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# **Wisconsin Contractors Institute**

## **Continuing Education**

**NEC 2011 Significant Changes Part 2**  
**8 Hours**

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**300.5 (C) Underground Cables under Buildings.** The 2011 Code has added two new exceptions that allow type MI and MC Cable to be installed under a building without being installed in a raceway as long as the cables are listed to be installed for direct earth burial. Table 300.5 has added type MI and MC Cable for direct burial, however, there is no minimum burial depth listed. The 2011 code has recognized reasonably that type MI and MC cable installed under a building are protected from physical damage.

**300.5 (I) Ex. No. 1 Underground Installations.** All conductors of the same circuit are required by this code to be installed in the same cable, raceway, or if installed in a trench, they are to be installed in close proximity with each other. This rule also addresses single direct buried conductors used for parallel feeders or other similar conductor configurations. This requirement is to prevent inductive heating and circuit impedance because magnetic fields cancel each other out when conductors of the same circuit are installed close together.

**300.11 (A)(2) Securing and supporting. Non fire rated assemblies.** Non fire rated assemblies are now required to have independent support ceiling wires installed to support boxes, luminaires, and other electrical equipment. These ceiling wires are required to be identified differently from the ceiling support wires and are allowed to be attached to the ceiling grid system. Ceiling support wires can be identified by paint, tagging, or other distinguishable means.

**300.21 Spread of Fire or products of combustion.** This section requires any opening into fire rated walls, partitions, ceilings and floors to be fire stopped. This revision is important to maintain the fire rating of a structure due to the installation of electrical material. All penetrations that require fire stopping must use an approved UL listed assembly for the material being penetrated as well as the electrical system that is penetrating.

**300.22 Wiring in ducts not used for air handling.** This section now allows metal cable trays to be used in plenums or other areas primarily used for air flow. The cable tray system can intern support other metal raceways such as RMC, IMC, EMT, and MC Cable with a metallic covering. Solid bottom, wall, and lid cable trays can house nonmetallic wiring systems in plenums if allowed by this code for use in such areas.

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**1) What is the minimum depth required by this code for MI cable to be run under a building.**

- A) 6 inches
- B) 8 inches
- C) 12 inches
- D) None of the above

**2) Type MC Cable that is listed for direct burial \_\_\_\_\_ be installed under a building.**

- A) Can not
- B) Can
- C) Shall not
- D) Must

**3) Parallel single conductors installed in a trench used to feed a 3 phase 480 volt 400 amp sub panel are required to be installed so the conductors are \_\_\_\_\_ each other.**

- A) Close to
- B) Separated from
- C) Far from
- D) No listed answer

**4) The requirement of 300.5 (I) Ex. No. 1 is to prevent \_\_\_\_\_.**

- A) Hysteresis
- B) Inductive
- C) Eddy currents
- D) Copper loss

**5) Ceiling support wires used to support a 4 11/16 box are required to be identified \_\_\_\_\_ than the ceiling support wires.**

- A) The same
- B) Different
- C) Similarly
- D) All listed answers

**6) An acceptable method for identifying ceiling support wires used to support electrical equipment and material is \_\_\_\_\_.**

- A) Tagging
- B) Tape
- C) Paint
- D) All listed answers

**7) EMT that penetrates a fire rated concrete ceiling assembly must use a fire stopping method that has a \_\_\_\_\_ number and is specific for that type of installation.**

- A) BR
- B) Phone
- C) Code
- D) UL

**8) True or False, Penetrating 2 layers of sheet rock from one dorm room to another does not require any fire stopping around the penetration if using RMC.**

- A) True
- B) False

**9) Section 300.22 allows cable trays to be installed in areas primarily used for \_\_\_\_\_.**

- A) Heat
- B) Air flow
- C) Venting
- D) Moisture

**10) Would it be considered acceptable or a violation of this code to run ENT inside a cable tray system that had solid sides, bottom, and a metal cover that runs through a plenum.**

- A) Acceptable
- B) Violation

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**300.50(B) Requirements for over 600 volts. Underground installations. Wet Locations.** The interiors of raceways and enclosures installed underground are considered wet locations. The 2008 Code stated that this was true for conductors 600 volts or less. The 2011 Code has now recognized this is also true for conductors operating at 600 volts or greater. Any conductor installed in an underground raceway system must have its insulation rated for use in a wet location.

**310 Conductors for general wiring.** The 2011 Code has completely changed and re-organized this article into three (3) parts. Part I covers general requirements, Part II covers conductor installation, Part III covers construction specifications. As part of this re-organization, the tables have all been relabeled from the traditional numbering system that we have grown accustomed to. Table 310.16 is now numbered 310.15(B)(16) and the other familiar tables follow the same numbering. The numbering of the tables start with 310.15(B)(?) and the last number coincides with the old table designator.

**310.10(E) Uses permitted. Shielding.** Section 310.6 has been re-numbered for the 2011 code to 310.10(E). This section has also been revised to allow non-shielded ozone resistant cable with a maximum of 5000 volts phase to phase to be used in industrial establishments under controlled conditions using qualified persons supervising the installation. A new exception No. 2 now permits non-shielded cable up to 5000 volts to be used as a replacement for existing equipment in industrial establishments only.

**310(H)(1) Conductors in parallel.** Section 310.4(A) has been re-numbered for the 2011 code to 310.10(H)(1). This section has been revised to more clearly state that “only in sizes 1/0 and larger” conductors are allowed to be run in parallel. The 2008 code stated “1/0 and larger shall be permitted” to be run in parallel which left some confusion as to whether smaller sizes could also be run in parallel. This revision makes it crystal clear that the smallest size conductors that can be run in parallel are 1/0. Exception No. 2 allows grounded neutral conductors sized 2 AWG and 1 AWG to be run in parallel under engineering supervision for existing installations.

**310.10(H)(6) Uses Permitted. Conductors in parallel. Equipment Bonding Jumpers.** New item (6) of 310.10(H) covers the sizing requirements for bonding jumpers installed with conductors in parallel. This new section references us to use 250.102 for sizing the supply side equipment bonding jumper. This section makes it clear that the supply side bonding jumper needs to be installed with each parallel conductor set and sized using table 250.66 based on the size of the ungrounded supply conductors in the conduit. Additionally, sizing the load side bonding jumper is done using table 250.122 based on the over current protective device of the parallel conductors.

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**11) Which statement is true about raceways installed underground?**

- A) A 2” RMC installed underground is considered to have its interior to be dry and free of moisture.
- B) A 150KVA line installed in 4” Schedule 80 PVC conduit underground is considered a dry location.
- C) All raceways installed underground and encased in concrete are considered a dry location.
- D) The internal area of a raceway installed underground is considered a wet location.

**12) Conductors installed in an underground raceway duct bank system that feed a twenty story office building are required to have their insulation suitable for \_\_\_\_\_ locations.**

- A) Wet
- B) Corrosive
- C) Dry
- D) Damp

**13) Chapter 310 has been re-organized into \_\_\_\_\_ parts.**

- A) 2
- B) 3
- C) 4
- D) 5

**14) The wire tables in chapter 310 have been re-numbered and now begin with \_\_\_\_\_ number designator.**

- A) 310.15(B)
- B) 300.15(B)
- C) 315.10(B)
- D) 310.16

**15) A 2000 HP Medium Voltage motors conductors need to be replaced. The 2011 code allows the use of non-shielded cable so long as the voltage does not exceed \_\_\_\_\_ volts phase to phase.**

- A) 5000
- B) 5250
- C) 6000
- D) 7000

**16) The 2011 code allows feeders that supply MV equipment operating in \_\_\_\_\_ facilities to be replaced with non-shielded cable as long as the installation is supervised by a qualified person.**

- A) Petro chemical
- B) Paper and pulp
- C) Chemical
- D) All listed answer

**17) The article and section in the 2011 code that describe the smallest size conductors that can be run in parallel is \_\_\_\_\_.**

- A) 310.4(A)
- B) 310.10(A)(1)
- C) 310.10(H)(4)
- D) 310.10(H)(1)

**18) Without the use of any exceptions with regards to conductors run in parallel, the smallest size conductor allowed to be run in parallel is \_\_\_\_\_.**

- A) 1 AWG
- B) 2 AWG
- C) 1/0
- D) All listed answers

**19) The 2011 code tells us to use the requirements of section \_\_\_\_\_ for sizing the supply side equipment bonding jumper.**

- A) 250.102
- B) 250.122
- C) 250.66
- D) None of the above

**20) The load side of an over current protective device needs the bonding jumper of the parallel conductors sized using table \_\_\_\_\_.**

- A) 250.102
- B) 250.122
- C) 250.66
- D) 250/102(C)

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**Tables 310.15(B)(2)(a) and 310.15(B)(2)(b).** The 2011 Code has taken the ambient temperature correction factors that were at the bottom of tables 310.16 and 310.18 and created two new tables that just have ambient

temperature correction information listed only. The new table 310.15(B)(2)(a) has the correction factors for 30°C ( 86 F) and table 310.15(B)(2)(b) has 40°C ( 104 F) ambient temperature correction factors listed . Ambient temperature is the temperature of an area where an electrical installation is installed. This information is vital to install the correct conductors based on current demands. The hotter an area is, the lower the current. The colder an area is, the higher the current.

**310.15(B)(3)(a) Adjustment factors for more than Three current carrying Conductors in a Raceway or cable.** The 2011 Code has changed the first column heading to “Number of Conductors” from the previous 2008 version that stated “Number of Current carrying Conductors”. This change accounts for spare conductors that may be pulled into a raceway and may not yet be energized. When extra conductors are installed in a raceway, the conductors that do carry current have a harder time cooling down thus reducing their current carrying capacity. **312.8 Switch and Overcurrent Device Enclosures with Splices, Taps, and Feed Through Conductors.** This section has been revised and clarifies language with regards to conductors that feed through, tap, and splice in a cabinet. Conductors can feed through a cabinet or enclosure so long as the total of the conductors does not exceed 40 percent of the cross sectional area of that space. Splices and taps are also allowed in cabinets and enclosures as long as the splices and taps do not exceed 75 percent of the cross sectional area of the space. Additionally, conductors that feed through an enclosure are required to be identified with a warning label on the enclosure in which they pass that indicates there are feed through conductors present, the conductors are located in this particular panel, and what panel the conductors are fed from. The result of this revision is to warn the qualified individual of the presence of energized conductors in the enclosure.

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**21) The current of a conductor in an area where the ambient temperature was 100°F would be \_\_\_\_\_ than the current of a conductor where the ambient temperature was 140°F.**

- A) Lower
- B) Higher
- C) The same
- D) No listed answer

**22) The new table 310.15(B)(2)(a) has the correction factors for \_\_\_\_\_ °C ( \_\_\_\_\_ F)**

- A) 20, 84
- B) 30, 86
- C) 40, 104
- D) 32, 98.6

**23) The 2011 Code has added \_\_\_\_\_ new tables that are dedicated for ambient temperature correction factors.**

- A) 1
- B) 2
- C) 3
- D) 5

**24) Spare conductors that share a raceway with current carrying conductors can inhibit the current carrying conductors from dissipating \_\_\_\_\_.**

- A) Moisture
- B) Heat
- C) Power
- D) Voltage

**25) Would it be considered acceptable or a violation of this code to not count spare conductors that share the same raceway with energized conductors for deration purposes.**

- A) Acceptable
- B) Violation

**26) A set of conductors that pass through a 100 amp disconnect are allowed by this code as long as they do not exceed \_\_\_\_\_ of the cross sectional area of the enclosure in which they pass through.**

- A) 40%
- B) 45%
- C) 50%
- D) 75%

**27) The 2011 Code allows enclosures to house splices and taps if the splices and taps do not occupy more than \_\_\_\_\_ of the cross section area of the enclosure where the splices and taps are made.**

- A) 75%
- B) 77%
- C) 80%
- D) 85%

**28) If conductors from a panel labeled C1 pass through a different panel labeled C2, panel C2 is required to have a \_\_\_\_\_ posted on its cover that indicates this is happening.**

- A) Diagram
- B) Map
- C) Warning label
- D) All listed answers

**29) What best describes the information required on an enclosures label that has conductors from a different source passing through it?**

- A) Conductors from a different source are located here
- B) Where the conductors are fed from
- C) There are feed through conductors
- D) All listed answers

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**Article 314.16(C)(3) Short Radius Conduit Bodies:** This revision is a relocation rather than a change. This move was to better group all related info concerning installation requirements of, *Short Radius Conduit Bodies*, with its associated outlet, device, pull or junction boxes and conduit bodies. This was accomplished by moving article 314.5 to Part II (Installation) Article 314.16(C)(3). This also does a better job of accomplishing the code books outline format. In the process Article 314.5 was eliminated and all of its requirements were moved to its new location. No technical changes were made. This section describes short radius conduit bodies and capped elbows not to have the ability for splices or taps when conductors 6 AWG and smaller are installed.

