Office of Education and Data Management

Spring 2018
Career Development

April 2018

National Electrical Code and the International Residential Code Electrical Updates with Photo Voltaic System Requirements

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Article 90 Preface 2017 NEC

- New sections, tables, and figures are indicated by a bold, italic ***N*** in a gray box to the left of the new material. An ***N*** next to an Article title indicates that the entire Article is new. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

210.11(C)4 New Requirement

- **210.11(C)(4) Garage Branch Circuits.**
- In addition to the number of branch circuits required by other parts of this section, at least one 120-volt, 20-ampere branch circuit shall be installed to supply receptacle outlets in attached garages and in detached garages with electric power. This circuit shall have no other outlets.

- ***Exception: This circuit shall be permitted to supply readily accessible outdoor receptacle outlets.***

2017 NEC 210.12

210.12 Arc-Fault Circuit-Interrupter Protection. Arc-fault circuit-interrupter protection shall be provided as required in 210.12(A), (B), (C), and (D). The arc-fault circuit interrupter shall be installed in a readily accessible locations

- **Kitchens**
- **Family rooms**
- **Dining rooms**
- **Living rooms**
- **Parlors**
- **Libraries**
- **Dens**
- **Bedrooms**
- **Sunrooms**
- **Recreation Rooms**
- **Closets**
- **Hallways**
- **Laundry Areas**

or similar rooms or areas

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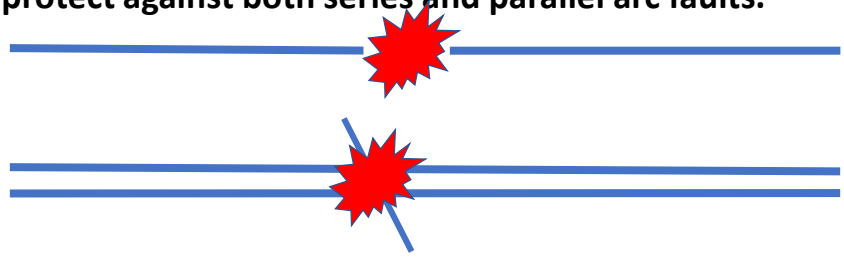
2017 NEC 210.12

- **It may be easier to think of where they are not required.**
  - **Bathrooms**
  - **Garages**
  - **Unfinished Basements**
  - **Attics**
  - **Crawl Spaces**
- **The way to provide this protection is where it gets interesting. Lets go over the six scenarios given in 210.12 of the 2017 NEC.**

2017 NEC 210.12(A)(1)

- **210.12(A)(1) A listed combination-type arc-fault circuit interrupter, installed to provide protection of the entire branch circuit. "current gold standard"**
- **It must be understood that a combination type AFCI is not a combination of a AFCI and GFCI breaker but is rather a type of AFCI breaker.**
- **The combination refers to the ability of the breaker to protect against both series and parallel arc faults.**



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Back to 2017 NEC 210.12(A)(1)

- **210.12(A)(1) A listed combination-type arc-fault circuit interrupter, installed to provide protection of the entire branch circuit.**

Thumbs UP!

2017 NEC 210.12(A)(2)

- 210.12(A)(2) A listed branch/feeder-type AFCI installed at the origin of the branch-circuit in combination with a listed outlet branch-circuit (OBC) type arc-fault circuit interrupter installed at the first outlet box on the branch circuit. The first outlet box in the branch circuit shall be marked.
- A few things we have to know.
- **Branch Circuit.** The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s).
- **Outlet.** A point on the wiring system at which current is taken to supply utilization equipment.
- **Utilization Equipment.** Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes.

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Some of the key words (UL White Book)

- **Branch/Feeder AFCI**
- Protects the portion of the branch circuit before the OBC from parallel arc-faults.
- Will not protect power supply or extension cords plugged into a standard receptacles from series arc faults.
- Will not protect branch circuits without a ground present from series arc faults

- **Outlet Branch Circuit (OBC) AFCI**
- Protects the downstream portion of the circuit from both parallel and series arc faults.
- Protects power supply or extension cords plugged into the OBC from series and parallel arc faults.

Back to 2017 NEC 210.12(A)(2)

- 210.12(A)(2) A listed branch/feeder-type AFCI installed at the origin of the branch-circuit in combination with a listed outlet branch-circuit (OBC) type arc-fault circuit interrupter installed at the first outlet box on the branch circuit. The first outlet box in the branch circuit shall be marked.

Thumbs DOWN

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2017 NEC 210.12(A)(3)

- 210.12(A)(3)-A listed Supplemental Arc Protection Breaker in combination with a listed OBC AFCI receptacle at the first outlet with 3 conditions that all must be met
- **a**. The branch-circuit wiring shall be continuous from the branch-circuit overcurrent device to the OBC. NO breaks or joints.
- **b**. The maximum length of the branch-circuit wiring from the branch-circuit overcurrent device to the first outlet shall not exceed 50 ft for a #14 or 70 ft for a #12.
- **c**. The first outlet box in the branch circuit shall be marked to indicate that it is the first outlet.

2017 NEC 210.12(A)(3)

- Advantage: Allows for local reset of the receptacle
- Disadvantage: Supplemental arc protection breakers are not currently available. Also there are limitations in homerun length, must be continuous and requires the AFCI receptacle to be located at the first outlet

Thumbs DOWN

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2017 NEC 210.12(A)(4)

- **210.12(A)(4)** A listed OBC AFCI installed at the first outlet on the branch circuit in combination with a listed branch-circuit OC device where all of the following conditions are met:
- a. The branch-circuit wiring shall be continuous from the branch-circuit overcurrent device to the OBC.
- b. The maximum length of the branch-circuit wiring from the branch-circuit overcurrent device to the first outlet shall not exceed 50 ft for a #14 or 70 ft for a #12.
- c. The first outlet box in the branch circuit shall be marked to indicate that it is the first outlet.

SO FAR, SO GOOD

Where 210.12(A)(4) gets sticky

- **210.12(A)(4)(d)** The combination of the branch-circuit OC device and OBC AFCI shall be identified as meeting the requirements for a system combination type AFCI and shall be listed as such.
- **UL WHITE BOOK**……If the system combination AFCI is provided as a kit consisting of an OBC and a molded-case circuit breaker packaged together, the following marking will be provided on each device:
- **CAUTION — System Combination AFCI** – For continued arc-fault protection, both the OBC AFCI receptacle and branch circuit breaker must be replaced together if it becomes necessary to replace either component.

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Back to 2017 NEC 210.12(A)(4)

- **The key phrases here are System Combination and Shall be listed as such. This would require that the breaker and the receptacle be sold as a matched pair as they have been tested that way.**

Thumbs DOWN

2017 NEC 210.12(A)(5)

- 210.12(A)(5) If RMC, IMC, EMT, Type MC or Type AC (this is BX) cables meeting the requirements of 250.118, and metal outlet and junction boxes are installed for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, it shall be permitted to install a listed OBC type AFCI at the first outlet to provide protection for the remaining portion of the branch circuit.

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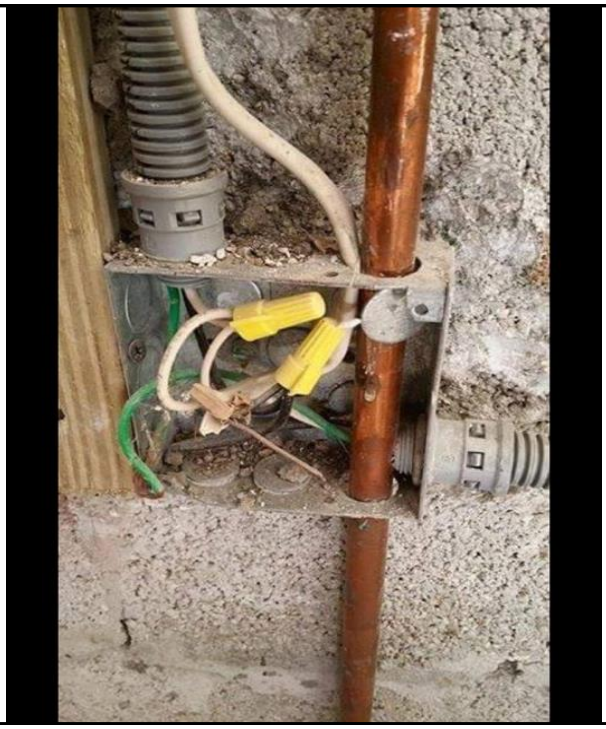
NOMENCLATURE

- **AC CABLE – ALSO CALLED BX**
- **MC CABLE- METAL CLAD CABLE-HAS SUB DESCRIPTORS**
- **EMT- ELECTRICAL METALLIC TUBING**
- **IMC/RMC- INTERMEDIATE/RIGID METAL CONDUIT**
- **ENT-ELECTRICAL NON-METALLIC CONDUIT - SMURF TUBE**
- **FMC – FLEXIBLE METAL CONDUIT – GREENFIELD**
- **RNC – RIGID NON-METALLIC CONDUIT – PVC SCHED 40/80**
- **NM – NON METALLIC SHEATHED CABLE – ROMEX**
- **UF – UNDERGROUND FEEDER AND BRANCH CIR. CABLE**
- **SE – SERVICE ENTRANCE CABLE----------SEU or SER**
- **USE – UNDERGROUND SERVICE ENTRANCE CABLE**



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Back to 2017 NEC 210.12(A)(5)

- **210.12(A)(5) If RMC, IMC, EMT, Type MC or Type AC (this is BX) cables meeting the requirements of 250.118, and metal outlet and junction boxes are installed for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, it shall be permitted to install a listed OBC type AFCI at the first outlet to provide protection for the remaining portion of the branch circuit.**

Thumbs up or Thumbs down

210.12(A)(6) Then Nuclear Option !

- **210.12(A)(6)** Where a listed metal or nonmetallic conduit or tubing or Type MC cable is encased in 2 in. of concrete for the portion of the branch circuit between the breaker and the first outlet, it shall be permitted to install a listed OBC type AFCI at the first outlet to provide protection for the remaining portion of the branch circuit.
- Not likely to be seen in your lifetime.

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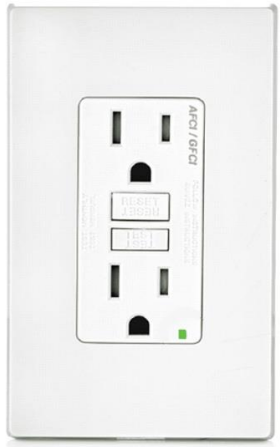
Real World Situation

- **Final inspection of a kitchen re-model in an existing older home. Electrician has run NM cable to a new plug on the counter and installed a AFCI/GFCI receptacle. He has pointed to 210.12(A)(2) and then 210.12(A)(4) as his justification.**



210.12(C) – New Requirement

- **210.12(C) Guest Rooms and Guest Suites.** All 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets and devices installed in guest rooms and guest suites of hotels shall be protected by any of the means described in 210.12(A)(1) through (6).

