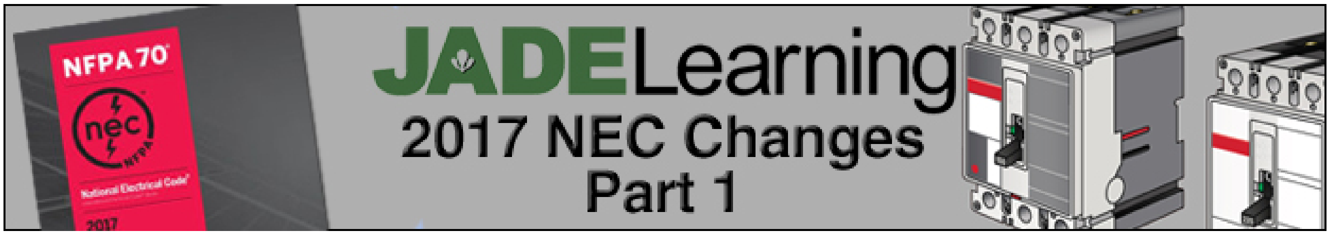


2017 NEC Changes Part 1 (Homestudy)

Alaska Electrical Administrator License

This course will review the first half of the most important National Electrical Code changes from the 2017 NEC. Changes from the addition of new articles to Article 408 will be covered.

Course# 15667 8 NEC Credit Hours $90.00

This course is currently approved by the Alaska Division of Labor Standards and Safety Mechanical Inspection under course number 15667.

Completion of this continuing education course will satisfy 8.000 credit hours of course credit type 'NEC' for Electrical Administrator license renewal in the state of Alaska. Course credit type 'NEC'. Board issued approval date: 12/30/2016. Board issued expiration date: 12/31/2017.

JADELearning

2017 NEC Changes Part 1 (Homestudy) - AK

Question 1: New Articles 425 and 691.

Question ID#: 1050.0

Article 425 Fixed Resistance and Electrode Industrial Process Heating Equipment

This new Article includes heating processes in industrial locations and does not include the following:

- Article 424 on "Fixed Electric Space-Heating Equipment"
- Article 427 on "Fixed Electric Heating Equipment for Pipelines and Vessels"
- Article 665 on Induction and Dielectric Heating Equipment
- Industrial furnaces incorporating silicon carbide, molybdenum, or graphite process heating elements

Many of these Industrial Process Heating Systems are custom designed for very specific purposes and, therefore, could not be properly addressed by the existing heating articles.

New Article 691 covers a Large-Scale Photovoltaic (PV) Electric Power Production Facility. New Article 425 covers Fixed Resistance and Electrode Industrial Process Heating Equipment

-

Article 691 Large-Scale Photovoltaic (PV) Electric Power Production Facility

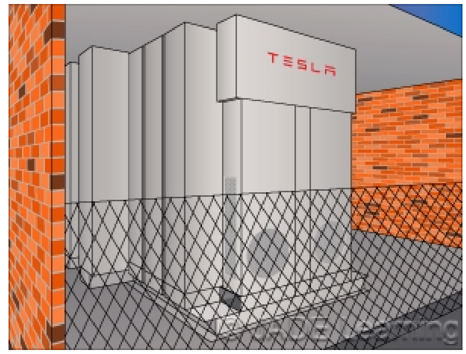
Article 691 is a new article for the 2017 NEC. It applies only to Photovoltaic Supply Stations of 5000 kW or larger. Photovoltaic systems less than 5000 kW are covered by Article 690, "Solar Photovoltaic (PV) Systems." The systems addressed in Article 691 are different from those addressed in Article 690 in terms of size and purpose. The systems covered by this new article are very large and intentionally designed to sell power back to a utility. These systems are not owned by the utility and not exclusively controlled by the utility. The utility buys energy from these large stations. They typically have output voltages of 4 kV and higher.

Question 1: What is the minimum capacity of a photovoltaic system for it to be covered by Article 691, Large-Scale Photovoltaic (PV) Electric Supply Stations?

A: 500 kW.
B: 5000 W.
C: 5000 kW.
D: 5000 MW.

Question 2: New Articles 706, 710, 712.

Question ID#: 1051.0



Articles 706, Energy Storage Systems (ESS); Article 710, Stand-Alone Systems; and Article 712 Direct Current Microgrids are new articles in the 2017 NEC.

Article 706 Energy Storage Systems (ESS)

Energy storage systems include batteries, capacitors, compressed air, flywheels, and other types of energy storage. Most energy storage systems today use batteries, but many other types are being developed. Energy storage systems can be stand-alone systems or interactive with another power source. Non-Electrical types of energy storage systems such as flywheels and compressed air are referred to as kinetic type by the NEC. Article 480 on Storage Batteries still applies to battery type energy storage systems. Section 706.3 says that Article 706 applies when the rules from other articles differ from those of Article 706.

Article 710 Stand-Alone Systems

Stand-alone system power sources supply power to wiring systems that are not connected to any other energy source. They are not interconnected with the utility or other power supplies. The NEC places no limit on what type of power source may be used for these systems. The power source could be an engine-driven generator, a wind generator, a fuel cell, a PV source, or other stand-alone power sources. All equipment used for these systems must be listed or field-labeled.

712 Direct Current Microgrids

A DC Microgrid provides a simple and reliable method of assuring continuity of dc power that can be used to power dc loads directly or be converted by dc-ac inverters to ac for powering ac loads. A DC Microgrid could be as simple as a PV source interconnected with a storage battery system. DC Microgrids will become more common as manufacturers develop more dc-powered loads. Interconnecting two or more dc sources and powering dc loads with that grid eliminates the need for converting to ac and, therefore, is a more efficient, simple system.

Question 2: Which statement best describes an Energy Storage System (ESS)?

A: Only batteries and capacitors are used to store energy.
B: Only kinetic energy devices are used to store energy.
C: All energy storage systems are stand alone.
D: All energy storage systems may be interactive or stand alone.

Question 3: 90.2(A) Scope. Covered.

Question ID#: 1052.0

The removal of conductors, as well as the installation of conductors, is covered in the 2017 NEC.

In this important section about what the 2017 National Electrical Code covers, the ***removal*** of electrical conductors, equipment and raceways is now included. In the 2014 version of the NEC, only the installation of electrical conductors, equipment, and raceways was listed in the Scope. Now, the installation and removal of electric conductors, equipment, and raceways, as well as the installation and removal of signaling and communications conductors, equipment, and raceways; and optical fiber cables and raceways is part of the Scope of the NEC.

There are numerous sections in the National Electrical Code where the removal of conductors and cables is required. For example, Section 590.3(D) says, ***Temporary wiring shall be removed immediately upon completion of construction or purpose for which wiring was installed.*** Section 590.3(B) says, ***Temporary electric power and lighting installations shall be permitted for a period not to exceed 90 days for holiday decorative lighting and similar purposes.***

Another example is Section 725.25, Abandoned Cables for Class 1, Class 2, and

Class 3 Remote-Control, Signaling, and Power-Limited Circuits, which covers the installation of computer and network cables outside of computer rooms. ***<u>The accessible portion of abandoned Class 2, Class 3 and PLTC cables shall be removed. Where cables are identified for future use with a tag, the tag shall be of sufficient durability to withstand the environment involved.</u>***

A similar statement is made in Section 800.25 for abandoned cables used for communications circuits, including telephone wiring. If the cables are accessible (cables installed in conduit are not accessible) and the cables are not connected to equipment or identified for future use, then they must be removed.

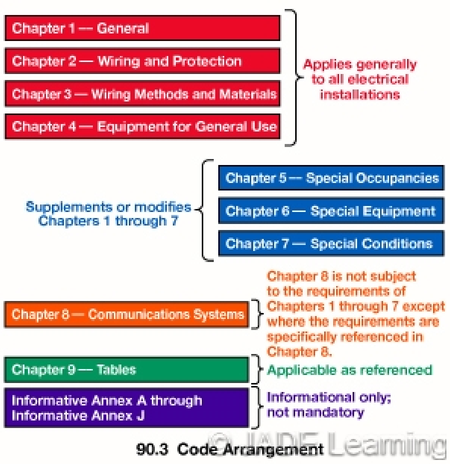
The Scope of the 2017 National Electrical Code now covers the installation and removal of electrical conductors, equipment and raceways; signaling and communications conductors, equipment, and raceways; and optical fiber cables and raceways.

Question 3: What is included in the Scope of the 2017 National Electrical Code?

A: Only the installation of electric conductors.
B: Only the removal of electric conductors.
C: Both the installation and removal of electric conductors.
D: The removal of electric conductors is not covered in the Scope of the 2017 NEC.

Question 4: Figure 90.3 Code Arrangement.

Question ID#: 1053.0



<u>Chapter 5, Chapter 6, and Chapter 7 can supplement and modify each other, as well as supplement or modify Chapters 1-4.</u>

Figure 90.3, Code Arrangement, has been modified to show that Chapter 5, Chapter 6 and Chapter 7 can supplement or modify Chapters 1 - 7. In the 2014 NEC, Chapters 5, 6 and 7 were only shown to supplement or modify Chapters 1 through 4. Now Chapter 5, Chapter 6, and Chapter 7 can supplement and modify each other, as well as supplement or modify Chapters 1-4.

There are examples where Articles in Chapter 6 also modify Chapter 7 articles. For example, section 645.4, Special Requirements for Information Technology Equipment Room, says Article 645 can provide alternate wiring methods for signaling wiring in Parts I and III in Article 725, and for optical fiber cabling in Parts I and V of Article 770.

If there are examples where code sections in Chapters 5, 6, or 7 supplement or modify sections within those same Chapters, then Figure 90.3, which illustrates how the code is arranged, needs to show that fact.

To summarize the new Figure 90.3:

Chapter 5, Special Occupancies; Chapter 6, Special Equipment; and Chapter 7, Special Conditions can supplement and modify the first 4 Chapters of the 2017 NEC, which apply generally, and now can supplement or modify any section in Chapters 5, 6, or 7. Chapters 1-4 apply generally. Chapter 8 is a standalone Chapter and is not subject to the requirements of Chapters 1-7, unless referenced in Chapter 8.

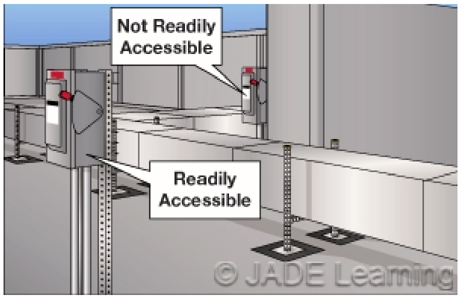
Question 4: How is the 2017 NEC arranged?

A: Chapters 5-7 can only supplement or modify requirements in Article 300.
B: Chapters 5-7 can only supplement or modify requirements in Article 314.
C: Chapters 5-7 can only supplement or modify requirements in Chapters 1-4.
D: Chapters 5-7 can only supplement or modify requirements in Chapters 1-7.

<u>Chapter 1</u>

Question 5: 100 Accessible, Readily. (Readily Accessible).

Question ID#: 1054.0



Equipment is not readily accessible if a person must climb over or under an obstacle to reach the equipment.

To be considered readily accessible equipment must be located such that it can be "reached quickly" for operation or inspection by "those to whom ready access is requisite" without the need to move or climb over obstacles or use a portable ladder. It should be noted that not everyone in a building has a requisite need to access the electrical equipment. For example, the patients in a hospital or the students in a school do not have any need to access the electrical panels.

The 2014 NEC states that, if a tool has to be used to gain access to equipment, the equipment is not considered readily accessible. For example, if a screwdriver is required to remove a panel to inspect the connections for a hot tub pump, the connections are not considered readily accessible. The 2017 NEC added the phrase "other than keys" to clarify that keys are excluded from what might be considered a tool when applying this definition. So a panelboard that is locked and requires a key to open is still considered readily accessible as long as qualified individuals have the key.

The 2014 NEC stated that having to "climb over" an obstacle to get to the equipment meant that it was not "readily accessible." The 2017 NEC expanded the phrase to read "climb over or under," so having to climb over or under an obstacle renders the equipment not readily accessible.

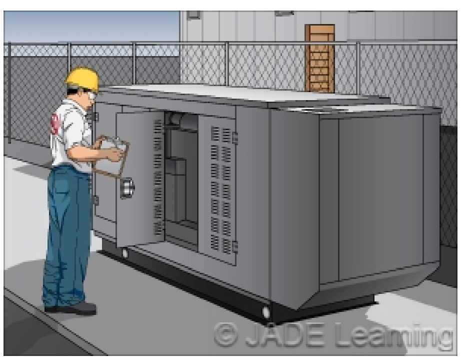
A new informational note gives background information on equipment requiring keys to access the equipment in "controlled or supervised" locations.

Question 5: When is equipment NOT considered to be readily accessible?

A: If a key is required to access the equipment.
B: If the equipment is located more than 50 feet away from other electrical equipment.
C: If permanent steps must be climbed to reach the equipment.
D: If climbing under ductwork is required to reach the equipment.

Question 6: 100 Field Labeled (as applied to evaluated products).

Question ID#: 1055.0



Equipment can be field labeled by personnel from a Field Evaluation Body (FEB).

Field Labeled means:

Equipment or materials to which has been attached a label, symbol, or other identifying mark of an FEB (Field Evaluation Body) indicating the equipment or materials were evaluated and found to comply with requirements as described in an accompanying field evaluation report.

Field labeled is different than "field inspections" made by 3rd party testing organizations. Field inspections, as described in 90.7, are part of the listing process, and can be done to determine if field installed equipment meets the standards of a listing agency.

Field labeled is an examination of equipment by a Field Evaluation Body to determine if the equipment or materials meet the requirements of a field evaluation report. It is not a listing label. The purpose of the field label is to certify that the equipment is safe and is ready for operation.

Field labeling will be used to certify equipment used in Large-Scale Photovoltaic (PV) Electric Supply Stations. Section 691.5, Equipment Approval, in the new Article 691 says equipment in Large-Scale Photovoltaic (PV) Electric Supply Stations can be approved for field installation by (1) Listing and labeling; (2) field labeling; and (3) if products are not available that comply with (1) and (2) then approval by engineering review validating that equipment has been tested to relevant standards or industry practice.

Question 6: What term is used when a Field Evaluation Body has evaluated and marked equipment on a jobsite?

A: Field Labeled.
B: Approved Equipment.
C: Factory Approved.
D: UL listed.

Question 7: 100 Structure.

Question ID#: 1056.0

A structure is â€œThat which is built or constructed, other than equipment.â€•

The 2014 NEC definition of the term ***structure*** was â€œ***That which is built or constructed.â€•*** The definition of ***structure*** in the 2017 NEC is ***â€œThat which is built or constructed, other than equipment.â€•***

Without including the phrase â€œ***other than equipment,â€•*** virtually all equipment would have to be considered structures since all equipment is â€œ***built or constructed.***â€• Equipment can be mounted on a structure, but the equipment itself is not considered part of the structure.

Outdoor transformers, outdoor lighting, rooftop air conditioners, fans, and air handlers are not structures.Â Generators, PV inverters and pumps are not structures.

Buildings, garages, car ports, bridges, towers or poles used as lighting standards, and billboards are structures.Â So are mobile homes, stadiums, and swimming pools.

If a structure is supplied by a feeder or branch circuit, and it is outdoors, then all the rules of Article 225, Outside Branch Circuits and Feeders, apply.Â The requirements of section 225.10 Wiring on Buildings (or Other Structures), section 225.11 Feeder and Branch-Circuit Conductors Entering, Exiting, or Attached to Buildings or Structures, and all the rules of Article 225, Part II, Buildings or Other Structures Supplied by a Feeder(s) or Branch Circuit(s) would have to be followed.

Also, section 250.32, Buildings or Structures Supplied by a Feeder(s) or Branch Circuits(s) requires a grounding electrode, grounding electrode conductor, and an equipment grounding conductor to be present at a structure.Â The structure must be supplied by a feeder or branch circuit for these rules to apply.Â They do not apply if the structure is just used to support the electrical equipment.

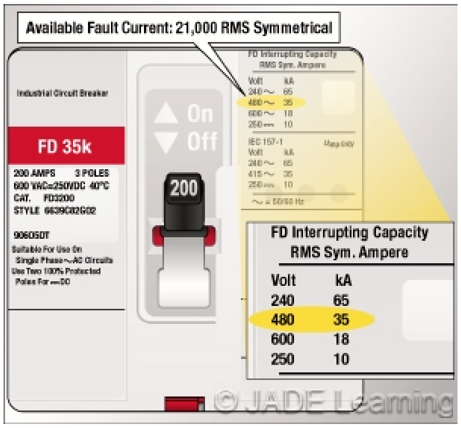
Updating the definition of a structure in the 2017 NEC should make it clearer that electrical equipment is not considered a structure.

Question 7: Which of the following would be considered a structure?

A: Motor.
B: Switchboard.
C: Transformer.
D: A pole used as a lighting standard in a parking lot.

Question 8: 110.9 Interrupting Rating.

Question ID#: 1057.0



The interrupting rating must be at least equal to the current that is available at the line terminals of the equipment.

Equipment that is intended to interrupt current at fault levels must be capable of interrupting the highest level of fault current that is available. For example, if a circuit breaker is installed at a location in an electrical system where the available fault current is 50,000 amperes, it must be capable of safely interrupting at least 50,000 amperes.

The 2014 NEC stated this requirement by saying the equipment had to have an interrupting rating "***sufficient for the current that is available at the line terminals of the equipment".*** The phrase ***"sufficient for"*** was changed to "***at least equal to".*** The 2017 NEC now says that the interrupting rating must be "***at least equal to the current that is available at the line terminals of the equipment."*** This change brings more clarity to the requirement since the expression "***sufficient for"*** was too vague.

The same change was made for equipment intended to interrupt current at something other than fault levels. For example, a switch intended to interrupt a current of 100 amperes must be rated to interrupt a current of 100 amperes or greater. The 2014 NEC stated that the switch needed to have an interrupting rating " ***sufficient for the current that must be*** interrupted." The 2017 NEC states that the switch must have an interrupting rating "***at least equal to the current that must be interrupted".***

Question 8: A circuit breaker is installed at a location where the fault current available on the line side is 32,545 amps. The circuit breaker must have an interrupting rating of ________________ .

A: 32,545 amps or less.
B: No more than 32,545 amps.
C: 32,545 amps or more.
D: 32,545 amps x 125%.

Question 9: 110.14(D) Electrical Connections. Installation.

Question ID#: 1058.0

A calibrated torque tool is now required to tighten electrical connections to the manufacturer's specifications.

Where the manufacturer provides a tightening torque, new section 110.14(D) requires the use of a "***calibrated torque tool"*** to assure the terminal connecting devices for electrical connections will be torqued to the manufacturer's requirements.

Terminal connecting devices must be torqued to the listed or labeled value given by the manufacturer. Common practice has been to use a standard wrench or screwdriver to torque the connection until it felt tight enough. If a calibrated torque tool is not used, there is no way of knowing if the connection is actually torqued to the correct value. In fact, studies have shown that well over half of field connections are not correctly torqued.

A calibrated torque tool is not required if the manufacturer "***has provided installation instructions for an alternative method of achieving the required torque."*** An example of such an alternative method is a single-use tool that bends or breaks when the proper torque has been achieved.