**Article 314.21 Repairing Noncombustible Surfaces:** This revision came about to better line up the requirements of 312.4 with 314.21. This change makes it clear that not only must drywall or plaster board be repaired to within 1/8 in of any flush mounted box, but that all *Noncombustible Surfaces* must also be repaired, so that no gap larger than 1/8 in is present.

**Article 314.27(C) Boxes at Ceiling-Suspended (Paddle) Fan Outlets:** This revision came about because it is not uncommon for builders to include an extra conductor for future use as a switched fan conductor. The code now makes it clear that if this extra separately switched conductor is provided, to a ceiling outlet box, then the outlet box must be listed for supporting a ceiling paddle fan.

**Article 314.28(E) Power Distribution Blocks:** While it has always been legal to have power distribution blocks in metal wireways per Art 376, this addition (part “E” of 314.28) makes it possible to also use distribution blocks in larger junction boxes (larger than 100 in.<sup>3</sup>). Keep in mind this addition still includes the same restrictions included in Art 376. There is however one additional item in Art 314.28(E), item “5” which makes it clear that conductors passing through must not cover/obstruct the distribution block terminals, when compared to Art 376.

**Article 328.14 Installation (of Medium Voltage Cable, type MV):** Most electrician/installers know how to install general use conductors, raceways, and cables using best practices. However most electricians don’t realize that MV type cable has its own set of installation requirements, and manufacturer’s recommendations. It was with this in mind that 328.14 has been added. This new article adds “shall” to the requirement of installation by “qualified persons”, which is an unusual requirement for the installation of any wiring type. The definition for “qualified person” should be looked up in Art 100 to have a better understanding of this requirement. An “informational note” has also been added listing IEEE 576, which gives the best recommended practices for splicing, terminating and installing type MV cable in the commercial, industrial world.

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**30) True or False, Capped elbows are the only conduit allowed to splice conductors as long as the conductors are 12 AWG and smaller.**

- A) True
- B) False

**31) Short radius conduit bodies containing conductor’s \_\_\_\_\_, shall not contain any splices, taps or devices.**

- A) 6 AWG and larger
- B) 4 AWG and smaller
- C) Smaller than 2 AWG
- D) 6 AWG or smaller

**32) Any junction box, in a CMU wall, shall not have a gap around its edge larger than \_\_\_\_\_.**

- A) 1/16 in
- B) 1/8 in
- C) 1/4 in
- D) 3/16 in

**33) You have provided a 14/3 NMB to a ceiling box. The red conductor is a spare for future use. The ceiling outlet box must be \_\_\_\_\_.**

- A) A 4/0 deep box.
- B) Acceptable to the AHJ.
- C) Listed as a fan box.
- D) Listed as a heavy-duty ceiling box.

**34) When sizing a junction box to be used with a power distribution block, there are two size considerations. One is to the junction box needs to be larger than 100 in.<sup>3</sup>. The second is...?**

- A) The width of the box must be 6 times the largest raceway entering the box.
  - B) The box must not be smaller than installation instructions of the power block.
  - C) The height of the box must be 8 times the largest raceway.
  - D) The depth of the box must be at least 50% of the width of the box.
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**35) One of the requirements for the installation of type MV cable is ?**

- A) The installer must be a certified electrician.
- B) Must be tested by a third party.
- C) Must be terminated, terminated and tested by a qualified person.
- D) Must be installed and tested by a qualified electrician.

**36) IEEE \_\_\_\_\_ gives the best recommended practices for splicing, terminating and installing type MV cable.**

- A) 576
- B) 567
- C) 400
- D) 536

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**Article 338.10(B)(4) SE Cable-Installation Methods for Branch Circuits and Feeders:** At first glance this seems like no change at all until one notices that Art 334.80 is excluded from SE cable requirements. This change allows SE Cable to be used at its rated at 75° C rather than to be limited to the 60° C rating of NM as before. However there was also a provision added for cables installed in thermal insulated areas. In these areas the maximum conductor temperature rating will be 60° C, but as before any corrections or adjustments are from the maximum temperature rating, with the final ampacity rating not to exceed 60° C column.

**Article 342, 344, 352, 355, 358, .30(C):** In the 2008 NEC we were given permission for not supporting conduits or raceways 18 in. or less where concentric knock-outs were not used, “Article 3XX.30(C)”. The .30(C) article has been removed and replaced with .30(A) in the 2011 NEC and now states that in general all raceways shall be securely fastened *within 3 ft.* of boxes, cabinets, or other fittings. We now see that the exception has been removed and all raceways will be supported.

**Article 348.30(A) & 350.30(A):** These two articles concern Flexible Metal Conduit and Liquidtight Flexible Metal Conduit. The general rule for support is that flex will be supported within 12ins of a junction box, conduit body or conduit termination, and then supported every 4 ½ feet after that. There is however an exception for flexibility after installation(motors, transformers, ect). Exception #2 in the 2008 NEC sounded like it was saying that no support was needed as long as the flex was less than the lengths listed in the exception. It sounds like you could have 4 feet of 1 ½ flex unsupported if this was for flexibility needs. The 2011 NEC has tried to clear up the intent of the exception which is that lengths of unsupported raceways talked about are measured after the last support that you have in place. As was always intended you must support your raceway 12 in after your box or conduit and then the 4 feet of unsupported flex starts.

**Article 348.60 & 350.60:** This is an addition to the article to clarify what most electricians were already doing. In the 2008 NEC we see that an equipment ground was required when the flex was used for flexibility after the installation. This addition clarifies the need for an equipment ground being needed when the flex is used not only for flexibility, but also when flex is used to mitigate vibration, such as motors or transformers. We now have two conditions for an equipment ground needing to be added, flexibility as well as vibration such as motors and transformers.

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**37) You have a #8/3 wg type USE cable with THWN-2 conductors. What is the maximum size OCPD that can be used?**

- A) 55 amps
- B) 65amps
- C) 40 amps
- D) 50 amps

**38) You have installed a 14 in. piece of EMT between two panels, how many supports are needed for the raceway?**

- A) One within 6 in. of each end.
- B) None, it's within 18 in. and is a nipple.
- C) One in the middle of the raceway.
- D) Any of the above.

**39) All raceways are required to be supported within \_\_\_\_\_ of a box.**

- A) 3 ft
- B) 4 ft
- C) 2 ft
- D) 18 inches

**40) You have installed an FS box and 3 feet of ¾ in. LFMC for flexibility, to a motor. What else must you do to have a legal installation?**

- A) Nothing else is needed.
- B) Add a support within 12 in of both the motor and the FS box.
- C) Add a support within 12 in of the FS box only.
- D) None of the above.

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**Article 392.18(H):** Much of article 319 has been rearranged to better align with the rest of the codebook concerning its outline format. This part of the article 392 is however an addition, due to safety concerns. Article 392.18(H) is under installation of cable tray and more specifically cable tray carrying conductors rated over 600 volts. We now have a requirement for marking/labeling of the cable tray as to the hazard of this higher voltage. You must now place a permanent and legible label stating "DANGER-HIGH VOLTAGE-KEEP AWAY". This label must be placed in a visible spot on the cable tray and spaced not more than 10 feet apart.

**Article 404.2(C):** Over the years we have seen an increase in the use of electronic lighting control devices. Due to the fact that these devices need a steady standby current to operate their electronic sensors and maintain their electronic brains even when the lights are off, these devices requires a grounded conductor. Until now that has been accomplished through the use of the ground wire. However if you start adding up all of the added and required lighting control devices now needed you can see that a fairly large current flow can be applied to the ground circuit causing an unsafe condition for people as well as many noise problems for other devices on the same ground. To help eliminate this problem the 2011 code states that all switches controlling lighting loads now need a grounded conductor (neutral) in the switch box. There are two exceptions to needing a neutral at the box. (1) If conduit with room for adding additional wires is used. (2) If using romex and there is access to the stud cavity from above or below on the same floor or the wall is open on one side.

**Article 404.9(B):** In general the code states that you must ground the metal yoke of a switch in one of two ways. You must use either the metal screws of the switch yoke to connect to a metal junction box or mud ring directly, or in the case of a plastic nail box you must connect the metal switch yoke with a grounding pigtail. However with the advent of new plastic switch assemblies that include screw less trim plates the code has created two new exceptions. Exception #1: If you are replacing a switch in an existing non-grounded system, and you use a non-metallic switch plate with plastic screws, or you use a GFI protected circuit, you don't need a ground. Exception #2: If you use one of the new plastic switch systems(Plastic yoke, switch housing, switch plate) that only allow their proprietary switch plates and don't allow for the attachment of metal switch plates you don't need to ground the switch. Keep in mind that Exception #2 doesn't mean you don't need an available ground system, just that you don't need to ground the switch.

**Article 406.4(D)(4):** The NEC introduced us to AFCI circuit protection in many areas of the home to prevent electrical fires. Up to this point the requirements have been for new construction, however the code committee has wisely agreed, that it is our older homes that are of a greater concern. As such the code has taken a proactive stance and now requires AFCI protection, for replacement of outlets, anywhere that AFCI protection is normally required according to the code, for branch circuits. This article does not mean you need to replace all of your existing outlets, only that if an outlet is replaced it must be brought up to the new code requirements. To accomplish this goal the code allows three methods, #1) You can replace the outlet with an AFCI type receptacle. #2) You can replace the receptacle with a standard receptacle that is protected by an upstream AFCI receptacle. Or #3) You can replace the receptacle with a standard receptacle of a circuit protected by an AFCI breaker.

**406.4(D)(5)&(6):** Here we have one of the few times the code requires you to update equipment to the most current code requirements, when the equipment is being replaced. These additions to the code are part of a new list concerning receptacle replacements. Part (D)(5) states that when receptacle are replaced in areas that the code now requires to be tamper-resistant, the new replacement receptacle must be of the tamper-resistant type. Part (D)(6) similarly states that when receptacle are replaced in areas that the code now requires to be weather-resistant, the new replacement receptacle must be of the weather-resistant type.

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**41) You are installing open bottom cable tray containing 5KV feeder cables, 20 feet in the air of a factory. You need to order labels for the cable tray and install them. What should the labels say and how often are they needed?**

- A) "WARNING 5000 VOLTS", every 20 feet.
- B) "DANGER KEEP AWAY", every 10 feet.
- C) Don't need warning labels its over 8 feet above the floor and in an Industrial setting.
- D) "DANGER-HIGH VOLTAGE-KEEP AWAY", every 10 feet.

**42) You are installing a dead-end three way switch in a house. The installation is in a finished basement, on an exterior wall, with sheetrock ceilings. How many wires minimum will you need in the switch box, not counting ground wires?**

- A) Two wires
- B) Four wires
- C) Three wires
- D) Five wires

**43) You are installing switches and their plates but you don't want to have to ground the switch. Which system is acceptable to the NEC for not grounding of the switch?**

- A) Plastic box, standard switch, grounded romex, plastic switch cover, plastic screws.
- B) Metal junction box, plastic yoke switch, stainless steel switch plate, plastic screws.
- C) Metal junction box, plastic switch, plastic yoke, snap-on proprietary plastic switch plate.
- D) None of the above.

