

Changes to the 2017 National Electrical Code[®]

Chapter 6

Special Equipment

600.4(B) - Marking for Retrofitted Signs

- New requirement for marking an existing sign when retrofitting with a listed illumination system
- The marking shall include
 - The kit provider
 - Installer's name, logo, or unique identifier
- Signs with tubular light-emitting diode lamps power from the existing sockets have additional labeling requirements
- Label alerting service personnel that the sign has been modified
- Label shall meet the requirements of 110.21(B)
- Label shall warn **not** to install fluorescent lamps
- Warning label shall be visible when relamping

ABC
CONSTRUCTION
SUPPLY

10% off on
all LEDs

Champion Signs, LLC.

ILLUMINATION SYSTEM
HAS BEEN REPLACED

RETROFIT KIT MANUFACTURER
ENERGY SAVER INDUSTRIES
RETROFIT KIT MODEL: ESI-564-D237
INSTALLED BY: CHAMPION SIGNS, LLC.

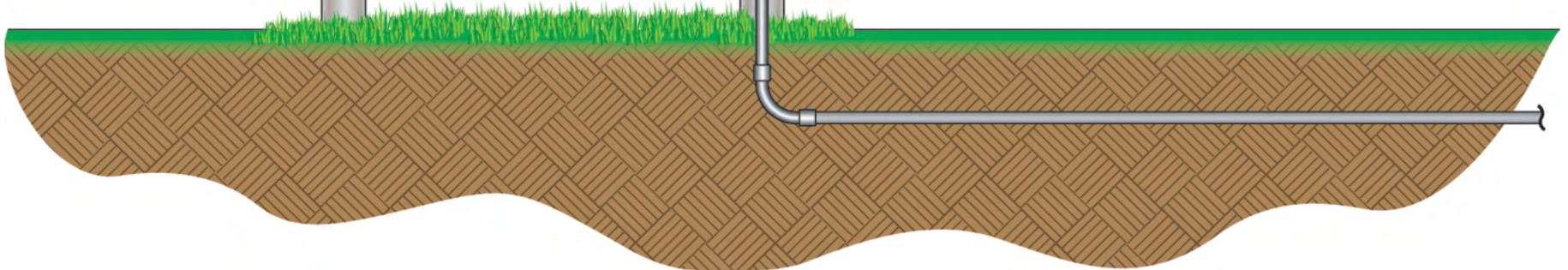
⚠ WARNING

SIGN HAS BEEN MODIFIED

Equipped with tubular light-emitting
diode (LED) lamps powered by the
existing sign sockets

DO NOT INSTALL
FLUORESCENT LAMPS

Retrofit Kit Mfg: [Energy Saver Industries](#)
Champion Signs, LLC Glenwood, IL 800-555-4077



600.6(A)(1), Ex. No. 2 Disconnects – Energized Conductors Warning Label

- New exception permitting feeder or branch circuit to enter as a sign body or enclosure without a disconnecting means at the point of entry, provided:
 - Enclosed in a Chapter 3 listed raceway or metal-jacketed cable identified for the location
 - A field-applied permanent label that is
 - Visible during servicing
 - Applied to raceway at or near point of entry
 - Complies with 110.21(B)

600.6(A)(1), Ex. No. 2 Disconnects – Energized Conductors Warning Label (cont.)

- States the following:

"Danger. This raceway contains energized conductors."

- Location of the disconnecting means
- The disconnecting means shall be capable of being locking in the open position per 110.25
- The Warning label will help to ensure safety of the servicing technician and emergency responders

**ABC
CONSTRUCTION
SUPPLY**

**10% off on
all LEDs**

FEEDER
PANELBOARDS
INSIDE SIGN

FEEDERS

ACCESS PANEL

⚠ DANGER ⚠

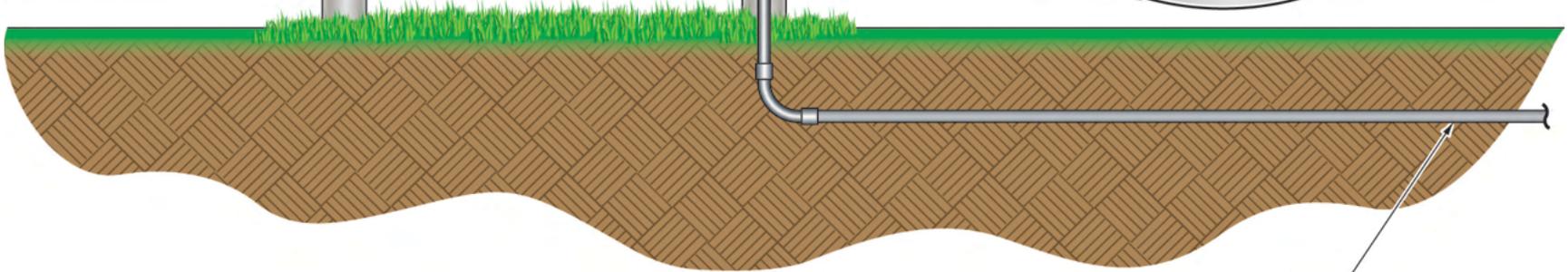
**THIS RACEWAY CONTAINS
ENERGIZED CONDUCTORS**

DISCONNECTING MEANS LOCATION:

*Panel LLB Circuit 24-26.
Panel LLB located in southwest corner
Electrical Room A12.*

Champion Signs, LLC Glenwood, IL 800-555-4077

FEEDER CONDUCTORS
TO MAIN BUILDING





DANGER



**THIS RACEWAY CONTAINS
ENERGIZED CONDUCTORS**

DISCONNECTING MEANS LOCATION:

*Panel LLB Circuit 24-26.
Panel LLB located in southwest corner
Electrical Room A12.*

Champion Signs, LLC

Glenwood, IL

800-555-4077



Catholics

600.33 LED Class 2 Sign Illumination Systems, Secondary Wiring

- Title has been changed from LED to "Class 2 Sign Illumination Systems, Secondary Wiring"
 - The change helps clarify that LED lighting is not the only Class 2 illumination system which this applies to.
- Reference to Part III of Article 725 has been removed and new requirements for Class 2 circuits contained in 600.12(C), 600.24, and 600.33(A)(B) and (C)
- The minimum size of secondary conductors have also been increased from 22 AWG to 18 AWG
- UL product standards for Class 2 secondary wiring to signs refer to 18 AWG as the minimum size

600.33 LED Class 2 Sign Illumination Systems, Secondary Wiring (cont.)

- Table 600.33(A)(1) and Table 600.33(A)(2)
 - New Table 600.33(A)(1)
 - Application of power-limiting cable in signs and outline lighting
 - Previously, 600.33(A) referred to Table 725.154 which did not directly reference Class 2 sign cables causing confusion on application
 - Having Table 600.33(A)(1) eliminates any misunderstanding and clarifies requirements
 - Table 600.33(A)(2) Class 2 cable substitution helps insure proper installation or substitution of cables
 - 600.32(A)(1) and (2) added new text to coordinate with tables and assists in the application and proper installation of Class 2 cables

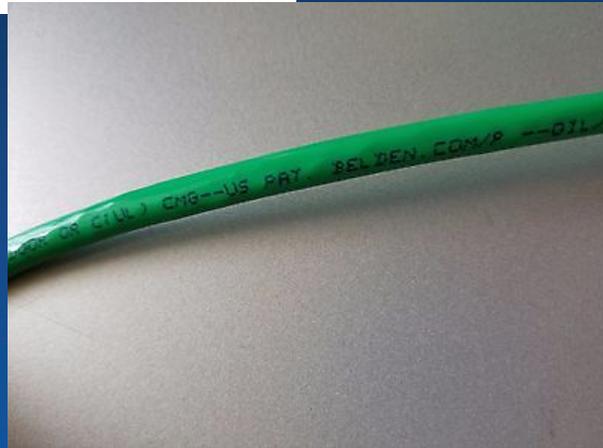


Table 600.33(A)(1) Applications of Power Limited Cable in Signs and Outline Lighting

Wiring Method	CL2	CL3	CL2R	CL3R	CL2P	CL3P	PLTC
Non-concealed spaces inside buildings	Y	Y	Y	Y	Y	Y	Y
Concealed spaces inside buildings that are not used as plenums or risers	Y	Y	Y	Y	Y	Y	Y
Environmental air spaces plenums or risers	N	N	N	N	Y	Y	N
Wet locations	N	N	N	N	N	N	Y

Y = Permitted. N = Not Permitted.

Reproduction of NEC Table 600.33(A)(1)

Table 600.33(A)(2) Class 2 Cable Substitutions

Cable Type	Permitted Substitutions
CL3P	CMP
CL2P	CMP, CL3P
CL3R	CMP, CL3P, CMR
CL2R	CMP, CL3P, CL2P, CMR, CL3R
CL3	CMP, CL3P, CMR, CL3R, CMG, CM, PLTC
CL2	CMP, CL3P, CL2P, CMR, CL3R, CL2R, CMG, CM, PLTC, CL3
CL3X	CMP, CL3P, CMR, CL3R, CMG, CM, PLTC, CL3, CMX
CL2X	CMP, CL3P, CL2P, CMR, CL3R, CL2R, CMG, CM, PLTC, CL3, CL2, CMX, CL3X

Reproduction of NEC Table 600.33(A)(2)

600.34 and 600.2 Photovoltaic (PV) Powered Signs

- 600.2
 - New definition for photovoltaic (PV powered) signs

A complete sign powered by solar energy consisting of all components and subassemblies for installation either as an off-grid stand-alone, on-grid interactive, or non-grid interactive system.
- 600.34 was added to address PV used in signs and to bring continuity between 600 and 690
 - Shall be installed per 690
 - Gives basic criteria for installation
 - Helps maintain compliance with UL 48 (Standard for Electric Sign)



605.9(C) Receptacles at Office Furnishings

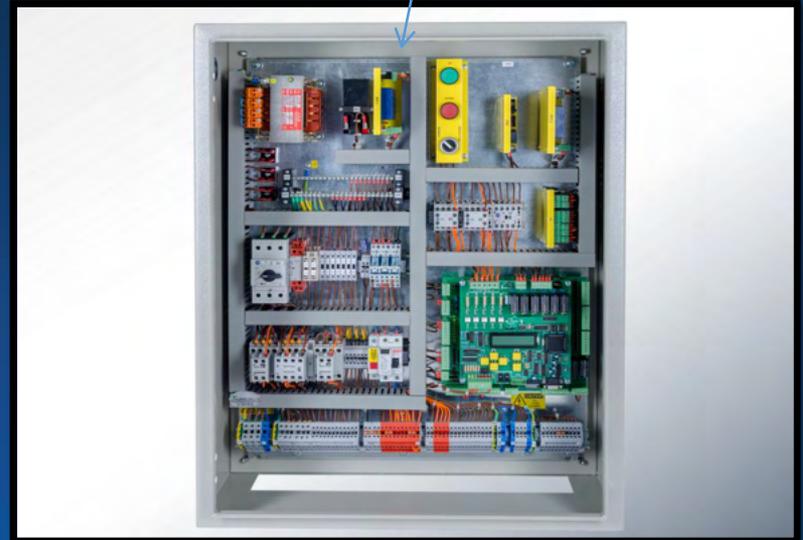
- Changes affect freestanding cord and plug connected office furnishing
- The term "receptacle outlets" was changed to "receptacles"
- Limiting individual office furnishing to (13) 15 amp 125 volt receptacles
- Also qualifying the term "receptacle" for this requirement
 - Up to two (simplex) receptacles provided within a single enclosure that are within 1 foot of each other
 - Or one duplex receptacle
- Limiting the maximum number of individual receptacle contact points to (26) 15 amp 125 volt

620.16 SCCR at Elevator Control Panels

- Elevator control panel shall be marked with its short circuit current rating (SCCR) based on:
 - SCCR rating of listed assembly
 - SCCR rating using approved method (see UL 508A)
- This helps to ensure that elevator control panels are not installed where the available SCCR exceeds its rating



Mark with Short Circuit Current



Article 625 - Electric Vehicle Charging System

- Equipment connection rules were revised to bring continuity between portable, stationary, and fixed equipment
- New Part IV "Wireless Portable Transfer Equipment" was added
- New definitions were added at 625.2

Article 625 - Electric Vehicle Charging System

- 625.2 Definitions

- New definitions for electric vehicle supply equipment (EVSE) include:
 - Fasted in place
 - Mounting means of an EVSE in which the fastening means are specifically designed to permit periodic removal for relocation, interchangeability, maintenance, or repair without the use of tools
 - Fixed in place
 - Mounting means of an EVSE attached to a wall or surface with fasteners that require a tool to remove
- Portable (applies to EVSE)
 - A device intended for indoor or outdoor use that can be carried from charging location to charging location and is designed to be carried in the vehicle when not in use



ELECTRIC
VEHICLE
CHARGING
STATION

EXCEPT FOR
ELECTRIC
VEHICLE
CHARGING

ELECTRIC
VEHICLE
CHARGING
STATION

EXCEPT FOR
ELECTRIC
VEHICLE
CHARGING

7JGE233

PREMIER 900

TEAM
7DTA758
VALLEJO

VISITOR

ELECTRIC
VEHICLE

ELECTRIC
VEHI

625.10 Electric Vehicle Coupler

- The requirement for EVC to be polarized and noninterchangeable were deleted
- These aspects of the plug configuration are dictated by UL Standard 2251 and automotive engineering standard SAE J1772 and will be addressed during the listing process of the product.