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2017 NEC 210.12(D)

- **(D) Branch Circuit Extensions or Modifications — Dwelling and Dormitory Units.**
- In any of the areas specified in 210.12 where branch-circuit wiring is modified, replaced, or extended, the branch circuit shall be protected by one of these two arrangements:
- (1) A listed combination-type AFCI located at the origin of the branch circuit
- (2) A listed OBC AFCI located at the first receptacle outlet of the existing branch circuit

IRC 3902.17 Amended

- (Amd) **E3902.17 Arc-fault circuit interrupter protection for branch circuit extensions or modifications.**
- Where branch-circuit wiring is modified, replaced, or extended in any of the areas specified in Section E3902.12, the branch circuit shall be protected by one of the following:
- 1. A combination-type AFCI located at the origin of the branch circuit.
- 2. An 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 6 feet in length and does not include any additional outlets or devices.

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Analysis of IRC 3902.17

- 1- Where branch-circuit wiring is modified, replaced, or extended in any of the areas specified in Section E3902.16, the branch circuit shall be protected by one of the following:…….
- An electrician would have to in some way modify, replace or extend the branch circuit in question to trigger these requirements.
- Replaced or extended would be easy to determine, modified may require interpretation by the AHJ.

Question from the field

- **Can help me figure out a couple of arc fault questions. If I were to extend a circuit from an outlet in a hallway that is not arc fault protected to feed a light switch and sconce in a bathroom that does not require arc fault protection, do I still have to arc fault the entire circuit I tapped from?**

- Taking a look at 210.12 I would say yes. The reason I would give would be you are adding an additional outlet or device. This would be achieved by one of the methods spelled out in 210.12(A) or (D).

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NEXT PART OF THE QUESTION

- **Then same question in reverse. If I tapped from the switch box in the bathroom to a outlet in the hall can I just install an arc fault outlet in the hall?**
- Looking at 210.12 the answer is no. The hallway is included in 210.12(A) as an area requiring AFCI protection. Adding just an AFCI outlet in the hall would not satisfy 210.12(D).
- Note that moving a panel a few feet or doing a panel change would not drive the requirement for AFCI protection.

Question Three

- **A 20 X 40 finished basement with no dividing partitions and a washer and dryer in one corner. Where does the laundry room technically end? Do I have to GFI everything in the finished basement? What about washers and dryers in open closet type cutouts in hallways. I don't know where the laundry room ends since the laundry room is part of the hallway.**
- **See next slide.**

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Answer Three

- **The key word here is finished. The basement we are looking at would require AFCI protection per 210.12(A) as it is living area. 210.8(A)(10) requires GFI protection and 210.12(A) requires AFCI protection for laundry areas. This question is probably best interpreted by THE INSPECTORS IN THIS CLASS.**

MY OPINION

- **The washer plug would be required to be GFCI protected. Having said that, the measurement of 6 feet appears a few times in 210.8(A).**
- **210.8(A)(7) Sinks — where receptacles are installed within 6 ft of the outside edge of the sink**
- **And 210.8(9) Bathtubs or shower stalls — where receptacles are installed within 1.8 m (6 ft) of the outside edge of the bathtub or shower stall**
- **It would stand to reason that all plugs within 6 ft of the laundry machines may need to be GFCI protected. Since the laundry machine is in living space all the outlets need to be AFCI protected per 210.12(A). This would most likely be achieved by using an AFCI/GFCI breaker.**

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AFCI and GFCI Breaker

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440.4 Marking on Hermetic Refrigerant Motor-Compressors and Equipment.

- **440.4(B) Multimotor and Combination-Load Equipment.**
- Multimotor and combination-load equipment shall be provided with a nameplate marked with the maker's name, the rating in volts, frequency and number of phases, minimum supply circuit conductor ampacity and the maximum rating of the branch-circuit OC device.

440.4 Marking on Hermetic Refrigerant Motor-Compressors and Equipment.

- Occasionally you will find that fuses are called for rather than a breaker. In that case fuses would be required to be installed.
- HACR type – This indicates the breaker is suitable for use with the group motor installations found in HVAC equipment. The NEC no longer has this requirement. The manufacturers determined that circuit breakers are considered suitable for use with such equipment without any further testing. HACR marking is no longer required on HVAC units or on circuit breakers.

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FROM SQUARE D

- **A great number of circuit breakers were investigated by UL using the special HACR testing. It was found that all circuit breakers that passed the normal UL 489 tests also passed the special HACR testing without a special design.**
- **Most customers and electrical inspectors are familiar with this section of the UL 489 standard and will accept UL 489 Listed circuit breakers in group motor applications requiring HACR type devices.**

440.9 New for 2017

- **440.9 Grounding and Bonding.**
- Where multi-motor and combination-load equipment is installed outdoors on a roof, an equipment grounding conductor of the wire type shall be installed in outdoor portions of metallic raceway systems that use non-threaded fittings.

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2017 NEC 440.35

- **440.35 Multimotor and Combination-Load Equipment.**
- The ampacity of the conductors supplying multimotor and combination-load equipment shall not be less than the minimum circuit ampacity marked on the equipment in accordance with 440.4(B).
- The manufacturer has already done all the calculations for the installer and the inspector. All that is necessary is to follow the nameplate.

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2017 NEC 430.53

- **430.53 Several Motors or Loads on One Branch Circuit.**
- Two or more motors or one or more motors and other loads shall be permitted to be connected to the same branch circuit. The branch-circuit protective device shall be fuses or inverse time circuit breakers.
- Most breakers still marked as HACR but that is no longer required.

Real World Situation

- **You are doing a final inspection on a single family home. As part of the inspection you check the nameplate on the HVAC condensing unit. The name plate is marked with a maximum fuse or breaker size of 25 amps.**
- **You point this out to the electrician and he responds that a 25 amp breaker is unavailable.**

- **True or False?**

FALSE

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GE and Square D Homeline

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

- 15 20 25 30 35 40 45 50

- **One of the more common statements I hear is that a 25 amp circuit breaker is not available. Not true! 25 amps is a standard breaker easily available.**

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IRC

(Amd) TABLE E3802.1 GENERAL INSTALLATION AND SUPPORT REQUIREMENTS FOR WIRING METHODS

- **Where wiring methods run parallel with the framing member or furring strip, the wiring shall be not less than 1¼ inches from the edge of a furring strip or a framing member, such as a joist, rafter or stud, or shall be physically protected.**

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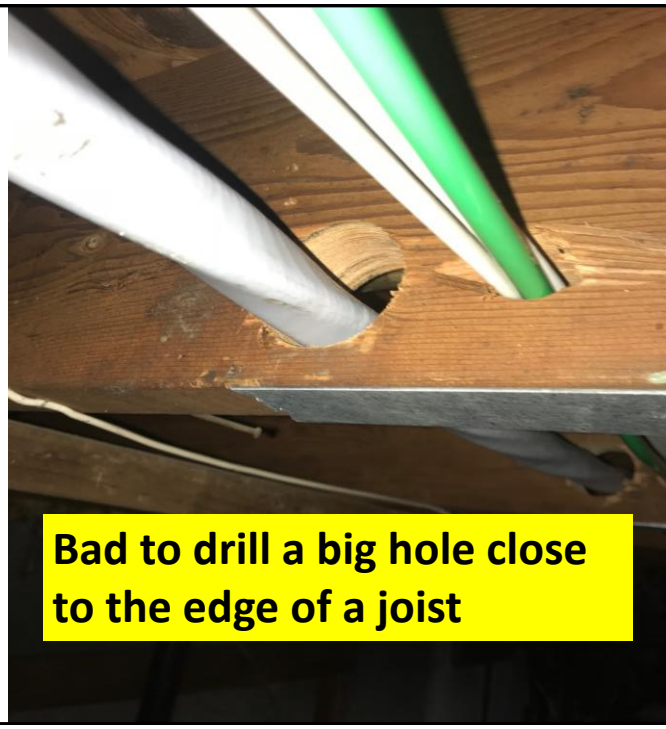
(Amd) TABLE E3802.1 GENERAL INSTALLATION AND SUPPORT REQUIREMENTS FOR WIRING METHODS

- Bored holes in framing members for wiring shall be not less than 2 inches from the edge of the joists or rafters and 1¼ inch from the edge of studs or shall be protected with a minimum 0.0625-inch steel plate or sleeve, a listed steel plate or other physical protection.
- See Sections R502.8 and R802.7 for additional limitations on the location of bored holes in horizontal framing members.



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(Amd) E3608.1 Grounding electrode system.

- If available on the premises at each building or structure served, each item in Section E3608.1.1 to E3608.1.6, inclusive, of this code shall be bonded together to form the grounding electrode system. Where none of these grounding electrodes are available, one or more of the grounding electrodes specified in Section E3608.1.3 to E3608.1.6, inclusive, shall be used.

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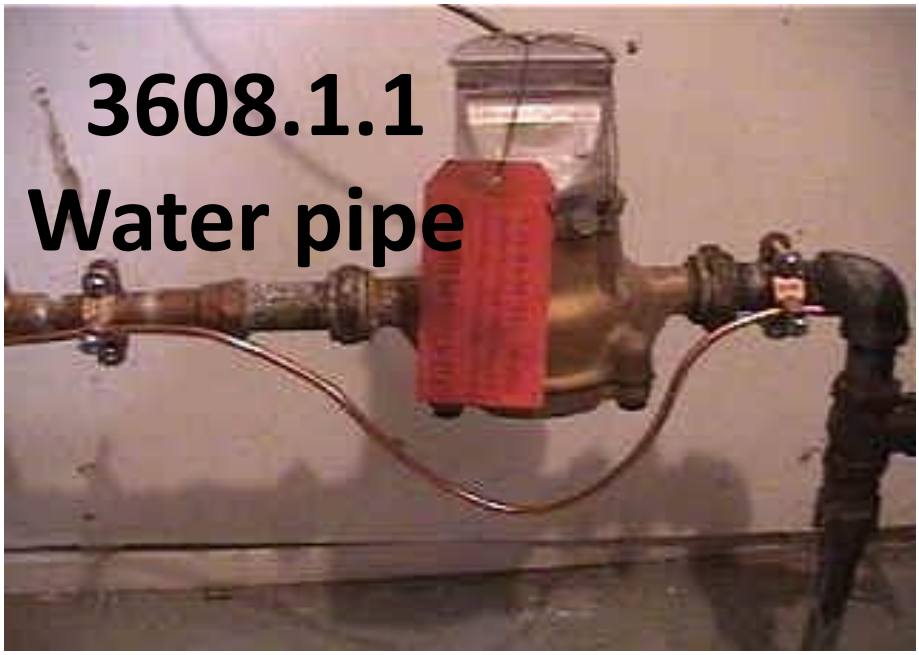
IRC 3608.1 Grounding Electrode System----------GEC

- **3608.1.1-Metal Underground H2O pipe**
- **3608.1.2-Concrete encased electrode (UFER)**
- **3608.1.3-Ground Rings**
- **3608.1.4-Rod and Pipe Electrodes**
- **3608.1.5-Plate Electrodes**
- **3608.1.6-Other Electrodes**



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3608.1.2 Concrete Encased Electrode UFER

- **(3) Concrete-Encased Electrode.** A concrete-encased electrode shall consist of at least 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 1⁄2 in. in diameter, installed in one continuous 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 20 ft or greater length; or
- (2) Bare copper conductor not smaller than 4 AWG

3608.1.2 Concrete Encased Electrode UFER

- Metallic components shall be encased by at least 2 in. of concrete and shall be located horizontally within that portion of a concrete foundation or footing that is in direct contact with the earth or within vertical foundations or structural components or members that are in direct contact with the earth.
- If multiple concrete-encased electrodes are present at a building or structure, it shall be permissible to bond only one into the grounding electrode system.
- Informational Note: Concrete installed with insulation, vapor barriers, films or similar items separating the concrete from the earth is not considered to be in “direct contact” with the earth.

