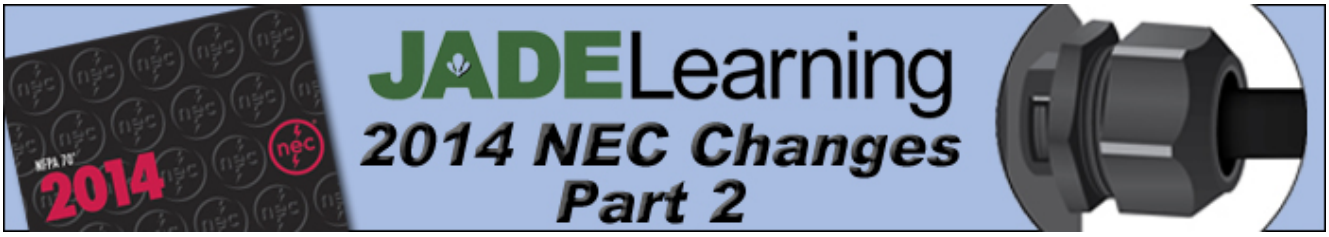


2014 NEC Changes Part 2 (Homestudy)

North Carolina Electrical License

This course will review 50 of the most important National Electrical Code changes from the 2014 NEC. Changes in Chapter 3 - Chapter 9 will be covered.

Course# CEC.02303 4 Homestudy Credit Hours $50.00

This course is currently approved by the North Carolina State Board of Examiners of Electrical Contractors under course number CEC.02303.

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: 7/1/2013. Board issued expiration date: 6/30/2018.

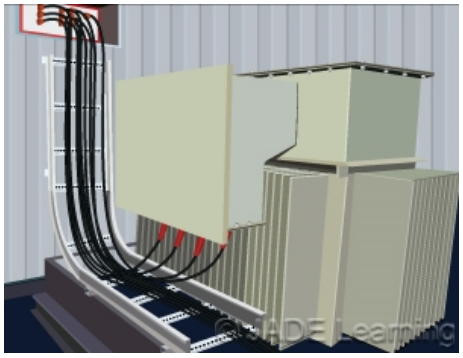
JADELearning

2014 NEC Changes Part 2 (Homestudy) - NC

Chapter 3 - Additional Questions

Question 1: 300.38 Raceways in Wet Locations Above Grade.

Question ID#: 687.0



The interiors of raceways installed in wet locations above grade are considered wet locations. Wet location conductors exposed to sunlight need to be sunlight resistant.

New Section 300.38, Raceways in Wet Locations Above Grade, states that ***where raceways are installed in wet locations above grade, the interior of these raceways shall be considered to be a wet location. Insulated conductors and cables installed in raceways in wet locations shall comply with 310.10(C).*** The purpose of adding this new section is to make above ground installation requirements over 1000 volts consistent with the requirements in Section 300.9 for 1000 volts and less.

The interior of above ground raceways that are in wet locations require conductors that are listed for use in wet locations. It is possible that these raceways will gather moisture and in fact become filled with water at times.

Wet locations are defined in Article 100 as: ***Installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas, and in unprotected locations exposed to weather.***

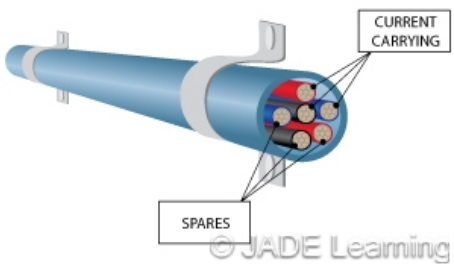
Conductors and cables for circuits over 1000 volts are required to be listed for wet locations, have a moisture-impervious metal sheath, or have an outer insulation which is type MTW, RHW, RHW-2, TW, THW, THW-2, THHW, THWN, THWN-2, XHHW, XHHW-2, ZW.

Question 1: Which of the following conductor insulation types could be used for an outdoor 480 volt feeder installed in a raceway?

A: THHN.
B: XHH.
C: THWN.
D: FEP.

Question 2: Table 310.15(B)(3)(a) Adjustment Factors for More Than Three Current-Carrying Conductors.

Question ID#: 688.0



Spare conductors now must be included in the total number of current-carrying conductors in the raceway or cable.

Table 310.15(B)(3)(a) was revised to make provisions for spare conductors and allowances for those conductors that cannot be energized at the same time.

Section 310.15(B)(3)(a) provides requirements for adjusting the final allowable ampacity of conductors where more than 3 conductors are considered to be current-carrying and installed within a raceway, cable, or bundled in lengths exceeding 24 inches without maintaining spacing. A change to Section 310.15(B)(3)(a) removed the phrase "in a raceway or cable" from the heading.

An important change was made to Note 1 under Table 310.15(B)(3)(a). The revised text in Note 1 states that the number of conductors is the total number of conductors in the raceway or cable, including spare conductors. The count for current-carrying conductors does not include equipment grounding conductors, and if the neutral carries only the unbalanced load, does not include the neutral. The count shall not include conductors that are connected to electrical components that cannot be energized at the same time.

Based on the old Code language, spare conductors installed in a raceway for future use would not technically be considered "current-carrying". This type of a situation could create an issue in the future if the spare conductors are connected to an energized component. Conductors that carry current will generate heat and the existing conductors in the raceway were sized without taking the then spare conductors into account.

The last sentence in Note 1 allows conductors that cannot be energized simultaneously to be excluded from the ampacity adjustment requirements. As an example, it would be pointless to apply an 80% correction factor to four conductors in a raceway that are connected to a 4-way switch if there was never a possibility that more than two of them could be energized at the same time.

Question 2: According to Table 310.15(B)(3)(a), what percentage is required to be used when applying correction factors to 12 current-carrying conductors and 9 spare conductors within the same 10 foot length of electrical metallic tubing?

A: 45%.
B: 50%.
C: 70%.
D: 80%.

Question 3: 310.15(B)(3)(c) Exception And Table. Raceways and Cables Exposed to Sunlight on Rooftops.

Question ID#: 689.0

A new exception exempts Type XHHW-2 insulated conductors from the ampacity adjustment for installations on rooftops.

The title of Table 310.15(B)(3)(c) was changed to ***Ambient Temperature Adjustment for Raceways or Cables Exposed to Sunlight on or Above Rooftops.*** The change eliminated the word â€œcircular,â€• recognizing the fact that some raceways installed on rooftops are not circular, and added the word â€œCables.â€•

Conductors in cables and raceways installed on rooftops in direct sunlight get much hotter than conductors installed inside cables or raceways in other locations.Â It is a fact that conduit installed on a rooftop is hot to the touch, and conductors installed inside raceways can be damaged by high temperatures.

Table 310.15(B)(3)(c) requires a temperature rise to be added to the ambient temperature for raceways and cables installed on rooftops.Â The closer the raceway or cable is to the roof, the greater the temperature adder is.Â For example, if the ambient temperature is 86Â°F, and a raceway is installed 4 inches above a roof, an additional 30Â°F must be added to the ambient temperature, making it 116Â°F.Â The ampacity adjustment to the conductors inside the conduit would be based on 116Â°F.

A study of XHHW-2 conductors installed in raceways on rooftops found they were not damaged by extreme heat.Â A new exception allows XHHW-2 conductors to be used in raceways on rooftops without adding the increased temperatures of Table 310.15(B)(3)(c).

NFPA has issued corrections to ***Table 310.15(B)(3)(c) in an errata sheet***

â€œTable 310.15(B)(3)(c). Revise second entry in the first column to read â€œAbove roof 13 mm (1â•„2 in.)â€“90 mm (3 1â•„2 in.).â€•

Question 3: What is the total ambient temperature that must be used for conductors (that are NOT type XHHW-2) in a raceway that is mounted 6 inches above a rooftop and the ambient temperature is 80Â°F?

A: 80Â°F.
B: 110Â°F.
C: 120Â°F.
D: 140Â°F.

Question 4: 310.15(B)(7) 120/240-Volt, Single-Phase Dwelling Services and Feeders.

Question ID#: 690.0

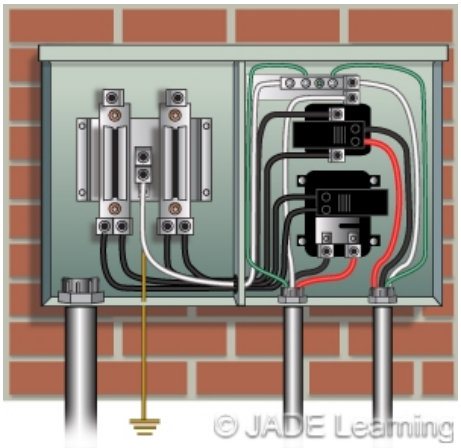


Table 310.15(B)(7) had been deleted, and now the sizes are calculated to be not less than 83% of the service or feeder rating.

Table 310.15(B)(7) has been deleted. One of the most frequently used tables in the NEC, the table was used to select the conductor sizes for 120/240-Volt, 3-Wire, Single-Phase Dwelling Services and Feeders for services and feeders rated 100 through 400 amperes.

In its place, a calculation must be done that determines the service and feeder conductors at an ampacity not less than 83% of the service or feeder rating. For example, the service conductors for a 100 amp service are required to carry not less than 83 amps.

Doing a calculation to determine the ampacity of service and feeder conductors at 83% of the service or feeder rating, rather than using the old Table 310.15(B)(7), does not make a difference in the size of the conductor. The wire sizes for both copper and aluminum, from Table 310.15(B)(16), when calculated at 83% of the service or feeder rating, are identical to the sizes in old Table 310.15(B)(7).

The conditions when the 83% calculation can be used are also the same as in 2011. It can be used for:

- Dwelling services and feeders that supply the entire load of the dwelling.
- 120/240-voltage rating.
- 3-wire.
- Single-phase.

Because using the 83% calculation is limited to service conductors and feeders that supply the entire load, the service conductors that feed a one-family dwelling can be selected based on 83% of the rating of the service, but the feeder conductors that supply a subpanel that does not carry the total load of the dwelling must carry 100% of the load.

Question 4: What are the minimum size copper, THWN service conductors for a 200-amp service, 120/240 volt, 3-wire, single-phase, where the conductors carry the entire load of the dwelling? Assume 75 degree C terminals.

A: 3/0.
B: 2/0.
C: 1/0.
D: No. 1.

Question 5: 314.15 Damp or Wet Locations.

Question ID#: 692.0

Drainage openings not larger than 1/4 inch can be installed in boxes or conduit bodies listed for use in damp or wet locations.

Section 314.15 is about installing boxes, conduit bodies, and fittings in damp or wet locations. A Code change will now allow weep holes to be installed in the field to provide drainage for condensation that can form inside the box.

Drilling weep holes in weatherproof boxes has been a common practice among electricians for many years. Anyone performing service work that has opened a die-cast aluminum weatherproof junction box years after the initial installation has first-hand knowledge of what kind of damage and corrosion can occur when moisture is allowed to build up within the enclosure with no provisions for drainage.

Inspectors have been placed in a unique situation when asked to inspect a listed weatherproof box or conduit body that someone has modified by drilling holes in it to provide proper drainage. Do the holes void the listing of the product? Does the manufacturer approve the idea of drilling drain holes in the box? The new text added to 314.15 will now clearly permit drain holes to be drilled in boxes or conduit bodies in damp and wet locations.

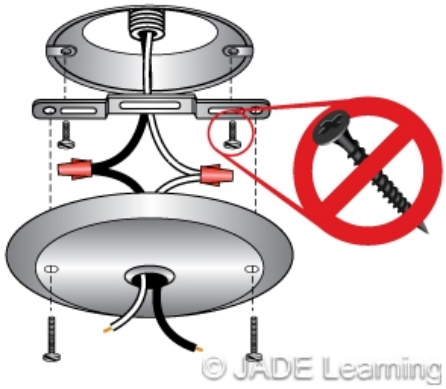
Section 314.15 now states that: ***approved drainage openings not larger than 6 mm (1â•„4 in.) shall be permitted to be installed in the field in boxes or conduit bodies listed for use in damp or wet locations. For installation of listed drain fittings, larger openings are permitted to be installed in the field in accordance with manufacturer's instructions.***

Question 5: Which of the following installations meets the intent of section 314.15?

A: A 1/4 inch hole drilled into the top of a weatherproof junction box.
B: A 1/2 inch hole drilled into the bottom of a weatherproof junction box.
C: A 1/4 inch hole drilled into the bottom of a weatherproof junction box.
D: A 1/2 inch hole drilled into the bottom of a weatherproof junction box for an unlisted drain fitting.

Question 6: 314.25 Covers and Canopies.

Question ID#: 693.0



Screws used for attaching covers to the box must be machine screws matching the thread gauge or whatever is required by the manufacturer's instructions.

New Code language in section 314.25 addresses a common Code violation regarding the use of incorrect screws to fasten canopies, covers, or lampholders to junction boxes.