**Charging socket
Type 2 standard**



**Standard
attachment**



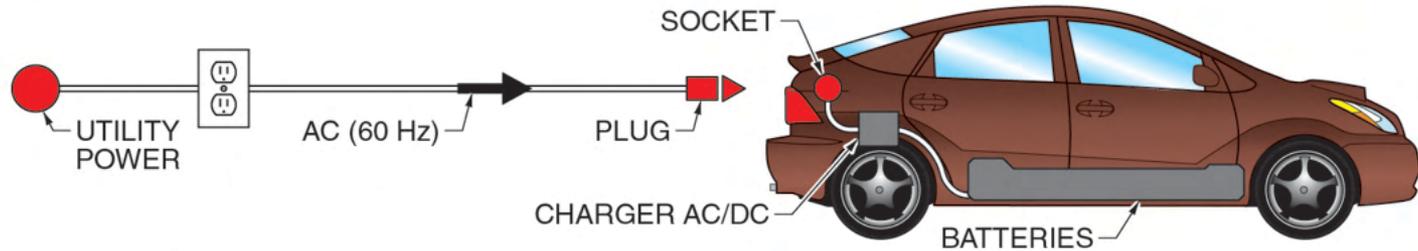
**Basic Type 2
Charging socket**



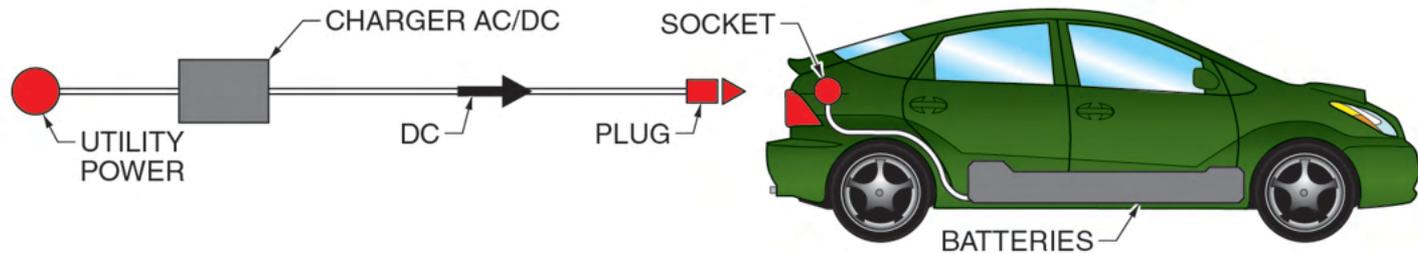
**Charging socket
Type 2 with Shutter**



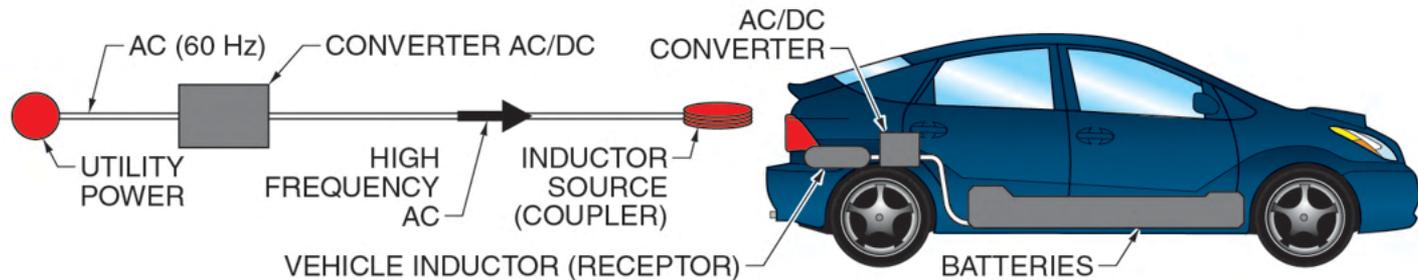
EV Charger Coupling Alternatives



On-Board AC Conductively Coupled (Direct Coupled AC)



Off-Board DC Conductively Coupled (Direct Coupled DC)



Inductively Coupled

625.44(A) Portable Equipment

- 625.44(A) was revised by TIA 17-2 December 1, 2016
- Portable equipment shall be connected to premises wiring by one of the following methods. - Was expanded to include
- (2) A non-locking, 2-pole, 3-wire grounding type receptacle outlet rated at 250 volt, single phase 15 or 20 amperes
- (3) A non-locking, 2-pole, 3-wire or 3-pole, 4-wire grounding type receptacle outlet rated at 250 volts, single phase 30 or 50 amperes

625.54 Ground-Fault Circuit-Interrupter Protection for Personnel

- 625.54 was added by TIA 17-2 December 1, 2016
- All single phase receptacles installed for the connection of electric vehicle charging that are rated 150 volts to ground or less and 50 amps or less shall have Ground-Fault Circuit-Protection For Personnel

625.56 Receptacle Enclosures

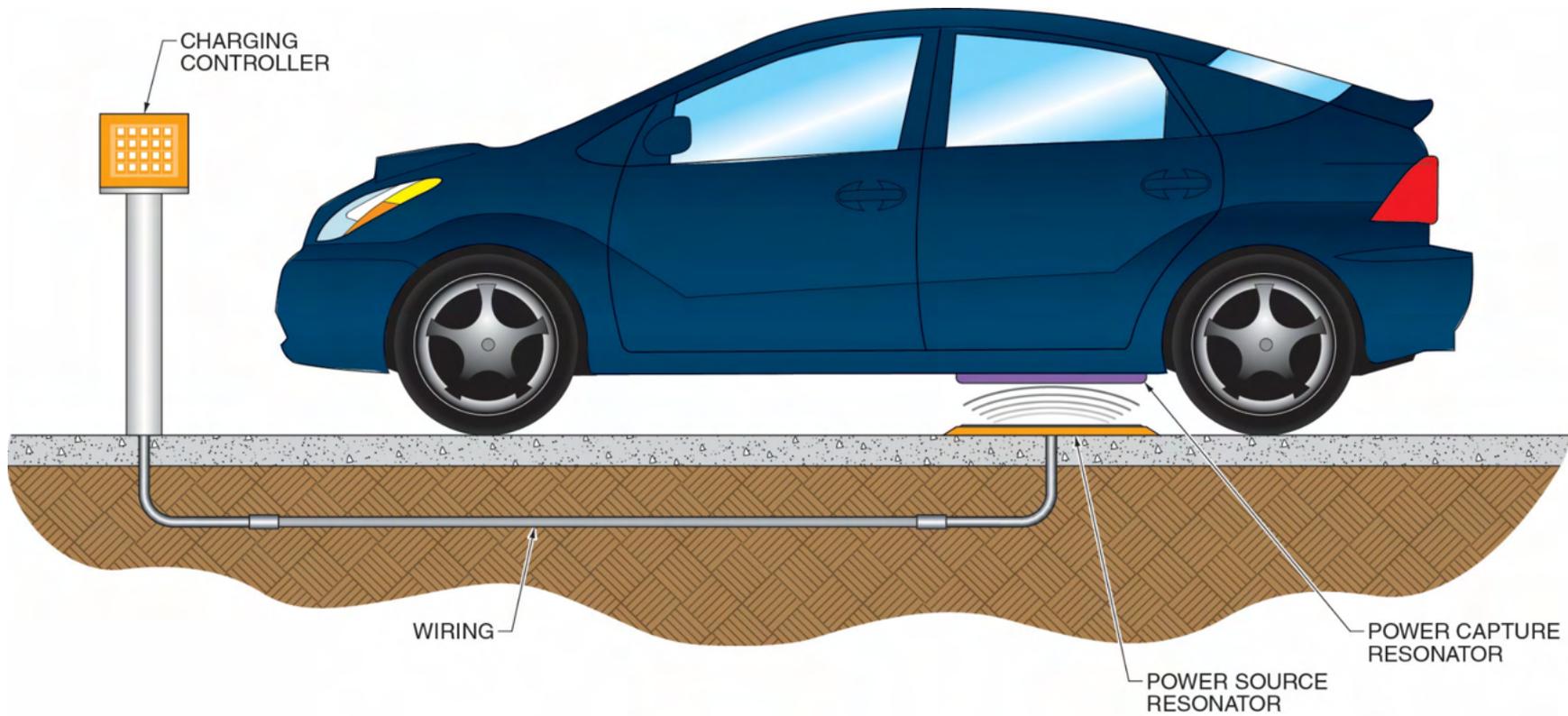
- 625.56 was added by TIA 17-2 December 1, 2016
- All receptacles installed in a wet location for electric vehicle charging shall have an enclosure that is weatherproof with the attachment plug cap inserted or removed.

Article 625, Part IV - EV Charging System Wireless Power Transfer Equipment

- Part IV is new to Article 625 and covers wireless power transfer equipment
- Wireless EV systems create a connection between a transmitting pad on ground level and a receiving pad on the electric vehicle
- Article 625 has two sections
 - 625.101 Grounding Requirements
 - 625.102 Construction Requirements

Article 625, Part IV - EV Charging System Wireless Power Transfer Equipment

- Two new definitions were added to 625.2 to help clarify part IV
 - Wireless Power Transfer (WRT)
 - The transfer of electrical energy from a power source to an electrical load via electric and magnetic fields or waves by a contactless inductive means between a primary and secondary device
 - Wireless Power Transfer Equipment (WPTE)
 - Equipment consisting of a charger power converter and a primary pad. The two devices are either separate units or contained within one enclosure





WIRELESS PARKING CHARGE



WIRELESS PARKING CHARGE



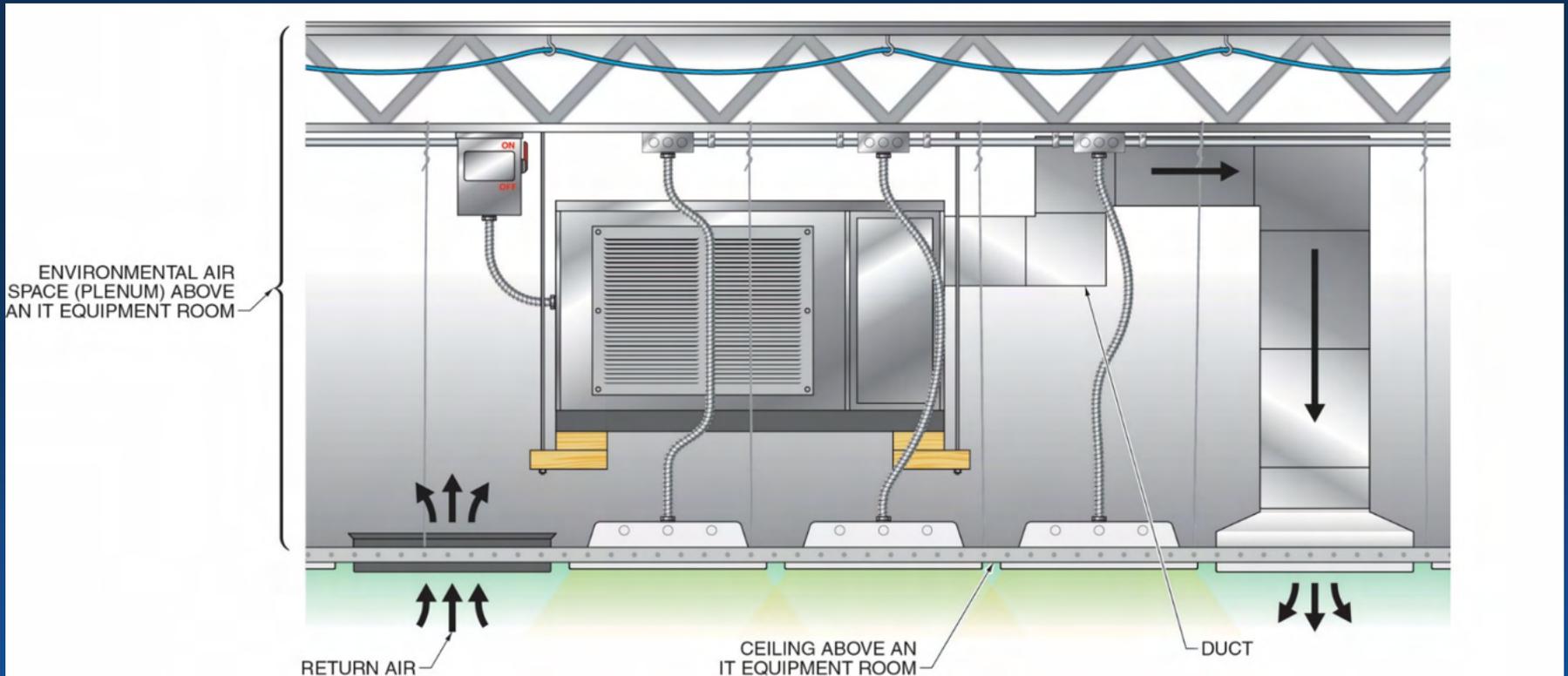
非接触充電システム
Wireless battery-charging system

645.3(B) Other Articles (Plenums) – Information Technology (IT) Equipment

- "Other Articles" applies to wiring and cabling in other spaces used for environmental air (Plenums) above an information technology equipment room
- The title was changed from "Plenums" to "Wiring and Cabling in Other Spaces Used for Environmental Air (Plenums)" to correlate with other Code language (300.22(C))
- The section was reformatted to a list format for clarity and ease of use

645.3(B) Other Articles (Plenums)

Other article and section references applying to wiring and cabling in plenums above an IT equipment rooms has been reformatted into a list format with appropriate titles added at each Code reference.