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"UFER"

- **In 1942, Herbert G. Ufer was a consultant working for the U.S. Army. Ufer was given the task of finding an alternative to traditional copper clad rods for dry locations. Ufer discovered that concrete had better conductivity than most soils. He developed a grounding scheme based on encasing the electrodes in concrete.**
- **This method proved to be very effective.**
- **After the war, Ufer continued to test his method, and his results were published in 1963. The use of concrete encased grounding electrode was added to the NEC in 1968.**

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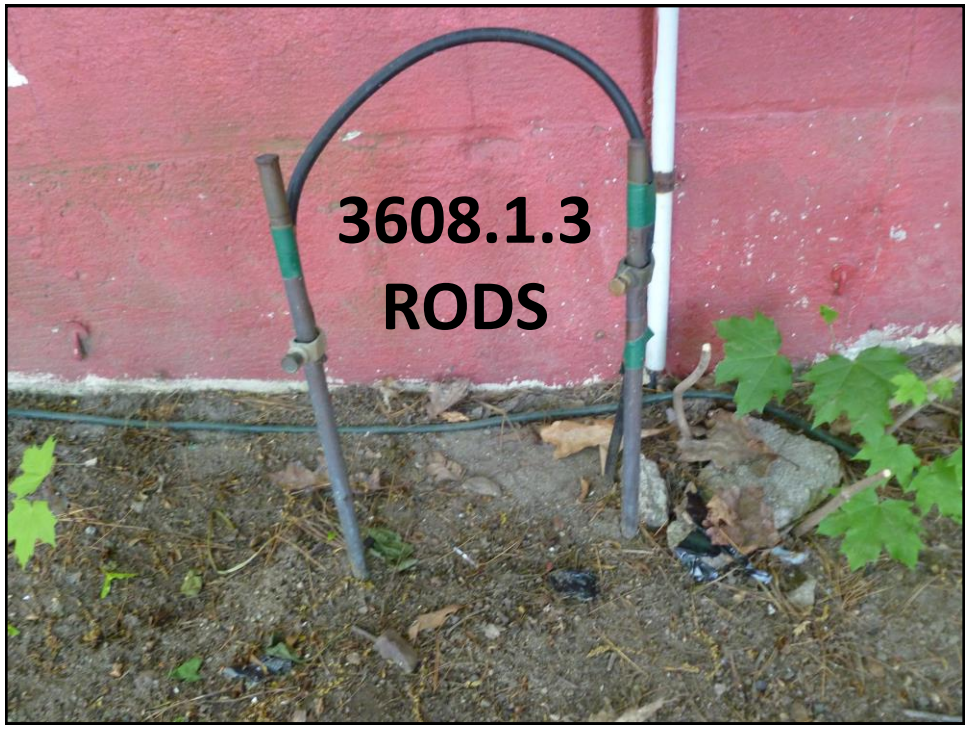
Most common ground rod violations

- Rods are not in contact with the soil for the full 8 FT.
- Rods are driven in at less than a 45 degree angle.
- Improper wire clamp used. Usually it is a water pipe clamp.
- Rods less than 6 feet apart.



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Corrugated Stainless Steel Tubing-CSST

- (Del) **G2411.1.1 (310.1) CSST**. Delete in its entirety without substitution.

- (Add) **G2411.2 (310.1.1) CSST.** This section applies to CSST that is not listed with an arc-resistant jacket or coating system. CSST gas *piping* systems and piping systems containing one or more segments of CSST shall be electrically continuous and bonded to the electrical service grounding electrode system or, where provided, the lightning protection grounding electrode system.

Corrugated Stainless Steel Tubing-CSST

- (Add) **G2411.3 Arc-resistant CSST.** This section applies to (CSST) that is listed with an arc-resistant jacket or coating system. (generally black)

- The CSST shall be electrically continuous and bonded to an effective ground fault current path. Where any CSST component of a piping system does not have an arc-resistant jacket or coating system, the bonding requirements of Section G2411.2 shall apply. Arc-resistant jacketed CSST shall be considered to be bonded when it is connected to the grounding conductor of the circuit that supplies that appliance.

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Corrugated Stainless Steel Tubing-CSST

- Add) **G2411.2.1 (310.1.1.1) Point of connection.** The bonding jumper shall connect to a metallic pipe, pipe fitting or CSST fitting.
- (Add) **G2411.2.2 (310.1.1.2) Size and material of jumper.** The bonding jumper shall be not smaller than 6 AWG copper wire or equivalent.
- (Add) **G2411.2.3 (310.1.1.3) Bonding jumper length.** The length of the bonding jumper between the connection to a gas piping system and the connection to a grounding electrode system shall not exceed 75 feet. Any additional grounding electrodes installed to meet this requirement shall be bonded to the electrical service grounding electrode system or, where provided, the lightning protection grounding electrode system.

CSST

(Add) **G2411.3 Arc-resistant CSST.** This section applies to corrugated stainless steel tubing (CSST) that is listed with an arc-resistant jacket or coating system in accordance with ANSI LC 1/CSA 6.26. The CSST shall be electrically continuous and bonded to an effective ground fault current path. Where any CSST component of a piping system does not have an arc-resistant jacket or coating system, the bonding requirements of Section G2411.2 shall apply. Arc-resistantjacketed
CSST shall be considered to be bonded where it is connected to an appliance that is
connected to the appliance grounding conductor of the circuit that supplies that appliance.

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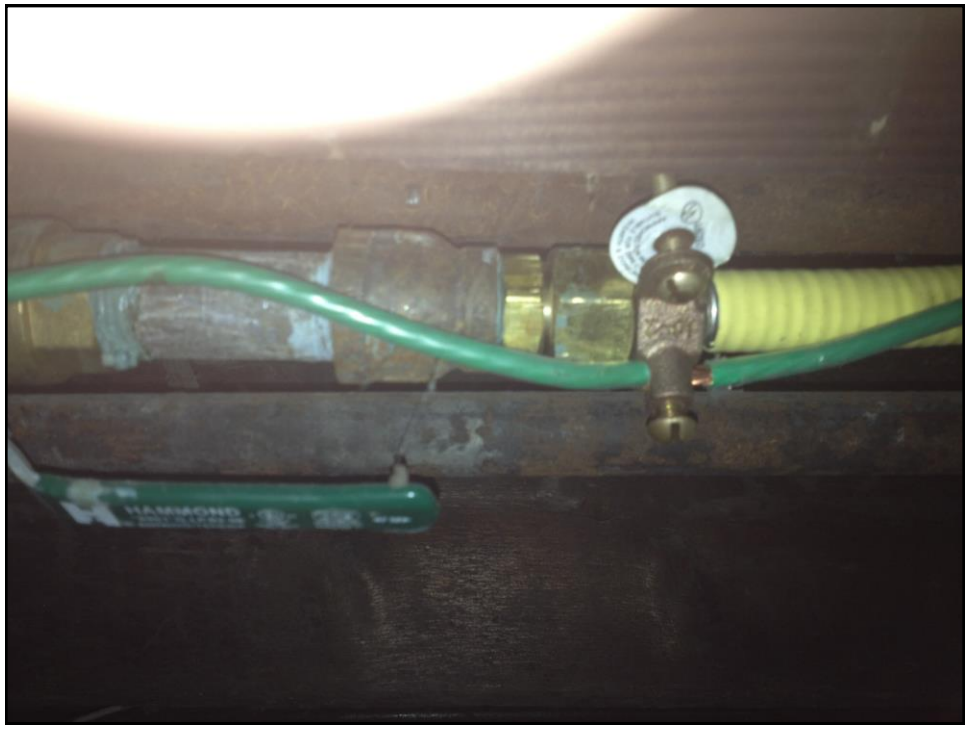
2017 NEC-250.104 Bonding of Piping Systems and Exposed Structural Metal.

- **250.104(B) Other Metal Piping.** If installed in or attached to a building or structure, a metal piping system(s), including gas piping, that is likely to become energized shall be bonded to any of the following:
- (1) Equipment grounding conductor for the circuit that is likely to energize the piping system
- (2) Service equipment enclosure
- (3) Grounded conductor at the service
- (4) Grounding electrode conductor, if of sufficient size
- (5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size



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G2410.1 Grounding

- **Gas piping shall not be used as a grounding electrode.**

IRC-State Amendments-Solar PV

- (Add) **R324.3 Photovoltaic systems.** Photovoltaic systems shall be designed and installed in accordance with Sections R324.3.1 through R324.7.2.5 and NFPA 70. Inverters shall be listed and labeled in accordance with UL 1741. Systems connected to the utility grid shall use inverters listed for utility interaction.

Use of Office of Education and Data Management (OEDM) training materials must be approved in writing by the State of Connecticut, Department of Administrative Services' Office of Communications.

IRC-State Amendments-Solar PV

- **(Add) R324.7 Access and pathways**. Roof access, pathways and spacing requirements shall be provided in accordance with Sections R324.7.1 through R324.7.2.5.
- **Exception:**
- Detached garages and accessory structures to one and two-family dwellings and townhouses, such as parking shade structures, carports, solar trellises and similar structures.

IRC-State Amendments-Solar PV

- **(Add) R324.7.1 Roof access points**. Roof access points shall be located in areas that do not require the placement of ground ladders over openings such as windows or doors, and located at strong points of building construction in locations where the access point does not conflict with overhead obstructions such as tree limbs, wires or signs.

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IRC-State Amendments-Solar PV

- **(Add) R324.7.2 Solar photovoltaic systems**. Solar photovoltaic systems shall comply with Sections R324.7.2.1 through R324.7.2.5.
- **(Add) R324.7.2.1 Size of solar photovoltaic array**. Each photovoltaic array shall be limited to 150 feet by 150 feet. Multiple arrays shall be separated by a clear access pathway not less than 3 feet in width.

IRC-State Amendments-Solar PV

- **(Add) R324.7.2.2 Hip roof layouts**. Panels and modules installed on dwellings with hip roof layouts shall be located in a manner that provides a clear access pathway not less than 3 feet in width from the eave to the ridge on each roof slope where panels and modules are located. The access pathway shall be located at a structurally strong location on the building capable of supporting the live load of fire fighters accessing the roof.
- **Exception**: These requirements shall not apply to roofs with slopes of 2 units vertical in 12 units horizontal and less.

