent device. Likewise, a No. 1 AL SE cable installed in thermal insulation can supply a 100 amp load using the 75Â°C rating. If the 60Â° rating is used, a 1/0 aluminum cable would be required.

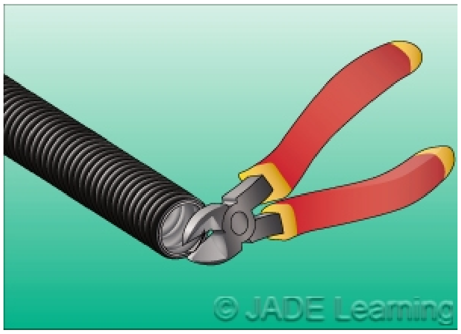
The 60Â° C ampacity limitation for SE cable now only applies to Type SE cable with conductors larger than No. 10 AWG if the equipment terminals are rated 60'C. If the terminals in an existing panelboard or other equipment are not identified with a temperature rating, the rules in 110.14(C) should be followed. Unless marked otherwise termination provisions for circuits rated 100 amps or less, or marked for No. 14 AWG through No. 1 AWG conductors are intended for use with conductors at the 60'C ampacity.

Question 30: The ampacity of Type SE Cable that is installed in thermal insulation may be based on the 75⁰C temperature rating only if the size of the cable is No. ____ AWG or larger.

A: 10.
B: 8.
C: 6.
D: 4.

Question 31: 350.28 Liquidtight Flexible Metal Conduit: Type LFMC. Trimming.

Question ID#: 1130.0



The cut ends of LFMC must be trimmed on both the inside and the outside to remove the rough edges.

A new section was added to Part II of Article 350, "Liquidtight Flexible Metal Conduit: Type LFMC." Part II provides installation requirements for this wiring method. The new section, 350.28 requires the trimming of the cut ends of liquidtight flexible metal conduit on both the inside and outside for the purpose of removing the rough edges. The reason provided during the code revision process was that proper trimming of the rough edges will allow for a better connection between the steel grounding ferrule of the connector and the steel sheath of the liquidtight flexible metal conduit. A solid connection is required to assure complete grounding continuity. In addition, it is always a good practice to trim any rough edges that may come in contact with an insulated conductor.

Liquidtight flexible metal conduit is permitted as a grounding means according to 250.118(6). The conduit can be used instead of a wire-type equipment grounding conductor if listed fittings are used, if the trade size of the conduit is 3/8 in. or 1/2 in and the circuit is protected at 20 amperes or less, or the trade size is 3/4 in. through 1 1/4 in. and protected at 60 amperes. Other conditions also apply, including requirements that the length of the liquidtight flexible metal conduit not be longer than 6 ft., and is used to connect to equipment which requires flexibility after installation.

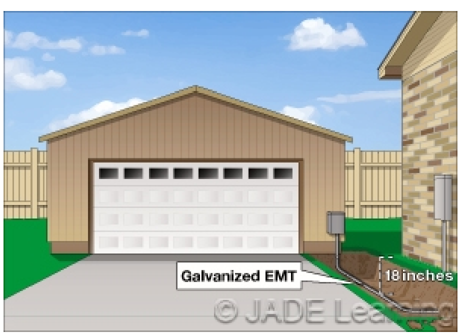
The new trimming requirement also brings the requirements for liquidtight flexible metal conduit in line with requirements for other wiring methods. NEC Article 356 "Liquidtight Flexible Nonmetallic Conduit: Type LFNC," Article 348 "Flexible Metal Conduit: Type FMC," already included the requirement for trimming.

Question 31: Why is trimming the edges of liquidtight flexible metal conduit important?

A: It makes the installation look more professional.
B: It ensures continuity between the grounding ferrule and the flexible metal conduit sheath.
C: If the edges are trimmed, water will be able to drain out of the cable.
D: It protects electricians from being cut by sharp edges.

Question 32: 358.10 Electrical Metallic Tubing: Type EMT. Uses Permitted.

Question ID#: 1131.0



EMT is permitted to be used in exposed and concealed locations. Dry, damp, and wet locations. It must be protected from corrosion when installed in direct contact with the earth.

NEC Section 358.10 lists the permitted uses of Electrical Metallic Tubing (EMT) and Section 358.12 lists the conditions under which EMT is not permitted. Much of the information in 358.12 (uses not permitted) has been moved to 358.10 (uses permitted), and the rules have been restated in more positive language to make them more reader-friendly and also to make the format more consistent with other articles in the NEC, such as Article 344 on Rigid Metal Conduit.

This is one of those places where the changes have been more editorial than technical. Each time the NEC is revised, some of the changes merely involve different wording or formatting to better conform with the NEC style manual, even though there may be no technical changes to the rules. However, code language has been added concerning the materials that EMT and associated fittings are manufactured from including galvanized steel, stainless steel, and aluminum. Stainless Steel EMT is now recognized as being suitable for installation in corrosive environments where protected from corrosion and approved as suitable for the conditions. The definition for EMT in the 2014 NEC only mentioned EMT made from steel or aluminum.

EMT may be installed in both exposed and concealed locations and can be installed in dry, damp, and wet locations. EMT may be installed in a hazardous (classified) location only as permitted by other articles in the NEC.

EMT must be protected from corrosion when installed in direct contact with the earth
or in extremely corrosive areas. Galvanized steel and stainless steel EMT, elbows, and fittings can be installed in concrete, in direct contact with the earth, or where subject to severe corrosion, but the corrosion protection must be provided that is suitable for the conditions of use.

Supplementary corrosion protection may be provided by bitumastic coatings, zinc-rich paints or other approved methods. Special tapes and shrink wraps are also available.

Aluminum EMT must be provided with supplementary corrosion protection acceptable to the AHJ when installed in concrete or in direct contact with earth.

EMT is not permitted to be used where subject to severe physical damage, or for the support of luminaires or other equipment, but EMT can be used to support conduit bodies no larger than the largest trade size of tubing.

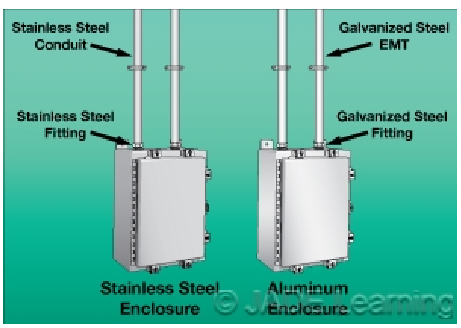
.Many electricians refer to EMT as "conduit," which is technically incorrect. EMT is actually electrical metallic tubing and is addressed as such in several places in the NEC. For example, the title to Table 1 of Chapter 9 is ***Percent of Cross Section of Conduit and Tubing for Conductors and Cables.***

Question 32: What does EMT installed in corrosive environments need?