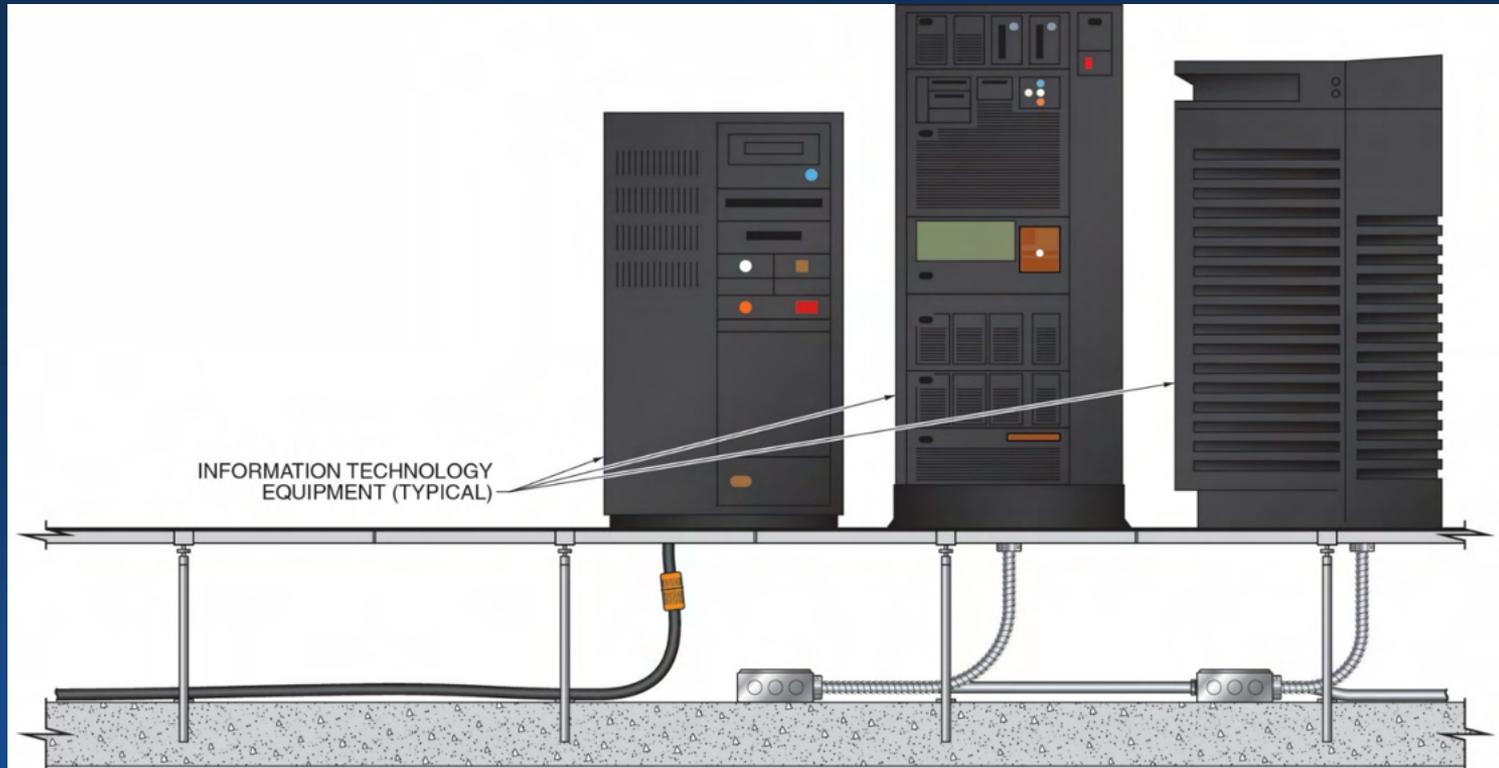
The title was changed from “Plenums” to “Wiring and Cabling in Other Spaces Used for Environmental Air (Plenums)”.

645.5(E) Wiring Under Raised Floors – IT Equipment Rooms

- Under Raised Floors, (1) through (6) were reformatted for clarity and revised to a list format
- New formatting includes
 - 645.5(E)(1) Branch Circuit Wiring
 - 645.5(E)(2) Supply Cords, Data Cables, Interconnecting Cables, and Grounding Conductors
 - 645.5(E)(3) Optical Fiber Cable
- Table 645.5(E)(6) was deleted

645.5(E) Wiring Under Raised Floors (ITE Rooms)

Requirements for installing wiring methods and cables under a raised floor in an IT equipment room have been revised into a list format for clarity



Previous Table 645.5(E)(6) was deleted as it contained conflicting information about permitted cable types permitted under a raised floor and is no longer needed



645.18 Surge Protection for Critical Operations Data Systems (IT Equipment)

- New requirement for surge protection device (SPD) on critical operating data systems
- Due to the nature of critical operating data systems that ensure public safety, emergency management, and business continuity, the added level of protection is warranted
- Correlates the SPD requirements with those in Critical Operating Power Systems (708.20(D))

645.18 Surge Protection for Critical Operations Data Systems



SURGE ARRESTER



SURGE PROTECTIVE DEVICES (SPD)

Surge protection is not required to be provided for critical operations data systems

Article 650 Pipe Organs

- Revised for clarity
- New definitions were added
 - Electronic Organ
 - A musical instrument that imitates the sound of a pipe organ by producing sound electronically
 - Pipe Organ
 - A musical instrument that produces sound by driving pressurized air (called wind) through pipes selected via a keyboard

Article 650 Pipe Organs

- Sounding Apparatus

The sound-producing part of a pipe organ, including, but not limited to, pipes, chimes, bells, the pressurized air (wind)-producing equipment (blower), associated controls, and power equipment

- New 650.9 "Protection from Accidental Contact" was added requiring wiring to be in a lockable enclosure

Ensures a higher safety level by limiting access to only qualified people

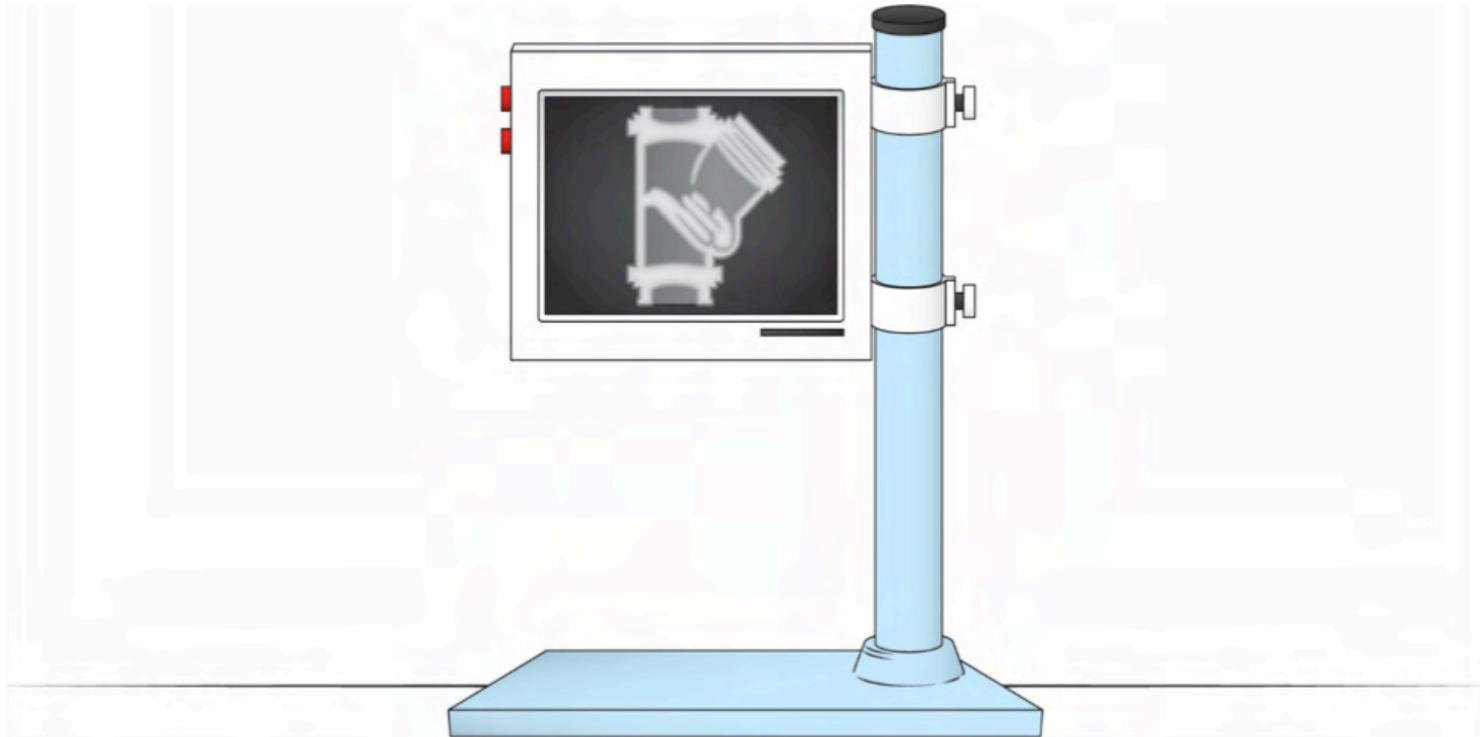


660.5 Disconnecting Means – Industrial X-Ray Equipment

- Disconnecting means for industrial X-ray shall be "within sight" from X-ray controls and readily accessible
- Clarifying the proper disconnect location. Previous editions of the code only required the disconnect to be readily accessible
- New exception was added for locations of disconnecting means that would be impractical or introduces additional or increased hazards
- Or Industrial installations with a written safety procedure where conditions of maintenance and supervision that ensure only qualified persons service equipment

660.5 Disconnecting Means (X-Ray Equipment)

New requirement clarifies disconnecting means for industrial equipment is now required to be located within sight of the x-ray controls and readily accessible. No longer allowed to be located in another room.





Delete this belongs to IAEI



670.6 Surge Protection for Industrial Machinery

- New surge protection requirement for safety interlock circuits
- New study commission by NFPA Research Foundation titled "Data Assessment for Electrical Surge Protection Devices" shows that 26% of responders showed damage to safety interlock systems due to power surges
- This requirement provides added protection for workers by protecting the safety interlock system

680.2 and Part VIII, Article 680 – Electrically Powered Pool Lift

- New definition for “Electrically Powered Pool Lift”
 - An electrically powered lift that provide accessibility to and from a pool or spa for people with disabilities
- This is required equipment at public facilities to meet ADA requirements
- Previous editions of the code had no requirements for electrically powered pool lifts

680.2 Definition: Electrically Powered Pool Lift

Electrically Powered Pool Lift. An electrically powered lift that provides accessibility to and from a pool or spa for people with disabilities.