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IRC-State Amendments-Solar PV

- **(Add) R324.7.2.3 Single ridge roofs**. Panels and modules installed on dwellings with a single ridge shall be located in a manner that provides two, 3-foot-wide access pathways from the eave to the ridge on each roof slope where panels or modules are located.
- **Exception**: This requirement shall not apply to roofs with slopes of 2 units vertical in 12 units horizontal and less.

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IRC-State Amendments-Solar PV

- **(Add) R324.7.2.4 Roofs with hips and valleys**. Panels and modules installed on dwellings with roof hips or valleys shall not be located less than 18 inches from a hip or valley where panels or modules are to be placed on both sides of a hip or valley. Where panels are to be located on one side only of a hip or valley that is of equal length, the 18-inch clearance does not apply.
- **Exception:** These requirements shall not apply to roofs with slopes of 2 units vertical in 12 units horizontal and less.

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Use of Office of Education and Data Management (OEDM) training materials must be approved in
writing by the State of Connecticut, Department of Administrative Services' Office of Communications.

IRC-State Amendments-Solar PV

- **(Add) R324.7.2.5 Allowance for smoke ventilation operations**.
- Panels and modules installed on dwellings shall not be located less than 3 feet below the roof ridge to allow for fire department smoke ventilation operations.

(Amd) APPENDIX F – PASSIVE RADON GAS CONTROLS

- (Amd) **AF101.1 General.** This appendix contains radon-resistant construction techniques for new construction.
- (Add) **AF101.2 Radon Mitigation Preparation Construction Technique.** All newly constructed detached one- and two-family dwellings and townhouses shall be provided with radon mitigation preparation construction in accordance with Section AF104 of this code.
- **Exceptions:**
- 1. Radon-resistant construction technique complying with Section AF103 of this code.
- 2. Such systems shall not be required in existing buildings undergoing repair, addition or alteration. In the case of an addition to an existing building, this exception also applies to the new construction.

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APPENDIX F – PASSIVE RADON GAS CONTROLS

- (Add) **AF102.2 Definitions.** Add or amend the following definitions.
- (Amd) **SOIL-GAS-RETARDER.** A continuous membrane of 6-mil polyethylene or other approved equivalent material used to retard the flow of soil gases into a dwelling.

(Amd) AF103.12 Power source and access for future radon fan.

- To provide for future installation of a radon fan, an electrical circuit terminated in an approved box shall be installed during construction in the anticipated location of the radon fan(s). An accessible clear space 22 inches in diameter by 3 feet in height adjacent to the vent pipe shall be provided at the anticipated location of a future radon fan.

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IRC Appendix F

- **(Add) AF104.6 Power source for future radon fan. To provide for future installation of a potential radon fan AF104.6.1 or AF104.6.2 shall be met:**

IRC Appendix F

- (Add) **AF104.6.1 Conduit for future radon fan**. A ¾ inch electrical compliant conduit from the basement or room or space that the electrical panel is located to the attic shall be installed during construction. This conduit is intended to and dedicated for accommodating electrical wiring should a radon mitigation fan be installed. The conduit shall be capped in both the bsmt. and in the attic. The conduit shall be labeled at the top and bottom and specifically state: "**Reserved for a Potential Radon Reduction Mechanical System".**

Use of Office of Education and Data Management (OEDM) training materials must be approved in writing by the State of Connecticut, Department of Administrative Services' Office of Communications.

Use of Office of Education and Data Management (OEDM) training materials must be approved in writing by the State of Connecticut, Department of Administrative Services' Office of Communications.

IRC Appendix F

- (Add) **AF104.6.2 Circuit for future radon fan.** To provide for future installation of a radon fan, an electrical circuit terminated in an approved box shall be installed during construction in the anticipated location of the radon fans.

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IRC Appendix F

(Add) **AF104.7 Accessible clear space.** An accessible clear space 22 inches in diameter by 3 feet in height adjacent to the vent pipe shall be provided in the attic or at an acceptable location of a potential radon fan.

(Add) R109.1.5.2 Additional electrical inspections.

- **In addition to those required by Sections R109.1.2 (plumbing, mechanical, gas and electrical} and R109.1.6 (final inspection) shall include installations of temporary services prior to activation and installation of underground piping and conductors after trenches are excavated and bedded and before backfill is put in place.**

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2017 NEC- 705.12 Point of Connection

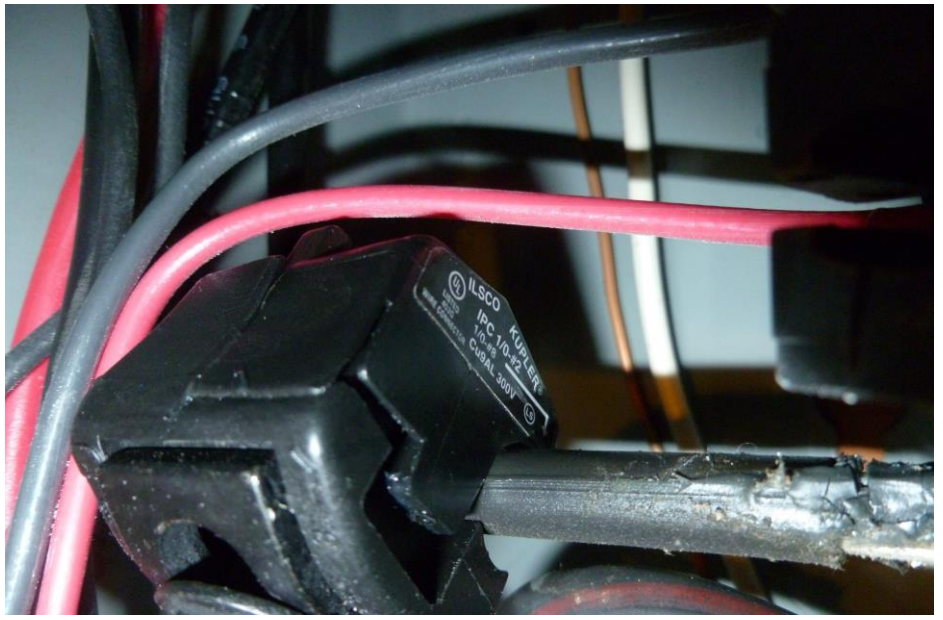
- **705.12 Point of Connection.** The output of an interconnected electric power source shall be connected as specified in 705.12(A) or (B).
- **705.12(A) Supply Side.** A PV System shall be permitted to be connected to the supply side of the service disconnecting means as permitted in 230.82(6). The sum of the ratings of all overcurrent devices connected to power production sources shall not exceed the rating of the service.

2017 NEC 230.82(6)

- **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:
- 230.82(6) Solar PV Systems, fuel cell systems, wind electric systems, energy storage systems or interconnected power production sources.

Use of Office of Education and Data Management (OEDM) training materials must be approved in writing by the State of Connecticut, Department of Administrative Services' Office of Communications.

2017 NEC- 705.12 Point of Connection



Installation instructions for ILSCO IPC

- **1) Suitable for use on copper and aluminum conductors.**
- **2) Installation Instructions For Use as a Run and Tap:**
- **a) Remove the tab blocking the main conductor groove with screwdriver or pliers. - Tap must be broken cleanly to the bottom of the channel.**
- **b) Cut insulated cable end squarely and apply a crisscrossed layer of UL listed electrical tape. Two pieces of Tape measuring approximately three (3) inches long.**

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Installation instructions for ILSCO IPC

- **c) Separate the connector halves by loosening the bolt.**
- **d) Slide the connector over the run conductor.**
- **e) Insert the Tap conductor until it butts up against the tab. BE SURE THE TAP CONDUCTOR IS ALL THE WAY THROUGH THE CONNECTOR.**
- **f) Center both conductors over the piercing teeth, and finger tighten the bolt.**
- **g) Holding the connector firmly in your hand, tighten the bolt to the Torque in the above table.**

Additional info on IPC connectors

- The IPC connectors are one time use only. This was verified in person at an IAEI seminar and through phone conversations with ILSCO.
- The IPC's are not suitable for use on fabric coated wire. <u>You may use on bare only if listed.</u>
- I have seen improperly sized connectors are more than a few occasions.
- The larger sizes have specific requirements as to the diameter of the tap and run conductors. Certain older conductors with certain types of insulation may fall outside the usable parameters.

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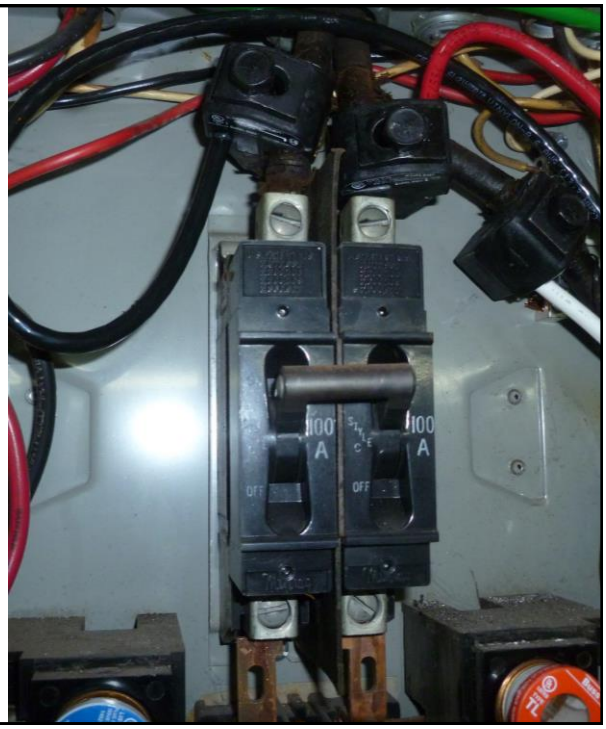
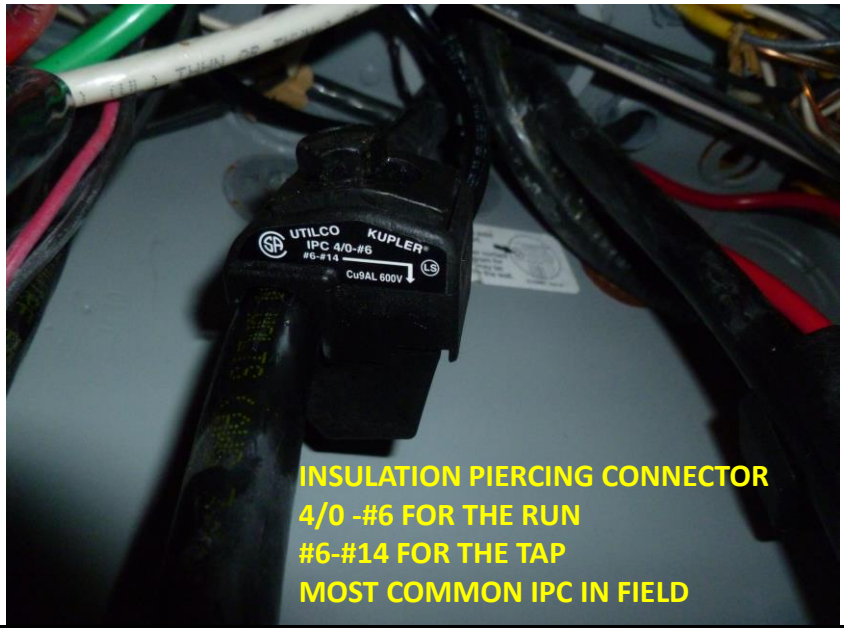
2017 NEC- 705.12 Point of Connection

