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The answers to these questions are the opinion of the person that answered the question. They are not the position of the IAEI, IAEI Western Section, NFPA or a code making panel.

1. An electrical contractor installed 6 feeders without equipment grounds in PVC 20ft to from a service to a pull box in a lower level of a building. He wants to resolve this issue by installing one equipment ground outside the raceways from the service to the pull box. Is this code compliant?

Answer: Not allowed. Code section – 250.120(A), 250.102(E)(2). This is not allowed to be installed outside of the PVC conduit. Bonding jumpers are allowed to be installed on the outside of conduits , but may not exceed 6' in length.

2. I have a 4160V feeder supplying a 4160V/480V oil filled transformer that is being installed inside a building to supply a single fire pump, is the transformer permitted to be installed in the same room as the fire pump? What are the requirements for the room?

Answer: Yes- There is no prohibition in Article 695 NEC for the transformer. NFPA 20 Installation of Stationary Pumps for Fire Protection (2010 edition) Section 4.12.1.1 addresses indoor fire pump units.

In a high-rise building the pump room is required to be separated by 2-hour fire barrier or in a separate building 50 feet away.

In non-high-rise if the building or room is not fully sprinkler protected the room requires 2-hour separation or 50 feet away, and fully sprinkler protected 1-hour separation or 50 feet away.

Section 4.12.1.1.4 would allow essential equipment to the operation of the pump to be in the room.

3. I am installing a fixed electrical radiant heating system under the floor of a building. Each section has a rated ampacity of 15.6 amps at 227V single phase. Is it permitted to install 12-#10 THHN conductors (6 circuits) in a 1 inch EMT conduit for 150 feet in length to the relay panel that controls the individual heat mat section?

Answer: NEC 424.22 (E) Conductors shall be sized at not less than 125% of load served
 $15.6 \text{ amps} \times 1.25 = 19.5 \text{ amps} \times 277\text{V} = 5,402 \text{ watts}$

NEC Table 310.15(B)(16) #35
NEC Table 310.15(B)(3)(a) 50% of 35 amps = 17.5 amps
 $35 \times 50\% = 17.5\text{A}$ amps Need 19.5 amps

NEC 240.4(B) & (D) allows rounding up 20A over current protection
20A , single pole, 277V would meet code

Excessive length of 150 ft may cause low voltage, additional heating at terminals, and possibly continuous operation tripping depending on surrounding ambient temperature. Where is conduit? What is floor? What is temperature where overcurrent device is located? Most likely a poor installation.

4. I installed an optional standby system for a customer that wants to just run heat off from the generator to keep pipes from freezing, it is an automatic transfer switch but the customer will shut off breakers before he leaves to control the load. The inspector rejected this system and said it would be required to have load shedding, is he right?

Answer: He is right. I would say the inspector is correct based on Section 702.4 that requires the optional standby systems to be sized for the full load or have load shedding capabilities.

702.4 Capacity and Rating.

(B) System Capacity. The calculations of load on the standby source shall be made in accordance with Article 220 or by another approved method.

(2) Automatic Transfer Equipment. Where automatic transfer equipment is used, an optional standby system shall comply with (2)(a) or (2)(b).

(a) Full Load. The standby source shall be capable of supplying the full load that is transferred by the automatic transfer equipment.

(b) Load Management. Where a system is employed that will automatically manage the connected load, the standby source shall have a capacity sufficient to supply the maximum load that will be connected by the load management system.

5. Does a walk way that overlooks a family room and is 25 feet long require a receptacle? It is open on both sides.

Answer: Reference: 210.52(H)

Answer: Probably

First let us look at the differentiation between walkway vs a hallway. According to Webster's Collegiate Dictionary 11th edition, which is the official NFPA dictionary. "walkway" is defined as a passage of walking, whereas "hallway" when used in the form of a corridor is a passageway into which compartments or rooms open. 210.52(H) first appeared in the 1990 NEC ROP 2-137 and related 2-138 with no definition of hallway however the substantiation stated receptacles are necessary in long hallways to avoid equipment (such as vacuum cleaners being powered from adjoining rooms leading to stretched cords, bent and damaged plugs and receptacles.

(H) Hallways. In dwelling units, hallways of 3.0 m (10 ft) or more in length shall have at least one receptacle outlet. As used in this subsection, the hallway length shall be considered the length along the centerline of the hallway without passing through a doorway.

Not sure if the submitter is present in the room but it would be interesting to know if the objective here is to call this a walkway only to avoid the requirement. Its obvious looking at the substantiation, the requirement should be the same for either as the same risk apply to both. Bottom line this is going to be an AHJ call.

6. A 400-amp service is made up of two 200 amp main breaker panelboards that are connected together by nipples. Can the service conductors pass through one panel to supply the other panelboard?

Answer: There is nothing currently in the NEC that would prohibit this installation.

7. A church undergoes a service change, the previous gear was rated at 800a and was replaced with the same size gear, and the personnel doors to the area do not comply with Article 110.26(C)(3), should the doors be updated to panic hardware and egress door swing?

Answer: Yes. 110.26(C)(3). This would be a new installation, and therefore would be required to have all doors within 25' of the service gear be equipped with panic hardware and doors must swing in the direction of egress

8. Can a receptacle behind a TV (below 5.5 feet) count for wall space above a work area/counter or is it considered not accessible?

Answer: Yes

If the receptacle placement meets all the requirements of 210.52. The receptacles required by this section shall be in addition to any receptacle that is:

- (1) Part of a luminaire or appliance, or
- (2) Controlled by a wall switch in accordance with 210.70(A)(1), Exception No. 1, or
- (3) Located within cabinets or cupboards, or
- (4) Located more than 1.7 m (5 ½ ft) above the floor

Reference: NEC 210.52

**Leave it to the discretion of the AHJ

9. If I have a switchboard/ panelboard or MCC and the label on the front says 480 volt 3 phase 4 wire, am I required to install a feeder with a grounded conductor to the switchboard/panelboard or MCC if I will not have any line to neutral loads supplied by the equipment?

Answer: Not knowing what tomorrow holds, it would be much more economical to pull a grounded conductor with the original pull than try to repull the 4th conductor at a time when it is needed.

I don't know the ampere rating of equipment or internal components of equipment but manufacture's listing labeling requires 4th wire. Manufacturer equipment may contain components that were designed to use neutral connection. There is no code requirement requiring that a grounded conductor must be pulled with a feeder.

10. Is it required that 'reconditioned' equipment now be 'listed' or only marked?

Answer: The 2017 and the 2020 just require the reconditioned equipment to be marked and not listed. The 2020 code will require the original listing mark removed.

110.21(A)(2) Reconditioned Equipment. Reconditioned equipment shall be marked with the name, trademark, or other descriptive marking by which the organization responsible for reconditioning the electrical equipment can be identified, along with the date of the reconditioning. Reconditioned equipment shall be identified as "reconditioned" and approval of the reconditioned equipment shall not be based solely on the equipment's original listing.

Exception: In industrial occupancies, where conditions of maintenance and supervision ensure that only qualified persons service the equipment, the markings indicated in 110.21(A)(2) shall not be required.

Informational Note: Industry standards are available for application of reconditioned and refurbished equipment. Normal servicing of equipment that remains within a facility should not be considered reconditioning or refurbishing.

11. I have a pull box that has multiple sets of 4/0 Copper coming in and going various directions. The customer now wants to tap off another set. Do I have to bond the box now that there is a tap and if so how do I do it?

Answer: Yes. Reference: 250.148 and 250.148(C)

250.148 Continuity and Attachment of Equipment Grounding

Conductors to Boxes. If circuit conductors are spliced within a box or terminated on equipment within or supported by a box, all equipment grounding conductor(s) associated with any of those circuit conductors shall be connected within the box or to the box with devices suitable for the use in accordance with 250.8 and 250.148(A) through (E).

(C) Metal Boxes. A connection shall be made between the one or more equipment grounding conductors and a metal box by means of a grounding screw that shall be used for no other purpose, equipment listed for grounding, or a listed grounding device.

Prior to the 2002 NEC 250.148 required that all EGC's be spliced or joined and in (B) required a connection to the metal box.

ROP 5-286 and ROC 5-159 revised the requirement so that only when the circuit conductors are spliced within the box or terminated on equipment that bonding to the metal box is required.

12. When doing the load calculations in accordance with Article 220, does the result need to be multiplied by 125% if it is a lighting load? If so, what is the NEC reference? The 125% is found in the branch circuit, feeder, etc. Articles; however, it is not to be found in Article 220.

Answer: The 125% rules cited in the question found in Article 210, Branch Circuits, 215, Feeders are related to conductor and overcurrent rating and ampacity. So for example, per 210.19(A)(1)(a) requires a 125% multiplier when determining allowable ampacity. There is no requirement in Article 220 to multiply continuous loads by 125 percent. It is not included as a requirement in Article 220 because the calculated load (in Article 220) and the required ampacity (210 & 215) are two different things and are discussed in two

different sections of the code. The wire has to be able to carry 125%, but the service does not have to be sized to supply 125% of the calculated load.