680.2 Definitions: Storable Swimming, Wading, or Immersion Pools; or Storable/Portable Spas and Hot Tubs

- Definition was revised for clarity
- Intended to be stored when not in use
- Constructed on or above the ground
- Nonmetallic molded polymeric wall or inflatable fabric, regardless of dimensions
- Maximum water depth of 42 inches

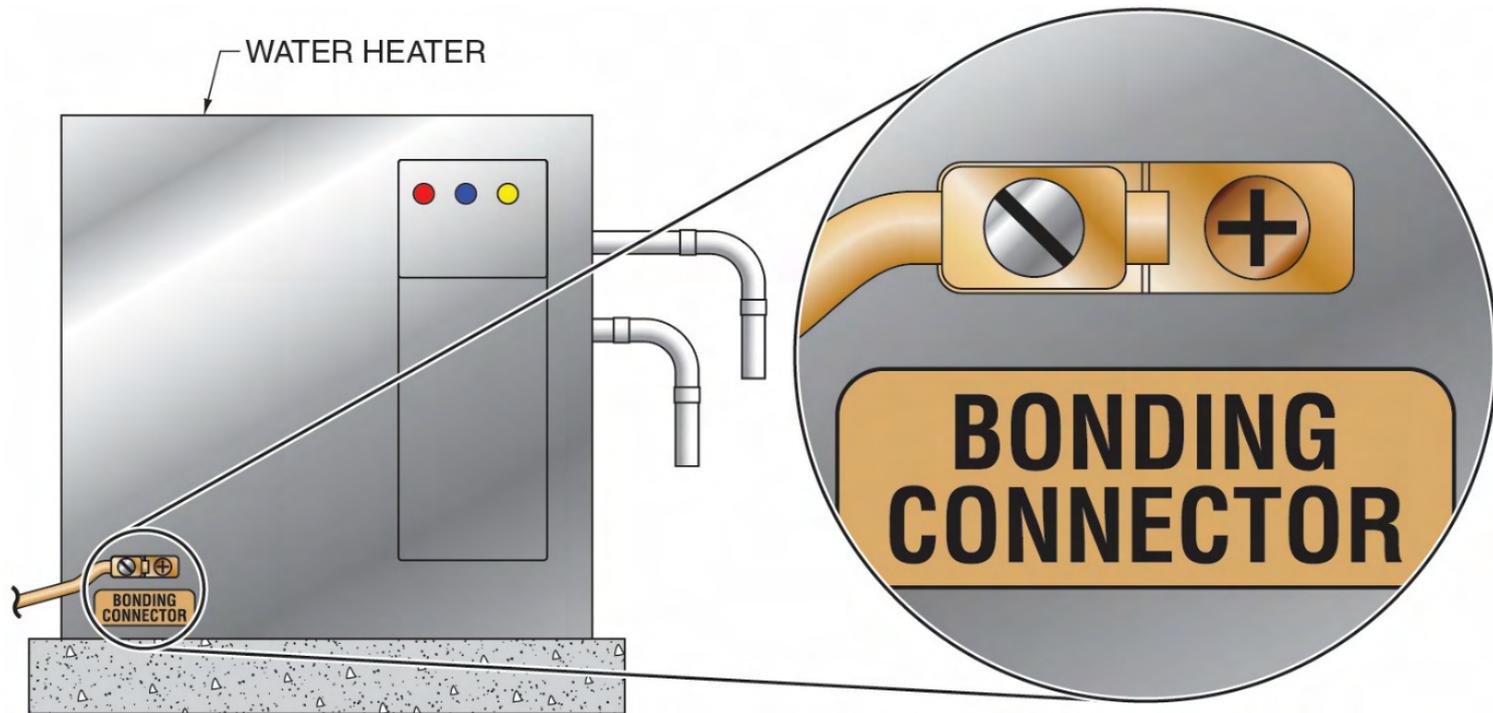
Storable Swimming Pools



680.7 Grounding and Bonding Terminals

- New requirement that grounding and bonding terminals shall be identified for use in wet and corrosive environments
- Field-installed grounding and bonding connections shall be composed of copper, copper alloy, or stainless steel and listed for direct burial
- Equipment in pools and spas are subject to very corrosive and wet environments so care should be taken to ensure the terminations are rated for the environment

680.7 Grounding and Bonding Terminals



Grounding and bonding terminals shall be identified for use in wet and corrosive environments.

Field-install grounding and bonding connections in a damp, wet, or corrosive environment shall be composed of copper, copper alloy, or stainless steel.

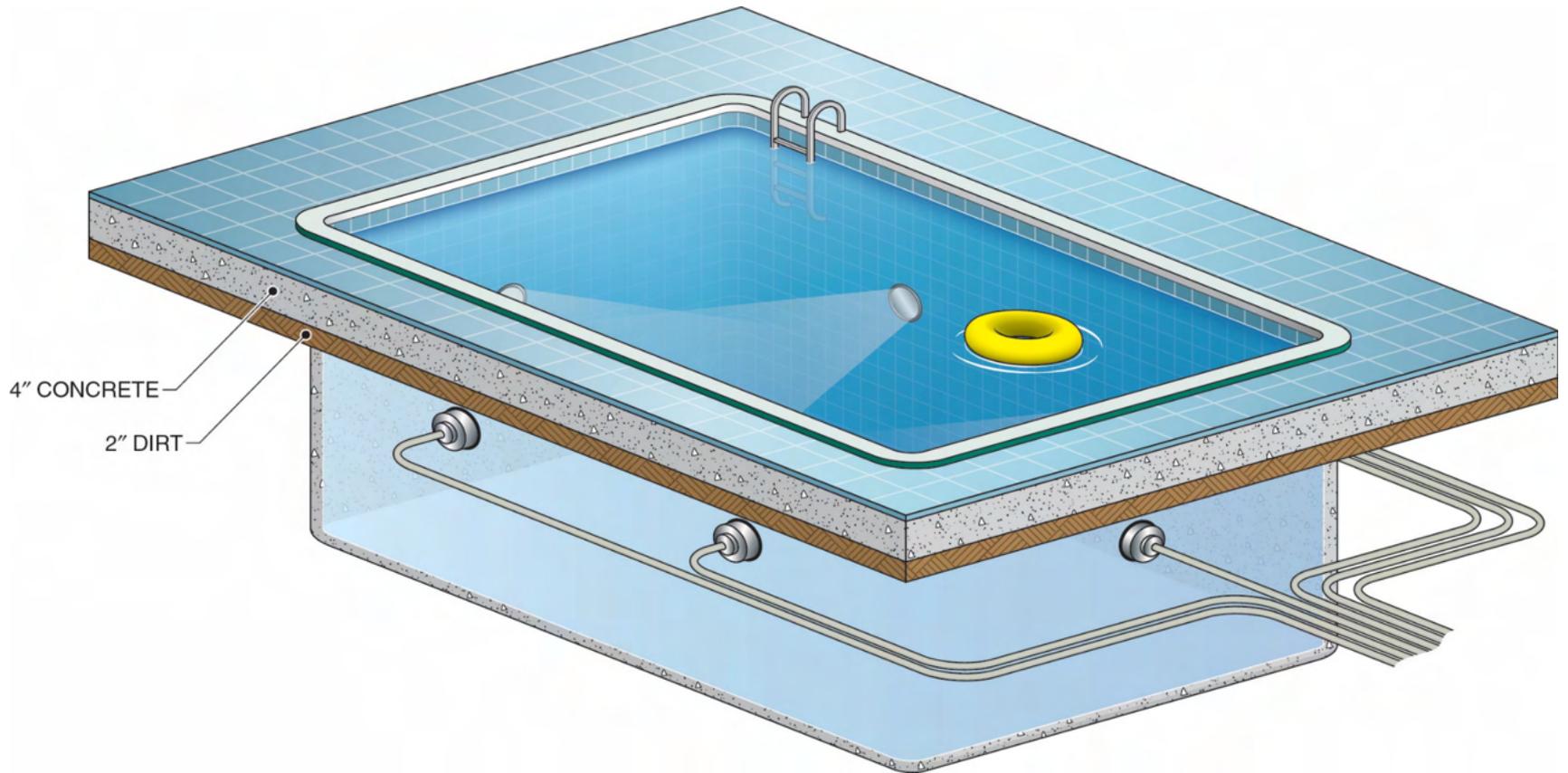
Grounding and bonding terminals shall be listed for direct burial use.



Previous Table 680.10 (Deleted) Underground Wiring Burial Depths

- Underground wiring location moved from 680.10 to 680.11
- Table 680.10 was deleted, so now Table 300.5 will apply to pools
- The requirement that wiring maintain 5 feet or more horizontally from the inside wall of the pool was eliminated
- The new revision now allows branch circuits and feeders to travel in close proximity to pool without limitation

Table 680.10 was deleted, so now Table 300.5 will apply to pools

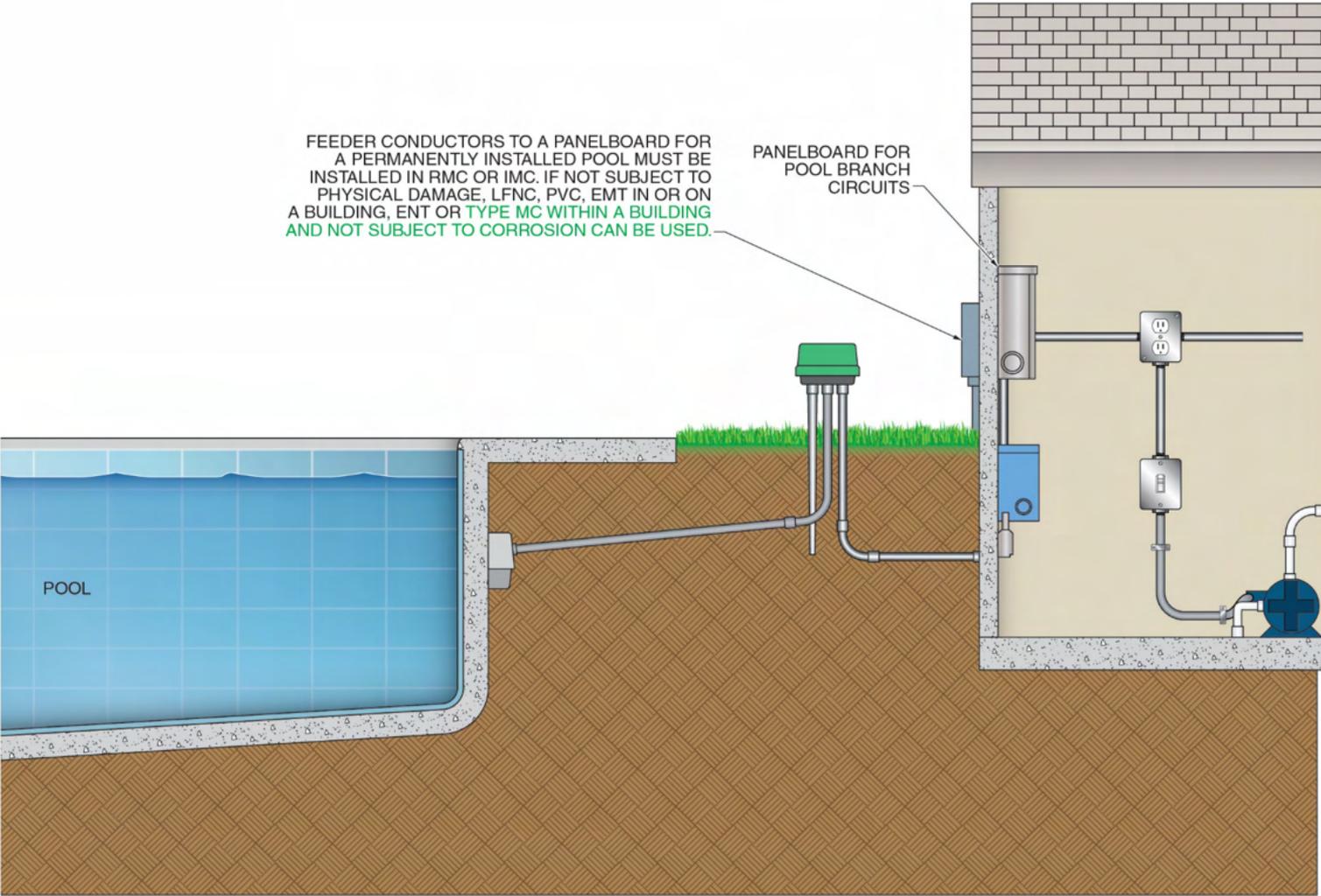


680.12 Equipment Rooms and Pits.

- Proper drainage to prevent accumulation of water during normal operations
- Equipment shall be suitable for environment
- New informational note on corrosive-nature pool chemicals such as chlorine and that adequate ventilation can reduce the likelihood of the accumulation of corrosive vapors.