A: Non-metallic covering.
B: Corrosion protection.
C: Equipment bonding jumpers.
D: A non-ferrous coating.

Question 33: 358.14 Electrical Metallic Tubing: Type EMT. Dissimilar Metals.

Question ID#: 1132.0



Stainless steel EMT can only be used with stainless steel fittings and enclosures. Galvanized steel EMT can be used with aluminum fittings and enclosures

The 2014 NEC addressed EMT used with dissimilar metals in section 358.12, ***Uses Not Permitted.*** In the 2017 NEC, those requirements were moved to a new section, 358.14, and new requirements were added covering galvanized steel, aluminum and stainless steel EMT and associated fittings.

Section 358.14 requires that "where practicable" dissimilar metals must be kept apart to avoid the possibility of galvanic action. For example, the galvanized coating of steel EMT contains zinc. Where galvanized steel EMT comes in contact with dissimilar metals, such as copper or brass, the zinc coating may corrode away and rust will appear on the EMT. Eventually the thin wall of the EMT may completely corrode away. There are similar requirements to prevent galvanic action when IMC conduit and RMC conduit may be in contact with dissimilar metals, but these conduits have a much thicker wall than EMT. Aluminum enclosures and fittings are also permitted to be used with both IMC and RMC, but certain conditions apply when aluminum fittings are used with galvanized steel EMT.

The AHJ will make the call whether or not it is "practicable" to keep dissimilar metals apart. "Practicable" means that it can be done in practice, not that it is possible or practical. In many cases it will not be practicable to eliminate all contact between EMT and dissimilar metals or even obvious that dissimilar metals are in contact, but if corrosion of the EMT occurs galvanic action may be the cause.

Galvanized steel EMT may be used with aluminum fittings and enclosures ***where not subject to severe corrosive influences.*** Likewise, aluminum EMT may be used with galvanized steel fittings and enclosures ***where not subject to severe corrosive influences.*** Examples of areas that may be considered severely corrosive are areas where chemicals such as chlorine, alkaline, or other acids are stored. Swimming pool equipment rooms and pool chemical storage rooms are considered corrosive environments in Article 680. EMT is not a permitted wiring method in these areas.

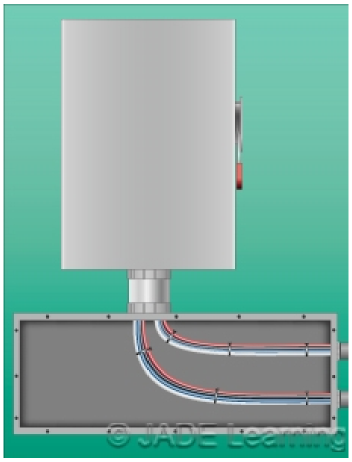
Stainless steel EMT may only be used with Stainless steel fittings and with approved accessories, enclosures, and boxes. That is a new requirement in the 2017 NEC.

Question 33: Dissimilar metals are generally required to be kept apart to avoid which of the following?

A: Overheating.
B: Galvanic action.
C: Electrolytic action.
D: Induced voltages.

Question 34: 366.20 Auxiliary Gutters. Conductors Connected in Parallel.

Question ID#: 1133.0



When parallel conductors are installed in an auxiliary gutter they must be grouped. Likewise when parallel conductors are installed in a metal wireway they must be grouped (376.20).

New section 366.20 spells out the requirements for installing conductors in parallel in an auxiliary gutter. The conductors must be installed in groups consisting of not more than one conductor per phase, neutral, or grounded conductor. This grouping will minimize current imbalances due to inductive reactance. Where conductors are not properly grouped, one conductor may carry substantially more load than another conductor within the same phase group resulting in overheating of the conductor or termination.

The 2014 NEC did not address parallel conductors installed in one metal enclosure such as an auxiliary gutter. The new requirement for installing parallel conductors in an auxiliary gutter is similar to the requirement for installing parallel conductors in raceways.

Section 310.10 (H) (3) requires that when installing parallel conductors in separate raceways each raceway must have the same number of conductors and have the same electrical characteristics.

Example: When installing a three-phase, four-wire feeder consisting of two conductors in parallel per phase, each of the two raceways must contain Phases A, B , and C, and the neutral.

NEC Section 300.20(A) also requires that conductors installed in ferrous metal raceways or enclosures must be arranged to avoid the heating of surrounding metals by induction. Under some conditions the currents induced in a metal enclosure will generate enough heat to cause the metal to fail. The new requirement for grouping each phase and the grounded conductor in separate groups will help prevent this induced heating of surrounding metal when parallel conductors are installed in sheet metal auxiliary gutters.

The general rules for installing conductors in parallel are found in Section 310.10(H). The paralleled conductors in each phase, polarity, neutral, grounded circuit conductor, equipment grounding conductor, or equipment bonding jumper must comply with five conditions below:

- Be the same length.
- Consist of the same conductor material.
- Be the same size in circular mil area.
- Have the same insulation type.
- Be terminated in the same manner.

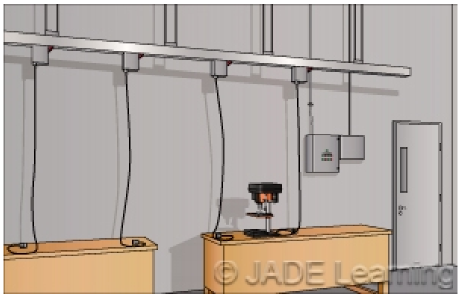
The new requirement in 366.20 for installing conductors in groups consisting of not more than one conductor per phase, neutral, or grounded circuit conductor is in addition to the requirements in 310.10(H).

Question 34: When installing parallel conductors in an auxiliary gutter, which conductors are required to be in each group?

A: All phase conductors only.
B: All conductors of the same phase only.
C: One conductor of each phase, neutral or grounded conductor.
D: One phase conductor only and no neutral conductors.

Question 35: 368.17(C) Ex. No. 4 Busways. Overcurrent Protection. Feeder or Branch Circuits.

Question ID#: 1134.0



A rope, chain or stick is not needed to operate a busway disconnect if the branch circuit or feeder disconnect, such as a cord connector with attachment plug is readily accessible.

The NEC generally requires branch circuit overcurrent devices to be readily accessible. The definition of readily accessible in Article 100 does not permit the use of portable ladders to reach the equipment that is being accessed. In addition, Section 240.24 limits the maximum height of switches containing fuses and circuit breakers. The center of the operating handle must be no more than 6 ft. 7 in. above the floor when in its highest position. However there is an exception for busways as provided in Section 368.17(C).