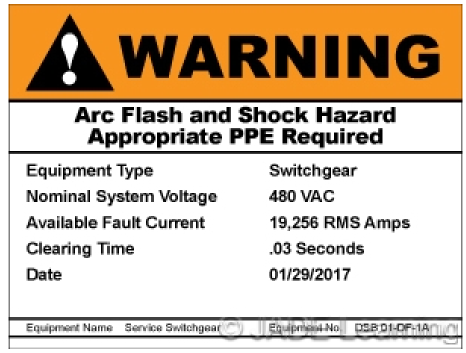
When doing a final inspection of an electrical installation, the Authority Having Jurisdiction (AHJ) will not be able to know if a ***"calibrated torque tool"*** was actually used. But the inspector can ask for the equipment manufacturer's installation instructions and compare the torque values of the actual termination with the required values.

Question 9: When must a calibrated torque tool be used?

A: When the manufacturer gives the torque values in the instructions.
B: When installing all terminals.
C: While the AHJ is present.
D: When terminating all copper or aluminum conductors.

Question 10: 110.16(B) Arc-Flash Hazard Warning. Service Equipment.

Question ID#: 1059.0



There are new requirements for arc-flash labels for equipment rated 1200 amps or more in other than dwelling units.

NEC Section 110.16 requires electrical equipment such as switchboards, switchgear, panelboards, and other electrical equipment to be marked with an "***Arc-Flash Hazard Warning***". This required marking is to alert qualified persons who may service or maintain the equipment that there is an arc-flash hazard present. The marking is not required for dwelling units. A new paragraph 110.16(B) has been added just for service equipment.

The 2017 NEC has added new requirements for labeling of service equipment that is rated 1200 amps or more and is located in other than dwelling units. The label can be field or factory installed and must contain information on:

- Nominal system voltage.
- Available fault current at the service overcurrent protective devices.
- The clearing time of service overcurrent protective devices based on the available fault current at the service equipment.
- The date the label was applied.

Having the system voltage, available fault current, and the clearing time of the service overcurrent device will go a long way to providing the information needed to calculate the incident energy at the service equipment. Incident energy, as defined in NFPA 70E, is the thermal energy impressed on a surface during an electrical arc event. In other words, incident energy is a measure of how dangerous an arc fault can be to personnel and equipment. The incident energy value is used to determine the arc flash boundary and the proper level of Personal Protective Equipment necessary to protect a technician working on energized equipment.

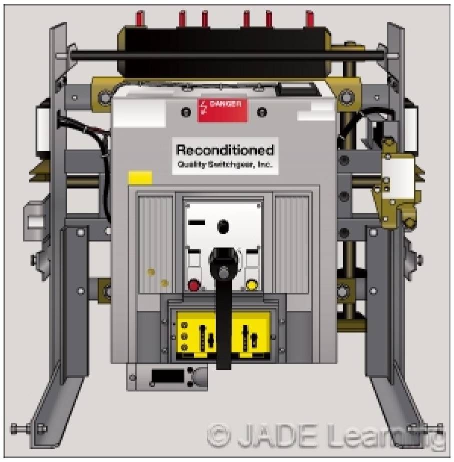
An exception will allow this label to be omitted if "***an arc-flash label is applied in accordance with industry practice".*** New informational note No. 3 says that "***acceptable industry practice***" labeling is described in "***NFPA 70E-2015 Standard for Electrical Safety in the Workplace".***

Question 10: Which one of the following is a required marking on a non-dwelling 1200 amp service?

A: The arc flash boundary.
B: The date the electrical service was installed.
C: The available fault current at the service overcurrent protective devices.
D: The date the service was inspected.

Question 11: 110.21(A)(2) Equipment Markings. Reconditioned Equipment.

Question ID#: 1060.0



Reconditioned equipment must be labeled to identify the company or organization that did the reconditioning.

Equipment which has been reconditioned must now be identified as "reconditioned." The reconditioned equipment must be marked with the name, trademark or other marking which clearly identifies the company or organization that did the reconditioning. The date when the reconditioning was done must also be included.

An exception allows industrial occupancies, where conditions of maintenance and supervision ensure that only qualified persons service the equipment, to be exempted from this rule.

Approval of the reconditioned equipment by an inspection authority is not to be based solely on the equipment's original listing. Re-listing of reconditioned equipment is not required, but the listing of the equipment when it was new may not cover the modifications made during reconditioning.

Normal servicing of equipment, where the equipment does not leave the facility, is not considered reconditioning or refurbishing.

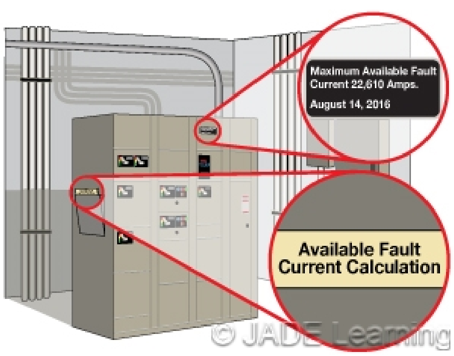
The title to 110.21(A) has been changed from Manufacturer's Markings to Equipment Markings. Markings for new and reconditioned equipment must be made on the equipment and must be able to withstand the environment where the equipment is located.

Question 11:   Which one of the following details must be included on the marking for reconditioned equipment?

A: Date of reconditioning.
B: Location of reconditioning.
C: Details of the reconditioning work performed.
D: Testing agency certification number.

Question 12: 110.24(A) Available Fault Current. Field Marking.

Question ID#: 1061.0



The calculation that results in the available fault current value must be documented and made available to interested parties.

According to the 2014 NEC, the maximum available fault current at a non-dwelling service must be field marked at the service location.Â The field marking must include the date the calculation was made.Â

The 2017 NEC has added another requirement that the calculation that resulted in the available fault current value must be documented and made available to those that design, install, inspect, maintain, or operate the system. One method would be to post a copy of the calculation at the equipment, but the calculation could also be kept in a file or maintenance notebook, as long as it could be made available to the authorized person(s) when needed.

The available fault current value is important because the short circuit current rating and the interrupting rating of electrical equipment has to be equal to or greater than the available fault current.Â If the available fault current value is wrong, and the short circuit current ratings and interrupting ratings of the electrical equipment are undersized, the equipment could be damaged and personnel could be injured if there is a fault.

An available fault current calculation is complicated and must allow for variables such as the size and impedance of the transformer, the length of the service conductors and the type of raceway. Documenting the available fault current calculation and having it accessible to interested parties will provide the information necessary to properly design, inspect and maintain the equipment.

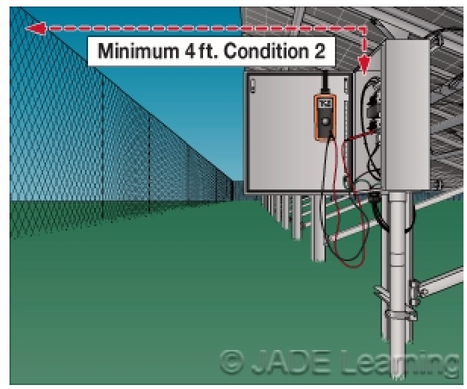
Including the date the calculation was performed is required because after the service has been installed and marked with the correct available fault current there may be changes made that would change the available fault current value. For example if the utility changed the transformer supplying the service to a larger transformer or a transformer with a lower % impedance, the available fault current would increase. The label put on the service equipment would then be incorrect. This could result in someone adding equipment to the service that is not rated for the fault current available after the transformer change was made.Â Â Â

Question 12: The calculation used to determine the maximum available fault current, for non-dwelling unit services, must be ___________.

A: Done by a professional engineer.
B: Documented and available.
C: Posted at the service equipment.
D: Reviewed by the inspector.

Question 13: Table 110.26(A)(1) Working Spaces.

Question ID#: 1062.0



Voltage levels between 601 - 1000 volts have been added to Table 110.26(A)(1) Working Spaces.

A new row of voltage ranges has been added to Table 110.26(A)(1), Working Spaces. The new row is for voltages between 601 and 1000 volts. The required depth of the working space in front of equipment which operates within this range is:

- 3 ft. for Condition 1
- 4 ft. for Condition 2
- 5 ft. for Condition 3

The 3 conditions refer to the type of surface which is directly opposite the electrical equipment. The required working space depth is the distance measured from the equipment to the opposite wall or exposed live parts.

Condition 1 - One side of the working space has exposed live parts and no live or grounded parts on the other side. Examples include sheetrock and wood walls.

Condition 2 - One side of the working space has exposed live parts and a grounded surface such as a concrete wall on the other side.

Condition 3 - Exposed live parts on both sides of the working space. Examples include 2 rows of switchgear facing each other.

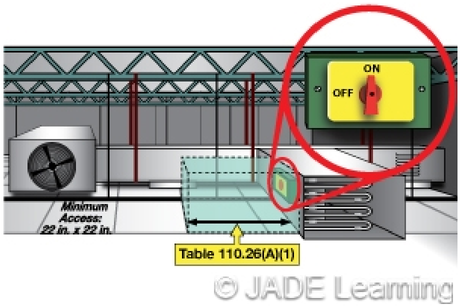
The 2014 NEC raised the voltage threshold from 600 volts to 1000 volts in many Articles. This was done to address emerging electrical systems such as photovoltaic and wind generation systems where voltages are often over 600 volts. Adding a new range of voltages between 601 and 1000 volts in Table 110.26(A)(1) for the required depth of the workspace recognizes that higher voltage systems are becoming more common.

Question 13: What is the required depth of working space in front of equipment operating at 700 volts to ground and across from a grounded surface?

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

Question 14: 110.26(A)(4) Working Space. Limited Access.

Question ID#: 1063.0



Equipment in spaces with limited access still require clear work space around the equipment.

Working space around electrical equipment is required to allow qualified individuals who are servicing the equipment enough room to safely do their job. If the equipment will require "examination, adjustment, servicing, or maintenance while energized" clear space around the equipment is required.

Some equipment like duct heaters or air handlers are located in spaces with limited access. New section 110.26(A)(4) addresses the required workspace and access to such equipment.

Earlier editions of the NEC did not make allowances for or give specific rules for equipment located in spaces with limited access.

Now, if the equipment is located above a lay-in ceiling a minimum of a 22 in. X 22 in. opening is required for access. If the equipment is located in a crawl space a minimum of a 22 in. X 30 in. access opening is required. The width of the working space may not be less than 30 inches or the width of the equipment whichever is greater. Doors on the equipment must be able to be opened at least 90 degrees.

The minimum depth of the space in front of the equipment may not be less than what's given in Table 110.26(A)(1).

The minimum height of the working space in front of the equipment is "***the height necessary to install the equipment in the limited space."*** A horizontal ceiling structural member or access panel is permitted inside the defined work space.

Question 14:   What are the minimum dimensions required for the opening to access equipment located above a lay-in ceiling?

A: 24 in. X 24 in.
B: 22 in. X 24 in.
C: 22 in. X 22 in.
D: 22 in. X 30 in.

Question 15: 110.41 Inspections and Tests.

Question ID#: 1064.0

Electrical systems operating at over 1000 volts must be tested before being put in operation. The test report must be made available to the AHJ.

Section 110.41 has been added to reinforce testing requirements for electrical systems operating at over 1000 volts.Â The requirements in Section 110.41 only apply when pre-energization and operating tests are required by other sections of the NEC. Â Section 110.41 requires equipment to be tested when first installed on site.

Where pre-energization testing is required â€œ***the complete electrical system design, including settings for protective, switching, and control circuits shall be prepared in advance and made available to the authority having jurisdiction upon request of the AHJ. Section 110.41 requires the equipment to be tested when first installed on site.***The AHJ may also need time to evaluate the system design to determine the scope of the performance testing that will be required by other code sections.

For example, 225.56 provides an extensive list of pre-energization tests required for outside branch circuits and feeders operating at over 1000 volts. Protective relays must be tested by injecting current or voltage, and demonstrated to operate in accordance with the electrical system design. The operation of each protective relay, control or signal circuit, and switching circuit must be verified by observation. Complete acceptance tests are required once the entire system is complete including any substations. These tests are typically performed under the supervision of a design professional or other qualified person knowledgeable in the operation and testing of high voltage systems.

Section 110.41 requires a test report must be made available to the AHJ prior to energizing the electrical system.Â The test report must include the results of all tests that were conducted. The test report must also be available â€œ***to those authorized to install, operate, test, and maintain the system.â€•*** Having a written record of the initial test results provides a useful benchmark for future tests and maintenance procedures.

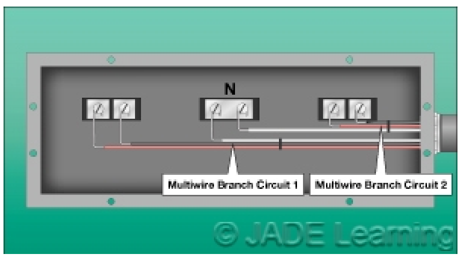
Question 15: Which one of the following electrical systems requires pre-energization testing?

A: A 4160-volt branch circuit installed outdoors.
B: A 480-volt, 3-phase feeder installed outdoors.
C: A 120/240-volt, 3-phase feeder with a high-leg conductor installed outdoors.
D: A 380-volt DC circuit from a PV array installed on a rooftop.

Chapter 2

Question 16: 210.4(D) Multiwire Branch Circuits. Grouping.

Question ID#: 1065.0



Ungrounded and grounded circuit conductors of each multiwire branch circuit must be grouped in every type of enclosure.

Chapter 2 of the National Electrical Code covers Wiring and Protection. Article 210 deals with the general requirements for ***branch circuits***, while 210.4 specifically covers ***multiwire*** branch circuits. There has been a revision to 210.4(D) regarding grouping together conductors within a multiwire branch-circuit.

Ungrounded conductors (hot conductors) and grounded conductors (white or gray conductors) within each multiwire branch-circuit must now be grouped together in ***every enclosure where they can be accessed***, not just in panelboards, as was required in 2014. A new reference to section 200.4(B) has also been added to section 210.4(D), which broadens the requirements even more for the grouping together of ungrounded and grounded circuit conductors in multiwire branch circuits.

Wire markers, cable ties, or similar means can be used to meet this requirement for grouping together the ungrounded and grounded conductors of the same circuit, within the enclosure.

There are two ***exceptions*** that exist for the grouping of multiwire branch-circuits, and they are found in 200.4(B), they are as follows: (1) If the multiwire branch circuit enters the enclosure from a cable or raceway that makes the grouping obvious, or (2) if the multi-wire branch-circuit conductors pass through a box or conduit body without forming a loop for future use, or without a splice or termination, then grouping is not required.

Failure to properly identify the grounded conductor with its associated ungrounded conductors in an enclosure can lead to wiring the grounded conductor improperly and unintentionally overloading the grounded conductor. For example: on a typical multiwire branch circuit, the grounded conductor carries only the unbalanced current measured between Phase A and Phase B. Since Phase A and Phase B are 180 degrees out of phase from one another, they can serve as each other's grounded conductor, when the load they serve is perfectly balanced- such as an AC condensing unit which operates on 240 Volts without a grounded conductor in the circuit. But when they are not balanced, such as when phase A is carrying 16 amps and phase B is carrying 13 amps, the white grounded conductor is carrying the difference, 3 amps. That is why one grounded conductor can be installed with two or even three ungrounded conductors in a cable. As long as the ungrounded conductors are properly terminated on different phases of the system (phase A, phase B, etc) within the electrical panel, they can carry the majority of the return path from the other conductors of that multiwire branch-circuit. But if that same grounded conductor in that multiwire branch circuit is unintentionally forced to serve two ungrounded conductors that are both terminated, by accident, on Phase A, then that grounded conductor would be forced to carry the sum total of the current from both conductors added together, and will be overloaded. Grouping the grounded conductor with all of the ungrounded conductors that it is serving, will reduce the chances of this happening, as the electrician will see what grounded conductor is serving what group of hot wires, and can land the hot wires on different phases (circuit-breakers) in the panel accordingly.

Since overcurrent protection is not typically provided for grounded conductors within a panel, overload of this conductor often goes undetected and can result in serious damage to conductor insulation and equipment.

Question 16: Which of the following statements is true?

A: Grounded conductors must all be grouped together in an enclosure.
B: Ungrounded and grounded conductors of the same multiwire branch circuit must be grouped together in an enclosure.
C: Ungrounded conductors must all be grouped together in an enclosure.
D: Ungrounded and grounded conductors of the same multiwire branch circuit are not required to be grouped together.

Question 17: 210.5(C)(1) Identification of Ungrounded Conductors. Branch Circuits Supplied from More Than One Nominal Voltage System.

Question ID#: 1066.0

There has been a change to NEC requirements for ***identifying branch circuits supplied by more than one voltage system.***

Generally speaking, when more than one voltage system supplies branch circuits on the premises, the NEC requires each ungrounded (hot) branch circuit conductor to be identified by its "***phase or line and system at all termination, connection and splice points***" (210.5(C)(1). Similar requirements for neutral conductors are found in Section 200.6(D). The most common identification method for conductors is color coding, but it should be noted, the NEC does NOT REQUIRE a particular color scheme for this purpose. Marking tape, tags, or other approved methods are also permitted. Whatever the method, it must be posted at each branch circuit panelboard or otherwise be readily available to be viewed.

In NEW installations each ungrounded branch circuit conductor must be identified at all termination, connection, and splice points. A NEW EXCEPTION has been added for existing installations.

Sample labels are provided below.

SAMPLE SYSTEM IDENTIFICATION LABELS FOR DISTRIBUTION EQUIPMENT:

208/120 Volt System	480/277 Volt System
Phase A- Black	Phase A-Brown
Phase B- Red	Phase B-Orange
Phase C- Blue	Phase C-Yellow
Neutral- White	Neutral- Gray

Adding New Wiring of a Different Voltage to Old Wiring - the rules have changed

The 2017 NEC provides a new ***Exception*** to the above-mentioned wire marking requirements for those instances where a different voltage system is added to existing installations (such as adding a new transformer inside an existing building). For example, if a 208/120-volt system is already in place and a 480/277-volt volt system is added to the building to power a few heavy-duty motors, the new exception for marking wires would guide your marking efforts.

Why the change? In the example above where the building is adding a new transformer of a different voltage, it can be nearly impossible to trace out all of the existing 208/120-volt wiring to ensure that all conductors at all "***termination, connection and splice points,"*** are consistently identified by both phase and system in every junction box. The wires could have all been marked at the time they were installed, but after thatâ€"good luck tracking them all down. The NEC now realizes this. Therefore, the new exception states that, in our example, the ***existing*** 208/120-volt system conductors are not required to be identified at each termination or splice point, but instead all ***distribution equipment, such as panelboards, of both the old and new systems must be labeled to indicate a new voltage system has been installed, and then only the new wiring has to have all conductors labeled.***

So let's recap. When existing wiring of an existing voltage is in a building and an additional transformer is added to the building so that new wiring of a different voltage can also serve that building, every piece of distribution equipment for both the old and new systems must be marked to indicate each system's voltage. Then only the NEW WIRING must be marked at every termination, connection, and splice point. The existing wiring does not have to be marked.

The new exception says that by identifying the voltage at all distribution equipment of both the old and new systems, and then marking the wiring of only the newly added system, it will be apparent that only one system is marked and electricians will know to be careful. It also says the labels that are to be installed on the distribution equipment of the new system must include the words ***"OTHER UNIDENTIFIED SYSTEMS EXIST ON THE PREMISES."***

All labels used must of course be suitable for the environment. Handwritten labels are not permitted.

Question 17:   When a new system with different voltage is added to an existing building, where is a label required to be placed that identifies to the electrician that only one voltage system has been marked by phase or line and system?

