


# 2014 NEC Changes Part 2 (Homestudy)

## California Electrical License

This course will review the second half of the most important National Electrical Code changes from the 2014 NEC. Changes in Articles 404 - Chapter 9 will be covered.

**16 NEC Credit Hours $150.00**

This course is currently accepted by the Department of Industrial Relations.

Completion of this continuing education course will satisfy 16.000 credit hours of course credit type 'NEC' for Electrical license renewal in the state of California. Course credit type 'NEC'. Board issued approval date: 10/25/2016. Board issued expiration date: 1/1/2020.

JADELearning

# 2014 NEC Changes Part 2 (Homestudy) - CA

## Chapter 4

### Question 1: 404.8(C) Accessibility and Grouping. Multipole Snap Switches.

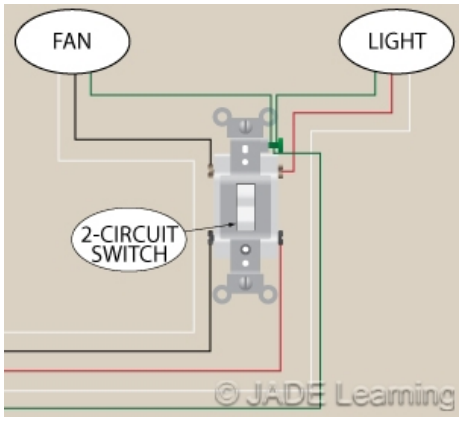
Question ID#: 715.0

In the 2011 NEC a general use multipole snap switch could be used to control more than a single circuit if it was listed and marked as a two-circuit or three-circuit switch. A general use multipole switch could also be used to control multiple circuits if the voltage rating of the switch was not less than the line-to-line voltage of the system supplying the circuits.

The 2014 NEC has deleted the permission to use a multipole switch to control more than a single circuit if the voltage rating of the switch is not less than the line-to-line voltage of the system supplying the circuits. Now the only time a general use multipole switch can be used to control multiple circuits is if the switch is listed and marked as a two-circuit or three-circuit switch.

When UL and other testing agencies list a general use multipole switch as suitable for controlling more than a single circuit, they have tested the switch in many different configurations. The switch is tested on multiple or multi-phase branch circuits that control multiple or multi-phase loads of no more than 120 volts to ground and 240 volts line-to-line, 240 volts total per circuit. The switches are tested simultaneously with multiple supply and loads present to represent actual service conditions. Tests include a high current overload test and 30,000 cycles at full load for endurance.

A general use multipole switch that is listed and marked for two- or three-circuit use has been manufactured to standards based on rigorous testing under conditions that ensure the multipole switch is suitable for the application.




***A multipole snap switch can only be fed from multiple branch circuits if it is listed and marked as a two-circuit or three-circuit switch.***

Question 1: Which of the following general use multipole switches could be used to control two circuits?

A: A switch that was listed for 240 volts, line-to-line.
B: A switch that was listed for 480 volts, line-to-line.
C: A switch that was listed for commercial grade.
D: A switch that was listed for two- or three-circuit operation.

## Question 2: 404.10(B) Mounting of Snap Switches. Box Mounted.

Question ID#: 716.0

Dry-wall screws are not permitted to fasten a snap switch to a box. In fact, according to this section, the screws that attach a snap switch to a box must be of the type provided with the switch, or they must be machine screws with 32 threads per inch. Screws that are provided with a switch/enclosure that is part of a listed assembly or system are also permitted.

Dry-wall screws or screws with coarse threads can damage a box that is made to accept machine threads. If the box is damaged the switch will not be securely mounted to the box. Snap switches that are loose in the box or can pull out of the box are a shock hazard.

A similar requirement was added to 406.5 for receptacle mounting. Using dry-wall screws to attach a receptacle to a box can damage the box and cause the receptacle to separate from the box.

Machine screws are also required in 250.8 for connecting grounding and bonding conductors to enclosures, where at least two threads are required to be engaged. Section 314.25 requires machine screws to be used to attach covers and canopies to boxes.




***To attach a snap switch to a box, you must use the screws provided or machine screws with 32 threads per inch.***

Question 2: Which type of screw is NOT permitted to attach a snap switch to the box?

A: A screw with 32 threads per inch.
B: A machine screw.
C: A screw that is part of a listed switch assembly.
D: A sheet metal screw.

## Question 3: 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.

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.




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

Question 3: 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 4: 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 4: 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 5: 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 5: 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.

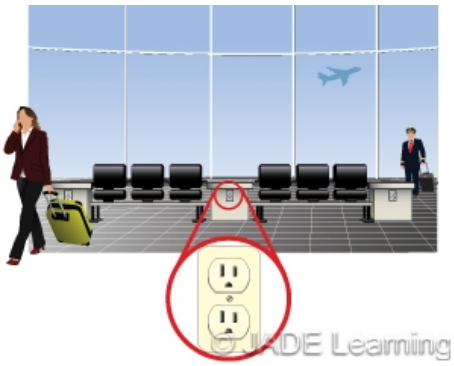
## Question 6: 406.5(F) Receptacles in seating Areas and Other Similar Surfaces.

Question ID#: 720.0

***In seating areas or similar surfaces, receptacles shall not be installed in a face-up position unless the receptacle is any*** of the following: (1) Part of an assembly listed as a furniture power distribution unit, if cord-and plug-connected (2) Part of an assembly listed either as household furnishings or as commercial furnishings (3) Listed either as a receptacle assembly for countertop applications or as a GFCI receptacle assembly for countertop applications (4) Installed in a listed floor box.

Receptacles in seating areas and other similar surfaces cannot be mounted in the face-up position, unless part of a listed assembly. Seating areas in public locations, like in airports or similar waiting areas, sometimes have receptacles installed in the furniture as a convenience to people using laptop computers or charging cell phones. Similar installations can be found in some conference rooms. The danger from liquids spilling into receptacles in a waiting area is similar to the danger of spillage into receptacles mounted face-up in kitchen countertops.

If the receptacle is part of a listed assembly, it has been subjected to a dielectric voltage withstand test after 1/2 gallon of liquid has been spilled into the assembly. If the receptacle has a self-closing cover, the cover has been tested for leakage with the cord plugged in.




***In seating areas and similar surfaces, receptacles shall not be installed face-up unless the receptacle meets specific requirements.***

Question 6: If a receptacle is mounted in the face-up position in a seating area or a conference room table, which of the following statements is true?

A: The receptacle must have an extra-duty cover.
B: The receptacle must be part of the branch circuit wiring that serves the lighting in the area.
C: The receptacle can only be installed in a list floor box.
D: The receptacle can be installed face up if part of a listed assembly for countertop applications.

## Question 7: 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 7: 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 8: 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 8: 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 9: 406.15 Dimmer-Controlled Receptacles.

Question ID#: 724.0

New section 406.15 requires dimmer-controlled receptacles that control lighting loads to have a nonstandard configuration that will only accept plugs that match the receptacle.

***A receptacle supplying lighting loads shall not be connected to a dimmer unless the plug/receptacle combination is a nonstandard configuration type that is specifically listed and identified for each such unique combination.***

Under-cabinet lighting and rope lights are sometimes plugged into a receptacle that is controlled by a dimmer. The problem with controlling a receptacle with a dimmer switch is that other loads besides incandescent lighting loads can be plugged into a standard receptacle. It is a Code violation to control a receptacle with a dimmer switch unless the receptacle and plug are a nonstandard combination.




***Dimmer-controlled receptacles are only allowed if of a nonstandard configuration type that is specifically listed and identified.***

Many loads do not respond well to reduced voltages. As the voltage goes down, the current goes up, and an increase of current can damage the appliance or equipment. The increased current can damage the internal insulation on the appliance and cause it to overheat or burn out. Some appliances will not work at all at lower voltages.

Section 404.14(E), Dimmer Switches, says that general-use dimmer switches can be used only to control permanently installed incandescent luminaires unless listed for the control of other loads.

Question 9: Which of the following statements about dimmer-controlled receptacles is true?

A: Incandescent luminaires can be plugged into a standard receptacle controlled by a dimmer.
B: Dimmer switches can control any receptacle load.
C: A dimmer switch can control a receptacle if lighting loads will be plugged into the receptacle.
D: A receptacle controlled by a dimmer must be listed for the plug/receptacle combination.

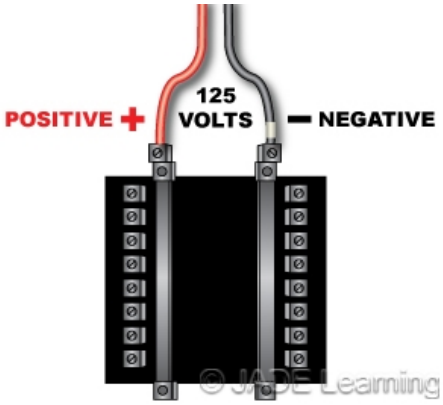
## Question 10: 408.3 Support and Arrangement of Busbars and Conductors.

Question ID#: 725.0

The busbar arrangement on DC switchboards, switchgear, or panelboards can be in any order. The arrangement of busbars must be field marked as to polarity, grounding system, and nominal voltage. Without any order required for the DC bus arrangement, the field marking becomes critical.

These requirements can be found in 408.3(E)(2) DC Bus Arrangement, which has been added as a separate section to the familiar section on AC phase arrangement, where the order for busbars is A, B, C, from front to back, top to bottom, or left to right.

In addition to the busbar arrangement being field marked, the switchboard, switchgear, or panelboard itself must be identified. Several new switchboard, switchgear, or panelboard types now require identification.




***Arrangement of DC buses must be field marked as to polarity, grounding system, and nominal voltage.***

- An ***ungrounded DC system*** must be field marked to say: CAUTION: UNGROUNDED DC SYSTEM OPERATING _____ VOLTS BETWEEN CONDUCTORS.
- A ***resistively grounded DC system*** must be field marked to say: CAUTION: DC SYSTEM OPERATING _____ VOLTS BETWEEN CONDUCTORS AND MAY OPERATE _____ VOLTS TO GROUND FOR INDEFINITE PERIODS UNDER FAULT CONDITIONS.
- ***A high-impedance grounded neutral AC system*** must be field marked to say: CAUTION: HIGH-IMPEDANCE GROUNDED NEUTRAL AC SYSTEM OPERATING _____ VOLTS BETWEEN CONDUCTORS AND MAY OPERATE _____ VOLTS TO GROUND FOR INDEFINITE PERIODS UNDER FAULT CONDITIONS.

A resistively grounded DC system and a high-impedance grounded neutral AC system have something in common. In order to keep equipment running, even under single fault conditions, the fault current is kept at low levels so the overcurrent devices will not trip. A ground fault monitoring system is connected which warns the operators of a fault condition but will not shut down the equipment.

Question 10: Which of the following statements about the support and arrangement of busbars is true?

A: The arrangement of DC busbars must be marked at the factory.
B: The DC busbars are field marked, positive, negative, ground, left to right in order.
C: The DC busbars must be marked in the field to describe how they are connected.
D: Only AC busbars are required to be marked.

## Question 11: 408.4(B) Field Identification Required. Source of Supply.

Question ID#: 726.0

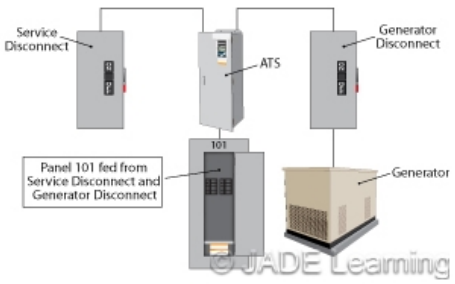
***All switchboards, switchgear, and panelboards supplied by a feeder(s) in other than one- or two-family dwellings shall be marked to indicate each device or equipment where the power originates.***

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 11: 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 12: 408.55 Wire-Bending Space Within an Enclosure Containing a Panelboard.

Question ID#: 727.0

Having enough wire-bending space in a panelboard enclosure prevents the wire insulation from getting damaged when the wire is bent to terminate it inside the panelboard.

In the 2011 NEC the minimum distances for the top and bottom wire bending spaces in a panelboard enclosure were sized from Table 312.6(B) for one wire per terminal. The side wiring bending space was sized from Table 312.6(A) for one wire per terminal. There was no requirement for wire-bending space for conductors that entered the panelboard from the back.

The 2014 NEC requires wire-bending space equal to the distances in Table 312.6(A) for one wire per terminal for conductors that enter from the side of the panelboard. There also is a new requirement for wire-bending space for conductors that enter from the rear of a panelboard.

***The distance between the center of the rear entry and the nearest termination for the entering conductors shall not be less than the distance given in Table 312.6(B).***

This means that conduit entries into the back of a panelboard must allow for the




***The 2014 NEC specifies wire-bending space for conductors that enter from the back of the panelboard.***

greater distances required in Table 312.6(B) between the center of the conduit and the nearest termination.

For example, the minimum wiring-bending space for a 1/0 conductor from Table 312.6(A) is 3 1/2 in. The wiring-bending space for a 1/0 conductor from Table 312.6(B) is 5 1/2 in. If a conduit with 1/0 conductors entered a panelboard from the back wall of the panelboard, the minimum wire-bending space from the center of the conduit to the nearest termination is 5 1/2 in.

Conduit entries into the back of panelboards will have to be arranged so the minimum wire bending space of Table 312.6(B) can be met.

Question 12: Based on one wire per terminal, what is the minimum wiring bending space for 2/0 copper conductors that enter a panelboard in conduit from the back of the panelboard?

A: 5 1/2 inches.
B: 6 inches.
C: 6 1/2 inches.
D: 7 inches.

## Question 13: 409.20 Industrial Control Panels. Conductor - Minimum Size and Ampacity.

Question ID#: 728.0

Conductors that supply industrial control panels must have an ampacity not less than the sum of:

- 125% of the full-load current rating of all heating loads.
- 125% of the full-load current rating of the highest rated motor.
- 100% of the full-load current ratings of all other connected motors and apparatus that may be in operation at the same time.

The 2011 NEC required the calculation to include 125% of only the resistance heating loads, not all heating loads.

Both induction and resistance heating loads in industrial machinery are likely to be continuous loads that are on for 3 hours or more. It makes sense to calculate all heating loads, rather than just resistance heating loads at 125%, when selecting the supply conductors for industrial control panels.

For example, an industrial panel controls the following loads: (1) 50 amps of induction heating; (2) 100 amps of resistance heating; (3) 75 amps of other connected apparatus that operate at the same time:

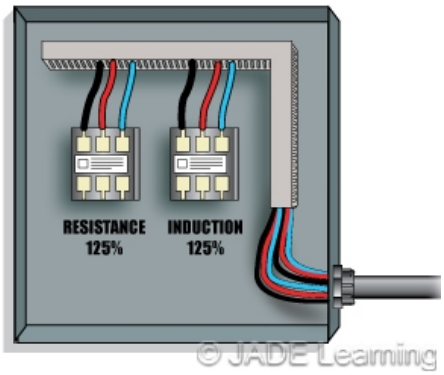
50 amps induction heating, 50 amps x 125% = 62.5 amps

100 amps of resistance heating, 100 amps x 125% = 125 amps

75 amps of other load, 75 amps x 100% = 75 amps

Total load: 62.5 amps + 125 amps + 75 amps = 262.5 amps

The supply conductors to the industrial control panel must have an ampacity equal to at least 262.5 amps.




***The NEC now requires the minimum size and ampacity for the industrial control panel calculation to include 125% of all heating loads.***

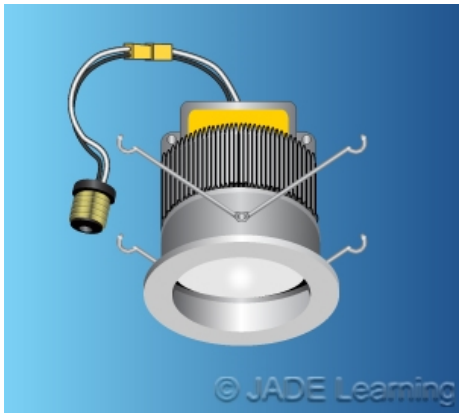
Question 13: What is the minimum ampacity of supply conductors to an industrial control panel with the following loads: 80 amps resistance heating; 110 amps induction heating; 45 amps of other non-motor loads operating at the same time?

A: 338.75 amps.
B: 282.5 amps.
C: 262.5 amps.
D: 255.0 amps.

## Question 14: 410.6 Luminaires, Lampholders, and Lamps. Listing Required.

Question ID#: 729.0

Since the 2008 edition of the NEC, all luminaires and lampholders have been required to be listed. A listing for a specific piece of equipment means that the product has been evaluated by an organization that is acceptable to the Authority Having Jurisdiction (See Article 100 for the full definition of the term "listed"). Section 410.6 in the 2014 Code has been expanded and now requires lighting retrofit kits to be listed as well.



***Retrofit kits are now required to be listed.***

The movement for energy conservation has created a great demand for energy efficient lighting sources in both commercial and residential applications. Rather than removing and replacing all the luminaires in a building, it is becoming more and more common to see the installation of lighting retrofit kits. These retrofit kits allow the housing of a fluorescent luminaire, for example, to be gutted and re-fitted with a more energy efficient lighting source such as light emitting diodes (LEDs).

Requiring the retrofit kits to be listed ensures that the kit will work with the luminaire. Generally, listed retrofit kits will specify what type of luminaire the kit is permitted to be installed in and may also provide specific housing dimensions needed to ensure that the new ballast or power supply will have proper heat dissipation. Luminaires that have been modified according to the instructions for the listed retrofit kit will no longer accept the original lamp designed for the luminaire. A new label (provided by the retrofit kit manufacturer) is required to be placed near the retrofit kit to indicate that the luminaire has been modified and can no longer operate the lamps that were originally intended for the luminaire.

Question 14: Which of the following items does Section 410.6 require to be listed?

A: A replacement ballast for a 4 foot fluorescent luminaire.
B: The fixture whip that supplies power to the luminaire.
C: A retrofit kit used to convert a high pressure sodium luminaire to a metal halide luminaire.
D: A replacement LED power supply for an LED luminaire that was damaged.

## Question 15: 410.10(F) Luminaires Installed in or Under Roof Decking.

Question ID#: 730.0

A new subsection has been added to Section 410.10 in order to protect luminaires installed under metal corrugated roof decking.



***Luminaires installed under metal-corrugated sheet roof decking must have at least 1 1/2 inches between the lowest point of the roof and the top of the luminaire.***

Section 410.10(F) has been added and specifies that ***luminaires installed in exposed or concealed locations under metal corrugated sheet roof decking shall be installed and supported so there is not less than 38 mm (1 1/2 in.) measured from the lowest surface of the roof decking to the top of the luminaire***. This is similar to the Code language introduced during the 2008 Code cycle in section 300.4(E) which requires the same 1 1/2 inch distance from metal corrugated roof decking to cables, raceways, or boxes that have been installed under the roof decking materials.