13. Does an increase in distance from the breaker increase incident energy? Does an increase in distance from the secondary side of a transformer decrease incident energy?

Answer: It depends. The further downstream the arcing fault, the lower the value of the arcing current due to more conductor impedance. If this reduced arcing current is still within the instantaneous trip region, the incident energy may actually be reduced. However if the lower value of the arcing current is not in the instantaneous trip region, the incident energy will increase. The reason for this is incident energy is a combination of clearing time and arcing current. With a circuit breaker, when in the instantaneous region the incident energy increases with higher arcing current. However, when the arcing current is less than the instantaneous trip, then the incident energy increases as the arcing current decreases. The next slide shows an example of this issue as noted per NFPA 70E, Table 130.5(C) informational note no. 3.

For the transformer question, more information is needed to determine the answer, but the same logic mentioned above still applies. Reduction of the arcing current due to added impedance may either decrease or increase the incident energy.

14. Does the size of breaker matter in calculating incident energy? I.E. if we go through several breakers is it the fact that the breakers get smaller the further into the system you go decrease incident energy or is it the clearing times that are decreasing incident energy? Example: 200 Amp Main Breaker, 100 Amp Feeder Breaker to next panel, 20 Amp branch circuit breaker

Answer: No. When considering the incident energy for a particular system, the available arcing current and clearing time of the overcurrent device are the two factors that can be potentially be adjusted. The available arcing current level is based on the available fault current so just as the available fault current normally drops as you move away from the service so does the arcing current. For molded case circuit breakers as stated in this example, the instantaneous tripping levels are usually around 10x the rated current and have clearing times around 1 – 2 cycles. Some may suggest by extension that the incident energy drops as you move away from the service but this should ALWAYS be verified through calculation versus being assumed.

When the available arcing current drops in the system it could land outside the instantaneous tripping region and thus result in an extended clearing time leading to much higher incident energy levels. One example of where this can occur is when calculating the incident energy of the system when fed from a generator. The low

available fault current and arcing current can mean the overcurrent devices are in their time delay regions of operation. Again, the determination of incident energy at each point in the system depends upon the arcing current and clearing time. The incident energy may or may not follow the normal reduction in circuit breaker sizes within a system.

15. 110.16(B) requires a label on 1200 Amp or more service equipment. Where do I get the 'Clearing Time' information if the Utility doesn't have it?

Answer: The utility can give you the transformer size and available fault current. Clearing time can be determined by reviewing the time current trip curves specific for the over current device installed.

16. How are grounding and bonding conductors counted when derating conductors for ampacity?

Answer: Not Counted. Grounding and bonding conductors are not counted per Section 310.15(B)(6).

310.15(B)(6) Grounding or Bonding Conductor. A grounding or bonding conductor shall not be counted when applying the provisions of 310.15(B)(3)(a). [2020 - 310.15(F)]

17. Is a servicing disconnect required on the side of a furnace in a house, even if it is in the same room as the panel?

Answer: Reference 422.31(C)

Answer Probably not

(C) Motor-Operated Appliances Rated over 1/8 Horsepower. The disconnecting means shall comply with 430.109 and 430.110. For permanently connected motor-operated appliances with motors rated over 1/8 hp, the disconnecting means shall be within sight from the appliance or be capable of being locked in the open position in compliance with 110.25.

Assuming we are referring to a typical gas or oil furnace that are defined as an appliance and covered under Article 422. So if the panel meets the definition of with in sight from the branch circuit breaker would be acceptable as the required disconnecting means.

18. I just installed a 480 volt fused service for a large chiller. The inspector told me I had to carry a grounded conductor to the service even though it will never need a neutral. This is pure motor load only. Why is that?

Answer: You must have the grounded conductor brought to the service disconnecting means per 250.24(C):

(C) Grounded Conductor Brought to Service Equipment. Where an ac system operating at 1000 volts or less is grounded at any point, the grounded conductor(s) shall be routed with the ungrounded conductors to each service disconnecting means and shall be connected to each disconnecting means grounded conductor(s) terminal or bus. A main bonding jumper shall connect the grounded conductor(s) to each service disconnecting means enclosure. The grounded conductor(s) shall be installed in accordance with 250.24(C)(1) through 250.24(C)(4).

AC current must always return to its source, so if a ground fault occurs from a phase conductor to the motor frame for instance, the fault current will flow through the equipment-grounding conductor to the main bonding jumper and over the grounded circuit conductor back to the transformer. The current flow that results will cause the fuse in the faulted circuit conductor to open.

19. When I am wiring a house that has been moved from one address to another address is it required to install tamper-resistant receptacles and install arc-fault protection and install ground-fault protection?

Answer: NO, 90.2(A), Annex H 80.9(A). The presently adopted NEC would apply in most Jurisdictions to new installations, existing installations would be expected to be in compliance with the Code which was in effect at the time of the installation of the electrical wiring. If new receptacles were installed, that wiring would be installed with the present Code requirements. Existing receptacles and circuits could remain as installed and AFCI and GFCI protection would not be needed.

If receptacles were being replaced, then additional requirements need to be addressed. NEC 406.4(D)

(D)(1) Grounding type receptacles where a grounding means exist within the box.

(D)(2) Non grounding receptacle replacement requirements

(D)(3) GFCI protection required if receptacles located in areas where GFCI is required by present NEC.

(D)(4) AFCI protection required for receptacles located in areas where AFCI protection required by present NEC

210.12(D) If existing circuits were to be extended where AFCI protection is required by 210.12(A), then the AFCI protection would be required for the new portion of the extended branch circuit.

20. Does the coffee maker and the roller dog machines require GFCI protection on the serving counter of a convenience store?

Answer: No.

Reference: 210.8 (B) Other than Dwelling Units.

(2) Kitchens

Article 100 - Kitchen. An area with a sink and permanent provisions for food preparation and cooking. (CMP-2)

Kitchen. An area with a sink and permanent provisions for food preparation and cooking.

21. . I was asked to bring power to a control box for a certain piece of equipment. The inspector told me it is not listed. I do see a UL mark on all the parts including the enclosure that they are in and that UL sticker reads "Industrial Panel Enclosure". What is up with this?

Answer: It appears that UL listed the equipment enclosure not the final assembly.

22. I was called to do a service change on an older home. I have to move the panel over to the right about 6 feet to gain proper working clearances and dedicated space issues. Am I required to install AFCI breakers in this new panel?

Answer: No. There is an exception to 210.12(D) that does not require AFCI protection for extensions or modifications that are six feet or less in length and that does not include additional outlets or devices.

210.12(D) Branch Circuit Extensions or Modifications — Dwelling Units and Dormitory Units. In any of the areas specified in 210.12(A) or (B), where branch-circuit wiring is modified, replaced, or extended, the branch circuit shall be protected by one of the following:

(1) (At the Breaker)

(2) (At the Receptacle)

Exception: AFCI protection shall not be required where the extension of the existing conductors is not more than 1.8 m (6 ft) and does not include any additional outlets or devices.

23. I have a 1200 amp main service with a 400 amp feed to a subpanel. This feeder is a parallel run set in two separate raceways. The ungrounded conductors are 250 kcmil aluminum. What is the minimum size equipment grounding conductor required in each raceway?

Answer: 1/0 Copper or Alum. Reference 250.122, 310.10(H)

250.122(F)(1) (b) Multiple Raceways. If conductors are installed in parallel in multiple raceways, wire type equipment grounding conductors, where used, shall be installed in parallel in each raceway. The equipment grounding conductor installed in each raceway shall be sized in compliance with 250.122 based on the overcurrent protective device for the feeder or branch circuit. Metal raceways or auxiliary gutters in accordance with 250.118 or cable trays complying with 392.60(B) shall be permitted as the equipment grounding conductor.

310.10(H)) Conductors in Parallel. (1) General. Aluminum, copper-clad aluminum, or copper conductors, for each phase, polarity, neutral, or grounded circuit shall be permitted to be connected in parallel (electrically joined at both ends) only in sizes 1/0 AWG and larger where installed in accordance with 310.10(H)(2) through (H)(6).

Example:

250.122 400Amp OCPD =#3CU

310.10(H) Requires 1/0 CU

Answer:

1/0 Conductor is required in each parallel run.

24. I have a piece of equipment with a SCCR rating of only 5k, but I have an available fault-current of about 8k. What options do I have to correct this? And why does so much equipment have only a 5k SCCR rating?

Answer:

- Install transformer
 - Increase conductor length
 - Equipment modification and field evaluation
 - Install current-limiting fuses where permitted per the AHJ. In this application, if overcurrent devices are present, they must have an interrupting rating equal or great to the calculated available fault current.
25. . I am wiring a new home that is slab on grade so I got there ahead of time and run a PVC conduit from the exterior wall out to where the island will be. I slipped a piece of NM cable through the pipe and had it rolled up lying on the floor when I called for my rough-in inspection. The inspector said I have to change it. Why?

Answer. Code section 334.12(B)(4), 300.5(B).vNM cables are only allowed to be installed in dry locations, and are prohibited from being installed in wet or damp locations. The interior of raceways installed underground are considered to be a wet location. Therefore a wet location type conductor shall be installed, such as UF, THWN or XHHW conductors.