A: At all voltage system distribution equipment (existing and new).
B: At each junction box where there is a termination or splice.
C: At locations where the ungrounded conductors are accessible.
D: At the service and at each transformer.

Question 18:   210.5(C)(2) Identification of Ungrounded Conductors. Branch Circuits Supplied from Direct-Current Systems.

Question ID#: 1067.0

There has been an addition to identifying conductors of branch circuits supplied from direct-current systems. There is a new method for identifying ungrounded DC conductors.Â Now No.6 AWG and smaller conductors can be identified at all termination, connection and splice points.Â Previously identification was required for the entire length of the conductor.

No. 6 AWG and smaller DC conductors can be identified at terminations and splice points, and are no longer required to be identified along the entire length of the conductor.

The ability to identify branch circuit conductors at termination, connection and splice points will allow existing conductors to be re-used instead of replaced. This will reduce the cost of updating or retrofitting existing DC systems.

This change will also speed the adoption of Direct-Current Microgrids as a power distribution system.Â Requirements for Direct-Current Microgrids are outlined in new Article 712 in the 2017 NEC.

According to section 210.5(C)(2), ungrounded POSITIVE polarity conductors No. 6 AWG and smaller may be identified by:

- A continuous red outer finish.
- A continuous red stripe on other than green, white, gray, or black insulation.
- Imprinted plus signs (+) or the words POSITIVE or POS at 24 inch intervals on other than green, white, gray or black insulation.
- ***<u>â€œan approved permanent marking means such as approved sleeving or shrink tubing that is suitable for the conductor size, at all termination, connection or splice points, with imprinted plus signs (+) or the word POSITIVE or POS durably marked on an insulation of a color other than green, white, gray, or blackâ€•</u>*** (2017 NEC).

Ungrounded NEGATIVE polarity conductors No. 6 AWG and smaller may be identified by:

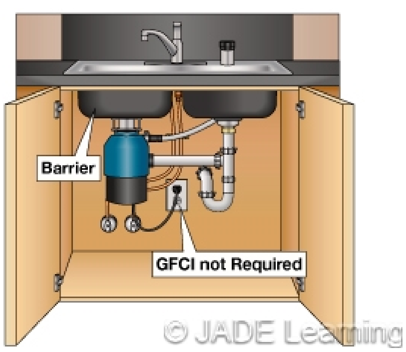
- A continuous black outer finish.
- A continuous black stripe on other than green, white, gray, or red insulation.
- Imprinted minus signs (-) or the words NEGATIVE or NEG at 24 inch intervals on other than green, white, gray or red insulation.
- ***<u>â€œan approved permanent marking means such as approved sleeving or shrink tubing that is suitable for the conductor size, at all termination, connection or splice points, with imprinted minus signs (-) or the word NEGATIVE or NEG durably marked on an insulation of a color other than green, white, gray, or redâ€•</u>*** (2017 NEC).Â

Question 18: Which of the following is acceptable for identifying a No.8 AWG ungrounded POSITIVE conductor at a splice point?

A: A continuous black outer finish.
B: A continuous red stripe on black insulation.
C: The word POSITIVE imprinted on gray insulation.
D: Approved shrink tubing durably marked POS on blue insulation.

Question 19: 210.8 GFCI Protection for Personnel.

Question ID#: 1068.0



<u>The required 6 ft. distance from a GFCI receptacle to a sink, bathtub, or shower stall is measured as the shortest path the cord of an appliance would follow without piercing a floor, wall, ceiling, doorway or window.</u>

Section 210.8 addresses ground-fault circuit-interrupter protection for personnel including specific requirements (A) through (E). Section (A) addresses dwelling units, and part 7 deals with sinks in particular. Receptacle outlets within 6 ft. of a sink, and receptacle outlets within 6 ft. of a bathtub or shower stall still are required to have GFCI protection.Â What is new in the 2017 NEC is how to measure that 6 ft. distance.

<u>The distance shall be measured as the shortest path the cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway or window.</u> 210.8.

Typical small appliance cords used within 6 ft. of a sink, bathtub or shower stall are not longer than 6 feet in length. If the shortest path the cord will follow is greater than 6 feet, the appliance will remain outside of the wet conditions around the sink or shower, and GFCI protection is not required.

The 2017 NEC also changes the measurement for sinks from the outside edge of the sink to the top inside edge of the bowl of the sink.Â Many sinks have raised bowls above the sink cabinet and this change will include those designs. For bathtubs and shower stalls the 6 feet is still measured to the outside edge.

For all receptacles inside bathrooms, as defined in the NEC, GFCI protection must be provided in accordance with 210.8, even if the receptacle is further away from the sink than 6 ft.

Question 19: Which of the following 15 amp, 125 volt dwelling unit receptacles DO NOT require GFCI protection?

A: A receptacle 6 ft. measured diagonally from the outside edge of a shower.
B: A wall receptacle installed 12 in. above the floor and 6 ft. 1 in. from the top inside edge of a kitchen sink.
C: An ironing board receptacle located 6 ft. above the floor and 5 ft. diagonally from the inside top edge of the laundry sink bowl.
D: A wall receptacle located 5 ft. measured around a corner from a wet-bar sink in the same room.

Question 20: 210.8(B) GFCI Protection for Personnel. Other Than Dwelling Units.

Question ID#: 1069.0

In other than dwelling units, many single-phase receptacles rated 150 volts to ground or less and 50 amps or less, as well as three-phase receptacles rated 150 volts to ground or less and 100 amps or less, now require GFCI protection.

Section 210.8(B) in the NEC declares all of the areas in ***other than dwelling units*** where receptacles must be GFCI protected. But not every receptacle in these areas must be GFCI protected, only the receptacles rated as follows:

(1) Single-phase receptacles rated 150-volts to ground or less AND 50-amperes or less.

(2) Three-phase receptacles rated 150-volts to ground or less AND 100-amperes or less.

Don't be confused when the NEC says "150-volts to ground," that requirement also includes 240-volt receptacles because each ungrounded energized conductor of a 240-volt receptacle measures 120-volts to ground, even though both ungrounded conductors together measure 240-volts.

Other than Dwelling Units

Section 210.8(B) of the NEC addresses locations ***other than dwelling units*** where receptacles must be supplied with GFCI protection. New for this 2017 Code cycle, unfinished basements as well as crawlspaces belonging to locations ***other than dwelling units*** have now made this list. There are now 10 locations in ***other than dwelling units*** where receptacles require GFCI protection:

- Bathrooms
- Kitchens
- Rooftops (These do not have to be readily accessible when on the rooftop, per NEC exception)
- Outdoors
- Sinks- ***within 6 feet of the top inside edge of the bowl of the sink*** (CHANGE)
- Indoor wet locations
- Locker rooms associated with showers
- Garages and service bays, (other than vehicle exhibition halls/showrooms)
- ***Crawl spaces*** (NEW)
- ***Unfinished basements*** (NEW)

You will notice that location number 5 from this list, ***Sinks,*** has also experienced a revision for the 2017 Code cycle. Notice the measurement when measuring 6 feet from the edge of a sink is taken from the top inside edge of the bowl of the sink in the 2017 Code cycle.

Example

Here is an example of the Code: A 30-ampere single-phase 120/240-volt receptacle outlet for a clothes dryer installed in a motel laundry room and positioned within 6 ft. of a sink requires GFCI protection according to Section 210..8(B). A 240-volt rated single-phase 20-ampere receptacle for a sump pump installed in an unfinished basement or crawlspace will also require GFCI protection.

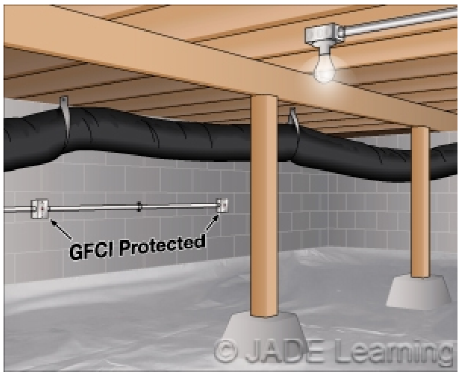
The number of accidental electrocutions of consumers has declined dramatically since GFCI protection was first introduced in the 1971 NEC. Expanding the protection to include more non-dwelling applications will increase safety. This is especially true for wet locations, unfinished basements, crawl spaces, or other areas where working conditions may increase the potential for electric shock.

Question 20: Which of the following receptacle outlets will require GFCI protection according to Section 210.8(B)?

A: A 120/240 volt, 30-amp rated, single-phase receptacle for a window unit air conditioner installed in an employee bathroom.
B: A 120/208 volt, 50-amp rated, 3-phase receptacle installed in an office.
C: A 480-volt, 3-phase, 60-amp rated receptacle for an air compressor in a commercial garage.
D: A 240-volt 20-amp rated single-phase receptacle in the finished area of the basement.

Question 21: 210.8(B)(10) GFCI Protection for Personnel. Other Than Dwelling Units. Basements.

Question ID#: 1070.0



Receptacles in unfinished basements in other than dwelling units require GFCI protection.

GFCI protection for personnel is now required for receptacles in unfinished basements in office buildings, schools, industrial facilities and other non-dwelling unit locations. An unfinished basement is any ***unfinished portions or areas of the basement not intended as habitable rooms.***

GFCI protection is required for single phase receptacles rated 150-volts to ground or less and not more than 50 amperes. Three phase receptacles rated 150-volts to ground or less and 100 amperes or less also require GFCI protection. All receptacles within these ratings in unfinished basements, including receptacles that may not be considered readily accessible must have GFCI protection.

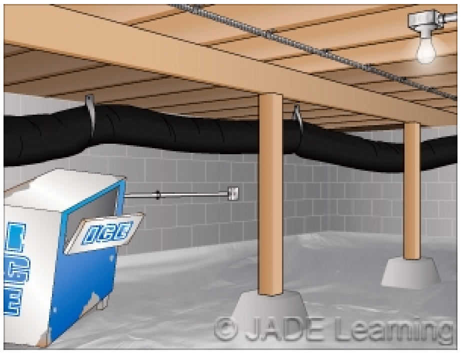
GFCI protection has been required for receptacles in unfinished basements in dwellings for many years. Similar electrocution hazards exist in unfinished basements regardless of the type of occupancy. The unfinished portions of basements are often poorly illuminated, damp and contain equipment that require periodic service. Extension cords and portable lights are often used in these areas. Providing GFCI protection for receptacles in unfinished basements will substantially reduce the electrical shock hazard for workers in these areas.

Question 21: In the unfinished portion of a basement at a hospital, which one of the following does NOT require GFCI protection?

A: A 120/208-volt, three phase, 20 ampere receptacle for a sump pump.
B: A 277-volt, single phase, 20 ampere lighting branch circuit.
C: A 125-volt, single phase, general purpose receptacle.
D: A 120/208-volt, single phase, 30 ampere receptacle.

Question 22: 210.8(E) GFCI Protection for Personnel. Crawl Space Lighting Outlets.

Question ID#: 1071.0



Lighting outlets not exceeding 120 volts in dwelling units and in other than dwelling units require GFCI protection.

The 2017 NEC requires lighting outlets not exceeding 120 volts to be GFCI protected when installed in crawl spaces. This requirement applies to both dwelling units and non-dwelling locations.

When crawl spaces are used for storage or contain equipment that requires servicing a lighting outlet is required. Lighting outlets may be installed in crawl spaces solely for convenience when not required. The luminaire of choice is usually a simple porcelain (or plastic) keyless lampholder with an incandescent lamp (light bulb) installed. If the lamp is broken the internal energized components may be exposed creating a hazard that will be difficult to see in a dark crawlspace. Ductwork, plumbing pipes and other systems provide multiple potential current paths to earth. Simply changing the lamp while in a damp crawlspace surrounded by metal pipes and ductwork poses a degree of risk.

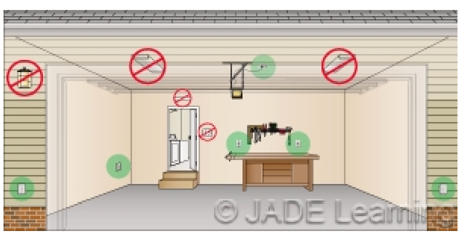
Electrocutions in crawlspaces are not uncommon. Electricians, plumbers, HVAC technicians and others are in and hopefully out of crawlspaces every day. The new requirement should increase safety by eliminating the potential shock hazard from a damaged lamp.

Question 22: Which of the following lighting outlets require GFCI protection?

A: A 277 volt fluorescent luminaire in an unfinished basement.
B: A 120 volt porcelain keyless lampholder in a walk up attic.
C: A 120 volt wall mounted luminaire in an equipment room.
D: A 120 volt porcelain keyless lampholder next to an air handler in a crawlspace.

Question 23: 210.11(C)(4) Dwelling Units. Garage Branch Circuits.

Question ID#: 1072.0



A 20-ampere branch circuit is required to supply receptacles in the garage. In addition to the receptacle outlets in the garage, this branch circuit may supply readily accessible outdoor receptacle outlets. The green circles in the illustration indicate the receptacle outlets permitted on this branch circuit.

Section 210.11 discusses required branch circuits. Section (C) specifies dwelling units. A new branch circuit has been added to the list of required branch circuits for dwelling units. At least one 20 amp rated 120-volt branch circuit shall be installed to supply receptacle outlets in a garage. A similar, but not identical requirement, was introduced in Section 210.52 of the 2014 NEC. Moving the requirement to Section 210.11(C) groups all of the required branch circuits for a dwelling unit in a single location. The garage receptacle branch circuit is not permitted to supply any other outlets with a single new exception provided for readily accessible outdoor receptacle(s).

The exception will allow any readily accessible outdoor receptacles including the required outdoor receptacles on the front and back of a dwelling and the receptacle for servicing heating and air conditioning equipment to be supplied by the garage receptacle branch circuit. Lighting outlets inside or outside of the garage are not permitted to be connected to the garage receptacle branch circuit.

Loads in residential garages have steadily increased over the years. Portable air compressors, electric tools, battery chargers, spare refrigerators and electric vehicles have become common items in the garage. Adding a requirement for a minimum of one 120-volt 20 ampere branch circuit for the garage receptacles should reduce the possibility of overloading the receptacle branch circuit.

Question 23: Which of the following receptacles is NOT permitted on the required garage branch circuit?

A: A readily accessible outdoor receptacle for servicing a heat pump.
B: The required outdoor receptacle on the front of a one-family dwelling.
C: A readily accessible receptacle on an exterior wood deck.
D: An outdoor receptacle above an equipment platform accessible by portable ladder.

Question 24: 210.12(B) AFCI Protection. Dormitory Units.

Question ID#: 1073.0

Receptacle outlets in dormitory bathrooms must be AFCI protected.

Section 210.12 covers arc-fault circuit-interrupter protection and Section (B) specifies Dormitory Units. The requirement for Arc-Fault Circuit-Interrupter (AFCI) protection in dormitory units has been expanded to include 120-volt, 15- and 20-amp branch circuits that supplyÂ outlets and device(s). The term device includes switches and similar electrical controls. Bathrooms were also added to the locations where AFCI protection is required. The 2017 NEC requires AFCI protection for all 120-volt single phase, 15 and 20 ampere branch circuits supplying outlets and devices installed in bedrooms, living rooms, hallways, closets, bathrooms, and similar rooms in dormitory units.Â Circuits that supply only kitchen and laundry areas are not included unless there is an outlet or switchÂ in a hallway, living room, or similar area whereÂ AFCI protection is required.Â

Any branch circuit extensions or modifications in dormitory units will also trigger the requirement for AFCI protection, per 210.12(D). There is an exception for extending existing branch circuits no more than 6 feet provided no outlets or devices are added. For example, branch circuit conductors could be extended to accommodate the replacement of a panelboard in a dormitory unit.

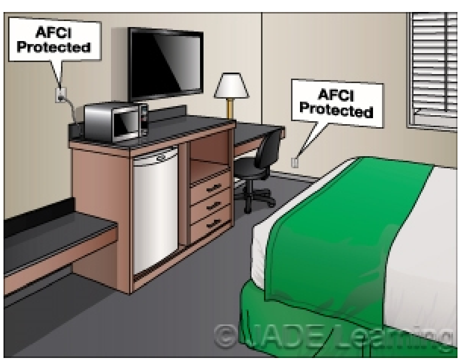
Dormitory units present a challenging fire safety environment. Extension cords and multi-plug adapters are common. Receptacle circuits may be loaded to maximum capacity by microwaves, hot plates, computers and similar 120 volt small appliances. Portable electric heaters may be in use during winter months as well. Hair dryers and similar electrical appliances are common in bathrooms. Switches and other devices also offer a potential source of ignition if the contacts deteriorate from heavy use or if the switch is damaged. Adding bathrooms and devices to the list for AFCI protection is a logical step in enhancing fire safety.Â

Question 24: Which of the following circuits must be AFCI protected in a dormitory unit?

A: A kitchen lighting circuit with switches located only in the kitchen.
B: A 120-volt, 20 amp rated circuit supplying kitchen counter receptacles.
C: A 120-volt, 20 amp rated circuit for a clothes washer.
D: A 120-volt, 15 amp GFCI protected circuit to a light in the shower.

Question 25: 210.12(C) AFCI Protection. Guest Rooms and Guest Suites.

Question ID#: 1074.0



All 15- and 20-amp rated branch circuits supplying guest rooms and guest suites, with or without permanent provisions for cooking, are required to have AFCI protection.

Guest rooms and guest suites in hotels and motels have been added to the locations where arc-fault circuit interrupter (AFCI) protection is required. Now all 120-volt, single phase, 15-and 20-amp rated branch circuits supplying guest rooms and guest suites are required to be AFCI protected. The 2014 NEC only required AFCI protection when the guest rooms or suites included permanent provisions for cooking.

Most guest rooms and guest suites do not have permanent provisions for cooking. A small 120-volt portable microwave is not typically considered permanent provisions for cooking. The new requirement for all outlets in any type of guest room or guest suite to have AFCI protection will greatly expand the use of AFCI protection in the hotel and motel industry.

In any motel room all of the 120-volt, 15-and 20-amp rated branch circuits for outlets and devices will require AFCI protection. This includes all 120-volt lighting outlets and switches as well as receptacles. Bathroom branch circuits supplying GFCI receptacles must also be AFCI protected.

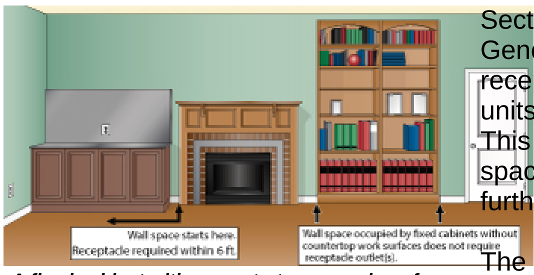
AFCI protection was first introduced in the 1999 NEC for circuits supplying bedrooms in dwelling units. Branch circuits supplying 120-volt, 15- and 20-amp outlets and devices in dormitory unit bedrooms also require AFCI protection. Adding the requirement to AFCI protect branch circuits in guest rooms and guest suites of hotels and motels, with or without permanent provisions for cooking, provides a consistent requirement for sleeping areas whether located in a dwelling unit, dormitory, hotel or motel.

Question 25: Which of the following outlets in a motel must be AFCI protected?

A: A 120-volt branch circuit supplying a portable microwave in the lobby.
B: A 240-volt receptacle for a wall mounted heat pump in a guest room.
C: A 120-volt, 15-amp GFCI receptacle in a guestroom bathroom.
D: A 120-volt, 20-amp branch circuit supplying the first floor corridor lighting.