When roofers repair a flat roof, they use 2 inch or 2 1/4 inch screws to hold down the insulating and waterproofing material. Unless the required distances are maintained, screws may penetrate the roof decking and damage electrical cables, raceways,

boxes or luminaires.

Requiring the luminaires to be located 1 1/2 inches below the roof decking ensures that the standard screws or fasteners used to secure the roofing materials do not pass through the metal roofing far enough to penetrate the luminaire. Prior to this Code change it was permissible to attach a surface mounted luminaire, such as a fluorescent strip light, directly to the underside of the metal roof decking. This creates the possibility that a roof deck screw might penetrate and damage the luminaire, the ballast, or its associated wiring.

Question 15: Which of the following statements is true of luminaires installed under corrugated metal roof decking?

A: They must be installed so that there is at least 2 1/2 inches between the roof decking and the luminaire.
B: They must be installed so that there is at least 1 1/2 inches from the top of the metal roof decking to the top of the luminaire.
C: They must be installed so that there is at least 1 1/2 inches from the lowest surface of the metal roof decking to the bottom of the luminaire.
D: They must be installed so that there is at least 1 1/2 inches from the lowest surface of the metal roof decking to the top of the luminaire.

## Question 16: 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 16: 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 17: 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.

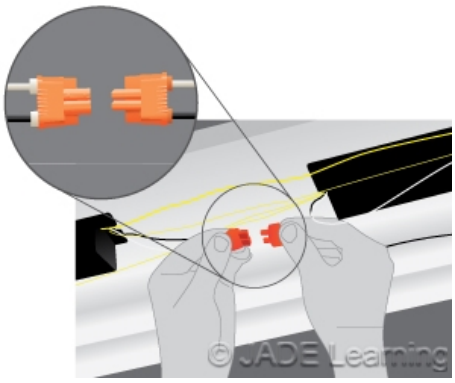
The 2011 NEC had an exception for industrial establishments with qualified persons to service the luminaires. The 2014 NEC has deleted that exception.

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 17: 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 18: 411 Lighting Systems Operating at 30 Volts or Less and Lighting Equipment Connected to Class-2 Power Sources.

Question ID#: 733.0

Article 411 has been revised to include equipment connected to Class 2 power sources. These revisions are part of an effort to modernize Article 411 in order to keep up with changing technology. It will provide answers to many questions concerning proper marking of Class 2 power sources, secondary wiring methods, and listing requirements.

The previous title for Article 411, "Lighting Systems Operating at 30 Volts or Less", has been changed to "Lighting Systems Operating at 30 Volts or Less and Lighting Equipment Connected to Class-2 Power Sources". Section 411.1, Scope, now says the article covers lighting equipment connected to a Class 2 power source.

Section 411.3 has been reorganized to include a new requirement that listed Class 2 lighting equipment must be rated to comply with Chapter 9, Table 11(A) for alternating-current or Table 11(B) for direct current. These tables provide the general requirements that Class 2 and Class 3 power sources must comply with as part of the listing process. The last sentence in section 411.4 is new and states that Class 2 power sources and lighting equipment connected to a Class 2 power source must be listed. When these power sources are listed, they will be required to be marked as a Class 2 power source. Requiring the Class 2 power source to be listed helps the installer and inspector determine what low voltage wiring methods are permitted to be installed on the load side of the power supply, according to Article 725, Part III.




***Article 411 now covers lighting equipment connected to Class-2 Power Sources.***

Question 18: A Class 2 alternating current power source must comply with which of the following?

A: Chapter 9, Table 11(A).
B: Chapter 9, Table 11(B).
C: Chapter 9, Table 5.
D: Chapter 9, Table 5(A).

## Question 19: 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 19: 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.

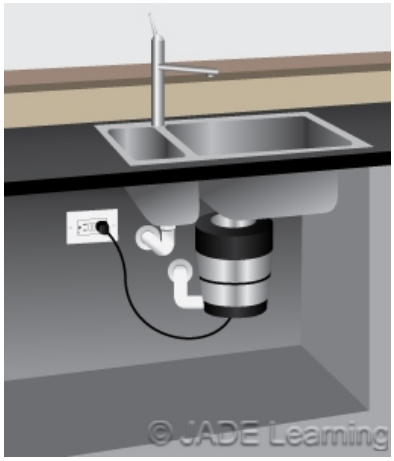
## Question 20: 422.16(B)(1) Electrically Operated In-Sink Waste Disposers.

Question ID#: 735.0

In the 2014 NEC, the term "kitchen" has been removed from 422.16(B)(1) and replaced with the phrase "in-sink" to make it clearer that waste disposers installed in sinks in other locations besides kitchens can be connected with a flexible cord. The phrase "in-sink" was added to distinguish food-type disposers from other types of waste disposers such as trash compactors.

Limiting cord-connected waste disposers to just kitchens in the 2011 NEC, meant that the location had to have permanent provisions for food preparation and cooking. Prep rooms in small grocery stores and convenience markets would not have met this definition of a kitchen and a cord-connected waste disposer would not have been permitted in the 2011 NEC.

A waste disposer that is connected by a flexible cord to a receptacle can be located in a kitchen, family room, wet bar, or any location where the waste disposer is installed in a sink. The 4 conditions of 422.16(B) must be met.




***An in-sink waste disposer that is connected by a flexible cord to a receptacle is permitted in locations besides kitchens.***

The 4 conditions are:

- ***The flexible cord shall be terminated with a grounding-type attachment plug. Exception: A listed in-sink waste disposer distinctly marked to identify it as protected by a system of double insulation, or its equivalent, shall not be required to be terminated with a grounding-type attachment plug.***
- ***The length of the cord shall not be less than 450 mm (18 in.) and not over 900 mm (36 in.).***
- ***Receptacles shall be located to avoid physical damage to the flexible cord.***
- ***The receptacle shall be accessible.***

Question 20: Which of the following waste disposer installations is permitted?

A: A listed waste disposer in a kitchen connected by a 42 inch cord with a grounding-type attachment plug.
B: A listed in-sink waste disposer in a restaurant connected by a 14 inch cord with a grounding-type attachment plug.
C: A listed in-sink waste disposer in a convenience market connected by a 24 inch cord with a grounding-type attachment plug.
D: A listed waste disposer in a wet bar connected by a 30 inch cord with a non-grounding type attachment plug.

## Question 21: 422.19,422.20,422.21 Requirements for Outlet Boxes.

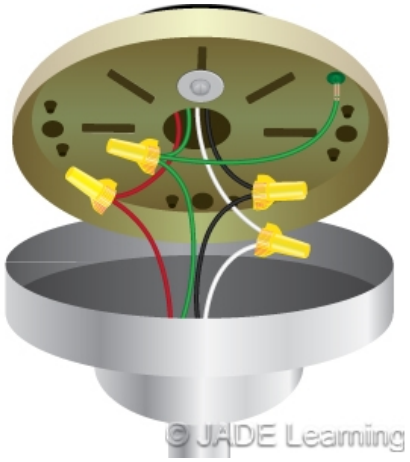
Question ID#: 736.0

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 21: 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 22: 422.23 Tire Inflation and Automotive Vacuum Machines.

Question ID#: 737.0

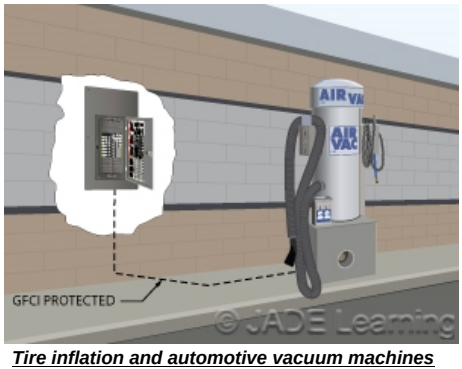
A new section has been added to Article 422 in order to provide an additional level of protection for the public.

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

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.




***Tire inflation and automotive vacuum machines need GFCI protection.***

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 22: 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 23: 422.49 High-Pressure Spray Washers.

Question ID#: 738.0

Two types of high-pressure spray washers now require GFCI protection:

- Single-phase spray washers rated 250 volts or less.
- Three-phase spray washers rated 208Y/120 volts and 60 amperes or less.

The requirement to add GFCI protection for 3-phase high-pressure spray washers that are rated 208Y/120 volts and 60 amps or less is new to the 2014 NEC.

GFCI protection is available for 3-phase systems rated 208Y/120 volts and 60 amperes and less. Since single phase high-pressure spray washers rated 250 volts or less were already required to be supplied with GFCI protection, the requirement was expanded to include 3-phase systems of 208Y/120 volts. GFCI protection for 3-phase systems above 60 amps is not readily available, so only those spray washers rated 60 amps or less were included in the requirement.




***GFCI protection is now required for spray washers that are 3-phase and rated 208Y/120 volts, 60 amperes or less.***

The GFCI protection for high-pressure spray washers can be provided in one of two ways:

- Factory-installed GFCI protection that is an integral part of the attachment plug.
- Factory-installed GFCI protection that is located in the supply cord within 12 inches of the attachment plug.

Any time an electrical appliance is used around water, there is a shock hazard. GFCI protection is required in damp and wet locations and for appliances like dishwashers and waste disposers that use water. Electricity and water do not mix. GFCI protection has made many common job tasks safer and protected generations of homeowners, workers, and others from electric shock.

Question 23: Which of the following high-pressure spray washers require built-in GFCI protection?

A: A 3-phase spray washer rated for use on a 208Y/120 volt system and rated 30 amperes.
B: A 3-phase spray washer rated for use on a 480Y/277 volt system and rated 60 amperes.
C: A single-phase spray washer rated 277 volts and 20 amperes.
D: A 3-phase spray washer rated for use on a 208Y/120 volt system and rated 75 amperes.

## Question 24: 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 24: 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.

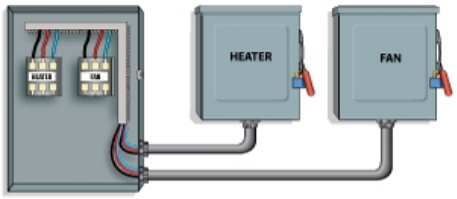
## Question 25: 424.19 Fixed Electric Space-Heating Equipment. Disconnecting Means.

Question ID#: 740.0

A simultaneous disconnecting means must be provided for fixed electric space-heating equipment which will disconnect the ungrounded conductors of the heater, motor controller, and supplementary overcurrent protection.

The 2014 NEC requires that when the heating equipment is supplied by more than one source, feeder, or branch circuit, the disconnecting means must be grouped and marked. The 2011 NEC said that the disconnecting means for the fixed electric space-heating equipment must be grouped and marked if they were supplied from one source. "Source" is not defined in the NEC, and installers and inspectors didn't know if "source" meant a source of AC voltage, a single panelboard, or a remote power supply. Now it is clear that if fixed electric space-heating equipment is supplied by more than one source, feeder, or branch circuit, the disconnecting means for the equipment must be grouped and marked.

Also, a reference to 110.25 has been added which requires the disconnecting means to be lockable in the open position with the provisions for locking remaining in place with or without the lock installed. There were a number of sections in the Code that required a disconnecting means to be lockable in the open position. Instead of saying the same thing in different places, the requirement to have the disconnecting means be capable of being locked in the open position was written in Section 110.25 and referred back to throughout the Code.




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***The 2014 NEC requires that when space-heating equipment is supplied by more than one source, feeder, or branch circuit, the disconnecting means must be grouped and marked. They must also be lockable.***

Question 25: Which of the following installations requires the disconnecting means for fixed electric space-heating equipment to be grouped?

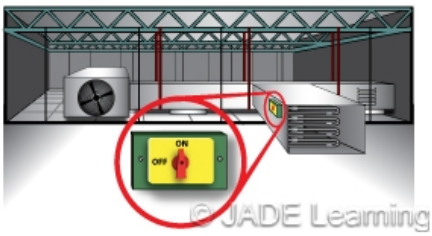
A: Space-heating equipment for two separate zones in a building.
B: Separate space-heating equipment units that serve the same building space.
C: Two branch circuits that supply the same piece of space-heating equipment.
D: All space heating equipment for a single floor in a building.

## Question 26: 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 26: 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 27: 430.22(G) Single Motor. Conductors for Small Motors.

Question ID#: 742.0

The general rule says the minimum size conductor permitted to supply a small motor is No. 14 AWG. However, if the conductors are installed in an enclosure or cabinet, both the 2011 NEC and the 2014 NEC specify conditions that allow No. 18 or No. 16 AWG copper conductors to be used for small motors. Except for using the word "current" rating rather than "ampacity", the three conditions in the 2011 NEC under which No. 16 or No. 18 AWG copper conductors were permitted to be used for small motors that are installed in an enclosure or cabinet are essentially the same. In each case there are two sets of three conditions that all must be complied with in order to use either No. 18 or No. 16 AWG copper conductors.




***Overload protection is permitted to be provided by either a Class 10 or a Class 10A overload device installed in accordance with 430.32.***

The requirements for overcurrent protection were not changed. However, the requirements for overload protection for motors covered by Section 430.22(G) were revised. Now, overload protection is permitted to be provided by either a Class 10 overload device or a Class 10 A overload device installed in accordance with Section 430.32. This change means that if a Class 10 A adjustable, bi-metallic overload relay complies with the listing requirements of ULÂ®, it is now permitted to be used to protect small motors supplied with either No. 18 or No. 16 AWG copper conductors from overloads.

NEMAÂ®, IECÂ®, and ULÂ® standards for Class 10 and 10A overloads relays require both types of these devices to be able to meet all of the following standards:

- Must open a circuit in 10 seconds or less under locked-rotor conditions.
- Must open a circuit in less than 2 hours under any condition specified in 430.32.
- Must open a circuit in less than 2 minutes after sensing overload current rated at 150% of their setting.

Question 27: What is the smallest copper conductor permitted to be used to supply a small motor that is NOT installed in either an enclosure or cabinet?

A: No. 18 AWG.
B: No. 16 AWG.
C: No. 14 AWG.
D: No. 12 AWG.

## Question 28: 430.52(C)(5) Rating or Setting for Individual Motor Control. Rating or Setting. Power Electronic Devices.

Question ID#: 743.0

Semiconductor fuses are now the type of fuses permitted to protect power electronic devices. In the 2011 NEC it said fuses used to protect power electronic devices only had to be "suitable."

With this change, 430.52(C)(5) now permits the use of ***"***semiconductor fuses***"*** in place of the overcurrent devices listed in Table 430.52, provided the fuse is designed to provide protection for power electronic devices that are used in equipment such as variable frequency drives and other solid-state motor control equipment. Semiconductor fuses are not interchangeable with current-limiting fuses. They are extremely fast acting devices used to minimize damage to power electronic devices caused by short circuits. Semiconductor fuses do not provide the full range of protection (from overcurrent through short circuit) that branch circuit type class rated fuses provide, such as CC, J, T, and RK5.

In addition to being permitted to protect electronic devices, semiconductor fuses are also permitted to provide overcurrent protection for electro-mechanical components like contactors and conductors and other electro-mechanical devices in power electronic equipment. When semiconductor fuses are installed, the equipment is required to be marked adjacent to the semiconductor fuse to identify devices permitted to replace them.




***Semiconductor fuses should now be used to protect power electronic devices.***

Question 28: Which of the following statements bests describes semiconductor fuses?

A: They are designed to be used specifically in place of current-limiting fuses.
B: They are fast acting devices permitted to be used in place of devices listed in Table 430.52 to protect power electronic devices.
C: They are only permitted to be used to protect electronic devices in power electronic equipment.
D: They are now one of the types of overcurrent devices listed in Table 430.52.

## Question 29: 430.53(D) Several Motors or Loads on One Branch Circuit. Single Motor Taps.

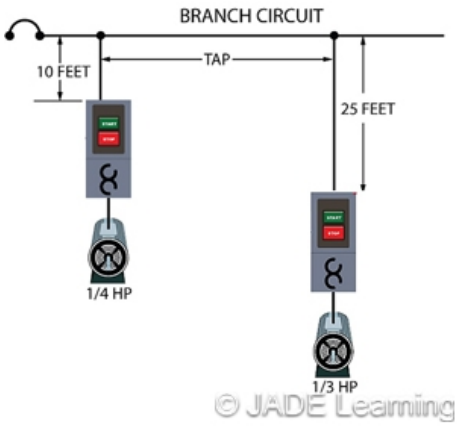
Question ID#: 744.0

This change clarifies the requirements for the length of 10 ft. and 25 ft. tap conductors for individual motors that are part of a group installation that is supplied by one branch circuit. The revision makes it clear that the length of the tap conductor is measured from the point of the tap to the ***motor overload device***.

The requirements in 430.53(D)(2) now say that when applying the 25 foot tap rule, the tap conductor is to be measured from the "point" where the tap conductor is connected to the branch-circuit conductor to the motor overload device, which is usually part of a motor controller or starter. Section 430.53(D)(3) requires that when applying the 10 foot tap rule, the tap conductor is to be measured from the "point" where the tap conductor is connected to the branch-circuit conductor to either a listed manual motor controller that is marked "Suitable for Tap Conductor Protection in Group Installations" or to a branch-circuit protective device.

If the tap conductors are protected by an approved means, a raceway, or are within an enclosed controller and the installation complies with one of the three requirements listed below, taps supplying a single motor that is part of a group installation are not required to have a separate overcurrent protective device installed to protect the tap itself.

No separate overcurrent protective device is required for a tap conductor if ***one of the following*** conditions is met:




***The length of the tap conductor is measured from the point of the tap to the motor overload device.***

- The ampacity of the tap conductors that supply a single motor are required to equal or exceed the ampacity of the branch-circuit conductors supplying the group installation.

- Tap conductors are permitted to be up to 25 feet long provided their ampacity is not less than 1/3 the ampacity of the branch-circuit conductors to which the tap is connected. ***For Example,*** the minimum ampacity of a 25 foot tap conductor that is tapped to a branch-circuit conductor that has an ampacity of 75 amps is 25 amps: (75 A Ã· 3 = 25 A).

- Tap conductors are permitted to be up to 10 feet long if their ampacity equals or exceeds 1/10 the rating of the branch-circuit short-circuit and ground-fault overcurrent protective device (OCPD) that protects the conductors to which the tap is connected. ***For Example***: the minimum ampacity of a 10 foot tap conductor that is tapped to branch-circuit conductors protected by a 200 amp OCPD is 20 amps: (200 A Ã· 10 = 20 A).

Question 29: In a group motor installation in which a single motor is supplied by tap conductors that are connected to one branch circuit, which of the following statements is correct?

A: Each tap conductor is always required to be provided with a separate short-circuit and ground-fault protective device.
B: Tap conductors must always have the same ampacity as the feeder that supplies the group installation.
C: When applying the 10 foot tap rule, conductors are measured from the point of the tap on the branch circuit to a listed manual motor controller or a branch-circuit protective device.
D: When applying the 25 foot tap rule, conductors are measured from the branch-circuit short-circuit and ground-fault protective device to the motor itself.

## Question 30: 430.130 Branch-Circuit Short-Circuit and Ground-Fault Protection for Single Motor Circuits Containing Power Conversion Equipment.