Section 314.25 states that in completed installations, each box shall have a cover, faceplate, lampholder, or luminaire canopy, except where the installation complies with 410.24(B). Section 410.24(B) is for installations where a surface mounted fixture is installed and covers the junction box but the fixture is not physically attached to the box.

The new text in 314.25 requires that screws used for the purpose of attaching covers or other equipment to the box shall be either machine screws matching the thread gauge or size that is integral to the box or shall be according to the manufacturer's instructions.

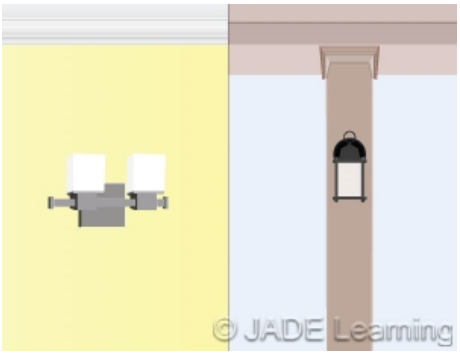
It is all too common for an installer to use drywall screws or other screws that may be convenient when fastening a cover, faceplate, or fixture canopy to a junction box rather than using the correct machine screw for the application. Boxes that have had a drywall screw used for this purpose instead of the correct machine screw can be damaged by the screw threads. When this happens the correct machine screw can never be used in those boxes again.

Question 6: If a junction box is equipped with threaded holes with an 8-32 thread pitch for the purpose of securing the cover, what can be used to secure the cover to the box?

A: A self-threading sheet metal screw.
B: A larger machine screw with an 10-24 thread pitch.
C: Standard drywall screws.
D: Machine screws that match the threads in the box.

Question 7: 314.27(A)(1) Vertical Surface Outlets.

Question ID#: 694.0



The requirements for wall outlets have now been expanded to include all vertical surfaces.

The title and text of 314.27(A)(1) were changed to include a vertical surface that is not necessarily a wall. This is to recognize that luminaires or lampholders may be mounted on interior posts or columns that are not necessarily walls. The basic provisions of the section have not changed.

The section now reads: ***Boxes used at luminaire or lampholder outlets in or on a vertical surface shall be identified and marked on the interior of the box to indicate the maximum weight of the luminaire that is permitted to be supported by the box, if other than 50 pounds.*** Basically, the box requires the weight marking if it is unable to hold up a 50 pound luminaire. If it can support up to 50 pounds, then no weight marking is required.

The exception has been reworded to say, ***a vertically mounted luminaire or lampholder weighing not more than 6 pounds shall be permitted to be supported on other boxes or plaster rings that are secured to other boxes, provided the luminaire or its supporting yoke, or the lampholder, is secured to the box with no fewer than two number 6 or larger screws.***

This editorial change means that the same rules for mounting outlet boxes in a wall now apply to any vertical surface, such as panels, posts, or columns.

Question 7: Which of the following installations is a Code violation?

A: A round metal box that is identified and marked on the interior of the box for support of a 20 pound luminaire mounted in the wall and used for a luminaire weighing 8 lbs. that is secured to the box with No. 8 screws.
B: A 5 lb. luminaire secured with No. 4 screws to a device box mounted on a vertical column.
C: A 5 lb. luminaire secured with No. 6 screws to a device box mounted on a vertical column.
D: A round metal box that is identified and marked on the interior of the box for support of a 20 pound luminaire mounted in the wall and used for a luminaire weighing 12 lbs. that is secured to the box with No. 10 screws.

Question 8: 314.27(C) Boxes at Ceiling-Suspended (Paddle) Fan Outlets.

Question ID#: 695.0

The requirement for a box listed for support of a ceiling-suspended (paddle) fan now also applies to two-family dwellings.

The term "two-family" has been added to the second paragraph in section 314.27(C) which describes ceiling boxes that contain spare, separately switched, ungrounded conductors.

New provisions in the 2011 Code required that if spare, separately switched, ungrounded conductors were provided to a ceiling mounted outlet box, in a location acceptable for a ceiling-suspended (paddle) fan in single or multi-family dwellings, the outlet box or outlet box system had to be listed for the sole support of a ceiling suspended (paddle) fan. This requirement applied only to single- or multi-family dwellings and failed to mention two-family dwellings.

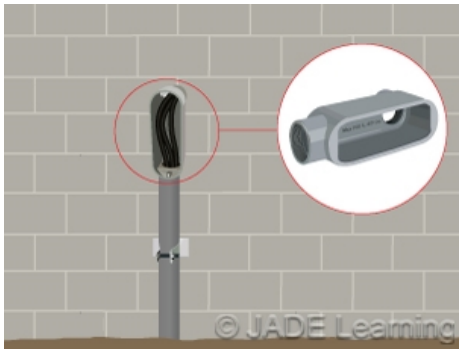
It has become a common practice during new home construction for a homebuilder to offer prewiring for future ceiling fans as part of an upgrade package to new homeowners. Prior to the 2011 Code, it was also commonplace to find that an electrician had provided spare separately switched ungrounded conductors to an unused ceiling box and placed a blank plate on it for future use. The requirement to install a listed ceiling fan box when spare, separately switched conductors were provided in the box was to prevent homeowners from installing ceiling fans at existing plastic ceiling boxes.

Question 8: Which of the following ceiling boxes are required to be fan rated?

A: A box installed in a single-family dwelling over a doorway and supplied with a separately switched ungrounded conductor.
B: A box installed in a two-family dwelling in the middle of a room and supplied with a spare, separately switched ungrounded conductor.
C: A box installed for future use in a single-family dwelling 7 feet above a bathtub.
D: A box installed for future use in a two-family dwelling 6 inches from a wall.

Question 9: 314.28(A)(3) Pull and Junction Boxes and Conduit Bodies. Minimum Size. Smaller Dimensions.

Question ID#: 696.0



Smaller dimension conduit bodies will have to be marked to either show they have been evaluated or show the maximum number and size of conductors permitted.

Conduit bodies that have smaller dimensions than those required for angle pulls made in pull and junction boxes are now permitted if the conduit body is shaped in such a way that the radius of the curve of the conduit body matches the sweep of a conduit bent with a one-shot or full-shoe bender, per Table 2 of Chapter 9.

If the dimensions of the conduit body are less than what is required for angle pulls in boxes, then the conduit bodies must be marked to show they have been evaluated accordingly.

If the permitted combinations of conductors is less than the maximum raceway fill from Table 1 in Chapter 9, the conduit body must be permanently marked with the maximum number and maximum size of conductors permitted.

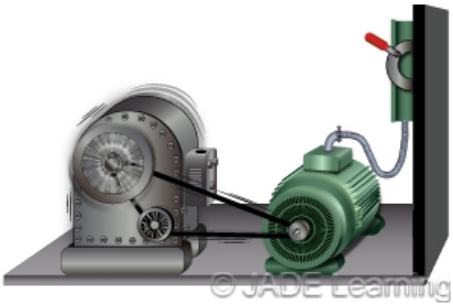
For example, if considering using an angle pull with 2 inch conduit and a pull box, and the rule in 314.28(A)(2) requires the distance from the entering raceway and the opposite wall of the box to be at least 12 inches (2 inch raceway X 6 = 12 inches to opposite wall). A smaller conduit body would be permitted to be used as long as it met the minimum dimensions for a one shot or full shoe bend listed in Table 2 of Chapter 9. This bending radius is no different than the minimum bending radius allowed for field bends made in IMC, RMC, or EMT. In some cases, it may be necessary to use a smaller conduit body where limited space prohibits making an angle pull with a large pull box.

Question 9: What is required of a 2 inch conduit body with dimensions less than those required for an angle pull in a pull box that is being used to enclose an angle pull with No. 4 AWG aluminum conductors?

A: It must have a radius of curve to centerline not less than that indicated in Table 2 of Chapter 9 for one-shot and full-shoe benders.
B: The conduit body must be marked to show that it has been specifically evaluated for at least a 8 1/4 inch bend per Chapter 9, Table 2.
C: The conduit body must have an area of 2.3 sq. in.
D: Since there are no splices in the conduit body, no marking is required.

Question 10: 330.30(D)(3) Securing and Supporting. Unsupported cables.

Question ID#: 699.0



There are now three conditions where type MC cable can be unsupported.

Section 330.30(D)(3) was added in the 2014 NEC and now allows metal clad cable (type MC) to be installed without support where flexibility is necessary.

For many Code cycles, type MC cable has been permitted to remain unsupported under the following two conditions:

- Where the cable is fished between access points through concealed spaces in finished buildings if supporting is impractical.
- Where the cable is not more than 1.8 m (6 ft.) in length from the last point of cable support to the point of connection to luminaires or other electrical equipment within an accessible ceiling.

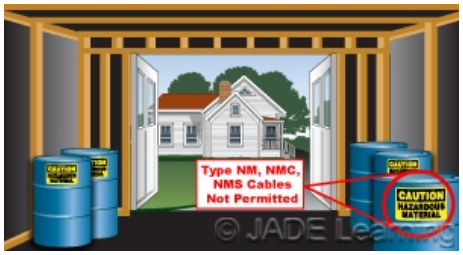
An additional allowance has now been made in 330.30(D)(3) for the installation of MC cable where flexibility is important. The new Code change states that MC cable can remain unsupported if it is of the interlocked armor type in lengths not exceeding 900 mm (3 ft.). The 3 ft. is measured from the last point where it is securely fastened to the equipment where flexibility is necessary. MC cable can be in the form of a smooth metal sheath, corrugated metal sheath, or interlocking metal tape armor. Interlocking metal armor type MC cable has a similar sheath to that of flexible metal conduit and stands up well to movement or vibration.

Question 10: A section of interlocked type MC cable, used to supply an air compressor, can be unsupported from the last fastening point for what maximum distance?

A: 2 feet.
B: 3 feet.
C: 4 feet.
D: 6 feet.

Question 11: 334.10 Installation. Uses Permitted.

Question ID#: 700.0



Type NM, type NMC, and type NMS cables are permitted to be used in five conditions, except as prohibited in 334.12.

A revision has been made in Section 334.10 regarding the permitted use of nonmetallic sheathed cable in order to help clarify the limitations of these types of cables.

Section 334.10 provides 5 locations where nonmetallic sheathed cable is permitted to be used. In previous Code editions, the phrase "except as prohibited in 334.12" was only seen after subsections 2 and 3, leading the user to believe that the references to 334.12, Uses Not Permitted, were only valid if the installation was a multi-family dwelling or "other structure of types III, IV or V construction". A description of construction types is in Informative Annex E, Table E.1, E. 2, & E3 on pages 70-849 - 850 of the 2014 NEC.

Now the Code states that type NM, type NMC, and type NMS cables are permitted to be used in the following, except as prohibited in 334.12:

- ***One- and two-family dwellings and their attached or detached garages, and their storage buildings.***
- ***Multi-family dwellings permitted to be of Types III, IV, and V construction.***
- ***Other structures permitted to be of Types III, IV, and V construction. Cables shall be concealed within walls, floors, or ceilings that provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies.***
- ***Cable trays in structures permitted to be Types III, IV, or V where the cables are identified for the use.***
- ***Types I and II construction where installed within raceways permitted to be installed in Types I and II construction.***

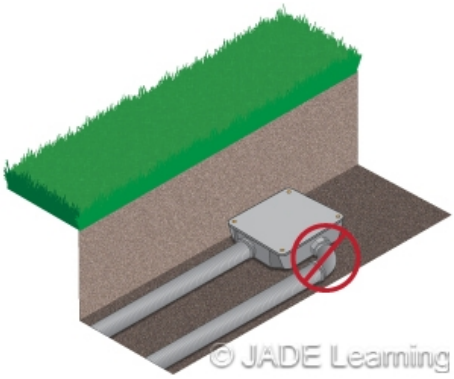
Changing the location of the phrase "except as prohibited in 334.12" to the introductory sentence in 334.10 makes it clear that these types of cables can be installed in any of the above 5 locations as long as none of the 5 locations conflict with the rules in 334.12 for uses not permitted. For example, type NM cable is permitted to be used as the wiring method for a storage building at a dwelling unit, but if the building contains corrosive products, then according to 334.12(B), this type of cable cannot be used. Prior to this Code change, this practice was not specifically prohibited.

Question 11: When is type NMC cable permitted to be used in a cable tray, installed in an office building of type IV construction?

A: When it is identified for the use.
B: When it does not conflict with the requirements in 334.10.
C: When it is installed above a suspended ceiling.
D: When it has a 15-minute finish rating.

Question 12: 350.42 Liquidtight Flexible Metal Conduit. Couplings and Connectors.

Question ID#: 704.0



Straight LFMC fittings are approved for direct burial where marked; angle fittings are not permitted.

Liquidtight Flexible Metal Conduit (LFMC) is approved for direct burial where it is listed and marked for the purpose. Now straight LFMC fittings are approved for direct burial where marked.

Only fittings which are listed for use with LFMC can be used. Angle connectors for LFMC conduit cannot be concealed. Since burying an LFMC angle connector would be concealing it, angle connectors are not permitted to be buried.