**44) Which of the following methods for replacing a grounded receptacle, for example in the living room an existing home, is acceptable?**

- A) Replace the receptacle with a like and kind receptacle.
- B) Replace the receptacle with a GFCI receptacle.
- C) Replace the receptacle with an AFCI receptacle.
- D) Doesn't matter what type of receptacle you use.

**45) If you need to replace a grounded type receptacle in a bedroom of your residence, you must replace it with a \_\_\_\_\_ type receptacle.**

- A) Equivalent grounded
  - B) 15 amp, 125 volt rated, standard
  - C) Tamper-resistant
  - D) GFCI
- 

**406.12 (Exc.):** In article 406.12 we are told that the general rule for all non-locking, 125 volt, 15-20 amp receptacles are to be tamper-resistant. However the 2011 NEC has added four exceptions to relax this requirement for tamper-resistant receptacles. All of these exceptions are for areas that are not seen as high probability areas for children to come in contact with receptacles. Exc. #1: Receptacles out of reach of children by being more than 5 ½ ft. above finished floor. Exc. #2: Receptacles that are part of a factory light fixture or appliance. These are typically located higher up above little ones reach. Exc. #3: This one is for dedicated outlets, like the fridge or an appliance bar area. And #4: For original non-grounded receptacles in use or being replaced.

**406.14:** In the 2008 NEC the need to protect young children from shocks or burns was accomplished with the addition of tamper-resistant outlets in the home, for all 15 and 20 receptacles. The 2011 addition of the code now recognizes that in today's world our children spend much of their time at a daycare (Child care facility). The 2011 NEC has added the tamper-resistant requirement to daycare 15 and 20 amp receptacles, to address this concern. Also to prevent any confusion as to what a daycare (Child care facility) is the NEC has added a new definition for "Child care facility", 406.2.

**408.3(F):** Due to safety concerns the NEC has been adding or changing the way we label Panelboards and Switchboards with warnings or information. One of these changes is with the Identification of Switchboards and Panelboards as to voltages and their configurations. The 2011 NEC has changed the title of 408.3(F) to "Identification" and included under that heading the 2008 NEC requirement for "High-leg Identification" 408.3(F)(1). The 2011 NEC has also added under Identification, part 408.3(F)(2) "Ungrounded Systems" and their new Identification requirements, "*Caution: Ungrounded System Operating at 480 Volts Between Conductors*". Both of these requirements should help to better inform Electricians of what to expect before opening a panel or switchboard.

**408.4(B): Field Identification;** of Panelboards and Switchboards. The NEC has renamed section 404.4 so that they could combine the Labeling of Individual Breakers (404.4(A)) with this new subsection 404.4(B). Many Engineers and Spec-books for projects have, required Panelboards and Switchboards to be Labeled as to where the panelboards feed originates from. Now the NEC spells out this required labeling for all Panelboards and Switchboards, other than residential. This has been a safety problem as well as a maintenance issue. Now rather than the electrician becoming frustrated with finding a way to de-energize the panel and therefore working on the panel hot, we now have an easy way to locate the panelboard and de-energize it before working on it.

**409.110(3): Marking/Labeling;** In order to properly install and maintain equipment we as electricians need to have a lot of pertinent information. One of the things we need to know in order to safely work on Industrial Control Panels is if a panel has more than one source of power. It is required by many safety standards that all power supplies are turned off. Here the NEC has tried to make that easier for the service electrician by requiring this addition to the list of information that already exists for Industrial Control Panels. You now must include in the labeling, previously required, a warning that there is more than one power supply to the equipment.

**46) Which one of the following residential receptacles are not required to be tamper-resistant per the NEC?**

- A) The unfinished basement receptacle.
- B) The overhead garage door receptacle.
- C) The bathroom GFI receptacle.
- D) The hallway receptacle.

**47) When am I allowed to use standard (non-tamper-resistant) receptacles in a daycare facility?**

- A) If my receptacles are GFI protected.
- B) If my receptacles are in the hallway.
- C) If there is to be a supervisory person present with the children all the time.
- D) None of the above

**48) You have installed a 3phase 480volt Panelboard and now you are ordering a phenolic Plate for it. The Labeling should read?**

- A) Danger High Voltage .
- B) Warning: Ungrounded 480 volt Panel
- C) Caution: Ungrounded System Operating at 480 Volts Between Conductors
- D) You only need the panel number. Ex. Panel "A".

**49) What type of Field Labeling is required for a new panel that is installed in a factory?**

- A) You only need to Identify the name of the panel, example: Emergency Panel.
- B) You only need to create a panel schedule of the individual breakers for the inside door of the Panel.
- C) You need to Identify where the panel is feed from and create a panel schedule for the individual breakers.
- D) You are not required to label/Identify the panel or switchboard unless the engineer requires it.

**50) Which of the following is not one of the required Informational Markings?**

- A) Manufacturer's name and trademark.
- B) Date of Manufacture of the equipment.
- C) Panel is supplied by more than one power source.
- D) Electrical wiring diagram.

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**410.64: Luminaires used as a Raceway;** The 2008 NEC was a little confusing as to whether you could use end to end fixtures for a raceway. To clear this up and to better put 410.64 into a correct outline format the 2011 NEC has combined 410.64 and 64 into one article. The 2011 NEC now has 410.64 subsections (A)(B)(C) which allows three conditions for fixtures to be used as a raceway. Hopefully this will clarify when and how we can use fixtures as raceways.

**410.130(G): Discharge Lighting Disconnecting Means;** The 2008 NEC made it clear that all Fluorescent lighting fixtures, needed a disconnecting means for their ballasts, with new installations. However here is another instance of the NEC requiring an existing circuit/equipment to be brought up to new code standards. The update in this case is that when an existing ballast is changed it must have a disconnecting means added, as if it was a new luminaire installation. There are however some limitations, such as this applies to indoor use only, and other than dwellings use. Also as in other instances the updating of the circuit only takes place upon replacement of the ballast. Also notice all Exceptions all still in place for this article.

**424.44(G): GFCI Protection;** In the past the requirements for GFI protection of Heating cables was reserved for cables imbedded in bathrooms and hydromassage areas only. This requirement is do, of course, to these areas be wet much of the time and therefore able to conduct electricity very easily. The code making committee agrees that the *Kitchen Area* is also very susceptible to water and liquids which conduct electric and shocks

making it a shock hazard. The 2011 code book now includes kitchens along with bathrooms and hydromassage, concrete poured floors with heat tape requiring GFCI protection.

**430.6(D): Valve Actuator Motor Assembles;** Article 430.6 of the NEC gives us all of the rules for sizing conductors and equipment. In the past many have considered the “VAM” to be a torque motor which is an incorrect assumption. This new subsection makes it clear as to how you are to size the branch circuit conductors, the OCPD’s and the actuator assembles for the “VAM’s”. This subsection makes it clear that the amperage to be used for this sizing is the name plate value on the Valve Actuator Assemble.

**450.14 Disconnecting Means (Transformer):** This is a new safety driven article that was added to the 2011 NEC. In the 2008 NEC Art 240.21(B)(3) “Taps supplying a Transformer”, a disconnect was not required for each tapped transformer, so long as the other requirements of the article were met. This can be a source of unsafe maintenance, do to not being able to isolate individual transformers from the feeder as a whole. By adding a disconnect, as is required in the 2011 NEC for each transformer, you create a safer maintenance environment by being able to isolate individual transformers. This new requirement can be accomplished with either a disconnect in sight of the transformer or a Lockable disconnect if not insight of the transformer. If the disconnect is not in sight of the transformer then you are required to label the transformer as to the local of the disconnect.

**514.11(A) Circuit Disconnect (Motor Fuel Dispensing Station):** In the 2008 NEC it seems as if the only circuits that need to be disconnected are the power circuits. The 2011 NEC has cleared up exactly what types of circuits are to be disconnected. “All power, communications, data, and video circuits” that pertain to the fuel dispensing station. Also note that as always all conductors are to be broken, simultaneously with approved (factory tie bars only) and readily accessible devices, from their respective sources. This addition is due to the addition of so many electronic devices now being used to control and monitor the newer dispensing systems.

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**51) You have a row of end to end connected fluorescent strip lights. The fixtures are listed for use as a raceway but are not listed for through-wiring. You are running a circuit through the fixtures to feed a sign outlet on the end of the fixture run. This circuit is \_\_\_\_\_.**

- A) Acceptable
- B) Not Acceptable

**52) You are retro fitting two by four fluorescent t-bar fixtures in a clothing store. What does the NEC require you to add to bring the fixture up to current NEC standards?**

- A) New T5 tomb stone sockets
- B) New wire connectors
- C) Replacing the Ballast is all that’s needed
- D) Add a disconnect for the ballast

**53) Which room with concrete imbedded heat tape does not need GFCI protection?**

- A) Bathroom
- B) Bedroom
- C) Hydro massage area
- D) Kitchen

**54) You need to know the ampacity to be used for sizing the branch circuit to a “VAM”. You are to use - \_\_\_\_\_ for the ampacity rating of the (VAM).**

- A) The Full Load Ampacity Tables from art 430.250
- B) The Name plate FLA rating on the “VAM”
- C) The Locked rotor current rating as if it is a Torque motor
- D) None of the above

**55) A disconnect for a transformer supply must be \_\_\_\_\_.**

- A) Within sight of the transformer.
- B) If not within sight of the transformer then it must be lockable.
- C) Transformer must be labeled with the disconnect location if not within sight of.
- D) All of the above
- E) None of the above

**56) You are installing a new gas dispensing island at a grocery store. Which systems need safety disconnects at their source?**

- A) Only non-power limited circuits.
  - B) All circuits except the intercom wiring.
  - C) All circuits leading to, including data, intercom, power, video.
  - D) None of the above.
- 

**800.48 Unlisted Cables Entering Buildings.** Outside unlisted plant communications cables are allowed to be installed in building spaces other than risers, and other spaces used for environmental air, as long as the length of the cable inside the building, and measured from its point of entrance does not exceed 50 feet and the cable enters the building from the outside and is terminated in a listed enclosure or, primary protector.

**830.44 Overhead Aerial Cables.** If network-powered broadband communications cables are to be run in parallel with power conductors, and are supported by the same pole, they are required to meet the following provisions: The Broadband Cable is required to be installed below any power conductors, the broadband cable cannot attach to the cross arm that is supporting the power conductors, separation shall be maintained as described in 225.14(D), and the broadband cables are required to be kept away from all power, Class 1, and fire alarm conductors as to avoid any contact.

**830 Network-Powered Broadband Communications Systems.** Informational note: The term Grounding conductor has been changed for this code cycle as pertaining to article 830 to Bonding Jumper, or Equipment Grounding Conductor (EGC) to clarify its function and application.

**820 Community Antenna Television and Radio Distribution Systems.** Informational note: The term Grounding conductor has been changed for this code cycle as pertaining to article 820 to Bonding Jumper, or Equipment Grounding Conductor (EGC) to clarify its function and application.

**820.154 Application of Listed CATV.** Table 820.154(a) lists the permitted and non-permitted use of listed coaxial cables. The permitted applications for coaxial cable are subject to the installation requirements of 820.113.