When installing a branch circuit overcurrent device as part of a plug-in unit for busway, the device is often not readily accessible and it is usually installed higher than 6 ft. 7 in. above the floor. However, Section 368.17(C) allows a fusible switch or circuit breaker to be installed in a location that is not readily accessible as long as ***suitable means such as ropes, chains, or sticks*** are provided so that the disconnect can be operated from the floor.

A new exception, No. 4, has been added to Section 368.17(C) which says that a method of operation from the floor (rope, chain, or stick) is not required for a branch circuit plug-in disconnect if it is ***directly supplying a readily accessible disconnect.***

The new exception will allow installation of branch circuit plug-in units that have overcurrent protection on the busway without having to provide a rope, chain, or stick to operate the busway switch or circuit breaker from the floor. The new exception only requires that the plug-in unit directly supplies a disconnecting means that is readily accessible and can be operated from the floor. This means that cord connectors and attachment plugs may be used as a disconnecting means where permitted elsewhere in the code.

Question 35: A chain or a rope is NOT required to operate a busway plug-in unit that has overcurrent protection provided that it directly supplies which of the following?

A: The load.
B: A separate overcurrent device.
C: A readily accessible disconnect.
D: A disconnect within 10 ft. of the busway.

Chapter 4

Question 36: 400.10 & 400.12 Flexible Cords and Cables. Uses Permitted and Uses Not Permitted.

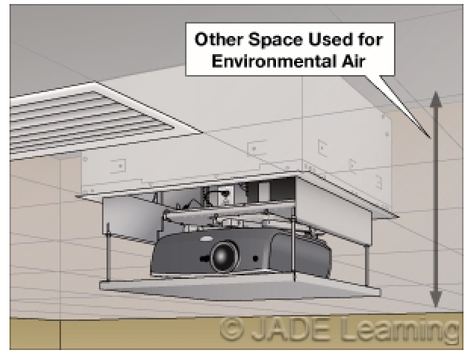
Question ID#: 1135.0

Chapter 4 covers equipment for general use. Section 400 in particular deals with general requirements and applications for flexible cords and flexible cables. Most of the rules for the installation and use of flexible cords and cables remain the same as the 2014 NEC. However, many of the sections have been re-numbered to more closely align with the NEC ***Style Manual:***

- NEC Section 400.7 (Uses Permitted) has been renumbered as 400.10.
- NEC Section 400.8 (Uses Not Permitted) has been renumbered as 400.12.
- NEC Section 400.9 (Splices) has been renumbered as 400.13.
- NEC Section 400.10 (Pull at Joints and Terminals) has been renumbered as 400.14.

These changes will align the numbering of paragraphs in Article 400 more closely to the rest of the NEC. As in other articles, the .10 paragraph lists â€œUses Permitted, ***â€•*** and the .12 paragraph lists â€œUses Not Permitted***.â€•***

A new exception has been added to 400.12 (5). NEC Section 400.12 (5) states that flexible cord may not be used ***located above suspended or dropped ceilings.***Â The exception allows cord above a drop ceiling ***if contained within an enclosure for use in Other Spaces Used for Environmental Air.***Â If the cord is inside an enclosure that is designed to be installed in â€œOther Spaces used for Environmental Air***,â€•*** then it is not actually in the air handling space. Some inspection authorities were not allowing cord in these enclosures because they were located ***above suspended or dropped ceilings.Â*** The new exception clarifies the intent of the NEC.



A flexible cord is permitted to be located above a suspended or dropped ceiling if it is contained within an enclosure for use in Other Spaces Used for Environmental Air.

Question 36: An enclosure is recessed into a dropped ceiling which is used as other space for environmental air. A receptacle outlet is installed in the enclosure and a cord and plug connected projector is plugged into the receptacle. Even though the cord is technically above the dropped ceiling, when is this permitted?

A: If the enclosure is approved for use in "Other Spaces used for Environmental Air".
B: If the cord is listed for hard usage.
C: If the enclosure is firestopped.
D: If the cord is listed for use above a dropped ceiling.

Question 37: 404.2(C) Switch Connections. Switches Controlling Lighting Loads.

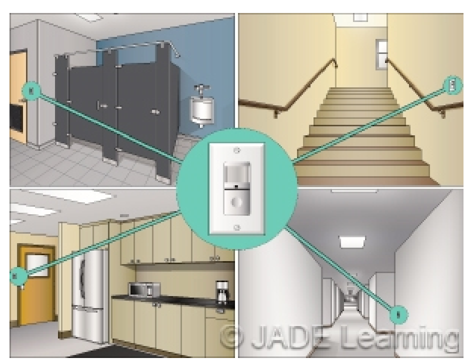
Question ID#: 1136.0

Section 404 covers switches, switching devices, and circuit breakers used as switches - operating at 1000 volts and below. NEC Section 404.2(C) has been extensively revised to clarify when the grounded conductor must be present at switch locations used for controlling lighting loads. There are exceptions, but, generally, the grounded conductor must be present at the following lighting switch locations:

- Bathrooms
- Hallways
- Stairways
- Rooms suitable for human habitation or occupancy as defined in the applicable building code.

The grounded conductor is not required at the above locations if one of the following apply:

- The conductors enter the box through a raceway that is adequately sized to contain an additional conductor should one need to be added.



The grounded conductor of a branch circuit must be located in bathrooms, stairways, hallways and rooms suitable for human occupancy.

- The box enclosing the switch is capable of having an additional or replacement cable installed without removing finish materials.
- The snap switch has an integral enclosure as allowed by 300.15(E).
- The lighting in the area is controlled by automatic means.
- The switch controls a receptacle load.

When multiple switch locations control the same lighting load and the entire lighted area is visible from each switch location, only one switch location must have the grounded conductor present.

The grounded conductor must be brought to the switch locations described above and connected to any switching device that requires a line to neutral voltage to power the electronic control circuitry of the switch. There are four exceptions to this connection requirement:

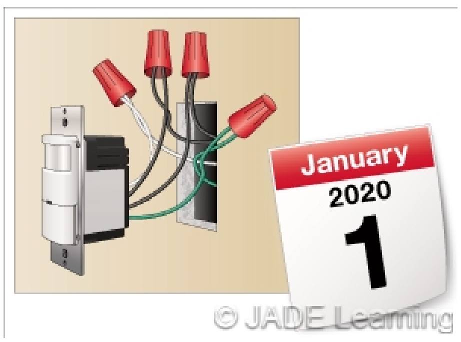
- The connection requirement does not apply until January 1, 2020.
- The connection requirement does not apply to replacement or retrofit switches that were put in before the grounded conductor was required to be installed and where the existing grounded conductor cannot be extended without removing finish materials.
- Not more than five electronic control switches may be put on one lighting branch circuit where the grounded conductor is not present.
- Not more than twenty-five electronic control switches may be put on one feeder supplied from the load side of a system or main bonding jumper when the grounded conductor is not present at the switch locations.