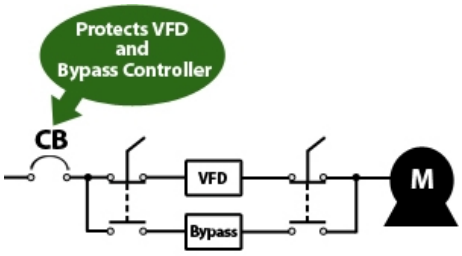
Question ID#: 745.0

Sections 430.130 and 430.131 are new in the 2014 NEC and provide requirements for motors connected to power conversion equipment. Adjustable speed drives or variable frequency drives (VFD's) are types of power conversion equipment that adjust the speed of the motor by adjusting the voltage and frequency of the input supply to the motor. Changing the speed of a motor with a variable frequency drive is much more energy efficient than using dampers or mechanical means to slow the rate of the driven load connected to the motor.

When a motor circuit includes a variable frequency drive, the branch-circuit short-circuit and ground-fault protection, whether a fuse or circuit breaker, is based on the full-load current rating marked on the motor nameplate, or on the controller nameplate. The setting of the overcurrent or ground-fault device is determined by applying the percentages of full-load current found in Table 430.52.

There may be a conflict between the maximum branch-circuit short-circuit and ground-fault settings found in the variable frequency drive manufacturer's instructions and the values calculated by applying Code rules. In such a case, the values from the manufacturer's instructions must be used.

A bypass device may be installed in the motor circuit to allow the variable frequency device to be cut out of the circuit for maintenance or other reasons. If a bypass device is installed, it must also have overcurrent protection. If a single overcurrent protective device is provided for both the main circuit and the bypass circuit, the rating of the overcurrent protection is determined by the larger of either the rating of the variable frequency drive circuit or the bypass circuit.




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***The branch-circuit short-circuit and ground-fault protective fuses or inverse time circuit breakers shall be of a type and rating or setting permitted for use with the power conversion equipment using the full-load current rating of the connected motor load in accordance with 430.53.***

Question 30: Branch-circuit protection for a variable frequency drive shall be determined by using which of the following?

A: The full-load current rating of the motor load.
B: The service factor listed on the motor nameplate.
C: The size of the required overload protection.
D: The temperature rise of the motor.

## Question 31: 430.233 Guards for Attendants.

Question ID#: 746.0

Where motors or motor controllers have exposed live parts operating at over 50 volts, and the motors require adjustment or servicing while energized, suitable mats or platforms must be provided to protect personnel. In the 2011 NEC, the voltage level was 150 volts, but in the 2014 NEC the voltage level has been reduced to 50 volts.

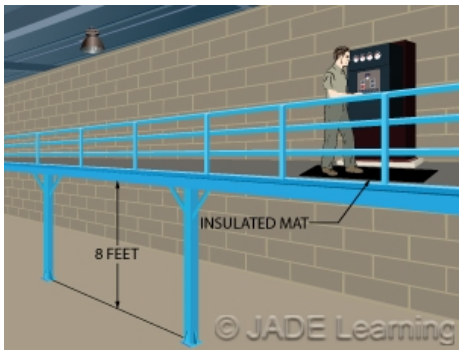
Fifty volts or greater is the threshold voltage for shock used by NFPA 70E, OSHA, and the NEC. At 50 volts there is a shock hazard to personnel who may come in contact with an energized part. In earlier editions of the Code, requiring guards for attendants to protect against live parts only if the voltage was over 150 volts was a considered a conflict with the rest of the NEC and other standards.

In fact, in the section immediately before 430.233, exposed live parts of motors and controllers operating at 50 volts or more require guarding against accidental contact. The situations described in 430.232 and 430.233 are different. Section 430.232 describes what is necessary to protect personnel from accidental contact. Section 430.233 describes how to protect personnel that may need to adjust or service motors or controllers that are guarded by location only.

Requiring mats or platforms for attendants to stand on while adjusting or servicing motors or controllers will insulate the personnel from ground, and it will help protect them from the dangers of electric shock.

Live parts that are guarded from contact only by location are required to be guarded if they are operated in excess of 50 volts to ground. Guarding by location means being:

- located in a room only accessible to qualified persons,
- located on a balcony or platform only accessible to qualified persons, or
- located 8 ft. or more above the floor.




***Operating at more than 50 volts to ground, motors or controllers must be guarded against accidental contact by enclosure or location.***

Question 31: Which of the following is required to be guarded if it is only guarded by location?

A: A motor with exposed live parts operated at 40 volts to ground.
B: A motor with exposed live parts operated at 60 volts to ground.
C: A motor with exposed live parts operated at 30 volts to ground.
D: A motor with exposed live parts operated at 12 volts between terminals.

## Question 32: 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.

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.




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

Question 32: 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 33: 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




***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.***

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.

Question 33: 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 34: 445.20 Ground-Fault Circuit-Interrupter Protection for Receptacles on 15- kW or Smaller Portable Generators.

Question ID#: 749.0

A new Section 445.20 has been added to Article 445 and requires GFCI receptacles on 15-kW or smaller portable generators.

The new section now requires all 125-volt, single-phase, 15- and 20-ampere receptacle outlets, that are a part of a 15 kW, or smaller, portable generator to have ground-fault circuit-interrupter protection for personnel integral to the generator or receptacle.

It is important to note that the Code section is only for portable generators and only includes 125- volt, single-phase, 15- and 20-amp receptacles. Many small generators are also equipped with 240-volt receptacles that are not affected by this new requirement.

These smaller portable generators are commonly used at carnivals, temporary events, equipment rentals, or for construction power or camping. In these types of locations, portable generators equipped with proper GFCI protection can help to greatly reduce shock hazards that may be present due to damaged or frayed power cords, power cords laying in standing water, faulty portable lighting, or damaged power tools. Most of these smaller generators do not receive any type of electrical inspection before use, and adding GFCI protection to receptacles mounted on the generator will provide an additional level of protection.




***125-volt, single-phase, 15- and 20-ampere receptacle outlets that are a part of a 15-kW or smaller portable generator must have GFCI protection.***

Question 34: Which type of generator is required to have integral ground-fault circuit-interrupter protection for its 125- volt 15-amp single-phase receptacle?

A: A 15 kW permanently installed generator at an amusement park.
B: A 16 kW portable generator.
C: A 12 kW generator permanently installed at a dwelling.
D: A 12 kW generator on wheels.

## Question 35: 450.10(A) Grounding. Dry-Type Transformer Enclosures.

Question ID#: 750.0

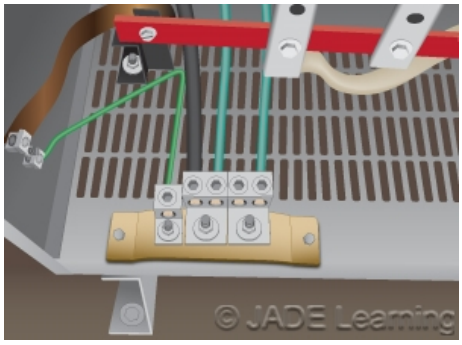
There are new requirements for grounding dry-type transformer enclosures. Connections for equipment grounding conductors and supply-side bonding jumpers must now be made at a terminal bar that is mounted inside the transformer enclosure.

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 35: 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 36: 450.11(B) Source Marking.

Question ID#: 751.0

Section 450.11, Marking, has been divided in section (A) General, and (B) Source Marking. Section (A) has been changed to list format.

***(A) General. Each transformer shall be provided with a nameplate giving the following information:***

***1. The name of the manufacturer***

***2. Rated kilovolt-amperes***

***3. Frequency***

***4. Primary and secondary voltage***

***5. The impedance of transformers 25kVA and larger***

***6. Required clearances for transformers with ventilating openings***

***7. The amount and kind of insulating liquid where used***

***8. For dry-type transformers, the temperature class for the insulation system***

Section B states: ***A transformer shall be permitted to be supplied at the marked secondary voltage provided the installation is in accordance with the manufacturer's instructions.***

The new section on Source Marking has been added because many transformers are




***A transformer can be supplied at the marked secondary voltage.***

reverse-fed, where the secondary is used as the input and the primary is used as the output. Reverse feeding, so that a step-up transformer becomes a step-down transformer and a step-down transformer becomes a step-up transformer, will work according to the turns ratio of the transformer. However, issues may arise in terms of wire insulation and cooling, so if a transformer is reverse-fed, it should only be done according to the manufacturer's instructions.

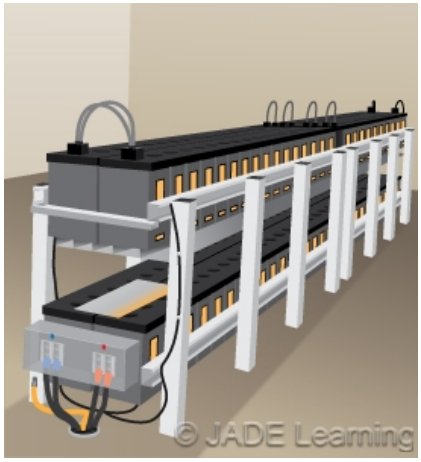
Question 36: Which of the following statements about transformers is true?

A: The date of manufacture must be on the transformer nameplate.
B: All dry type transformers can be reverse fed, where the supply is connected to the secondary of the transformer.
C: The impedance of a 15 KVA transformer must be on the nameplate.
D: A transformer can be reverse-fed if installed according to the manufacturer's instructions.

## Question 37: 480.3 Battery and Cell Terminations.

Question ID#: 752.0

This new section includes requirements for (a) how conductors are connected to batteries, (b) the minimum required ampacities of field-installed battery conductors, and (c) how the conductors that connect batteries on separate levels or racks should be installed.




***Electrical connections shall not put mechanical strain on battery terminals.***

480.3(A) requires that when mating dissimilar metals, antioxidant material suitable for the battery connection shall be used. The informational note that follows 480.3(A) refers the installer to the battery manufacturer's installation instructions for guidance on what types of antioxidant should be used. Antioxidant aids in the prevention of corrosion as well as provides for a better connection, especially in the event that dissimilar metals are used when terminating the cable to the battery.

480.3(B), requires the cross-sectional area of field-assembled inter-cell and inter-tier connectors and conductors to be large enough so that the temperature rise under maximum load and at maximum ambient temperature cannot exceed the safe operating temperature of the conductor insulation or the conductor supports.

480.3(C) requires that electrical connections from cables to batteries and between cells on separate levels or racks shall not subject the battery terminals to mechanical strain and also requires the use of terminal plates whenever practicable. Using terminal plates allows for less strain on battery terminals and lessens the likelihood that a battery acid leak will corrode the electrical termination.

Question 37: When the terminal of a battery and the interconnecting cable are of different materials, what must be used at the point of connection?

A: Antioxidant.
B: A terminal listed as corrosion-resistant.
C: Listed terminals.
D: Terminals listed for fine strand cables.

## Question 38: 480.8(C) Racks and Trays. Accessibility

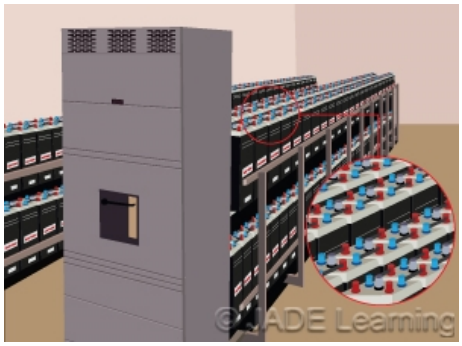
Question ID#: 753.0

Storage battery terminals must be readily accessible for readings, inspection, and cleaning if maintenance on the batteries is required.Â  One side of transparent battery containers must be readily accessible for inspection of internal components.

Most battery systems require visual inspection.Â  All storage batteries require periodic or regular monitoring of voltage, resistance, and physical condition.Â  If the storage batteries are not readily accessible, maintenance personnel can be put in danger climbing on ladders or over obstacles to perform the monitoring or maintenance.Â  Voltage levels of batteries connected in series can be high, and a shock hazard definitely exists.

Some equipment designs place the batteries in closed modules with embedded monitoring.Â  In these cases maintenance is not required or even possible, and the battery terminals are not required to be readily accessible.

Readily accessible means equipment is capable of being reached quickly for operation, renewal, or inspections without requiring personnel to use tools, to climb over or remove obstacles, or to resort to portable ladders.




***Battery terminals must be readily accessible for readings, inspections, and cleanings.***

Question 38: If storage battery terminals require periodic inspection and cleaning, what is required?

A: The batteries must be housed in transparent modules.
B: The battery terminals must be accessible.
C: The batteries must be stored on open racks.
D: The battery terminals must be readily accessible.

## Question 39: 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 39: 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.

## Question 40: 490.22 Isolating Means.

Question ID#: 755.0

There were three editorial changes to this section on the isolating means for equipment over 1000 volts.

The isolating means completely isolates high voltage equipment from all ungrounded conductors. A separate isolating means is not required if there are other ways of de-energizing the equipment for inspection and repairs. In the 2011 NEC, one of the ways to de-energize the equipment was by a "draw-out-type metal-enclosed switchgear unit." Throughout the NEC in 2014 "metal-enclosed switchgear" has been changed to "switchgear."

If the isolating means is not interlocked with another circuit-interrupting device, a warning sign is required instructing the user not to open the switch under load. A reference to 110.21(B) has been added here which points to a section on field-applied hazard markings. The warning sign must use a standardized system of words, colors, and symbols. The warning sign or label must be permanently fixed to the equipment used as the isolating means and cannot be handwritten. The warning sign or label must be durable enough to withstand the environment where the equipment is installed.




***The warning sign(s) or label(s) on isolating means shall comply with 110.21(B).***

An identified fuseholder and fuse shall be permitted as an isolating switch. The 2011 NEC said both the fuse and fuseholder had to be "identified for the purpose." The 2014 NEC simply says the fuse and fuseholder must be identified. Saying "identified for the purpose" was not necessary because the definition of "identified" means "recognizable as suitable for the specific purpose, function, use, environment, or application."

Question 40: Which of the following statements about a warning sign for a high voltage isolating means is correct?

A: A warning sign is required for all isolating means for equipment over 1000 volts.
B: The warning sign can be handwritten if the equipment is in a dry location.
C: The warning sign can be located adjacent to the isolating means.
D: If a warning sign is required, it must be installed on the equipment used as the isolating means.

## Question 41: 490.47 Switchgear Used as Service Equipment.

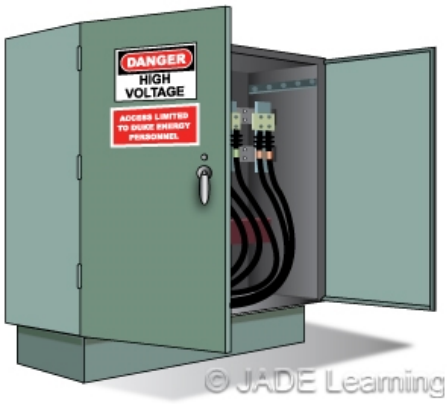
Question ID#: 756.0

High voltage switchgear (over 1000 volts) that is used as service equipment must include a ground bus for the connection of service cable shields. The ground bus also provides a place to attach safety grounds during maintenance work.

A new requirement says a notice must be posted at the equipment if access to the switchgear is limited to the serving utility or if the utility must provide authorization for onsite personnel to service the equipment. A warning sign that reads, DANGER - HIGH VOLTAGE - KEEP OUT, is also required on panels and doors that provide access to live parts over 1000 volts.

The notice that warns onsite personnel that access to the high voltage switchgear is limited to the serving utility will increase worker safety. Maintenance employees cannot de-energize equipment that is owned by the utility. Working on energized high voltage switchgear is a very special skill and very dangerous work. If access to the switchgear is limited to the utility, facility technicians will be reminded by the notice that they should not attempt to work on the equipment.

This new section in Article 490 of the 2014 NEC about high voltage switchgear used as service equipment was moved from Article 225, Outside Branch Circuits and Feeders.




***High voltage switchgear used as service equipment must include a ground bus.***

Question 41: What is the purpose of the ground bus required by Section 490.47 for high-voltage switchgear used as service equipment?

A: It provides a neutral connection for line to neutral loads.
B: It provides a connection point for service cable shields.
C: It stabilizes the voltage to ground.
D: It acts as a grounding electrode and provides lightning protection.

## Question 42: 490.48 Substations.

Question ID#: 757.0

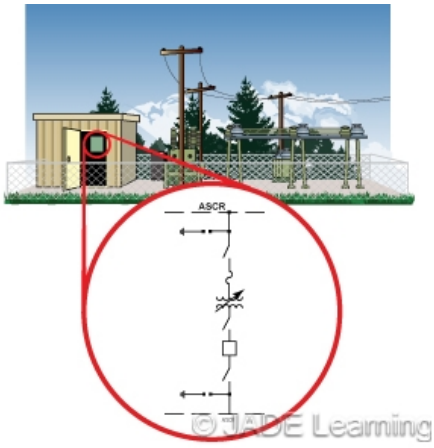
This section on Substations in Article 490 has been moved from Article 225, Outside Branch Circuits and Feeders. An important new section on design documentation for substations has been added.

Documentation on the engineered design of the substation must be made available to the Authority Having Jurisdiction. The substation design must be done by a licensed professional engineer who is primarily engaged in the design of substations. The documentation for the substation design must include information on the following:

***(1) General***
***(2) Protective Grounding***
***(3) Grounding Live Parts***
***(4) Transformers and Regulators***
***(5) Conductors***
***(6) Circuit Breakers, Switches and Fuses***
***(7) Switchgear Assemblies***
***(8) Metal-Enclosed Bus***
***(9) Surge Arrestors***

***The 9 items above are from the code language prior to the Errata No. 70-14-1.***

Providing documentation on the substation design will help the Authority Having Jurisdiction in the plan review process. The inspection department will have the documentation plus a single-line diagram of the switchgear that identifies the interlocks, isolation means and all the voltage sources for the substation. Substations




***Documentation of the substation design by a licensed engineer shall be available.***

that are not utility owned fall under the requirements of the National Electrical Code and must be inspected to ensure a safe installation.

The single-line diagram of the switchgear must be posted in a readily visible location within the same room or enclosed area where the switchgear is located.

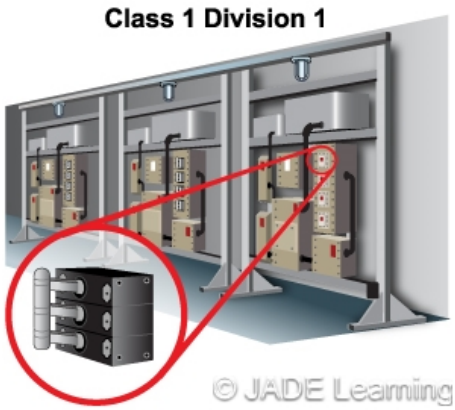
Question 42: In the design documentation provided for a new substation, which of the following items is NOT required?

A: Disconnection of fuses.
B: Motor rotation of cooling fans.
C: Conductor terminations.
D: Types of enclosures.