26. I installed a meter-main on the outside of a single-family dwelling, but the UFER is stubbed up in the basement near the sub-panel location. Where do I connect the grounding electrode conductor from that UFER?

Answer: The service disconnect.

Reference: 250.24 (A) (1) General. The grounding electrode conductor connection shall be made at any accessible point from the load end of the overhead service conductors, service drop, underground service conductors, or service lateral to, including the terminal or bus to which the grounded service conductor is connected at the service disconnecting means.

27. Can I feed a multi-wire feeder to a detach garage and the put in a panel board with 3 single-pole breakers and 3 double-pole breakers and without main breaker?

Answer: Yes, per NEC 225.33, the disconnecting means for each power supply permitted by 255.30 shall consist of not more than 6 switches or 6 circuit breakers in a single enclosure.

28. Does a receptacle installed near the roof for snow melting and de-icing heat cables require to be GFCI protected?

Answer: No. The exception in 210.8(A)(3) and 210.8(B)(4) does not require GFCI protection the provisions in 426.28 or 427.22 would require GFP protection, but not GFCI protection.

210.8(A)(3) and 210.8(B)(4) Outdoors

Exception: Receptacles that are not readily accessible and are supplied by a branch circuit dedicated to electric snow-melting, deicing, or pipeline and vessel heating equipment shall be permitted to be installed in accordance with 426.28 or 427.22, as applicable.

29. I have a question on NEC 210.25(A) which says. "Branch circuits in dwelling units shall supply only loads within that dwelling unit or loads associated only with that dwelling unit. The question is: Due to space constraints, the builder wants to put both water heaters in the basement apartment of a two-family dwelling unit. Each water heater

would be fed with a branch circuit from the dwelling unit panel associated with that water individual water heater. (Each dwelling unit panel is fed from its own breaker in a 2-gang meter stack.) In this instance the branch circuit would be feeding a load associated with, but not in a particular unit. The load would be in another unit.

Answer: Reference: 210.25(A)

Answer: Permitted

210.25 Branch Circuits in Buildings with More Than One Occupancy. (A) Dwelling Unit Branch Circuits. Branch circuits in each dwelling unit shall supply only loads within that dwelling unit or loads associated only with that dwelling unit.

The key here is that branch circuits shall only supply loads within that dwelling unit. The location of the equipment is not a concern.

30. I have a question regarding the grounding electrode requirement for a feeder to a separate structure (NEC 250.32). We have a solar array several hundred feet from the building. The inverters are located at the array, with the AC side from the inverters landing in an AC combiner panel (two 50-amp 480-volt breakers). The combiner panel feeds to the building through a required disconnect on the outside of the building then into the MDP for a load side connection. Is a grounding electrode connection at the building disconnect required? 250.32 says Buildings...supplied by a feeder. Is this building supplied by a feeder from the array? Or is the array supplied by the feeder from the building? The definition of feeder of conductors between source and final branch circuit device would imply the two 50-amp 480-volt breakers are the branch circuit devices. Plainly it takes very little to confuse me.

Answer: Based on the 2017 NEC, Section 690.2 created a new term "Interactive Inverter Output Circuit". This term is defined as "The conductors between the interactive inverter and the service equipment or another electrical power production and distribution network." Based on this definition the conductors described would not be feeders, they are an interactive inverter output circuit.

Fast forward to the 2020 NEC and the new term "Interactive Inverter Output Circuit" created in the 2017 NEC disappears. Due to global task work with definitions, a lot of the .2 definitions throughout the NEC have been relocated to Article 100 as the terms were used in more than one NEC Article. Also, there were similar terms defined by more than one Article such as Interactive Inverter Output Circuit (690.2), Inverter Output Circuit (690.2), Inverter Output Circuit (694.2), Interactive Inverter Output Circuit (705.2) and Inverter Output Circuit (706.2).

Article 690 was not immune to this work and now defines "Inverter Output Circuit" as the "Conductors connected to the ac output of an inverter." With this definition, the conductor between the AC combiner to the disconnect on the separate structure then

from that disconnect to the MPD would be seem to fall under Article 100's definition of a "Feeder." All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch-circuit overcurrent device.

Now, since this separate structure already has the MPD, I would assume the building already has a grounding electrode system and the building is only separate from the PV array and inverter equipment. If that is a correct assumption, will the 2020 NEC now require a second grounding electrode system? It would be my opinion that it would not as a building is only required by Article 250 to have one grounding electrode. Per Section 250.50, all grounding electrodes that are present are to be bonded together to create a single grounding electrode system. The only exception to the requirement of Section 250.50 would be an auxiliary grounding electrode installed per Section 250.54.

31. Can a main breaker with a spare lug be used to attach a line side connection from a solar inverter? Can a main breaker with a spare lug be used to attach other service conductors to feed a small service disconnect next to each other. line side or load side or "tap" is ampacity is good.

Answer: Yes. 705.12(A), 110.3(B), 230.71, 230.72 Yes, this would be permitted to connect the PV system on the line side of the main breaker. The sum of the ratings of all of the overcurrent devices connected to the service must not exceed the rating of the service.

Yes to 2nd part also – Allowed up to six service disconnected provided they are grouped together. The "tap" service conductors would need to be properly protected by the overcurrent device they are terminated into.

32. A PV system that is ground mounted and use a 24 to 36 inch bored footings 4 to 5 feet deep and having 5, ½ inch rebar cut into 4 feet length and connecting them together with a #4 copper conductor to fit in the bored footings and incased in concrete. My question does this meet the requirements for 250.52(A)(3) Concrete-Incased Electrode? What is the minimum length of rebar and bored hole that can be cut for this type of installation?

Answer: Yes. Reference: 250.52 (A)(3) Concrete-Encased Electrode.

A concrete-encased electrode shall consist of at least 6.0 m (20 ft) of either (1) or (2):

(1) One or more bare or zinc galvanized or other electrically conductive coated steel reinforcing bars or rods of not less than 13 mm (1/2 in.) in diameter, installed in one continuous 6.0 m (20 ft) length, or if in multiple pieces

connected together by the usual steel tie wires, exothermic welding, welding, or other effective means to create a 6.0 m (20 ft) or greater length; or

(2) Bare copper conductor not smaller than 4 AWG

33. I am remodeling a building that an optometrist will be doing Laser Surgery for correcting vision among other services that they offer. My question is does the part of the building that will be part of the laser surgery need to meet the requirements of 517 of the NEC? I do not see where the optometrist needs to meet the requirement.

Answer: Yes because it is a patient care space and will require a metal raceway and isolated and insulated equipment grounding conductors per NEC 517.13.

34. How often does the ground-fault protection for equipment need to be tested? 230.95 (C) states when it is installed a performance testing is required but after that it is not clear when it needs to be tested after that.

Answer: The NEC in Section 230.95(C) requires performance testing when first installed on site and does not require additional testing. The installation instructions in 110.3(B) may require additional testing by the manufacturer.

230.95(C) Performance Testing. The ground-fault protection system shall be performance tested when first installed on site. This testing shall be conducted by a qualified person(s) using a test process of primary current injection, in accordance with instructions that shall be provided with the equipment. A written record of this testing shall be made and shall be available to the authority having jurisdiction.

35. I am feeding a fused AC disconnect from AC combiner panel that receives it power from three inverters from a large solar array. NEC 240 requires the fuses in the AC disconnect need to be de-energized when the switch is open. How does one do that when both sides are hot?

Reference: 90.3, 240.40 & 690.13(B) Answer: Permitted With Conditions
690.13 Photovoltaic System Disconnecting Means. Means shall be provided to disconnect the PV system from all wiring systems including power systems, energy storage systems, and utilization equipment and its associated premises wiring. Means shall be provided to disconnect the PV system from all wiring systems including power systems, energy storage systems, and utilization equipment and its associated premises wiring.

B) Marking. Each PV system disconnecting means shall plainly indicate whether in the open (off) or closed (on) position and be permanently marked "PV SYSTEM DISCONNECT" or equivalent. Additional markings shall be permitted based upon the specific system configuration. For PV system disconnecting means where the line and load terminals may be energized in the open position, the device shall be marked with the following words or equivalent:

WARNINGELECTRIC

SHOCK HAZARD

TERMINALS ON THE LINE AND LOAD SIDES

MAY BE ENERGIZED IN THE OPEN POSITION

Chapter 6 may supplement or modify the requirements in Chapters 1 through 7 (Article 90.3). Therefore 690.13(B) would permit both line and load lugs to be energized with the proper warning label installed.

36. On a residential install, the well is 200' feet deep. NEC 430 does not require a disconnect within sight as it is considered impractical. If the controller is mounted in the house, can that disconnect be used for the motor as well? Does there have to be a disconnect at the well head?

Answer: 430.102(B)(1) Separate Motor Disconnect. A disconnecting means for the motor shall be located in sight from the motor location and the driven machinery location.

430.102(B)(2) Controller Disconnect. The controller disconnecting means required in accordance with 430.102(A) shall be permitted to serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.