680.14 Corrosive Environments

- Identify corrosive areas such as:
 - Storage area for pool sanitation chemicals
 - Circulation pump areas
 - Automatic chlorinators
 - Filters and open area under decks
 - Similar areas
- The air in these areas tends to be laden with acid, chlorine, and bromine
- Wiring methods shall be listed and identified for use in these areas



FEEDER CONDUCTORS TO A PANELBOARD FOR A PERMANENTLY INSTALLED POOL MUST BE INSTALLED IN RMC OR IMC. IF NOT SUBJECT TO PHYSICAL DAMAGE, LFNC, PVC, EMT IN OR ON A BUILDING, ENT OR TYPE MC WITHIN A BUILDING AND NOT SUBJECT TO CORROSION CAN BE USED.

PANELBOARD FOR POOL BRANCH CIRCUITS

POOL

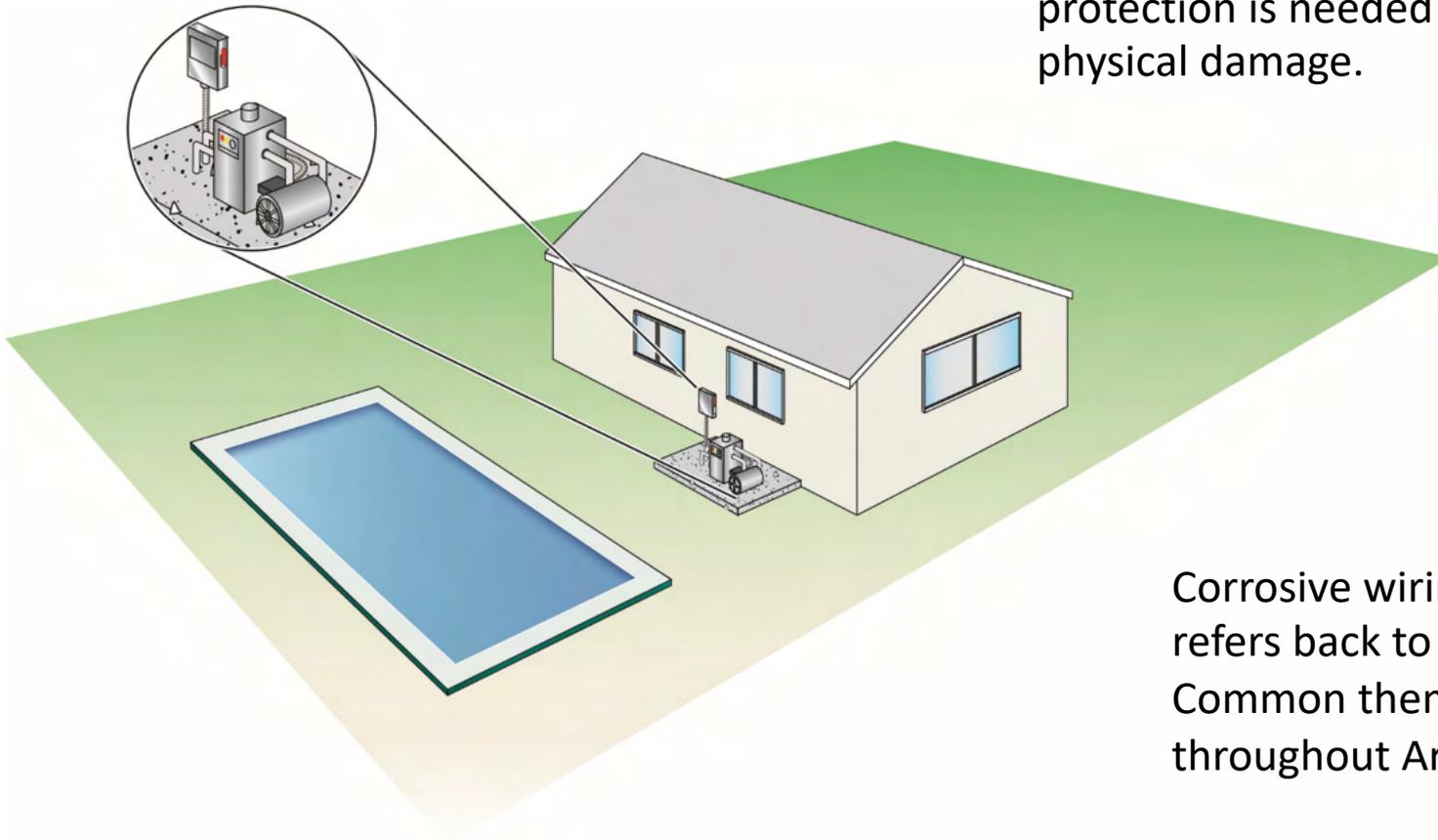
680.21(A) Wiring Methods for Motors – Swimming Pools and Similar Installations

- In 2014 Pool Pump motors were required to be installed using IMC, GRS, PVC, RTRC, or MC where it was listed for the location.
- 2017 NEC allows for Chapter 3 wiring methods to be used where pump motor is located in non-corrosive environment.
- Refers user back to 680.14 for wiring in corrosive environments.
- Wiring method shall include a copper insulated conductor per 250.122 but not less than #12 AWG

680.21(A) Wiring Methods (Motors)

Non-corrosive wiring methods can use Chapter 3 wiring methods.

Restricted wiring methods will only apply in corrosive conditions and where protection is needed from physical damage.

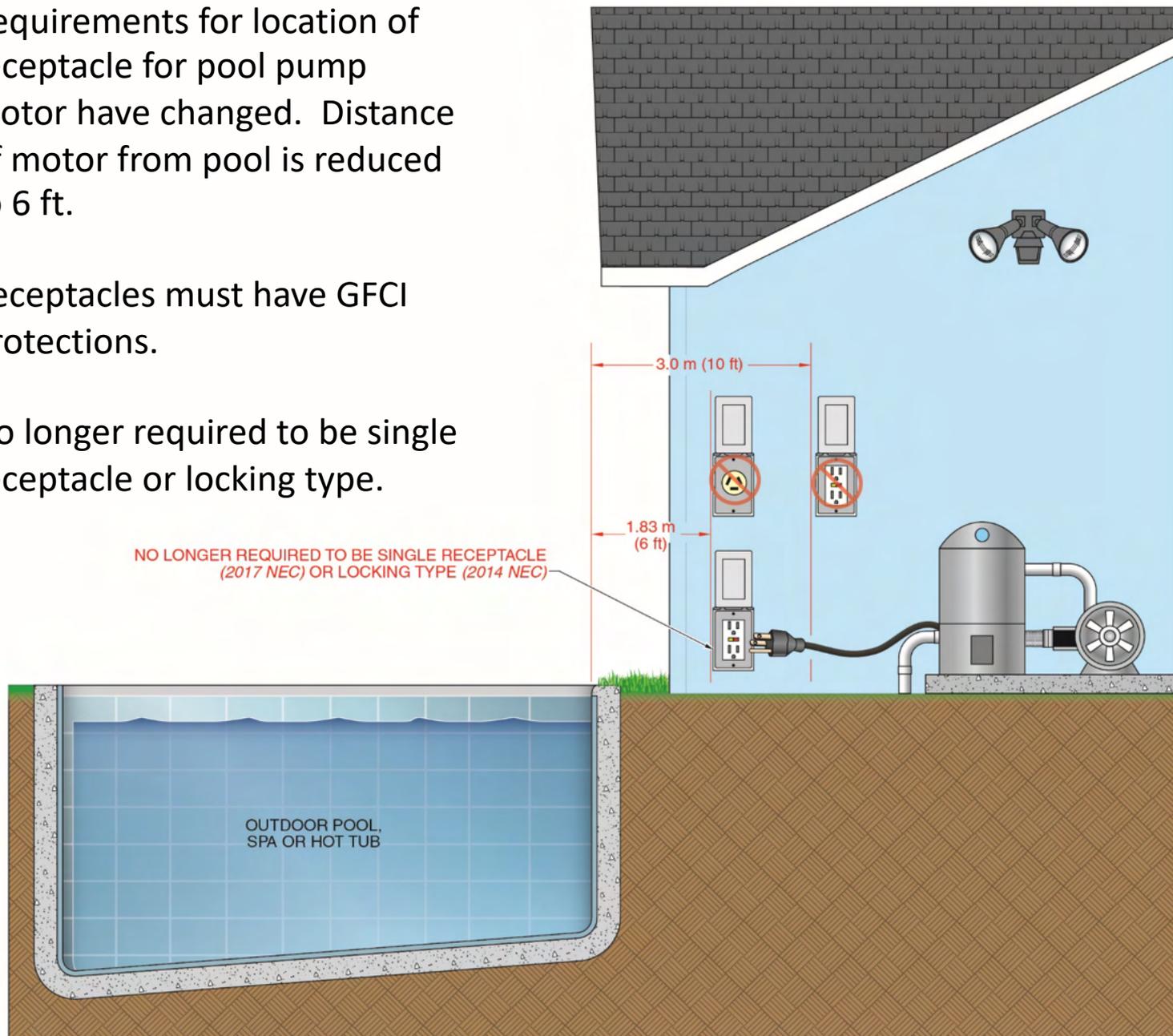


Corrosive wiring for pools refers back to 680.14.
Common theme throughout Article 680

680.22(A)(2) Location of Circulation and Sanitation System Receptacle

- Receptacles that provide power to circulation or sanitation systems shall be located at least 6 feet from inside wall of pool
- Removed the single receptacle requirement along with the 10 feet requirement for duplex
- A duplex or single receptacle can now be located from 6 feet to 10 feet from the inside wall of the pool

- Requirements for location of receptacle for pool pump motor have changed. Distance of motor from pool is reduced to 6 ft.
- Receptacles must have GFCI protections.
- No longer required to be single receptacle or locking type.



680.22(B)(7) Low-Voltage Gas-Fired Luminaires, Equipment, Etc.

- New provisions were added to specifically address low-voltage gas-fired luminaires, decorative fireplaces, fire pits, and similar equipment
- With the inclusion of electronic ignitors for these devices, NEC regulations were needed for this type of equipment
- New provisions for low-voltage gas fire equipment needed with the conversion of gas luminaire technology away from manual ignition and toward the use of low-voltage electronic ignitors

680.22(B)(7) Low-Voltage Gas-Fired Equipment



- Increased use of outdoor living spaces.
- 680.22(B)(7) now requires that listed low-voltage gas-fire luminaries, decorative fireplaces, fire pits, and similar equipment using low-voltage ignitors that do not require grounding and are supplied by listed transformers with outputs that do not exceed the low-voltage contact limit shall be permitted to be located less than 1.5m (5 ft) from the inside walls of a permanently install pool.



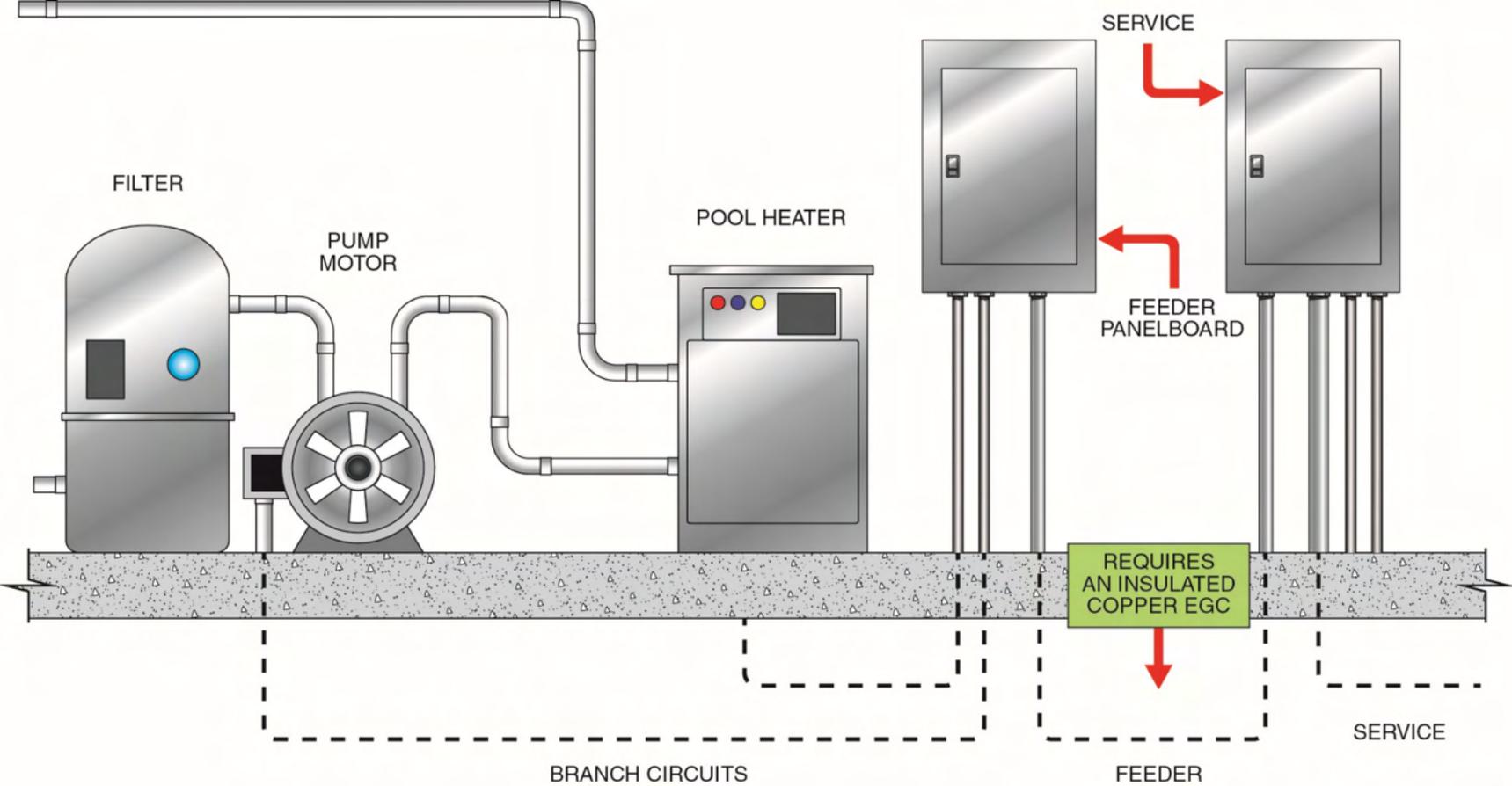
680.25 Feeders – Swimming Pools, Fountains, and Similar Installations