Question 26: 210.52(A)(2) Dwelling Unit Receptacle Outlets. General Provisions. Wall Space.

Question ID#: 1075.0



A fixed cabinet with a countertop or work surface is considered wall space and must be included in the measurements to determine receptacle placement.

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Section 210.52 addresses dwelling unit receptacle outlets, and Section (A) includes General Provisions. Changes have been made to address questions about receptacle placement in fixed cabinets and fixed panels in interior walls in dwelling units. A fixed cabinet with a countertop is now considered as part of the wall space. This means that receptacles should be spaced so that no point along the entire wall space (including the space occupied by the cabinet with the countertop) should be further than 6 ft. (measured horizontally) from a receptacle.

The general rule remains the same, no point along a wall shall be more than 6 ft. from a receptacle outlet. The fixed panel of a sliding glass door in an exterior wall was considered wall space in the 2014 NEC, but no mention was made of fixed panels in interior walls. Fixed panels in interior walls are now treated the same way as fixed panels in exterior walls. In both exterior and interior locations, "***the space occupied by fixed panels in walls, excluding sliding panels"*** is considered wall space, 210.52(A)(2)(2). Any wall space 2 ft. or wider requires at least one receptacle outlet.

The 2014 NEC treated fixed cabinets, along with doorways and fireplaces, as breaks in wall space. This eliminated the need to add receptacles in built-in cabinets and bookcases. An extreme example is provided by a library (in a dwelling unit) with fixed book cases built around the entire perimeter of the room. Receptacle outlets were not required under the 2014 NEC and are not required under the 2017 NEC as long as the cabinets do not have countertops.

More commonly today fixed cabinets with countertops or similar work surfaces are being installed in living rooms and dens. Are receptacles required to serve these countertops?

Fixed cabinets with countertops or similar work surfaces are now considered as wall space. Receptacles must be spaced so that no point along the wall is further than 6 ft. from an outlet. The key factor is the presence of countertops or similar work surfaces. Fixed cabinets "***that do not have countertops or similar work surfaces"*** are treated the same as a fireplace, 210.52(A)(2)(1).

For example, a 4 ft. wide built-in fixed bookcase without countertops or similar work surfaces in the center of an otherwise unbroken wall 26 ft. in length. The bookcase breaks the wall into two separate 11 ft. wall spaces. Each of the 11 ft. wall spaces requires at least one receptacle to meet the 6 ft. spacing rule. A receptacle is not required for the bookcase because it does not have a countertop.

If the 4 ft. fixed bookcase includes a countertop or similar work surface such as a desk top, the wall is considered a single wall space 26 ft. in length. If one outlet is spaced a maximum of 6 ft. from each end, then there is 14 ft. between the two receptacle outlets. This requires ***TWO outlets to meet the 6 ft. spacing***

requirement rule. The receptacle(s) are not required to be in the countertop space, but must be located so that no point along the wall line is further than 6 ft. measured horizontally from a receptacle.

If a fixed cabinet does not have a countertop or work surface it is not counted as wall space. If the fixed cabinet does have a countertop or work surface it is counted as wall space.

Question 26:   A fixed cabinet 3 ft. in length and equipped with a usable countertop surface, is installed in the center of a living room wall that is 10 ft. in length. When it comes to determining receptacle placement, which of the following is correct?

A: There is one wall space and the fixed cabinet is part of it; it is 10 ft. in total length.
B: There are two separate wall spaces, they are each 3.5 ft. in length.
C: There are three separate wall spaces (two 3.5 ft. wall spaces and one 3 ft. wall space, which is the fixed cabinet).
D: There are two separate wall spaces, each are 5 ft. in length.

Question 27:   210.52(B)(1) Ex.No. 2. Dwelling Unit Receptacle Outlets. Small Appliances. Receptacle Outlets Served.

Question ID#: 1076.0

A 15-ampere branch circuit to serve a specific appliance (other than just the refrigerator) within a dwelling unit kitchen, is now permitted.

Exception No. 2 to 210.52(B)(1) is no longer limited to just refrigeration equipment. An individual 15 ampere branch circuit can now be added to supply a receptacle for any specific appliance being installed within a kitchen or similar areas of dwelling units. However, that individual branch circuit cannot supply more than one appliance, nor can it supply any other loads other than an appliance.

Receptacle outlets in the kitchen, dining room, breakfast room, pantry or similar room in a dwelling are generally supplied by one of the two or more 20-amp small appliance branch circuits required by 210.11(C)(1). Two exceptions to the 20-amp minimum requirement are provided in 210.52(B)(1). Exception No. 1 is unchanged.

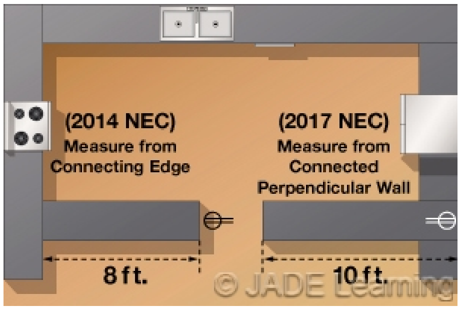
Exception No. 2 previously allowed a 15-amp individual branch circuit to be installed for refrigeration equipment only. Individual branch circuits serving other specific appliances were required to meet the 20-amp minimum rating for a small appliance branch circuit. Individual 15-amp branch circuits are now allowed for a specific appliance. The receptacle installed for a specific appliance must be in addition to the receptacles required by 210.52.
Allowing a separate 15-amp circuit for the refrigerator was logical because it removed a significant load from one of the 20-amp small appliance branch circuits. This new revision to the Code will extend that same logic to other appliances, where it is applicable.

Question 27:   In a dwelling kitchen, which one of the following scenarios is NOT permitted to be supplied by a 15-ampere individual branch circuit?

A: A receptacle for a cord-and-plug connected 5-amp range hood.
B: Two receptacles, one for a range hood and the other for the under-cabinet microwave oven.
C: A receptacle for an 8-amp garbage disposal.
D: A receptacle for a 9-amp Espresso machine.

Question 28: 210.52(C)(3) Countertops and Work Surfaces. Peninsular Countertop Spaces.

Question ID#: 1077.0



A wall receptacle can count as the required receptacle for peninsular countertops.

The way the peninsular countertop length is measured has changed in 2017 (See illustration to your left) Instead of measuring from the connecting edge of the countertop as it was previously, a peninsular countertop now starts its measurement ***from the connected perpendicular wall,*** 210.52(C)(3). Keep in mind, at least one receptacle must still be installed at all peninsular countertop spaces with a long dimension of 24 in. or greater and a short dimension of 12 in. or greater, but this new rule will change how we measure that long dimension.

For example, in the 2014 NEC a peninsular countertop space 24 in. wide extending less than 12 in. from the connecting edge of a wall countertop did not require a receptacle outlet at all, because the measurement was taken from the connecting edge, and fell short of the 24" x 12" minimum requirement. But in the 2017 NEC a 24 in. wide countertop extending out 10 in. from the edge of a 24 in. wide wall countertop has a long dimension of 34 inches, because it is now measured to the connected perpendicular wall instead of just the 10 inches jutting out from the connecting edge. Therefore, with this new style of measurement, a receptacle is required to serve this space. A wall receptacle located at the peninsular space is acceptable.

The intent of changing the way peninsular countertops are measured is to allow wall receptacles (along the wall space countertop) to count as the required receptacle for the peninsular countertop. Since only one receptacle is required for a peninsular countertop, even if the peninsular was 10 ft. long, but had a wall receptacle installed at one end, no additional receptacle outlets would be required because the wall receptacle counts as the required peninsular receptacle.

Peninsular countertops are often broken into separate countertop spaces by a sink or rangetop. Each countertop space created must then be measured separately. Any peninsular countertop space with a long dimension of 24 in. or greater and a short dimension of 12 in. or greater requires at least one receptacle outlet.

Question 28: A peninsular countertop extends outward 12 in. from where it abuts the connecting edge of a kitchen wall countertop. That kitchen wall countertop that it abuts is 24". Applying the new method of measurement found in the 2017 Code, what is the length of the entire peninsular? Keep in mind the new starting point of the measurement, in 2017. Let the illustration assist you in this new style of measurement.

A: 24 in.
B: 36 in.
C: 12 in.
D: 60 in.

Question 29: 210.52(D) Dwelling Unit Receptacle Outlets. Bathrooms.

Question ID#: 1078.0

A receptacle in a dwelling unit bathroom must be located not more than 12 inches below the top of the basin or the basin countertop.

Finding the proper place to install a receptacle outlet in a bathroom can be challenging. Receptacles must be installed on the wall adjacent to the basin and within 3 ft. of the outside edge of the basin per the NEC section 210.52(D). There is often a mirror over the basin countertop that eliminates installing the outlet on the wall above the basin. One option is to install a receptacle in the countertop using a receptacle outlet assembly "***listed for use in countertops***" (2017 NEC). Another option is to locate the receptacle on the wall or cabinet below the countertop.

The 2014 NEC did not permit the required bathroom receptacle to be located more than 12 in. below the top of the basin. Simple enough to do with a conventional flush mounted basin in a countertop, but the increased popularity of basins with raised bowls created challenges in meeting the 12 in. maximum. A basin with an 8 in. raised bowl above the countertop leaves only a 4 in. space for the receptacle. The exact choice of the basin to be used may not even be known until the last minute or may change. If the basin is replaced with a different style in the future, does that mean the receptacle should be relocated?

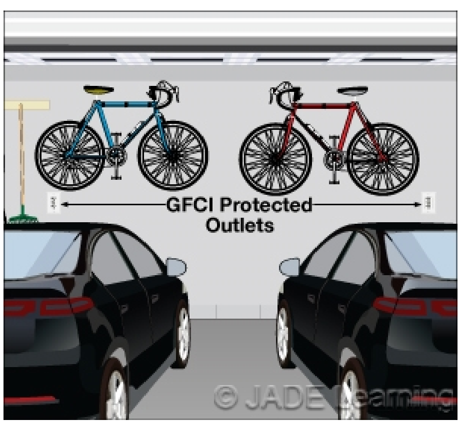
It is much more practical to locate the receptacle relative to the countertop as the height of the countertop is less likely to change. The 2017 NEC allows the 12 in. measurement to be made from either the top of the basin or the basin countertop. For a pedestal or wall-hung sink, measure down from the top of the basin. If the basin is installed in a countertop, the receptacle is permitted to be located not more than 12 in. below the top of the basin countertop.

Question 29: Which of the following meet the bathroom receptacle requirement?

A: A receptacle located on the wall 4 ft. from the outside edge of the basin.
B: A receptacle located 24 in. below the top of a pedestal sink.
C: A receptacle located on the side of the basin cabinet 12 in. below the countertop.
D: A receptacle located on a non-adjacent wall 5 ft. from the basin.

Question 30: 210.52(G)(1) Dwelling Unit Receptacle Outlets. Garages.

Question ID#: 1079.0



At least one receptacle outlet is required in each vehicle bay in a dwelling unit garage.

Section 210.52(G)(1) has been revised to clarify that at least one receptacle outlet is required in each vehicle bay in a garage.

The 2014 NEC required a receptacle outlet "***for each car space***", but did not specify a location. The 2017 NEC requires ***"at least one receptacle outlet shall be installed in each vehicle bay***." The term car space was dropped in favor of vehicle bay. Garages are used for many types of vehicles, not just cars. The receptacle can be located on any wall in the vehicle bay, but there must be an outlet in each vehicle bay. The receptacle outlets serving the vehicle bay cannot be located more than 5-1/2 feet above the floor and must be in addition to any receptacles installed for specific equipment.

Clarifying that at least one receptacle outlet is required in each vehicle bay eliminates any question as to where the required receptacles should be placed. Receptacles located in each vehicle bay will typically be accessible for charging the battery of an electric vehicle or other vehicle service. A receptacle in each vehicle bay will also reduce the need for extension cords in the garage.

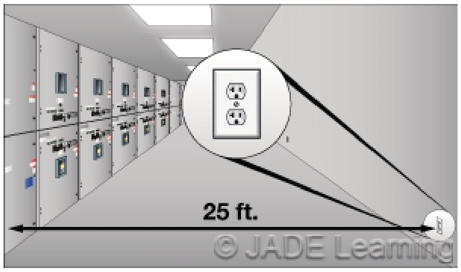
The requirement for a branch circuit to serve only the garage receptacles has been relocated to Section 210.11. In a major Code change, the 20-ampere garage receptacle circuit required in Section 210.11(C)(4) is now permitted to supply outdoor outlets outside the garage.

Question 30: Which one of the following choices would meet the minimum Code for one of the required receptacles installed within a garage?

A: A receptacle on the ceiling for the garage door opener.
B: A receptacle in a storage closet opening directly into the garage.
C: A receptacle for a clothes washer if installed in the garage.
D: A receptacle installed in the vehicle bay 5 ft. above the floor.

Question 31: 210.64 Electrical Service Areas.

Question ID#: 1080.0



A 15- or 20-ampere receptacle outlet is required within 25 ft. of indoor electric service areas.

The 15- or 20-ampere receptacle that was required for electrical service areas in the 2014 NEC is now only required for indoor electrical service equipment. Outdoor electrical service equipment does not require a receptacle outlet to be installed.

The distance from the service equipment to the receptacle outlet has been reduced from 50 ft. to 25 ft. A receptacle within 25 ft. will allow for the more convenient connection of test equipment or temporary load monitoring equipment.

The receptacle must be installed in the same room or area as the service equipment and must be installed in an accessible location. Having the receptacle in the same room eliminates the need to run extension cords through doorways and reduces the possibility of damage to the cord. The receptacle must be accessible, but need not be readily accessible.

A new exception has been added specifically for services rated over 120-volts to ground and dedicated to supplying electrically driven irrigation machines covered by Article 675 or electrical equipment associated with natural and artificially made bodies of water covered by Article 682. For this type of specialized equipment, it is not necessary to install a 120-volt receptacle outlet.

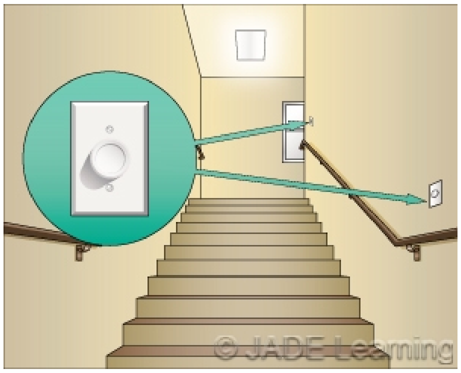
The only other exception is for one and two family dwellings. An electrical service receptacle is not required at one and two family dwellings.

Question 31: Which of the following apply to the electrical service area receptacle?

A: The receptacle must be located no more than 5 ft. above the floor.
B: The receptacle must be GFCI protected.
C: The receptacle must be installed in the same room or area as the service equipment.
D: The receptacle must be installed within 50 ft. of indoor service equipment.

Question 32: 210.70(A)(2) Lighting Outlets Required. Dwelling Units. Additional Locations.

Question ID#: 1081.0



If a dimmer switch is used for interior stairways or exterior entrances, each location where the switch is installed, such as the top and bottom of a stairway, must have the full range of dimming control.

If the lighting outlet in an interior stairway in a dwelling unit is controlled by a dimmer switch, the full range of dimming control must be available at all switch locations.

For interior stairways in dwelling units with six or more risers, the NEC requires a wall switch at each floor and at each landing level that includes an entryway. The intent is for someone entering the stairs to be able to turn on the stairway luminaire(s). This is usually accomplished by the use of three-way switches or a combination of three and four-way switches. Automatic control of stairway lighting is also an option.

The increasing use of dimmer switches to control stairway lighting results in a range of possible illumination levels in stairways. This can create a situation where there is insufficient lighting to safely navigate the stairs. According to the National Safety Council over 20,000 people died from falls at home in 2014. Many of these falls occurred on stairs.

The 2017 NEC requires that when dimmer switches are used to control stairway lighting outlets, the full range of dimming control must be available at each switch location. This will enable anyone entering the stairway at any floor level to fully illuminate the stairs.

For example, a two story house has a stairway with one lighting outlet over the stairs. The lighting outlet is controlled by a three-way switch at the top of the stairs and a second three-way switch at the bottom of the stairs. If a dimmer switch is installed at the bottom of the stairs and set to the lowest lighting level, it is impossible for someone entering the stairway from the second floor to properly illuminate the stairs. There must be a dimmer switch installed at both the first and second floor levels in order to provide the capability to fully illuminate the stairway from either switch location.

Question 32: If dimmer switches are installed to control stairway lighting in a three story dwelling unit with a single stairway and one wall switch at each floor level, how many dimmer switches are required?

A: 1 four-way switch and 2 dimmer switches.
B: 2 three-way switches and 1 dimmer switch.
C: 3 dimmer switches are required.
D: 2 dimmer switches and 2 three-way switches.

Question 33: 210.70(C) Lighting Outlets Required. All Occupancies.

Question ID#: 1082.0

Utility rooms and basements in all occupancies that are used for storage or contain equipment that requires servicing require a switch controlled lighting outlet.

The title of this section has been changed from ***Other Than Dwelling Units*** -to- ***All Occupancies***.

Also, utility rooms and basements have been added to the locations where lighting outlets are now required when the space is used as storage or the space contains equipment (such as HVAC, pumps, etc.) that will require servicing at some point.

Where Outlets are Required

In every occupancy, a minimum of one lighting outlet (meaning a fixture of some sort, such as a pull-chain or keyless fixture) is required for the attic and for underfloor spaces, as well as utility rooms and basements that are used for storage or that contain equipment that requires service. A lighting outlet must be located at or near any piece of equipment or appliance that will require servicing in these spaces as well. If six pieces of equipment are in an attic and they aren't side-by-side, then six lighting outlets would likely be required to illuminate the areas so that technicians could service each piece of equipment. Also, the Code says at least one point of control (one switch) must be located near the usual point of entry into the space. It does not however say that a lighting OUTLET is required at the entry.

Example

If there is more than one piece of equipment in the space, more than one lighting outlet may be required. For example, if a heating unit is located in one corner of a large basement and the water heater is 50 feet away, a lighting outlet is going to be necessary at the heating unit and another lighting outlet is necessary at the water heater.

The lighting outlet(s) must either contain a switch or be controlled by a wall switch.

A Switch Near the Point of Entry

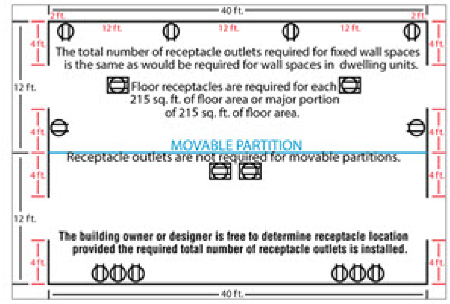
As stated earlier a person entering one of these spaces must be able to turn on the light from a control at or near the entry into the space. A lampholder equipped with a pull chain switch is only acceptable where the switch can be operated from the point of entry and it provides adequate illumination of the equipment to be serviced. Additional lighting controls (switches) at other locations in these spaces are permitted, but not required.

Question 33: A basement under a lawyer's office is 80 ft. in length. It contains a heating unit at one end and a sump pump 60 ft away at the other end. How many lighting outlets are required altogether?

A: 1 lighting outlet.
B: 2 lighting outlets.
C: 3 lighting outlets.
D: No lighting outlets are required.