Question 37: When is a grounded conductor NOT required at a lighting switch location?

A: The switch controls a bathroom light.
B: The switch controls a hallway light.
C: The switch controls a stairway light.
D: The switch comes as a listed assembly with an integral enclosure.

Question 38: 404.22 Electronic Lighting Control Switches.

Question ID#: 1137.0



After January 1, 2020 a grounded conductor must be part of the circuit to power the electronics of a light switch.Â An equipment grounding conductor cannot be used to power the electronic light switch.

New Section 404.22 prohibits electronic lighting control switches from using the equipment grounding conductor as part of the circuit to power the electronics of the switch. The electronic circuitry of the switch must be powered by connecting it to an ungrounded conductor and a grounded conductor. Using an ungrounded conductor and an equipment grounding conductor to power the electronic circuitry of the switch introduces about Â½ of a milliamp of current on the equipment grounding conductor.

When replacing a conventional switch with an electronic lighting control switch, installers have used the equipment grounding conductor as part of the circuit to power the electronics of the switch because there was no grounded conductor present in the switch box.

The new requirement that the equipment grounding conductor not be used as part of the circuit to power the electronics of the switch does not take effect until January 1, 2020. After January 1, 2020, all new installations will require the use of a grounded conductor and prohibit the use of the equipment grounding conductor as part of the circuit to provide power for the electronic circuitry.

For retrofit or replacement applications, the equipment grounding conductor will still be allowed as part of the circuit to power the electronics of the switch if the electronic switch is listed for that purpose, and there is no grounded conductor present in the box. This is allowed by the exception to 404.22.

NEC Section 250.6 (A) generally prohibits having â€œobjectionable***â€•*** current on the equipment grounding conductor. For retrofit or replacement installations where the equipment grounding conductor is used as part of the circuit to power the electronics of a switch, the current on the equipment grounding conductor would not be considered â€œobjectionable.***â€•Â***

Question 38: As a general rule, electronic lighting control switches may not introduce current on which conductor?

A: Ungrounded conductor.
B: Grounded conductor.
C: Equipment grounding conductor.
D: Switched conductor.

Question 39: 406.2 Definitions. Outlet Box Hood.

Question ID#: 1138.0

An outlet box hood is not intended to complete the electrical enclosure.Â It reduces the risk of water coming in contact with electrical components inside the box.

Article 406 addresses receptacles, cord connectors, and attachment plugs (caps). A new definition of â€œOutlet Box Hoodâ€• was added to define a term used in Section 406.9(B)(1).Â The definition describes the type of housing used to make receptacle outlets weatherproof when 15- or 20-ampere, 125- and 250-volt receptacles are installed in wet locations. In order to meet the requirements of Section 406.9(B)(1) an outlet box hood is required to be identified as â€œextra duty,â€• but that is not part of the new definition.

Outlet Box Hood Definition: ***A housing shield intended to fit over a faceplate for flush-mounted wiring devices, or an integral component of an outlet box or of a faceplate for flush-mounted wiring devices.Â The hood does not serve to complete the electrical enclosure; it reduces the risk of water coming in contact with electrical components within the hood, such as attachment plugs, current taps, surge protective devices, direct plug-in transformer units, or wiring devices.***Â

Although the definition alone does not change any requirements for installation of the hoods it does help to explain the types of things, other than attachment plugs, that the hood is intended to protect. Since the definition says â€œsuch as,â€• the list of items that are specifically mentioned does not include every item that might be protected by an outlet box hood.Â For example, many items such as switches are included in the broad term â€œwiring devices.â€• But the most common item used with an outlet box hood is a receptacle, and the list of items mentioned are all things that might plug into a receptacle.

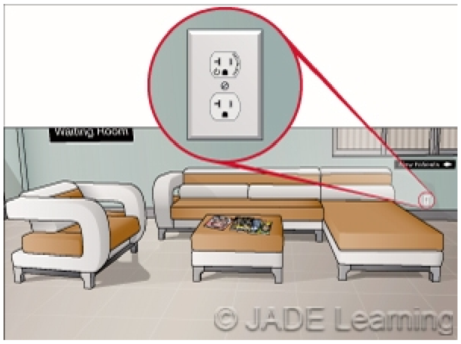
As defined, the hood may be designed to fit over a faceplate, or may be part of an outlet box or faceplate. Many outlet box hoods include a faceplate, but the outlet box hood is intended to protect the enclosed items, not to complete the outlet box enclosure itself.Â

Question 39: Which of the following statements about an outlet box hood is true?

A: An outlet box hood serves to complete the electrical enclosure.
B: The definition of outlet box hood expands the requirements for their use.
C: An outlet box hood will reduce the risk of water coming in contact with enclosed electrical components.
D: Outlet box hoods cannot be used with switches.

Question 40: 406.3(E). Receptacle Rating and Type. Controlled Receptacle Marking.

Question ID#: 1139.0



Receptacles that are controlled by an energy management system must be marked with the power symbol and the word "controlled."

All receptacles of the ordinary straight-blade (non-locking) type that are rated 125-volt, 15- or 20-ampere, are required to be marked if they are controlled by an automatic control device. These receptacles could be controlled by energy management or building automation controls to activate or deactivate the receptacle or they could be controlled by some other automatic control device such as an automatic timer or occupancy sensor.

The marking on the controlled receptacle must be on the face of the receptacle, not on the cover plate, and must be visible after installation. If a duplex or multiple receptacle device is used, the marking must indicate which contact device or devices are automatically controlled.

The 2014 NEC required a similar marking, but was a symbol only, a symbol that is widely used to indicate a power switch, or on/off. The intent of the symbol was that the marking be clear to non-English speakers. Unfortunately, that symbol was not universally recognized or understood. The 2017 NEC requires that the word "Controlled" be added to the symbol. The controlled receptacle itself must be marked, not just the receptacle outlet as was allowed in the 2014 NEC. So if only the top receptacle of a duplex outlet is controlled, the marking must indicate it is the one being controlled.

The primary concern behind this change was that a clear message be provided for people using a receptacle if the receptacle may not always be energized or activated. Having power available at all times may be important or critical in some applications, and it should be obvious to a user if a receptacle is likely to be deactivated by some automatic means. Another concern is that the marking should indicate precisely which receptacle is controlled. Markings on cover plates may be lost when cover plates are changed or removed temporarily. For example, a typical cover plate can be installed in either direction (up/down or left/right) and when the cover is removed to change a wall finish, the plate could easily be reinstalled in the wrong position. So the new requirement is that the marking be directly on the receptacle face.

This requirement does not apply to wall-switch controlled receptacles used as lighting outlets in some rooms of dwelling units as permitted in Section 210.70.