Section 350.42 Couplings and Connectors now reads:

Only fittings listed for use with LFMC shall be used. Angle connectors shall not be concealed. Straight LFMC fittings shall be permitted for direct burial where marked.

Straight, non-angle fittings can be buried only where marked, meaning that the manufacturer has used "suitable for direct burial" or equivalent wording on the fitting or on the packaging.

Liquidtight Flexible Nonmetallic Conduit (LFNC) fittings are not to be used with LFMC. The two wiring methods have a similar outward appearance, but LFNC does not have a metal sheathing under the outer liquid-tight jacket.

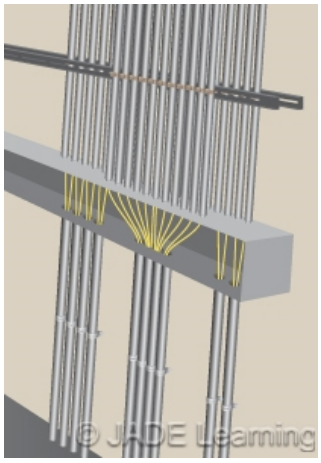
LFMC and LFNC are permitted for direct burial. Flexible metal conduit (FMC) and flexible metal tubing (FMT) are not permitted for direct burial, and misapplication of these wiring methods could require extensive rework or create a hazardous condition.

Question 12: Which of the following is permitted for direct burial?

A: Angle fittings listed for use with LFMC.
B: Flexible Metal Conduit.
C: Flexible Metal Tubing.
D: Straight LFMC fittings where marked for direct burial.

Question 13: 376.22(B) Number of Conductors and Ampacity. Adjustment Factors.

Question ID#: 706.0



Ampacity of conductors inside a metal wireway will be adjusted if there are more than 30 current-carrying conductors at any cross section of the wireway.

The ampacity of conductors inside a metal wireway will need to be adjusted if the number of current-carrying conductors inside the metal wireway exceeds 30 at any cross section of the wireway. Conductors for signaling circuits, conductors used only for starting a motor, and neutral conductors that carry only the unbalanced load are not considered current carrying conductors.

The 2011 NEC required the ampacity of conductors inside of a metal wireway to be adjusted if the total number of conductors inside the wireway was greater than 30. By adding "at any cross section of the wireway" the 2014 NEC will limit when ampacity adjustment factors will be required to be applied for metal wireways.

For example, if in a wireway there are a total of 50 wires, but no more than 25 wires at any cross section, no ampacity adjustment is necessary. This is important because the ampacity adjustment factors in Table 310.15(B)(3)(a) for 31-40 conductors is 40% and for 41 conductors and above the adjustment factor is 35%.

If for instance there are 38, No. 3 conductors, rated at 100 amps each from Table 310.15(B)(16), but no more than 12 conductors at any cross section, in the 2011 Code each conductor could only carry 40 amps (100 amps x 40%), but in the 2014 each conductor could carry the full 100 amps because no ampacity adjustment is required.

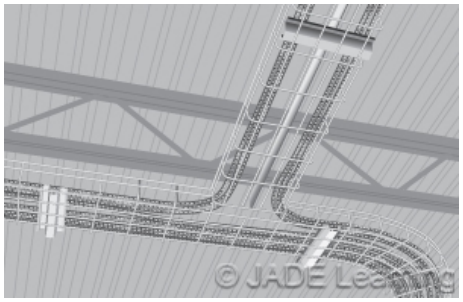
Another example: if there are 42 conductors at any cross section of a wireway, and each conductor is rated at 130 amps, the maximum amount of current each conductor can carry is 45.5 amps (130 amps x 0.35).

Question 13: How much current can a conductor which is rated for 65 amps carry if it is installed in a metal wireway with 35 other conductors, but there are never more than 20 conductors at any cross section of the wireway?

A: 65 amps.
B: 52 amps.
C: 35 amps.
D: 26 amps.

Question 14: 392.20(A)&(B) Multiconductor Cables Operating at 600 Volts or Less. Cables Operating at Over 600 Volts.

Question ID#: 710.0



Cables operating at 600 volts or less are permitted to be installed with those operating at over 600 volts if they are separated with a barrier.

Cables in cable tray or raceway are often ***operated at voltages less than the voltage rating of the cable***. A cable that is ***rated*** for 600 volts might be ***operated*** at 480 volts. A cable that is rated for 5000 volts might be operated at 2000 volts. There is a big difference between the voltage rating of a cable and the voltage at which the cable operates.

The revisions to this section changed the yardstick that is used to determine how multiconductor cable is installed in cable tray from the voltage rating of the cable to the circuit operating voltage.

Conductors that operate at over 600 volts must be separated from conductors operating at 600 volts or less if installed in the same cable tray. Either the cables operating at over 600 volts must be installed in MC cable, or a permanent barrier must be installed between the cables operating at 600 volts or less and the cables operating at over 600 volts.

These requirements add cost and complexity to a job. Under the 2011 NEC, if some cables were rated for over 600 volts, even if the circuit voltage for all the cables in the cable tray was 480 volts, the cables that were rated for over 600 volts had to be

separated from the cables with a 600 volt rating. Now, even if some of the cables in the cable tray have a voltage rating of more than 600 volts, and some of the cables have a voltage rating of 600 volts or below, if the operating voltage for all cables in the tray is 600 volts or below, the cables are not required to be separated.

Question 14: The OPERATING VOLTAGE for all cables in a cable tray is 480 volts. One cable in the tray is RATED for 2000 volts and the other is RATED at 600 volts. Which of the following statements is correct?

A: The cables with different voltage ratings must be separated by a fixed barrier.
B: The cables may be installed in the cable tray without a fixed barrier.
C: The cable with the higher voltage rating must be installed in MC cable.
D: Cables with different voltage ratings cannot be installed in the same cable tray.

Question 15: Article 393 Low Voltage Suspended Ceiling Power Distribution Systems.

Question ID#: 711.0

Low-voltage suspended ceiling power distribution systems are permitted to supply listed utilization equipment in indoor dry locations, for residential, commercial, or industrial installations.

Low-voltage suspended ceiling power distribution systems use special ceiling grid rails as a bus to distribute low voltage power throughout a suspended ceiling. Luminaires and other low voltage equipment and sensors are electrically connected to the grid with special connectors. This system is well suited for LED luminaires.

With a low-voltage suspended ceiling power distribution system in place, luminaires can be easily repositioned when a building tenant wants to change the layout of a room. Without changing the grid, the luminaires can be moved around by simply connecting the luminaire to a different point on the grid. Operating voltages of 30 VAC or 60 VDC mean the risk of electric shock will be much less than with standard 120 or 277 AC voltages. Qualified electricians will install the low voltage bus that attaches to the ceiling grid. Other trades will install the ceiling grid.

A standard branch circuit will supply the listed Class 2 power supply for the ceiling grid bus. A power distribution cable or connector will connect the power supply to the busbar.

Low-voltage suspended ceiling power distribution systems are permitted to supply listed utilization equipment in indoor dry locations, for residential, commercial, or industrial installations, and in other spaces used for environmental air. The systems are NOT permitted in damp or wet locations, where subject to corrosive fumes or physical damage, in concealed or classified locations, for lighting in critical or general care areas of a health care facility, or as part of a fire-rated floor-ceiling or roof-ceiling assembly.

Question 15: Where can low-voltage suspended ceiling power distribution systems be installed?

A: In a battery room with corrosive fumes.
B: In a wet or damp location.
C: In a Class I, Division 2 location.
D: Inside an office building.

Chapter 4

Question 16: 400.7(A)(11) Flexible Cords and Cables. Uses Permitted.

Question ID#: 713.0

New text added in Section 400.7(A)(11) states that:

400.7(A)(11) Between an existing receptacle outlet and an inlet, where the inlet provides power to an additional single receptacle outlet. The wiring interconnecting the inlet to the single receptacle outlet shall be a Chapter 3 wiring method. The inlet, receptacle outlet, and Chapter 3 wiring method, including the flexible cord and fittings, shall be a listed assembly specific for this application.

There are listed products, like Legrand's Flat Screen TV Cord and Cable Power Kit, that are available to connect wall-mounted flat screen TVs without wires showing on the outside of the wall.

Do-it-yourself homeowners were using extension cords installed inside a wall to connect a wall-mounted flat screen TV to an existing receptacle outlet, so that cords did not show outside the wall. This is a clear violation of section 400.8, Uses Not Permitted for flexible cords and cables.

A listed power and cable kit, consisting of a cable installed inside the wall that connects a flanged inlet to an existing receptacle, will now be one of the uses permitted for flexible cords and cables.

The inlet, receptacle outlet, and wiring method need to be a listed assembly specific for the application.

Question 16: When connecting a wall-mounted flat screen TV to a receptacle outlet which of the following methods is not permitted?

A: Plugging the TV cord into an existing outlet with the cords on the outside of the wall.
B: Installing a standard extension cord inside the wall between the TV and an existing outlet.
C: Installing a listed cord and cable power kit assembly.
D: Installing a new receptacle outlet directly behind the flat screen TV.

Question 17: 404.2(C) Switches Controlling Lighting Loads.

Question ID#: 714.0

In the 2011 NEC, a grounded circuit conductor was first required at the switch location for a switch controlling lighting loads that are supplied by a grounded general-purpose branch circuit. The reason for the requirement is to provide a grounded conductor for an electronic control device, like an occupancy sensor, that needs a grounded conductor for the device to operate.

Two conditions where the grounded circuit conductor is not required to be provided at the switch location have been carried over from the 2011 NEC. Five new conditions have been added that would make a grounded conductor at the switch location unnecessary.

A grounded circuit conductor is not required at the switch location for lighting loads:

(1) Where the conductors enter the switch box through a raceway.

(2) Where the switch box is accessible for additional cable without removing finish materials.

(3) Where the switch has an integral enclosure, such as those used for doorjamb switches.

(4) Where a switch does not serve a habitable room or bathroom, such as in an attic.

(5) Where there is more than one switch location, such as for 3-way or 4-way

There are now seven situations where a grounded circuit conductor is not required at the switch location.

switches, and the entire floor area of the room is visible from a single or combined switch locations.

(6) Where the lighting in the area is controlled by automatic means, such as a ceiling mounted occupancy sensor.

(7) Where a switch controls a receptacle load.

One reason for requiring a grounded neutral conductor at a switch location is to provide for occupancy sensors. Therefore, it makes sense to omit a grounded conductor if there is already an occupancy sensor installed in the ceiling, if only travelers run between switch locations, such as when using a 4-way switch, and if the room with the switch is not habitable, like a closet or attic.

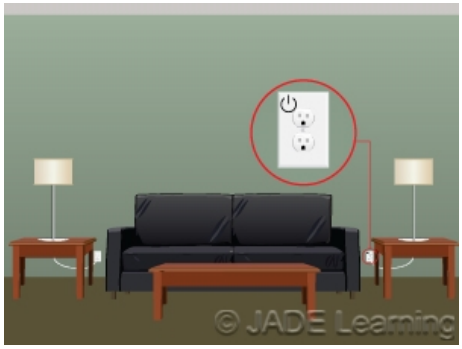
Question 17: Assume the switches are wired with NM-Cable not installed in a raceway and that the switch boxes will be enclosed in a finished wall.
When is a grounded conductor required at a switch location for a lighting load?

A: When the switch is installed in the living room in a dwelling.
B: When the switch controls lighting in a storage closet.
C: When the switch controls switched receptacles in a motel.
D: When a ceiling mounted occupancy sensor automatically controls the lighting in the room.

Question 18: 406.3(E) Receptacle Rating and Type. Controlled Receptacle Marking.

Question ID#: 717.0

Nonlocking receptacles rated 125-volts, 15- and 20-amperes, that are controlled by an automatic control device like an energy management system, a timer, or an occupancy sensor, must be marked with the symbol shown below. Switched receptacles that are controlled by a wall switch and provide one of the required room lighting outlets permitted by 210.70 are not required to have the marking.



Nonlocking-type 125-volt, 15- and 20-ampere receptacles that are controlled by an automatic control device must be marked with the new symbol.

Energy management codes, like ASHRAE 90.1, require that up to 50% of 125-volt 15- and 20-ampere receptacles are automatically controlled. If a receptacle is being turned off or turned on automatically, the user needs to be able to identify which receptacles are being controlled.

Automatic control of lighting and HVAC loads is common. Most people know and understand that an automatic system can turn the lights off in a building and control the heating and cooling systems.

Automatically controlling a receptacle is less certain because a number of different type loads can be connected to a receptacle outlet. Table lamps are plugged into receptacle outlets and can be controlled automatically. Some types of electronic equipment, like computers, will still consume power in sleep mode and will save energy if completely turned off.

Marking receptacle outlets that are controlled by an energy management system will be a convenience for users who may see luminaires or appliances unexpectedly turn on or turn off.

Question 18: Which receptacles are required to have the controlled receptacle marking?