# Chapter 5

## Question 43: 501.40 Multiwire Branch Circuits. Deleted.

Question ID#: 758.0




***Multiwire branch circuits are still permitted in hazardous locations if all ungrounded conductors are disconnected simultaneously at the point where the circuit originates.***

Section 501.40, addressing the use of multiwire branch circuits in Class I, Division I locations, has been deleted.

Wiring methods and materials used in Class I locations have stricter requirements than those used in ordinary locations due to the increased hazard(s) that exist because of flammable liquids or vapors that might be present.

The previous Code requirement did not allow a multiwire branch circuit to be used in a Class I, Division 1 location unless the disconnecting device for the circuit opened all ungrounded conductors of the circuit at the same time. The intent of the Code section was to ensure that there was never a situation where an ungrounded conductor that was part of a multiwire branch circuit could be disconnected by itself without also disconnecting the other ungrounded circuit conductors of the circuit. If only one of the two ungrounded conductors are disconnected, then there is potential for return current from the other ungrounded conductor to flow on the common shared grounded conductor which could create a spark or ignition source if it is opened by the electrician working on the de-energized portion of the circuit.

Section 501.40 was removed because it was already covered in Section 210.4(B). Section 210.4(B) requires each multiwire branch circuit to be provided with a means that will simultaneously disconnect all ungrounded conductors at the point where the branch circuit originates. If all ungrounded conductors of a multiwire circuit are disconnected, there is no chance of a spark in a hazardous location setting off a fire or explosion.

Multiwire branch circuits are still permitted in hazardous locations as long as they comply with 210.4(B).

Question 43: What is required of a multiwire branch circuit that is used in a Class I, Division 1 location?

A: Multiwire branch circuits are not permitted in hazardous locations.
B: All ungrounded conductors must be able to simultaneously disconnect at the point where the branch circuit originates.
C: All ungrounded and grounded conductors must be able to simultaneously disconnect at the point where the branch circuit originates.
D: All grounded conductors must be able to simultaneously disconnect at the point where the branch circuit originates.

## Question 44: 514.3(B) Classified Locations.

Question ID#: 759.0




***New figures display classified areas adjacent to fuel dispensers mounted on aboveground storage tanks.***

The illustration in Section 514.3 that shows the classification of hazardous areas in the vicinity of fuel dispensers has been modified and a new illustration for hazardous areas around fuel dispensers with aboveground fuel storage tanks has been added. Figure 514.3 in the NEC shows the classification of areas adjacent to fuel dispensers and Figure 514.3(B), new in the 2014 NEC, displays classified areas adjacent to fuel dispensers mounted on aboveground storage tanks.

Although the physical measurements for hazardous areas around and under the fuel dispensers have remained unchanged in Figure 514.3, the illustration has been updated in an effort to reflect similar illustrations found in NFPA 30A-2012, ***Code for Motor Fuel Dispensing Facilities and Repair Garages***. It is also easier to recognize the below grade sump required to be considered as a Class I, Division 1 location under the fuel dispenser in the revised illustration.

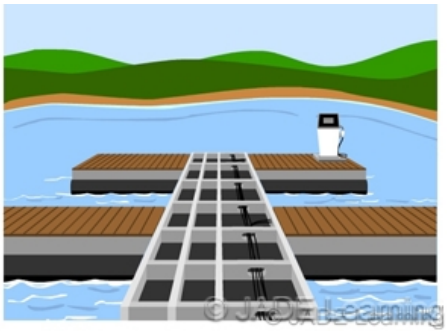
Figure 514.3(B) on page 70-444 of the 2014 NEC is new and shows the classified area surrounding an aboveground storage tank and associated dispenser. The illustration makes it clear that the area within 20 feet of any edge of the dispenser measured horizontally is considered as a Class I, Division 2 location up to 18 inches above grade. Figure 514.3(B) also shows that the area within 18 inches horizontally of the dispenser as well as surrounding the envelope of the storage tank is considered to be a Class I, Division 2 location. The end and side views of the above ground tank in figure 514.3(B), clearly show that the area immediately above the dispenser is unclassified.

Question 44: According to Figure 514.3(B), what is the classification for the area up to 18 inches above grade that is within 20 ft. horizontally of the fuel dispenser on an above ground tank?

A: Class I, Division 1.
B: Class I, Zone 1.
C: Class I, Division 2.
D: Unclassified.

## Question 45: 514.3(C)(D) and(E) Motor Fuel Dispensing Stations in Boatyards and Marinas. Closed Construction. Open Construction.

Question ID#: 760.0




***Regardless of location, the area around a fuel pump is a classified location.***

The requirements for motor fuel dispensing stations in boatyards and marinas have been moved from Article 555, Marinas and Boat Yards, to Article 514, Motor Fuel Dispensing Facilities. In any location the area around a fuel pump is a classified location. Requirements for installing fuel pumps in marinas and boatyards are better placed in Article 514.

There are two types of dock and wharf construction included: (1) Closed construction docks have no space between the bottom of the dock and the surface of the water, such as concrete-enclosed expanded foam docks, and (2) Open construction, where the dock is built on stringers supported by piling or floats.

For both closed and open construction type docks, the area 18 inches above the dock and 20 ft. in all directions from the outside edge of the dispenser is a Class I, Division 2 location. For closed construction docks, chases, enclosures, and voids below the surface of the dock are a Class I, Division 1 location. Any enclosures or chases below the surface of the dock within 20 ft. of the dispenser for an open construction dock are Class I, Division 1 locations.

Closed construction docks have chases for fuel pipes and electrical conduit that extend the length of the dock. These areas can accumulate vapors and are an

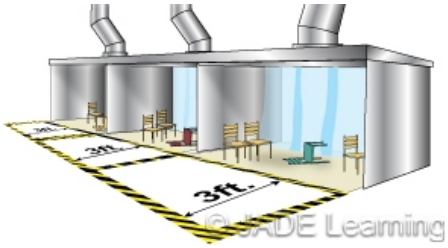
explosion hazard. They are classified Class I, Division 1. If there is an air space between dock sections where fumes can be released, then they are Class I, Division 2 locations. If there are dock sections where flammable liquids and vapors cannot travel, then these dock sections are unclassified.

Question 45: For a closed construction type of dock, how is a junction box below the surface of the dock immediately under a dispenser classified?

A: Class I, Division 1 location.
B: Class I, Division 2 location.
C: Class II, Division 1 location.
D: Unclassified.

## Question 46: 516 Spray Application, Dipping, Coating, and Printing Processes Using Flammable Combustible Materials.

Question ID#: 761.0




***For limited finishing workstations, the area 3 ft. horizontally from the enclosure is a classified location. For a printing process, see NEC figure 516.3(D)(6)(e).***

Article 516 has been completely re-built to update its requirements to match those found in NFPA 33, ***Standard for Spray Application Using Flammable and Combustible Materials***, and NFPA 34, ***Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids.***

Some of the more significant changes include:

- The title of the article has been expanded to include printing processes.
- 4 new definitions have been added and the existing 3 definitions have been revised.
- 8 new illustrations have been added.
- 516.3(A), Zone Classifications of Locations, now covers a new zone classification system.
- A Limited finishing workstation is now addressed in 516.3(D)(5).
- 516.4(C) has been rewritten with new illumination requirements.
- 516.4(F) has been added to address static electric discharge.

Figure 516.3(D)(5) shows area classification requirements for limited finishing work stations. Section 516.2 defines a limited finishing work station as:

***an apparatus that is capable of confining the vapors, mists, residues, dusts, or deposits that are generated by a spray application process and that meets the requirements of Section 14.3 of NFPA 33, Standard for Spray Application Using Flammable or Combustible Materials, but does not meet the requirements of a spray booth or spray room, as herein defined***.

Determining the classification of an area requires knowing what kind of paint or materials are being applied. For example, Figure 516.3(D)(6)(e) shows the area classification of the typical printing process. All of the associated classified areas having to do with a printing process are considered to be Class I locations due to the fact that printing processes utilize chemicals that produce a flammable vapor.

Many of the captions for the illustrations and the illustrations themselves in Article 516 show that areas surrounding painting processes as well as equipment used in a printing process may be classified as either a Class I or Class II hazardous location.

Question 46: NEC Figure 516.3(D)(6)(e) shows the area classification for equipment used in a printing process. The area between the outer most edge of the equipment and the class I Division 2 area is considered a Class 1, division 1 area . This classified area extends in all directions horizontally and vertically from the press.
According to NEC Figure 516.3(D)(6)(e), what is the distance between the outer most edge of equipment used in a printing process and the boundary between the Class 1, division 1 area and the Class 1, division 2 area?

A: 1 foot
B: 3 feet
C: 5 feet
D: 10 feet

## Question 47: 517.2 Health Care Facilities. Definitions.

Question ID#: 762.0




***Patient care space includes areas where patients are examined or treated while support space is an area that does not physically impact patients or caregivers.***

Section 517.2, which provides definitions that are specific to health care facilities, has been revised. In an effort to more closely follow NFPA 99 (***Standard for Health Care Facilities),*** several definitions and informational notes in this section have been added, deleted, or modified.

The definition of "Emergency System" has been removed from section 517.2 as well as Article 517 altogether and the term "essential electrical system" will be used instead. This change was made in an effort to remove confusion that may occur since there are similar, but yet great differences, in the way the term "Emergency System" is used in Article 517, Health Care Facilities, and Article 700, Emergency Systems.

The terms "Critical Branch" and "Life Safety Branch" have been slightly modified and the term "Emergency System" has been removed from those definitions.

"Patient Care Area" has now become "Patient Care Space" and has additional descriptions within the definition in order to clarify the following locations:

- Basic Care Space. Space in which failure of equipment or a system is not likely to cause injury to the patients or caregivers but may cause patient discomfort.
- General Care Space. Space in which failure of equipment or a system is likely to cause minor injury to patients or caregivers.
- Critical Care Space. Space in which failure of equipment or a system is likely to cause major injury or death to patients or caregivers.
- Support Space. Space in which failure of equipment or a system is not likely to have a physical impact on patients or caregivers.

Also, 5 informational notes have been added after the definition of "Patient Care Space" that provide actual examples of facilities that fall into these categories.

Question 47: Which of the following is one of the functions of the essential electrical system?

A: To provide backup power during the disruption of normal power sources.
B: To provide alternate power primarily to 3-phase power equipment.
C: To provide backup power in order to maintain electricity during disruption of emergency power.
D: To provide backup power in order to maintain electricity during disruption of the alternate power source.

## Question 48: 517.16 Use of Isolated Ground Receptacles.

Question ID#: 763.0




***Isolated ground receptacles cannot be used in a patient care vicinity.***

In the 2011 NEC, isolated ground receptacles were not permitted anywhere in a health care facility. In the 2014 NEC, isolated ground receptacles are not permitted within the patient care vicinity, but they are permitted in other locations of a health care facility such as at a nurse's station.

The patient care vicinity is a space within 6 ft. of a patient bed, chair, table, or treadmill where a patient is receiving treatment. The patient care vicinity extends to a height of 7 ft., 6 in. above the floor.

Isolated ground receptacles, as described in 406.3(D), do not provide the redundant grounding required in patient care spaces. Isolated ground receptacles are used for sensitive electronic equipment and are permitted at nurse's stations or other areas outside the patient care vicinity where computers or monitoring equipment might be affected by electromagnetic interference.

In the patient care vicinity, protecting the patient from the threat of electric shock is the main concern. Redundant grounding, where the metal raceways, boxes, and enclosures and an insulated equipment grounding conductor are used as equipment grounds, provides the highest level of protection from electric shock.

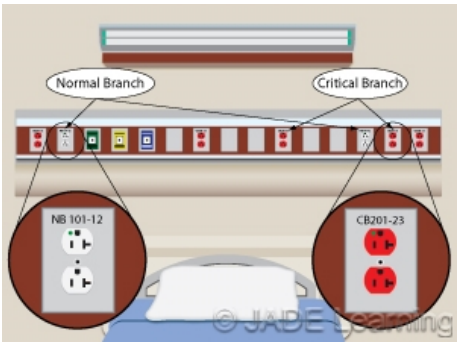
Previously isolated ground receptacles were not permitted anywhere inside a health care facility. Now they are permitted in areas outside the patient care vicinity.

Question 48: Which of the following is considered to be within the patient care vicinity of a hospital?

A: A wall switch located 10 feet away from the patient bed that controls a light fixture installed 7 feet above the floor located directly over the patient bed.
B: A luminaire installed 100 inches above the floor directly above a patient bed.
C: A receptacle located 5 feet from a patient bed.
D: A luminaire located 7 feet above the floor and 7 feet horizontally from the patient bed location.

## Question 49: 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.

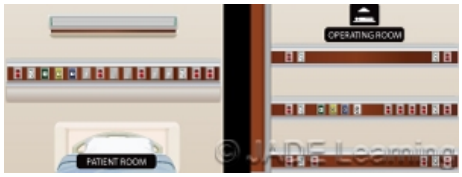
All receptacles shall be listed "hospital grade" and shall be so identified. As part of the listing process, receptacles that are listed as "hospital grade" are required to be identified by the green dot on the front of the receptacle as well as marked "Hospital Grade" or "Hosp. Grade", typically on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

Question 49: 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 50: 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 50: 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 51: 517.26 Application of Other Articles.

Question ID#: 766.0




***Now only the life safety branch, which includes exit signs, must meet the requirements of Article 700.***

A clarification to section 517.26 as well as a new informational note will help to eliminate confusion when applying the provisions of Article 700 to essential electrical systems in health care facilities.

Previously, section 517.26 required that the entire essential electrical system meet the requirements found in Article 700 (Emergency Systems) except as amended by Article 517. A hospital essential electrical system is made up of 3 parts: (1) the equipment system, (2) the life safety branch, and (3) the critical branch.

The new Code text states that instead of the entire essential electrical system needing to meet the requirements of Article 700, only the life safety branch of the essential electrical system must meet the requirements found in Article 700. The significance of this change is that now only the following systems or components are required to comply with Article 700:

- Means of egress illumination
- Exit signs
- Alarms and alerting systems
- Communication systems
- Generator illumination and essential generator receptacles
- Generator accessories needed for generator performance
- Elevators
- Automatic doors

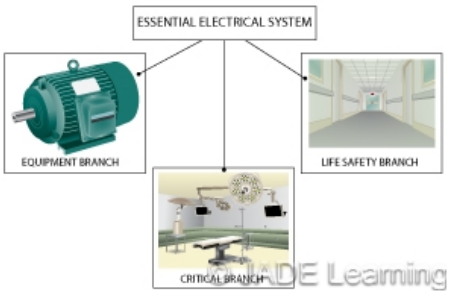
These systems and components that make up the life safety branch are found in section 517.32 and assist in creating a safe environment for occupants to exit the building in an emergency. Prior to this change, the entire essential electrical system was required to comply with Article 700, except where amended in Article 517. The essential electrical system of a health care facility includes far more than just the minimum systems or components needed to safely exit the building. The essential electrical system includes provisions for supplying limited lighting, selected receptacles and selected power circuits to critical care areas and to the equipment system to power basic hospital operation. This new change will ease some of the restrictions that were previously placed on essential electrical systems by Article 700 and limit them to only the life safety branch.

Question 51: In a health care facility, which of the following is part of the life safety branch and must comply with Article 700 requirements?

A: Manually operable egress doors.
B: Signaling systems for elevators.
C: Receptacles in waiting rooms.
D: Parking lot lighting.

## Question 52: 517.30 Essential Electrical Systems for Hospitals.

Question ID#: 767.0




***The three branches of the essential electrical system are equipment, critical, and life safety.***

There have been a number of changes to Section 517.30, Essential Electrical Systems for Hospitals. The changes were made to help align the NEC with ***NFPA 99-2012, Health Care Facilities Code***.

In 517.30(B) the term "emergency system" was deleted. Now there are 3 separate branches to the Essential Electrical System: Equipment Branch, Life Safety Branch, Critical Branch. The Essential Electrical System must be ***capable of supplying a limited amount of lighting and power service that is considered essential for life safety and effective hospital operation during the time the normal electrical service is interrupted for any reason.***

The receptacles or the receptacle cover plates that are connected to the essential electrical system must be marked with a distinctive color, usually red, so they are readily identifiable. The change is that now receptacles that are connected to the equipment branch must also be identified, as well as receptacles connected to the critical branch and the life safety branch.

New Section 517.30(F), Feeders from Alternate Power Source, permits a single feeder from a generator or other alternate source to feed the entire Essential Electrical System, up to the point where the life safety, critical, and equipment branch separate.

New Section 517.30(G), Coordination, requires that overcurrent protective devices that protect the essential electrical system must be coordinated for the length of time that a fault extends beyond 0.1 seconds. Most short circuit or ground faults would clear much faster than 0.1 seconds. Coordination is meant to prevent cascading outages and localize a fault to the overcurrent device immediately upstream from the fault.

Question 52: Which of the following is NOT part of the essential electrical system in a hospital?

A: Critical branch.
B: Equipment branch.
C: Emergency branch.
D: Life safety branch.

## Question 53: 517.41(E) Essential Electrical Systems. Receptacle Identification.

Question ID#: 768.0




***In a nursing home or limited care facility, non-locking, 125-volt, 15- and 20-ampere receptacles supplied by the critical and life safety branches must have an illuminated face or indicator light to show there is power to the receptacle.***

***Non-locking-type, 125-volt, 15-and 20-ampere receptacles shall have an illuminated face or an indicator light to indicate that there is power to the receptacle.***

The general requirement in section 517.40(A) specifies that 517.41(E) applies to nursing homes and limited care facilities such as health clinics. It does not apply to hospitals.

In order to identify receptacles as being part of the essential electrical system in a nursing home or limited care facility, all receptacles, or the receptacle cover plates, must have a distinctive color or marking, usually red, to identify them as being powered by the essential electrical system. In addition, in the 2014 NEC, non-locking, 125-volt, 15- and 20-ampere receptacles must have an illuminated face or indicator light.

The essential electrical system in a nursing home or limited care facility is made up of the critical branch and the life safety branch. Both the critical branch and the life safety branch are powered by the emergency generator when the utility power fails.

If the power goes out in a nursing home or similar facility, nonessential loads will drop out, and there will be a short period of time before the generator will start supplying circuits that are connected to the critical and life safety branch. When staff are caring for patients with the general lighting at less than 100% levels, illuminated receptacles will indicate they are powered up and available for use with cord-and-plug connected equipment.

Losing power in a nursing home is an emergency that staff will have to respond to quickly to guarantee patient safety. Illuminated receptacle outlets will reassure nursing home staff that power is available and ready.

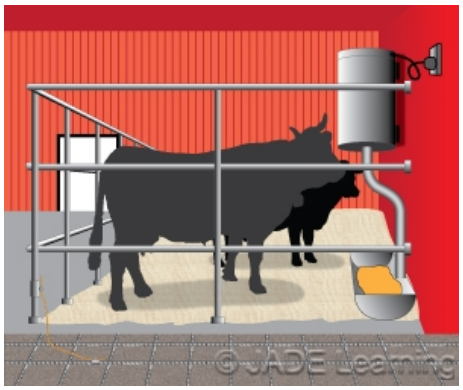
A tentative interim amendment has been submitted that would make NFPA 99 ***Health Care Facilities Code*** responsible for receptacle configuration instead of the NEC.