Question 34: 210.71 Meeting Rooms.

Question ID#: 1083.0



Fixed walls in meeting rooms require the same number of receptacle outlets as would be required by section 210.52(A) for wall spaces in a dwelling unit.

Receptacle outlets are now required in meeting rooms with a floor area of 1000 sq. ft. or less.

Meeting rooms are used for many different purposes and may be temporarily re-configured by movable partitions. Receptacles are often in short supply or located in such a manner as to require the use of extension cords.

This new section in the 2017 NEC provides requirements for receptacle outlets in meeting rooms of not more than 1000 sq. ft. The required receptacle outlets shall be 125-volt, 15- or 20-amp rated receptacles of the non-locking type. Where movable partitions are installed, each room must be evaluated based on the smallest size meeting room created with the partitions in place. Receptacle outlets are not required to serve wall space created by movable partitions.

Fixed walls in meeting rooms require the same number of receptacle outlets as would be required by section 210.52(A) for wall spaces in a dwelling unit. This means that the same receptacle spacing rules used for dwellings will be used to determine the number of receptacle outlets required in a meeting room. In a dwelling unit any fixed wall space 2 ft. or greater in width requires at least one receptacle outlet. Receptacles must be spaced so that no point in any wall space is more than 6 ft. measured horizontally from a receptacle outlet in that wall space.

Floor receptacles will be required in meeting rooms that are 12 ft. or more wide and that have 215 sq. ft. or more of floor area. Each 215 sq. ft. of meeting space or major fraction of 215 sq. ft. must be included when determining the minimum number of floor receptacles required.Â A major fraction of 215 sq. ft. is any area equal to or greater than 107.5 sq. ft. Floor receptacles must be installed at least 6 ft. from any fixed walls.

Once the total number of wall and floor receptacle outlets required is determined the owner or designer has the option to locate the outlets wherever they please. Receptacle outlets in fixed furniture can be included in satisfying the minimum number of receptacle outlets required.

Example 1. Meeting Room (See illustration provided.)

Refer to the drawing.Â A meeting room has an overall dimension of 24 ft. by 40 ft. with a movable partition installed that can divide the room into two 12 ft. X 40 ft. meeting rooms. Door openings create 3 separate wall spaces on each side of the partition. Two wall spaces next to the doors are 4 ft. in length and one wall space is 48 ft. in length. Each wall space 2 ft. or greater requires a receptacle outlet so each of the 4 ft. wall spaces requires an outlet. Receptacles for the 48 ft. wall section must be spaced so that no point along the wall is further than 6 ft. from an outlet. A minimum of 4 receptacle outlets are required to accomplish this. This makes a total of 6 receptacle outlets required for the fixed wall space in each 12 ft. X 40 ft. meeting room.

Floor receptacles are required for meeting rooms that are 12 ft. or greater in width and over 215 sq. ft. There must be at least one floor receptacle for each 215 sq. ft. of floor area or major portion of 215 sq. ft. A 12 ft. X 40 ft. meeting room has a floor area of 480 sq. ft. Two floor receptacle outlets are required. One for each 215 sq. ft. of floor area. The remaining 50 sq. ft. does not require a floor receptacle because it is not a major portion of 215 sq. ft. Two floor receptacles are required for each 12 ft. X 40 ft. space.

Adding the 6 receptacle outlets required for the wall spaces and the 2 floor receptacle outlets brings the total number of receptacle outlets required to 8 outlets for each space. The owner or designer is free to determine receptacle location as long as at least 8 receptacle outlets are installed in each meeting room, and those 8 outlets adhere to the "no point measured horizontally along the floor line of any wall space is more than 6' from a receptacle outlet" rule, in 210.52(A)(1).

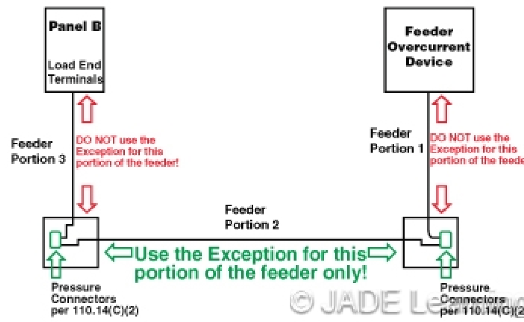
Question 34: Which of the following statements about receptacle outlets in meeting rooms is true?

A: Receptacle outlets are required in movable partitions.
B: Wall receptacles are required only in fixed wall spaces greater than 6 ft. in length.
C: All 120-volt receptacles must be of the locking type.
D: At least 1 floor receptacle is required in a 16 ft. wide X 20 ft. meeting room.

Question 35: 215.2(A)(1)(a) Exception No. 2. Minimum Rating and Size. Feeders Not More Than 600 Volts. General.

Question ID#: 1084.0

Article 215 covers the installation requirements, overcurrent protection, size, and ampacity of conductors for feeders. Section 215.2 specifically addresses minimum rating and size.



Depending on the layout, some sections of a feeder can be reduced in size.

A new exception will allow conductors in a portion of a feeder circuit to be reduced in size under some conditions.

The general rule is that the allowable ampacity of feeder conductors is based on 125% of the continuous load plus the noncontinuous load. This rule is in place because most electrical equipment rated 600 volts or less, such as circuit breakers, are not designed to operate continuously at 100% of their rating.

Including 125% of the continuous load when calculating the feeder ampacity results in a larger size conductor that reduces heating at equipment terminals. Overheated terminals are a common cause of electrical equipment failure, but it is not always necessary to increase conductor size for the entire length of the feeder. If a smaller conductor can be used for a portion of the circuit, the cost savings can be significant.

A new exception has been added to 215.2(A)(1)(a) that allows sizing the conductors for a portion of a feeder based on the noncontinuous load plus 100% (not 125%) of the continuous load. Two conditions must be met in order to use this exception:

- Load and supply end connections for that portion of the feeder must be made with separately installed pressure connectors per 110.14(C)(2).
- No portion of the reduced size feeder conductors can enter an enclosure containing either the feeder supply or load terminations covered by 110.14(C)(1).

For example, in the drawing the allowable ampacity of a feeder, 120 ft. in length, with 100 amps of continuous load at 125% and 75 amps of noncontinuous load is 200 amps. If Type THWN copper conductors are used, the minimum size required is 3/0 AWG per Table 310.15(B)(16).

If junction boxes are installed 10 ft. from each end of the feeder, the exception can be used. The allowable ampacity of this portion of the feeder is 175 amps (100A continuous + 75A noncontinuous). The minimum size THWN copper conductor required for the 100 ft. portion of the feeder between the junction boxes is 2/0 AWG. The 10 ft. of feeder conductor on each end of the feeder from the junction box to the feeder terminations does not qualify for the exception and is still required to be sized at 3/0 AWG.

Question 35: In the diagram provided, what is the allowable ampacity of feeder conductors for PORTION 2 of the feeder (between the junction boxes) when the continuous load is 80 amps and the noncontinuous load is 100 amps?

A: 100 amps.
B: 80 amps.
C: 180 amps.
D: 280 amps.

Question 36: 220.12 Exception No. 2. Lighting Load for Specified Occupancies.

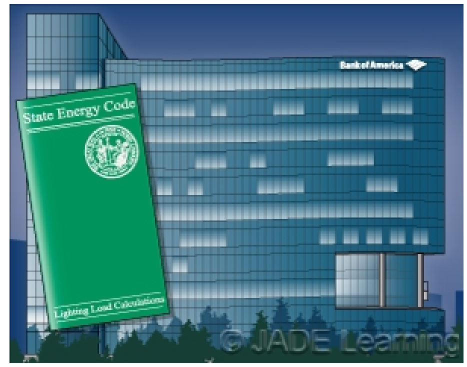
Question ID#: 1085.0

Article 220 includes requirements for calculating branch circuit, service, and feeder loads. This includes general requirements for calculations as well as methods for branch circuit loads, feeders and service loads, and farm loads.

A new Exception No. 2 permits the lighting load for banks and office spaces to be reduced if the entire building complies with specific energy code requirements.

Banks and office buildings have the highest lighting load per sq. ft. of all the occupancies listed in Table 220.12. The 3-1/2 watts (now volt-amperes) per sq. ft. unit load for banks and office areas first appeared in the 1981 NEC.

If the building complies with a legally adopted energy code that specifies an overall lighting density of less than 1.2 volt-amperes (VA) per 1.2 sq. ft. for the entire building, the lighting load for those areas of the building used for banking or office purposes can be reduced from 3 1/2 VA per sq. ft. to 2 1/2 VA per sq. ft.



The lighting load for banks and offices can be reduced if the entire building complies with current energy code requirements.

For example, an energy code mandates an overall lighting density of 0.82 VA per 1.2 sq. ft. for a 100,000 sq. ft. commercial building. The entire building is used for office or banking purposes. The lighting load is a continuous load.

Using the Table value of 3 1/2 VA per sq. ft., the calculated lighting load is:

100,000 sq. ft. X 3.5 VA X 125%(for continuous load) = 437,500 VA.

Exception No. 2 can be used because the overall lighting density specified by the energy code is less than 1.2 VA per sq. ft.

100,000 sq. ft. X 2.5 VA X 125%(for continuous load) = 312,500 VA.

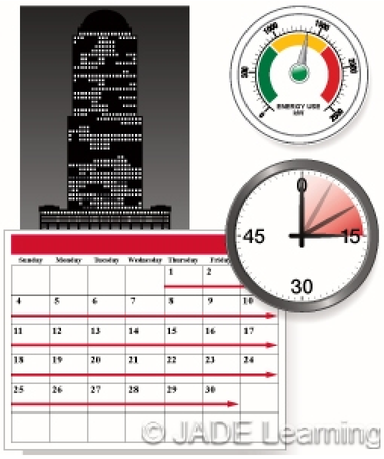
By using the exception for banks and office spaces, the calculated load is reduced by 125,000 VA.

Question 36: A bank occupies 10,000 sq. ft. of a commercial building. The building has an energy code specified overall lighting density of 1 VA per 1.2 sq. ft. The lighting load is a continuous load.
What is the calculated continuous lighting load for the bank space?

A: 10,000 VA.
B: 35,000 VA.
C: 25,000 VA.
D: 31,250 VA.

Question 37: 220.87 Determining Existing Loads.

Question ID#: 1086.0



The maximum demand for an existing building can be determined by taking continuous readings from a power meter or ammeter for 30 days.

The exception that permits calculating existing loads based on the maximum demand over a 30-day period has been revised.

Calculating feeder or service loads for new buildings is a relatively straightforward process. The loads are known and the sq. ft. area of the building is known. After the building is occupied things change. Tenants change, loads are added and equipment is replaced. The code allows existing loads to be calculated using the maximum demand data over a 1-year period, but this is often not available.

The exception to 220.87 provides another alternative. If the demand data is not available for a 1-year period, the calculated load can be based on the maximum demand over a continuously recorded 30-day period measured by a recording ammeter or power meter. The 2017 NEC clarifies that the maximum demand is ***"the highest average kilowatts reached and maintained for a 15-minute interval."***"

To account for seasonal variations in the load, the larger of the heating or cooling loads must be included either by measurement or by calculation. As an additional safety factor the maximum value obtained in this manner is taken at 125% before adding any new loads.

The proposed new load plus 125% of the 30-day maximum demand obtained must not exceed the ampacity rating of the feeder or service.

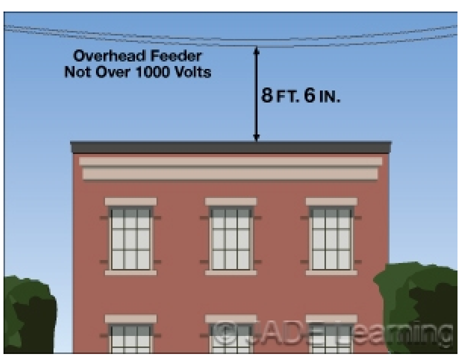
For example, if the maximum demand over the 30-day period for an existing 600-amp feeder is 300 amps, the existing load on the feeder is calculated as 375 amps (300A X 1.25 = 375A). Assuming the feeder conductors are rated for 600 amps there is capacity for 225 amps of new load.

Question 37: If a recording ammeter shows the maximum demand on a 400-amp service for a 30-day period is 160 amps, how many amps of new load can be added to the service?

A: 160 amps.
B: 200 amps.
C: 300 amps.
D: 400 amps.

Question 38: 225.19(A) Clearances from Buildings for Conductors of Not Over 1000 Volts, Nominal. Above Roofs.

Question ID#: 1087.0



The minimum clearance above roofs for conductors up to 1000 volts has been increased.

Article 225 covers requirements for outside branch circuits and feeders - run on or between buildings, structures, or poles, and wiring for the supply of utilization equipment on the outside of buildings, structures, or poles. Section 225.19 addresses clearances from buildings for conductors not over 1000 volts.

The vertical clearance for overhead spans of open conductors above rooftops has been increased from 8 ft. to 8 ft. 6 in.

The 2014 NEC changed the voltage limitation for this section from ***Not over 600 Volts, Nominal*** (2011 NEC) to ***Not over 1000 Volts, Nominal*** (2014 NEC). The increase in vertical clearance in the 2017 NEC is consistent with the higher voltage limitation.

The change also brings the NEC in line with clearances in the National Electrical Safety Code (NESC) used by electric utility companies. Having the same requirement in both codes will promote uniformity in electrical installations whether the overhead conductors are installed by the customer under the NEC or by the utility under the NESC.

The 8 ft. 6 in. vertical clearance must be maintained for a distance of 3 ft. in all directions from the edge of the roof.

Roof surfaces subject to pedestrian or vehicular traffic must meet the more strict clearance requirements of Section 225.18.

The existing exceptions to the overhead clearance rule are unchanged.

For roofs with a slope of not less than 4 in. in 12 in., the 8 ft. 6 in. clearance can be reduced to 3 ft. provided the voltage between conductors does not exceed 300 volts.
A reduction to not less than 18 in. above the overhanging portion of a roof is permitted when the conductors terminate at a through-the-roof raceway, the horizontal distance over the roof overhang does not exceed 4 ft., and the conductors passing over the roof do not exceed 6 ft. in total length. The voltage must also be limited to no more than 300 volts between conductors.

Question 38: What is the minimum clearance of open cable rated 120/240 volts over a flat roof (not an overhang)?

A: 8 ft. 6 in.
B: 8 ft.
C: 3 ft.
D: 18 in.

Question 39: 225.22 Raceways on Exterior Surfaces of Buildings or Other Structures.

Question ID#: 1088.0

Racewaysonthe exterior of buildings must be listed or approved for wet locations.

In Section 225.22, the phrase "***suitable for use in wet locations"*** is replaced with ***"listed or approved for use in wet locations,"*** (2017 NEC). Listed or approved raceways installed on exterior surfaces are still required to be arranged to drain.

Although the word suitable has been used throughout the NEC for many years, it is not defined in Article 100 and is open to interpretation. Definitions for both listed and approved are found in Article 100. If a raceway is listed for use in a wet location, it has been evaluated by a third party testing agency and found to meet the appropriate standards for use in a wet location. A listed product may be labelled to indicate that it is approved for use in a wet location. Labeled is another term defined in Article 100. Not all listed products are evaluated or labeled for use in wet locations.

Rigid metal conduit, rigid non-metallic PVC conduit, and liquidtight flexible nonmetallic conduit are examples of raceways that are listed for use in wet locations. There is no need for the local authority having jurisdiction to evaluate the construction of the listed rigid metal conduit, other than to verify a listing mark or label on the conduit.

Approved is defined in Article 100 as, "Acceptable ***to the authority having jurisdiction."*** In some situations, an off-the-shelf listed raceway solution may not be available. The authority having jurisdiction may approve an unlisted product as an alternative. For example, a local metal working shop may fabricate a sheet metal auxiliary gutter to meet dimensions unique to a specific job site. The shop can construct the auxiliary gutter to meet the construction requirements of Article 366, but it is not a listed product. The authority having jurisdiction then evaluates both the construction of the gutter and the installation of the gutter for compliance with the NEC.

Question 39: Which statement about raceways on the exterior of a building is correct?

A: Only raceways listed for a wet locationÂ are permitted to beÂ approved by the AHJ.
B: Only rigid metal conduit may be used on the exterior surface of a building.
C: The authority having jurisdiction may approve an unlisted raceway.
D: All listed products are approved for use in both wet and dry locations.

Question 40: 225.27 Raceway Seal.

Question ID#: 1089.0

Racewaysenteringabuildingfromoutsidemust be sealed.

All raceways entering a building or structure from outside must now be sealed, not just raceways connected to underground distribution systems.

The 2014 NEC only required raceways entering a building or structure to be sealed when connected to an underground distribution system. Other raceways entering the building or structure were not required to be sealed. This was inconsistent with the requirement in Article 300 that raceways exposed to different temperatures be â€œ***filled with an approved material to prevent the circulation of warm air to a colder section of the raceway,â€•*** (300.7). Preventing the warm air circulation reduces moisture build up in electrical enclosures. Raceways, especially spare raceways, also offer a potential path for mice or other undesirable visitors to enter a building.Â

The raceway seal required is not the same as the explosion-proof seal fitting required for a raceway entering a hazardous (classified) location such as a gasoline dispenser. For installations in ordinary non-hazardous locations the sealant used need only be â€œ***identified for use with cable insulation, conductor insulation, bare conductor, shield, or other components***,â€• (225.27). There is no requirement that the sealant be listed by a third party testing agency. There are numerous products available that are identified by the manufacturer as suitable for sealing around electrical cables and conductors. Having the product literature or product package on site for the AHJ at the time of inspection is always a good idea.

Although raceways entering a building are required to be sealed, a special fitting is not required. The NEC also does not provide a specific location for the raceway seal. A conduit body, such as an LB, or a junction box at the point where the raceway enters the building is often a convenient location for installing the required sealant. There is no requirement to seal both ends of a raceway and doing so could allow water to accumulate in the raceway. Raceways on the exterior of a building are required to be arranged to drain.Â

Question 40: Type THWN conductors installed in trade size 3 in. EMT enter a building from outside. Which of the following statements about the raceway seal is true?

A: An explosion proof seal fitting is required.
B: The sealant materials shall be identified for use with the conductor insulation.
C: A listed swimming pool potting compound must be used.
D: Both ends of the raceway must be sealed.

Question 41: 225.30(A)(7) Number of Supplies. Special Conditions.

Question ID#: 1090.0

Electric vehicle charging systems are permitted to be supplied by more than one branch circuit or feeder when they are listed, labeled, and identified for such.

Outdoor electric vehicle charging systems may now be supplied by more than one branch circuit or feeder if they are "***listed, labeled and identified for more than a single branch circuit or feeder,"*** 225.30(A)(7).

The basic rule in section 225.30 is that where a building or structure is served by a remotely located electrical service, the building or structure shall be supplied by only one branch circuit or feeder. For example, a detached residential garage building may be supplied by a single branch circuit or feeder from a one-family dwelling. Buildings are easy to recognize, but what about structures other than buildings?

The 2014 NEC defined a structure as, ***"That which is built or constructed."*** This led to questions as to whether an electric vehicle charging station installed outdoors was a structure and limited to only a single supply circuit. Charging stations designed for use by more than one vehicle may require or accept multiple supply circuits, but in some cases they were classified by the authority having jurisdiction as structures and limited to a single supply circuit.

The 2017 NEC resolves the issue. Electric vehicle charging systems are specifically permitted to be supplied by more than one branch circuit or feeder when, ***"listed, labeled, and identified for more than a single branch circuit or feeder,"*** 225.30(A)(7).