A: Receptacles that are in common areas of buildings.
B: Receptacles in dwellings that are controlled by a wall switch.
C: Receptacles that provide power to air conditioning units.
D: Receptacles that are controlled by an energy management system.

Question 19: 406.4(D) General Installation Requirements. Replacements.

Question ID#: 718.0

Replacement receptacles for arc-fault and ground-fault circuit-interrupter type receptacles must now be installed in a readily accessible location.

From the 2011 NEC, when a receptacle outlet is located in an area that requires GFCI protection, the replacement receptacle must be GFCI protected. When a receptacle outlet is located in an area that requires AFCI protection, the replacement receptacle must be AFCI protected. In the 2014 NEC, those replacement receptacles must be readily accessible.

The reason for the new rule is to give the occupant a way to test the devices, as required by the manufacturer, and to reset them if they have tripped. In the long run, this requirement will cut down on service calls to reset a tripped device.

Readily accessible means the device can be reached quickly without removing obstacles or using ladders. An example of a GFCI type receptacle that must be readily accessible is the garage door opener at a dwelling. Outlets in garages are required to be GFCI protected, but a GFCI type receptacle cannot be mounted in the ceiling because that is not readily accessible.

AFCI and GFCI replacement receptacles need to be readily accessible.

Question 19: Which of the following locations may be considered readily accessible?

A: Eight feet above the floor.
B: Some walk-in clothes closets.
C: Behind a wall-mounted electric drinking fountain.
D: Behind a large appliance fixed in place.

Question 20: 406.5(E) Receptacles in Countertops and Similar Work Surfaces.

Question ID#: 719.0

In the 2011 NEC, receptacles were not allowed to be installed in the face-up position in dwelling units. "Dwelling units" was deleted in the 2014 NEC for this section, and now receptacles cannot be installed in the face-up position in any location, unless they are listed as receptacle assemblies for countertop applications.

The same problems of having liquids, food, or other scraps fall into a receptacle that is mounted face-up exist in any location, not just in dwelling units.

There are listed assemblies for countertop applications where the receptacle pops up out of the counter, then can be pushed back down when not in use. In the down position the hole for the receptacle assembly is sealed against liquids and debris. In the up position, the receptacle face is perpendicular to the countertop surface.

Receptacles on a kitchen countertop and within 6 ft. of a sink are required to be GFCI protected. When a receptacle assembly listed for countertop applications is required to provide GFCI protection, the receptacle assembly is permitted to be listed as a GFCI receptacle assembly for countertop applications.

Listed receptacle assemblies for countertops solve an installation problem when there is not a backsplash on the counter and mounting a receptacle below the countertop is not practical.

Only listed receptacle assemblies can be installed for countertop applications.

Question 20: Which of the following statements about receptacles in countertops is true?

A: If the countertop does not have a backsplash, the receptacle can be mounted in the face-up position.
B: A listed receptacle assembly for countertop applications can be installed in a countertop.
C: Listed receptacle assemblies for dwelling unit kitchen countertops are not required to be GFCI protected.
D: If the countertop has a backsplash, using a listed receptacle assembly is prohibited.

Question 21: 406.9(B)(1) Receptacles of 15 and 20 Amperes in a Wet Location.

Question ID#: 722.0

"Extra duty" covers are now required for 15- and 20-ampere receptacles in wet locations at dwelling and non-dwelling locations. In earlier Codes the extra duty covers were only required at non-dwelling locations if the receptacle was supported from grade. In the 2014 NEC the extra duty covers are required at dwellings and non-dwelling locations if the receptacle is installed in a wet location, whether it is mounted directly to the building or supported from grade by another structure.

In an independent study, the "in use" covers used in residential applications had a 90% failure rate. With the slightest contact the "in use" cover broke off and left the receptacle exposed to the weather.

The requirement for the extra duty cover only applies to 15 and 20 ampere rated receptacles in a wet location. In addition, 15 and 20 amp, 125 volt through 250 volt receptacles in a wet location must be of the listed weather-resistant (WR) type. WR type receptacles will hold up better in a wet location, but without a cover that protects the receptacle, the receptacle will be exposed to rain, sleet, or snow, which will shorten the life of the receptacle.

According to Article 100, a wet location is an unprotected location exposed to the weather. A damp location is protected from the weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture.

The extra duty covers required in residential, commercial, and industrial locations will protect the receptacle from the elements whether or not the attachment plug cap is inserted.

"Extra duty" covers are now required for 15- and 20-ampere outlets in wet locations at dwelling units.

Question 21: Which of the following types of receptacles when installed in a wet location require an extra duty cover?

A: 125-volt, nonlocking-type, 30 amp.
B: 125-volt, locking-type, 30 amp.
C: 250-volt, nonlocking-type, 15 amp.
D: 250-volt, nonlocking-type, 30 amp.

Question 22: 406.12 Tamper-Resistant Receptacles.

Question ID#: 723.0

Tamper-resistant receptacles are required for nonlocking type 125-volt, 15- and 20-ampere receptacles in dwellings, guest rooms and guest suites of hotels and motels, and child care facilities.
There are four exceptions where tamper-resistant receptacles are not required:

- Receptacles located more than 5 Â½ ft. above the floor.
- Receptacles that are part of a luminaire or appliance.
- A single receptacle or a duplex receptacle for two appliances located within dedicated space and not easily moved.
- Nongrounding receptacles used for replacements.

The exceptions cover locations where children cannot reach the receptacle, and there was no reason why these receptacles would be more accessible to children in hotels or motels or child care facilities than in dwellings.
It should be noted that for hotels and motels, the requirement for tamper resistant receptacles only applies within the guest rooms or guest suites. Receptacles located in the hotel/motel office, lobby, breakfast area or other common areas outside of a guest room or guest suite are not required to be tamper resistant.

Exceptions 1 and 2 cover receptacles that are out of reach of a child.Â Exception No.

Receptacles in dwelling units, hotel guest rooms, and child care facilities must be tamper-resistant unless covered by one of the 4 exceptions.

3 recognizes that a child could not move an appliance that was large enough to be in a dedicated space.Â Exception No. 4 acknowledges that nongrounding type receptacles are not available as tamper-resistant.

Question 22: Which location does NOT require tamper-resistant receptacles?

A: The lobby of a motel.
B: The kitchen in a dwelling.
C: The sleeping area in a hotel guest room.
D: The reception area of a day care facility for children.

Question 23: 408.4(B) Field Identification Required. Source of Supply.

Question ID#: 726.0

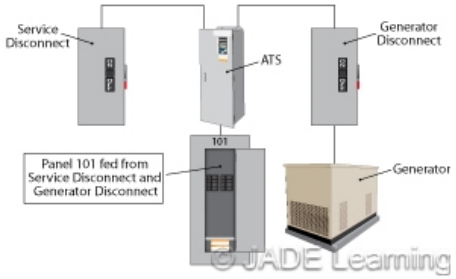
All switchboards, switchgear, and panelboards supplied by a feeder(s) in other than one- or two-family dwellings shall be marked to indicate each device or equipment where the power originates.

The change is that now ***each*** device or equipment where the power originates must be marked on a switchboard, switchgear, or panelboard.

Optional standby systems and legally required or emergency systems are very common in commercial and industrial systems. They are a second source of power for electrical distribution systems. Also, storage batteries, a second utility service, or alternate energy systems, like solar PV or wind generators, can be connected to switchboards, switchgear, and panelboards.

When there is more than one source of power to a distribution network, every source must be marked to indicate not only where the normal source originates, but any additional sources.

The more detail that is included on the sign, the more helpful it will be. The requirement says "each device or equipment" must be identified, so a general description of where the source is located is not good enough. A sign that says, "Circuit 3A fed from Standby Generator," is not as good as a sign that says, "Circuit 3A fed from Standby Generator Located in Basement Electrical Room." Likewise, a sign that says, "Circuit 4B fed from PV Disconnect Switch Located East End Building 1" is better than a sign saying "Circuit 4B fed from PV System."



Switchboards, switchgear, and panelboards must be marked to indicate where the power originates, in other than one- or two-family dwellings.

Question 23: Which of the following is the best example of a sign which is located at a switchboard that is supplied by a service disconnect and an optional standby system?

A: Service disconnect located in electrical room on ground floor.
B: Standby generator located rear of building on the first floor.
C: Switchboard supplied from panelboard in electric room.
D: Switchboard supplied from service disconnect located west wall in electrical room. Switchboard also supplied by generator located next to loading dock.

Question 24: 410.23 Covering of Combustible Material at Outlet Boxes.

Question ID#: 731.0

Section 410.23 addresses installations where a luminaire is surface mounted over an outlet box that has been recessed into a combustible wall or ceiling finish and the edge of the luminaire housing extends beyond the opening for the outlet box. The revised text states that ***any combustible wall or ceiling finish exposed between the edge of a luminaire canopy or pan and an outlet box having a surface area of 1160 mm2 (180 sq. in.) or more shall be covered with noncombustible material***. Previous editions of the NEC required the combustible wall covering between the opening for the outlet box and the edge of the canopy to be covered with noncombustible material in all cases.

A combustible surface area of 180 sq. in. or more must be covered with noncombustible material.

Sheetrock is the most common material used for wall and ceiling finishes but some installations involve mounting the luminaire over an outlet box that has been recessed into combustible surfaces such as wood wall paneling, tongue and groove wood ceilings, and even decorative wooden beams. According to the Code change, these types of installations would require the exposed combustible surface under the canopy of the luminaire to be covered with noncombustible material if the surface was 180 sq. in. or more.

Section 410.6 requires all luminaires to be listed. Canopy-type luminaires that have been listed by a nationally recognized testing laboratory have been tested and found to be suitable to be surface mounted over an exposed combustible surface less than 180 sq. in. without subjecting the combustible surface to more than 90Âº C per section 410.11. Anything larger than that has not been evaluated by a testing lab, and the exposed combustible surface must be covered with noncombustible material.

Question 24: Which of the following installations requires a wall finish to be covered with noncombustible material?

A: A luminaire installed over an outlet box, recessed in wood paneling, where a 13 inch X 13 inch section of the wood surface is exposed under the luminaire canopy.
B: A luminaire installed over an outlet box, recessed in wood paneling, where a 12 inch X 15 inch section of the wood surface is exposed under the luminaire canopy.
C: A luminaire installed over an outlet box, recessed in wood paneling, where less than 180 sq. in. of the wood surface is exposed under the luminaire canopy.
D: A luminaire installed over an outlet box, recessed in a noncombustible surface, where 200 sq. in. of the surface is exposed under the luminaire canopy.

Question 25: 410.130(G) Disconnecting Means.

Question ID#: 732.0

Fluorescent luminaires with double-ended lamps and ballasts require a disconnecting means either inside or outside each luminaire. For existing luminaires without disconnecting means, a disconnecting means must be installed when the ballast is replaced.

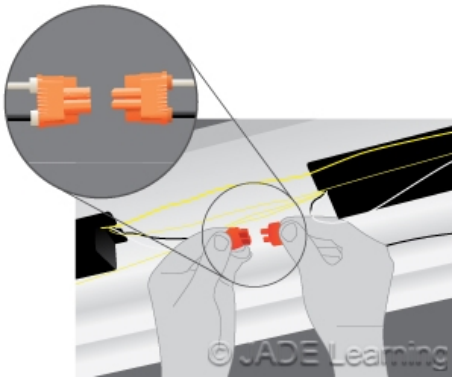
The 2011 NEC had an exception for industrial establishments with qualified persons to service the luminaires. The 2014 NEC has deleted that exception.

The arguments to delete the exception and require fluorescent luminaires in industrial locations to have disconnecting means were about providing the same level of protection to qualified persons when servicing luminaires as was required elsewhere.

The popular inline disconnects used with fluorescent luminaires have made installing them in existing luminaires quick and relatively inexpensive.

The remaining 4 exceptions to 410.130(G) are:

- Luminaires in hazardous locations do not require a disconnecting means.
- Emergency lighting, including exit signs, do not require a disconnecting means.
- Cord-and-plug connected luminaires are considered to already have a disconnecting means if the plug and receptacle are accessible.
- If there is more than one luminaire in a space, and there is a way to disconnect the luminaires so that the space cannot be left in total darkness, then each luminaire is not required to have a disconnecting means.



Industrial locations now also require that fluorescent luminaires with double-ended lamps and ballasts have a disconnecting means.

Question 25: Which of the following luminaires require a disconnecting means for each luminaire?

A: An LED luminaire in an office conference room.
B: An HID luminaire in a big box retail store.
C: A fluorescent luminaire in a hazardous location.
D: A fluorescent luminaire in an industrial facility.

Question 26: 422.5 Appliances. Ground-Fault Circuit-Interrupter (GFCI) Protection.

Question ID#: 734.0

All GFCI devices that are required by Article 422 for appliances must be readily accessible.

Section 422.5 states that the device providing GFCI protection shall be readily accessible. According to Article 100 definitions, readily accessible means ***capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to actions such as to use tools, to climb over or remove obstacles, or to resort to portable ladders, and so forth.***

Similar requirements can be found in section 210.8 for dwelling and non-dwelling locations. Making sure that the GFCI is readily accessible ensures that the device can easily be reached for routine testing to confirm proper operation.