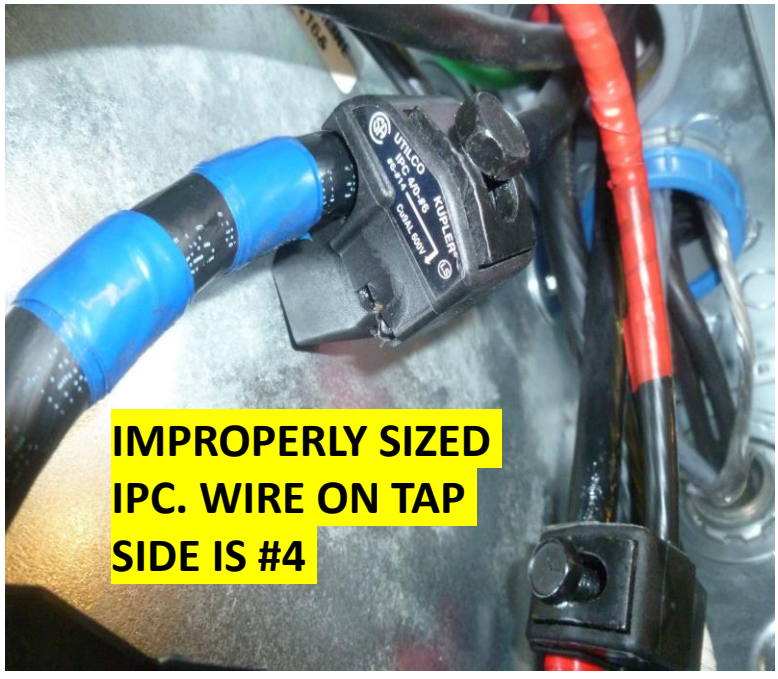
Not suitable for use on fabric coated wire

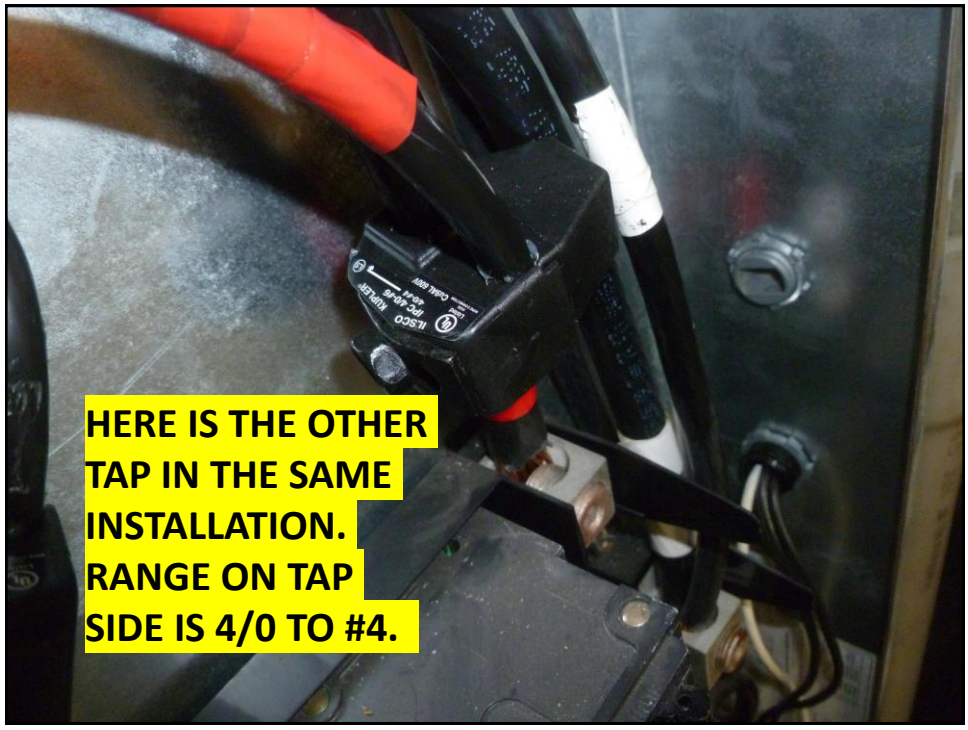
- **Some are not suitable for use on bare conductors.**
- **Some give directions to strip insulation and install on bare conductor.**
- **Some have torque values in inch pounds.**
- **Some have torque values in foot pounds.**



2017 NEC- 705.12 Point of Connection







THINGS TO WATCH FOR

- **NON-FUSIBLE DISCONNECT SWITCH.**
- **LINE AND LOAD SWAPPED ON SWITCH**
- **WRONG SIZE IPC TAPS**
- **GREATER THAN 10 FOOT LONG TAP.**
- **IPC ON CURVED WIRE**
- **EVIDENCE OF REMOVAL AND REPLACEMENT OF IPC**

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2017 NEC- 705.12 Point of Connection

- **705.12(B) Load Side.** The output of a PV System shall be permitted to be connected to the load side of the service disconnecting means at any distribution equipment on the premises.
- Where distribution equipment, such as panelboards are fed simultaneously by a primary source of electricity and one or more other power source(s), and where this distribution equipment is capable of supplying multiple branch circuits or feeders, or both, the interconnecting provisions for other power sources shall comply with 705.12(B)(1) through (B)(5).

2017 NEC- 705.12 Point of Connection

- **705.12(B)(1) Dedicated Overcurrent and Disconnect.**
- Each source interconnection of one or more power sources installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.
- The connection can be to a single breaker or fusible switch
- The AC output of Inverters can be combined in a combiner box and then connected to a single breaker or fusible disconnect switch.

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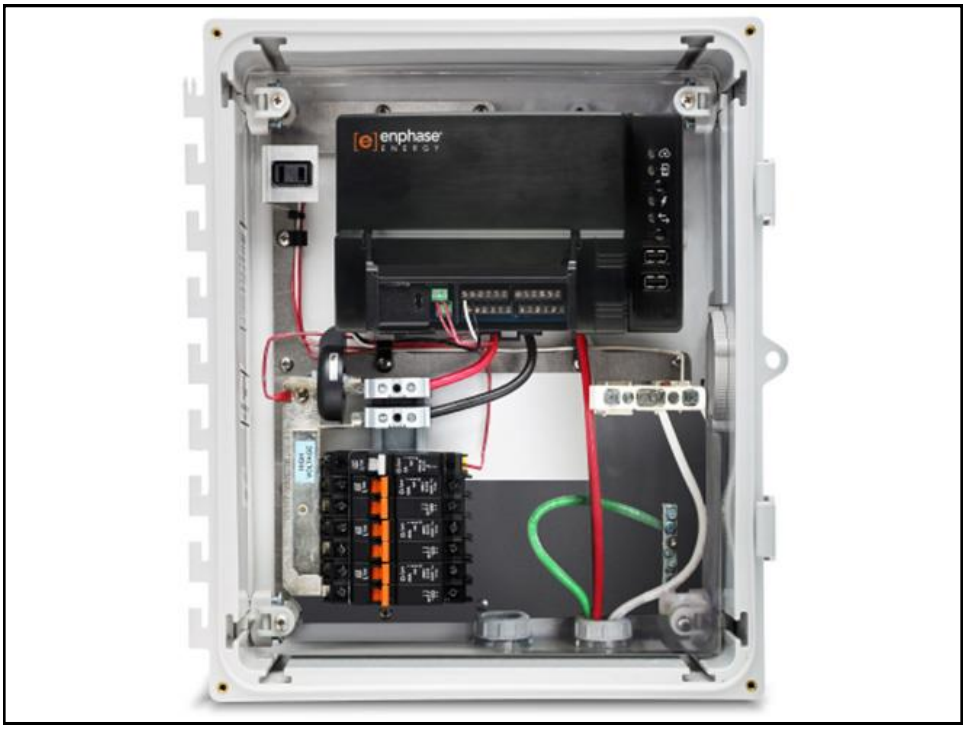


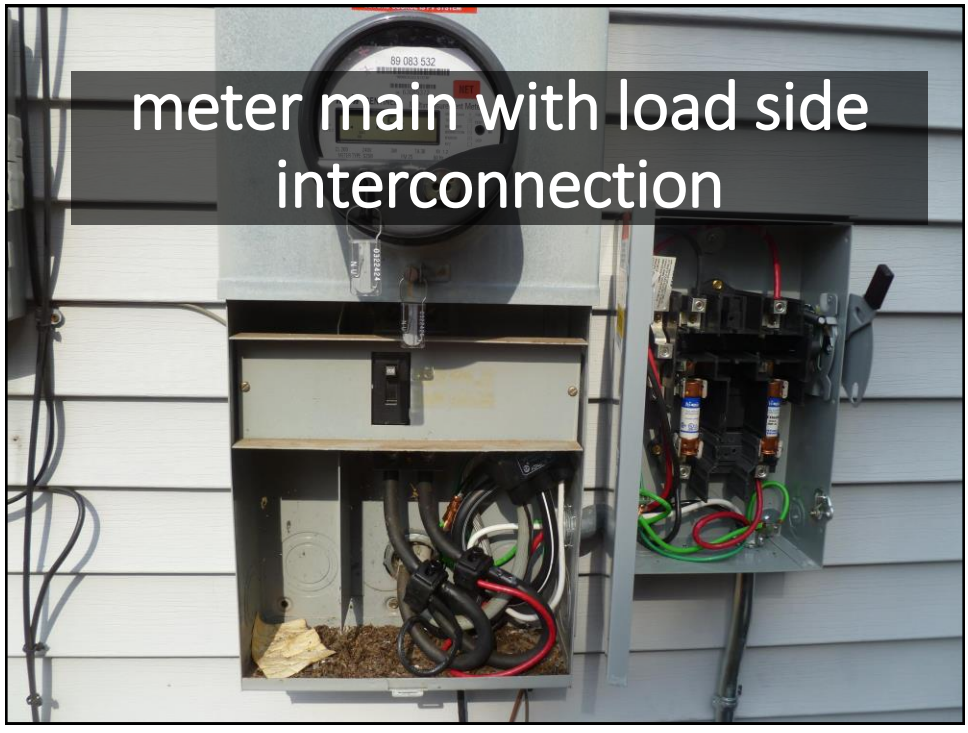
2017 NEC- 705.12 Point of Connection

- **705.12(B)(1) Dedicated Overcurrent and Disconnect.**
- Each source interconnection of one or more power sources installed in one system shall be made at a dedicated circuit breaker or fusible disconnect.
- (1) *Feeders*. Where the power source output connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder on the load side of the power source output connection shall be protected by one of the following:

Use of Office of Education and Data Management (OEDM) training materials must be approved in writing by the State of Connecticut, Department of Administrative Services' Office of Communications.