Question 53: Which of the following statements about 125-volt, non-locking receptacles supplied by the essential electrical system in a nursing home is correct?

A: The cover plates must be brown, ivory, or white.
B: The receptacles must be rated 20-amps.
C: The receptacles must be GFCI protected.
D: The receptacles must be illuminated.

## Question 54: 547.2 and 547.5(F) Agricultural Buildings. Definitions and Separate Equipment Grounding Conductor.

Question ID#: 769.0




***Underground equipment grounding conductors in the scope of Article 547 must be insulated or covered.***

Article 547, Agricultural Buildings, has seen two significant revisions during the 2014 Code cycle. One item is a clarification to the definition of an equipotential plane and the other is a new provision to allow aluminum conductors to be installed underground.

The last part of the definition in 547.2 of an equipotential plane has been reworded in order to make it clear that its purpose is "to minimize voltage potentials within the plane and between the planes, the grounded equipment, and the earth".

The old definition said the purpose of an equipotential plane was "to prevent a difference in voltage from developing within the plane." This change was made in order to align with the true intent of an equipotential plane, which has always been to minimize voltage potentials to a level that a potential shock hazard does not exist.

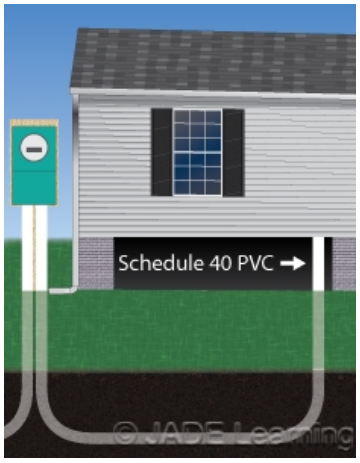
Another change in 547.5 now allows the use of aluminum equipment grounding conductors installed underground at agricultural buildings. Section 547.5(F) states that equipment grounding conductors installed underground within a location falling under the scope of Article 547 shall be insulated or covered. The previous Code language was similar but only allowed the use of a copper conductor. Copper conductors were previously required because of their ability to resist corrosion, but studies have since shown that aluminum also has excellent corrosion-resistant properties, especially in moist areas where ammonia, carbon dioxide, and methane are present.

Question 54: Which of the following best describes an equipotential plane as related to an agricultural building?

A: An area where wire mesh is placed under concrete, bonded to all metal structures that may become energized, and connected to the electrical grounding system.
B: An area where fiberglass mesh is embedded in concrete, bonded to all metal structures that may become energized, and connected to the electrical grounding system.
C: An area where wire mesh is placed on concrete, bonded to all metal structures that may become energized, and connected to the electrical grounding system.
D: An area where wire mesh is placed under concrete and bonded to all metal structures that may become energized.

## Question 55: 550.15(H) Under-Chassis Wiring (Exposed to Weather).

Question ID#: 770.0




***Under-chassis wiring needs to be protected by conduit or raceway approved for use in wet locations.***

Under-chassis wiring (exposed to weather) for a mobile home that operates at 120 volts or higher can be in any raceway approved for use in a wet location or that will provide protection from physical damage. The conductors inside the raceway must be listed for use in wet locations.

The new language does away with the requirement to use Schedule 80 PVC or RTRC listed for exposure to physical damage when the conduit comes out of the ground and terminates to a factory-installed conduit or enclosure.

The old rules required rigid metal conduit or intermediate metal conduit for under-chassis wiring (exposed to weather) for a mobile home. If the wiring method was installed tight up against the frame, it was permitted to be installed in RTRC, EMT, MI cable, or PVC conduit.

Mobile homes are manufactured under HUD regulations. Non-metallic conduit has been installed in mobile homes at the factory for many years. The practice of installing rigid metal conduit or intermediate metal conduit was abandoned long ago as impractical or unnecessary because of other conduits being listed for wet locations or that will provide protection from physical damage. The changes made at Section 550.15(H) will permit the Authority Having Jurisdiction to approve nonmetallic wiring methods for under-chassis wiring for mobile homes.

Question 55: Which of the following wiring methods, installed in a moist area under the chassis of a mobile home, is required to be enclosed within a raceway that is suitable for use in wet locations?

A: An alarm cable that operates at 24 volts DC.
B: A satellite coax cable.
C: A 240-volt type cable that supplies power to a clothes dryer.
D: Cat-5 telephone cable.

## Question 56: 590.4(D)(2) Receptacles in Wet Locations.

Question ID#: 771.0




***Temporary installations will now also require "extra duty" covers for 15- and 20-ampere 125- and 250- volt receptacles in wet locations.***

There has been no actual change to the Code in section 590.4(D)(2) but, since that section references 406.9(B)(1), the changes at 406.9(B)(1) will apply to the 15 and 20 amp 125-volt and 250-volt receptacles installed in a wet location for temporary installations governed by article 590.

This now means that the "extra duty" covers mentioned in section 406.9(B)(1) will need to be installed on all 15- and 20- amp 125-V and 250 V receptacles installed in a wet location for temporary installations, including at one- and two-family dwellings. This new requirement comes as a result of the failure of the commonly used plastic "in use" covers that break off easily leaving the receptacle fully exposed and unprotected from the weather. Section 406.9(B)(1) also requires the following:

- Receptacles of 15- and 20-amperes installed in a wet location shall have an enclosure that is weatherproof whether or not the attachment plug cap is inserted.
- All 15- and 20-ampere, 125- and 250-volt non-locking-type receptacles shall be listed weather-resistant type.

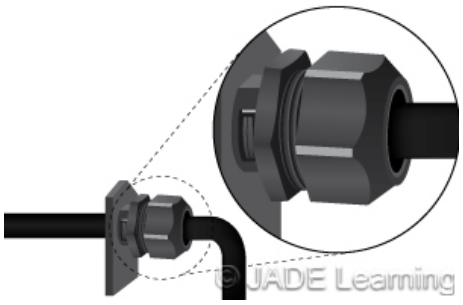
Since Article 590 applies to all temporary electric power and lighting installations, the provisions in 590.4(D)(2) will be required for the receptacles used in areas such as job sites during construction and temporary events. The types of areas covered include residential, commercial, and industrial locations.

Question 56: Which of the following temporary jobsite receptacles are required to have a cover that is listed as "extra duty"?

A: All receptacles used in a wet location.
B: Those receptacles that are also equipped with GFCI protection.
C: 30-amp 125-volt receptacles used in a wet location.
D: 20-amp 125-volt receptacles used in a wet location.

## Question 57: 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 57: 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.

## Question 58: 590.4(J) Temporary Installations. General. Support.

Question ID#: 773.0




***Branch circuit flexible cords and cables cannot be installed on the floor.***

Temporary electrical wiring on construction sites is a necessity for all trades to finish their projects, and electrical wiring that serves power to a construction site must be installed safely in order to protect all personnel from electrical shock.

Extension cords used on construction sites for power hand tools and portable equipment are required to be GFCI protected, and that has definitely saved lives. However, many times feeder and branch circuit wiring installed for other uses such as lighting may not be GFCI protected and are dangerous. This is especially true if they are laid on the ground or are in a wet environment and not properly protected from physical damage.

590.4(J) now clearly defines that all cable assemblies and flexible cords that serve branch circuits and feeders shall not be installed on the floor or ground, and they shall be supported in place at intervals that will protect them from physical damage. Support for these types of cables shall be in the form of staples, cable ties, straps, or similar type fittings. Vegetation shall not be used as a method of support. Extension cords which derive their power from GFCI type protected devices shall not be required to comply with 590.4(J).

Question 58: Which of the following temporary electrical wiring types is NOT required to be supported and protected from physical damage?

A: A multi-wire branch circuit cable serving lighting branch circuits.
B: An extension cord plugged into a GFCI protected outlet.
C: A cable assembly serving a temporary panelboard.
D: A flexible cord serving a 220-volt receptacle outlet.

# Chapter 6

## Question 59: 600.3 Listing 600.4 Markings.

Question ID#: 774.0

According to 600.3 all signs have to be listed and provided with the installation instructions. This includes fixed, mobile and portable electric signs, section signs, outline lighting, and retrofit kits, regardless of voltage. With the written special permission of the Authority Having Jurisdiction, this requirement can be waived.

According to 600.4 all signs and retrofit kits must be marked to indicate that field wiring and installation instructions are required.

In the 2011 NEC, section 600.4(E) specified that only section signs were required to be marked to indicate that field wiring and installation instructions were required. Now all signs, outline lighting, skeleton tubing systems, and retrofit kits shall be marked to indicate that field wiring and installation instructions are required.




***Fixed, mobile, or portable electric signs need to have installation instructions.***

***Exception: Portable, cord-connected signs are not required to be marked.***

These new marking requirements will be controversial. Section 600.3 requires signs to be listed unless otherwise approved by special permission (See Article 100 definition of "special permission"). Part of the standard for signs that are listed to UL 48 is that they are required to be marked "installation and assembly required, see installation instructions". If special permission is being granted by the Authority Having Jurisdiction (AHJ) so that listing is not required, then do the signs still need to be marked as required in 600.4(E)? Furthermore, if during an inspection for a listed sign, the installer hands the installation instructions to the inspector and the entire

installation is Code compliant but the sign sections are not physically marked to state that "installation instructions are required", would the inspector be required to reject the installation? Often, changes made to certain Code sections are a step in the right direction but don't quite make it to the finish line. Hopefully future Code proposals will work to eliminate these inconsistencies.

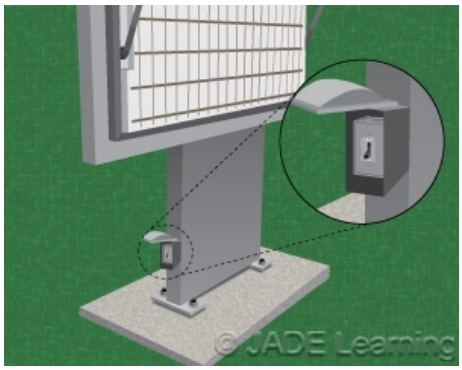
Question 59: Which of the following signs are NOT required to be marked to indicate that field wiring and installation instructions are required?

A: Section signs.
B: Skeleton tubing systems.
C: Portable cord-connected signs.
D: Retrofit kits.

## Question 60: 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.



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

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.

***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 60: 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 61: 620.21 Wiring Methods. Exception.

Question ID#: 776.0

A new exception has been added after Section 620.21 in order to allow cord-and plug-connected equipment to be installed in elevator hoistways and similar areas without requiring the cords for these devices to be installed in a raceway.




***Listed cord-and plug-connected equipment does not require a raceway.***

Section 620.21 requires that raceways and cables such as rigid metal conduit, intermediate metal conduit, electrical metallic tubing, rigid nonmetallic conduit, wireways, type MC, MI, or AC cable must be used for conductors and optical fibers located in the following areas:

- Hoistways
- Escalator and moving walk wellways
- Platform lifts, stairway chairlift runways
- Machinery spaces, control spaces, in or on cars
- Machine rooms and control rooms

The new exception states that cords and cables of listed cord- and plug-connected equipment shall not be required to be installed in a raceway. As technology improves, the presence of high tech elevator monitoring equipment, computer displays, and power supplies become more common. This new exception eases the raceway requirements in order to allow for listed cord- and plug-connected equipment that was never intended to be wired with anything other than a cord and plug connection.

Other types of wiring methods used with elevators, escalators, platform lifts and stairway chairlifts, as outlined in 620.21(A), (B), and (C) are permitted.

Question 61: Which of the following statements about the wiring methods used in an elevator hoistway is true?

A: The cord for a monitor mounted inside the elevator must be installed in a metallic raceway.
B: The only wiring method permitted to supply equipment inside or attached to the elevator car is rigid or flexible metal conduit.
C: Flexible cords and cables are not permitted to supply equipment inside an elevator car.
D: A flexible cord or cable which is part of listed equipment is not required to be installed in a raceway.

## Question 62: 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.

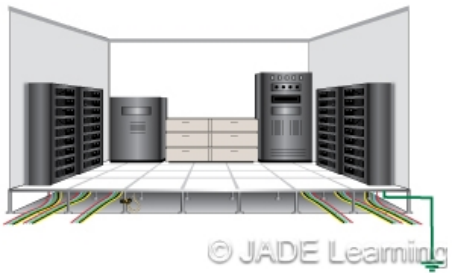
Question 62: Which one of the following receptacle types is permitted to supply cord-and plug- connected electric vehicle supply equipment?

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 63: 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.

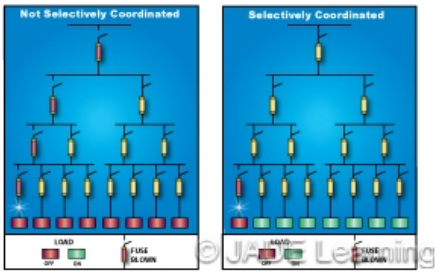
Question 63: A power system derived within listed IT equipment that supplies IT systems through a cable assembly supplied as part of the equipment is NOT _____?

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

## Question 64: 645.27 Selective Coordination.

Question ID#: 779.0

A new section has been added in Article 645 requiring selective coordination for critical operations data systems. A critical operations data system is defined in Section 645.2 as an information technology (IT) equipment system that requires continuous operation for reasons of public safety, emergency management, national security, or business continuity.




***Critical operations data systems overcurrent protective devices have to be selectively coordinated with other supply-side OCPDs.***

Section 645.27 is new and requires the overcurrent protective devices for critical operations data systems to be selectively coordinated with all supply-side overcurrent protective devices. See Article 100 definition of "coordination (selective)". Similar requirements can be found in Article 708 (critical operations power systems or COPS) in section 708.54.

Selective coordination is the process of designing an electrical system in which the upstream overcurrent device, nearest to the system fault, clears the fault without affecting the operation of the overcurrent devices that are ahead of it. In the case of a

critical operations data system, if an electrical system is selectively coordinated, then a fault on a 20-amp branch circuit caused by a shorted appliance cord in the break room should only cause the 20-amp overcurrent device to trip. This way, the 800-amp main breaker protecting the entire electric system won't trip and turn off other circuits that may be feeding critical data systems.

Question 64: Which of the following types of IT equipment are considered to be part of a critical operations data system?

A: The computer system and server that is used to operate the 911 call center for a police station.
B: The computer system and server that is used to dispatch waste management employees for neighborhood trash pickup.
C: The computer system and server that is used to operate the phone system of a local hotel.
D: The computer system and server that is used to operate the receptionist desk at a doctor's office.

## Question 65: Article 646 Modular Data Centers.

Question ID#: 780.0

Modular Data Centers (MDC) are modular type, pre-fabricated units that contain information technology equipment (ITE), and the necessary electrical equipment such as supply and distribution wiring, overcurrent protection, grounding, and HVAC equipment.Â  New Article 646 describes the requirements for installing Modular Data Centers.Â




***A new article covers prefabricated units consisting of an outer enclosure housing ITE and various support equipment.***

These units are built in an offsite manufacturing facility, listed and labeled, and then delivered to a site as a complete package. Once on site, wiring from a facility is then installed to the pre-wired unit just the same as any pre-manufactured unit such as HVAC equipment. The use of the modular type data center can greatly reduce the cost of a traditional in-house installed data center. In some modular units, as a facilityâ€™s needs for greater data infrastructure capabilities expand, the modular unit components can be expanded quickly and more efficiently. They also are very adaptable for military installations, emergency situations, and for temporary events. Â MDC units can be built for both exterior and interior use to suit a number of applications.Â Â Â Â Â

***Overcurrent Protection.***

Overcurrent protection for a MDC is based on 646.6(B)(1) and (2) and is calculated in one of two ways. If the MDC is manufactured with its own self-contained service equipment and service conductors as part of the unit, then the service conductor overcurrent protection size is based on 230.90 through 230.95. For this type of application, the size of the overcurrent protection serving the unit shall have a rating or setting not higher than the ampacity of the conductors supplying the MDC.Â

If the MDC does not come with pre-installed service equipment, and overcurrent protection is provided with the MDC, the conductors that supply the MDC are considered feeders or taps. The overcurrent protection must comply with the following: (1) The overcurrent protection shall consist of a single circuit breaker or set of fuses.Â  (2) The MDC shall be marked â€œOVERCURRENT PROTECTION PROVIDED AT MDC SUPPLY TERMINALS.Â  (3) The supply conductors shall be considered either as feeders or as taps and be provided with overcurrent protection complying with 240.21.

Â

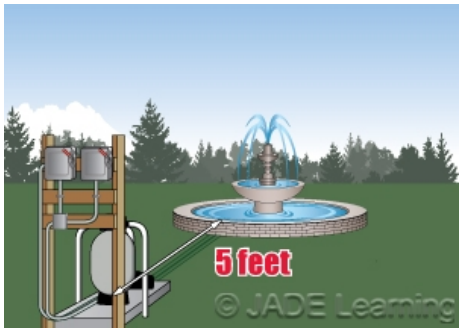
Question 65: What is the maximum allowable overcurrent protection size for a MDC with self-contained service equipment and three, 75 degree C, 2/0 THWN copper service entrance conductors?

A: 150 amperes.
B: 175 amperes.
C: 200 amperes.
D: 225 amperes.

## Question 66: 680.12 Maintenance Disconnecting Means.

Question ID#: 781.0

A maintenance disconnect for utilization equipment is now required for fountains. The 2011 NEC required a maintenance disconnect for pools, spas, and hot tubs. The 2014 has added fountains to the list of locations where a maintenance disconnect for equipment is required. The definition of a fountain in 680.2 includes fountains, ornamental pools, dsiplay pools, and reflection pools. Drinking fountains are not included.



***The disconnect for the fountain is within sight of the fountain.***

A maintenance disconnect for utilization equipment in pools, fountains, spas, and hot tubs is required to disconnect all ungrounded conductors and to:

- Be readily accessible.
- Simultaneously disconnect all ungrounded conductors.
- Be within sight from the equipment it supplies.
- Be at least 5 feet from the inside wall of the pool, fountain, spa,or hot tub, unless the disconnect is separated from the water by a permanent barrier that when measured horizontally creates a 5 foot reach path between the water and the disconnect.

Lighting is not required to have a maintenance disconnect, but illuminated signs are included as utilization equipment.

There is an obvious danger of standing in water and coming in contact with a disconnecting means. The disconnect is required to be located at least 5 ft. away from the water to prevent this. The distance is measured to the inside wall of the fountain or pool that retains the water. The disconnecting means can be located closer than 5 ft. from the edge of the fountain if a barrier is installed and the reach path around the barrier is 5 ft. or more. Reach path means that a person at the inside wall of a fountain, pool, spa, or hot tub would have to reach at least 5 ft. to come in contact with the disconnect. The distance is measured from the water's edge.