Exception to (1) and (2): The disconnecting means for the motor shall not be required under either condition (a) or condition (b), which follow, provided that the controller disconnecting means required in 430.102(A) is lockable in accordance with 110.25.

(a) Where such a location of the disconnecting means for the motor is impracticable or introduces additional or increased hazards to persons or property

See also Informational Note No. 1 which includes submersible motors and a well pump is submersible. All the provisions of the exception must be met in this case. It is best to check with the local AHJ on their requirements for well pump motor disconnects as they may have a local rule that amends the NEC requirements.

37. I have a brewery with process equipment such as barite tanks, fermenting tanks and mash tanks all in the same room location. The motor control center with motor starters and control circuits are located in a separate electrical room. The feeder breaker for the

Motor control center is in the same room as the tanks. Can I use the lockable feeder breaker as the disconnecting means for all of the equipment?

Answer: Code section: 430.102(A) & (B).

430.102(A) requires individual disconnecting means be provided for each motor controller.

430.102(B) requires a disconnecting means be provided for a motor in accordance with (B)(1) or (B)(2).

(B)(1) requires a disconnect be located within sight of the motor and driven machinery location. Motor is singular in this section

(B)(2) allows the controller disconnect required by 430.102(A) to be the disconnect for the motor if located within sight of the motor or driven machinery location.

The main breaker for the MCC would not be allowed to serve as the disconnect for all equipment. In these breweries, the size of equipment, tanks, etc. would most likely not meet the "in sight of" requirement either.

38. In a residential house with NM cable run throughout with spray foam insulation applied to the walls. Is the spray foam compatible with the NM cable insulation? Does the NM cable have to be de-rated because of the bundling of cables above the circuit breaker panel?

Yes and Yes.

<https://www.nema.org/Technical/Documents/Thermal%20Effects%20of%20Residential-Installed%20Type%20NM-B%20Cable.pdf>

A report from the University of Toronto in 1985 illustrates the potential heating effects of Type NM-B Cable when encased in spray foam insulation. In reviewing the test results for the 1985 University of Toronto study, the maximum temperatures reached for the 14 AWG and 12 AWG conductors were 48.8°C and 53.9°C respectively. Reference: 334.80 requires ampacity adjustment when...

More than two Type NM-B cables are run through a bored hole that is to be fire or draft stopped using thermal insulation or sealing foam, the ampacity must be adjusted.

More than two NM cables containing two or more current-carrying conductors are installed in contact with thermal insulation without maintaining spacing between cables, the allowable ampacity of each conductor shall be adjusted in accordance with Table 310.15(B)(3)(a).

39. I am using the tap rules allowed in NEC Article 240.2(B) (5). I am tapping off the load side of the 400 amp service disconnect with #2 CU cables that feed a 100 amp main breaker CB panel. When sizing the equipment grounding conductor, table 250.122, do I size it for a 400 amp breaker or can I size it for 100 amp breaker?

Answer: NEC 250.122(G) Yes, size for 400A. #3 is smaller than #2 phase conductor.

40. I keep finding that some electricians like to run the NM cables across the trusses, they consider the trusses are support. But 334.30 requires that NM cable needs to be secured no more that 4-1/2 ft. apart. And when run them at extreme angles there may be a lot longer between trusses. Can they do this without violating 334.30?

Answer: No, it is a violation. NM Cable shall be secured and supported every 4 1/2 feet. Laying on the top of a truss would not meet this requirement.

334.30 Securing and Supporting. Nonmetallic-sheathed cable shall be supported and secured by staples; cable ties listed and identified for securement and support; or straps, hangers, or similar fittings designed and installed so as not to damage the cable, at intervals not exceeding 1.4 m (4 1/2 ft) and within 300 mm (12 in.) of every cable entry into enclosures such as outlet boxes, junction boxes, cabinets, or fittings. Flat cables shall not be stapled on edge.

Sections of cable protected from physical damage by raceway shall not be required to be secured within the raceway.

41. A 200-amp circuit is increased from 3/0 copper to 500 kcmil copper to compensate for voltage drop. What size copper equipment grounding conductor would be required for this circuit?

Reference: 250.22(B)

Answer: #1 AWG CU

(B) Increased in Size. Where ungrounded conductors are increased in size from the minimum size that has sufficient ampacity for the intended installation, wire-type equipment grounding conductors, where installed, shall be increased in size proportionately, according to the circular mil area of the ungrounded conductors.

Example:

200-ampere feeder normally requires a 3/0 copper conductor

A 6 AWG EGC would normally be installed

For excessive voltage drop, the feeder size needs to be increased from 3/0 to 500 kcmil copper

3/0 copper is 167,800 cm per Table 8, Chapter 9 of NEC

$500,000 \text{ kcmil} \div 167,800 \text{ kcmil} = 2.989$

(2.98 is multiplier or ratio increased)

$26,240 \text{ (cir. mil. of 6 AWG)} \times 2.98 = 78,165$

Per Table 8 Chapter 9, the next larger size required would be a #1 AWG copper conductor (83,690 cm)

42. The AC output of a 5000 Watt 120/240 Volt solar power inverter is fed into the load terminals of a 2 pole 30 Amp circuit breaker located in an adjacent load center. The inverter has a factory supplied DC disconnect switch. Is this installation code compliant?

Answer:

Assuming the conductors are 10 AWG copper, that both the load center and inverter are installed in a readily accessible location and within sight (10 feet) of each other, based on the information provided, it appears to be.

690.8(A)(3) (3) Inverter Output Circuit Current. The maximum current shall be the inverter continuous output current rating. (5000 watts)

690.8(B) Conductor Ampacity. PV system currents shall be considered to be continuous. (125%)

$5000 \text{ w} \times 125\% = 6250 \text{ W}$

$6250 \text{ W} / 240 \text{ V} = 26.04 \text{ A}$

26 amperes would require a #10 AWG copper / #8 AWG aluminum

690.9(A) Circuits and Equipment. PV system dc circuit and inverter output conductors and equipment shall be protected against overcurrent.

26 amperes would require a 30 amp OCPD

690.13 Photovoltaic System Disconnecting Means. Means shall be provided to disconnect the PV system from all wiring systems including power systems, energy storage systems, and utilization equipment and its associated premises wiring.

690.13(A) Location. The PV system disconnecting means shall be installed at a readily accessible location.

690.15(A) Location. Isolating devices or equipment disconnecting means shall be installed in circuits connected to equipment at a location within the equipment, or within sight and within 3 m (10 ft) of the equipment. An equipment disconnecting means shall be permitted to be remote from the equipment where the equipment disconnecting means can be remotely operated from within 3 m (10 ft) of the equipment.

43. An electrician has set a 150 Amp 120/240 Volt single phase combination meter/main & panel service on a home. They uses a 100 Amp circuit breaker to feed # 2 Aluminum 4 wire SER cable that runs to a sub-panel in the home. The 100 Amp circuit breaker is the only breaker in the panel. Is this up to code?

Answer: NO. Code Section 310.15(B)(7)(1) & Annex D, Example D7, Table 310.15(B)(16) This installation would most likely be not be acceptable. The 100 ampere circuit breaker in the 150 amp panel is not allowed to protect #2 aluminum assuming this SER cable does not supply the entire load for this home. If this is the case, the #2 aluminum SER would be required to be protected by a 90 ampere circuit breaker.

44. In article 404.2.(C) where a grounded conductor is needed in a switch box, do you need a grounded conductor for each circuit in the box? If not, will the ark fault device still work?

Answer: Yes

Reference: NEC 404.2(C)

Switches Controlling Lighting Loads. The grounded circuit conductor for the controlled lighting circuit shall be installed at the location where switches control lighting loads that are supplied by a grounded general-purpose branch circuit

45. If I have a separate underground service for a fire pump entering the fire pump controller at the nearest point of entry and the controller has a disconnecting means built into it (they are all service rated by code), do I need an additional disconnecting means ahead of the controller?

Answer: NEC 695.4(A)(B)(1) Permits but does not require. The most dependable continuous service will have the minimum amount of connections so fire pump can run at locked rotor current.

46. A solar photovoltaic system is installed on a detached garage which has a 30A sub-panel and 3-wire feeder so the grounded conductor is bonded to the grounding electrode system (ground rod) at the garage. The PV system is larger than the conductors can carry for a grid-tie system so the PV grid-tie conductors were run back to the main structure's main panel. The PV inverter is grounded to the grounding electrode system of the detached garage. Since the garage has only a 3-wire system the grounded conductor was isolated to avoid a parallel path and the equipment ground with the PV grid-tie conductors was upsized to accommodate the two systems. Is this legal?

Answer: Simple answer, no it is not legal. It is required to run all circuit or feeder conductors, including equipment grounding conductors together, unless all of the conductors are in the same raceway they cannot share the equipment grounding

conductor. The inverter requires an AC disconnect within 10 feet of the inverter and have an equipment grounding conductor installed in it. 690.47 requires connection to a grounding electrode at the building for grounding of metal parts associated with the PV system, however, the equipment grounding conductor of the inverter output circuit connected to the supply system is permitted to serve this function. The problem here is that the PV system is on a separate building so a grounding electrode conductor at the separate building would be required and should be connected to the equipment grounding conductor in the inverter AC disconnect. That solves the problem for the PV system but a separate equipment grounding conductor should still be installed for the existing feeder and the feeder grounded conductor should be isolated from the enclosure at the second building.