2017 NEC- 705.12 Point of Connection

- a. The feeder ampacity shall be not less than the sum of the primary source overcurrent device and 125 percent of the power source output circuit current.
- So where are you most likely to see this scenario?
- A meter/main combination.



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2017 NEC- 705.12 Point of Connection

- 705.12(B)(3)(a)(3) *Busbars*. One of the methods that follows shall be used to determine the ratings of busbars in panelboards.
- (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.
- One possible scenario here is the reduction in size of the main circuit breaker. Of course the question that will arise is "Is the breaker being replace a match for the panel.
- Manufacturers do sell replacement main breakers.

2017 NEC- 705.12 Point of Connection

- 705.12(B)(3)(b) Where two sources, one a primary power source and the other another power source are located at opposite ends of a busbar that contains loads, the sum of 125 percent of the power source(s) output current and the rating of the main switch protecting the busbar shall not exceed 120 percent of the ampacity of the busbar.

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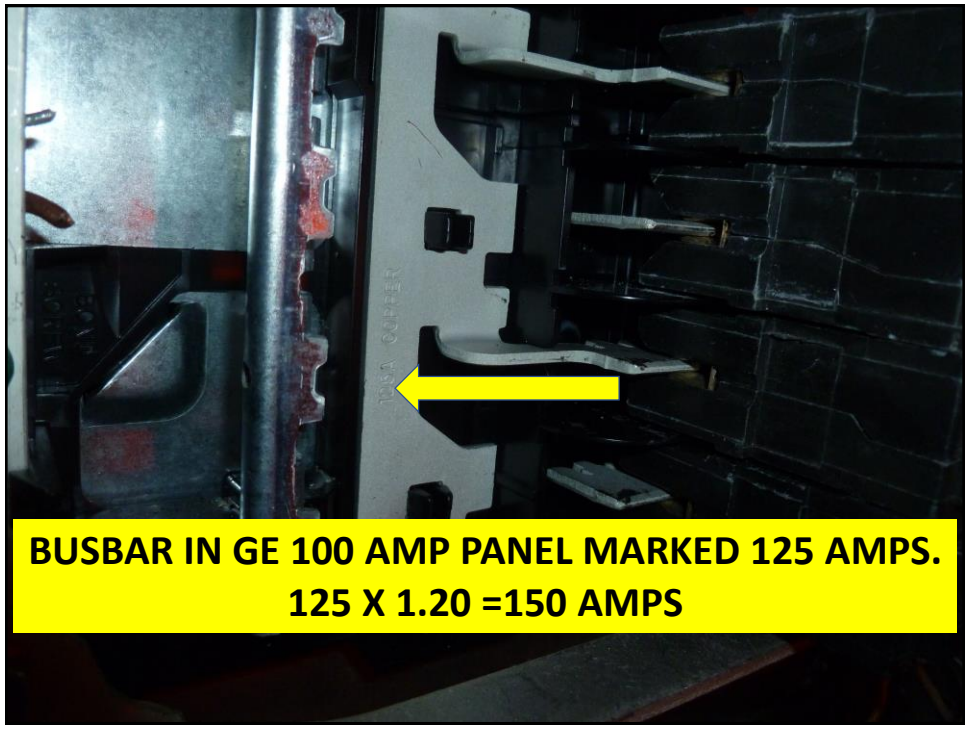
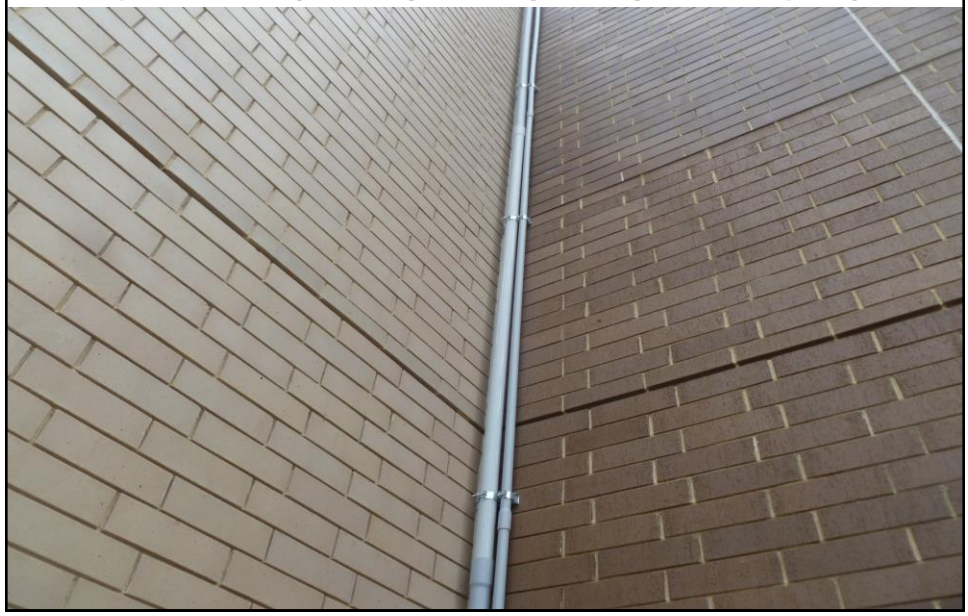


TABLE 352.30 NEC—3802.1 IRC—SUPPORT PVC EVERY 3 FT. OVER SIZE ONE INCH 5FT



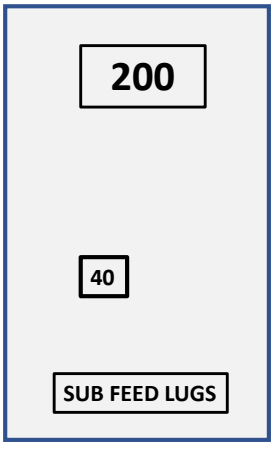
Use of Office of Education and Data Management (OEDM) training materials must be approved in writing by the State of Connecticut, Department of Administrative Services' Office of Communications.

2017-NEC 690.13(C) Suitable for Use

- **690.13(C) If the PV system is connected to the supply side of the service disconnecting means as permitted in 230.82(6), the PV system disconnecting means shall be listed as suitable for use as service equipment.**
- **There has been a major rework of 690.13 for the 2017 NEC. It has cleared up some of the confusion regarding disconnecting means. It would require careful reading and analysis to fully understand**

Use of Office of Education and Data Management (OEDM) training materials must be approved in writing by the State of Connecticut, Department of Administrative Services' Office of Communications.

New main breaker panel with 200 amp bussing and sub-feed lugs



THE NEW MAIN BREAKER AND DISTRIBUTION PANEL THIS PANEL CONTAINS A 200 AMP MAIN BREAKER AND A BUS BAR SUITABLE FOR INSTALLATION OF BRANCH CIRCUIT BREAKERS. 110.3 – 250.24 and 28

ONE CIRCUIT BREAKER HAS BEEN INSTALLED IN THE NEW MAIN BREAKER PANEL. Range outlet 40 amps

THIS PANEL IS FED FROM THE EXISTING METER SOCKET WITH A #4/0 ALUMINUM SEU CABLE. 310.15(B)(7)

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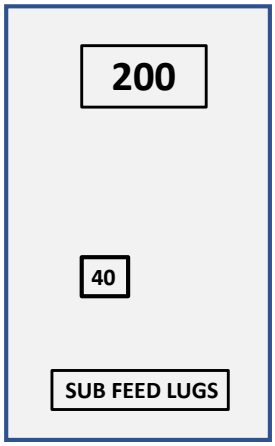
New main breaker panel with 200 amp bussing

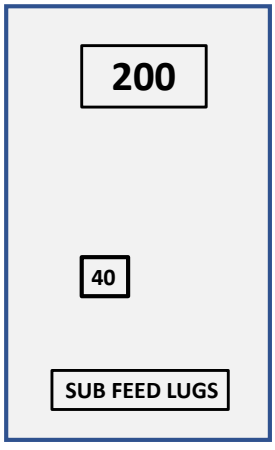


THE PANEL ITSELF IS LISTED FOR USE AS SERVICE EQUIPMENT AND AS SUCH HAS AN APPROPRIATE SHORT CIRCUIT WITHSTAND RATING AS WELL AS A MAIN BONDING JUMPER. 250.24 AND 250.28

THE SUB-FEED LUGS ARE RATED FOR 200 AMPS

THE SUB FEED LUGS SUPPLY CURRENT TO THE GATEWAY. EVERYTHING BEYOND THESE LUGS IS CONSIDERED A SUB-PANEL.

New main breaker panel with 200 amp bussing



THE FIRST QUESTION THAT COMES TO MIND IS CAN I USE # 4/0 ALUMINUM CONDUCTORS TO FEED ANYTHING BEYOND THIS DISTRIBUTION PANEL.

THE ANSWER WOULD BE YES. 310.15(B)(7)(3)

THIS IS SITUATION IS VERY MUCH LIKE A METER/MAIN EXCEPT THAT THERE IS A BREAKER INTALLED IN THE MAIN PANEL.