Also, the definition of structure has also been amended. The 2017 NEC definition for a structure is, "***That which is built or constructed, other than equipment***," (Article 100). An electric vehicle charging system is equipment, not a structure.

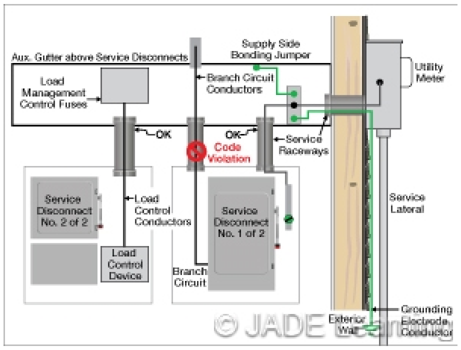
A listed and labeled electric vehicle charging station will be identified by the manufacturer with the number of branch circuits or feeders for which it is designed. A listed and labeled electric vehicle charging system is now permitted to be supplied by the number of branch circuits or feeders identified by the manufacturer.

Question 41: Under what conditions may an electric vehicle charging system be supplied by more than one branch circuit or feeder?

A: Where the electric vehicle charging system is listed, labeled and identified for more than a single branch circuit or feeder.
B: Where the electric vehicle charging system is classified as a structure by the authority having jurisdiction.
C: Where the electric vehicle charging system is identified with a label installed by the electrical contractor.
D: Where an existing electric vehicle charging system is replaced.

Question 42: 230.7 Other Conductors in Raceway or Cable.

Question ID#: 1091.0



Service conductors and conductors that are not service conductors cannot be installed in the same raceway.

Article 230 covers service conductors and equipment. 230.7 addresses other conductors in raceway or cable. The intent of this section has not changed. The wording has been revised to clarify that conductors other than service conductors are not permitted to be installed in the same service raceway or service cable, ***â€œin which the service conductors are installed,â€•*** (2017 NEC). The two exceptions have been re-written as complete sentences.

Service conductors are installed on the line side of the service overcurrent protective device(s) and are not protected against short-circuits or ground-faults by fuses or circuit breakers. If other conductors are installed in the same raceway with the service conductors, the overcurrent devices for these circuits could be bypassed in the event of a fault in one of the service conductors. This could result in extensive damage to the electrical system on the load side of the service equipment.

In Exception No. 1, the 2014 NEC language ***â€œequipment bonding jumpers and conductors,â€•*** has been changed to ***â€œsupply side bonding jumpers and conductors,â€•*** (2017 NEC). Bonding jumpers installed on the line side of the service disconnect are supply side bonding jumpers, not equipment bonding jumpers. Supply side bonding jumpers are sized per Table 250.102(C)(1) and are intended to carry current in the event of a fault on the line side of the service overcurrent device. Supply side bonding jumpers and supply side conductors are permitted to be installed in the same raceway with the service conductors. Grounding electrode conductors are also permitted to be installed in the same service raceway in which the service conductors are installed.

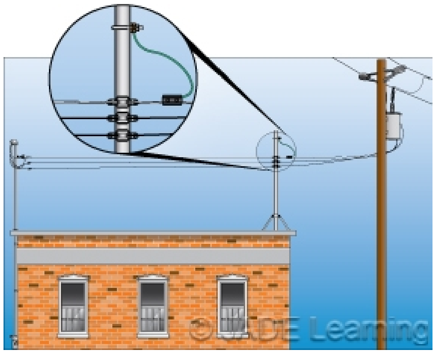
Exception No. 2 permits load management control conductors having overcurrent protection to be installed in the same raceway with the service conductors. These conductors may have to be installed in the service raceway in order to perform their function and pose little threat to other parts of the electrical system in the event of a short-circuit or ground-fault in the service conductors.

Question 42: A one-family dwelling is served by a 200-amp rated overhead service. Which of the following is permitted to be installed in the same raceway in which the service conductors are installed?

A: A No. 4 AWG copper grounding electrode conductor.
B: A No. 4 AWG TYPE SER cable feeding a rooftop heating and air conditioning unit.
C: A No. 6 copper equipment bonding jumper for a sub-panel on the load side of the service disconnect.
D: Type CATV cables for cable television.

Question 43: 230.29 Supports Over Buildings.

Question ID#: 1092.0



Any metal structure that is used to support service conductors of a grounded system must be bonded to the grounded overhead service conductor.

There is a new requirement that any metal structure used to support service conductors for a grounded system over a building shall be bonded to the service grounded conductor. Bonding of metal support structures is not required for ungrounded systems.

For a grounded system, where the substantial structure is metal, it shall be bonded by means of a bonding jumper and listed connector to the grounded overhead service conductor.

The previous edition of the NEC did require that service conductors passing over a building be supported, but it did not address the grounding of that structure if it was metal. The requirement now is that a bonding jumper must be installed between the metal structure and the grounded conductor of the set of service conductors that passes over the building. Bonding the metal support structure is not required for ungrounded systems.

Listed connectors must be used and the bonding jumper must be sized in accordance with Table 250.102(C)(1) for a supply-side bonding jumper.

Question 43: Which of the following support structures must be bonded to the grounded overhead service conductor?

A: All nonconductive support structures must be bonded.
B: Metal support structures for both ungrounded and grounded systems must be bonded.
C: Only metal support structures for ungrounded systems.
D: Only metal support structures for grounded systems.

Question 44: 230.53 Raceways to Drain.

Question ID#: 1093.0

Raceways installed outdoors must be listed or approved for wet locations.

Service raceways containing service entrance conductors and exposed to the weather or embedded in masonry must be installed in a manner that will allow any moisture to drain from the raceway. The raceway itself must also be of a type that is approved for use in wet locations. There are no changes to those two requirements. The change is in how the acceptable type of raceway is described. Where it used to say that the raceway had to be "suitable" for use in wet locations it now says it has to be "listed or approved" for wet locations.

The term "suitable" was somewhat vague and left the door open a little too wide for misinterpretation. There is no confusion by using the term "listed" as it is defined in article 100. However the NEC does not require all equipment to be listed. It does require that some certain types of equipment be listed such as luminaires in 410.6 and type NM cable in 334.6. Other equipment that is not required to be listed only has to be "approved" as required by 110.2.

An auxiliary gutter is allowed as a wiring method for service entrance conductors, per section 230.43. No reference is made about the auxiliary gutter being metallic or non-metallic. Section 366.6(A)(2) requires that nonmetallic auxiliary gutters used outdoors in wet locations be listed. There is no listing requirement given for a metallic auxiliary gutter. Section 366.10(A)(2) requires that metallic auxiliary gutters used in wet locations be "***suitable for such locations***". So a metallic auxiliary gutter could be used outdoors exposed to the weather as long as the AHJ approved it.

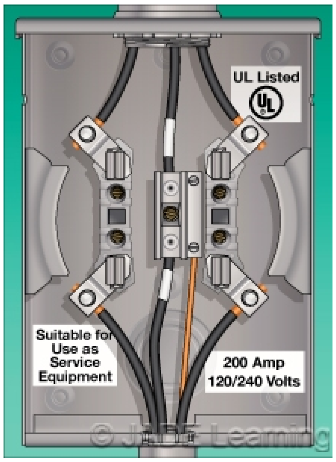
It is now clear that a service raceway installed outdoors must either be "listed" for that purpose or "approved" for that purpose by the AHJ. The installer will no longer need to wonder what "suitable" means.

Question 44: Which of the following statements about a service raceway installed outdoors is true?

A: Only raceways listed for wet locations are permitted.
B: The raceway must be rigid metal conduit.
C: The raceway must be listed for a damp location.
D: The raceway must be listed, or approved by the AHJ, for use in a wet location.

Question 45: 230.66 Marking.

Question ID#: 1094.0



Service equipment must be listed or field labeled and marked to identify it as being suitable for use as service equipment. Meter socket enclosures must be listed and rated for the ampacity and voltage of the system.

There were three changes made in Section 230.66. The main rule of 230.66 is that service equipment must be "***marked to identify it as being suitable for use as service equipment."*** That main requirement has not changed. Equipment that is suitable for use as service equipment means the equipment must be provided with or have the means to install a main bonding jumper.

The previous edition of the NEC required that all service equipment "***be listed."*** The 2017 NEC now allows the service equipment to be "***listed or field labeled***". This will allow non-listed equipment to be evaluated and labeled in the field.

The second change is to require meter socket enclosures to be "***listed and rated for the ampacity and voltage of the service".*** It should be noted that meter socket enclosures are not considered to be service equipment.

The third change was the addition of an exception to the new requirement that meter socket enclosures be listed. The exception states that ***meter sockets supplied by and under the exclusive control of an electric utility*** need not be listed.

Question 45: Which of the following is a requirement for all service equipment?

A: Service equipment must be listed.
B: Service equipment must be listed or field labeled.
C: Service equipment must be field labeled.
D: Service equipment must be labeled by the manufacturer at the factory.

Question 46:   230.82 Equipment Connected to the Supply Side of Service Disconnect.

Question ID#: 1095.0

Solar photovoltaic, fuel cell, energy storage, and wind electric systems can be installed on the supply side of the service.

In general, equipment cannot be connected to the supply side of the service disconnect. The service disconnecting means is intended to disconnect all of the conductors that serve the premises.

Section 230.82 lists the types of equipment that can be connected ahead of the service disconnecting means. Examples are meter sockets, meter disconnect switches, instrument transformers, and load management devices.

In section 230.82(6) of the 2014 NEC, solar photovoltaic systems, fuel cell systems, and interconnected electric power production sources could be connected to the supply side of the service disconnect. In the 2017 NEC, wind electric systems and energy storage systems have been added.

Energy Storage Systems, Article 706, is a new article. An Energy Storage System (ESS) is ***a device or more than one device assembled together capable of storing energy for use at a future time.*** An Energy Storage System includes batteries, flow batteries (similar to fuel cells) capacitors, and kinetic energy devices (e.g. flywheels and compressed air). These systems can have ac or dc output, and can include inverters and converters to change stored energy into electrical energy.

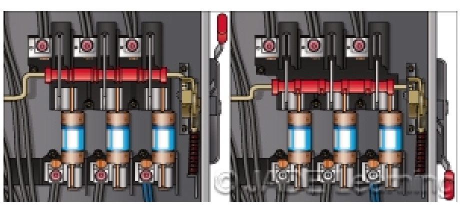
Energy Storage Systems, as well as wind electric systems, can now be connected to the supply side of the service disconnect.

Question 46:   Which of the following systems can be connected to the supply side of the service disconnect?

A: HVAC equipment.
B: Energy storage systems.
C: Feeders that supply premises wiring.
D: Branch circuits that supply a separate building.

Question 47:   230.91 Location.

Question ID#: 1096.0



In the off position the fuses for a service disconnecting means are de-energized.

Section 230.91 of the 2014 NEC required that the service overcurrent device be either "***an integral part of the service disconnecting means***"or "***be located immediately adjacent thereto".*** There was no stated requirement that the service disconnect had to be located on the line side of the fuses. The clarification in the 2017 NEC is that: ***"Where fuses are used as the service overcurrent device, the disconnecting means shall be located ahead of the supply side of the fuses".***

This requirement makes it clear that when the disconnect is in the off position, the fuses will be de-energized before they are removed, and will remain de-energized while they are re-installed, as long as the service disconnect is turned off. Since the service conductors are unfused at their source, this is especially important.
The fuses are not required to be located in the same enclosure as the disconnect. If the fuses and disconnect are in separate enclosures the enclosures must be adjacent to each other and the disconnect must be ahead of the fuses.

Question 47:   Which of the following statements is true?

A: The service fuses may be placed ahead of the service disconnect.
B: The service fuses must be on the line side of the service disconnect.
C: The service disconnect must be located ahead of the service fuses.
D: The service fuses and disconnect must be in the same enclosure.

Question 48: 240.6(A) Standard Ampere Ratings. Fuses and Fixed-Trip Circuit Breakers.

Question ID#: 1097.0

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

Standard Ampere Ratings				
15	20	25	30	35
40	45	50	60	70
80	90	100	110	125
150	175	200	225	250
300	350	400	450	500
600	700	800	1000	1200
1600	2000	2500	3000	4000
5000	6000			

New Table 240.6(A) does not change the standard ratings of fuses and inverse time circuit breakers, but presents them in Table format.

Article 240 covers general requirements for overcurrent protection and overcurrent protective devices. Section 240.6 addresses standard ampere ratings.

A new table was added to section 240.6(A). The information given in section 240.6(A) remains the same but is now given in the form of a table rather than an extremely long sentence. The NFPA is always striving to make the NEC more user friendly and easy to read. This new table is another step in that direction.

There are many sections of the NEC where a calculation results in an ampere rating that is not a standard ampere rating for a fuse or fixed trip circuit breaker. Often times there are exceptions to the main rule that state you may choose the next larger â€œ***standard rating***â€• overcurrent device when your calculation does not result in a standard rating. You would then look up that next â€œ***standard rating***â€• in the new Table 240.6(A).

The lower standard ratings change by small increments. For example the next standard size up from 30 amps is 35 amps. The higher ratings change by larger increments. For example the next size standard size up from 600 amps is 700 amps. Section 240.4(B) generally allows the use of the next standard rating to protect a conductor that has an ampacity between two standard ratings. However, that is only allowed up to 800 amps because the next standard rating up from 800 amps is 1000 amps. You can protect a conductor with an ampacity of 86 amps with a 90 amp fuse but you cannot protect a conductor with an ampacity of 846 amps with a 1000 amp fuse.

Additional standard ampere ratings for fuses are 1, 3, 6, 10, and 601 amperes.

It should be noted that 240.6(A) does allow the use of other ratings of overcurrent devices. There is no violation in using a 55 Amp rated fuse, itâ€™s just not considered a standard rating.

Question 48: Which of the following is a standard ampere rating for a fuse?

A: 275 A.
B: 900 A.
C: 110 A.
D: 65 A.

Question 49: 240.24(A) Location In or On Premises. Accessibility.

Question ID#: 1098.0

A tool can be used to access overcurrent devices located in listed industrial control panels or similar enclosures and the overcurrent devices are still considered readily accessible.

The main change to 240.24(A) is the addition of an exception to the general rule that "***switches containing fuses and circuit breakers shall be readily accessible"***.

The new exception will permit fuses and circuit breakers in listed industrial control panels or similar enclosures to be considered readily accessible, even if a tool is required to open the enclosure.

There are four examples given in section 240.24(A) where fuses or circuit breakers do not need to be readily accessible. If the installation is not included in that list of four, the overcurrent device must be readily accessible.

The 2014 NEC expanded the definition of readily accessible by adding the clarification that if a tool was required to access an overcurrent device then it was not "***readily"*** accessible.

For example, NEC Article 440.14 says that the disconnect for Air Conditioning and Refrigerating Equipment can be "***on or within the air-conditioning or refrigerating equipment."*** Since the disconnect had to be readily accessible, but could be within the equipment and a tool was needed to remove a panel to get to the disconnect, it was unclear whether or not the disconnect was considered readily accessible. The revised definition in the 2014 NEC meant that a disconnect within the equipment was not readily accessible since a tool was needed to access it.

Overcurrent devices are commonly installed in industrial control panels and motor controller enclosures. Often a tool is required to open the door of the enclosure. The revised definition in the 2014 NEC made it clear that these overcurrent devices were not readily accessible. Therefore a new exception was necessary for industrial control panels or similar enclosures.

The new exception is "***Exception: The use of a tool shall be permitted to access overcurrent devices located within listed industrial control panels or similar enclosures."***

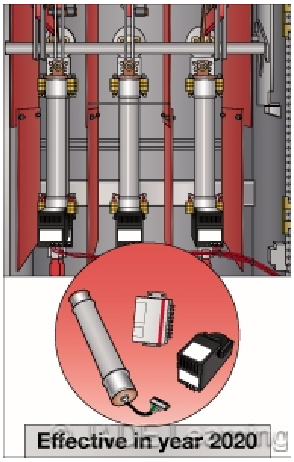
An additional minor change to 240.24(A) is that the phrase "Overcurrent Devices" has been replaced with ***"Switches containing fuses and circuit breakers".***

Question 49: Switches that contain fuses must generally be readily accessible. If a listed industrial motor controller requires a screwdriver to open the enclosure cover, the fuses inside the enclosure are ___________________:

A: permitted by the exception.
B: Not permitted under any condition.
C: to be permanently removed.
D: Not considered accessible.

Question 50: 240.67 Arc Energy Reduction.

Question ID#: 1099.0



By the year 2020 arc energy reduction will be required for fuses with certain characteristics.

A new section, 240.67, about arc energy reduction for fuses has been added to Article 240. NEC Article 240.87 already had requirements for arc energy reduction for circuit breakers, and now there are similar requirements for fuses. Large electrical systems protected by fuses have the potential for extreme arc fault events just the same as those protected by circuit breakers.

Section 240.67 states that arc energy reduction is required if fuses rated 1200 amps or higher have a clearing time of more than .07 seconds. However, this requirement does not become effective until January 1, 2020 to allow time for manufacturers and the electrical industry in general to develop methods and materials to satisfy the requirement.

Just like section 240.87 for circuit breakers, section 240.67 for fuses requires that documentation on the location of these fuses is available to those authorized to design, install, operate, or inspect the installation.

Fuses rated 1200 A, or more must have a clearing time of .07 seconds or less at the available arcing current or some other method of arc energy reduction must be provided. At 60hZ, a time of .07 seconds is slightly more than 4 cycles. If the fuse cannot de-energize the circuit in .07 seconds or less, then four other methods of arc energy reduction are allowed:

(1) Differential relaying

(2) Energy-reducing maintenance switching with local status indicator

(3) Energy-reducing active arc flash mitigation system

(4) An approved equivalent means

There are three informational notes for 240.67

No. 1 explains the function of an ***"Energy-reducing maintenance switch."***

No. 2 gives information about an ***"Energy-reducing active arc flash mitigation system."***

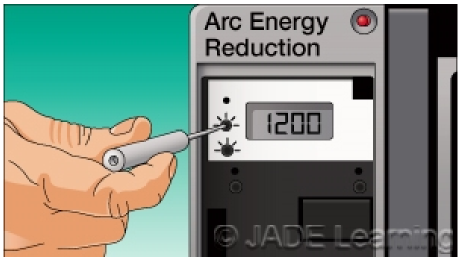
No. 3 references an IEEE standard that shows how to make an arc fault hazard calculation.

Question 50: If the clearing time is more than .07 seconds, which fuse requires some form of Arc Energy Reduction?

A: 1000 amp rated fuse.
B: 1200 amp rated fuse.
C: 1100 amp rated fuse.
D: 800 amp rated fuse.

Question 51:   240.87 Arc Energy Reduction.

Question ID#: 1100.0



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

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

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

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

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

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

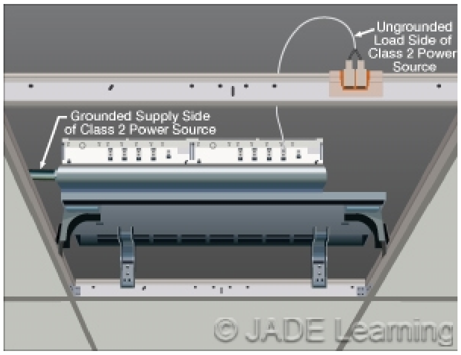
This code change will provide a safer installation by including an instantaneous trip function as a way to reduce arc energy by reducing the amount of time the arc is allowed to continue.