47. Is it required to have a bonding bushing in a 208v disconnect when a reducing washer is used and all of the rings were not removed? If so what if MC is the wiring method.

Reference: UL Category QCRV

Answer: Yes

Metal reducing washers are considered suitable for grounding for use in circuits over and under 250V and where installed in accordance with ANSI/NFPA 70, "National Electrical Code," for raceways containing other than service conductors. Reducing washers are intended for use with metal enclosures having a minimum thickness of 0.053 in. Reducing washers may be installed in enclosures provided with concentric or eccentric knockouts, only after all of the concentric and eccentric rings have been removed. However, those enclosures containing concentric and eccentric knockouts that have been certified for bonding purposes may be used with reducing washers without all knockouts being removed.

48. Can the receptacle on the front porch that has 3 steps of a single family dwelling also be the receptacle for the front of the house?

Answer: Yes. (E) Outdoor Outlets. Outdoor receptacle outlets shall be installed in accordance with 210.52(E)(1) through (E)(3). Informational Note: See 210.8(A)(3). (1) One-Family and Two-Family Dwellings. For a one-family dwelling and each unit of a two-family dwelling that is at grade level, at least one receptacle outlet readily accessible from grade and not more than 2.0 m (6 1/2 ft) above grade level shall be installed at the front and back of the dwelling.

49. I have seen installers cut some of the grates at the bottom of the transformer and stub up PVC conduits in this area, is this legal?

Answer: Code Section 450.9, 110.3(B). No, this is not legal or acceptable. 450.9 specifically prohibits any ventilating openings from being blocked. Installing conduits

into the ventilation grates blocks and diminishes the ventilation designed for the transformer.

50. Separate structures require a grounding electrode. Since this conductor does not go to the grounded conductor is it legal to simply install a lug in the panel and use the panel as a conductor to the ground bar?

Answer: NEC 250.8, 250.32, 250.64

YES 250.8 allows machine screws that engage at least two threads to the enclosure with a listed lug would be allowed. If there is a ground bar it would be simple to go directly to the ground bar!!!

51. I recently inspected a barn type horse stable, are the receptacles in the tack room and all other receptacles required to be GFCI protected?

Answer: As always, check with your AHJ. In Colorado, the answer no for the Tack Room. For other areas, GFCI protection will likely be required if associated with residential property. (See 210.8(A)(2))

52. Does a 480 Volt 3 phase ungrounded delta electrical service require bonding of service conduits?

Answer: 250.24 (E) A premises wiring system that is supplied by an ac service that is ungrounded shall have at each service a grounding electrode conductor connected to the grounding electrode (s) required by Part ||| of this article The grounding electrode conductor shall be connected to a metal enclosure of the service conductors at any accessible point from the load end of the overhead conductors , service drop , underground service conductors or service lateral to the service disconnecting means

53. A utility interactive PV inverter has built in output overcurrent protection. The output conductors terminate in a non-fused disconnect prior to terminating in the utility transformer. Should there be overcurrent protection at the disconnect? And if not, wouldn't the inverter need to be service rated?

Answer: The requirements found in 240.21 mandate that circuits have overcurrent protection where they receive their supply. Although there are circumstances where this may not be necessary per code especially with PV systems. The picture in this slide is definitely not one of them!!

Current-limited sources, such as PV sources that are connected to the utility, must be protected with overcurrent devices installed at the source end of the supply. This requirement is found in 690.9

Also, NEC 705.30 mandates the same requirements found in 690.9. 705.30 requires overcurrent protection for PV systems when they are connected to the utility supply

54. Can liquid tight flexible metal conduit be used under water to provide flexibility to a dock where a subfeed switch board provides the overcurrent protection to the individual slips? If so, how should it be secured and supported? Is the connector coming into the bottom of the switch gear not adequate to secure the seal tight?

Answer: Marinas and boatyards found in 555.13A1 allows any Chapter 3 wiring method Note ; NFPA 307 for Large craft and ships and 553 floating buildings etc 350.10 use permitted, ok if not subject to physical damage, 350.30 states securing by approved means or listed and identified cable ties, within 12" near box, then not to exceed 4.5' intervals, but as this is needed for flexibility the exception 2 would state 3ft ½-1 ¼, 4ft 1 ½- 2", 5' 2 ½" and larger. Exception also states for purpose of 350.30 listed fittings shall be permitted as secure and supporting. Note; 350.60 requires and equipment grounding conductor installed since this application is for flexibility.

55. In the construction of a swimming pool, a connection between the building steel and the reinforcing rod in the pool casing is prohibited. Does it create a hazard if they are connected and the building steel and the reinforcing is common to each other?

Answer: Art. 680.26 (A) 2017 Handbook

"The function of equipotential bonding differs from the primary function of bonding to meet the requirements of Article 250. Providing a path for ground fault current is not the function of the equipotential bonding grid and associated bonding conductors." The #8 solid bonding jumper is not required to extend or connect to any parts or equipment than those covered in 680.26 (B)(1) through (B)(7) and to a pool water bonding element covered in 680.26(C).

If they are tied together, an issue could arise in the future.

56. Are ground rod electrodes required to supplement anything other than water lines? NEC 256 gives us the required electrode conductors. Our utility does not recognize UFERs. Is it always necessary to have the ground rods in conjunction with other grounding methods such as UFERs, building steel, or rings? Other than cost associated with time to install, is there any reason to try to make a formal utility requirement change?

Answer: This question code panel 5 members help me!! I cannot find NEC 265 or even 250.56. this is a three part question for the first part NO 250.53 (D)(2). for the utility not recognize the UFER I am sorry. The next part NO 250.52 lists the grounding electrode systems. You can make a request to the utility to accept the UFER.

57. A student housing apartment complex has a 3,000A 480V service that has 5 disconnects. The utility feeds the disconnects and the disconnects feed 4 transformers at multi gang meter locations on various floors and the 5th breaker feeds a 480V CT cabinet for house power. The problem is they have 5 service disconnects of 480V, they are not in excess of 1,000A so no ground fault protection is required. The individual meter switch boards are 208V fed by 4 transformers. The CT cabinet is 480V fed by a 600A 3 phase breaker. Since it also has a neutral and an equipment grounding conductor. The utility is used to CT cabinets being the first point of entry because that is where the metering is. This CT cabinet is fed by a feeder so therefore an equipment grounding conductor is necessary and the grounded conductor should be isolated from the enclosure. The meter tech has never seen such a thing so he has now made the neutral grounded conductor parallel to the equipment grounding conductors. Any experiences with other utilities? As I write this question, I find a concern that I did not identify originally. The transformers for the student housing section are not metered. Each individual apartment is metered along with the house meter. The transformer is ahead of the meter disconnect, switch boards are not.

Answer: WOW! That's a lot to unpack! A simple one-line drawing would have really helped. Without it, I am left to make some guesses about the system configuration. As I understand the it, the question is; "How do we ground this?" I would not accept the meter man's approach unless it belongs to them. That brings up another central question: Where is the service point? The serving utility defines this, and this serves as the demarcation point between the utility company and the customer. From the layout described, I would guess the service point is the current transformer (CT) cabinet which makes the 3000 A. main distribution panelboard (MDP) utility owned? If not, then where? If the service point is at or before the MDP, then that leaves the MDP un-metered, something that makes most power companies bristle!

Assuming we have a 3000 A. switchboard with 5 handles as the MDP, that is where the grounding for the 480 V. system must take place. A grounded conductor must be brought from the utility transformer to the MDP per 250.24(C). The grounding electrode system must be connected to the grounded conductor at this point. It appears there is no neutral load on this system. This takes care of grounding the 480/277 V. system.

The feeder to the CT cabinet ahead of the 208/120 V. transformer must include an equipment grounding conductor (EGC), as correctly stated in the question. There is no need for a grounded conductor to be installed with this feeder to the primary side of the 208/120 V. transformer. Only phases A, B, and C plus the EGC are needed. The EGC is connected to the CT enclosure but there should be no neutral present and thus no parallel path issue. Next, the separately derived system must be grounded per 250.30. Where no overcurrent protection for the transformer was mentioned, I must assume there is a main overcurrent device for the meter center. The connection of the grounding electrode conductor should be made here. And, I don't understand the last

sentence, so I will let it go. Whoever said “A picture is worth a thousand words” knew what they were talking about!

58. Most non-fused service disconnects and meter sockets only have a 10,000 AIC rating and there is no overcurrent protection with a fault current rating prior to the service disconnect for the service on the facility. Is there a need for higher fault current ratings for this service equipment ahead of the disconnect?