Question 40: Which of the following statements about a controlled receptacle is true?

A: The marking may be on the receptacle or on the cover plate.
B: The marking must be on the receptacle face.
C: The required marking is the same as in the 2014 NEC.
D: The universal power symbol is well recognized so no additional marking is required.

Question 41: 406.3(F). Receptacle Rating and Type. Receptacle with USB Charger.

Question ID#: 1140.0

Receptacles with built in USB chargers must be listed.

Section 406.3(F) is completely new for the 2017 NEC Code-cycle. This new rule addresses 125-volt, 15- or 20-ampere receptacles that include one or more USB charging ports or output connectors. The Class 2 power supply for the USB output connectors must be an integral part of the receptacle.

NEC article 406 (Receptacles, Cord Connectors, and Attachment Plugs) covers many kinds of receptacles that are required to be listed. In fact, Section 406.3(A) requires all receptacles to be listed. Other sections within the NEC require specific listings for receptacles installed in special locations, such as wet locations. These receptacles must be listed as "weather-resistant." Also, receptacles installed within a dwelling (or other locations required by 406.12) that are within 5 1/2 feet of the floor must be listed as "tamper-resistant." With all of these requirements for "listing" in place, the 2014 NEC, along with previous NEC editions did not contain specific listing requirements for receptacles that contain additional Class 2 type power (such as USB ports).

There are some USB add-on products available on the market, these devices can be connected and secured to an ordinary receptacle, but the safety of such products had not been tested nor approved by a third party, such as UL. One of the main concerns that exists regarding any assembly that includes both 120V AC power and the limited energy of a Class 2 power source, is the ability to safely maintain a separation between the Class 2 wiring and the 120V AC wiring. A USB charging source is treated as a Class 2 source in the NEC. A Class 2 source is, by definition (in Article 725), neither a shock hazard nor a fire hazard under normal conditions. However, mixing these limited energy Class 2 circuits with 120V AC circuits can compromise the integrity of the Class 2 power source and impose higher energy levels on the Class 2 circuit. ***Listed*** receptacle - USB port combinations, now required by NEC 406.3(F) will have adequate separations incorporated into their design, so that this is not a problem.

Question 41: Which of the following statements about receptacles with USB chargers is true?

A: The USB output connectors must be supplied by an integral Class 2 power supply.
B: USB output connectors may be supplied by a separate power supply that is added on to the receptacle in the field.
C: USB connector kits have been investigated for safety together with the receptacles to which they are attached.
D: The requirement for listing of the USB chargers in receptacles applies only to 250-volt 20-ampere receptacles.

Question 42: 406.4(D)(2) General Installation Requirements. Replacements. Non-Grounding-Type Receptacles.

Question ID#: 1141.0

Not all non-grounding type receptacles can be replaced with a GFCI receptacle. Some manufacturers require an equipment ground for their equipment or appliance.

Section 406.4(D) covers replacements of receptacles. In general, the requirement for replacements of receptacles is that they be replaced with the type of receptacle currently required by the NEC for the specific location. When a non-grounding type receptacle is replaced, the general requirement of Section 406.4(D)(1) is to replace the receptacle with a grounding type receptacle if there is an equipment grounding conductor that is either already available or can be made available.

One of the options when replacing a non-grounding type receptacle with a grounding type receptacle is to supply the replacement grounding type receptacle through a GFCI.

The 2017 NEC makes it clear that a grounding type receptacle supplied through a GFCI but without an equipment grounding conductor must be labeled "GFCI Protected" and "No Equipment Ground" and the markings must be visible after installation. The markings can be on the receptacle or on the cover plate. The 2014 NEC required markings too, but the location of the marking was not specified and it was not clear that the marking must be visible to the user of the receptacle.

Two informational notes were also added to Section 406.4(D)(2)(c) in the 2017 NEC. The purpose of the informational notes is to explain that some equipment and some appliances require an equipment grounding conductor with the branch circuit. This may be true even though the GFCI can provide shock protection without an equipment grounding conductor. The informational notes explain to the user of the NEC, hopefully the qualified person replacing receptacles that some equipment may not operate properly or safely without an equipment grounding conductor. In such cases, Section 406.4(D)(1) will apply and an equipment grounding conductor must be installed.

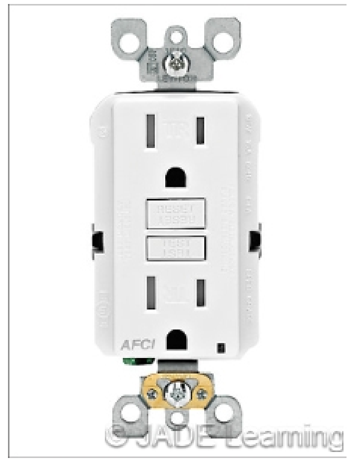
Question 42: A non-grounding type receptacle is replaced by a grounding type receptacle supplied through a GFCI. What is one of the labels that is required?

A: Equipment Grounding Conductor Not Required.
B: Not Grounded.
C: No Equipment Ground.
D: Caution.

Question 43: 406.4(D)(4) General Installation Requirements. Replacements. AFCI Protection.

Question ID#: 1142.0

Section 406.4(D)(4) addresses Arc-Fault Circuit Interrupter protection for ***replacement receptacles***. Three significant changes were made in this section in the 2017 NEC. One change is a clarification of the previous rule. The other two are new exceptions. The effective date was also deleted, because it has now passed.



Replacing a non-grounding type receptacle with another non-grounding type receptacle in an area that requires AFCI protection is not permitted.

The first change makes the previous requirement much clearer. Rather than say that the rule applies "where specified elsewhere in the NEC", the revised 2017 rule specifies that the places where the rule applies to replacement receptacles, are the locations where AFCI protection is required for branch circuits under Sections 210.12(A) and (B). These sections, along with 406.4(D)(4) require AFCI protection for replacement receptacles supplied by 120-volt 15- or 20-ampere branch circuits. This applies to most, but not necessarily all areas of dwelling units and dormitory units, including sleeping and living areas. However, the rules in Sections 210.12(A) and (B) in the 2017 NEC do not apply to bathrooms or garages in dwelling units, or to any part of guest rooms or guest suites of hotels and motels. Guest rooms and guest suites are covered in 210.12(C).

The second change is Exception No. 1, it states that AFCI protection will not be required for a replacement receptacle if all of the following four conditions are met:

- The replacement receptacle must have GFCI protection as required by 406.4(D)(2)(b), which states that the GFCI protection that is required, be supplied by replacing this receptacle with an actual GFCI type receptacle.
- Adding an equipment grounding conductor to this outlet, as permitted by 250.130(C) is "***impracticable***."
- A listed combination type AFCI circuit breaker must not be "***commercially available***."
- Dual function GFCI/AFCI receptacles are also not "***commercially available***."