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**57) What is the maximum footage allowed for unlisted outside communications cable that enter a building and terminate in a listed communications box?**

- A) 50
- B) 55
- C) 60
- D) 75

**58) Would it be considered acceptable or a violation of this code to attach network-powered broadband cable to the same messenger wire that support phase conductors.**

- A) Acceptable
- B) Violation

**59) Network-powered broadband cable is required by this code to be installed \_\_\_\_\_ any power cables.**

- A) Above
- B) Directly
- C) Below
- D) All Listed answers

**60) Network-powered broadband cable installed below a set of phase conductors that supply a 240 volt light are required to be \_\_\_\_\_ away from the phase conductors.**

- A) 22 inches
- B) 20 inches
- C) 18 inches
- D) 24 inches

**61) Article 830 has changed the term \_\_\_\_\_ to specify its function.**

- A) Bond
- B) Bonding Jumper
- C) Electrode
- D) Grounding Conductor

**62) The language changing bonding jumper and equipment grounding conductor from grounding conductor is discussed in the first informational note of article \_\_\_\_\_.**

- A) 800
- B) 840
- C) 830
- D) 790

**63) The language changing bonding jumper and equipment grounding conductor from grounding conductor is discussed in the first informational note of article \_\_\_\_\_.**

- A) 800
- B) 820
- C) 840
- D) 790

**64) To determine if a listed coaxial cable can be installed in a non-concealed space, table \_\_\_\_\_ must be used.**

- A) 820.154(a)
- B) 800.5
- C) 770.34(b)
- D) No listed answer

**65) If you were to install a listed coaxial cable in a fabricated duct for environmental air, section \_\_\_\_\_ shall be used.**

- A) 820.115
- B) 820.154(a)
- C) 820.56
- D) 820.113

**820.110 Raceways for coaxial Cables (A)(1)(2).** Coaxial cables are permitted to be run in any raceway system as described in 820.110 (A)(1) or (A)(2). Coaxial cable is permitted in any raceway listed in Chapter 3 of this code, (Chapter 3 contains information with regards to raceway system installations). The raceway systems listed in Chapter 3 that contains coaxial cable must be installed as per the requirements of Chapter 3 and the individual raceway system. Coaxial cable is allowed to be run in a plenum communications raceway, a listed general purpose communications raceway, and a listed riser communication raceway. The raceway fill requirements of Chapter 3 and 9 do not apply to coaxial cable.

**Part IV Grounding Methods: 820.100 exception.** This now allows the shield of a coaxial cable to ground directly to an equipment grounding conductor of a grounded receptacle provided a dedicated grounding conductor is installed and connected to a listed device. A plug and Cord installation is not allowed to make this connection. The coaxial cable needs to be isolated from any existing cables and their raceways to allow the use of this exception.

**810 Radio and Television Equipment.** Informational note: The term Grounding conductor has been changed for this code cycle as pertaining to article 810 to Bonding Jumper, or Equipment Grounding Conductor (EGC) to clarify its function and application.

**800.154 Application of Listed Communications Wires, Cables and Raceways .** Table 800.154(a) lists the permitted and non-permitted use of listed Communications Wires, Cables, and Raceways. The permitted applications for these systems are subject to the installation requirements of 800.110 and 800.113.

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**66) Coaxial cable is permitted in any listed raceway system as allowed by Chapter \_\_\_\_\_ of this code.**

- A) 1
- B) 2
- C) 3
- D) 6

**67) True or False, raceway systems that contain coaxial cables are not required to be installed by the requirements of Chapter 3.**

- A) True
- B) False

**68) Would it be considered acceptable or a violation of this code to run coaxial cable in a raceway through a plenum that houses CAT 6 communications cable.**

- A) Acceptable
- B) Violation

**69) 820.100 informational note describes the possibility of attaching the \_\_\_\_\_ of a coaxial cable to an equipment grounding conductor under certain conditions.**

- A) Jacket
- B) Covering
- C) Shield
- D) Signal Conductor

**70) Connecting the shield of a coaxial cable directly to the Equipment Grounding Conductor of a grounded receptacle is acceptable provided the EGC is \_\_\_\_\_.**

- A) Dedicated
- B) Sufficient
- C) Bare
- D) No listed answer

**71) Would it be considered acceptable or a violation of this code to connect the shield of a coaxial cable to the EGC of a 480 volt motor feeder conductor set.**

- A) Acceptable
- B) Violation

**72) True or False, an existing coaxial cable shield can be extended to a nearby grounded listed receptacle using a cord and plug type connection as long as the grounded receptacle has a dedicated equipment grounding conductor.**

- A) True
- B) False

**73) To comply with the 820.100 exception, the coaxial cable needs to be run \_\_\_\_\_ from any existing cables or the raceways that house them.**

- A) Parallel
- B) Perpendicular
- C) Isolated
- D) All Listed answers

**74) The language changing bonding jumper and equipment grounding conductor from grounding conductor is discussed in the first informational note of article \_\_\_\_\_.**

- A) 820
- B) 830
- C) 810
- D) All listed answers

**75) To determine if a listed CMR wire can be installed in a raceway that passes into a plenum used for communications systems, table \_\_\_\_\_ must be used.**

- A) 810.5
- B) 800.154(a)
- C) 820.34(b)
- D) No listed answer

**76) If you were to install type CMP cable in a fabricated duct for environmental air, section \_\_\_\_\_ shall be used.**

- A) 800.113
- B) 800.115
- C) 800.154(a)
- D) 800.56

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**800.110 Raceways for Communications Wires and Cables (A)(1)(A)(2).** Communications wires and Cables are permitted to be run in any raceway system as described in 800.110 (A)(1) or (A)(2). Communications wires and Cables are permitted in any raceway listed in Chapter 3 of this code, (Chapter 3 contains information with regards to raceway system installations). The raceway systems listed in Chapter 3 that contain these systems must be installed as per the requirements of Chapter 3 and the individual raceway system. Communications wires and Cables are allowed to be run in a plenum communications raceway, a listed general purpose communications raceway, and a listed riser communication raceway. The raceway fill requirements of Chapter 3 and 9 do not apply to Communications wires and Cables.

**800.2 Definitions:**

**Communications Raceway:** An enclosed Channel of nonmetallic materials designed for holding communications wire and cables in plenum, riser, and general purpose applications.

**700.154 Application of Listed Optical Fiber Cables and Raceways, and Cable Routing Assemblies.** Table 770.154(a) lists the permitted and non-permitted use of listed Optical Fiber Cables and Raceways, and Cable Routing Assemblies. The permitted applications for these systems are subject to the installation requirements of 770.110 and 770.113.

**770.110 Raceways for Optical Fiber Cables (A)(1)(A)(2).** Optical Fiber Cables are permitted to be run in any raceway system as described in 770.110 (A)(1) or (A)(2). Optical Fiber Cables are permitted in any raceway listed in Chapter 3 of this code, (Chapter 3 contains information with regards to raceway system installations). The raceway systems listed in Chapter 3 that contain these systems must be installed as per the requirements of Chapter 3 and the individual raceway system. Optical Fiber Cables are allowed to be run in a listed plenum communications raceway, a listed general purpose optical fiber raceway, and a listed riser optical fiber raceway. The raceway fill requirements of Chapter 3 and 9 do not apply to optical fiber cables if no electric power or lighting circuits share the same raceway. However, if power and lighting conductors share the same raceway as the optical fiber cables, then the fill requirements of chapters 3 and 9 shall apply.

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**77) Communication wires and cables are permitted in any listed raceway system as allowed by Chapter \_\_\_\_\_ of this code.**

- A) 1
- B) 2
- C) 3
- D) 6

**78) True or False, raceway systems that contain communication cables are not required to be installed by the requirements of Chapter 3.**

- A) True
- B) False

**79) Would it be considered acceptable or a violation of this code to run a CAT 6 communications cables in a raceway through a plenum that houses coaxial cable.**

- A) Acceptable
- B) Violation

**80) How many CAT 5 Communications Cables can be installed in a 1" ENT raceway system.**

- A) 5
- B) 7
- C) As many that will fit
- D) No listed answer

**81) A 1 ½" ENT Raceway that contains CAT 5 communications cable installed in a plenum would be considered a \_\_\_\_\_.**

- A) Raceway system
- B) Data Housing
- C) Field Bus System
- D) Communications Raceway

**82) To determine if a listed OFNP cable can be installed in a raceway that is installed in a place used for environmental air, table \_\_\_\_\_ must be used.**

- A) 770.5
- B) 770.154(a)
- C) 770.34(b)
- D) No listed answer

**83) If you were to install type OFNP cable in a fabricated duct for environmental air, section \_\_\_\_\_ shall be used.**

- A) 770.113
- B) 770.115
- C) 770.154(a)
- D) 800.56

**84) Optical Fiber cables are permitted in any listed raceway system as allowed by Chapter \_\_\_\_\_ of this code.**

- A) 1
- B) 2
- C) 3
- D) 6

**85) True or False, raceway systems that contain Optical Fiber cables are required to be installed by the requirements of Chapter 3.**

- A) True
- B) False

**86) Would it be considered acceptable or a violation of this code to run 277 Volt lighting circuits in the same raceway that contains Optical Fiber cable.**

- A) Acceptable
- B) Violation

**87) True or False, under no circumstance is it required to use the chapter 3 and 9 fill requirements for Optical Fiber cables.**

- A) True
- B) False

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### **770.2 Definitions:**

**Cable Routing Assembly.** A single channel or connected multiple channels, as well as associated fittings, forming a structural system that is used to support, route and protect high densities of wires and cables, typically communications wires and cables, optical fiber and data (Class 2 and Class 3) cables associated with information technology and communications equipment.

**Conductive Optical Fiber Cable.** A factory assembly of one or more optical fibers having an overall covering and containing non-current-carrying conductive member(s) such as metallic strength member(s), metallic vapor barrier( s), metallic armor or metallic sheath.

**Nonconductive Optical Fiber Cable.** A factory assembly of one or more optical fibers having an overall covering and containing no electrically conductive materials.

**Optical Fiber Cable.** A factory assembly of one or more optical fibers, having an overall covering, that transmits light for control, signaling, and communications.

**Optical Fiber Raceway.** An enclosed channel of nonmetallic materials designed for holding optical fiber cables in plenum, riser, and general-purpose applications.

**760.176 (C) Listing and Marking of NPLFA Cables, Informational note:** To determine if a cable is low smoke-producing and fire-resistant. The cable shall exhibit a maximum peak optical density of 0.5 or less, an

average optical density of 0.15 or less, and a maximum flame spread distance of 1.52 m (5 ft) or less when tested in accordance with NFPA standards.

### **III. Power-Limited Fire Alarm (PLFA) Circuits Power Sources for PLFA Circuits**

#### **760.121(B) Branch Circuit.**

A branch circuit that supply's the fire alarm equipment(s) is required by this code to serve no other loads. Where the circuit originates, it shall be permanently labeled at the fire alarm control unit. The circuit disconnecting means is required to have its identification marked using the color red. The circuit that provides power to the FA system shall be accessible only to qualified personnel, and must be marked as **"FIRE ALARM CIRCUIT."** When marking the breaker, the red identifier shall not damage the breaker or obscure the manufacturer's markings.