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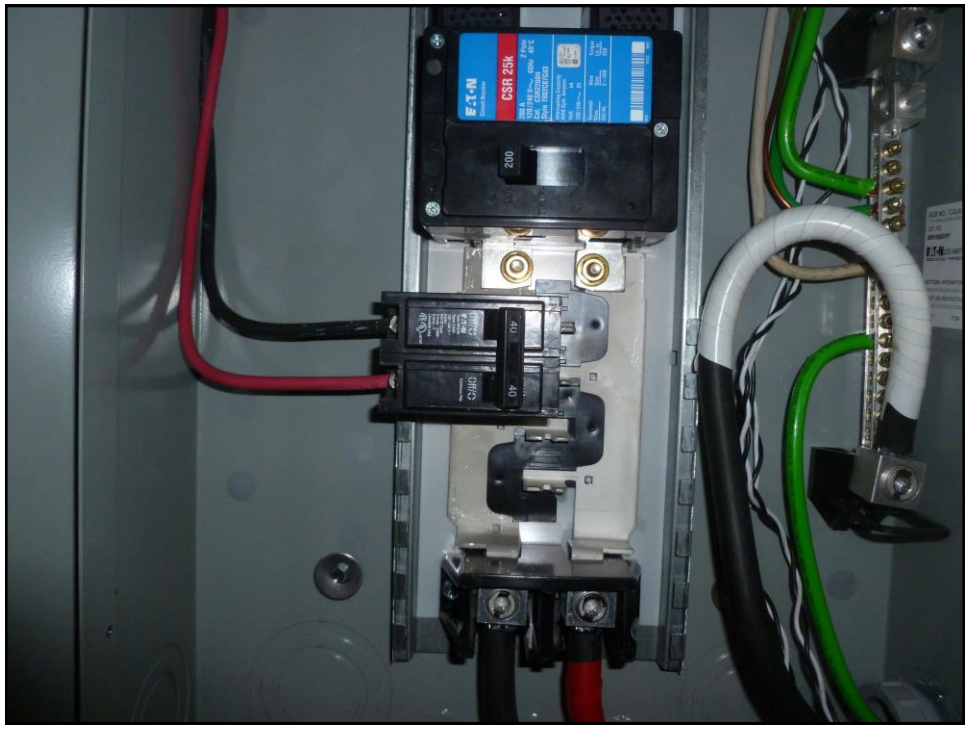
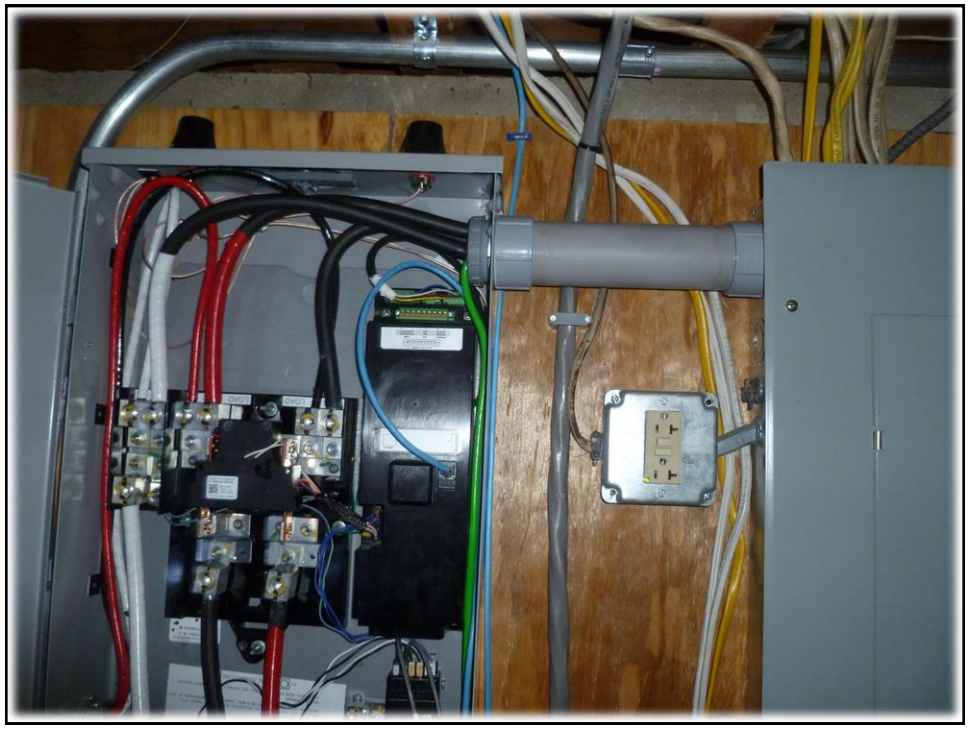
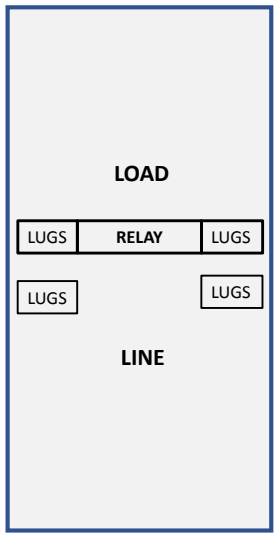




Use of Office of Education and Data Management (OEDM) training materials must be approved in writing by the State of Connecticut, Department of Administrative Services' Office of Communications.

The "GATEWAY"



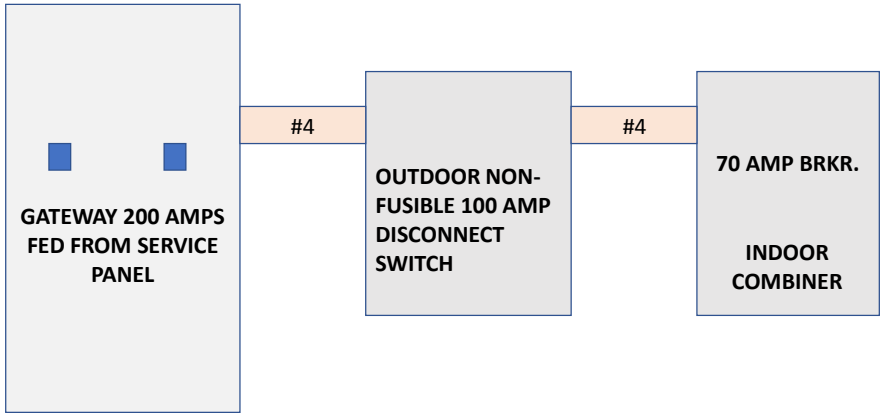
THE LUGS ON THE LINE SIDE OF THE GATEWAY ARE FED FROM THE SUB-FEED LUGS IN THE SERVICE ENCLOSURE.

THE LUGS ON THE LOAD SIDE OF THE GATEWAY FEED TO TWO LOCATIONS. THE 70 AMP BREAKER IN THE COMBINER PANEL, AND THE MAIN BREAKER IN THE HOUSE SERVICE PANEL WHICH NOW BECOMES A SUB PANEL. 250.6

ONE OF THE CODE ISSUES WITH THIS INSTALL WAS THE CONDUCTORS FEEDING THE 70 AMP BREAKER. THE BREAKER SUPPLYING THESE CONDUCTORS IS RATED 200 AMPS.

LETS LOOK AT THE PATH THIS CURRENT WOULD TAKE. WIRES ARE #4 THWN COPPER.

SIMPLIFIED VERSION OF THE CURRENT PATHWAY SOLAR INTERCONNECT



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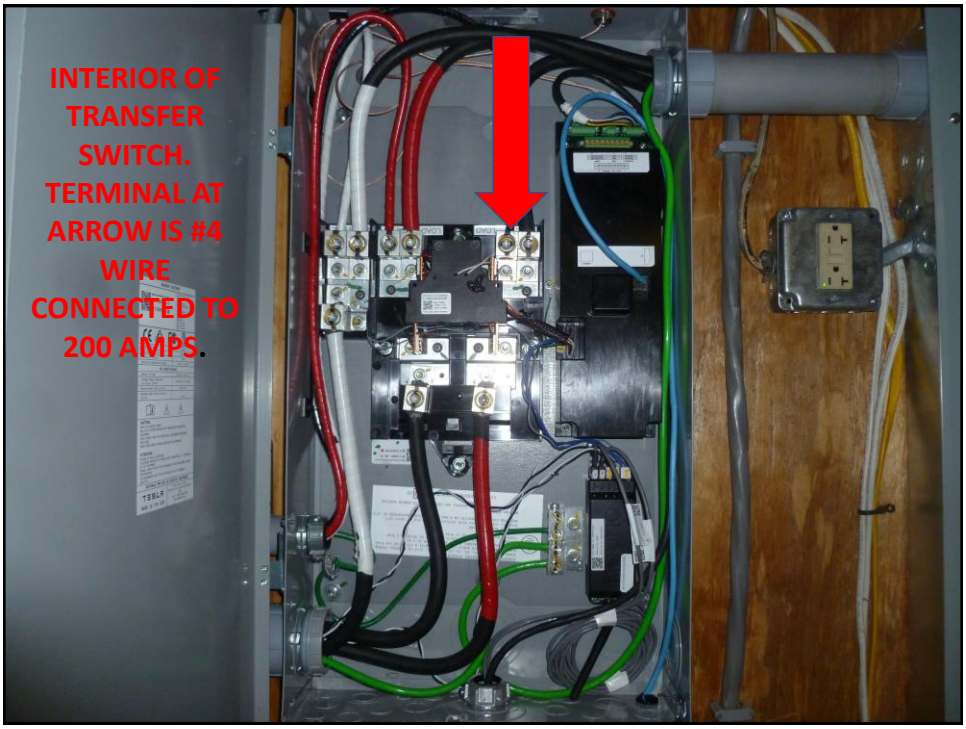

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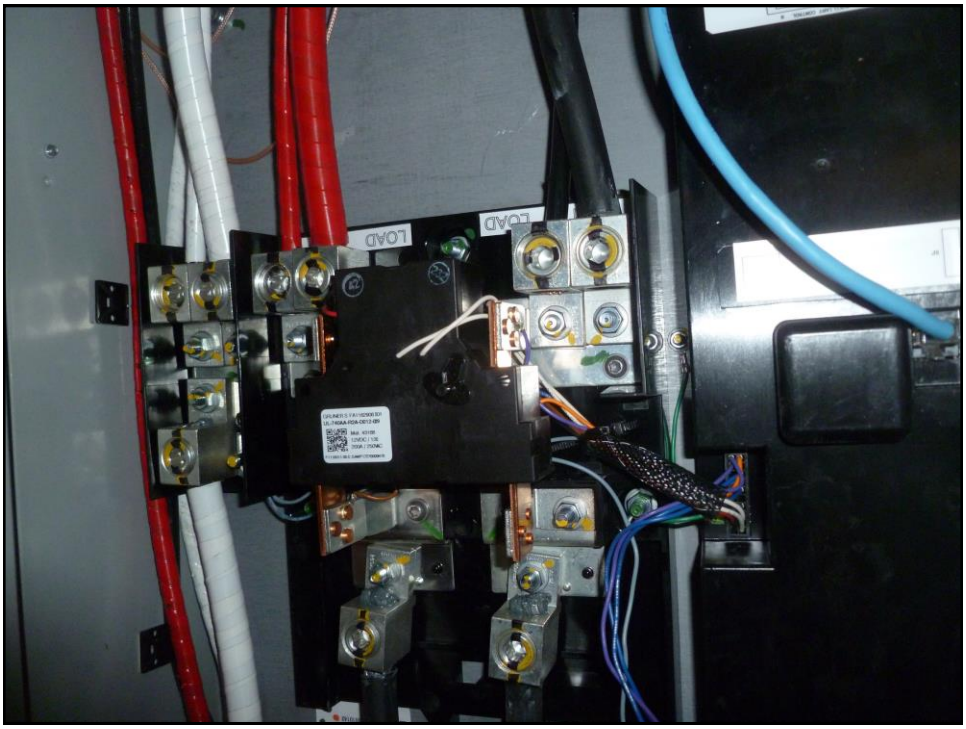