The four conditions may be difficult to meet in many cases and are subject to interpretation. For example, impracticable is a term that is not well understood. It does not mean impossible or impractical. It means "cannot be done in practice." So one person might argue that it could be done but it would cost too much. That is really an example of impractical, not impracticable. As another example, the dual function AFCI/GFCI receptacle is available for ordering but might not be readily available in local stock. Listed combination type AFCI breakers are certainly commercially available, but perhaps not from the manufacturer of the panelboard already installed. Final and official interpretation of these issues can only be provided by the Authority Having Jurisdiction.

Having to meet all four of the conditions listed above means that replacing a non-grounding type receptacle in an area that requires AFCI protection with another non-grounding type receptacle is not permitted. Either AFCI protection must be provided or the non-grounding receptacle must be replaced with a GFCI type receptacle, which is condition 1, and the other 3 conditions must also be met.

The new Exception No. 2 is intended to require AFCI protection for replacement receptacles in short extensions or rewiring even where the entire branch circuit is not required to have AFCI protection added to the branch circuit extension or rewiring.

Question 43: Which of the following statements regarding AFCI protection being required for replacement receptacles, is true ?

A: AFCI protection is not required if an ungrounded type receptacle is replaced with another ungrounded type receptacle.
B: AFCI protection is required for replacement receptacles in areas of a dwelling or dormitory unit covered by 210.12(A) or (B).

C: AFCI protection is only required for replacement receptacles that do not have GFCI protection.
D: AFCI protection is required for any replacement receptacle rated more than 20 amperes.

Question 44: 406.4(D)(5) General Installation Requirements. Replacements. Tamper-Resistant Receptacles.

Question ID#: 1143.0

A tamper-resistant receptacle cannot replace a non-grounding receptacle. A non-grounding receptacle is permitted to replace a non-grounding receptacle without providing tamper-resistant protection.

The NEC includes requirements for specific types of receptacles in specific places. When a receptacle of a type that does not meet current NEC requirements is replaced it is usually required to be replaced with the specific type required for that location. The most general requirement is for replacing non-grounding type receptacles with grounding type receptacles but similar rules apply where tamper-resistant receptacles are required in the current code. Tamper-resistant receptacles are currently required for new installations in dwelling units, guest rooms and guest suites of hotels and motels, in child care facilities and in other locations specified in Section 406.12 if the receptacles are of the nonlocking-type and the receptacles are rated 15- or 20-ampere 125- or 250-volt. Exceptions to this section apply if the receptacles are located in areas that cannot be reached by children.

The change in Section 406.4(D)(5) addresses replacements that are required to be tamper-resistant elsewhere in the NEC. It does not change where tamper-resistant receptacles are required in new installations. However, Section 406.12 includes an exception that says certain receptacles are not required to be tamper-resistant. Some of those exceptions are related to height or use of the receptacles. One of those exemptions recognizes that a non-grounding type receptacle that is replaced by another non-grounding type receptacle as allowed in 406.5(D)(2)(a) will not be tamper-resistant. So, to make the requirements and exceptions clearer, to make the code easier to use, and to eliminate any perception that the rules were contradictory, the exemption for non-grounding type receptacles was repeated in 406.4(D)(5). However, it was not added as an exception. Instead, 406.4(D)(5) now states the general requirement and then adds in the same sentence: ***"except where a non-grounding receptacle is replaced with another non-grounding receptacle*."**

Question 44: Assuming a receptacle is in an area where tamper-resistant receptacles are required in the current NEC, which of the following statements about replacing the receptacle with a tamper-resistant receptacle is true?

A: Replacement receptacles must always be tamper-resistant.
B: Receptacles must be replaced with whatever type of receptacle was removed.
C: Receptacles may be replaced with receptacles that are not tamper-resistant if a tamper-resistant cover is added.
D: Receptacles must be replaced with tamper-resistant receptacles except where a non-grounding receptacle is replaced with another non-grounding receptacle.

Question 45: 406.5(E), (F), (G), (H) Receptacle Mounting. Receptacles in Countertops, Work Surfaces, Orientation, in Seating Areas.

Question ID#: 1144.0

Receptacles that are listed for installation in work surfaces cannot be installed in countertops. Receptacles listed for installation in countertops may be installed in work surfaces.

In the 2014 NEC, Section 406.5(E) was titled "***Receptacles in Countertops and Similar Work Surfaces***." However, the listing and testing standards for receptacle assemblies in countertops and receptacles in other types of work surfaces are different.

The difference in the testing requirements is based on the assumed amount of liquid that would likely be spilled in each case. For the kitchen or bathroom countertop, a fairly large amount of liquid might reasonably be expected to be involved in a spill, while other work surfaces were more likely to see only about as much liquid spilled as might be in a cup of coffee.

Because the testing and listing requirements are different, the NEC installation requirements are now separated into multiple sections. The new title of 406.5(E) is "***Receptacles in Countertops***," and a new Section 406.5(F) is titled "***Receptacles in Work Surfaces***." In addition, a third new section, 406.5(G) is titled "***Receptacle Orientation***." Together, these three sections address the various issues in the previous Section 406.5(E).

Based on the differences in testing procedures, receptacles installed in countertops are now required to be specifically listed for use in countertop applications. Because the listing for countertop applications assumes the receptacle assembly might be exposed to a larger liquid spill, the assembly listed for countertop applications may be installed in either countertops or work surfaces. The receptacle assembly listed for work surfaces may be installed in work surfaces but may not be installed in countertops.

The other new section that addresses receptacle orientation says that a receptacle may be installed in a face-up position only if it is listed for either countertop or work surface applications. One reason this is a separate rule is that not all assemblies for countertops or work surfaces include receptacles that are in face-up positions.

Another change was in Section 406.5(H), titled "***Receptacles in Seating Areas and Similar Surfaces***." One of the provisions for such receptacles allowed them if they were "***Part of an assembly listed as a furniture power distribution unit, if cord-and-plug connected***." Since all listed furniture power distribution units are cord-and-plug connected, that portion of the rule was deleted.

The practical application of these changes will only change the use of receptacles listed for work surfaces. The NEC is clear now that those types of receptacles may not be installed in countertops. The other requirements were reorganized and rewritten somewhat, but the other essential requirements did not change.

Question 45: Which of the following statements about receptacles installed in COUNTERTOPS is true?

A: If a receptacle is listed for use in a countertop, or if a receptacle is listed for use in a work surface, it may be installed in a countertop.
B: Only receptacles listed for use in work surfaces may be installed in countertops.
C: Only receptacles listed for use in countertop applications may be installed.
D: Receptacles may not be installed in countertops or work surfaces.