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**88) A Structural system that supports and protects communications and Optical fiber cables is known as a \_\_\_\_\_.**

- A) Optical Fiber Cable
- B) Nonconductive Optical Fiber Cable
- C) Cable Routing Assembly
- D) Conductive Optical Fiber Cable

**89) A factory assembly of optical fibers having an overall covering and containing non-current-carrying conductive members would be considered a \_\_\_\_\_.**

- A) Conductive Optical Fiber Cable
- B) Optical Fiber Raceway
- C) Nonconductive Optical Fiber Cable
- D) Optical Fiber Cable

**90) A factory assembled optical fiber cable having an overall covering that contains no electrically conductive materials is known as a \_\_\_\_\_.**

- A) Optical Fiber Cable
- B) Conductive Optical Fiber Cable
- C) Optical Fiber Raceway
- D) Nonconductive Optical Fiber Cable

**91) One or more optical fibers factory assembled having an overall covering that transmits light would be considered a \_\_\_\_\_.**

- A) Conductive Optical Fiber Cable
- B) Optical Fiber Cable
- C) Optical Fiber Raceway
- D) Nonconductive Optical Fiber Cable

**92) An enclosed nonmetallic channel designed to hold optical fiber cables for general-purpose applications is known as \_\_\_\_\_.**

- A) Cable Routing Assembly
- B) Optical Fiber Cable
- C) Nonconductive Optical Fiber Cable
- D) Optical Fiber Raceway

**93) A quality indicative for a fire-resistant cable is one that has a max peak optical density of \_\_\_\_\_ or less.**

- A) 0.5
- B) 0.6
- C) 1.0
- D) all listed answers

**94) One would expect to see a low smoke-producing cable to exhibit an average optical density of \_\_\_\_\_ or less.**

- A) 0.17
- B) 0.9
- C) 0.2
- D) 0.15

**95) The maximum flame spread for a cable classified as fire-resistant would be \_\_\_\_\_ or less.**

- A) 5'
- B) 5.5'
- C) 6.3
- D) 7

**96) The circuit that supply's a Fire alarm panel is required to be \_\_\_\_\_.**

- A) PLC Controlled
- B) Type L
- C) Dedicated
- D) Oversized

**97) The Fire Alarm unit is required to have a \_\_\_\_\_ marking of where it is being fed from.**

- A) Listed
- B) Permanent
- C) Factory
- D) All listed answers

**98) A 20 amp single pole breaker that feeds a FA system is required to be identified \_\_\_\_\_.**

- A) By system
- B) Clearly
- C) At its source
- D) Red

**99) The subpanel that feeds a Fire Alarm system is required to be accessible only to \_\_\_\_\_ people.**

- A) Seasoned
- B) Skilled
- C) Qualified
- D) Maintenance

**100) The 2011 Code tells us that a Fire Alarm breaker (Overcurrent Device) needs to be identified by the color red and the words \_\_\_\_\_.**

- A) FACP
- B) Fire Circuit
- C) FIRE ALARM
- D) FIRE ALARM CIRCUIT

**760 Fire Alarm Circuits. This Article has changed some requirements for raceways that contain Fire Alarm systems.**

**760.3(H)** requires raceways or sleeves exposed to different temperatures be filled with an approved material to stop the circulation of the different temperatures when a raceway or sleeve enter a structure from outside as with its reference to 300.7 for this installation situation.

**760.3(I)** require supporting fire rated cables vertically at the minimum values as listed in table 300.19(A). If the manufactures requirements are stricter than what is required by table 300.19(A), then the more stringent of the 2 supporting requirements shall be used.

**760.3(J)** requires a raceway never to be filled with more conductors than will permit dissipation of the heat without causing damage to the conductors or cables.

**760.3(K)** The ends of a raceway do not need to terminate into a box that provide support or protection for cables against physical damage, but the use of a bushing on each end is required.

**725.154 (D) Industrial establishments.** This section permits industrial establishments that ensure only qualified persons install type PLTC cable to have the ability provided that the cable is not subject to physical damage. The cable needs to also comply with the crush and impact requirements of Type MC Cable and is identified as PLTC-ER for this type of use. The cable can then be installed exposed between a cable tray and the utilization equipment it connects to.

**ARTICLE 708 Critical Operations Power Systems (COPS).**

**708.10 (A)(2)** requires the cover plates of receptacles powered by COPS systems to be a distinctive color or marking so as to be readily identifiable and distinguishable from other systems. The COPS systems is primarily used for critical operations facilities in the event of a natural disaster or terrorist attack.

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**101) A raceway that contains fire alarm cables that enter from outside is required to have the inside of the raceway \_\_\_\_\_ with an approved material.**

- A) Sealed
- B) Filtered
- C) Assembled
- D) Insulated

**102) Article 760 references article \_\_\_\_\_ for specific installation requirements when you have a raceway system exposed to different temperatures that contain FA cable.**

- A) 300.17
- B) 300.19
- C) 300.15(C)
- D) 300.7

**103) A type CI cable is run vertically from a basement FACP to the attic of a 4 story building. The manufacturers vertical support distances are less than what is required by this code. The vertical supporting requirements of the \_\_\_\_\_ would be used for this scenario.**

- A) Code
- B) Manufacturer

**104) Article 760 references article \_\_\_\_\_ for specific installation requirements when you need information for supporting FA cable vertically.**

- A) 300.7
- B) 300.17
- C) 300.15
- D) 300.19

**105) True or false, Article 760 allows maximum fill for FA cables installed in a raceway so long as the cables fit.**

- A) True
- B) False

**106) Article 760 references article \_\_\_\_\_ for the installation requirements when you need information with regards to conduit fill that contain FA cables.**

- A) 300.19
- B) 300.7
- C) 300.17
- D) 300.15

**107) A conduit that is installed for the physical protection of FA cables is required to have \_\_\_\_\_ on either end if it does not terminate into a box.**

- A) Bushings
- B) Throated connectors
- C) Meyers Hubs
- D) All listed answers

**108) Article 760 references article \_\_\_\_\_ on how to leave the ends of a raceway that contain FA cables.**

- A) 300.19
- B) 300.15(C)
- C) 300.7
- D) 300.15

**109) Only \_\_\_\_\_ individuals are allowed to install PLTC cable in an industrial facility.**

- A) Seasoned
- B) Experienced
- C) Qualified
- D) Maintenance

**110) PLTC cable cannot be installed in an industrial setting if exposed to \_\_\_\_\_ damage.**

- A) Physical
- B) Heat
- C) Moisture
- D) UV

**111) PLTC Cable used in an industrial facility is required the same crush and impact characteristics as type \_\_\_\_\_ cable.**

- A) NMC
- B) SO
- C) MI
- D) MC

**112) Would it be considered acceptable or a violation of this code to run PLTC cable directly from a cable tray system to a piece of equipment provided all the code requirements are met.**

- A) Acceptable
- B) Violation

**113) In article 708 COPS stands for \_\_\_\_\_.**

- A) Critical Operational Phase Systems
- B) Critical Operations Power Systems
- C) Critical Operating Power Systems
- D) Civil Operations and Power Systems

**114) The cover plate of a receptacle powered by a COPS circuit is required to be \_\_\_\_\_.**

- A) Colored
- B) Marked
- C) Labeled
- D) All listed answers

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## **ARTICLE 705**

### **Interconnected Electric Power Production Sources**

#### **705.2 Definitions**

**Power Production Equipment.** The generating source, and all distribution equipment associated with it, that generates electricity from a source other than a utility supplied service.

Informational Note: Examples of power production equipment include such items as generators, solar photovoltaic systems, and fuel cell systems.

**705.6 System Installation.** This code requires that if one or more electrical power production sources are being installed and operating in parallel with the main electrical source, then the system is required to be installed only by qualified person.

**705.12 Utility-Interactive Inverters. (D)(2) Exception:** If a photovoltaic system has an energy storage device that allows a stand-alone operation of loads, then the value used in the calculation of bus or conductor loading is required to be 125 percent of the rated utility-interactive current from the inverter. The rating of the overcurrent device between the inverter and the bus or conductor will not be used.

## **ARTICLE 702 Optional Standby Systems.**

**702.7(B) Grounding.** If the removal of grounding or bonding connection in a normal power source interrupts the grounding electrode conductor connection to the alternate power sources grounded conductor, a warning sign is required to be installed at the normal power source equipment and state:

**WARNING SHOCK HAZARD EXISTS IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER CONNECTION IN THIS EQUIPMENT IS REMOVED WHILE ALTERNATE SOURCE(S) IS ENERGIZED.**

## **ARTICLE 701**

### **Legally Required Standby Systems.**

#### **701.6(D)Ground Fault.**

To determine if a ground fault has occurred in a solidly grounded wye legally required standby system. A sensor to detect these groundfaults is required to be installed ahead of or at the main disconnect for such a standby system, and can only be set to a maximum ground-fault current of 1200 amperes . This sensor is

required for systems 150 volts to ground and circuit-protective devices rated 1000 amperes or more. A posted set of instructions near or at the sensor need to explain what to do in the event of a groundfault.

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**115) A power source with all its associated equipment that generates power without the help of the utility would be considered \_\_\_\_\_.**

- A) Utility-Interactive Inverter Output Circuit
- B) Interactive Output Circuit
- C) Utility Output Circuit
- D) Power Production Equipment

**116) True or False, a solar panel on the roof of your neighbor's house would be considered power production equipment.**

- A) True
- B) False

**117) True or False, the 2011 Code specifies who is considered acceptable to install electrical power production sources.**

- A) True
- B) False

**118) The bus or conductor loading calculation for a stand-alone PV system is required to be \_\_\_\_\_ of the rated utility-interactive current from the inverter.**

- B) 100 %
- C) 115 %
- A) 125 %
- D) 130 %

**119) Would it be considered acceptable or a violation of this code for a transfer switch to disconnect the grounding electrode conductor of a backup generator while the normal service power is energized.**

- A) Acceptable
- B) Violation

**120) A warning sign installed at the \_\_\_\_\_ warning of a potential shock hazard is required if a generators operation effects the service bond or grounding system.**

- A) Generator
- B) Office
- C) Service
- D) Service yard

**121) A legally required standby system over \_\_\_\_\_ to ground is required to have a sensor installed.**

- A) 150 MV
- B) 150 volts
- C) 135 volts
- D) 135 MV

**122) True or False, The placement of the sensor for a legally required standby system can only be done at its service disconnect.**

- A) True
- B) False

**123) A set of \_\_\_\_\_ need to posted by the sensor describing what to do if there is an issue.**

- A) Instructions
- B) Diagrams
- C) Listings
- D) All listed answers

**124) The sensor used to detect ground faults in legally required standby systems can be set to a maximum ground-fault current of \_\_\_\_\_ amperes.**

- A) 1200
  - B) 1220
  - C) 1250
  - D) 1800
- 

## **ARTICLE 700**

### **Emergency Systems**

**700.24 Automatic Load Control Relay.** An emergency lighting load that automatically energizes when normal power is lost must use a listed automatic load control relay. This is the only type of relay allowed to energize such loads. The listed automatic load control relay shall not be used as transfer equipment.

**700.12 (F) Exception 2:** Remote heads that provide emergency lighting and that are installed indoors by an exit door are now allowed to supply power to emergency lighting fixtures directly outside of the exit door.

**700.12(B)(6) Outdoor Generator Sets.** Outdoor generators that serve a building or structure equipped with a readily accessible disconnecting means that are located within sight of the building or structure supplied are not required to have an additional disconnecting means where ungrounded conductors serve or pass through the building or structure. The disconnect shall meet the requirements of 225.36. However, the 700.12(B)(6) Exception: allows the disconnecting means for a generator to not be located within sight of the building or structure served if it is an installation under single management where maintenance and supervision ensure that only qualified persons will monitor and service the generator, and where documented safe switching procedures are established and maintained for disconnection.

**700.10 Wiring, Emergency System.** (B)(5)(d). The 2011 Code allows for single or multiple feeders to supply distribution equipment between an emergency source and the point where the combination of emergency, legally required, or optional loads are separated.