Placing a GFCI receptacle behind a large vending machine or behind a cord-and-plug connected electric drinking fountain makes it difficult for those who are troubleshooting the circuit and now is a Code violation. Many installers remedy the situation by using a GFCI circuit breaker located in a readily accessible panelboard rather than a GFCI-type receptacle which may be considered readily accessible up until the time that a large vending machine gets delivered and installed in front of the device.

GFCI devices required by Article 422 must be readily accessible.

Question 26: Which of the following receptacles is required to be readily accessible?

A: A receptacle that does not require GFCI protection.
B: A GFCI-type receptacle that supplies power to a drinking fountain.
C: A receptacle that is supplied by a GFCI breaker in a panelboard.
D: A receptacle that provides power for a vending machine that has its own GFCI built into the appliance cord.

Question 27: 422.19,422.20,422.21 Requirements for Outlet Boxes.

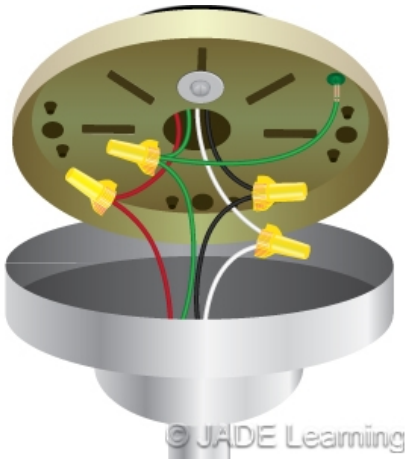
Question ID#: 736.0

New sections 422.19, 422.20, and 422.21 have been added to provide specific requirements for ceiling-suspended paddle fans.

Section 422.19 now permits the cubic inch capacity of a ceiling suspended (paddle) fan canopy and the outlet box to be added together to provide sufficient space for conductors and their connecting devices. It is important that there is enough space within the box and canopy of a ceiling fan to make all the needed connections. Sometimes a ceiling fan box becomes a junction box for other conductors besides those for the actual fan. This practice is allowable as long as the box complies with Section 314.16 and has sufficient space for all conductors within the box.

Section 422.20 states that in a completed installation, each outlet box shall be provided with a cover unless covered by means of a ceiling-suspended (paddle) fan canopy. Similar language is found in 410.22 which allows a luminaire, lampholder, or receptacle to be used for this purpose but does not include a ceiling fan as an acceptable way to cover the box.

Section 422.21 requires any combustible ceiling finish exposed between the edge of a ceiling-suspended (paddle) fan canopy or pan and an outlet box to be covered with noncombustible material. This is important for installations where a ceiling fan is mounted over an outlet box that has been recessed into a combustible ceiling such as wood paneling or a tongue and groove wood finish. It is common for the canopy of a ceiling fan to be significantly larger than the outlet box that it covers thus leaving an exposed combustible surface present next to the wiring splices. These surfaces are now required to be covered with noncombustible material.



Canopies and outlet boxes must provide sufficient space for the conductors and their connecting devices.

Question 27: What is the purpose of providing sufficient space within an outlet box and a ceiling fan canopy?

A: To provide enough room for future connections.
B: To allow space for devices such as remote control fan receivers.
C: To provide enough room for future conductors.
D: To provide enough room for conductors and splicing devices.

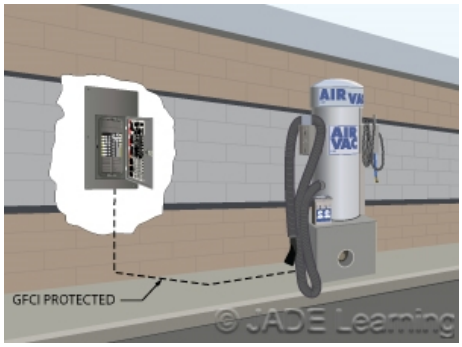
Question 28: 422.23 Tire Inflation and Automotive Vacuum Machines.

Question ID#: 737.0

A new section has been added to Article 422 in order to provide an additional level of protection for the public.

Section 422.23 requires tire inflation and automotive vacuum machines provided for public use to be protected by a ground-fault circuit-interrupter (GFCI).

Tire inflation and automotive vacuum machines are heavily used and abused.Â Â Â Â They are located outdoors and exposed to all weather conditions.Â The electrical components can become damaged from constant use.Â The areas around the machines can be wet and a person could be standing in water while using the equipment.Â Â



Tire inflation and automotive vacuum machines need GFCI protection.

The Consumer Product Safety Commission reported a patron was killed while operating an automotive vacuum machine.Â Ground-fault circuit-interrupter protection has proved to be an effective way to protect people while using appliances, especially when used in wet locations.

Note that the new requirement for GFCI protection is not voltage specific nor does it specify that the GFCI protection be in the form of a receptacle at the equipment or a GFCI breaker where the circuit originates.

The following is a partial list of locations where GFCI protection is currently required:

- Bathrooms (125-volt,15-and 20-amp) receptacles)
- Dwelling unit garages & accessory buildings (125-volt, 15- and 20-amp receptacles)
- Outdoors (125-volt, 15-and 20-amp receptacles)
- Dwelling unit crawl spaces (125-volt, 15-and 20-amp receptacles)
- Unfinished basements in dwellingsÂ (125-volt, 15-and 20-amp receptacles)
- Kitchens (125-volt, 15-and 20-amp receptacles)
- Within 6 feet of a sink (125-volt, 15-and 20-amp receptacles)
- Boathouses (125-volt, 15-and 20-amp receptacles)
- Rooftops (125-volt, 15-and 20-amp receptacles)
- Indoor wet locations (125-volt, 15-and 20-amp receptacles)
- Locker rooms with associated showering facilities (125-volt, 15-and 20-amp receptacles)
- Repair garages and aircraft hangars where electric hand tools are used (125 volt, 15-and 20-amp receptacles)
- Dwelling unit boat hoists (up to 240 volts)
- ***Tire inflation and vacuum machines for public use (any voltage)***
- Circuits supplying floor heating cables (any voltage)
- Agricultural buildings
- Receptacles on portable generators 15 kw or smaller (125-volt, 15-and 20-amp receptacles)
- Elevator pits (125-volt, 15-and 20-amp receptacles)
- Pool lighting
- Single-phase 15- or 20-amp 120- or 240-volt swimming pool pump motors
- Electric pool covers
- Spas, hot tubs, hydromassage and therapeutic tubs
- Floating buildings

Â

Question 28: Which of the following types of equipment require ground-fault circuit-interrupter protection?

A: All tire inflation machines.
B: All automotive vacuum machines.
C: Air compressors rated at 240 volts inside a dwelling unit garage.
D: An automotive vacuum installed for public use.

Question 29: 422.51 Vending Machines.

Question ID#: 739.0

New requirements for ground-fault circuit-interrupter protection (GFCI) at vending machines have been added to Section 422.51. Now vending machines that are directly wired, as well as those that are cord-and-plug connected, are required to be GFCI protected.

422.51(A) is similar to the vending machine section in the 2011 NEC, but requires a ground-fault circuit-interrupter that is a part of the attachment plug to be identified for portable use. Cord-and-plug connected vending machines that are manufactured or remanufactured on or after January 1, 2005, must include a ground-fault circuit-interrupter identified for portable use as an integral part of the attachment plug or be located in the cord within 300 mm (12 in.) of the attachment plug if it is not built into the plug itself. Older vending machines manufactured or remanufactured prior to January 1, 2005, must be connected to a GFCI protected outlet. The GFCI protection can be provided by using a GFCI-type receptacle or installing a GFCI breaker ahead of the branch circuit in the panelboard.

Vending machines that are hardwired must be connected to a GFCI protected circuit.

422.51(B), which is new in the 2014 NEC, states that vending machines not utilizing a cord-and-plug connection shall be connected to a GFCI protected circuit. The same hazard exists for vending machines that are hardwired as for those that are cord-and-plug connected. Vending machines are often installed in damp or wet locations and subject to heavy use or abuse by the general public. In the event of an electrical malfunction, it is important that GFCI protection be present for the vending machine whether the machine is cord-and-plug connected or directly wired to the branch circuit without the use of a receptacle. It is also important that the GFCI device is readily accessible according to 422.5.

Question 29: Which of the following is true of vending machines that are not cord-and- plug connected?

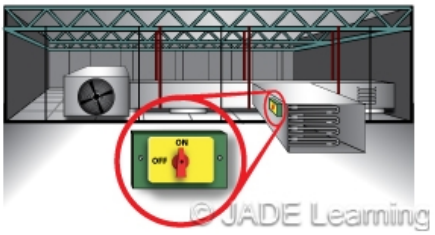
A: They must be connected to a receptacle that is GFCI protected.
B: They must be connected to a circuit that is GFCI protected.
C: They must be connected to a GFCI-type receptacle.
D: They must be equipped with a GFCI that is integral to the attachment plug.

Question 30: 424.66(A)&(B) Duct Heaters. Installation. General and Limited Access.

Question ID#: 741.0

There are new requirements for working space around duct heaters installed above a suspended ceiling.

In the past, this type of heater was often installed above suspended ceilings with little regard for providing access to the equipment or safe working conditions for individuals who would service the equipment after the installation was complete. In earlier editions of the NEC, Section 424.66(A) included a note telling the reader to "See 110.26." However, it did not require that the installation comply with the minimum working space clearances given in Section 110.26. Previously, 424.66 just stated that "sufficient clearance" was to be provided for servicing the equipment without specifying minimum working space requirements.



There are new requirements for access to duct heaters installed above a ceiling including a minimum working space width of 30 inches.

424.66(B) Limited Access

When electric duct heaters are installed in a space above a ceiling, the following requirements apply:

- They are required to be accessible through access panels or by removal of suspended ceiling panels.
- The working space must be 30 inches wide or the width of the equipment, whichever is greater.
- Access panels and doors on the equipment are required to open 90 degrees or more.
- The minimum depth of working space in front of the equipment is to comply with the requirements of Table 110.26(A)(1).

Question 30: An electric duct heater that measures 28 inches wide is installed in a limited access space above a ceiling. Which of the following statements is correct?

A: The width of the required work space is 30 inches.
B: The width of the required work space is 28 inches.
C: The width of the required work space is 40 inches.
D: The width of the required work space is 48 inches.

Question 31: 445.11 Generators. Marking.

Question ID#: 747.0

Major revisions have been made to the marking requirements for generators. Some re-organizing now requires that the marking requirement for power factor, subtransient and transient impedances, insulation system class, and time rating is only for nameplates of generators larger than 15 kW.

The most significant change to this section is the new requirement that marking shall be provided by the manufacturer to indicate whether or not the generator neutral is bonded to the generator frame. Since generators are permitted to be installed either as a separately derived system or not, this change will greatly assist installers and inspectors as they try to determine proper bonding requirements, transfer switch application, and signage required by 700.7, 701.7, and 702.7.

Generators now must be marked to indicate whether or not the generator neutral is bonded to the generator frame.

In many installations, the generator supplier will install the generator and an electrical contractor will provide all wiring methods from the generator through the transfer switch and on to the loads served by the generator. Since the electrician is contracted only to install the wiring methods, it is quite common for the electrician to have no idea if the generator is equipped with a system bonding jumper. Prior to this Code change, it was very common for the electrical inspector to request that the generator enclosure be dismantled in order to verify if the generator contained a system bonding jumper. Based on the findings, the inspector could then inspect the generator as either a separately derived system or a system that is not separately derived.

The last part of this Code change specifies that where the bonding of a generator is modified in the field, additional marking shall be required to indicate whether or not the generator neutral is bonded to the generator frame.

Question 31: When the bonding of a generator has been field modified, additional marking shall be required to indicate which of the following?

A: Whether or not the generator neutral is bonded to the grounding electrode.
B: Whether or not the generator equipment grounding conductor is bonded to the generator frame.
C: Whether or not the generator neutral is bonded to the generator frame.
D: Whether or not the generator neutral is bonded to the grounded conductor.

Question 32: 445.18 Disconnecting Means Required for Generators.

Question ID#: 748.0

Working on generator installations should be safer for maintenance personnel because of the changes made to 445.18.

Generators must be equipped with a disconnecting means which is lockable in the OFF (open) position and which will disconnect all of the circuits supplied from the generator. Portable generators are not included in this requirement because cords that are plugged into the generator can simply be removed from the receptacles mounted on the generator. Also, a portable generator that is connected to a flanged inlet device can easily be unplugged.

A generator disconnecting means is not required if both of the following conditions are met:

- The driving means for the generator can be readily shut down, is rendered incapable of restarting, and is lockable in the OFF position in accordance with 110.25.
- The generator is not arranged to operate in parallel with another generator or other source of voltage.

Requiring the driving means for a generator to be shut down, locked out, and prevented from automatically restarting will mean working on generators in the field will be safer for personnel.