Question 46: 406.6(D) Receptacle Faceplates. Receptacle Faceplate with Integral Night Light and/or USB Charger.

Question ID#: 1145.0

Receptacle cover plates are now available that incorporate a night light and/or a USB connector. These cover plate assemblies must be listed.

A new Section 406.6(D) was added in the 2017 NEC. It is titled "***Receptacle Faceplate (Cover Plates) with Integral Night Light and/or USB Charger.***" This addition is intended to address the use of cover plates for flush duplex receptacles that attach to the receptacle and include an integral night light or a Class 2 power supply with Class 2 USB output connectors, or both. The concern is that these devices may not be tested and may not meet appropriate safety standards. An ANSI/UL standard exists that includes requirements for such devices. So the reason for the new requirement is quite simple: Such devices should not be allowed unless they are tested and listed by a nationally recognized testing laboratory such as UL to ensure their safety, especially when they are combined with the receptacle to which they are attached.

The new requirement is that if a faceplate or cover plate includes a night light or a USB charger or both, the night light and/or the USB connector and its power supply and circuitry must be an integral part of the cover plate and the assembly must be listed. USB power supplies or chargers alone are typically listed as information technology equipment (ITE) and according to Section 725.121(A)(4) are required to be listed if they are to be considered as Class 2 power supplies. By definition, the output of a Class 2 power supply is not a fire or shock hazard under normal but sometimes limited conditions. Power limitations of ITE equipment are usually even lower than other typical Class 2 sources. So the safety issue is mostly related to the power supply from the receptacle to the Class 2 source or the night light and the requirement that the Class 2 source itself be tested and listed.

These devices are likely sold as add-on devices that are installed by homeowners rather than being primarily sold to and installed by qualified electricians. But requirements for listing of electrical equipment in order to meet NEC requirements will often encourage retailers to stock and sell equipment that is recognized by the NEC over equipment that is not, and it will make qualified electricians more likely to be aware of the issue.

Question 46: Which of the following statements about receptacle faceplates with integral USB chargers is true?

A: The assembly must be listed by a nationally recognized testing laboratory.
B: The USB power supply can be separate from the assembly if it is listed for use separately.
C: Faceplates with integral USB chargers are prohibited.
D: The USB charger and power supply must be part of the receptacle.

Question 47: 406.9(B)(1) Wet Locations. Receptacles of 15 and 20 Amperes in a Wet Location.

Question ID#: 1146.0

All receptacles in wet locations do not require an outlet box hood identified for extra duty. Listed power outlets include a hinged cover and do not require the use of a separate outlet-box hood.

15- and 20- amp, 125 and 250-volt rated receptacles in a wet location must be weatherproof with or without a cord plugged into the receptacle. The only exception is for locations subject to routine high pressure spray washing. Where an outlet box hood must be installed to fit over a flush-mounted wiring device to meet this requirement the hood must be listed and identified as "Extra-Duty."

Section 406.9(B)(1) was reorganized to clarify that certain types of receptacle enclosures do not require the installation of a separate outlet box hood to meet the weatherproof requirement. If a listed receptacle assembly, outlet box, enclosure, or similar assembly is identified as suitable for a wet location with or without a cord plug cap inserted, the listed enclosure is not required to be marked "Extra-Duty."

Enclosures that do not require installation of an outlet box hood can be identified by type numbers such as Type 3R. An example is an outdoor power outlet that houses a receptacle behind a hinged door and is identified for use outdoors. Outdoor power outlets with hinged metal covers are commonly used at RV parks and for temporary construction site power. The intended use of various enclosure types is found in Table 110.28. The integral hinged cover on a listed power outlet enclosure is not the same thing as an outlet box hood as defined in 406.2.

The exception to the rule that receptacles in wet locations must have an enclosure that is weatherproof whether or not the attachment plug cap is inserted was relocated. The exception is only for wet locations subject to high-pressure spray washing. It says the receptacle enclosure must be weatherproof only when the attachment plug is removed. The relocation of the exception was intended to clarify that the requirement for the listed "extra-duty" cover applies to both non-locking type and locking-type 15- and 20-amp, 125 and 250 volt rated receptacles.

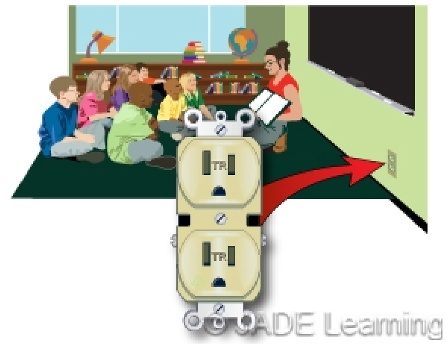
The requirement for weather-resistant (WR) identification for receptacles only applies to nonlocking-type receptacles. All 15- and 20-ampere, 125 and 250-volt nonlocking-type (straight blade) receptacles in wet locations are required to be identified as weather resistant regardless of the type of cover.

Question 47: Which of the following statements about enclosures that are identified for outdoor use and contain receptacles is true?

A: Enclosures that contain receptacles and are identified as weatherproof without an outlet box hood are not required to be marked "extra duty."
B: Outlet box hoods are required to be marked "extra duty" only for nonlocking-type receptacles.
C: All outdoor enclosures containing receptacles must be marked "extra duty."
D: Enclosures listed for indoor use only can be used outdoors if an "extra duty" box hood is installed.

Question 48: 406.12 Tamper-Resistant Receptacles.

Question ID#: 1147.0



Tamper resistant receptacles are now required in preschools and elementary schools, waiting rooms in medical clinics and dentist offices, gymnasiums, skating rinks, auditoriums and dormitories.

This section has significantly expanded the locations where listed tamper-resistant receptacles are required. The list of locations in the 2014 NEC included only a few locations where children are likely to be present, including dwelling units, guest rooms in hotels and motels, and child care facilities. No list can cover every possible location where children are likely to be present, but the 2017 NEC has expanded the list to include preschools and elementary education facilities, a limited number of assembly occupancies, and dormitories. Business offices, corridors, waiting rooms and the like in clinics, medical and dental offices, and outpatient facilities are also included as areas requiring tamper resistant receptacles in the 2017 NEC. Hospitals are not included on the list in 406.12, but tamper resistant receptacles are required in designated pediatric care locations by Article 517.

The requirements for listed tamper-resistant receptacles apply to all 15- and 20-ampere 125- and 250-volts nonlocking-type receptacles in the areas included in the list. The intent was to cover the more common configurations of receptacles typically installed. An Informational Note was added to list the types of receptacles required to be tamper-resistant. The ANSI/NEMA configurations are 5-15, 5-20, 6-15, and 6-20. These are the common receptacles that accept straight-blade 15- and 20-ampere attachment plugs. They do not include locking-type receptacle configurations such as L5-15R and L5-20R.