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**125) A listed \_\_\_\_\_ relay is the only device the code will accept to energize emergency lighting loads.**

- A) Manual
- B) I/O logic
- C) Ice cube
- D) Automatic control

**126) True or False, an automatic load control relay has a dual purpose of also transferring equipment loads.**

- A) True
- B) False

**127) Would it be considered acceptable or a violation of this code to directly connect an external 277v wall pack for emergency lighting within 3 feet of an exit door to an internal emergency light supplied by a 277v source.**

- A) Acceptable
- B) Violation

**128) An outdoor generators disconnect is required to meet the installation requirements of \_\_\_\_\_.**

- A) 223.56
- B) 225.63
- C) 225.36
- D) 220.36

**129) Is it required or not required for an outdoor generator that has a local disconnect installed within sight of a building to also add extra disconnects for ungrounded conductors that serve or pass through the building.**

- A) Required
- B) Not required

**130) True or False, under no circumstance shall an outdoor generator have its disconnect installed so it is not within sight of the building or structure for which it serves.**

- A) True
- B) False

**131) A building under single management that has an outdoor generator installed is allowed to have its generators disconnect not located within line of sight of the building if only \_\_\_\_\_ persons monitor the generators operation.**

- A) Qualified
- B) Maintenance
- C) Trained
- D) All listed answers

**132) A \_\_\_\_\_ switching program is a requirement to install an outdoor generators disconnect not within line of sight of the building or structure for which it serves.**

- A) Controlled
- B) Registered
- C) Safe
- D) Transfer

**133) Would it be considered acceptable or a violation of this code to have a common enclosure where legally required, optional, and emergency loads enter.**

- A) Acceptable
- B) Violation

**134) \_\_\_\_\_ or Multiple \_\_\_\_\_ are allowed to supply distribution equipment between emergency sources and where the combination of emergency, legally required, or optional loads are separated.**

- A) Single, Disconnects
- B) Bundling and, Switches
- C) Single, Feeders
- D) No listed answer

**Emergency Systems.** Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction. These systems are intended to automatically supply illumination, power, or both, to designated areas and equipment in the event of failure of the normal supply or in the event of accident to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life.

**Relay, Automatic Load Control.** A device used to energize switched or normally-off lighting equipment from an emergency supply in the event of loss of the normal supply, and to de-energize or return the equipment to normal status when the normal supply is restored.

**Article 695.14 control wiring, fire Pumps (F) Generator Control Wiring Methods.** The control conductors that serve stand by generators for fire pumps are required to be run separately from other conductors between the fire pump transfer switch and the generator. The raceway systems are required to be protected by ONE of the following methods:

(1) Be encased in a minimum of 50 mm (2 in.) of concrete.

(2) Be protected by a fire-rated assembly listed to achieve a minimum fire rating of 2 hours and dedicated to the fire pump circuits.

(3) Be a listed electrical circuit protective system with a minimum 2-hour fire rating. The installation shall comply with any restrictions provided in the listing of the electrical circuit protective system used.

**695.7 Voltage Drop. (A) Starting.** When a fire pump starts under normal conditions, the controllers rated voltage at the controller line terminals cannot drop below 15 percent.

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**135) A legally required emergency system receives its classification from \_\_\_\_\_ bodies.**

- A) State
- B) Federal
- C) Government
- D) All listed answers

**136) An emergency system is installed to protect \_\_\_\_\_.**

- A) Humans
- B) Equipment
- C) Structures
- D) All listed answers

**137) Emergency systems are intended to automatically supply \_\_\_\_\_, power, or both**

- A) Water
- B) Illumination
- C) Heat
- D) Pumps

**138) An \_\_\_\_\_ relay is used to switch normal power to emergency power in the event of a normal power loss situation.**

- A) Auto Level
- B) Ice Cube
- C) Auxiliary
- D) Automatic Load

**139) A stand by generator that feeds a fire pump is required to have its control conductors \_\_\_\_\_ from other conductors.**

- A) Isolated
- B) Joined
- C) Connected
- D) Marked

**140) Protection of control wiring for generators that feed fire pumps is addressed in article \_\_\_\_\_.**

- A) 682
- B) 695
- C) 700
- D) 725

**141) The 2011 Code Specifically identifies \_\_\_\_\_ methods for protecting control wiring for generators that support fire pumps.**

- A) 3
- B) 2
- C) 4
- D) 7

**142) A method of protecting control wiring of generators that service fire pumps is by a fire-rated assembly listed to achieve a minimum fire rating of \_\_\_\_\_ and dedicated to the fire pump circuits.**

- A) 1 hour
- B) 45 minutes
- C) 50 minutes
- D) 2 hours

**143) Would it be considered acceptable or a violation of this code for a fire pump controllers rated voltage to drop 18 percent upon start up.**

- A) Acceptable
- B) Violation

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**695.6 Power Wiring. (J) Raceway Terminations.** The 2011 Code has added language when a raceway terminates at a fire pump controller and requires the following shall be met:

- (1) Listed conduit hubs shall be used.
- (2) The type rating of the conduit hub(s) shall be at least equal to that of the fire pump controller.
- (3) The installation instructions of the manufacturer of the fire pump controller shall be followed.
- (4) Alterations to the fire pump controller, other than conduit entry as allowed elsewhere in this *Code*, shall be approved by the authority having jurisdiction.

**695.6 (I) Junction Boxes.** The 2011 Code has added language when fire pump controller wire is routed through a junction box, the following shall be met:

- (1) The junction box shall be securely mounted.
- (2) Mounting and installing of a junction box shall not violate the enclosure type rating of the fire pump controller(s).

- (3) Mounting and installing of a junction box shall not violate the integrity of the fire pump controller(s) and shall not affect the short-circuit rating of the controller(s)
- (4) As a minimum, a Type 2, drip-proof enclosure (junction box) shall be used where installed in the fire pump room. The enclosure shall be listed to match the fire pump controller enclosure type rating.
- (5) Terminals, junction blocks, wire connectors, and splices, where used, shall be listed.
- (6) A fire pump controller or fire pump power transfer switch, where provided, shall not be used as a junction box to supply other equipment, including a pressure maintenance (jockey) pump(s).
- 

**144) When a conduit hub is used at a fire pump controller, it is required to be \_\_\_\_\_.**

- A) Oversized
- B) Rated
- C) Listed
- D) Sealed

**145) The type rating of a conduit hub used at a fire pump controller is required to be at least \_\_\_\_\_ to that of the fire pump controller.**

- A) Equal
- B) Greater
- C) Less
- D) No listed answer

**146) True or False, the manufacturers installation instructions are not required to be followed for a fire pump controller.**

- A) True
- B) False

**147) The \_\_\_\_\_ can allow alterations to a fire pump controller.**

- A) Contractor
- B) Electrician
- C) Trades Person
- D) AHJ

**148) The 2011 Code lists \_\_\_\_\_ provisions when conduits enter a fire pump controller.**

- A) 2
- B) 3
- C) 4
- D) 5

**149) A junction box that houses fire pump controller wire is required to be mounted \_\_\_\_\_.**

- A) Securely
- B) With conduit
- C) Directly
- D) With kendorf

**150) If mounting a junction box for fire pump controller wire, it is important that the junction box does not violate the \_\_\_\_\_ rating of the fire pump controller.**

- A) Classification
- B) Area
- C) Type
- D) Location

**151) Using a junction box for fire pump controller wire is acceptable so long as the junction box does not affect the \_\_\_\_\_ of the controller.**

- A) Short circuit rating
- B) Integrity
- C) Operation
- D) All listed answers

**152) If installing a junction box in a fire pump room, it shall be a minimum of a Type \_\_\_\_\_ drip-proof enclosure if it houses fire pump controller wire.**

- A) 1
- B) 2
- C) 3
- D) 4

**153) A junction box is required to be \_\_\_\_\_ to match the fire pump controller enclosure type rating.**

- A) Listed
- B) Rated
- C) Designed
- D) Manufactured

**154) Splices and connections are allowed to be made in junction boxes that house fire pump control wire as long as the type of connections are \_\_\_\_\_.**

- A) Rated
- B) Designed
- C) Solid
- D) Listed

**155) True or false, a fire pump power transfer switch can be used as a junction box to supply other equipment.**

- A) True
- B) False

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**695.6 (H) Listed Electrical Circuit Protective System to Controller Wiring. This new subsection has been added to clarify electrical circuit protective system installations and to also comply with any restrictions listed for the circuit protective system.**

Electrical circuit protective system installation shall comply with any restrictions provided in the listing of the electrical circuit protective system used and the following also shall apply:

- (1) A junction box shall be installed ahead of the fire pump controller a minimum of 300 mm (12 in.) beyond the fire-rated wall or floor bounding the fire zone.

(2) Where required by the manufacturer of a listed electrical circuit protective system or by the listing, or as required elsewhere in this *Code*, the raceway between a junction box and the fire pump controller shall be sealed at the junction box end as required and in accordance with the instructions of the manufacturer.

(3) Standard wiring between the junction box and the controller shall be permitted.

**695.6 (E) Loads Supplied by Controllers and Transfer Switches. This is a new subsection that was added to clarify the requirements for loads supplied by fire pump controllers and transfer switches.**

A fire pump controller and fire pump power transfer switch, if provided, shall not serve any load other than the fire pump for which it is intended.

**695.6 (A)(2) Feeders. (a)(b)(c)(d). Fire pump supply conductors or conductors that connect directly to an on-site standby generator on the load side of the final disconnecting means as allowed by 695.4(B) are required to comply with all of the following:**

(a) ***Independent Routing.*** The conductors shall be kept entirely independent of all other wiring.

(b) ***Associated Fire Pump Loads.*** The conductors shall supply only loads that are directly associated with the fire pump system.

(c) ***Protection from Potential Damage.*** The conductors shall be protected from potential damage by fire, structural failure, or operational accident.

(d) ***Inside of a Building.*** Where routed through a building, the conductors shall be installed using one of the following methods:

(1) Be encased in a minimum 50 mm (2 in.) of concrete

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

(3) Be a listed electrical circuit protective system with a minimum 2-hour fire rating

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**156) A junction box must be installed a minimum of \_\_\_\_\_ beyond the fire rated wall of the electrical circuit protective system.**

A) 10 inches

B) 11 inches

C) 12 inches

D) All listed answers

**157) A raceway installed between a junction box and the fire pump controller is required to be \_\_\_\_\_ at the junction box end.**

A) Complete

B) Listed

C) Rated

D) Sealed

**158) Would it be considered acceptable or a violation of this code to use standard wiring methods between a fire pump controller and a junction box.**

- A) Acceptable
- B) Violation

**159) A fire pump controller \_\_\_\_\_ serve any load other than the fire pump.**

- A) May
- B) Can Not
- C) Shall Not
- D) Will

**160) The feeder conductors for a fire pump shall be kept \_\_\_\_\_ independent of all other wiring.**

- A) Entirely
- B) Somewhat
- C) Partially
- D) Mostly

**161) True or False, feeders that supply a fire pump system are allowed to feed power to other non-fire pump systems.**

- A) True
- B) False

**162) When installing the feeder conductors that will service a fire pump, the conductors shall be protected from potential damage by \_\_\_\_\_.**

- A) Fire
- B) Structural failure
- C) Operational accident
- D) All listed answers

**163) A method for protecting feeders that serve a fire pump routed through a building is to encase them in a minimum of \_\_\_\_\_ concrete.**

- A) 1 inch
- B) 1 1/2"
- C) 2 inches
- D) No listed answer

**164) A method for protecting feeders that serve a fire pump routed through a building is to be protected by a fire-rated assembly listed with a minimum fire rating of \_\_\_\_\_ and dedicated to the fire pump circuit(s)**

- A) 1 hour
- B) 45 minutes
- C) 30 minutes
- D) 2 hours

**165) A method for protecting feeders that serve a fire pump routed through a building is to have a listed electrical circuit protective system with a minimum \_\_\_\_\_ fire rating.**

- A) 2 hour
- B) 1 1/2 hour
- C) 1 hour
- D) 45 minutes

**166) The 2011 Code lists \_\_\_\_\_ different options for protecting feeders for fire pumps that route through a building.**

- A) 2
  - B) 3
  - C) 4
  - D) 7
- 

**695.3 (F) Phase Converters.** Phase converters are not allowed to be used for fire pump service.

**695.3 (E) Arrangement.** All power supplies for fire pumps shall be installed as to protect against damage by fire from within the structure and exposing hazards. Multiple power sources are required to be installed so that a fire at one source does not cause an interruption at the other source.

**695.3 (D) On-Site Standby Generator as Alternate Source.** An on-site standby generator(s) used as an alternate source of power for fire pumps shall comply with (D)(1) through (D)(3).

**(1) Capacity.** The generator shall have sufficient capacity to allow normal starting and running of the motor(s) driving the fire pump(s) while supplying all other loads simultaneously. Automatic shedding of one or more optional standby loads in order to comply with this capacity requirement is permitted.