It is important to remember that the requirements in 445.18(2) are not the same as the disconnecting requirements found in 700.12, 701.12, and 702.12, which apply to the disconnection of conductors supplied by an outdoor generator. These requirements allow the generator to keep running as long as the conductors supplied by the generator that serve or pass through a building can be disconnected whereas the requirements in 445.18(2)(a) require that all circuits supplied by the generator be shut down completely by a disconnecting means that can be locked in the OFF position.

Generators must be equipped with a disconnecting means which is lockable in the OFF position unless cord-and-plug connected or the driving means can be shut down and not restart and not arranged to operate in parallel.

Question 32: Which of the following types of generators is NOT required to be equipped with a lockable disconnect switch?

A: A generator on wheels that only has lug terminals for hardwired connections.
B: A generator on wheels that only has provisions for cord-and-plug connected loads.
C: A generator that is permanently installed and wired in parallel with another generator.
D: A generator that is permanently installed and capable of being re-started from 3 different remote locations in the event that the generator turns off.

Question 33: 450.10(A) Grounding. Dry-Type Transformer Enclosures.

Question ID#: 750.0

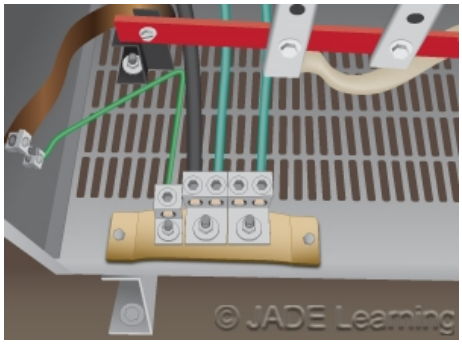
There are new requirements for grounding dry-type transformer enclosures. Connections for equipment grounding conductors and supply-side bonding jumpers must now be made at a terminal bar that is mounted inside the transformer enclosure.

The terminal bar must be bonded to the enclosure and cannot be installed on or over any vented portion of the enclosure.

There is an exception that permits the grounding and bonding connections for dry-type transformers with wire-type leads to be made with pressure connectors, fasteners, or any of the other methods in 250.8.

When a terminal bar is mounted to the transformer enclosure, it is important that the terminal bar or the conductors connected to it do not block the vents that provide air flow around the transformer coils.

A terminal bar will ensure that all of the grounding and bonding connections made at the transformer have a common point and do not depend on the metal transformer enclosure to tie the connections together.



Where separate equipment grounding conductors and supply-side bonding jumpers are installed, a terminal bar for all grounding and bonding conductor connections shall be secured inside the transformer enclosure.

Question 33: When can the grounding and bonding connections be made at a dry-type transformer without using a terminal bar?

A: When the transformer is connected as a step-down transformer.
B: When the transformer is mounted 8 ft. or more above the floor.
C: When the transformer is equipped with wire-type connections.
D: When the transformer is equipped with vented openings.

Question 34: 480.9 Battery Locations.

Question ID#: 754.0

A number of new requirements have been added for battery locations:

480.9(C) Spaces About Battery Systems
Minimum 1 inch clearance between a battery and a wall on the side that does not require maintenance. Work space is measured from the edge of the battery cabinet, rack, or tray.

480.9(D) Top Terminal Batteries
When batteries with terminals on the top are installed on racks, the required working space between the batteries and the row or ceiling above the batteries is per the manufacturer's instructions.

480.9(E) Egress
The personnel doors for entrance to or egress from the battery room must open in the direction of egress and be equipped with panic hardware.

480.9(F) Piping in Battery Rooms
No gas piping is permitted in a dedicated battery room.

480.9(G) Illumination
Illumination must be provided in a battery room unless the battery room is lit from an adjacent light source. Lighting cannot be controlled by automatic means only. Lighting cannot expose personnel servicing the luminaires to energized battery components.

A personnel door(s) intended for entrance to, and egress from, rooms designated as battery rooms shall open in the direction of egress and shall be equipped with listed panic hardware.

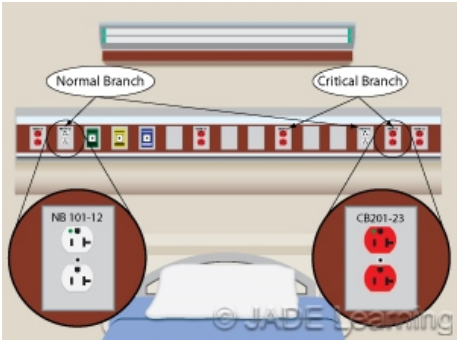
Question 34: How is battery system working space to be measured?

A: From the edge of the battery.
B: From the center of the battery.
C: From battery terminals.
D: From the edge of the battery cabinet, racks, or trays.

Chapter 5

Question 35: 517.18(A) & (B) Patient Bed Location and Receptacles.

Question ID#: 764.0



Patient bed locations shall be supplied by at least two branch circuits; receptacles supplied from the critical branch shall be readily identifiable.

Section 517.18(A) and (B), which apply to general care areas within health care facilities, have seen significant revisions regarding branch circuit identification and minimum number of receptacles required at patient bed locations.

Section 517.18(A) deals with the minimum number of branch circuits required to serve patient bed locations and requires each patient bed location to be supplied by at least two branch circuits, one from the ***critical branch*** and one from the normal system. The term "emergency system", which was used in previous Code editions, has been replaced with the term "critical branch". A new requirement in this section requires that the electrical receptacles or the cover plate for receptacles supplied from the critical branch have a distinctive color or marking so as to be readily identifiable. The receptacles or cover plates shall also indicate the panelboard and branch-circuit number supplying them.

Section 517.18(B) specifies the minimum number of receptacles required to serve patient bed locations in general care areas. In order to correlate with the new rules found in NFPA 99 ***Health Care Facilities Code,*** the previous requirement of at least four receptacles has been increased to eight. The revised text states that each patient bed location shall be provided with a minimum of eight receptacles. They shall be permitted to be of the single, duplex, or quadruplex type or any combination of the three. A duplex receptacle is counted as 2 receptacles, and a quad receptacle is counted as 4 receptacles.

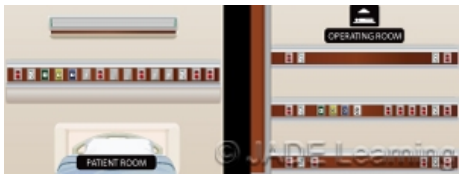
All receptacles shall be listed "hospital grade" and shall be so identified. As part of the listing process, receptacles that are listed as "hospital grade" are required to be identified by the green dot on the front of the receptacle as well as marked "Hospital Grade" or "Hosp. Grade", typically on the back of the receptacle where visible during installation.

Question 35: Receptacles in general care areas that serve patient bed locations must be marked so that they are readily identifiable in order to make it evident that they are supplied from what branch?

A: Critical.
B: Normal.
C: Emergency.
D: Essential.

Question 36: 517.19(B) and (C) Patient Bed Location Receptacles and Operating Room Receptacles.

Question ID#: 765.0



A specific number of receptacles are required at patient bed locations and operating rooms.

Major changes have occurred in the minimum number of receptacles required at patient bed locations. There is also a new requirement detailing the minimum number of receptacles required to serve an operating room.

In section 517.19(B), the previous edition of the Code required critical care areas to have at least 6 receptacles serving the patient bed location. Now there must be at least 14 receptacles serving the patient bed location in critical care areas, and at least one of them is required to be supplied from either (1) the hospital normal system branch circuit or (2) a critical branch circuit supplied by a different transfer switch than the other receptacles at the location.

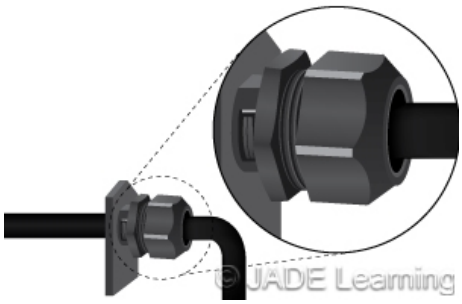
Receptacle requirements for operating rooms have never been addressed by the NEC prior to this new Code cycle. Each operating room will be required to be equipped with a minimum of 36 receptacles. At least 12 of the receptacles shall be connected to either of the following: (1) The normal system branch circuit required by 517.19(A); or (2) A critical branch circuit supplied by a different transfer switch than the other receptacles at the same location.

Question 36: Of the following receptacle configurations, which installation complies with the minimum number of receptacles required at a patient bed location in a critical care area? (Assuming that the normal system and critical branch are fed from different backup power transfer switches). A duplex receptacle counts as two receptacles.

A: Twelve single receptacles fed from the critical branch and one single receptacle fed from the normal system branch circuit.
B: Six duplex receptacles fed from the critical branch and one single receptacle fed from the normal system branch circuit.
C: Twelve duplex receptacles fed from the equipment branch circuit.
D: Six duplex receptacles fed from the critical branch and one duplex receptacle fed from the normal system branch circuit.

Question 37: 590.4(I) Termination(s) at Devices.

Question ID#: 772.0



Fittings need to be listed for the purpose of connecting flexible cords and cables to boxes.

In temporary installations, when a flexible cord or cable enters an enclosure that has devices where conductors are terminated, the fittings for the flexible cord or cable must be listed for connecting the flexible cords and cables to boxes.

In the 2011 NEC, the fittings that connected the cord or cable to the box had to be "designed for the purpose." The stronger language in the 2014 NEC will increase the safety of the installation by requiring fittings that have passed a round of testing by 3rd party testing labs.

Temporary installations are subject to abuse by workers of all trades. Temporary wiring is often removed and re-installed in another location. If a flexible cord or cable is connected to a device box where the conductors are terminated, and the cord or cable comes loose from the enclosure, the conductors can pull out of the terminations and create a ground fault. Listed fittings for flexible cord and cable keep the cord secure inside the fitting by different clamping mechanisms that are designed for the shape of the cord or cable. Using a fitting which is not listed to connect a flexible cord or cable to an enclosure means the cord or cable will not be as securely attached to the enclosure.

Using an NM connector as a fitting to secure a round cord to a device box is an example of using a fitting which is not listed for the purpose and would be a clear Code violation.

Question 37: In a temporary installation, when a flexible cord is connected to a box, which of the following statements is true?

A: The fittings used must be listed for connecting flexible cords and cables to boxes designed for the purpose.
B: The fittings used with flexible cords cannot be connected to boxes with eccentric knockouts.
C: When connecting flexible cords to boxes, an anti-short bushing must be installed.
D: Non-metallic fittings are not permitted to be used with metallic boxes.

Chapter 6

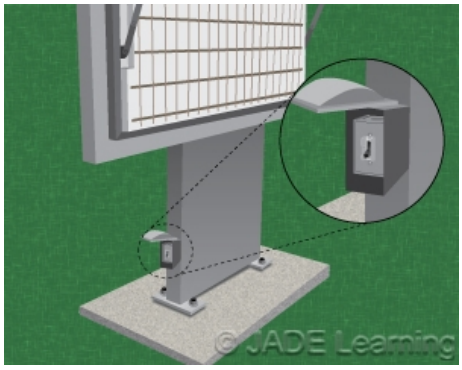
Question 38: 600.6(A)(1) Disconnects. At Point of Entry to a Sign Enclosure.

Question ID#: 775.0

Disconnects for electric signs and outline lighting must now be located at the point where the feeder or branch circuit enters the sign enclosure or pole.

In the 2011 NEC, the disconnect could be located anywhere on the sign enclosure. This meant that the feeder or branch circuit could enter the sign enclosure at one end of the sign and the disconnect could be at the other end of the enclosure. Line-side conductors inside the sign would remain energized even if the disconnect was in the off position, posing a serious shock hazard to the sign technician.

Requiring the disconnecting means at the point where the feeder or branch circuit enters the sign, or where the conductors enter the pole that supports the sign, will mean that when the disconnect is off all conductors inside the sign will be de-energized.



A sign disconnect is required at the point the feeder circuit or branch circuit(s) enters the sign enclosure.

Exception: A disconnect shall not be required for branch or feeder circuits passing through the sign where enclosed in a Chapter 3 listed raceway.

For a sign that has an integral disconnect switch, it is common for individually insulated branch circuit conductors feeding the sign to be routed up inside the support pole or sign body before ever reaching the line side of the disconnecting means. Even when the disconnect switch is turned off, there are still live conductors inside the sign which can be dangerous for those servicing the sign who assume the sign has no power. Requiring the disconnecting means to disconnect the conductors at the point where the conductors enter the sign enclosure will ensure that there are no conductors within a sign pole or enclosure that are still live after the switch is opened. The exception allows conductors in listed raceways to pass through the sign enclosure without the need of a disconnect switch. It is important to understand that this will only apply if the conductors pass through the sign and do not terminate within the sign enclosure.

Question 38: Which of the following conductors are required to be disconnected at the point where the conductors enter a sign enclosure?