Question 66: The requirements for a maintenance disconnect for utilization equipment for a fountain include all of the following EXCEPT:

A: Simultaneously disconnect the grounded (neutral) conductor and all ungrounded conductors.
B: Be located at least 5 ft. away from the edge of the fountain.
C: Be readily accessible.
D: Be within sight of the equipment it supplies.

## Question 67: 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 67: 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 68: 680.22(A)(1) and (2) Receptacles. Required Receptacles, Location. Circulation and Sanitation System, Location.

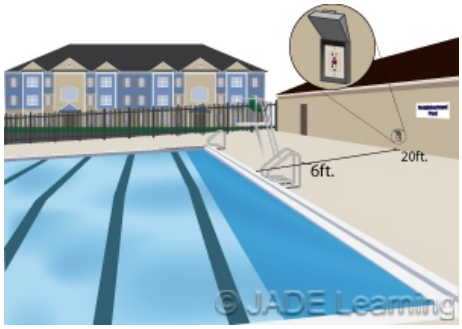
Question ID#: 783.0

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

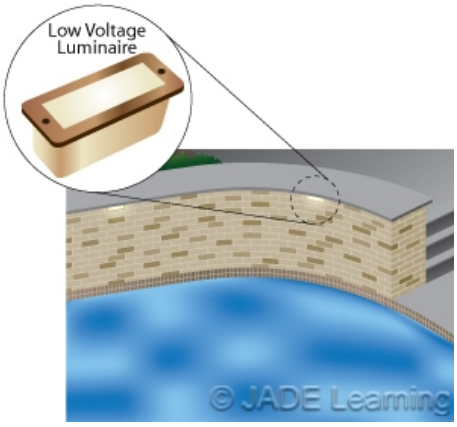
A: Dwelling units only.
B: Public pools only.
C: Dwelling unit or public pools.
D: Inflatable pools only.

## Question 69: 680.22(B)(6) Low-Voltage Luminaires.

Question ID#: 784.0

Listed low-voltage luminaires can now be installed within 5 ft. of the inside walls of a pool. In the 2011 NEC, lighting systems could not be installed closer than 10 ft. from the nearest edge of the water for pools, spas, or fountains. A new section has been added which permits low-voltage luminaires to be installed within 5 ft. of the pool under the following conditions:

- The low-voltage luminaire is listed.
- The low-voltage luminaire must be operated at or below the low-voltage contact limit.
- The low-voltage luminaire must be supplied by transformers or power supplies that are listed for swimming pool and spa use. The transformer must be of the isolated winding type with an ungrounded secondary, but has a grounded metal barrier between the primary and secondary windings, or be of the double-insulated type.




***Some listed low-voltage luminaires can be located closer to the inside walls of a pool.***

The low-voltage contact limit is defined in 680.2 as basically 15 volts RMS for AC voltages and 30 volts continuous for DC.

Prior to this revision, some jurisdictions were permitting the installation of listed luminaires that complied with the low-voltage contact limit specified in 680.2 of the 2011 NEC even though the NEC did not specifically permit such installations. In the 2011 NEC, the general requirement in Section 411.4(B) required luminaires to be located at least 10 feet from the edge of pools but permitted closer proximity if permitted in Article 680. Until the 2014 NEC, closer proximity was not permitted in Article 680.

Now, provided low-voltage luminaires meet the conditions in 680.22(B)(6), the NEC permits luminaires to be installed less than 5 feet from the inside wall of pools, spas, and similar locations.

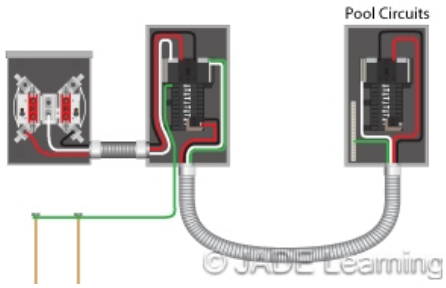
Question 69: Which of the following statements about listed low-voltage luminaires installed in accordance with 680.22(B)(6) around swimming pools or spas is correct?

A: Low voltage luminaires are required to be more than 10 feet from the inside wall of a swimming pool.
B: Low-voltage luminaires are not permitted to be installed within 5 feet from the inside wall of a spa.
C: Listed low-voltage luminaires meeting the conditions in 680.22(B)(6) are permitted to be installed less than 5 feet from the inside wall of a spa.
D: Luminaires are not permitted to be installed within 10 feet of the inside wall of a spa.

## Question 70: 680.25(A)(1) Wiring Methods. Feeders. Exception.

Question ID#: 785.0

The first printing of the 2014 NEC included an exception under 680.25(A) that allowed flexible metal conduit or cable type wiring methods with an insulated equipment ground to be used as feeders to pool equipment panels in one- and two-family dwellings. In fact this exception was not adopted as part of the 2014 NEC. NFPA has posted an errata notice on their website. Flexible metal conduit and cable assemblies other than Type MC are not permitted for feeders supplying pool equipment panelboards.




***FMC CANNOT be used to supply a remote panelboard that supplies branch circuits for a permanently installed swimming pool.***

The wiring methods permitted in 680.25(A)(1) for feeders to panelboards that supply swimming pool equipment are as follows:

- Where the feeder is subject to physical damage, it is required to be installed in either RMC or IMC.
- Where it is not subject to physical damage, it is permitted to be installed using any of the following wiring methods:
  - Liquidtight flexible nonmetallic conduit.
  - Rigid polyvinyl chloride conduit.
  - Reinforced thermosetting resin conduit.
  - Electrical metallic tubing installed within or on a building.
  - Electrical nonmetallic tubing installed within a building.
  - Type MC cable installed within a building in a noncorrosive environment.

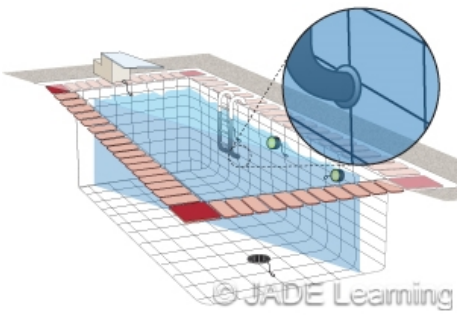
Question 70: Which of the following wiring methods is required when installing a feeder from a service to a remote panelboard that is used for loads associated with a swimming pool at a motel, if the feeder is subject to physical damage?

A: RMC or IMC.
B: Liquidtight flexible nonmetallic conduit.
C: Nonmetallic sheathed cable.
D: Electrical nonmetallic tubing installed within or on a building.

## Question 71: 680.26(C) Equipotential Bonding. Pool Water.

Question ID#: 786.0

Water that contains chemicals used to minimize growth of bacteria in pools and spas is highly conductive. If the water comes in contact with an electrical source such as a defective submerged luminaire or a pump motor, persons in the pool can be subject to a lethal shock hazard. The hazard is greatest in pools in which the water is electrically isolated from the pool's equipotential bonding grid by non-conductive fiberglass shells. The NEC requires protection from this shock hazard by maintaining an effective connection between the water itself and the pool's equipotential bonding grid.




***If the pool water is in direct contact with metal ladders that are bonded to the equipotential bonding grid, the water is considered to be effectively bonded to the equipotential bonding grid.***

If the pool water is in direct contact with metal ladders or other conductive structures that are bonded to the equipotential bonding grid in accordance with Section 680.26(B), no further action is required. However, if a pool does not have such components, then a corrosion-resistant conductive structure with a surface area of at least 9 square inches must be installed in contact with the water and bonded to the equipotential bonding grid. This ensures that the pool water and the equipotential bonding grid have the same electrical potential. If it is bonded to the equipotential bonding grid, a properly sized stainless steel or red brass pipe that is used for circulating pool water is an effective way of complying with the requirements in 680.26(C).

The 2011 NEC said that an "intentional" bond had to be made between the pool or

spa water and the equipotential bonding grid. So even if ladders or underwater luminaries were bonded and in contact with the water, another bonded connection to the water was required. The new language in the 2014 NEC makes it clear that the water in a pool or spa must be in contact with the equipotential bonding grid, but if a pool ladder or other component is in contact with the water, an additional bonding means is not required.

Question 71: Which of the following is permitted to bond pool water in a fiberglass shell to the equipotential bonding grid?

A: A square piece of galvanized iron that is 1/4 inch thick and measures 12 inches X 12 inches.
B: A piece of stainless steel that is 1/4 inch thick and measures 2 inches X 4 inches and is in contact with the water on only one side.
C: A metal ladder that is in direct contact with pool water and is bonded to the equipotential bonding grid.
D: A circular stainless steel disk that is 3 inches in diameter and is in contact with the water on only one side.

## Question 72: 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.

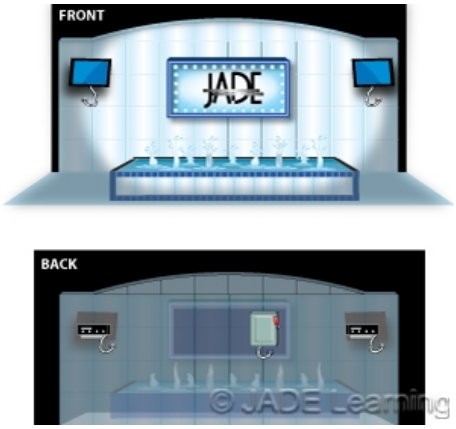
Question 72: Which of the following is one of the conditions that would permit a spa to be installed without equipotential bonding for the perimeter surfaces?

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 73: 680.57(B) Fountains. Signs. GFCI Protection for Personnel.

Question ID#: 788.0

Section 680.57(B) has been revised to clarify the types of circuits supplying a fountain that are required to be provided with GFCI protection for personnel. In the 2011 NEC, "all circuits" supplying a sign were required to provide GFCI protection for personnel. "All circuits" could be interpreted to include low voltage data acquisition circuits, computer and video control circuits, as well as both feeders and branch circuits that are connected to a sign in or on a fountain. Even the secondary circuits of sign transformers, power supplies, or ballasts could be interpreted to need GFCI protection under the 2011 NEC language.
In the 2014 NEC, Section 680.57(B) was revised to say that GFCI protection for personnel is only required for either branch circuits or feeders, but not both, that supply signs in or on a fountain. If a feeder supplying branch circuits for a sign is GFCI protected, then there is no need to provide GFCI protection at the branch circuit level also. Communication circuits, low voltage data acquisition circuits, and Class 2 control circuits are not required to be GFCI protected.




***Branch circuits or feeders supplying the sign shall have GFCI protection for personnel.***

Question 73: Which of the following statements correctly describes the requirements for circuits run to a sign in or on a fountain?

A: All circuits, including data and communications circuits, run to a sign within a fountain are required to be provided with GFCI protection for personnel.
B: Both the feeder that supplies a panel where a branch circuit to a sign in a fountain originates and the branch circuit itself are required to be provided with GFCI protection for personnel.
C: Class 2 control circuits that supply a sign on a fountain are required to be provided with GFCI protection for personnel.
D: If a feeder that supplies a panelboard where the branch circuit to a sign originates does not provide GFCI protection for personnel, the branch circuits to the sign originating at the panelboard are required to provide it.

## Question 74: 690.5(A) Ground-Fault Protection. Ground-Fault Detection and Interruption.

Question ID#: 789.0

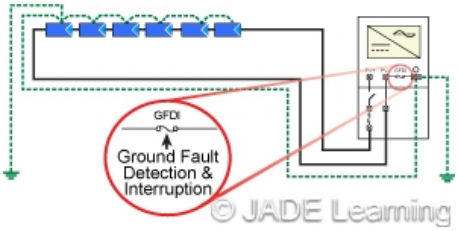
Ground-fault detection equipment in grounded photovoltaic (PV) systems is now required to detect a ground-fault in the PV array DC conductors, including grounded and ungrounded conductors. The 2011 NEC did not say the ground-fault detection equipment had to be capable of detecting a ground-fault in the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

Ground-fault 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.




***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.***

Question 74: 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 75: 690.71(H) Storage Batteries. Disconnects and Overcurrent Protection.

Question ID#: 790.0

***In some editions of the 2014 NEC, the text that is in 690.71(H) was also included as section 690.7(F).***

A list of new requirements has been added about providing disconnects and overcurrent protection for energy storage devices (batteries) that are used with PV systems.

If the output terminals from the energy storage devices (batteries) are more than 5 ft., from the equipment they supply or when the circuits pass through a wall or partition, disconnects and overcurrent protection must be installed where the batteries are located. If a second disconnect is installed within sight of the equipment that the batteries supply, in addition to the first disconnect, overcurrent protection at the second disconnect is not required. The second disconnect can simply be a nonfused disconnect switch.




***When PV circuits pass through a wall or partition, disconnects and/or overcurrent protection are required.***

Either fused disconnecting means or circuit breakers are permitted. The disconnecting means and overcurrent protection must be installed at the battery end of the circuit. 690.71(H)(1).

If fused disconnecting means are used, the line terminals of the disconnecting means must beconnected towards the energy storage device terminals. 690.71(H)(2).

Overcurrent devices or disconnecting means cannot be installed in battery enclosures where explosive gases may exist. 690.71(H)(3)

Where the disconnecting means for the batteries is not within sight of the equipment connected to the batteries, a second disconnect must be connected at the equipment. 690.71(H)(4).

Placards or directories for all disconnecting means must be installed that indicate the location of all other disconnecting means if the batteries are not within sight of the PV system AC and DC disconnecting means.

Question 75: In a PV system, the storage batteries and the equipment the batteries supply are separated by a wall. Which of the following statements about the energy output conductors between the batteries and the equipment they supply is correct?

A: Energy output conductors between batteries and the equipment they supply are not permitted to be less than 5 feet long.
B: Energy output conductors between batteries and the equipment they supply are not permitted to be more than 5 feet long.
C: A disconnect and an overcurrent protective device (OCPD) are required on each end of the energy output conductors.
D: A disconnect and overcurrent protective device are required on the battery end of the conductors; only a disconnect is required on the equipment end of the conductors.

## Question 76: 690.9 Overcurrent Protection.

Question ID#: 791.0

This section was reorganized to bring all requirements about overcurrent protection for PV systems into a single section. For example, the requirement that overcurrent devices must be rated no less than 125% of the maximum calculated current was moved to this section. Also, language requiring the use of overcurrent devices specifically listed for use in PV systems was clarified in the 2014 NEC.




***PV source circuit, PV output circuit, inverter output circuit, and storage battery circuit conductors and equipment require overcurrent protection.***

PV source circuits, PV output circuits, inverter output circuits, and storage battery circuit conductors all require overcurrent protection if there is potential for backfeeding that could damage PV wiring or components.

Overcurrent devices, either fuses or circuit breakers, used in the DC portion of a PV power system must be listed. The overcurrent protection for the PV source and output circuits must be listed PV overcurrent devices. They are required to be accessible, but not readily accessible. For example, that means the fuses for the source conductors from the PV modules could be located in a combiner box on the rooftop.

A single fuse or circuit breaker in a grounded PV source circuit is required in the ungrounded conductor to protect the PV modules and the interconnecting conductors. In an ungrounded system, overcurrent devices must be installed in each ungrounded conductor.

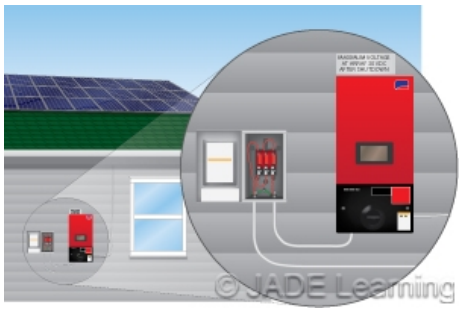
Question 76: Ungrounded PV source circuits are:

A: Permitted to be protected by a fuse or circuit breaker listed for use in any AC or DC circuit.
B: Permitted to be protected by a single overcurrent protective device in either of the two ungrounded PV source circuit conductors.
C: Required to have overcurrent protective devices installed in each ungrounded PV source circuit conductors.
D: Required to have an overcurrent protective device installed in the PV source circuit conductor that is grounded.

## Question 77: 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 77: 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.

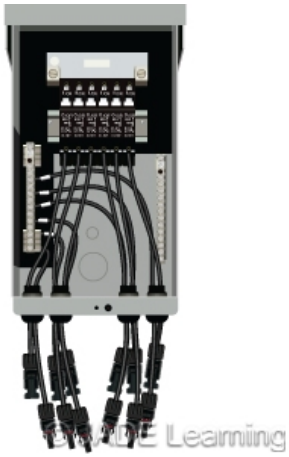
## Question 78: 690.15(C) Direct-Current Combiner Disconnects.

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 78: 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 79: 690.17(A) Disconnect Type. Manually Operable.

Question ID#: 794.0

Disconnect types for ungrounded solar photovoltaic (PV) conductors can now be manual or power operated. In the 2011 NEC only manually operated switches or circuit breakers were permitted. If a power operated disconnect is used, it must be able to be manually operated in the event of a power-supply failure.

Power operated disconnects will allow ungrounded PV conductors to be disconnected from one or more remote locations. Power operated disconnects will give installers the flexibility to satisfy varying requirements, such as a utility wanting the PV disconnect to be located near the revenue meter, a fire department requiring the disconnect to be near the service disconnect, and a maintenance department wanting the disconnect on the roof adjacent to the PV modules.

Service disconnects can be manually or power operated, per 230.76. Now disconnects for ungrounded PV conductors can be also.

A disconnecting means marked for use in PV systems can be a manually-operable industrial control switch, a molded case circuit breaker, a molded case switch, an enclosed switch, or an open-type switch.




***Disconnects for ungrounded solar photovoltaic (PV) conductors can now be manual or power operated.***

Molded case circuit breakers and switches that are not marked for use on PV systems are permitted if they are not specifically labeled "line" and "load" and are suitable for backfeed operation. Also, enclosed switches, open-type switches, and low voltage power circuit breakers (600 VDC or less without a PV marking) are allowable for use if the circuit breaker or switch is rated for DC.

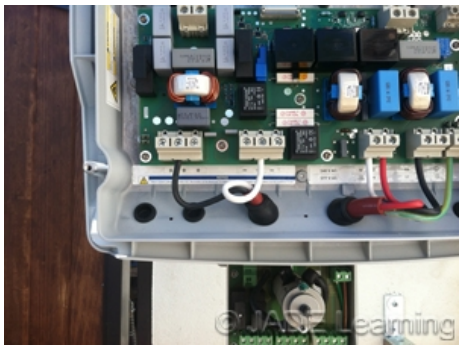
Question 79: Which of the following disconnecting means is NOT allowable for use in a DC PV array?

A: A listed switch marked for use in PV systems.
B: A listed, DC-rated molded case circuit breaker with "line" and "load" marking.
C: A listed PV enclosed switch marked for use in PV systems.
D: A listed, DC-rated open-type switch.

## Question 80: 690.31 Wiring Methods. Methods Permitted.

Question ID#: 795.0

The methods permitted for PV wiring systems in Section 690.31 were reorganized and several new permitted wiring methods were added.