**(2) Connection.** A tap ahead of the generator disconnecting means shall not be required.

**(3) Adjacent Disconnects.** The requirements of 430.113 shall not apply. 430.111 states motor and motor-operated equipment receiving electric energy from more than one source shall be provided with disconnecting means from each source of electric energy immediately adjacent to the equipment served.

**692.4 (C) System Installation.** The installation of Fuel cell systems including all associated wiring is required to be installed only by qualified persons.

**690.74 (A) Flexible Cables.** Battery connections using flexible, fine-stranded cables for solar photovoltaic (PV) systems shall be terminated only with terminals, lugs, devices, or connectors in accordance with 110.14(A).

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**167) True or false, phase converts are permitted to be used for fire pumps.**

- B) True
- A) False

**168) A major concern when protecting fire pump power supplies is from the threat of\_\_\_\_\_.**

- A) Moisture
- B) Water
- C) Fire
- D) Harmonics

**169) True or False, multiple power supplies for a fire pump are required to be so installed that fire at one source does not affect the operation of the others.**

- A) True
- B) False

**170) Would it be considered acceptable or a violation of this code to use a common standby generator to power the motors for a fire pump system as well as normal building systems.**

- A) Acceptable
- B) Violation

**171) If a generator is used to power motors for fire pumps as well as other build systems simultaneously, it shall have sufficient \_\_\_\_\_ for this use.**

- A) Fuel
- B) Eddie Current
- C) Inductance
- D) Capacity

**172) Automatic \_\_\_\_\_ of one or more optional standby loads in order to comply with the fire pump operational capacity requirement is permitted.**

- A) Loading
- B) Cascading
- C) Shedding
- D) Inversion

**173) True or False, tapping ahead of a generators disconnect in order to feed a motor for a fire pump is required if the generator feeds other building systems upon start up.**

- A) True
- B) False

**174) True or False, multiple optional standby systems that feed fire pump motors are required to have a disconnect installed for each source adjacent to the motors being fed as required by 430.113.**

- A) True
- B) False

**175) The 2011 Code lists \_\_\_\_\_ provisions for on-site standby generators used as an alternate source for powering fire pump motors.**

- A) 2
- B) 3
- C) 4
- D) 5

**176) Would it be considered acceptable or a violation of this code for a licensed and bonded plumbing contractor to install a fuel cell system if they were trained to recognize the hazards involved and qualified for such an installation.**

- A) Acceptable
- B) Violation

**177) The requirements of \_\_\_\_\_ shall be used when making battery connections using fine stranded flexible cables.**

- A) 110.14
- B) 110.13(A)
- C) 110.14(A)
- D) 110/13

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**690.72 (C) Buck/Boost Direct-Current Converters.** When buck/boost charge controllers and other dc power converters used in solar photovoltaic (PV) systems that increase or decrease the output current or output voltage

with respect to the input current or input voltage are installed, the requirements of 690.72(C)(1) and (C)(2) shall be followed.

(1) The ampacity of the conductors in output circuits shall be based on the maximum rated continuous output current of the charge controller or converter for the selected output voltage range.

(2) The voltage rating of the output circuits shall be based on the maximum voltage output of the charge controller or converter for the selected output voltage range.

**690.63 Unbalanced Interconnections.** Unbalanced connections for solar photovoltaic (PV) systems shall be in accordance with 705.100.

**690.64 Point of Connection.** Point of connection for a solar photovoltaic (PV) system shall be in accordance with 705.12.

**690.47(C)(3) Combined Direct-Current Grounding Electrode Conductor and Alternating-Current Equipment Grounding Conductor.** A combined solar photovoltaic (PV) system equipment grounding conductor is required to be unspliced, or irreversibly spliced. This combined equipment grounding conductor shall be run from the marked dc grounding electrode conductor connection point along with the ac circuit conductors to the grounding busbar in the associated ac equipment. This combined grounding conductor shall be the larger of the sizes specified by 250.122 or 250.166 and shall be installed in accordance with 250.64(E).

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**178) The 2011 Code lists \_\_\_\_\_ provision(s) to follow when using buck/boost charge controllers for photovoltaic (PV) systems.**

- B) 1
- A) 2
- C) 3
- D) 4

**179) The ampacity for conductors in output circuits using buck/boost charge controllers for PV systems shall be based on the \_\_\_\_\_ rated continuous output current of the charge controller.**

- A) Minimum
- B) Load
- C) Continuous
- D) Maximum

**180) The voltage for conductors in output circuits using buck/boost charge controllers for PV systems shall be based on the \_\_\_\_\_ rated continuous output voltage of the charge controller.**

- A) Maximum
- B) Minimum
- C) Load
- D) Continuous

**181) The Unbalanced connections for solar photovoltaic (PV) systems are required to be installed in accordance with \_\_\_\_\_.**

- A) 705.10
- B) 705.100
- C) 704.100
- D) 704.10

**182) The Point of connection for a solar photovoltaic (PV) system is required to be done in accordance with \_\_\_\_\_.**

- A) 705.12
- B) 705.10
- C) 704.12
- D) 704.10

**183) A combined equipment grounding conductor used in a PV system that serves DC and associated AC equipment is required to be unspliced or \_\_\_\_\_.**

- A) Continuous
- B) Split Bolted
- C) Tie Wired
- D) Irreversibly spliced

**184) The combined PV equipment grounding conductor shall be run from the marked \_\_\_\_\_ grounding electrode conductor connection point.**

- A) AC
- C) Connected
- C) DC
- D) Listed

**185) A combined Grounding Conductor used in a PV system for the AC and DC system is required to be the \_\_\_\_\_ of the sizes specified by 250.122 or 250.166.**

- A) Smaller
- B) Larger
- C) Combination
- D) Circular Mils

**186) When installing a combined equipment grounding conductor for a PV system, the installation is required to be done in accordance with \_\_\_\_\_.**

- A) 250.66
- B) 250.120
- C) 250.64(E)
- D) 250.36(C)

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**690.47 (C)(2) Common Direct-Current and Alternating-Current Grounding Electrode.** A photovoltaic (PV) system dc grounding electrode conductor of the size specified by 250.166 shall be run from the marked dc grounding electrode connection point to the ac grounding electrode. If an ac grounding electrode is not accessible, the dc grounding electrode conductor shall be connected to the ac grounding electrode conductor in accordance with 250.64(C)(1). This dc grounding electrode conductor shall not be used as a substitute for any required ac equipment grounding conductors.

**690.47 (C)(1) Separate Direct-Current Grounding Electrode System Bonded to the Alternating-Current Grounding Electrode System.** The 2011 Code has added this new subdivision that requires a separate dc grounding electrode or system to be installed if there is no direct connection between the dc grounded conductor and ac grounded conductor for a photovoltaic (PV) system. This dc system is required to be bonded directly to the ac grounding electrode system. The size of any bonding jumper(s) between the ac and dc systems shall be based on the larger size of the existing ac grounding electrode conductor or the size of the dc grounding electrode conductor specified by 250.166. The dc grounding electrode system conductor(s) or the bonding jumpers to the ac grounding electrode system shall not be used as a substitute for any required ac equipment grounding conductors.

**690.47(C) Systems with Alternating-Current and Direct-Current Grounding Requirements. A**

Photovoltaic system that has dc and ac circuits and having no direct connection between the dc grounded conductor and ac grounded conductor is required to have a dc grounding system. This dc grounding system is required to be bonded to the ac grounding system by one of the methods as specified in 690.47(C)(1), (2), or (3). This section does not apply to ac PV modules. When using the methods of (C)(2) or (C)(3), the existing ac grounding electrode system shall meet the applicable requirements of Article 250, Part III.

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**187) The DC grounding electrode conductor shall be run from the marked \_\_\_\_\_ grounding electrode connection point.**

- A) AC
- B) Connected
- C) Listed
- D) DC

**188) A dc grounding electrode conductor used for a PV system is required to be sized using the requirements of \_\_\_\_\_.**

- A) 250.66
- B) 250.122
- C) 250.166
- D) 250.122(E)

**189) The DC grounding electrode conductor for a PV system shall be run to the \_\_\_\_\_ grounding electrode.**

- A) AC
- B) DC
- C) Listed
- D) Sized

**190) If installing a PV system and the AC grounding electrode is not accessible, the DC grounding electrode conductor is allowed to be connected to the AC grounding electrode conductor as long as it complies with the requirements of \_\_\_\_\_.**

- A) 250.166
- B) 250.66
- C) 250.122
- D) 250.64(C)(1)

**191) Would it be considered acceptable or a violation of this code to substitute a DC grounding electrode conductor for any required AC equipment grounding conductors.**

- A) Acceptable
- B) Violation

**192) True or False, a photovoltaic (PV) system does not require a separate dc grounding electrode or system if a current 200 amp AC service exists.**

- A) True
- B) False

**193) A photovoltaic grounding system is required to be connected the \_\_\_\_\_ grounding electrode system.**

- A) AC
- B) Utility
- C) District
- D) CATV

**194) The bonding jumper that connects a DC and AC system together of a photovoltaic system is required to be sized based on the \_\_\_\_\_ grounding electrode conductor of either the AC or DC system.**

- A) Utility
- B) Service
- C) Smaller
- D) Larger

**195) To size a DC grounding electrode conductor, the 2011 code requires one to look in \_\_\_\_\_.**

- A) 250.122
- B) 250.66
- C) 250.166
- D) 430.52

**196) True or False, a DC grounding system may be used as a substitute for any required ac equipment grounding conductors.**

- A) True
- B) False

**197) A dc grounding system is not required for a Photovoltaic system that has a \_\_\_\_\_ connection between the dc and ac grounded conductors.**

- A) Partial
- B) Open
- C) Nominal
- D) Direct

**198) A dc grounding system is required to bond directly with the \_\_\_\_\_ grounding system.**

- A) AC
- B) Utility
- C) Network
- D) Telephone

**199) True or False, alternating current photovoltaic modules are required to comply with 690.47(C)(1), (2), or (3).**

- A) True
- B) False

**200) To use the requirements of 690.47(C)(1), (2), or (3), the ac grounding electrode system is required to meet the applicable provisions of Article 250, Part \_\_\_\_\_.**

- A) II
  - B) III
  - C) IV
  - D) VII
-

**680.47(B) Direct-Current Systems.** The grounding electrode system for a dc system is required to be installed in accordance with 250.166 for grounded systems or 250.169 for ungrounded systems. The grounding electrode conductor is required to be installed in accordance with 250.64. The 2011 Code allows a common dc grounding-electrode conductor to serve multiple inverters. The size of a common grounding electrode and tap conductors shall be in accordance with 250.166. Tap conductors are required to be connected to the common grounding-electrode conductor by exothermic welding or with connectors listed for such use. This connection is to be made in such a manner that the common grounding electrode conductor remains without a splice or joint.

**690.43 (D) Photovoltaic Mounting Systems and Devices.** When devices and systems that are used for mounting PV modules are also used to provide grounding of the module frames, they are required be identified for the purpose of grounding the PV modules.

**690.43 (C) Structure as Equipment Grounding Conductor.** Devices listed and identified for grounding the metallic frames of PV modules or other equipment shall be permitted to bond the exposed metal surfaces or other equipment to mounting structures. Metallic mounting structures, other than building steel, used for grounding purposes shall be identified as equipment-grounding conductors or shall have identified bonding jumpers or devices connected between the separate metallic sections and shall be bonded to the grounding system.