A: Branch circuit conductors entering a sign pole from an underground raceway stubbed into the pole base.
B: Feeder conductors passing from one section to another within a sign but are enclosed in liquidtight flexible nonmetallic conduit.
C: Circuit conductors that supply a time clock mounted on the sign post but do not enter the sign enclosure.
D: Circuit conductors that supply a convenience receptacle that happens to be secured to the sign post but does not enter the sign.

Question 39: Article 625 Electric Vehicle Charging System.

Question ID#: 777.0

Article 625, Electric Vehicle Charging Systems, has been reorganized, new definitions have been added, and a number of changes have been made.Â

Article 625 is now organized into 3 parts:

Part IÂ Â Â Â Â Â Â Â Â General

Part II Â Â Â Â Â Â Â Â Â Equipment Construction

Part IIIÂ Â Â Â Â Â Â Â Â InstallationÂ

New definitions have been added for Cable Management System (Electric Vehicle Supply Equipment), Output Cable to the Electric Vehicle, and Power-Supply Cord.Â The definition of a power-supply cord is, ***An assembly of an attachment plug and length of flexible cord that connects the electric vehicle supply equipment (EVSE) to a receptacle.***Â

A power-supply cord includes the attachment plug and flexible cord that connects the electric vehicle supply equipment (EVSE) to a receptacle.

The new definition of power-supply cord is important because some jurisdictions were only approving EVSE equipment that was hardwired and not approving EVSE equipment that was connected to a receptacle.Â

Section 625.17 limits the length of the power-supply cord to 12 inches if the personnel protection system is located within the enclosure of the supply equipment or charging system.Â The power-supply cord (not the output cable to the electric vehicle) can be between 6 ft. and 15 ft. long if the personnel protection system is located at the attachment plug, or within the first 12 inches of the power-supply cord.Â Â Â

EVS equipment is permitted to be cord-and-plug connected in accordance with 625.44. Only non-locking, grounding type receptacles are permitted to be used. Section 625.44 permits EVSE equipment to be connected to 125-volt, single-phase, 15- and 20-ampere non-locking receptacle outlets.Â EVSE equipment rated for a maximum of 250 V is permitted to be connected to 2-pole, 3-wire and 3-pole, 4-wire grounding-type nonlocking receptacle outlets rated not more than 50 amperes.Â Connections can also be made to a supply of less than 50 volts DC.Â All other electric vehicle supply equipment not mentioned above must be hardwired with a permanent connection.

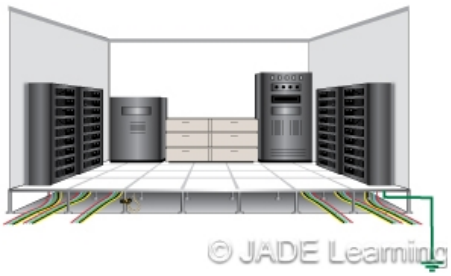
Question 39: Which one of the following receptacle types is permitted to supply cord-and plug- connected electric vehicle supply equipment?

A: A 125-volt, single-phase, 15-ampere, grounding-type, locking receptacle.
B: A 250-volt, single-phase, 50-ampere, grounding-type, non-locking receptacle.
C: A 250-volt, single-phase, 60-ampere, grounding-type, non-locking receptacle.
D: A 125-volt, single-phase, 15-ampere, non-grounding type, non-locking receptacle.

Question 40: 645.14 & 645.15 System Grounding & Equipment Grounding and Bonding.

Question ID#: 778.0

Section 645.15, Grounding, in the 2011 NEC has been divided into System Grounding in 645.14 and 645.15, Equipment Grounding and Bonding, in the 2014 NEC. Important clarifications have been made in both sections.



Auxiliary grounding electrode conductors for IT equipment must comply with 250.54.

The first sentence in 645.14 states that separately derived power systems shall be installed in accordance with the provisions of Parts I and II of Article 250. Simply put, if a separately derived system is used in conjunction with IT equipment, it must comply with the same rules as other separately derived systems installed in ordinary locations. The remainder of 645.14 is a mirror image of existing requirements in section 645.15 and states that power systems derived within listed IT equipment that supply IT systems through receptacles or cable assemblies supplied as part of this equipment shall not be considered separately derived for the purpose of applying 250.30.

A new sentence has been added to 645.15 and states that any auxiliary grounding electrode(s) installed for information technology equipment shall be installed in accordance with 250.54. Section 250.54 makes it clear that auxiliary grounding electrodes can be used, but the earth can never be used as an effective ground-fault current path. Section 250.54 also says auxiliary ground rods are not required to be bonded to the grounding electrode system, or have a resistance to ground of 25 ohms or less.

This is commonly violated when isolated ground-type receptacles are installed in an IT setting and the equipment grounding conductor is connected only to an auxiliary grounding electrode that has no direct connection back to the service or derived system, thus using the earth as a ground. At some point, equipment grounding conductors for branch circuits and feeders used for IT equipment are required to terminate directly at an equipment grounding conductor terminal of the applicable derived system or service. See 250.146(D) and 408.40 Exception for more information.

Question 40: A power system derived within listed IT equipment that supplies IT systems through a cable assembly supplied as part of the equipment is NOT _____?

A: Grounded.
B: Separately derived.
C: Isolated.
D: Code compliant.

Question 41: 680.21(C) Motors. GFCI Protection.

Question ID#: 782.0

According to Section 680.21(C) in the 2011 NEC, GFCI protection was required for all 15- and 20- amp, single-phase 120-, 208-, and 240-volt branch circuits that supplied pool pump motors that were hardwired or cord-and-plug connected. Under this rule, a 120-volt 20-amp branch circuit was required to be GFCI protected, but a 120-volt pump supplied by a 25- or 30-amp branch circuit was not required to be GFCI protected. From a safety stand-point, this didn't make sense.

The 2014 NEC corrected this problem by deleting the language that limited the requirement for GFCI protection to pumps supplied by 15- and 20- amp branch circuits. Under the 2014 NEC, cord-and-plug connected as well as hardwired pumps supplied by single-phase 120 to 240 volt branch circuits, regardless of their ampacity, are required to be GFCI protected.

All single-phase, 120 through 240 volt branch circuits that supply pool pump motors are required to be GFCI protected.

Question 41: Which of the following branch circuits for a swimming pool pump motor is required to be GFCI protected?

A: A 20-amp, 3-phase, hardwired, 208 VAC branch circuit.
B: A 15-amp, 3-phase, 230 VAC branch circuit, cord-and-plug connected.
C: A 25-amp, 1-phase, hardwired, 230 VAC branch circuit.
D: A 30-amp, 3-phase, hardwired, 230 VAC branch circuit.

Question 42: 680.22(A)(1) and (2) Receptacles. Required Receptacles, Location. Circulation and Sanitation System, Location.

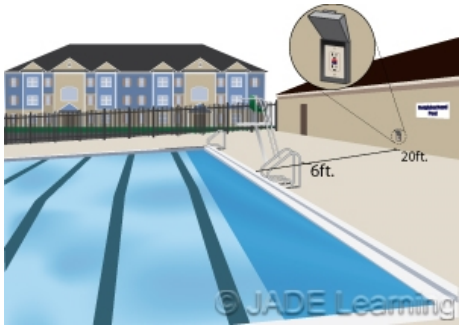
Question ID#: 783.0

In the 2011 NEC, Section 680.22 required that permanently installed pools at dwellings have at least one GFCI protected, 125-volt, 15- or 20-amp receptacle connected to a general purpose branch circuit installed near the pool. This receptacle was required to be at least 6 feet from the pool but not more than 20 feet from the inside wall of the pool and not more than 6 feet, 6 inches above the grade or deck level surrounding the pool.

The change to this section is to broaden the requirement to all locations, not just dwelling units. Public pools, hotel pools, and neighborhood pools are now all required to have at least one GFCI protected, 125-volt, 15- or 20-amp receptacle connected to a general purpose branch circuit installed at least 6 feet from the pool but not more than 20 feet from the inside wall of the pool and not more than 6 feet, 6 inches above the grade or deck level surrounding the pool.

The reason for requiring this receptacle was to prevent people from using extension cords plugged into non-GFCI protected outlets and bringing the devices close to the edge of the pool. If such a practice was dangerous at dwelling units, it is equally dangerous at other locations. In the 2014 NEC, a receptacle on a general-purpose branch circuit is required at all permanently installed pools, not just at dwelling pools.

Also, a change at 680.22(A)(2) did away with the requirement for a pool pump motor to be connected to a locking type receptacle. Receptacle outlets for circulation and sanitation pump motors still must be of the grounding type, consist of a single receptacle, and be GFCI protected, but they are no longer required to be of the locking type.



A receptacle outlet needs to be not less than 6 ft. and not more than 20 ft. from the inside wall of a permanent pool.

Question 42: Which locations require at least one GFCI protected, 125-volt, 15- or 20-amp, receptacle outlets installed near a swimming pool?

A: Dwelling units only.
B: Public pools only.
C: Dwelling unit or public pools.
D: Inflatable pools only.

Question 43: 680.42(B) Outdoor Installations. Bonding.

Question ID#: 787.0

A self-contained spa or hot tub now does not require an equipotential bonding grid. The 2014 NEC has incorporated a Tentative Interim Amendment from the 2011 NEC that permits a self-contained spa or hot tub to be installed on or above grade without a connection to an equipotential bonding grid.

In order to install a spa or hot tub without an equipotential bonding grid underneath the perimeter surfaces, the spa or hot tub must meet the following conditions:

- It must be self-contained and listed for aboveground use.
- It cannot be identified for indoor use only.
- It must be installed according to the manufacturer's instructions.
- The top rim of the tub must be a minimum of 28 inches above any surface that extends up to 30 inches horizontally from the spa or hot tub.

In certain instances, an aboveground spa or hot tub does not require equipotential bonding of perimeter surfaces.

Requiring an equipotential bonding grid around a hot tub that was installed above ground usually meant cutting the concrete around the spa or hot tub and installing a bare No. 8 AWG copper conductor. This added considerable expense and a lot of extra work to the installation.

There had not been any reported incidents of people getting shocked in an aboveground spa that could be tied to the lack of an equipotential bonding grid. Without proof that installing an equipotential bonding grid around a spa or hot tub reduced the shock hazard and increased safety for the general public, the NEC Code panels decided to do away with the requirement for an equipotential bonding plane for self-contained spas or hot tubs installed above ground.

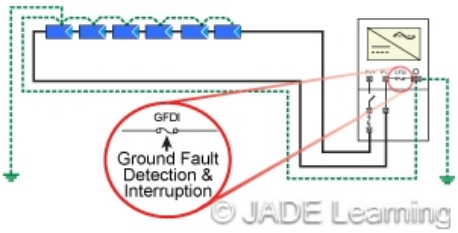
Question 43: Which of the following is one of the conditions that would permit a spa to be installed without equipotential bonding for the perimeter surfaces?

A: The spa is installed in the ground rather than above ground.
B: The top rim of the spa is 26 inches above the perimeter surface.
C: The spa is installed outdoors and listed for above ground use.
D: The spa is identified as suitable for indoor use only.

Question 44: 690.5(A) Ground-Fault Protection. Ground-Fault Detection and Interruption.

Question ID#: 789.0

Ground-fault detection equipment in grounded photovoltaic (PV) systems is now required to detect a ground-fault in the PV array DC conductors, including grounded and ungrounded conductors. The 2011 NEC did not say the ground-fault detection equipment had to be capable of detecting a ground-fault in the DC grounded conductor.



Ground-fault protection devices must detect a ground fault in the PV array, interrupt the flow of fault current, provide indication of the fault, and be listed.

Ground-fault detection equipment for PV systems must also be listed, so from now on listed ground-fault detection equipment must be capable of detecting a ground-fault in both grounded and ungrounded DC conductors.

Older style ground-fault detection equipment had trouble detecting ground-faults in the grounded conductor. These undetected ground-faults were the cause of a number of rooftop fires where PV systems were installed. Newer style ground-fault detection equipment for PV systems will be able to sense ground-faults in both grounded and ungrounded conductors, and will have lower trip settings than older models.

Also, one of the exceptions to this section in the 2011 NEC has been deleted. The old exception permitted ground-fault protection to be omitted on non-dwelling locations if the equipment grounding conductor was sized at twice the size required by Table 250.122. Increasing the size of the equipment grounding conductor was found not to make a significant difference in preventing fires.

In addition to being listed and capable of detecting ground-fault currents in grounded and ungrounded conductors, ground-fault detection for PV systems must interrupt the flow of fault current and indicate a ground-fault is present.

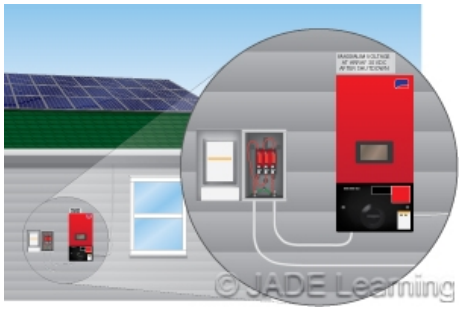
Question 44: Which of the following statements about ground-fault protection for grounded DC PV arrays is correct?