In the 2014 NEC, the areas where receptacles were required to be tamper-resistant were:

- Dwelling units as required in 210.52,
- Guest rooms and guest suites of hotels and motels, and
- Child care facilities as defined in 406.2.

The areas added in the 2017 NEC include an expansion of the requirements for dwelling units to the receptacles required for mobile homes and manufactured homes in Section 550.13. The other areas added in 2017 are:

- Preschools and elementary education facilities;
- Business offices, corridors, waiting rooms, & similar areas inside clinics, medical and dental offices, and outpatient facilities;
- A subset of assembly occupancies limited to places of awaiting transportation, gymnasiums, skating rinks, and auditoriums; and
- Dormitories.

The same exception that applied to the areas in the 2014 NEC applies to all of these new areas as well, so receptacles more than 5-1/2 feet above the floor, receptacles that are part of a luminaire or appliance, single receptacles (or duplex receptacles for two appliances) that are located in dedicated spaces for specific cord-and-plug connected appliances that are not easily moved in normal use, and non-grounding replacement receptacles are not required to be tamper resistant.

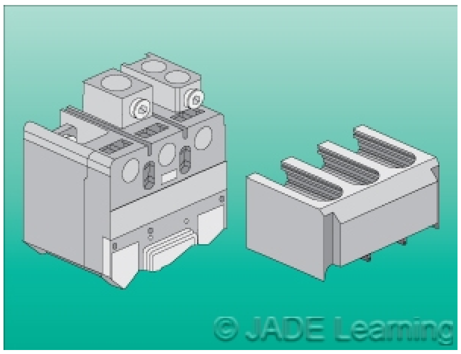
Receptacles are not necessarily required by the NEC in all of the areas in the list. For example, Article 210 requires receptacles in dormitory rooms, but the NEC does not specifically require them in many assembly occupancies. If receptacles are installed in these areas, they must be tamper-resistant.

Question 48: Which of the following statements about locations requiring tamper-resistant 20-ampere 125-volt nonlocking-type receptacles is true?

A: One of the new areas added to the 2017 NEC is conference rooms at a real estate business office.
B: One of the new areas added to the 2017 NEC is child care facilities.
C: One of the new areas added to the 2017 NEC is dormitories.
D: One of the new areas added to the 2017 NEC is museums.

Question 49: 408.3(A)(2) Conductors and Busbars on a Switchboard, Switchgear, or Panelboard. Service Panelboards, Switchboards, and Switchgear.

Question ID#: 1148.0



Barriers are required in service panelboards which will prevent accidental contact with live load terminations.

This section was changed to include requirements for barriers in service panelboards in addition to service switchboards and switchgear. The main rule requires that barriers be located in such a way that uninsulated, ungrounded service busbars or terminals will not be inadvertently contacted while servicing load terminations. This is a major change that will require barrier kits to be installed in service panelboards.

Many panelboards that are marked "Suitable for Use as Service Equipment" (SUSE) can be and are intended to be convertible from feeder-supplied panelboards to service panelboards. Some of these panelboards may contain more than one service overcurrent device. Therefore, an exception has been added to exempt panelboards that are installed with more than one service disconnect in a single enclosure. So the barriers are required only in service panelboards with a single main service disconnect.

Panelboards with single main disconnects are usually converted in the field from feeder-supplied to service-supplied by the installation of a main bonding jumper. Such jumpers have usually been provided with panelboards if the panelboards have the SUSE marking. But the manufacturer of the panelboard will not know how each panelboard will be used, so the expectation in adding this requirement is that manufacturers will make listed barrier kits that can be field installed when a panelboard with a single main disconnect is converted to use as service equipment. When new panelboards with single main disconnects are installed as service equipment two modifications will now have to be made. A main bonding jumper will be required to be installed and the barrier kit will have to be installed as well.

Question 49: Which of the following statements about requirements for barriers in service panelboards is true?

A: Barriers are required in all panelboards used as service equipment.
B: Barriers are required only in service panelboards that contain more than one service disconnect.
C: Barriers are required only in service panelboards that contain a single main service disconnect.
D: Barriers are required in all panelboards that are converted to use as service equipment.

Question 50: 408.4(B) Field Identification Required. Source of Supply.

Question ID#: 1149.0

A label indicating the source of supply for a panelboard, switchboard or switchgear must be permanent, durable enough to withstand the environment where the equipment is installed, and cannot be handwritten.

This section has been changed to expand on a previous requirement that feeder-supplied switchboards, switchgear and panelboards, except those in one- and two-family dwellings, must be marked to indicate the source of supply. The new requirement is that the marking must be permanent. To fit this requirement the label must meet three new conditions: The label must be permanently affixed. The label must be sufficiently durable to withstand the environment where the equipment is installed. The label may not be handwritten.

These requirements are different from and in addition to those for a circuit directory or circuit identification of all the circuits supplied from a switchboard, switchgear or panelboard. Because those circuits may change or be added the circuit directory is not required to be permanently attached and may be handwritten as long as it is legible.

The new requirements for permanent marking are very much the same as those required in Section 110.21(B), but that section covers hazard markings. Marking of the source of supply is not intended to be a warning of a hazard. The basic requirement is intended to help in locating the source or sources of supply so that the equipment can be put into a safe working condition. Circuit directories are required in all occupancies, but the marking of the source of supply is not required in one- or two-family dwellings.

As a practical matter some of these requirements may be challenging in certain situations and easy in others. For example, if the equipment is located in a clean and dry indoor location, without exposure to corrosive materials, typical typewritten adhesive labels may meet the requirements, or engraved labels could be attached with rivets or screws. However, in outdoor locations where the equipment is exposed to sunlight, weather, and/or corrosives, the choice of label material, and means of attachment will have to be carefully considered. The holes made for rivets/screws may not be acceptable in outdoor enclosures; labels may have to be resistant to UV radiation of sunlight; and label materials and adhesives will have to be evaluated for resistance to whatever corrosive material is likely to be encountered.

Question 50: How is the source of supply for a switchboard, switchgear or a panelboard required to be identified?

A: Labels must be permanently affixed, have sufficient durability for the environment, and not be handwritten.
B: Handwritten labels are permitted as long as they are legible.
C: Each circuit must be labeled to distinguish it from all other circuits.
D: Marking of the source of supply is required in all occupancies.

Answer Sheet **Darken the correct answer. Sample: A ● C D**

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13.) A B C D	**30.) A B C D**	**47.) A B C D**
14.) A B C D	**31.) A B C D**	**48.) A B C D**
15.) A B C D	**32.) A B C D**	**49.) A B C D**
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