- Wiring method and grounding of feeders supplying swimming pools has been revised
- Feeders installed in corrosive environments shall be installed per 680.14(B)
 - Or liquidtight flexible nonmetallic conduit
 - Shall contain insulated copper conductor per Table 250.122 with minimum #12 AWG
 - All Non-corrosive environment shall comply with the general requirements of Chapter 3
- Aluminum conduit not permitted in corrosive area

680.25 Feeders – Swimming Pools, Fountains, and Similar Installations

- 2014 Requirements for corrosive wiring at pools was covered in 680.14
- 680.25(A) corrosive requirements were deleted and user was directed back to 680.14

680.25 Feeder for Swimming Pool Panelboard



680.27(B)(1), Ex. and 680.27(B)(2), Ex. Electrically Operated Pool Covers

- New exception for the Pool cover motor location and GFCI protection
- Pool cover motors powered by a listed transformer or power supply that does not exceed the low voltage contact limit may be installed within 5 feet of the inside wall of the pool
- Motors that meet this requirement do not need to be GFCI-protected



680.28 Gas-Fired Water Heater – Swimming Pools, Fountains, and Similar Installations

- New requirement for branch circuits serving gas-fired swimming pools and spa water heaters that operate above the low voltage contact limits to be GFCI-protected
- GFCI protection is not required for electric water heaters with proper grounding per 680.6(3) and a listing requirement for "current collectors"
- Gas-fired pool heaters do not have current collectors and the potential for failure is no different than any other pool equipment, so GFCI protection of branch circuit is required

680.74 Bonding of Hydromassage Bathtubs

- Bonding requirement has been reformatted to list format for clarity
 - The following part shall be bonded:
 - Metal fittings or parts that contact circulating water
 - Metal parts associated with circulating systems including pumps and blowers
 - All exposed metal within 5 feet of the tub, including MC cable and raceways
 - Electrical devices not associated with the tub but within 5 feet

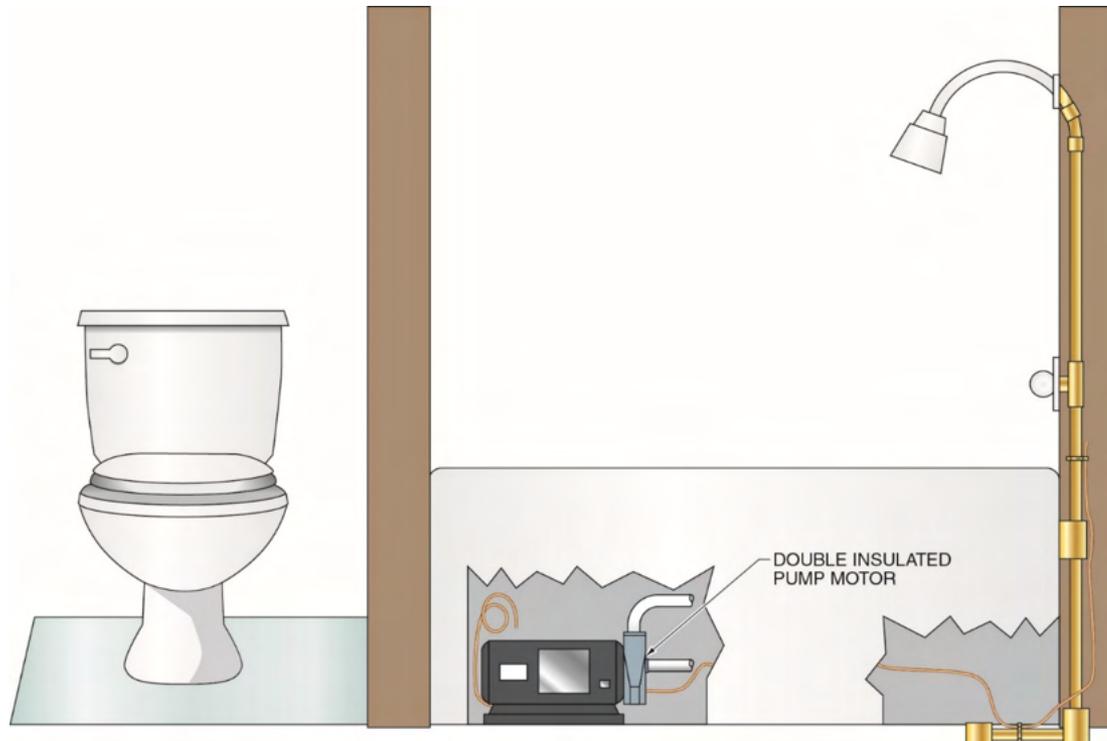
680.74 Bonding of Hydromassage Bathtubs

- Exceptions include:
 - Small conductive parts such as air and water jets, towel bars, and mirror frames not connected to metal stubs
 - Double-insulated blower motors

680.74 Hydromassage Bathtub - Bonding

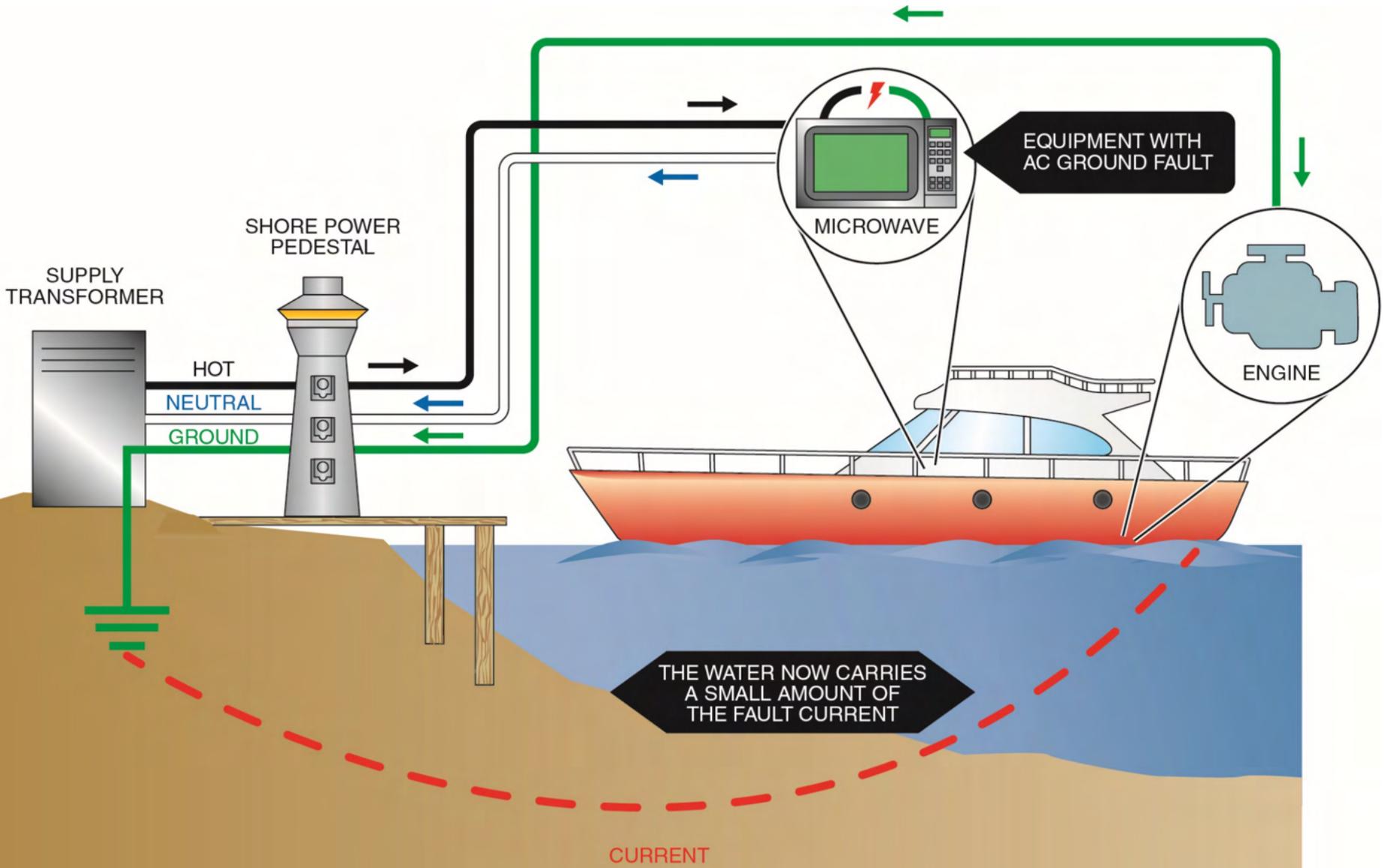
The parts shall be bonded together:

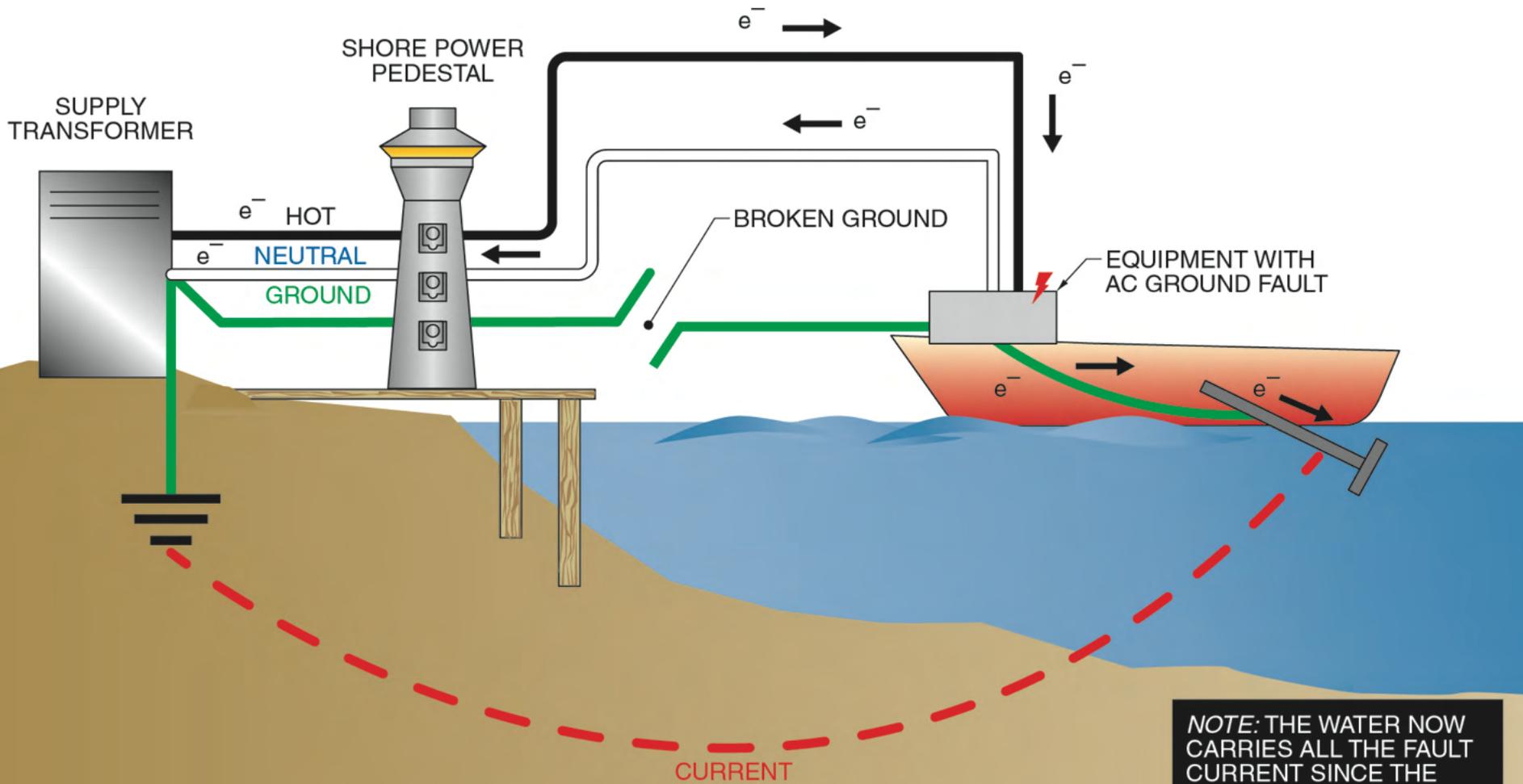
- All metal fittings and metal parts of electrical equipment that are in contact with Circulating water.
- All metal-sheathed cables, metal raceways, metal piping, all exposed metal surfaces, and electrical devices and controls that are located within 1.5m (5ft) of the inside walls of the tub.