A: Ground-fault protection is not required for any PV array system installed for a single-family dwelling unit.
B: Ground-fault protection for DC PV arrays is required to protect people from electrical shock hazards.
C: Devices installed to provide ground-fault protection for grounded DC PV arrays are required to be listed.
D: Devices installed to provide ground-fault protection for grounded DC PV arrays are required to provide both a visible and audible indication that the device has detected a ground-fault.

Question 45: 690.12 Rapid Shutdown of PV Systems on Buildings.

Question ID#: 792.0

When a building is on fire, energized conductors pose an additional risk to firemen and other first responders. Solar photovoltaic systems will continue to generate power as long as the sun is shining. If the PV modules are mounted on the roof, and the manual DC disconnect is mounted at grade level, the conductors from the PV combiner boxes on the roof to the DC disconnect will remain energized, even if the DC disconnect is shut off.



PV systems installed on buildings will now need to be capable of a rapid shutdown.

A new requirement in 690.12 requires an automatic rapid shutdown of PV systems installed on or in buildings. The rapid shutdown must reduce the voltage on PV conductors that are more than 5 ft. in length inside the building or more than 10 ft. from a PV array. The voltage on the PV conductors must be reduced to not more than 30 volts within 10 seconds of when the rapid shutdown starts.

If the building with the PV modules also has a utility service, a permanent plaque must be posted with the words, PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN.

Exactly how the rapid shutdown of the PV system is accomplished is not spelled out. Sensors embedded in the combiner boxes or in the modules themselves are a

possibility. Until such systems are commercially available, the authority having jurisdiction may not enforce this requirement.

Question 45: Which of the following installations would require a rapid shutdown method be provided for PV system conductors?

A: Rooftop PV array conductors that have a length of 20 feet from the array to an inverter.
B: Pole-mounted PV source circuit conductors that have a length of 4 feet.
C: Rooftop source circuit conductors that enter the building for 4 feet and have a total length of 10 feet.
D: Rooftop PV array conductors with a length of 10 feet from the array to an inverter.

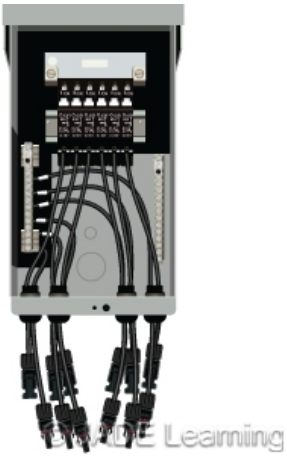
Question 46: 690.15(C) Direct-Current Combiner Disconnects.

Question ID#: 793.0

Disconnects are now required for the outputs of DC combiners that are mounted on the roofs of dwellings or other buildings. The load break disconnecting means must be located in the combiner or within 6 ft. of the combiner. The disconnecting means can be remotely operable but must be capable of being operated manually if the control power is off.

A new definition of Direct-Current (DC) Combiner is in 690.2. ***A device used in the PV source and PV output circuits to combine two or more DC circuit inputs and provide one DC circuit output.*** The DC combiner takes multiple inputs from solar PV panels (PV source) and combines them into a single DC output circuit. It is the single DC output that must be capable of being disconnected.

Having a disconnecting means for the PV modules on the roof of a building will allow firefighters and first-responders to quickly disconnect the PV system at the source. In an emergency this will disconnect PV wiring in the walls of the structure as well as de-energize PV conductors anywhere downstream from the combiner boxes. This will mean that firefighters on the roof won't come in contact with energized conductors as they fight the fire on the roof or make roof penetrations if the fire has spread to the inside of the structure.



DC combiner disconnects must be in the combiner box or within 6 ft.

Question 46: Where are direct-current combiner disconnects required?

A: On the roofs of dwellings.
B: For PV systems mounted on wood structures on the ground.
C: For PV systems that use micro-inverters.
D: On pole-mounted PV systems.

Question 47: 694 Wind Electric Systems.

Question ID#: 798.0

The title and scope of Article 694 was revised to include the requirements for wind electric systems regardless of their rated output. Article 694 now covers Wind Electric Systems both below and above 100 kW. It was recognized that the rated output of a wind turbine electric system did not affect the requirements for installing the turbine.

Article 694 is no longer limited to wind electric systems 100 kW or less.

The word "small" has been deleted from the title to Article 694 and at every place it was used in the Article. Now the NEC covers all wind electric system generators regardless of their size. UL standards which cover wind electric systems do not have a dividing line between systems 100kW or less and systems over 100kW, and now the NEC does not make a distinction either.

In addition to changes affecting the size of the systems that the NEC covers, two changes in 694.7 affect the installations of these systems.

Section 694.7(E) which permits the installation of a receptacle supplied by the wind electrical system for maintenance and data acquisition was revised; now, all 125- volt single-phase, 15- and 20- amp receptacles have to be provided with GFCI protection.

Section 694.7(F) was revised to permit the towers that support wind generators and alternators to be used as raceways if evaluated for that purpose when listed.

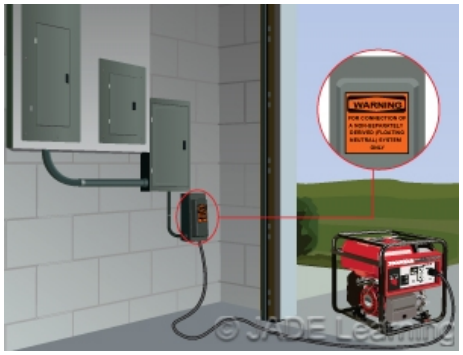
Question 47: Which of the following statements about wind electrical systems is correct?

A: Wind electrical systems with a rated output in excess of 10 kW are not covered by the NEC.
B: Wind electrical systems with a rated output in excess of 100 kW are not covered by the NEC.
C: Wind electrical systems are covered by the NEC regardless of their rated output.
D: Only interactive wind electrical systems are covered by the NEC.

Chapter 7-9

Question 48: 702.7(C) Optional Standby Systems. Signs. Power Inlet.

Question ID#: 802.0



A warning sign is required at the power inlet temporary connection to a portable generator.

A sign is now required at a power inlet used to connect a portable generator to a premises wiring system. The sign must say what type of generator will be connected to the power inlet based on the wiring in the transfer switch.

Portable generators can be one of two types: (1) A separately derived system with the neutral bonded to the frame of the generator. (2) A non-separately derived system where the neutral conductor is not bonded to the frame of the generator.

When the neutral is bonded to the frame of the generator the sign must say, WARNING: FOR CONNECTION OF A SEPARATELY DERIVED (BONDED NEUTRAL) SYSTEM ONLY.

When the neutral is not bonded to the frame of the generator the sign must say, WARNING: FOR CONNECTION OF A NON-SEPARATELY DERIVED (FLOATING NEUTRAL) SYSTEM ONLY.

A transfer switch for a separately derived system where the neutral from the generator is bonded to the frame of the generator has a separate pole for the neutral conductor and transfers the neutral from the generator to the premises wiring system. A transfer switch for a non-separately derived type of generator does not transfer the neutral to the premises wiring system. The neutral connection from the

utility is used when the generator is supplying power to the transfer switch.

The type of generator must match the type of transfer switch. If, for example, the generator has the neutral bonded to the generator frame making it a separately derived system type of generator, the transfer switch must disconnect the neutral from the utility and reconnect the neutral from the generator. If there is a mismatch, and the grounded conductor from the utility remains connected to the generator neutral, parallel ground currents will circulate on the premises wiring system.

Question 48: Where is the warning sign required for a portable generator used for an optional standby system?

A: At the generator.
B: At the transfer switch.
C: At the utility meter.
D: At the power inlet used to connect a portable generator to the premises wiring.

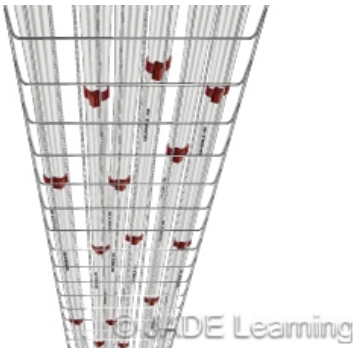
Question 49: 800.24 Mechanical Execution of Work.

Question ID#: 811.0

There have been problems with installing communications (telephone) cables in a neat and workmanlike manner for a number of years. Most communications cabling is installed above the ceiling, and there have been many jobs where the telephone cables were laid on top of the ceiling tiles without any support. Section 800.24 clearly requires telephone cables to be supported by the building structure using straps, staples, cable ties, hangers, or fittings that will not damage the cable.

A new section now requires the support fittings to be low smoke producing when installed in plenums or other spaces used for environmental air.

Nonmetallic cable ties and other non-metallic cable accessories used to secure and support cables in other spaces used for environment air (plenums) shall be listed as having low smoke and heat release properties.



Nonmetallic cable ties and accessories used to secure and support cables in plenums need to be listed as having low smoke and heat release properties.

Any material that will burn and produce smoke is limited when installed in plenums or above a dropped ceiling that is used as an air return. When the space above a ceiling is used for environmental air, the air gets distributed to other areas in the building. If there is a fire above the ceiling, the smoke produced by the fire can be deadly to building occupants throughout the building. Even material as small as a cable tie, when installed in other space used for environmental air, must have low smoke and heat release properties.

A similar requirement has been added at 770.24, for Optical Fiber and Raceways; 820.24, for Community Antenna Television and Radio Distribution Systems; and 830.24 for Network-Powered Broadband Communications Systems.

Question 49: Which of the following statements about installing communications circuits is correct?

A: Communications circuits cannot be installed in other space used for environmental air.
B: Nonmetallic cable ties are not permitted to be installed above a ceiling that is used as an air return.
C: Communications circuits cannot be bundled or installed in hangers as long as they are listed as having low smoke properties.
D: Communications cabling and support accessories shall be listed as having low smoke and heat release properties when installed in the space above a ceiling that is used for environmental air.

Question 50: Chapter 9, Table 4 & 5.

Question ID#: 815.0

The column headings for both Table 4 and Table 5 in Chapter 9 have been re-arranged to make the tables easier to use.

Table 4 lists the area in square inches and the internal diameter for 12 different types of conduit or tubing. Table 4 is used to select the size of conduit, based on the square inch area permitted for 1 wire, 2 wires, or over 2 wires in the conduit or tubing. The most common column used to select the proper size conduit is "Over 2 Wires 40%." In the 2011 NEC, this was the far right column. It was easy to make a mistake reading all the way across the table. In the 2014 NEC, the "Over 2 Wires 40%" column has been moved to the first column on the left, after the column for the standard trade sizes of conduit.

Table 5 gives the approximate area and approximate diameter of different wire types and gauges. The approximate area of a conductor is used to calculate how many conductors can fit inside conduit or tubing. In the 2011 NEC, the approximate area of a conductor was located on the far right side of the table. In the 2014 NEC, the approximate area of a conductor has been moved to the first column on the left after the size of the conductor in AWG or kcmil. This change will make Table 5 easier to use.

TABLE 4 Article 342 - Intermediate Metal Conduit (IMC)

Trade Size	> 2 Wires 40% sq. in.	60% sq. in.	1 Wire 53% sq. in.	2 Wires 31% sq. in.
1/2 inch	.0137	.205	.181	.106
3/4 inch	.235	.352	.311	.182
1 inch	.384	.575	.508	.297
1 1/4 inch	.659	.988	.873	.510
1 1/2 inch	.890	1.335	1.179	.690
2 inches	1.452	2.178	1.924	1.125
2 1/2 inches	2.054	3.081	2.722	1.592
3 inches	3.169	4.753	4.199	2.456
3 1/2 inches	4.234	6.351	5.610	3.281
4 inches	5.452	8.179	7.224	4.226

Tables 4 and 5 have been reorganized to make them easier to use.

Question 50: What is the approximate area in sq. in., over 2 wires 40%, for 1 1/2 inch Intermediate Metal Conduit (IMC)?

A: .659 sq. in.
B: .890 sq. in.
C: .873 sq. in.
D: .510 sq. in.

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

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1.) A B C D	**18.) A B C D**	**35.) A B C D**
2.) A B C D	**19.) A B C D**	**36.) A B C D**
3.) A B C D	**20.) A B C D**	**37.) A B C D**
4.) A B C D	**21.) A B C D**	**38.) A B C D**
5.) A B C D	**22.) A B C D**	**39.) A B C D**
6.) A B C D	**23.) A B C D**	**40.) A B C D**
7.) A B C D	**24.) A B C D**	**41.) A B C D**
8.) A B C D	**25.) A B C D**	**42.) A B C D**
9.) A B C D	**26.) A B C D**	**43.) A B C D**
10.) A B C D	**27.) A B C D**	**44.) A B C D**
11.) A B C D	**28.) A B C D**	**45.) A B C D**
12.) A B C D	**29.) A B C D**	**46.) A B C D**
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**
16.) A B C D	**33.) A B C D**	**50.) A B C D**
17.) A B C D	**34.) A B C D**	

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