***All wiring methods, systems, and fittings listed for use for PV arrays and systems are permitted.***

***690.31(B) Identification and Grouping***: To minimize problems caused by damaged insulation and short-circuits, PV source and output circuits are not permitted to be installed in the same enclosure, raceway or cable with non-PV system conductors or inverter output conductors, unless separated by a partition.

PV source, PV output, and inverter output conductors are required to be identified at each termination, connection, and splice. If conductors of two or more PV systems are in the same enclosure, the conductors of different systems are to be identified and grouped separately by cable ties or by spacing unless grouping by cable or raceway makes further grouping unnecessary.

***690.31(D) Multiconductor Cables***: This section permits Type TC and Type USE-2 multiconductor cables that contain an equipment grounding conductor to be installed outdoors for PV inverter output circuits that are used with utility-interactive inverters installed where they are not readily accessible. The maximum interval for securing these multiconductor cables is 6 feet.

***690.31(G) DC PV Source and DC Output Circuits on or Inside a Building:*** This section was revised to clarify the requirement for identifying the location of DC PV source and DC output circuit conductors that are embedded within a laminated, built-up roof structure or membrane. In areas of the roof that are not covered by PV equipment or PV modules, the location of DC PV source and DC output circuit conductors is required to be marked by a means of identification approved as suitable for exposure to weather and direct sunlight.

***690.31(I) Bipolar PV Systems:*** If the sum of the voltages of two monopole sub-arrays exceeds the voltage rating of the output conductors or the equipment they are connected to, the output conductors of each monopole sub-array have to be installed in separate raceways and kept separate from conductors of the other sub-array except where they are connected to an inverter. The monopole sub-arrays themselves are required to be separated physically. Unless installed in switchgear where disconnects are separated by a physical barrier and are listed for the maximum voltage between the sub-arrays, disconnects and overcurrent protective devices (OCPDs) are required to be installed in separate enclosures. A permanent notice is required to warn that disconnection of grounded conductors can cause an overvoltage.

***690.31(J) Module Connection Arrangement:*** This section now requires the connections to panels and modules to be arranged so that the grounded conductor connection to PV source circuits is not interrupted by removal of a module or panel.

Question 80: Which of the following multiconductor cables is permitted to be installed in an outdoor location when used for PV inverter output circuits from a utility-interactive inverter installed where it is not readily accessible?

A: Type XHHW.
B: Type USE-2.
C: Type THWN-2.
D: Type XHHW-2.

## Question 81: 690.41 Grounding. System Grounding.

Question ID#: 796.0

This section has been reorganized into a list format. In the 2014 NEC all grounded and ungrounded PV systems are installed according to this section, regardless of their voltage.



***PV Systems may be grounded or ungrounded.***

The 2014 NEC has removed the requirement for having to solidly ground the system. Removal of this requirement permits impedance grounding of grounded two-wire systems and of bipolar systems that have a grounded center tap. The revision makes reference to Section 690.5 which requires PV systems to incorporate a ground-fault protection system to reduce fire hazards.

Section 690.41 states that PV systems must comply with ***ONE*** of the following:

- (1) PV systems can be ungrounded as long as they comply with the requirements of 690.35 which specify the requirements for ungrounded systems.
- (2) Grounded, two-wire systems must have one conductor that is either grounded or impedance grounded.
- (3) Bipolar grounded systems must have the reference or center-tap conductor grounded or must be impedance grounded.
- (4) Other types of PV systems that are neither solidly grounded or impedance grounded must use listed equipment that affords equivalent system protection in accordance with 250.4(A).

Question 81: Which of the following statements about the grounding of PV systems is correct?

A: All PV systems are required to be solidly grounded.
B: PV systems operating at more than 50 volts are not permitted to be grounded.
C: Only PV systems operating at less than 300 volts are required to be grounded.
D: Impedance grounding of a grounded bipolar PV system is permitted.

## Question 82: 690.47(D) Grounding Electrode System. Additional Auxiliary Electrodes for Array Grounding.

Question ID#: 797.0

Section 690.47(D) is a new section in the 2014 NEC.

Auxiliary grounding electrodes are now required to be installed at all ground- and pole-mounted PV arrays. If the PV array is mounted on the roof of a structure, the auxiliary grounding electrode must be mounted as close as practicable to the location of the roof-mounted array.

The grounding electrode conductor for the auxiliary grounding electrode must connect to the frame of the PV modules or the structure that supports the modules. The DC grounding electrode conductor is sized from section 250.166.

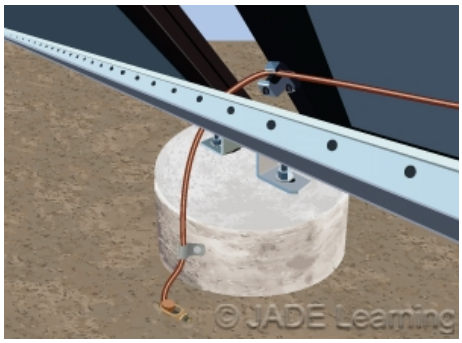
The auxiliary grounding electrode and grounding electrode conductor are not a substitute for the equipment bonding and grounding conductors that are connected to the PV equipment.

Unlike the DC grounding electrode required in 690.47(B) & (C), the auxiliary grounding electrode for the PV array is not required to be bonded to other grounding electrodes.

There are two purposes for requiring installation of an additional auxiliary grounding electrode:

- It minimizes damage to PV systems in the event lightning strikes the structure on which the arrays are mounted.
- It minimizes any voltage difference between the pole, or structure on which PV modules are mounted, and the surface (earth or rooftop) on which arrays are mounted.

Local grounding of PV arrays and their supporting structure minimizes shock hazards that may occur by relying on equipment grounding conductors to effectively connect PV arrays and their supporting structure to a grounding electrode system that may be installed a long distance away from the PV array.




***Auxiliary grounding electrodes are now required to be installed at all ground- and pole-mounted PV arrays.***

Question 82: How is an auxiliary grounding electrode for a pole-mounted PV array connected?

A: Bonded to the AC grounding electrode system.
B: Bonded to the DC grounding electrode system.
C: Bonded to the frames of the PV modules.
D: Bonded to the inverter.

## Question 83: 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.

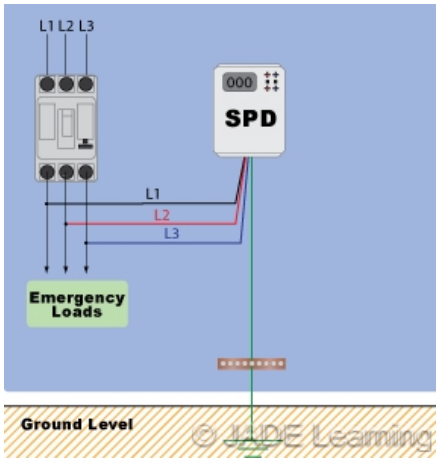
Question 83: Which of the following statements about wind electrical systems is correct?

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

## Question 84: 700.8 Surge Protection.

Question ID#: 799.0




***Emergency system switchboards and panelboards need a listed surge protective device.***

A new Section 700.8, Surge Protection, has been added to Article 700, Emergency Systems. It says: ***A listed SPD shall be installed in or on all emergency systems switchboards and panelboards.*** An SPD is a Surge Protective Device.

The new section expands the required use of listed surge protective devices (SPD) to include all emergency system switchboards and panelboards. The SPD is highly effective in preventing fires and equipment damage caused by a power surge due to utility switching, direct or indirect lightning strikes, or high voltage lines crossing low voltage lines. Any of these can cause the system voltage within a facility to abruptly spike. Although this surge may last for only an instant, it could puncture a conductor's insulation, establishing a permanent conductive path and set the stage for problems to occur in the future. This may take place either in the wiring or within the equipment.

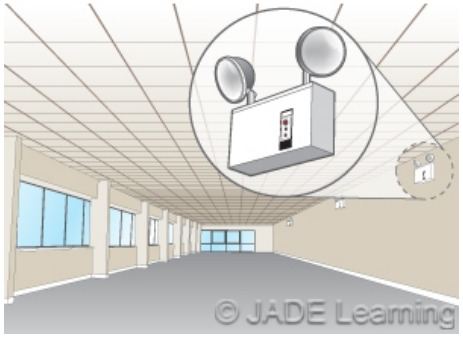
The rating of an SPD is critical. Too high a rating will mean that low-level surges are let through, and too low a rating will mean that the surge may destroy the protective device. An effective strategy is to install SPDs with different ratings in cascade with the more robust devices placed upstream in the electrical system.

Question 84: Which of the following units would comply with Section 700.8?

A: A listed plug-in strip with surge protection.
B: Utility-owned equipment installed on a pole adjacent to the transformer.
C: An SPD installed in a hospital panelboard that supplies non-essential loads.
D: An SPD installed in an office building panelboard that supplies emergency loads.

## Question 85: 700.12(F) Emergency Systems. Unit Equipment.

Question ID#: 800.0




***The requirements for emergency lighting have changed.***

Individual unit equipment for emergency illumination consists of a rechargeable battery, a battery charging means, one or more lamps, and an automatic way to energize the lamps when the supply to the unit equipment fails.

The branch circuit feeding the unit equipment must be the same branch circuit as that serving the normal lighting in the area and connected ahead of any local switches. An exception permits a separate branch circuit to be installed as the supply to the unit equipment, if an uninterrupted area is supplied by 3 or more normal branch circuits, the circuits originate from the same panelboard, and the circuit breaker that feeds the emergency lighting has a lock-on feature.

The exception has been changed to permit a separate branch circuit to the emergency lighting only if the normal branch circuits that supply lighting to the area are not part of a multiwire branch circuit. Multiwire branch circuits must have identified handle ties, or be wired to a multi-pole circuit breaker, so that there is a way to simultaneously disconnect all ungrounded conductors. With individual circuits wired to multi-pole breakers, or with handle ties, it is more likely that a fault on one circuit will cause the other circuits that are part of the multiwire branch circuit to trip. If all the breakers that supply normal lighting to the area trip, the area is left in total darkness, and there is an increased hazard.

A separate circuit can still supply emergency lighting if all the conditions of the exception are met, but the separate emergency lighting circuit cannot be part of a multiwire branch circuit.

Question 85: Which of the following statements about unit equipment for emergency lighting is true?

A: An emergency light is to be controlled by a switch adjacent to the unit.
B: The branch circuit feeding the unit is to be the same branch circuit as that serving the normal lighting in the area.
C: An emergency light is to be on a branch circuit that serves no other load.
D: Remote heads are not permitted.

## Question 86: 700.19 Emergency Systems. Multiwire Branch Circuits.

Question ID#: 801.0




***Emergency lighting cannot be part of a multiwire branch circuit.***

***The branch circuit serving emergency lighting and power circuits shall not be part of a multiwire branch circuit.***

This new requirement is meant to increase the reliability of emergency lighting and power circuits. A fault on a single leg of a 3-pole circuit breaker used in a multiwire branch will de-energize all three circuits. Instead of one emergency lighting circuit being disabled, all three lighting circuits will trip. If individual circuits are installed for each branch circuit, rather than a multiwire branch circuit, a fault on a single branch circuit will only affect that circuit.

Multiwire branch circuits cannot be used in health care facilities for branch circuits serving receptacles at patient bed locations in general care areas and critical care areas for the same reason. Receptacles at patient bed locations are critical for the care of the patient. If multiwire branch circuits were permitted, a fault on a single piece of equipment could de-energize other equipment that was vital for patient care. Not allowing multiwire branch circuits increases reliability by limiting a fault to a single circuit.

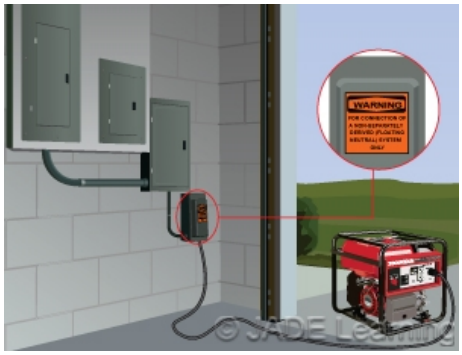
Handle ties used in a multiwire branch circuit are meant to provide a way to simultaneously disconnect the circuit. Handle ties do not provide a common trip for overloads or ground faults. A fault on a single circuit might not trip the other circuits of the multiwire branch circuit. However, for emergency lighting and power circuits it doesn't matter. Multiwire branch circuits are never permitted.

Question 86: Why are multiwire branch circuits not allowed for emergency lighting or power circuits?

A: A multiwire branch circuit will overload the grounded, neutral conductor.
B: A multiwire branch circuit will over-fill the conduit.
C: A fault on one leg of a multiwire branch circuit can de-energize other circuits that are part of the multiwire branch circuit.
D: A fault on one leg of a multiwire branch circuit will de-energize other circuits that are connected to the same phase in the panelboard.

## Question 87: 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 87: 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 88: 702.12 Outdoor Generator Sets.

Question ID#: 803.0




***A disconnecting means is not required for a portable 15 kW or less cord-and-plug connected generator.***

Outdoor generator sets have been divided into two categories:

- (A) Permanently Installed Generators and Portable Generators Greater than 15 kW.
- (B) Portable Generators 15 kW or Less.

If an outdoor generator set rated ***greater than 15 kW*** is equipped with a readily accessible disconnecting means that meets the requirements of Section 445.18 and is within sight of the building, ***an additional disconnecting means is not required*** where the generator circuit conductors enter or pass through the building.

In order to qualify under Section 445.18, the disconnect in the greater than 15 kW generator must be lockable in the open position unless cetain conditions in that section are met. For a portable generator, the cord and plug can serve as the disconnecting means. If the generator supply conductors terminate at a disconnecting means in or on the building, the disconnecting means shall be suitable for use as service equipment.

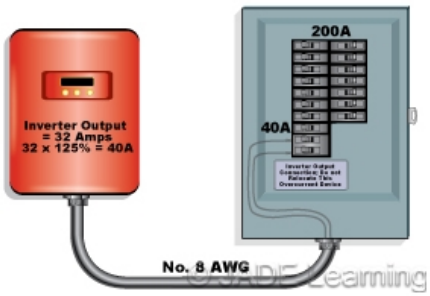
For portable generators rated ***15 kW or less***, a flanged inlet and cord-and-plug type connection can serve as the required disconnecting means. No further disconnecting means is required.

Question 88: An outdoor generator set is rated 20 kW, has a readily accessible disconnecting means, and is within sight of the building. Which of the following statements is true?

A: A flanged inlet and cord-and-plug connection can serve as the disconnecting means.
B: A disconnecting means is always required at the building supplied by the generator.
C: Under certain conditions the disconnecting means in the generator can serve as the only disconnecting means.
D: Any disconnecting means inside the generator must be suitable for use as service equipment.

## Question 89: 705.12 Interconnected Electric Power Production Sources. Point of Connection.

Question ID#: 804.0




***For feeders that are connected to the output of the inverter, the size of the feeder cannot be less than the sum of the primary source overcurrent device and 125% of the inverter output circuit current.***

This section has been reorganized, expanded, and simplified.

A new sub-section has been added requiring arc-fault protection for utility-interactive inverters, such as the micro-inverters that attach to a single PV module, rated 240 volts and 30 amperes or less. Arc-fault protection is required if there is exposed cable or a wire harness that is not installed within an enclosed raceway.

Most of the changes have been made at 705.12(D)(2), Bus or Conductor Ampere Rating. There are now 3 subsections: (1) Feeders, (2) Taps, and (3) Busbars. The requirements have become more permissive because for Feeders and Busbars there is now a choice for the designer or installer about how to determine the ampere rating.

For feeders that are connected to the output of the inverter, per 705.12(D)(2)(1)(a), the size of the feeder cannot be less than the sum of the primary source overcurrent device and 125% of the inverter output circuit current. Or, per 705.12(D)(2)(1)(b), the overcurrent device on the load side of the inverter connection must be rated no greater than the ampacity of the feeder.

There are also two main ways to determine the rating of the busbar in a panelboard.

In the first method, according to 705.12(D)(2)(3)(b), the sum of 125% of the inverter output circuit current and the rating of the overcurrent device protecting the busbar cannot exceed 120% of the ampacity of the busbar. For example, the output from an inverter rated 32 amps backfeeds a 40 amp circuit breaker (32 amps x 125% = 40 amps) in a panelboard with 200 amp busbars and a main breaker rated 200 amps. This is acceptable because the 40 amp circuit breaker is 20% of the rating of the busbars. If this method is chosen, a sign must be posted at the panelboard: WARNING: INVERTER OUTPUT CONNECTION; DO NOT RELOCATE THIS OVERCURRENT DEVICE.

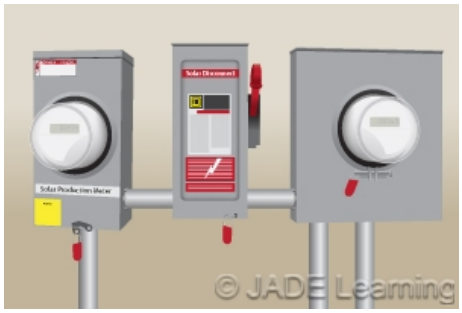
In the second method, the sum of the ampere ratings of all overcurrent devices in a panelboard cannot exceed the ampacity of the panelboard. Load and supply circuit breakers must be counted, but the main breaker is not counted. If this method is used, a sign must be posted at the panelboard: WARNING: THIS EQUIPMENT FED BY MULTIPLE SOURCES. TOTAL RATING OF ALL OVERCURRENT DEVICES, EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE, SHALL NOT EXCEED AMPACITY OF BUSBAR.

Question 89: Which of the following statements about determining the size of a feeder connected to the output of a utility-interactive inverter is true?

A: The feeder must be rated at 150% of the inverter output circuit current.
B: The overcurrent device on the load side of the inverter connection can be 125% of the feeder ampacity.
C: The overcurrent device on the load side of the inverter connection cannot be rated greater than the feeder ampacity.
D: The feeder must be rated 100% of the inverter output circuit current.

## Question 90: 705.31 Location of Overcurrent Protection.

Question ID#: 805.0




***Overcurrent protection needs to be within 10 ft. of where the electric power production source conductors are connected to the service.***

Article 705, Interconnected Electric Power Production Sources, sets the rules for when the electric power to a building is supplied by multiple sources like a utility, generator, solar photovoltaics, or wind generators. When these alternate power sources are connected ahead of the service disconnect, the overcurrent protection for the conductors from the alternate power sources to the service point have been installed remotely.

The Code change requires the overcurrent protection that is connected to the supply side of the service disconnecting means to be located within 10 feet of the point where the electric power production source conductors are connected to the service. An Informational Note says that the overcurrent protection protects against short-circuit current supplied from the primary source of electricity, i.e. the utility.

An exception permits the overcurrent protection for the power production sources to be located more than 10 feet from the point of connection to the utility service if cable limiters or current limited circuit breakers are installed at the service in the ungrounded conductors.