682.15 GFCI Protection at Natural and Artificially Made Bodies of Water

- All receptacles installed outside, in or on a floating building or structure within the electrical datum plane shall be GFCI-protected
 - 15 and 20 amp single phase 125 volts through 250 volts
- Removed language pertaining to areas used for storage, maintenance or repair, portables tools and portable lights
- Requiring GFCI protection for all situations





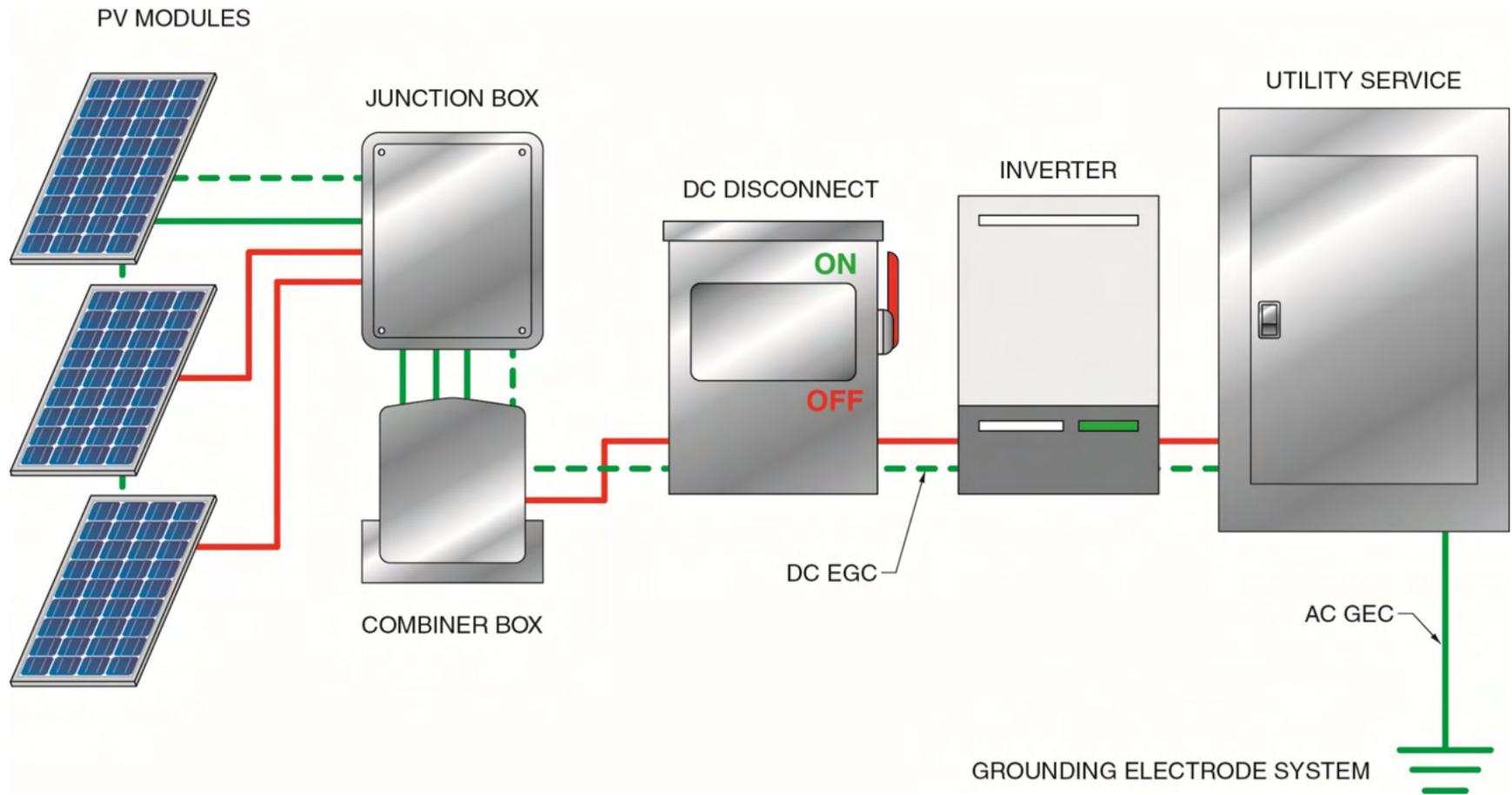
NOTE: THE WATER NOW CARRIES ALL THE FAULT CURRENT SINCE THE GROUNDING CONDUCTOR IS BROKEN

690.2 Definitions: Functional Grounded PV System

- New definition: "Functional grounded system"
 - A PV system that as an electrical reference to ground that is not solidly grounded
- New informational note further helps clarify that the functional ground system is often connected to ground through a fuse, circuit breaker, etc.
- Helping establish a clear difference between functional grounded PV system and solidly grounded PV system

690.2 Functional Grounded PV System

Functional Grounded PV System: A PV system that has an electrical reference to ground that is not solidly grounded.



690.7 Maximum Voltage – Solar Photovoltaic (PV) Systems

- Maximum voltage requirements have been revised and reformatted for clarity
- Shortened to 3 subdivisions and reworded
 - PV source and output circuit
 - DC to DC combiner
 - Bipolar source and output circuit

690.7 Maximum Voltage – Solar Photovoltaic (PV) Systems (cont.)

- Simplified language for calculating maximum PV system voltage
- Permitting a new method for calculating PV systems 100 kW or larger with the following requirements
 - Documented and stamped design
 - Using industrial standard method
 - Provided by licensed professional electrical engineer

690.8(A)(1) PV Source Circuit Currents

- Typical method to calculate sizing of PV Source Circuits was to add short-circuit currents and multiply by 125%.
- In 2017 an additional calculation option was added for calculating the maximum current of PV systems 100 kW or larger
- Calculations must be
 - Documented and stamped PV system design
 - Using "Industrial Standard Method"
 - Provided by licensed professional electrical engineer
 - Calculated based on elevation and orientation
- The 125% method is okay for smaller systems but 100 kW and larger require engineering. 100 kW may be overdesigned with 125% percent method.

690.11 PV (dc) Arc-Fault Protection

- PV AFCI requirements.
- New exception added for PV Systems allowing PV output circuits and dc-to-dc converter output circuits that are
 - not installed on buildings
 - that are direct buried
 - Installed in metallic raceways
 - Or installed in enclosed metallic cable trays
- PV AFCI can be omitted.

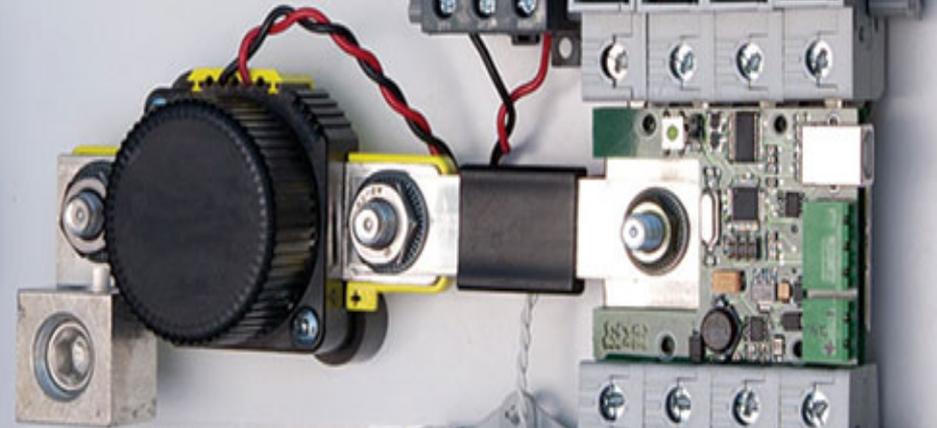
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REPLACE WITH ONLY 600VDC UL LISTED
FUSES NOT TO EXCEED 30ADC PV IN(+)

24 VDC (-)

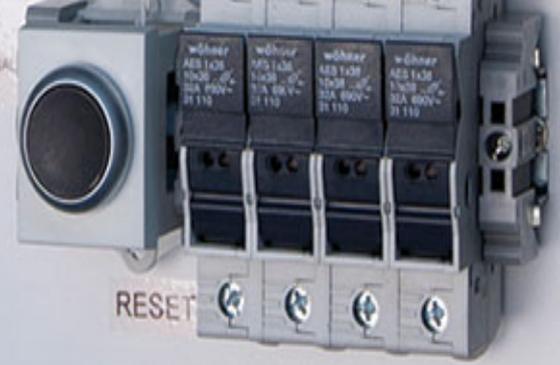
PV IN(-)



PV OUT(+)

CAUTION RISK OF ELECTRICAL SHOCK. TERMINAL IS LIVE. DISCONNECT UNIT BEFORE SERVICING.

PV OUT(-)



RESET

WARNING: FOR CONTINUED PROTECTION AGAINST RISK OF FIRE, REPLACE ONLY SAME TYPE AND RATING OF FUSE.
REPLACE WITH ONLY 600VDC UL LISTED FUSES NOT TO EXCEED 30ADC PV IN(+)



690.12 Rapid Shutdown of PV Systems on Buildings

- Rapid shutdown requirements were revised into 4 subsections
 - Control conductors
 - Controlled limits (array boundary)
 - 1 foot from the array in all directions
 - Outside the array boundary
 - Limited to not more than 30 volts within 30 seconds once rapid shutdown is initiated
 - Inside the array boundary
 - Limited to not more than 80 volts within 30 seconds once the rapid shutdown is initiated

690.12 Rapid Shutdown of PV Systems on Buildings

- Initiation device
 - Located outside on one- and two-family dwellings
- Equipment shall be listed
 - Function of rapid shutdown is to reduce the hazard to emergency personnel