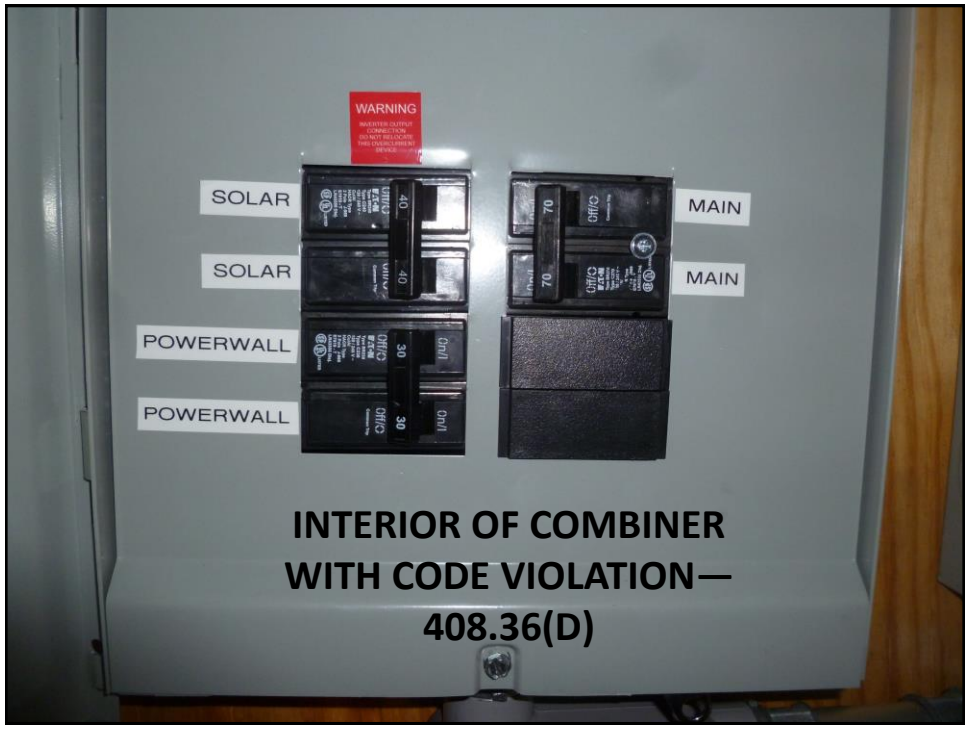
CODE VIOLATIONS

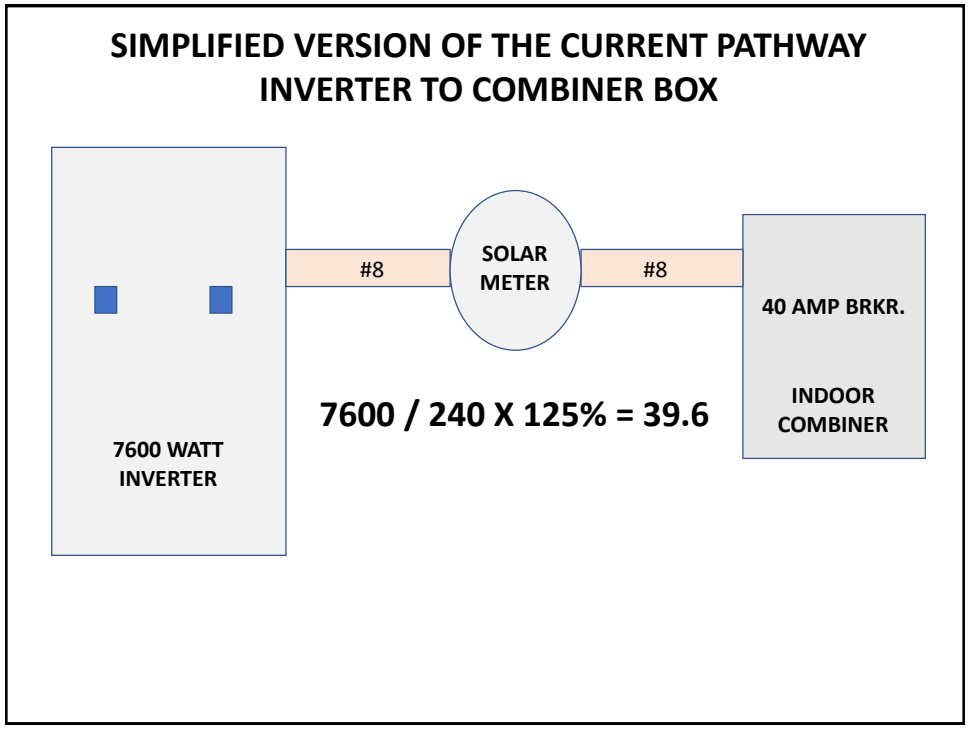
- **The #4 wire in the previous slide was connected to the 200 amp breaker in the new main switch. The #4 left the enclosure and went outside to a 100 amp non-fusible switch. The #4 then left the switch and came back inside to terminate on the 70 amp breaker in the combiner. In order to comply with the code a second fusible switch had to be added to comply with 240.21(B)(1), the 10 foot tap rule.**

Use of Office of Education and Data Management (OEDM) training materials must be approved in writing by the State of Connecticut, Department of Administrative Services' Office of Communications.


ENERGY STORAGE SYSTEM
ON SITE
LOCATED WITHIN LINE OF SIGHT
CAUTION
DUAL POWER SOURCE
SECOND SOURCE IS
PHOTOVOLTAIC SYSTEM

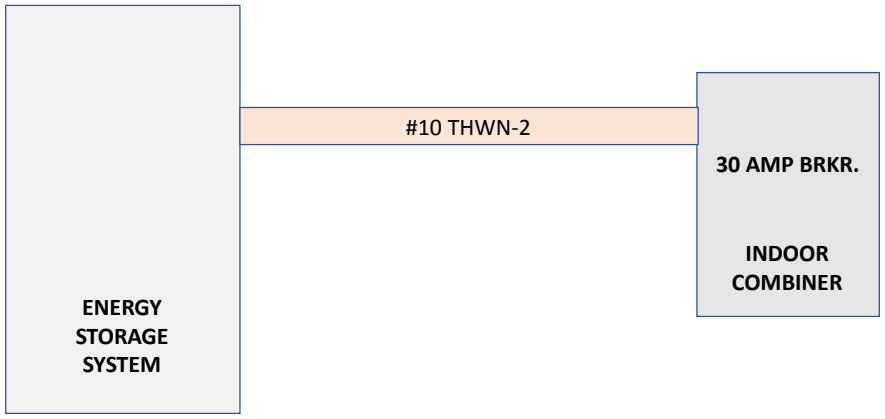

COMBINER
NEW MAIN SWITCH WITH RANGE BREAKER ONLY
TRANSFER SWITCH
ORIGINAL SERVICE PANEL
NOW CONVERTED TO SUB PANEL
TESLA

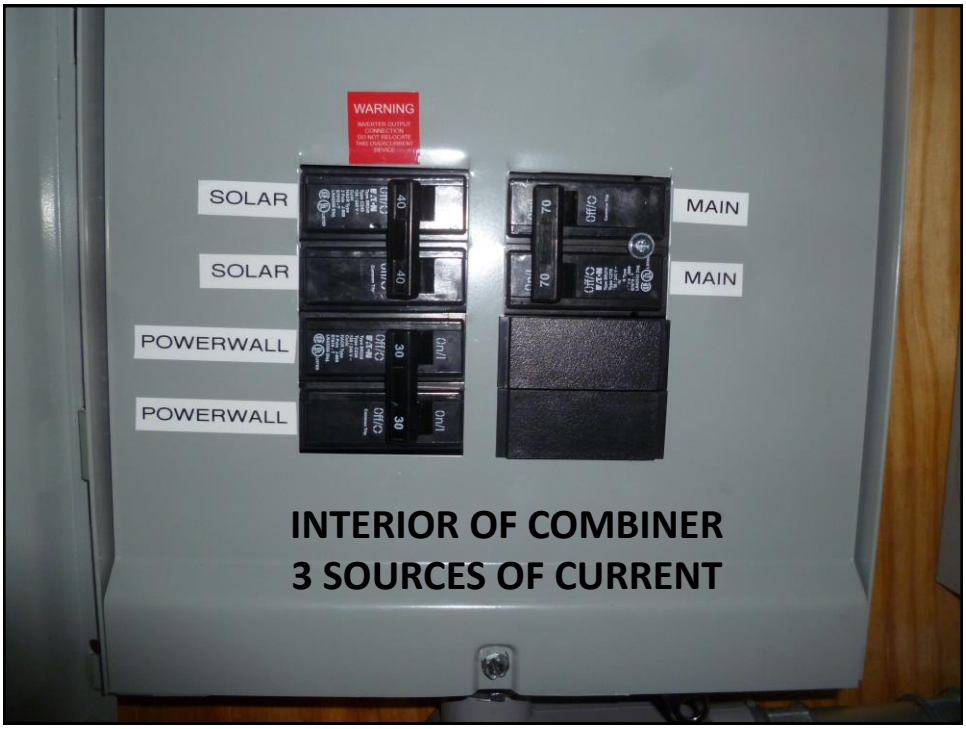




Use of Office of Education and Data Management (OEDM) training materials must be approved in writing by the State of Connecticut, Department of Administrative Services' Office of Communications.

SIMPLIFIED VERSION OF THE CURRENT PATHWAY BATTERY/INVERTER TO COMBINER BOX





UL WHITE BOOK

- **CONDUIT FITTINGS (DWTT)**
- **This category covers metallic and nonmetallic conduit fittings, such as connectors, couplings, conduit bodies, short-radius conduit bodies, expansion fittings, locknuts and sealing (liquid-tight) locknuts for use in the assembly of nonmetallic and metallic wiring systems. Also covered are fittings used to provide a transition between metallic and nonmetallic wiring systems.**

UL White Book-Free online

- **All male threaded fittings and nipples have only been investigated for use with locknuts.**
- **Fittings with internal female threads (e.g., hubs, conduit bodies, couplings) have only been investigated for use with threaded rigid conduit.**

Use of Office of Education and Data Management (OEDM) training materials must be approved in writing by the State of Connecticut, Department of Administrative Services' Office of Communications.

TRANSITIONS

POOL SEASON WILL SOON BE UPON US. SOME QUICK NOTES.

- **2011 NEC**
- **CONSIST OF A SINGLE RECEPTACLE**
- **BE OF A LOCKING CONFIGURATION**
- **ARE OF THE GROUNDING TYPE**
- **HAVE GFCI PROTECTION**

Use of Office of Education and Data Management (OEDM) training materials must be approved in writing by the State of Connecticut, Department of Administrative Services' Office of Communications.

POOL SEASON WILL SOON BE UPON US. SOME QUICK NOTES.

- **2014 NEC**
- **CONSIST OF A SINGLE RECEPTACLE**
- **ARE OF THE GROUNDING TYPE**
- **HAVE GFCI PROTECTION**

POOL SEASON WILL SOON BE UPON US. SOME QUICK NOTES.

- **2017 NEC**
- **ARE OF THE GROUNDING TYPE**
- **HAVE GFCI PROTECTION**

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2017 NEC 680.22(A)(2)

- **680.22(A)(2) Circulation and Sanitation System, Location.**
- Receptacles that provide power for water-pump motors or for other loads directly related to the circulation and sanitation system shall be located at least 6 ft from the inside walls of the pool.
- These receptacles shall have GFCI protection and be of the grounding type.

BEAVER

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The End

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