- **Answer:** The equipment must have a short-circuit rating that is adequate for the calculated available fault current per NEC 110.10

This leads us to NEC 230.82(3) as shown below:

- 230.82 Equipment Connected to the Supply Side of Service Disconnect. Only the following equipment shall be permitted to be connected to the supply side of the service disconnecting means:
 - (3) Meter disconnect switches nominally rated not in excess of 1000 V that have a short-circuit current rating equal to or greater than the available short-circuit current, if all metal housings and service enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250. A meter disconnect switch shall be capable of interrupting the load served. A meter disconnect shall be legibly field marked on its exterior in a manner suitable for the environment as follows:
 - METER DISCONNECT
 - NOT SERVICE EQUIPMENT
 -
 - So, a fused disconnect equipped to accept only Class R or J fuses, has an SCCR of 200kA, and can be used in lieu of a non-fused disconnect would be permitted ahead of the meter. In addition, the current-limiting fuse could be evaluated to determine if the available fault current can be reduced to 10kA or less in order to provide proper protection of the meter socket.

59. NEC 250.50 Part III Grounding Electrode Systems and Grounding Electrode Conductors specifies that you shall use any of the electrodes available in NEC 250.52 (A)(1) through (A)(7) that are present. It does not require that you provide a grounding rod electrode if you have other systems such as UFER ground, building steel, and the like. The utility does require grounding electrodes. For the price it is not worth the argument but is there any reason to use grounding electrodes when they are not nearly as effective as the building steel or UFER grounding?

Answer: You're right! It is really is not wasted time or effort to install a ground rod to the grounding system of this structure.

The NEC, per 250.4, does in fact, require a grounding electrode to be installed at all structures in which electrical systems are installed.

Section 250.4(A)(5) and (B)(5) require that electrical equipment be bonded to create low-impedance path back to the source.

If, in fact, if there are more than one electrode, than those electrodes must be bonded together per 250.50.

Slide #2

Grounding and bonding are the safety circuits installed with electrical systems. Electrical grounding and bonding are protective processes that happen simultaneously. During a ground-fault event, current returning to the source will be present in multiple paths such as equipment grounding conductors, the earth, conductive parts of equipment and also through a person!!

Slide #3

The meter tech cannot see that there are other grounding electrodes properly attached. By installing an "extra" ground rod, the meter tech can physically see that the equipment is grounded. This assures him that at least there is a direct connection with the earth!

60. I'm working in a church. Why can't I use SER cable from the combination meter socket disconnect to the subfeed panel?

Answer: 338.10(B) generally would allow it, however in B(4) you are referred to 334 part 2 where in 334.12 uses not permitted, it references 334.10 uses permitted items 1,2,3,5 which talks about "Types" of construction, and I then assume the Type of construction of this Church does not allow it. It would need to be behind a 15 minute thermal barrier or within a raceway and it does not state either of these methods being used in the question.

61. I have been told it is legal to zip tie L.V. occ sensor cable to lighting conduit in said room for a clean install. Would I be able to do the same with 0-10v 16-2 cable? Being that it is being installed to specifically run the lighting as intended. If there is a reference in the code I would like to know for future. If you need any clarifications feel free to call.

Answer: 300.11 (C) Raceways Used as Means of Support. Raceways shall be used only as a means of support for other raceways, cables, or nonelectrical equipment under any of the following conditions:

(1) Where the raceway or means of support is identified as a means of support

(2) Where the raceway contains power supply conductors for electrically controlled equipment and is used to support

Class 2 circuit conductors or cables that are solely for the purpose of connection to the equipment control circuits.

62. I am working on a Solar PV project at this really big building. As shown in the attached one-line diagram, the PV is proposed to be interconnected at the 600A, 208V, 3-PH House CT cabinet fed from a 400A house circuit breaker. The PV system size is 53kVA. Per 2017 NEC 705.12(D)(2)(3)(a): "The sum of 125 percent of the power source(s) output circuit current and the rating of the overcurrent device protecting the busbar shall not exceed the ampacity of the busbar." As a result, $400A + 1.25 * (53/208 * 1.732) = 584A$ which is less than the CT bus rating of 600A. Please can you confirm that the PV connection as described is adequate with respect to the above referenced code section?

Answer: I did not see an attached one-line diagram! To answer the question yes the code reference is correct but 705.12(D)(2)(3)(b) shall also apply possibly.

63. Is it true that we now must identify the raceways and cables used for emergency wiring?

Answer: The requirement to identify components of an emergency system, including raceways and cables, first appeared in the 1987 NEC. (I can remember installing red spray-painted connectors, couplings, boxes, and covers as far back as 1979 for this purpose.) The 2017 NEC simply expanded the requirements, adding specific details including receptacle identification.

64. I installed a 100 amp house panel for a commercial building that never had a house panel before. The inspector said it didn't pass. What's the deal? I'm just trying to help the owner out.

Answer: I am not sure any number of things could be wrong maybe you installed it upside down 210.25(B) Branch circuits installed for the purpose of lighting, central alarm, signal, communications or other purposes for public or common areas of a two

family dwelling ,a multifamily dwelling, or a multi occupancy building shall not be supplied from equipment that supplies an individual dwelling unit or tenant space.

230.71 would limit you to six switches or sets of circuit breakers or a combination of not more than six switches and sets of circuit breakers ,mounted in a single enclosure, there shall be not more than six sets of disconnects per service grouped in any

65. We have a 200 amp 3 phase service. It has a wireway above the main disconnect. Does the bonding jumper for the raceway need to be installed inside of the raceway?

Answer: Bonding is the means of providing electrical continuity between metallic raceways and metallic enclosures. NEC 250.92 is the prescriptive language for bonding services. This particular code section addresses the supply-side bonding before the first overcurrent device.

Slide #2

Bonding can be accomplished following section 250.102. This section describes the type of material, size of the jumper for both a single raceway and for parallel raceways 250.102(E) describes installation methods that are to be used. 250.102(E)(2) allows bonding jumpers to be installed outside a raceway or enclosure as long as the length of the jumper is limited to a length of no more than 6 feet and it is run with the raceway.

So, yes, the supply-side bonding jumper does not necessarily need to be installed inside this raceway.

66. Do the switches in a screen porch need a weatherproof cover? The inspector seems to think so.

Answer: In 404.4 Damp or wet locations,

[A] states surface mounted switch needs to have a weatherproof enclosure as seen in 312.2 and

[B] requires a flush mounted switch to have a weatherproof enclosure also.

So it comes down to the Inspectors definition of this location being subject to a “moderate degree of moisture” and if so it is at the minimum “Damp” per Definitions in 100.

67. The design professional told us he wanted a lock on the main disconnect for a commercial building. We told him we couldn't do that because in case of an emergency, the disconnect could not be shut off. He is pretty sure it is alright. What do you say?

Answer: Art. 110.25

If a disconnecting means is required to be lockable open elsewhere in the Code, it shall be capable of being locked in the open position. The provisions for locking shall remain in place with or without the lock installed.

Disconnects can be purchased with a lockable door. Some industrial facilities, Schools, Hospitals, etc., require locks on disconnects and breaker panels to insure only "Qualified Personnel" have access.

68. Is it a code violation if a switch is behind a door? The builder installed a door that had a different "swing" than what was on the plan. The owner is ok with the location and doesn't want to change. I don't think it can be there. What do you say?

Answer: The code does not prohibit a wall switch being behind a door. If the home owner is OK with that location. NEC 404

69. In a service garage, the inspector wanted the cables for the door sensors in a raceway. Why would he request something that isn't even made?

Answer: Depending upon the type of "service garage", the inspector is likely correct. In a Major Repair Garage (an NEC-defined term), the area within 18" of the floor is generally considered a Class I, Division 2 location and only the wiring methods specified in 501.10(B) are permitted. The cable is not the only concern. What about the sensors? They must also be listed and identified for a Class I, Div. 2 area. The simplest solution is to provide ventilation per Table 511.3(C) and declassify the area.

70. We installed an emergency panel for an office building. We identified the panel the way the engineer told us to – LSH4. Now the inspector says it is not compliant. Who is right?

Answer: 700.10 (A)(1) All boxes and enclosures (including transfer switches generators , and power panels) for emergency circuits shall be permanently marked as a component of an emergency circuit or system

700.7 (A) A sign shall be placed at the service entrance equipment , , indicating type and location of each on-site emergency power source.

110.16 (A) Electrical equipment such as switchboards switchgear , panel boards , industrial control panels , meter socket enclosure and motor centers that is in other than dwelling units and is likely to require examination, and adjustment, servicing , or maintenance while energized , shall be field marked to warn qualified persons of potential electric arc flash hazards

210.5 (C) (1) (b) Posting of Identification Means The method utilized for conductor originating within each branch-circuit panel board or similar –circuit distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each branch-circuit distribution equipment

408.4(B) Source of Supply All switchboards , switchgear and panel-boards supplied by a

feeder(s) in other than one – or two family dwellings shall be permanently marked to indicate each device or equipment where the power originates

71. In a home remodel, does an existing receptacle that is in the kitchen area need to be re-supplied in order to connect it to one of the small appliance branch circuits? The receptacle is not otherwise part of the remodel.

Answer:

NEC 210.11(C) requires 2-20-amp “Small-Appliance” branch circuits in a dwelling unit and 210.52(B) require the receptacles that these circuits serve be located in the kitchen, pantry, breakfast room dining room, or similar area of a dwelling.