Question 51:   Which of the following requires some form of Arc Energy Reduction?

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

Question 52: 250.22 Circuits Not to Be Grounded.

Question ID#: 1101.0



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

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

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

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

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

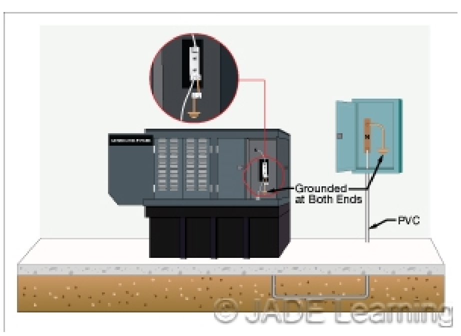
Class 2 load side circuits operate at a maximum of 30 volts ac or 60 volts dc.Â The maximum power output for Class 2 Power Sources is most commonly 100 VA.Â The output values for Class 2 power sources are given in Chapter 9, Tables 11(A) and 11(B).

Question 52: How is a Class 2 power supply for a Low-Voltage Suspended Ceiling Power Distribution System grounded?

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

Question 53: 250.30(A)(1) Ex. No. 2. Grounded Systems. System Bonding Jumper.

Question ID#: 1102.0



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

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

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

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

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

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

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

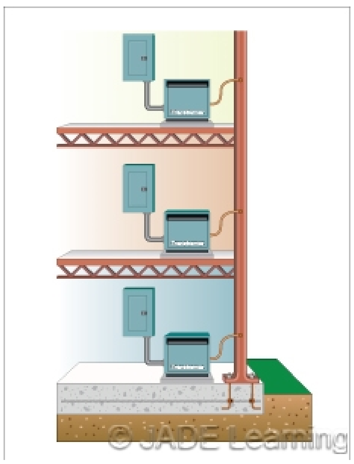
If this exception is used, then the grounded conductor is connected to the enclosure at the source of the separately derived system and at the first disconnecting means.Â A supply side bonding jumper is not installed between the source and the first disconnecting means.Â Fault current returning to the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

Question 53: When can a system bonding jumper be installed at a separately derived system and the first disconnecting means?

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

Question 54: 250.30(A)(4) Grounded Systems. Grounding Electrode.

Question ID#: 1103.0



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

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

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

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

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

Question 54: A transformer is installed as a separately derived system in a building with a 277/480 service. How is the transformer connected to the grounding electrode?

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

Question 55: 250.30(A)(6) Grounded Systems. Grounding Electrode Conductor, Multiple Separately Derived Systems.

Question ID#: 1104.0

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

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

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

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

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

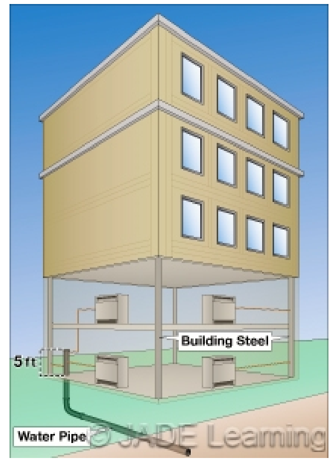
The metal structural frame of a building or structure is permitted to serve as a common grounding electrode conductor for multiple separately derived systems under any of the following conditions:

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

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

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

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



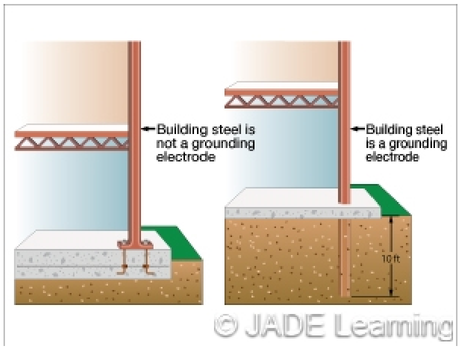
A metal underground water pipe may be used as a grounding electrode conductor if connected within the first 5 ft. of where the water pipe enters the building.

Question 55: Which one of the following can be used as a common grounding electrode conductor for five separately derived systems in a building?

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

Question 56: 250.52(A)(2) Electrodes Permitted for Grounding. Metal In-ground Support Structure(s).

Question ID#: 1105.0



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

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

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

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

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

Question 56: If 50 metal pilings are each driven to a depth of 65 ft. to support a building, how many pilings must be connected to the grounding electrode system?

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

Question 57: 250.52(B)(3) Grounding Electrodes. Not Permitted for Use as Grounding Electrodes.

Question ID#: 1106.0

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

(1) Metal underground gas piping systems.

(2) Aluminum.

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

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

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

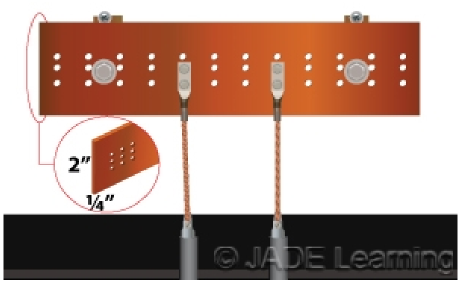
Using the bonding system of a swimming pool or similar structure as part of the grounding electrode system could introduce current from the electrical system into the earth near the swimming pool. In addition, lighting strikes or unintentional contact between high-voltage lines may result in temporary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

Question 57: Which one of the following is permitted to be used as a grounding electrode?

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

Question 58: 250.64 Grounding Electrode Conductor Installation.

Question ID#: 1107.0



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

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

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

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

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

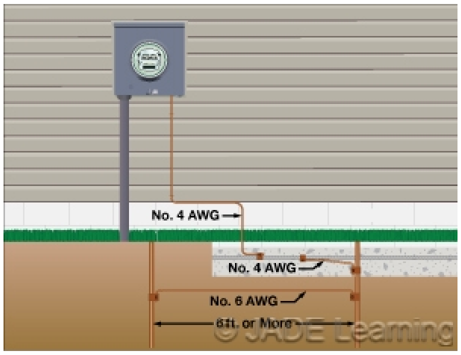
Bonding jumpers from grounding electrodes can be connected to an aluminum or copper busbar if the busbar is at least 1/4 in. thick x 2 in. wide and is long enough to accept the number of terminations necessary to connect all of the bonding jumpers in the installation. ***The busbar requirements mentioned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

Question 58: A No. 6 AWG solid copper grounding electrode conductor from a residential service to a ground rod is exposed to physical damage and run on the building surface. Which one of the following provides acceptable physical protection?

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

Question 59: 250.66 Size of Alternating-Current Grounding Electrode Conductor.

Question ID#: 1108.0



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

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

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

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

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

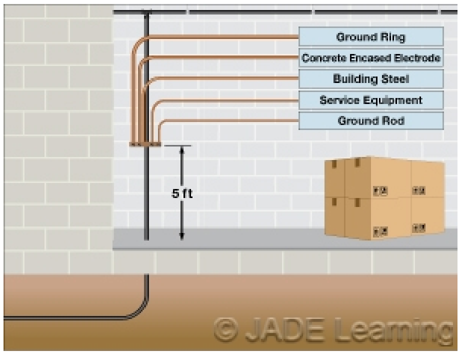
However, if the conductor or conductors making a connection to one of these types of electrodes also extends to another type of electrode that requires a larger size bonding jumper or GEC, then that larger size must be used throughout the conductor, all the way back to the service. In other words, if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

Question 59: In which of these situations, is the connection to a ground rod required to be larger than 6 AWG copper?

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

Question 60: 250.68(C) Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes. Grounding Electrode Conductor Connections.

Question ID#: 1109.0



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

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

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

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

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

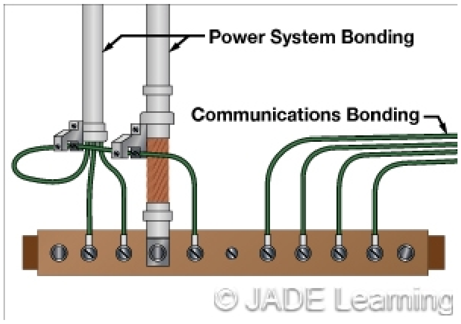
The third part of this section permits the use of a separate section of rebar to extend the connection from the rebar that forms a concrete-encased electrode to an accessible location above grade. A grounding electrode conductor or bonding jumper may be connected to the separate section of rebar at the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

Question 60: A metal building frame connected to concrete-encased rebar by way of an approved hold-down bolt, is considered:

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

Question 61: 250.94 Bonding for Communication Systems.

Question ID#: 1110.0



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

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

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

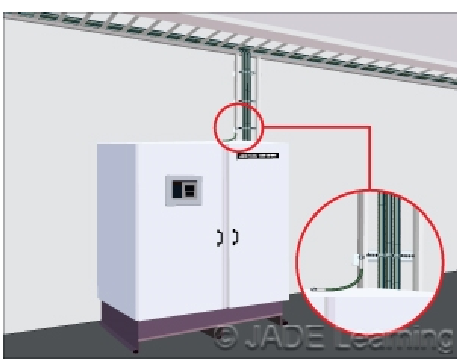
The new exception allows the busbar or intersystem bonding termination at a building to be omitted if communications systems are not likely to be installed at the structure For example, a service to a separate structure that is only used for a sign or a storage building and where there would be no telephone,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

Question 61: Which of the following is a requirement for a busbar used for communications intersystem bonding terminations?

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

Question 62: 250.122(F) Size of Equipment Grounding Conductors. Conductors in Parallel.

Question ID#: 1111.0



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

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

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

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

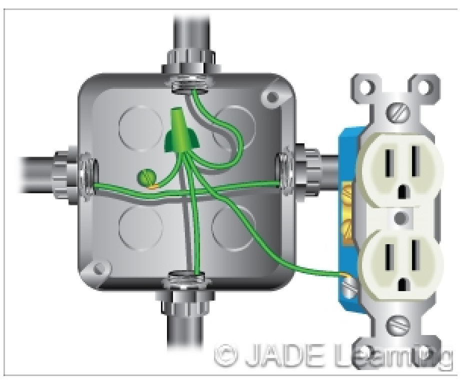
Similar requirements are in place for multiconductor cables as well, meaning the EGC must be sized per T250.122 for multiconductor cables. The difference with multiconductor cables is that the size of the EGC is typically predetermined by the cable manufacturer based on the anticipated rating of an overcurrent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

Question 62: When are the EGCs in multiconductor cables, when installed in parallel and in a single nonmetallic raceway, permitted to be sized smaller than the minimum EGC specified in Table 250.122?

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

Question 63: 250.148 Continuity and Attachment of Equipment Grounding Conductors to Boxes.

Question ID#: 1112.0



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

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

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

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

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

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

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

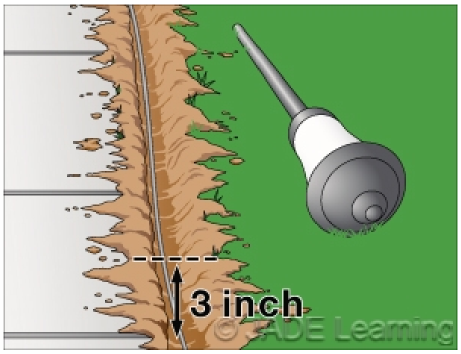
Question 63: Select the one statement that is true regarding a non-metallic box containing three sets of circuit conductors, each one having its own equipment grounding conductor. The ungrounded circuit conductors are all spliced within the box.

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

Chapter 3

Question 64: Table 300.5 Minimum Cover Requirements, 0 to 1000 Volts, Nominal, Burial in Inches.

Question ID#: 1113.0



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

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

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

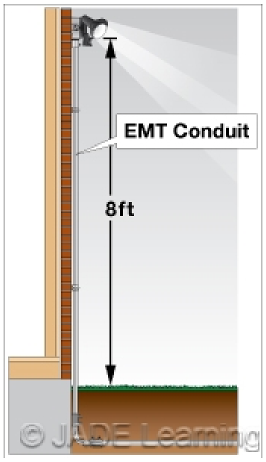
Footnote "b" was added to clarify that the 6 inch minimum cover requirement may also be used for "pool, spa, and fountain lighting installed in a nonmetallic raceway, limited to not more than 30 volts where part of a listed low-voltage lighting system." Since the heading of Column 5 did not state it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

Question 64: Which one of the following would allow for low-voltage lighting circuits to be covered by less than 6 inches?

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

Question 65: 300.5(D)(4) Protection from Damage. Enclosure or Raceway Damage.

Question ID#: 1114.0



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

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

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

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

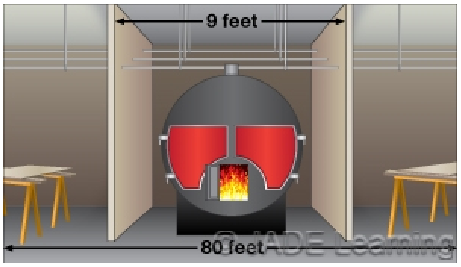
Supplementary corrosion protection may be provided by bitumastic coatings, zinc-rich paints or other approved methods. Special tapes and shrink wraps are also available. The authority having jurisdiction has the final say in the type of supplementary corrosion protection required based on local conditions.Â

Question 65: Type UF cable is installed in EMT on the side of a wooden light pole. How far above grade must the EMT extend?

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

Question 66: 310.15(A)(2) Ex. Ampacities For Conductors Rated 0 - 2000 Volts. Selection of Ampacity.

Question ID#: 1115.0



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

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

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

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

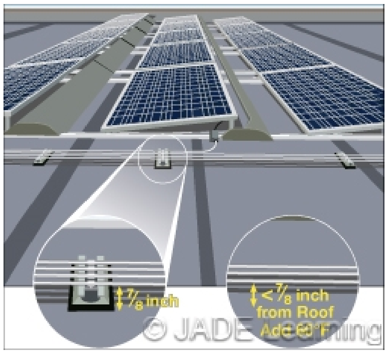
Example: A circuit is 80 feet long. Nine feet of that circuit passes through a higher ambient temperature than the rest of the circuit. The ampacity of all of the circuit conductors would have to be based on that higher ambient temperature. Even though less than 10 feet of the circuit passes through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

Question 66: A conduit run is 75 feet in length. Part of it runs through a higher ambient temperature than the rest of the run. The ampacity of the entire length of conductors would have to be based on the higher ambient temperature, if the portion of the circuit passing through the higher ambient temperature is any greater than ____________ feet in length. (Your math here should be based on 75 feet)

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

Question 67: 310.15(B)(3)(c) Tables. Adjustment Factors. Raceways and Cables Exposed to Sunlight on Rooftops.

Question ID#: 1116.0



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

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

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

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

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

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

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

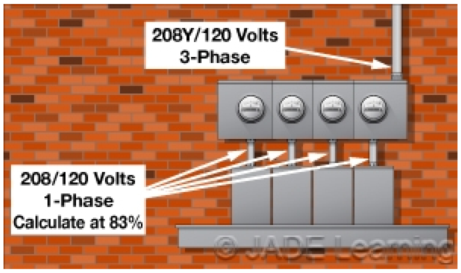
The elimination of Table 310.15(B)(3)(c) results in a much simpler process for determining conductor ampacity in raceways and cables on rooftops. There should be few instances where the 7/8 inch distance from a raceway or cable to the roof surface cannot be maintained.

Question 67: Unless 33'C is added to the ambient temperature for ampacity adjustment, the NEC requires that raceways on rooftops exposed to direct sunlight be raised a minimum of ____ above the rooftop.

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

Question 68: 310.15(B)(7) Tables. Single-Phase Dwelling Services and Feeders.

Question ID#: 1117.0



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

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

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

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

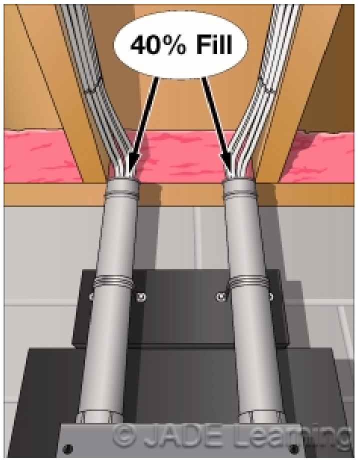
When performing calculations, don't forget NEC 220.5(B) that says it is permissible to round up to the nearest whole number any fraction(s) greater than .5. You can then omit fractions that are less.

Question 68: A 208Y/120-volt three-wire feeder serves an individual apartment unit inside a multi-unit building. The individual apartment unit is equipped with a 100 amp load center and its feeder carries 100% of the load for that individual apartment unit. What is the minimum ampacity rating allowed for the feeder conductors serving that individual apartment?

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

Question 69: 312.5(C) Exception. Cabinets, Cutout Boxes, and Meter Socket Enclosures. Cables.

Question ID#: 1118.0



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

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

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

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

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

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

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

Question 69: When using an 8 foot raceway to protect NM cables coming out of the top of a cabinet, which of the following is true?

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

Question 70: Table 312.6(A) Minimum Wire-Bending Space at Terminals and Minimum Width of Wiring Gutters.

Question ID#: 1119.0

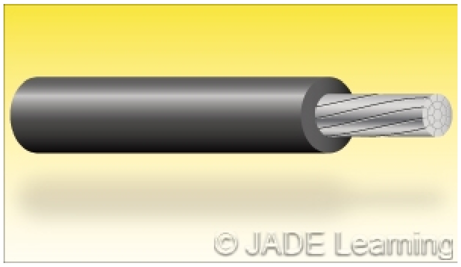


Table 312.6(A) includes wire bending space for compact stranded aluminum conductors.

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

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

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

Example of Table 312.6(A)

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

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

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

New Column in the 2017 NEC

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

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

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

Table 312.6(B)

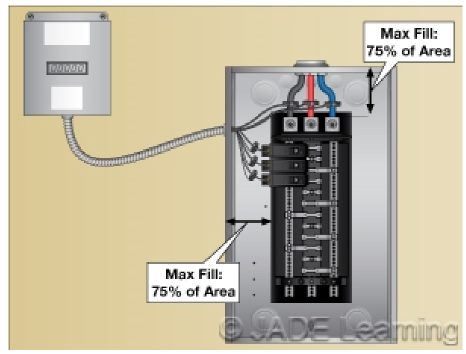
The other Table in 312.6, Table 312.6(B), applies to when the conductor enters/exits the enclosure through a wall that IS opposite the terminal. The 2014 NEC already had a separate column for Compact Stranded AA-8000 Aluminum Alloy Conductors in Table 312.6(B). This change brings Table 312.6(A) into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

Question 70: How much wire-bending space is needed when a 250 kcmil Compact Stranded AA-8000 Aluminum Alloy conductor enters/exits the enclosure through a wall NOT opposite the terminal where the wire terminates? (Note: There is only one wire per terminal).

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

Question 71: 312.8 Switch and Overcurrent Device Enclosures.

Question ID#: 1120.0



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

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

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

NEC Section 312.8(A)

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

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

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

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

NEC Section 312.8(B)

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

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

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

Question 71: Power Monitoring Equipment may be installed inside enclosures meant for switches and overcurrent devices provided the equipment meets which one of the following requirements?

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

Question 72: 314.16(A) Number of Conductors in Outlet, Device, Junction Boxes, and Conduit Bodies. Box Volume Calculations.

Question ID#: 1121.0

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

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

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

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

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

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

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

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

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

Question 72: How much volume must be considered for a metal barrier not marked with its volume?

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

Question 73: 314.17(B) Conductors Entering Boxes, Conduit Bodies, or Fittings. Metal Boxes and Conduit Bodies.