The reasoning behind this requirement is that when connections are made at some distance ahead of service equipment, these conductors are not adequately protected against overcurrent because the utility overcurrent protection is at a very high level. Requiring overcurrent protection within 10 feet of the service will limit the damage that can be done to these conductors if there is a fault on the utility side.

Question 90: Which of the following installations meets the requirements for overcurrent protection for interconnected electric power production sources?

A: The overcurrent protection for electric power production source conductors is located 9 feet from the service disconnecting means.
B: The overcurrent protection for electric power production source conductors is located remotely from the service disconnecting means.
C: The overcurrent protection for electric power production source conductors is located 13 feet from the service disconnecting means.
D: The overcurrent protection for electric power production source conductors is located ahead of the service point.

## Question 91: Article 728 Fire-Resistive Cable Systems.

Question ID#: 806.0




***Fire-resistive systems are designed to ensure survivability of critical circuits under fire conditions.***

Article 728 is new to the 2014 NEC and covers fire-resistive cable systems. This new article covers the installation of fire-resistive cables, fire-resistive conductors, and other system components used for survivability of critical circuits during a fire.

Prior to this new article, only listing information or manufacturer installation instructions for the cable system provided the necessary information to properly install such cables or systems. Now, installers and inspectors have a resource where specific methods of mounting, supporting, splicing, marking, and even types of acceptable pulling lubricants can be referenced.

Many Code articles have sections that allow the use of "listed electrical circuit protective systems". For example, section 695.6(A)(2) requires that when feeders for fire pumps are run inside of a building, the conductors shall be installed using one of the following methods:

- Be encased in a minimum 50 mm (2 in.) of concrete.
- Be protected by a fire-rated assembly listed to achieve a minimum fire rating of 2 hours and dedicated to the fire pump circuit(s).

- Be a listed electrical circuit protective system with a minimum 2 hour fire rating.

Many installers resort to using method 1 or 2 as listed above because they do not understand how to properly apply method 3. Previously, many electrical estimators use the same reasoning during a bid because they might be unsure of additional requirements or restrictions that may apply when using a fire-resistive cable system.

Question 91: Which of the following is true of fire-resistive cables?

A: Fire-resistive cables can be installed with non-fire resistive cables.
B: Fire-resistive cables can be used in any type of cable tray.
C: The fire-resistive system shall be supported in accordance with the Code article for the type of raceway that is used.
D: Fire-resistive cables shall be tested and listed and shall not be interchangeable between other systems.

## Question 92: Article 750 Energy Management Systems.

Question ID#: 807.0




***Article 750 covers systems that monitor and/or control electrical loads, power production, or storage sources.***

Article 750 applies to the installation and operation of energy management systems. An energy management system consists of any of the following: a monitor, communications equipment, a controller, a timer, or other devices that monitor and/or control an electrical load or a power production or storage source.

Article 750 specifies the types of electrical loads and systems that Energy Management Systems are NOT permitted to control. Energy Management Systems are permitted to control and monitor electrical loads that are not specifically restricted in accordance with 750.30(A) through (C). These sections require that critical building systems, such as fire pumps, emergency systems, and essential electrical systems in health care facilities, and elevators and escalators are not overridden or disconnected by energy management systems.

An energy management system cannot override an alternate power source, such as a generator, that supplies power to:

- Fire pumps
- Health care facilities
- Emergency systems
- Legally required standby systems
- Critical operations power systems.

An energy management system cannot override the load shedding controls that ensure the minimum electrical capacity for the following:

- Fire pumps
- Emergency systems
- Legally required standby systems
- Critical operations power systems.

An energy management system cannot cause disconnection of power to the following:

- Elevators, escalators, moving walks, or stairway lift chairs
- Positive mechanical ventilations for hazardous (classified) locations
- Ventilation used to exhaust hazardous gas or reclassify an area
- Circuits supplying emergency lighting
- Essential electrical systems in health care facilities.

Question 92: An Energy Management System is permitted to:

A: Remove electrical power to a fire pump which is supplied by an alternate source.
B: Override the load shedding controls which ensure the minimum electrical capacity for Critical Operations Power Systems.
C: Disconnect electrical power from escalators and elevators
D: Monitor and control electrical loads that are not restricted by Article 750.

## Question 93: 770.110 Raceways and Cable Routing Assemblies for Optical Fiber Cables.

Question ID#: 808.0



***Optical fiber cables are permitted in listed communications raceways when installed to Code.***

Optical fiber cables can be installed in any of the following ways:

- In raceways recognized in Chapter 3.
- In communications raceways listed as plenum, riser, or general-purpose communication raceways.
- In cable routing assemblies.

The definition of a cable routing assembly is in Article 100 and describes it as a structural system used to support communications wires and cables, optical fiber cables, data cables, Class 2 and Class 3 cables, and power-limited fire alarm cables.

Like communications raceways, cable routing assembles are used to support optical fiber cables in plenums, risers, or in general-purpose applications.

Cable routing assemblies must be selected according to Section 800.113 and Table 800.154(c). These references give the locations and types of cables where cable routing assemblies can be installed, including:

- Fabricated Ducts Used for Environmental Air.
- Other Spaces Used for Environmental Air.
- Risers - Cables and Raceways in Vertical Runs.
- Risers - Cables and Raceways in Metal Raceways.
- Risers - Cables, Raceways and Cable Routing Assemblies in Fireproof Shafts.
- Risers - One- and Two-Family Dwellings.
- Cable Trays.
- Distributing Frames and Cross-Connect Arrays.
- Other Building Locations.
- Multifamily Dwellings.
- One- and Two-Family Dwellings.

Cable routing assembles must be supported every 3 ft. and at each end or joint when run horizontally, unless listed for other support distances. In no case can the support distance be greater than 10 ft.

When installed vertically, cable routing assemblies must be supported at least every 4 ft., unless listed for other support distances. No more than one joint in the cable routing assembly is permitted between supports.

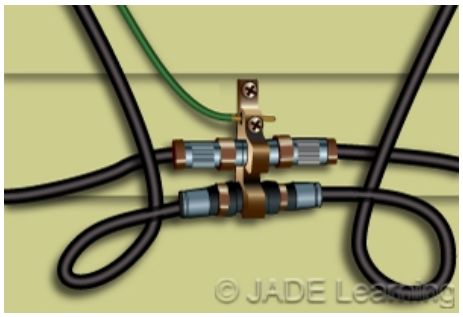
Question 93: A 12 ft. run of a cable routing assembly containing optical fiber cables is installed horizontally between two enclosures; the routing assembly is supported at each end by the fitting attached to the enclosures.
If the cable routing assembly is not listed for other support distances, how many additional supports are required?

A: 2.
B: 3.
C: 4.

D: 5.

## Question 94: 770.180 Grounding Devices.

Question ID#: 809.0




***Devices connecting a shield, sheath, or non-current-carrying cable to a bonding conductor or GEC must be listed.***

A series of Code change proposals were submitted and accepted to require listed grounding devices to be used when bonding or grounding Optical Fiber Cables and Raceways (Article 770), Community Antenna Television and Radio Distribution Systems (Article 820), Network-Powered Broadband Communications Systems (Article 830), and Premises-Powered Broadband Communications Systems (Article 840).

When optical fiber, video, or communications cables contain a shield, sheath, or a non-current-carrying metallic member, it is required to be connected to a bonding conductor or grounding electrode conductor with listed devices. In previous Codes there was not a requirement for the devices used for bonding or grounding to be listed.

Unlisted devices can use materials that are unsuitable for a low-resistance bonding connection or not sturdy enough to make a solid connection. Requiring a listed connection between a cable sheath and a grounding and bonding conductor would also prevent questionable installation methods like twisting the cable shield and bonding conductor together.

An intersystem bonding termination, as described in 250.94, is already required to be listed. The methods of grounding and bonding conductor connections to electrodes at Section 250.70 require ground clamps to be listed.

There are a number of requirements for grounding methods in Article 770. There are rules for the types of materials and size and length of the bonding conductor or grounding electrode conductor in Section 770.100. There are also requirements about how to make the connection between the bonding conductor and grounding electrode conductor.

There is now a new requirement that the device used to connect the shield, sheath, or non-current-carrying metallic member of optical fiber cable to the bonding conductor or grounding electrode conductor be a listed device or part of listed equipment.

Question 94: A cable has optical fibers and electrical conductors and a non-current-carrying metallic member. How is the non-current-carrying metallic member connected to the bonding conductor?

A: Wrapping the bonding conductor around the cable metallic member.
B: Soldering the bonding conductor and metallic member together.
C: Using a listed device to connect the bonding conductor to the metallic member.
D: Wrapping the metallic member around a screw in the enclosure.

# Chapter 8

## Question 95: 800.12 Innerduct.

Question ID#: 810.0

Innerduct is defined in Article 800 as a nonmetallic raceway placed within a larger raceway.

Listed plenum communications raceway, listed riser communications raceway, and listed general-purpose raceway are permitted to be installed as innerduct in any Chapter 3 raceway if installed according to Table 800.154(b).

Table 800.154(b) has 4 locations where listed communications raceways can be installed in buildings. Within each location are a number of applications where the raceways can be installed. A ***Y*** or ***N*** in the Table indicates whether or not a particular type of communications raceway can be installed in a certain location or application.

The locations where communications raceways can be installed as innerduct, according to Table 800.154(b) are:

- In specifically fabricated ducts as described in 300.22(B).
- In other spaces used for environmental air as described in 300.22(C).
- In risers.
- Within buildings in other than air-handling spaces and risers.

Examples of applications where communications raceways can be installed as innerduct are:

- For risers: in metal raceways, or in fireproof shafts.

For other spaces used for environmental air: supported by solid bottom metal cable trays with solid metal covers, or in metal raceway that complies with 300.22(C).




***Listed communications raceways are permitted to be installed as innerduct.***

Question 95: Which of the following is required if plenum raceways or communications raceways are to be installed as innerduct?

A: They must be in vertical risers only.
B: They must be listed.
C: They must be installed in other spaces used for environmental air.
D: They must be metallic.

## Question 96: 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.***

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




***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.***

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.

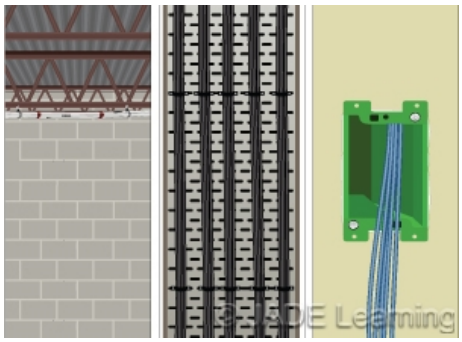
Question 96: Which of the following statements about installing communications circuits is correct?

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 97: 800.182 Communications Raceways and Cable Routing Assemblies.

Question ID#: 812.0

Three informational notes have been deleted from this section within the NEC. All three informational notes referred to a UL Standard about the flammability of Optical Fiber Cable Raceway or Optical Fiber Cable Routing Assemblies. One single informational note now takes their place in the 2014 NEC, and it references ANSI/UL standard 2024-4-2011, "***Signaling, Optical Fiber and Communications Raceways and Cable Routing Assemblies."***




***Communication raceways as well as cable routing assemblies in plenums, must be listed as fire-resistant and low-smoke producing.***

Communications raceways in plenums and cable routing assemblies in plenums must both be listed as "fire-resistant" as well as "low-smoke producing." UL tests communications raceways for plenums and cable routing assemblies for plenums, for a maximum flame spread distance of 5 ft. UL also tests the smoke producing capabilities of these materials by measuring the peak and the average optical density of the smoke, when a flame is applied.

Riser communications raceways and riser cable routing assemblies must be listed as having "adequate fire-resistant characteristics capable of ***preventing*** fire from spreading from floor to floor." UL has a flame propagation test that it uses for this product listing that determines how well the raceways and cable routing assemblies can resist the spread of fire from floor to floor.

General-purpose communications raceways and general-purpose cable routing assemblies must be listed as "***resistant*** to the spread of fire."

Notice how the riser raceway must "prevent" the spread of fire, while the general-purpose raceway must only "resist" it. UL uses a Vertical-Tray Flame Test (general use) to test for fire-resistant characteristics in the general-purpose communication raceways.

Question 97: Which of the following is a test for the resistance to the spread of fire for the listing of general-purpose communications raceways and general-purpose cable routing assemblies?

A: Vertical-Tray Flame Test.
B: Peak Optical Density of Smoke.
C: Flame Propagation Test.
D: Resistance to the spread of fire from floor to floor test.

## Question 98: 820.3 Community Antenna Television and Radio Distribution Systems. Other Articles.

Question ID#: 813.0

Two subsections have been added to 820.3, Other Articles:

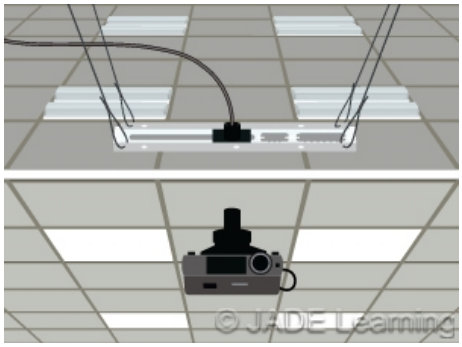
- 820.3(B) Wiring in Ducts for Dust, Loose Stock, or Vapor Removal.
- 820.3(C) Equipment in Other Space Used for Environmental Air.

Including these two sections will make Article 820 on CATV systems similar to Article 800, Communications Circuits, Article 830, Network-Powered Broadband Communications Systems, and Article 840, Premises-Powered Communications Systems.

Section 820.3 says that CATV circuits and equipment must comply with the references to other articles listed in 820.3(A)-(J). The reference for Wiring in Ducts for Dust, Loose Stock, or Vapor Removal is 300.22(A). The reference for Equipment in Other Space Used for Environmental Air is 300.22(C)(3).

No wiring of any sort is permitted in ducts used to transport dust, loose stock, or flammable vapors. No wiring is ever permitted in ducts used for vapor removal or ventilation of commercial-type cooking equipment.

CATV equipment within a metal enclosure is permitted to be installed in other space used for environmental air. Equipment in nonmetallic enclosures must have adequate fire-resistant and low-smoke-producing characteristics and be listed for installation in other space used for environmental air. According to 300.22(C), the phrase, "other space used for environmental air" means spaces not specifically fabricated for environmental air-handling purposes but used for air-handling purposes as a plenum. An example of "other space used for environmental air" is the space above a suspended ceiling if return air is being pulled through it instead of through separate HVAC ductwork.




***CATV wiring needs to comply with other articles such as Articles 770, 830, and 840.***

Question 98: Which of the following statements about community antenna television and radio distribution systems installed in an above ceiling area being used as a return air plenum is true?

A: CATV wiring can be installed inside a duct used to vent steam.
B: CATV equipment can be installed inside a ventilation duct for a spray booth.
C: CATV cables of any type can be installed above a suspended ceiling in a return air plenum.
D: CATV equipment can be installed above a suspended ceiling being used as an environmental air return if listed for the purpose.

# Chapter 9

## Question 99: Chapter 9, Table 1.

Question ID#: 814.0

We still calculate conduit fill in the same way in the 2014 NEC by using Table 1 in Chapter 9. But the column headings and title to the table have changed, and a new note has been added.

The title and the left hand column heading have changed to include cables as well as conductors. The reason given for the change was because fiber optic cables are not considered conductors, but the fill requirements of Table 1 apply to fiber optic cables as well as conductors.

The right hand column heading of Table 1 has changed from "All Conductor Types" to "Cross-Sectional Area (%)." The change should help clarify how to use the table: For one conductor or cable in the conduit or tubing, the conduit or tubing cannot be filled greater than 53% of the cross-sectional area. The fill percent for 2 conductors or cables is 31%, and the fill percent for over 2 conductors or cables is 40%.

A new note 10 has been added that provides helpful information about Table 5. Table 5 is used to look up the approximate area and approximate diameter when round, stranded, concentric-lay conductors are used. Table 5A is used when round, compact-stranded conductors are used.

TABLE 1 PERCENT OF CROSS SECTION OF CONDUIT AND TUBING FOR CONDUCTORS AND CABLES

| Number of Conductors and/or Cables | Cross-Sectional Area (%) |
|---|---|
| 1 | 53 |
| 2 | 31 |
| Over 2 | 40 |

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***Changes to Table 1 include the title and the "All Conductor Types" column has been renamed "Cross-Sectional Area (%)".***

Question 99: Two inch EMT has an total internal area of 3.356 sq. in. How many sq. in. can be filled by 4 conductors?

A: 1.342 sq. in.
B: 1.778 sq. in.
C: 1.040 sq. in.
D: 3.356 sq. in.

## Question 100: 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 |

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

Question 100: 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**

**CA 2014 NEC Changes Part 2 16 NEC Credit Hours $150.00**

| | | | | |
|---|---|---|---|---|
| 1.) A B C D | 21.) A B C D | 41.) A B C D | 61.) A B C D | 81.) A B C D |
| 2.) A B C D | 22.) A B C D | 42.) A B C D | 62.) A B C D | 82.) A B C D |
| 3.) A B C D | 23.) A B C D | 43.) A B C D | 63.) A B C D | 83.) A B C D |
| 4.) A B C D | 24.) A B C D | 44.) A B C D | 64.) A B C D | 84.) A B C D |
| 5.) A B C D | 25.) A B C D | 45.) A B C D | 65.) A B C D | 85.) A B C D |
| 6.) A B C D | 26.) A B C D | 46.) A B C D | 66.) A B C D | 86.) A B C D |
| 7.) A B C D | 27.) A B C D | 47.) A B C D | 67.) A B C D | 87.) A B C D |
| 8.) A B C D | 28.) A B C D | 48.) A B C D | 68.) A B C D | 88.) A B C D |
| 9.) A B C D | 29.) A B C D | 49.) A B C D | 69.) A B C D | 89.) A B C D |
| 10.) A B C D | 30.) A B C D | 50.) A B C D | 70.) A B C D | 90.) A B C D |
| 11.) A B C D | 31.) A B C D | 51.) A B C D | 71.) A B C D | 91.) A B C D |
| 12.) A B C D | 32.) A B C D | 52.) A B C D | 72.) A B C D | 92.) A B C D |
| 13.) A B C D | 33.) A B C D | 53.) A B C D | 73.) A B C D | 93.) A B C D |
| 14.) A B C D | 34.) A B C D | 54.) A B C D | 74.) A B C D | 94.) A B C D |
| 15.) A B C D | 35.) A B C D | 55.) A B C D | 75.) A B C D | 95.) A B C D |
| 16.) A B C D | 36.) A B C D | 56.) A B C D | 76.) A B C D | 96.) A B C D |
| 17.) A B C D | 37.) A B C D | 57.) A B C D | 77.) A B C D | 97.) A B C D |
| 18.) A B C D | 38.) A B C D | 58.) A B C D | 78.) A B C D | 98.) A B C D |
| 19.) A B C D | 39.) A B C D | 59.) A B C D | 79.) A B C D | 99.) A B C D |
| 20.) A B C D | 40.) A B C D | 60.) A B C D | 80.) A B C D | 100.) A B C D |

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