When a remodel occurs to an existing dwelling, certain requirements can go into effect. Barring any electrical hazards that may be present, most jurisdictions will have in place, certain protocols that would trigger an electrical upgrade to meet current code requirements.

Slide #2

Although the NEC is not retroactive, certain actions by the installer may make it mandatory to enforce current code regulations. At the same time, remodel work offers a unique opportunity to bring older electrical work into a safer condition, electrically.

The AHJ in this area should be contacted to find the answer before any remodel work is to be performed. This will help clarify any confusion in the planning stages, putting everyone on the same page!

72. Can you go over the requirements of a peninsula with a sink in it? The inspector and I don't agree on what is required.

Answer: In 210.52(C)3 it states a Peninsular counter top needs a receptacle if greater than 12x24, but now we measure from the connected wall, so the receptacle on the wall 'may' be all that is needed.

However, when you put a sink in it then (4) gets involved and if the space behind the sink is less than 12", the code considers the space to be "broken" and a receptacle would be needed for each section.

73. We used a cable tray to install the wiring to a beer making process. The inspector said our wiring method is "not acceptable". We have done it this way a number of times and no one has ever said anything. Did something change in the Code?

Answer: 392.10 – (A) Uses Permitted/Wiring Methods.

Cable tray shall be permitted to be used as a support system for service conductors, feeders, branch circuits, communications circuits, control circuits, and signaling circuits. Cable tray installations shall not be limited to industrial establishments. Where exposed to direct rays of the sun, insulated conductors and jacketed cables shall be identified as being sunlight resistant. Cable trays and their associated fittings shall be identified for the intended use.

(A) Wiring Methods. The wiring methods in Table 392.10(A) shall be permitted to be installed in cable tray systems under the conditions described in their respective articles and sections.

74. : I have an existing commercial building that was built in the 60's. The feeder to the fire pump is run inside the building in rigid metal conduit and does not meet the requirements in 690. The pump and controller needs to be replaced. Is it grandfathered?

Answer: Article 690 is for solar PV systems and fire pumps is the requirements for fire pumps. 695.3 it must have a reliable source of power. If the controller will be replaced it will be a call of the Fire AHJ as well as the electrical AHJ.

75. There was an old concrete pad in front of the old panel. We installed a new panel at the same location. The inspector says it has the concrete pad has to be removed, otherwise we have to move the panel. The old pad is 32" X 40". Shouldn't this be legal?

Answer: Not if it obstructs the working space in any way! Clear working space in front of a panelboard must be maintained per 110.26(A). If the "old concrete pad" is flat and could be considered a work platform, I know of no reason to move it. A minimum platform area of 30" wide x 36" deep is required in front of the panel "from the grade, floor, or platform to a height of 6-1/2 feet, or the height of the equipment, whichever is greater." I suggest discussing with the inspector his concerns and taking any necessary corrective action.

76. Most backup generator packages designed for residential use with portable generators include 2-pole transfer switches. Is this acceptable?

Answer: Yes 702.11 (B) Non separately Derived System Where a portable optional standby source is used as a non separately derived system the equipment grounding conductor shall be bonded to the system grounding electrode

77. Why does an outlet located below a wet bar sink need GFCI protection but an outlet located below the kitchen sink does not need GFCI protection?

Answer: The 2017 NEC, 210.8, requires any receptacle located within 6 feet of any sink be protected. This includes receptacles both at kitchen sinks and sinks at wet bars.

This requirement does have conditions, which could omit GFCI protection for these receptacles. For instance, if the receptacle is behind a cabinet door, passes through a doorway or window and is within 6 feet of a sink, then, that receptacle would not require GFCI protection.

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Commonly, kitchen sinks are installed in cabinets that have doors that will cover these receptacles, thus omitting the GFCI requirement. Wet bar sinks are more commonly installed using different furniture, which can be open underneath with no door or doorway. This would qualify this receptacle at this sink to be GFCI protected.

It is to be measured as if using a 6-foot cord from an appliance following the shortest pathway to the receptacle.

78. Is an above grid return air plenum considered a hollow space for the installation of a transformer smaller than 50Kva.

Answer: Yes,

Per 450.13[B] as long as the hollow spaces are not permanently enclosed and they meet the ventilation requirement of 450.9 and separation requirement of 450.21[A] Of course the wiring methods of 300.22[C]1 must also be met.

79. An existing ceiling fan is being replaced, and the new ceiling fan is mounted by a means that is now considered a receptacle by Article 100. Would this be considered a modification of the circuit and would it now be required to have AFCI protection?

Answer: No. 210.12.(D) Branch Circuit Extensions or Modifications — Dwelling Units and Dormitory Units. In any of the areas specified in 210.12(A) or (B), where branch-circuit wiring is modified, replaced, or extended, the branch circuit shall be protected by one of the following:

(1) A listed combination-type AFCI located at the origin of the branch circuit.

(2) A listed outlet branch-circuit-type AFCI located at the first receptacle outlet of the existing branch circuit.

Exception: AFCI protection shall not be required where the extension of the existing conductors is not more than 1.8 m (6 ft) and does not include any additional outlets or devices.

80. Does the 6'7" maximum height requirement for "Readily Accessible" found in Art. 240.24 (A) apply to the disconnect switch contained in PV Inverters?

Answer: 690.13(A) the location must be in a readily accessible location and does not mention 240.24(A) 690.15(A) mentions the disconnection of PV equipment locations and (D) mentions equipment disconnecting means check with your AHJ

81. How do properly calculate the bus rating of a 125A sub panel with 30 Amps of back fed PV current available? Feeder OCPD is 100 Amps

Answer: Section 705.12(B) provides several options. I believe, from the way the question is worded, the question is "How much PV output can I connect to this panel?" 705.12(B)(2)(3) offers 2 options: (a) permits using the sum of 125% of the power source output circuit current plus the rating of the overcurrent device protecting the busbar cannot exceed the ampacity of the busbar, and (b) permits using 125% of the output circuit current plus the ampacity of the overcurrent device protecting the busbar cannot exceed 120% of the rating of the busbar.

The rating of the bus is 125 Amperes. Assuming we connect the PV at the opposite end of the bus from the main supply and assuming the 30 A. breaker is equal to 125% of the inverter output current rating, by using option (b) we can have up to 150 A. connected to the busbar ($125 \times 1.20 = 150$). By having a 100 A. feeder supplying the 125 A. panel, we could connect as much as 50 A. of PV output to this panel.

82. A LG Energy Storage System (ESS) has a built in ON/OFF switch located behind a removeable (2 latches) cover for access. Is a separate external disconnect required adjacent to the unit? Or would Labeling/ Placarding be required to indicate the location of the internal switch for 1st Responders?

Answer: Maybe if the door requires no tools to open must be readily accessible 706(A) A ESS Disconnecting Means A disconnecting means shall be provided for all ungrounded conductors derived from an ESS A disconnecting means shall be readily accessible and located within sight of the ESS
(B) Remote Actuation Where controls to activate the disconnecting means of an ESS are not located within sight of the system, the disconnecting means shall be capable of being locked in the open position, in accordance with 110.25, and the location of the controls shall be field marked on the disconnecting means.

83. Are the branch circuit conductors feeding an EV Charger, rated 80 Amps on the Nameplate, required to be full sized? Even though the installer/ owner can internally select a lesser ampacity charging output based on the vehicle charging requirements.

Answer: Conductor sizing. You must size conductors no less than 125% of the continuous loads, plus 100% of the noncontinuous loads per 210.19 and 625.42. Don't forget to look at the terminal temperature rating to base any ampacity adjustments per 110.14

The question does not state whether or not there is a minimum branch circuit size on the nameplate so the 80-amp load must be used to calculate the conductor size;

$80 \text{ amp} \times 125\% = 100 \text{ amps}$

Use Table 310.15(B)(16) to figure the size of the conductor for this charger/load

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Overcurrent Sizing. Since the conductor is now sized, you match the overcurrent protective device to the ampacity of the conductor.

Art. 625.41 mandate that the overcurrent device have a rating not less than 125% of the maximum load of the equipment;

Again, maximum load of 80 amps \times 125% = 100 amps

This will protect the conductors feeding this load.

84. Are the branch circuit conductors feeding an EV Charger, rated 80 Amps on the Nameplate, required to be full sized? Even though the installer/ owner can internally select a lesser ampacity charging output based on the vehicle charging requirements.

Answer: Electric vehicle charging systems in 625.41 states the Overcurrent protection must be not less than 125% of the maximum load of the equipment.

In this case $80a \times 125\% = 100a$.

If “automatic load management” is used as referenced in 625.42 then the feeder or service can use the lower calculation of what the management can supply, but not for branch circuits or as in this case manual selection of output.

It goes on to say the ‘equipment’ shall have sufficient rating for the load, but no specific mention of ‘conductors’.

See 210.19[A]1a for conductors of continuous use requiring the 125% sizing.

85. The requirement of 690.12 (B)(2) became effective January 1, 2019. Are there any known manufactured products on the market that comply with 690.12(B)(2)(1) listed as a Rapid Shut Down PV array?