Question ID#: 1122.0

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

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

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

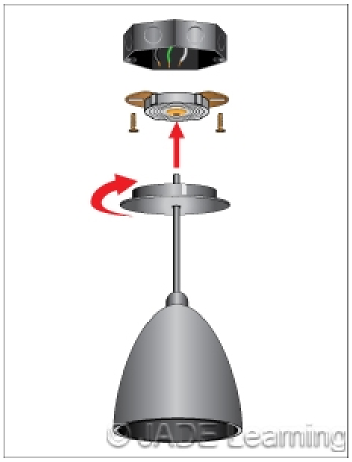
Nonmetallic sheathed cable installed in a nonmetallic box must also be secured to the box as a general rule. There is one exception for single gang nonmetallic boxes that are not larger than 4 inches by 2 1/4 inches. If the cable is securely fastened within 8 inches of the box it is not required to be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

Question 73: How far into the box must the sheath of Nonmetallic Sheathed Cable extend when entering a metal box with cable clamps inside the box?

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

Question 74: 314.27(E) Outlet Boxes. Separable Attachment Fittings.

Question ID#: 1123.0



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

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

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

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

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

Question 74: Which of the following is a requirement for a Separable Attachment Fittings used with a box to support a luminaire?

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

Question 75: 314.28(A)(3) Pull and Junction Boxes and Conduit Bodies. Minimum Size. Smaller Dimensions.

Question ID#: 1124.0

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

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

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

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

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

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

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

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

Question 75: A 3 inch conduit body is marked as being suitable for three 1/0 conductors. Those markings are based on what insulation type?

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

Question 76: 320.6 Armored Cable: Type AC. Listing Requirements.

Question ID#: 1125.0

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

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

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

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

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

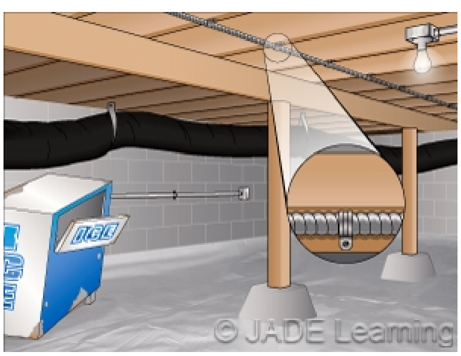
Part of the listing requirements for AC Cable is that the appropriate types of fittings are used with the cable. It is a common code violation to use a fitting suitable for one type of cable with a cable of another type. For example, a cable clamp listed for use with NM cable only should not be used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

Question 76: When must Type AC Cable be listed?

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

Question 77: 330.15 Metal-Clad Cable: Type MC. Exposed Work.

Question ID#: 1126.0



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

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

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

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

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

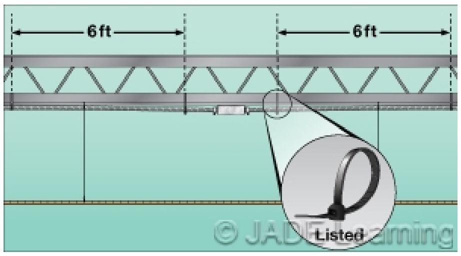
There is no minimum size given for Type MC cable installed on joists, but the cable must be supported at each joist and protected from physical damage. Type MC cable installed in accessible attics or roof spaces must still meet the requirements in 320.23 for Type AC cables.

Question 77:   MC Cable run exposed on the underside of floor joists must be supported:

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

Question 78:   330.30(A) Metal-Clad Cable: Type MC. Securing and Supporting. General.

Question ID#: 1127.0



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

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

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

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

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

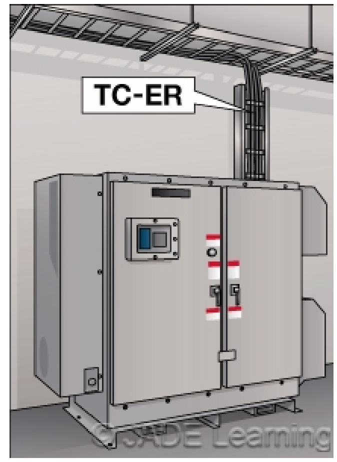
Other methods allowed for securing and supporting MC Cable include staples, straps, hangers, similar fittings, and other approved means. There are a variety of support devices available which are made specifically for the support of cables. Other types of support devices may be used if they are "approved***".***

Question 78:   MC Cable may be supported with cable ties provided the cable ties are:

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

Question 79: 336.10 Power and Control Tray Cable: Type TC. Uses Permitted.

Question ID#: 1128.0



The permitted uses for Type TC cable have been revised.

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

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

Here is a summary of the changes to 336.10:

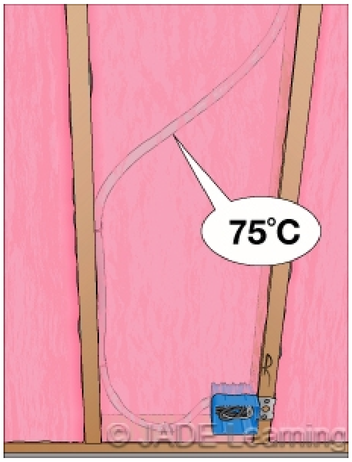
- Type TC cable can be used in cable trays where there is a gap between sections of not more than 1 ft. It is not unusual for there to sections of cable tray separated by short gaps. Type TC cable is permitted to be unsupported where the gap between sections is no more than 1 ft.
- Type TC-ER (ER is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

Question 79: When installing Type TC Tray Cable in cable tray, the cable tray itself may have discontinuous sections up to ______ .

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

Question 80: 338.10(B)(4) Service-Entrance Cable: Types SE and USE. Uses Permitted. Branch Circuits or Feeders. Installation Methods for Branch Circuits and Feeders.

Question ID#: 1129.0



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

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

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

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

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

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

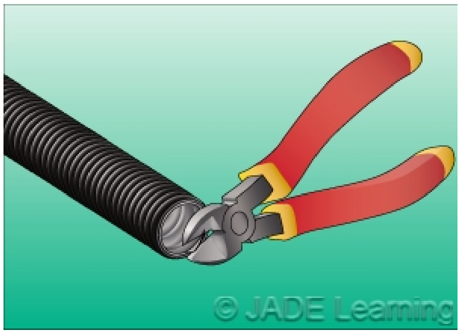
The 60Â° C ampacity limitation for SE cable now only applies to Type SE cable with conductors larger than No. 10 AWG if the equipment terminals are rated 60'C. If the terminals in an existing panelboard or other equipment are not identified with a temperature rating, the rules in 110.14(C) should be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

Question 80: The ampacity of Type SE Cable that is installed in thermal insulation may be based on the 75⁰C temperature rating only if the size of the cable is No. ____ AWG or larger.

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

Question 81: 350.28 Liquidtight Flexible Metal Conduit: Type LFMC. Trimming.

Question ID#: 1130.0



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

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

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

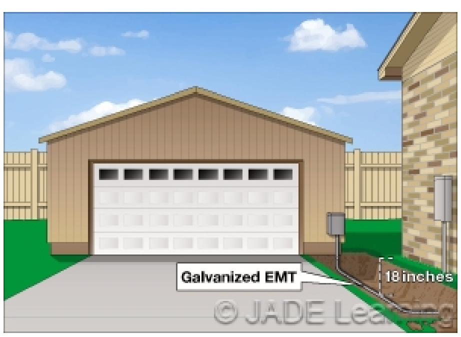
The new trimming requirement also brings the requirements for liquidtight flexible metal conduit in line with requirements for other wiring methods. NEC Article 356 "Liquidtight Flexible Nonmetallic Conduit: Type LFNC," Article 348 "Flexible Metal Conduit: Type FMC," already included the requirement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

Question 81: Why is trimming the edges of liquidtight flexible metal conduit important?

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

Question 82: 358.10 Electrical Metallic Tubing: Type EMT. Uses Permitted.

Question ID#: 1131.0



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

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

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

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

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

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

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

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

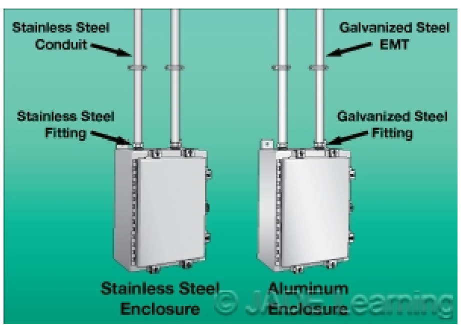
.Many electricians refer to EMT as "conduit," which is technically incorrect. EMT is actually electrical metallic tubing and is addressed as such in several places in the NEC. For example, the title to Table 1 of Chapter 9 is ***Percent of Cross Section of Conduit and Tubing for Conductors and Cables.***

Question 82:   What does EMT installed in corrosive environments need?

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

Question 83:   358.14 Electrical Metallic Tubing: Type EMT. Dissimilar Metals.

Question ID#: 1132.0



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

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

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

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

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

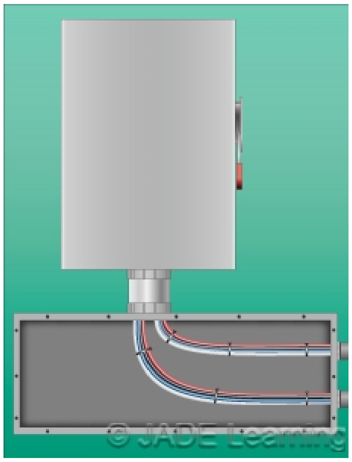
Stainless steel EMT may only be used with Stainless steel fittings and with approved accessories, enclosures, and boxes. That is a new requirement in the 2017 NEC.

Question 83: Dissimilar metals are generally required to be kept apart to avoid which of the following?

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

Question 84: 366.20 Auxiliary Gutters. Conductors Connected in Parallel.

Question ID#: 1133.0



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

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

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

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

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

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

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

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

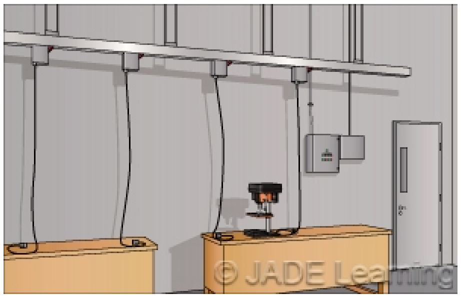
The new requirement in 366.20 for installing conductors in groups consisting of not more than one conductor per phase, neutral, or grounded circuit conductor is in addition to the requirements in 310.10(H).

Question 84: When installing parallel conductors in an auxiliary gutter, which conductors are required to be in each group?

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

Question 85: 368.17(C) Ex. No. 4 Busways. Overcurrent Protection. Feeder or Branch Circuits.

Question ID#: 1134.0



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

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

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

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

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

Question 85: A chain or a rope is NOT required to operate a busway plug-in unit that has overcurrent protection provided that it directly supplies which of the following?

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

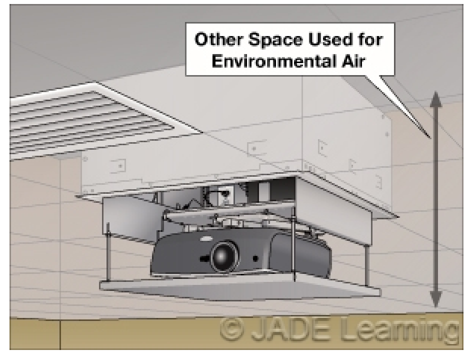
Chapter 4

Question 86: 400.10 & 400.12 Flexible Cords and Cables. Uses Permitted and Uses Not Permitted.

Question ID#: 1135.0

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

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



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

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

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

Question 86: An enclosure is recessed into a dropped ceiling which is used as other space for environmental air. A receptacle outlet is installed in the enclosure and a cord and plug connected projector is plugged into the receptacle. Even though the cord is technically above the dropped ceiling, when is this permitted?

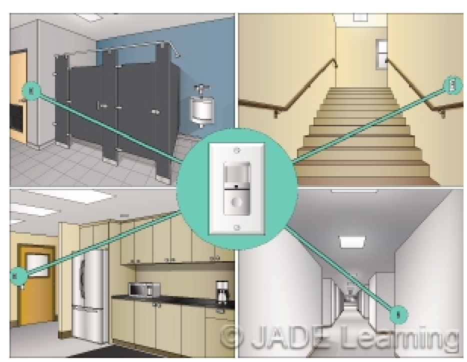
A: If the enclosure is approved for use in "Other Spaces used for Environmental Air".
B: If the cord is listed for hard usage.
C: If the enclosure is firestopped.
D: If the cord is listed for use above a dropped ceiling.

Question 87: 404.2(C) Switch Connections. Switches Controlling Lighting Loads.

Question ID#: 1136.0

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

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



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

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

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

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

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

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

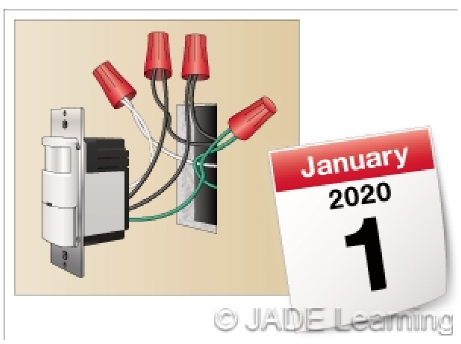
- The connection requirement does not apply until January 1, 2020.
- The connection requirement does not apply to replacement or retrofit switches that were put in before the grounded conductor was required to be installed and where the existing grounded conductor cannot be extended without removing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

Question 87: When is a grounded conductor NOT required at a lighting switch location?

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

Question 88: 404.22 Electronic Lighting Control Switches.

Question ID#: 1137.0



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

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

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

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

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

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

Question 88: As a general rule, electronic lighting control switches may not introduce current on which conductor?

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

Question 89: 406.2 Definitions. Outlet Box Hood.

Question ID#: 1138.0

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

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

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

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

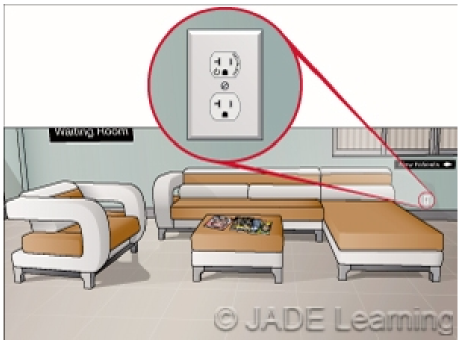
As defined, the hood may be designed to fit over a faceplate, or may be part of an outlet box or faceplate. Many outlet box hoods include a faceplate, but the outlet box hood is intended to protect the enclosed items, not to complete the outlet box enclosure itself.Â

Question 89: Which of the following statements about an outlet box hood is true?

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

Question 90: 406.3(E). Receptacle Rating and Type. Controlled Receptacle Marking.

Question ID#: 1139.0



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

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

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

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

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

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

Question 90: Which of the following statements about a controlled receptacle is true?

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

Question 91: 406.3(F). Receptacle Rating and Type. Receptacle with USB Charger.

Question ID#: 1140.0

Receptacles with built in USB chargers must be listed.

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

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

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

Question 91: Which of the following statements about receptacles with USB chargers is true?

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

Question 92: 406.4(D)(2) General Installation Requirements. Replacements. Non-Grounding-Type Receptacles.

Question ID#: 1141.0

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

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

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

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

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

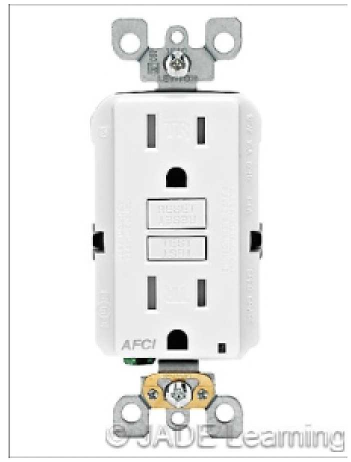
Question 92: A non-grounding type receptacle is replaced by a grounding type receptacle supplied through a GFCI. What is one of the labels that is required?

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

Question 93: 406.4(D)(4) General Installation Requirements. Replacements. AFCI Protection.

Question ID#: 1142.0

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



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

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

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

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

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

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

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

Question 93: Which of the following statements regarding AFCI protection being required for replacement receptacles, is true ?

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

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

Question 94: 406.4(D)(5) General Installation Requirements. Replacements. Tamper-Resistant Receptacles.

Question ID#: 1143.0

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

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

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

Question 94: Assuming a receptacle is in an area where tamper-resistant receptacles are required in the current NEC, which of the following statements about replacing the receptacle with a tamper-resistant receptacle is true?

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

Question 95: 406.5(E), (F), (G), (H) Receptacle Mounting. Receptacles in Countertops, Work Surfaces, Orientation, in Seating Areas.

Question ID#: 1144.0

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

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

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

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

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

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

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

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

Question 95: Which of the following statements about receptacles installed in COUNTERTOPS is true?

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

Question 96: 406.6(D) Receptacle Faceplates. Receptacle Faceplate with Integral Night Light and/or USB Charger.

Question ID#: 1145.0

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

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

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

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

Question 96: Which of the following statements about receptacle faceplates with integral USB chargers is true?

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

Question 97: 406.9(B)(1) Wet Locations. Receptacles of 15 and 20 Amperes in a Wet Location.

Question ID#: 1146.0

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

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

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

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

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

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

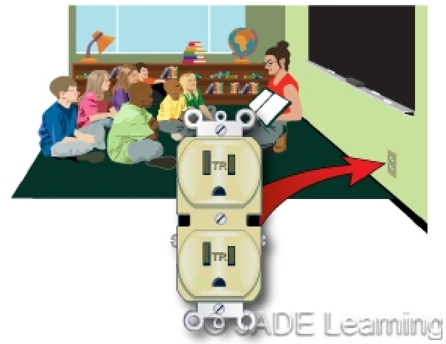
Question 97: Which of the following statements about enclosures that are identified for outdoor use and contain receptacles is true?

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

Question 98:   406.12 Tamper-Resistant Receptacles.

Question ID#: 1147.0

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



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

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

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

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

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

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

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

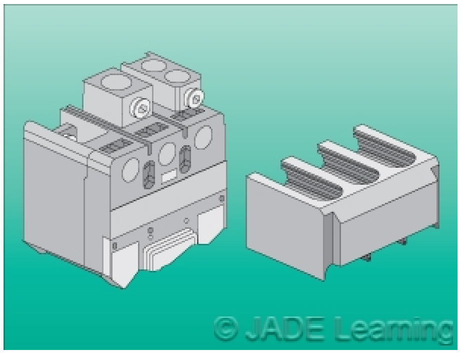
Receptacles are not necessarily required by the NEC in all of the areas in the list. For example, Article 210 requires receptacles in dormitory rooms, but the NEC does not specifically require them in many assembly occupancies. If receptacles are installed in these areas, they must be tamper-resistant.

Question 98: Which of the following statements about locations requiring tamper-resistant 20-ampere 125-volt nonlocking-type receptacles is true?

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

Question 99: 408.3(A)(2) Conductors and Busbars on a Switchboard, Switchgear, or Panelboard. Service Panelboards, Switchboards, and Switchgear.

Question ID#: 1148.0



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

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

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

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

Question 99: Which of the following statements about requirements for barriers in service panelboards is true?

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

Question 100:   408.4(B) Field Identification Required. Source of Supply.

Question ID#: 1149.0

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

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

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

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

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

Question 100:   How is the source of supply for a switchboard, switchgear or a panelboard required to be identified?

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

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

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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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