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**201) A dc grounding electrode system is required to be installed as specified in \_\_\_\_\_.**

- A) 250.166
- B) 250.169
- C) 250.66
- D) 250.122

**202) The 2011 Code requires a dc grounding electrode conductor to be installed as per \_\_\_\_\_.**

- A) 250.64
- B) 250.166
- C) 250.169
- D) 250.122

**203) True or False, the 2011 code does not allow a common dc grounding-electrode conductor to serve multiple inverters.**

- A) True
- B) False

**204) A common grounding electrode tap conductor is required to be sized as per section \_\_\_\_\_ for a dc system.**

- A) 250.196
- B) 250.122
- C) 250.166
- D) 250.66

**205) Would it be considered acceptable or a violation of this code for a dc tap conductor to connect directly to a common grounding-electrode conductor.**

- A) Acceptable
- B) Violation

**206) Connecting dc tap conductors to a common grounding electrode conductor must be made by \_\_\_\_\_.**

- A) Exothermic welding
- B) Irreversible crimp
- C) Listed Split Bolt
- D) All listed answers

**207) If the frame of a photovoltaic module is also used for grounding the system, then the frame must be \_\_\_\_\_ for that purpose.**

- A) Added
- B) Identified
- C) Installed
- D) All listed answers

**208) A device listed to ground the metallic frame of a photovoltaic module is allowed by this code to \_\_\_\_\_ equipment to the mounting structure.**

- A) Weld
- B) Install
- C) Attach
- D) Bond

**209) True or False, identified bonding jumpers connected between separate metallic sections for PV systems are required to be bonded to the grounding system.**

- A) True
- B) False

**210) If using the PV metallic mounting structures for grounding purposes, the 2011 code requires the mounting structures to be \_\_\_\_\_ as equipment-grounding conductors.**

- A) Identified
- B) Marked
- C) Labeled
- D) All listed answers

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**690.31 (E)(4) Marking and Labeling Methods and Locations.** When any wiring systems are used for photovoltaic direct current systems, they are required to be labeled or marked, and shall be visible after installation. Photovoltaic power circuit labels shall appear on every section of the wiring system that is separated by enclosures, walls, partitions, ceilings, or floors. Spacing between labels or markings, or between a label and a marking, shall not be more than 3 m (10 ft). Labels required by this section shall be suitable for the environment where they are installed.

**690.31 (E)(3) Marking or Labeling Required.** The 2011 Code has added this new subdivision to address the marking and labeling requirements of dc photovoltaic systems. The following wiring methods and enclosures that contain PV power source conductors shall be marked with the wording "Photovoltaic Power Source" by means of permanently affixed labels or other approved permanent marking:

- (1) Exposed raceways, cable trays, and other wiring methods
- (2) Covers or enclosures of pull boxes and junction boxes
- (3) Conduit bodies in which any of the available conduit openings are unused

**690.31 (E)(2) Flexible Wiring Methods.** This new subdivision was added to the 2011 code to address flexible wiring systems that contain photovoltaic dc systems. Where flexible metal conduit (FMC) smaller than metric

designator 21 (trade size 3/4) or Type MC cable smaller than 25 mm (1 in.) in diameter containing PV power circuit conductors is installed across ceilings or floor joists, the raceway or cable shall be protected by substantial guard strips that are at least as high as the raceway or cable. Where run exposed, other than within 1.8 m (6 ft) of their connection to equipment, these wiring methods shall closely follow the building surface or be protected from physical damage by an approved means.

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**211) Metal Clad cable used as a wiring method for a photovoltaic system is required to be \_\_\_\_\_.**

- A) Marked
- B) Labeled
- C) Identified
- D) All listed answers

**212) If using a flexible wiring method to install a PV system, the cable or system is required to be labeled at intervals not to exceed \_\_\_\_\_.**

- A) 5 ft
- B) 10 ft
- C) 15 ft
- D) 20 ft

**213) Labels used to mark PV systems cables are required to be \_\_\_\_\_ suitable.**

- A) Openly
- B) Directly
- C) Environmentally
- D) Systematically

**214) True or False, photovoltaic power circuit labels are required to be installed on every section of a wiring system that is separated by a wall.**

- A) True
- B) False

**215) Any conduit or cable tray system that contains dc circuits for a photovoltaic system are required to be \_\_\_\_\_.**

- A) Painted
- B) Dedicated
- C) Labeled
- D) Rigid

**216) A label that identifies dc conductors for a photovoltaic system are present is required to read "Photovoltaic \_\_\_\_\_".**

- A) Power Source
- B) Potential
- C) Service
- D) System

**217) True or False, a pull box that have pass through dc photovoltaic conductors contained are not required to have a label affixed.**

- A) True
- B) False

**218) The affixed labels used to identify that dc photovoltaic circuits are present is required to have an approved \_\_\_\_\_ marking.**

- A) Large
- B) Open
- C) Permanent
- D) Fixed

**219) A flexible metal conduit that has a 1/2" diameter and is installed across ceiling floor joists that contains PV conductors is required to be protected by \_\_\_\_\_.**

- A) Guard Strips
- B) 3/8" mesh
- C) 1/4" particle board
- D) Mesh weave

**220) A metal clad cable that has a 3/4" diameter and is installed across ceiling floor joists that contains PV circuits is required to be protected by \_\_\_\_\_.**

- A) 1/8" mesh
- B) 3/16" particle board
- C) Mesh Stripping
- D) Guard Strips

**221) True or False, PV cables are not required to closely follow the building surface or be protected from physical damage by an approved means if limited access to the cables is provided.**

- A) True
- B) False

**222) According to the 2011 code, a flexible wiring method installed for a PV system is not required to be protected within \_\_\_\_\_ of their connection to equipment.**

- A) 6 ft
- B) 7 ft
- C) 8 ft
- D) 9 ft

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**690.31 (E)(1) Beneath Roofs.** The 2011 code has added this new subdivision to address photovoltaic dc systems installed under roofs. Wiring methods for PV systems shall not be installed within 25 cm (10 in.) of the roof decking or sheathing except where directly below the roof surface covered by PV modules and associated equipment. Circuits shall be run perpendicular to the roof penetration point to supports a minimum of 25 cm (10 in.) below the roof decking.

Informational Note: The 25 cm (10 in.) requirement is to prevent accidental damage from saws used by fire fighters for roof ventilation during a structure fire.

**690.16 (B) Fuse Servicing.** The 2011 code requires a disconnecting means to be installed on PV output circuits where overcurrent devices (fuses) must be serviced that cannot be isolated from energized circuits. The disconnecting means shall be within sight of, and accessible to, the location of the fuse or integral with fuse holder and shall comply with 690.17. Where the disconnecting means are located more than 1.8 m (6 ft) from the overcurrent device, a directory showing the location of each disconnect shall be installed at the overcurrent device location. Non-load-break-rated disconnecting means shall be marked "Do not open under load."

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**223) What section of the 2011 code addresses the minimum distances from roof decking PV dc wiring methods can be installed.**

- A) 690.31 (E)(2)
- B) 690.31 (E)(3)
- C) 690.31 (E)(1)
- D) 680.31 (E)(1)

**224) PV systems are required to be installed below \_\_\_\_\_ of a structures roof decking or sheathing.**

- A) 8 inches
- B) 6 inches
- C) 9 inches
- D) 10 inches

**225) PV circuits are required to be run \_\_\_\_\_ to the roof penetration point.**

- A) Parallel
- B) Perpendicular
- C) Next
- D) Concealed

**226) The minimum distance requirement from roof decking or sheathing to PV systems came about due to concerns from the \_\_\_\_\_.**

- A) Fire Department
- B) Utility
- C) General Contractor
- D) Electrical Contractor

**227) A disconnect is required to service fuses for photovoltaic systems if they cannot be \_\_\_\_\_ from energized parts.**

- A) Closed
- B) Open
- C) Isolated
- D) Verified

**228) A disconnect used to service fuses for a PV system are required to comply with the installation provisions of \_\_\_\_\_.**

- A) 690.(A)(2)
- B) 690.17
- C) 250.46
- D) 240.6

**229) If a disconnect is installed more than \_\_\_\_\_ from the fuses or fuse holder it disconnects in a photovoltaic system, then a directory showing the location of all disconnects is required where fuses or fuse holder are located.**

- A) 2 ft
- B) 4 ft
- C) 6 ft
- D) 44 inches

**230) A Non-load-break-rated disconnect used to disconnect a PV system is required by this code to be marked on its cover “\_\_\_\_\_.”**

- A) Do not reset load
  - B) Open Here
  - C) Open with other loads
  - D) Do not open under load
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**690.11 Arc-Fault Circuit Protection (Direct Current).** A photovoltaic system with either dc source or output circuits, or both that penetrates a building operating at a maximum system voltage of 80 volts or greater is required to be protected by a listed (dc) arc-fault circuit interrupter or other listed device that provides equivalent protection. The PV arc-fault protection means shall comply with the following requirements:

- (1) The system shall detect and interrupt arcing faults resulting from a failure in the intended continuity of a conductor, connection, module, or other system component in the dc PV source and output circuits.
- (2) The system shall disable or disconnect one of the following:
  - a. Inverters or charge controllers connected to the fault circuit when the fault is detected
  - b. System components within the arcing circuit
- (3) The system shall require that the disabled or disconnected equipment be manually restarted.
- (4) The system shall have an annunciator that provides a visual indication that the circuit interrupter has operated. This indication shall not reset automatically.

**690.4 (H) Multiple Inverters.** This section addresses the requirements of having multiple PV inverters. A photovoltaic system is allowed to have multiple utility-interactive inverters installed in or on a single building or structure. If the inverters are remotely located from each other, a directory in accordance with 705.10 it is required to be installed at every dc PV system disconnect, ac disconnect, and at the main service disconnect. This directory is required to show the location of all ac and dc PV system disconnecting means in a building.

Exception: A directory shall not be required where all inverters and PV dc disconnecting means are grouped at the main service disconnecting means.

**690.4 (G) Bipolar Photovoltaic Systems.** The 2011 code has added language which addresses bipolar photovoltaic systems. If the sum of two monopole subarrays voltages exceeds the rating of the conductors and connected equipment, the monopole subarrays in a bipolar PV system are required to be physically separated. The electrical output circuits from each monopole subarray are required to be installed in a separate raceway until connected to the inverter. The disconnect and overcurrent protective devices for each monopole subarray output shall be in separate enclosures. All conductors from each separate monopole subarray shall be routed in the same raceway.

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**231) A photovoltaic system is required to have a \_\_\_\_\_ dc arc-fault circuit interrupter installed for protection if it enters a building and operates at a dc voltage of 80 volts or more.**

- A) Listed
- B) Rated
- C) Manufactured
- D) Operating

**232) The arc fault protection for a photovoltaic system is required to detect and \_\_\_\_\_ any arcing faults.**

- A) Delay
- B) Interrupt
- C) Resolve
- D) Open

**233) A PV arc-fault circuit interrupter is required to disable or disconnect an arcing system circuit, \_\_\_\_\_ or charge controller.**

- A) Diode
- B) Transistor
- C) Inverter
- D) Bridge

**234) If an arc fault system disables or disconnects a photovoltaic system or equipment, this code requires it to be \_\_\_\_\_ restarted.**

- A) Partially
- B) Incrementally
- C) Sequentially
- D) Manually

**235) The photovoltaic arc fault system is required to have a \_\_\_\_\_ indication that the circuit interrupter has operated.**

- A) Colored
- B) Audible
- C) Visual
- D) Monitored

**236) True or False, when an arc fault system has activated and detected a fault, the optical indicator will reset after 30 seconds automatically.**

- A) True
- B) False

**237) Would it be considered acceptable or a violation of this code to install multiple PV inverters in an existing electrical room.**

- A) Acceptable
- B) Violation

**238) If multiple PV inverters are to be installed remotely from one another, a \_\_\_\_\_ must be installed at all ac and dc disconnecting means showing their locations.**

- A) Indicator
- B) Phenolic
- C) Causeway
- D) Directory

**239) If the voltages of two monopole subarrays exceeds the rating of the conductors and connected equipment, the 2011 code requires them to be \_\_\_\_\_.**

- A) Paralleled
- B) Insulated
- C) Physically separated
- D) Removed

**240) True or False, the electrical output circuits from each monopole subarray are required to be installed in the same raceway until connected to an inverter.**

A) True

B) False