Answer: Yes. As one option in the 2017 NEC Section 690.12(B) (2)(1) requires that inside the array boundary the photovoltaic (PV) array shall be Certified (Listed) or field labeled as a rapid shutdown PV array and the PV array shall be installed and used in accordance with the instructions included with the rapid shutdown PV array Certification (Listing) or field labeling. See UL product code (QIJW) & (QIJS) for further information on these products.

86. What are the placarding requirements when PV equipment i.e. Inverter, Production Meter, ESS etc... cannot be installed in the same location as the utility service/ Main service Disconnect?

Answer: 690 part VI marking 705.10 Marking must be at the utility disconnect and power distribution where the PV system is connected

87. When installing a PV system via a Line Side Tap: your 1st AC disconnect switch constitutes a new "Service Disconnect". Are there any exceptions in the installation of the MJB and GEC terminations at the Grounded (Neutral) conductor terminal to avoid a parallel path with the original service (Utility) Grounded Conductor?

Answer: Well, the question starts off with a false assumption. A PV system is NOT considered a service (see Art. 100 – Service). Any grounding of the system must be done in accordance with Part V of Article 690. No parallel paths will be present if done accordingly.

88. Is it a violation to hang a 10' stick of rigid conduit to a 4" square box that an exit sign is attached to without supporting the box at the exit sign?

Answer: 314.23(H)(2) Conduit A box supporting lamp holders or luminaires , or wiring enclosures within luminaires used in lieu of boxes in accordance with 300.15(b) shall be supported by rigid or intermediate metal conduit stems longer than (18in) the stems shall be connected to the wiring system with flexible fittings suitable for the location. At the luminaires , the conduit(s) shall be threaded wrench tight into the box wiring enclosure, or identified hubs Where supported by only a single conduit, the threaded joints shall be prevented from loosening by the use of set screws or other effective means , or other effective means, or the luminaire , at any point , shall be at least (8ft) above grade or standing area A luminaire supported by a single conduit shall not exceed(12 in)in any horizontal direction from the point of conduit entry

89. Is it permissible to install LFNC underground for a feeder raceway from one structure to another such as a house to a detached garage?

Answer: LFNC or “Liquidtight Flexible Nonmetallic Conduit” is a nonmetallic, circular raceway that can be found in article 356 of the NEC. Per NEC 356.10(4) LFNC may be buried as long as some prescriptive measures have been met. The informational note located after 356.10 is making a note on temperature extremes and the raceway becoming brittle. This should be taken into consideration before using this type of wiring method. Make sure that this raceway is marked for direct burial, which the marking is a requirement of 356.120.

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Article 225 contains the installation requirements for outside branch circuits and feeders run on or between buildings, structures, or poles.

Also, LFNC can be found in Article 225.10(9), as an approved wiring method as an outside wiring method to feed another structure.

This is an acceptable method to feed to another structure.

90. Why are the bathroom, garage, and outside excluded from AFCI protection?

Answer: Good question. 201.12 does not say. One thought is the areas are already GFCI protected, however Kitchens have been added to the NEC. Another is there is not enough evidence of safety issues in these areas and of course “cost” and “nuisance tripping” always come up. The CMP tried to end the incremental approach and remove the list and expand the requirements to the total dwelling unit, but it failed ballot.

91. Can I use the 110.24-required available short-circuit current making to determine my arc-flash PPE? Some experts have told me yes and other expert have told me no.

Answer: No

Assuming the question meant Available Fault Current rather than Available Short-Circuit Article 110.24 refers to the Available Fault Current which is used to complete an arc flash risk assessment per NFPA 70E

92. We have a contractor that places his Walker boxes and EMT conduit on top of vapor barrier for the slab on grade pour. He states this installation is not in contact with the earth and therefore is not defined as a wet location or corrosive area, do you concur?

Answer: No. Article 100 Location Wet installations underground or in concrete slabs or masonry in direct contact with the earth in locations subject to saturation with water or liquids.

93. I have an installation that an inspector requires me to install a wall space required receptacle put in an island. I’m sure that if a top is installed on this island I do not need to install it. What does the code say?

Answer: What does the question say? I'm not sure. An island in a dwelling unit kitchen must comply with Section 210.52(C)(2). You wouldn't normally have a connection to ANY wall on an island, thus no wall spacing requirements would apply. If there was a wall in contact with this whatever it is, it would more likely be a wall cabinet or a peninsula and not an island. An island generally requires at least one receptacle unless 210.52(C)(4) is applicable.

94. We have a 45 kva transformer installed above a lay in tile ceiling, is a light required?

Answer: No 210.70 (C) All Occupancy. For attics and underfloor spaces < utility rooms , and basements , at least one lighting outlet containing a switch or controlled by a wall switch shall be installed where these spaces are used for storage or contain equipment requiring servicing. At least one point of control shall be at the usual point of entry to these spaces. The lighting outlet shall be provided at or near the equipment requiring servicing .h 450.13(B)Hollow Space Installations Dry –type transformers 1000 nominal , or less and not exceeding 50 kva shall be permitted in hollow spaces of buildings not permanently closed in by structure , provided they meet the ventilation requirements of 450.9 and separation from combustible materials requirements of 450.21(A) .

95. I have been told that when I install a go-from (EMT to Type MC Cable) that the fitting must be accessible, is that accurate? If why?

Answer: The 2017, NEC 300.15 is the code article that addresses “Boxes, Conduit Bodies, or Fittings” and “Where Required” in a raceway or cable.

This article addresses the basic rule of when a box or conduit body is required where splices are made in conductors or where these conductors are terminated.

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Now, Art. 300.15 are the basic rule pertaining to boxes, conduit bodies and fittings. What follows 300.15 in “A” through “L” are really exceptions or modifications to that rule!

Art. 300.15(F) addresses type AC or MC cable to a raceway using identified fittings, which is a common practice.

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The last sentence of 300.15(F) make mandatory that this particular fitting be accessible.

Since there is actually a change in wiring methods using a fitting instead of a box or conduit body, the Code Making Panel deemed it necessary to require this fitting accessible.

This change was added as an exception to Art. 300.9(B) in the 1987 NEC and stands as prescriptive language today in 300.15(F).

96. 410.36(B) requires luminaires installed in suspended ceilings to be attached to the ceiling members. Some jurisdictions require independent supports wires instead. Are the wires allowed and/or required?

Answer: 410.36 requires bolts, screws, rivets or Listed clips. However, 300.11 references 'wiring' above fire rated and non-fire rated suspended ceilings where some persons extrapolate the luminaire also needs extra wires to support separate from the grid Also some want it for seismic conditions. It would be up to the AHJ if they allow separate, independent support wire, instead of the clips, bolts rivets etc as long as the intent of the code not allowing the luminaires to fall down or out is met.

97. Some jurisdictions require that holes drilled in floor joists for the installation of wiring must be drilled in the center third of the joist and in the outside third of the joist span – no holes in the middle third of the span. Is this an actual Building Code requirement that everyone should be following?

Answer: 2308.4.2.4 Notches and holes. Notches on the ends of joists shall not exceed one-fourth the joist depth. Notches in the top or bottom of joists shall not exceed one-sixth the depth and shall not be located in the middle third of the span. Holes bored in joists shall not be within 2 inches (51 mm) of the top or bottom of the joist and the diameter of any such hole shall not exceed one-third the depth of the joist.

98. Is an individual branch circuit required for cord-connected range hood?

Answer: No 422.10

99. In Art. 230.7 Exception #2 Does this include Type TC Tray Cable?

Answer: Yes, if used for "load management control conductors" and provided with overcurrent protection.

100. 240.87 requires arc flash reduction, the installer had them retrofitted and installed them at the top of the gear at 8' is this a violation

Answer: Not for me but maybe for Don Iverson 404.8 (A) Location. All switches and circuit breakers used as switches shall be located so that they may be operated from a readily accessible place. They shall be installed such that the center of the grip of the operating handle of the switch or circuit breaker ,when in its highest position , is not more than 6 ft. 7 inches above the floor or working platform.

Monday Code Panel Question Assignments

Robert Fahey	1, 7, 13, 19, 25, 31, 37, 43, 49
Dean Hunter	2, 8, 14, 20, 26, 32, 38, 44,
Jack Jamison	3, 9, 15, 21, 27, 33, 39, 45
Dave Williams	4, 10, 16, 22, 28, 34, 40, 46
Tom Moore	5, 11, 17, 23, 29, 35, 41, 47
Bret Johnson	6, 12, 18, 24, 30, 36, 42, 48

Tuesday Code Panel Question Assignments

Borgia Noel	50, 56, 62, 68, 74, 80, 86, 92, 98
Grant Hammett	51, 57, 63, 69, 75, 81, 87, 93, 99
Larry Kippes	52, 58, 64, 70, 76, 82, 88, 94, 100
Donald Gerjevic	53, 59, 65, 71, 77, 83, 89, 95
Steve Froemming	54, 60, 66, 72, 78, 84, 90, 96
Scott Weaver	55, 61, 67, 73, 79, 85, 91, 97