690.12 Rapid Shutdown of PV Systems

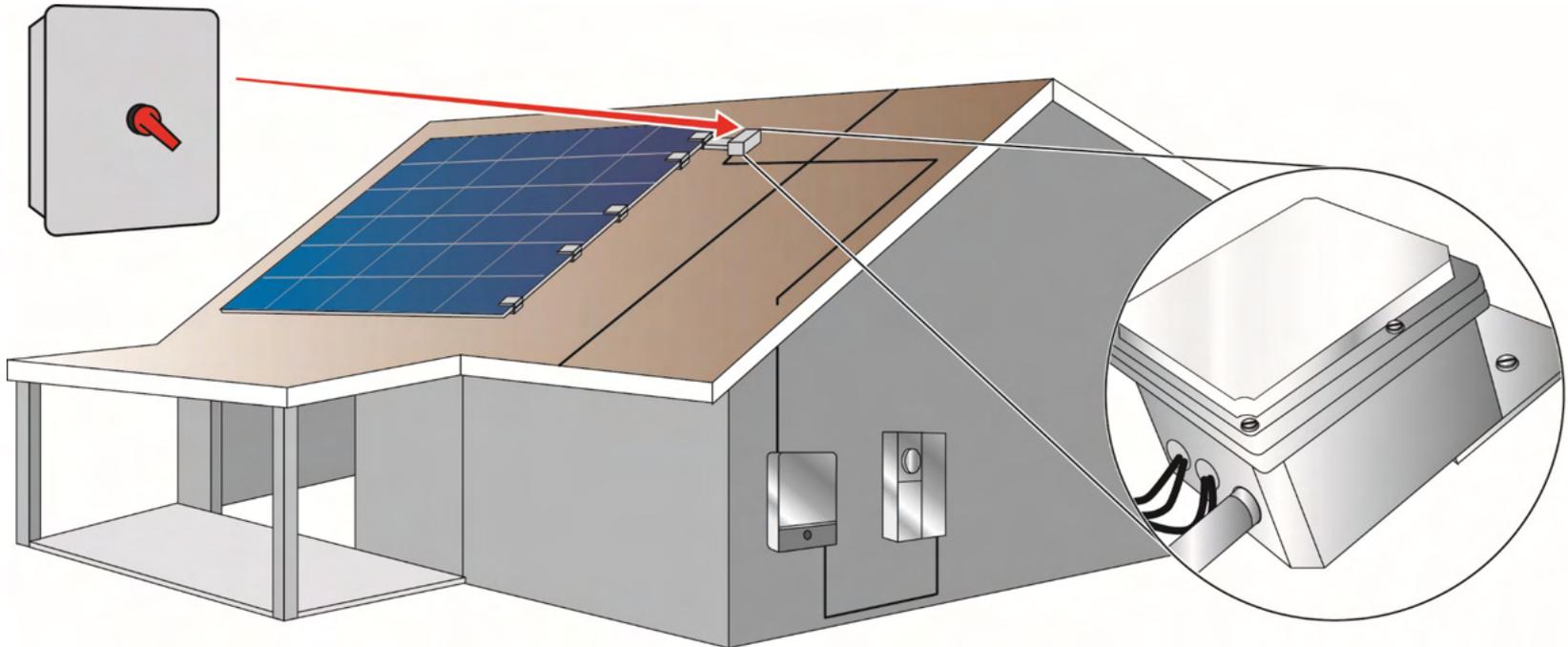
680.12 Now broken down into 4 subdivisions.

(A) Controlled Conductors

(B) Controlled Limits

(C) Initiation Device

(D) Equipment



690.13 PV System Disconnecting Means

- New Changes were made to further clarify disconnect requirements
- Location was shortened to "readily accessible location" with informational note referring back to 690.12 for concerns related to energized circuits entering building
- New marking requirements:
 - "PV System Disconnect"
 - "Warning: Electrical shock hazard terminals on the line and load sides may be energized in the open position"
- PV Disconnects connected to the supply side of service shall be suitable as service equipment

690.13 PV System Disconnecting Means (cont.)

- PV disconnect shall be rated for:
 - Maximum available short circuit current
 - Maximum voltage available
- PV disconnect shall simultaneously disconnect PV circuit from other systems
- DC PV disconnect shall be rated for PV systems or be suitable for backfeed or reverse current
- Devices marked "Line" and "Load" cannot be back fed

PHOTOVOLTAIC
FROM ARRAY
DC DISCONNECT

ON

⚠ WARNING

ELECTRICAL SHOCK HAZARD

DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND
LOAD SIDES MAY BE ENERGIZED
IN THE OPEN POSITION

DC VOLTAGE IS ALWAYS PRESENT
WHEN SOLAR MODULES
ARE EXPOSED TO SUNLIGHT



SQUARE D®

HEAVY DUTY
SAFETY SWITCH
INTERRUPTOR DE
SEGURIDAD DE
SERVICIO PESADO

30 A

600 Vac / V~ 600 Vdc / ⎓

⚠ DANGER / PELIGRO

690.31(C)(1) Wiring Methods Permitted – Solar Photovoltaic (PV) Systems

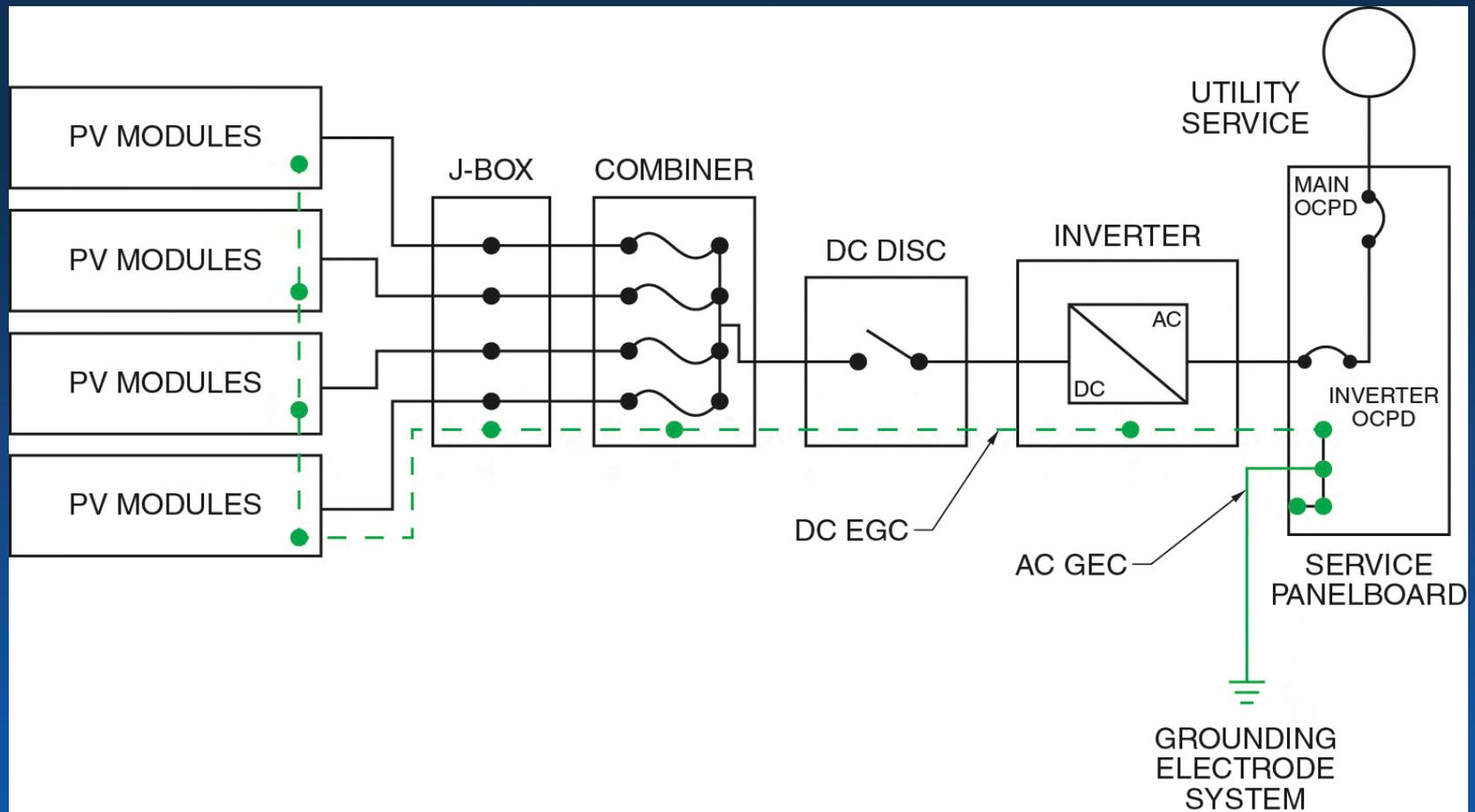
- Single conductor cables are permitted in exposed outdoor locations in PV source circuit
 - Type USE-2, and
 - Single conductor cable listed and identified for PV
 - Installed per 338.10(B)(4)(b) and 334.30
 - Support within 12 inches of box
 - At intervals not to exceed 4-½ feet

690.35 Ungrounded PV Systems (Deleted)

- Section 690.35 for "Underground PV Power Systems" has been deleted
- 690.35 has been addressed in other locations of Article 690
 - 690.35(A) Disconnects covered in 690.13
 - 690.35(B) Overcurrent covered in 690.9
 - 690.35(C) Ground fault covered in 690.41(B)
 - 690.35(D) PV conductors covered in 690.31

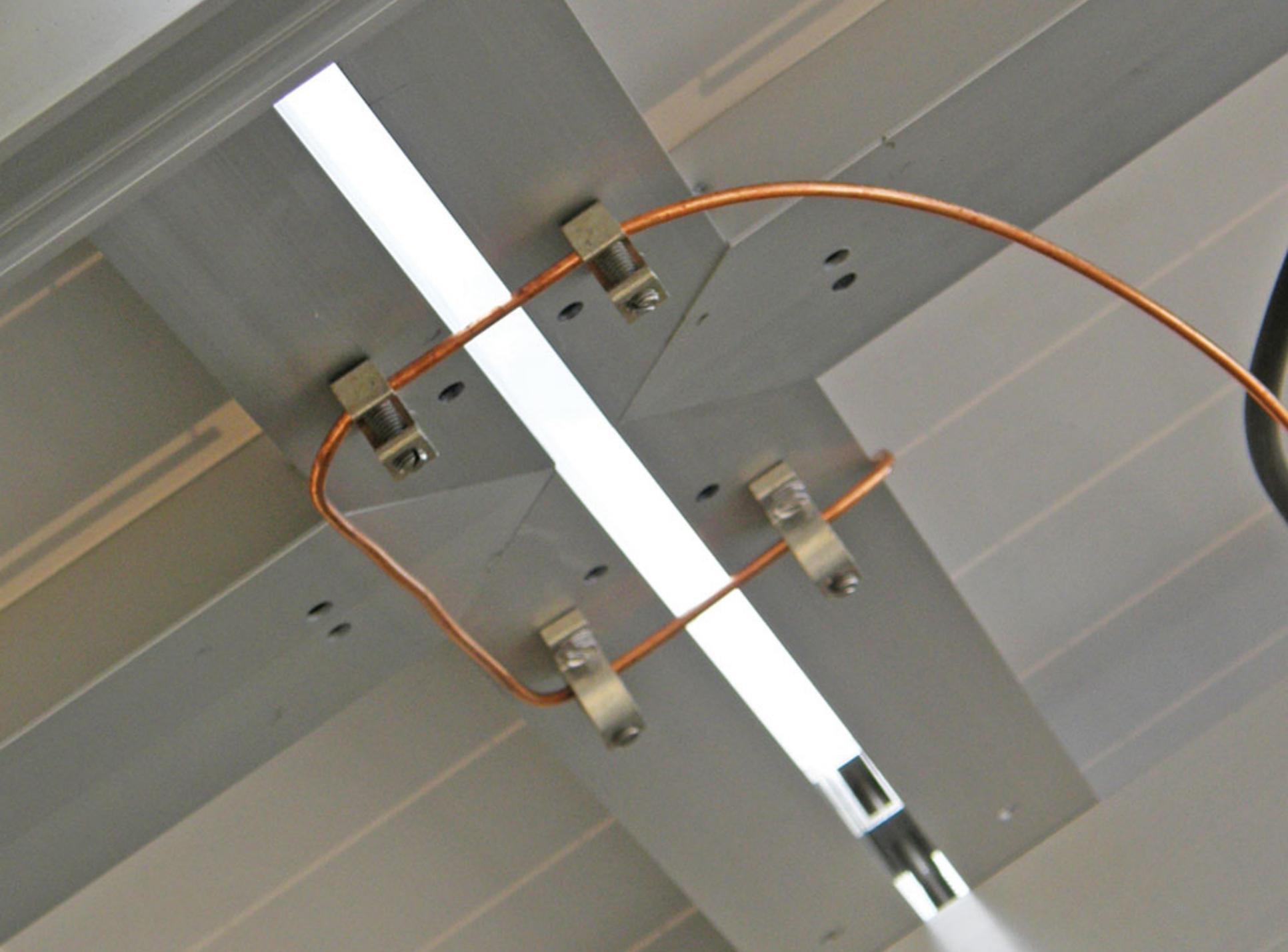
690.35 Ungrounded PV System

- Requirements for Ungrounded PV Systems have been deleted since topics covered in 690.35 are addressed in other locations within Article 690.



690.41 System Grounding for PV Systems

- Addresses the 6 system grounding systems that shall be employed
- Both grounded and ungrounded PV arrays require ground fault protection on PV source and output conductors
- One exception for PV array with no more than 2 source circuits and not located on or in a building
- PV ground fault protection is often a built-in feature of an inverter or charger but may also be a stand-alone product
- The revised text better encompasses all types of ground fault protection products

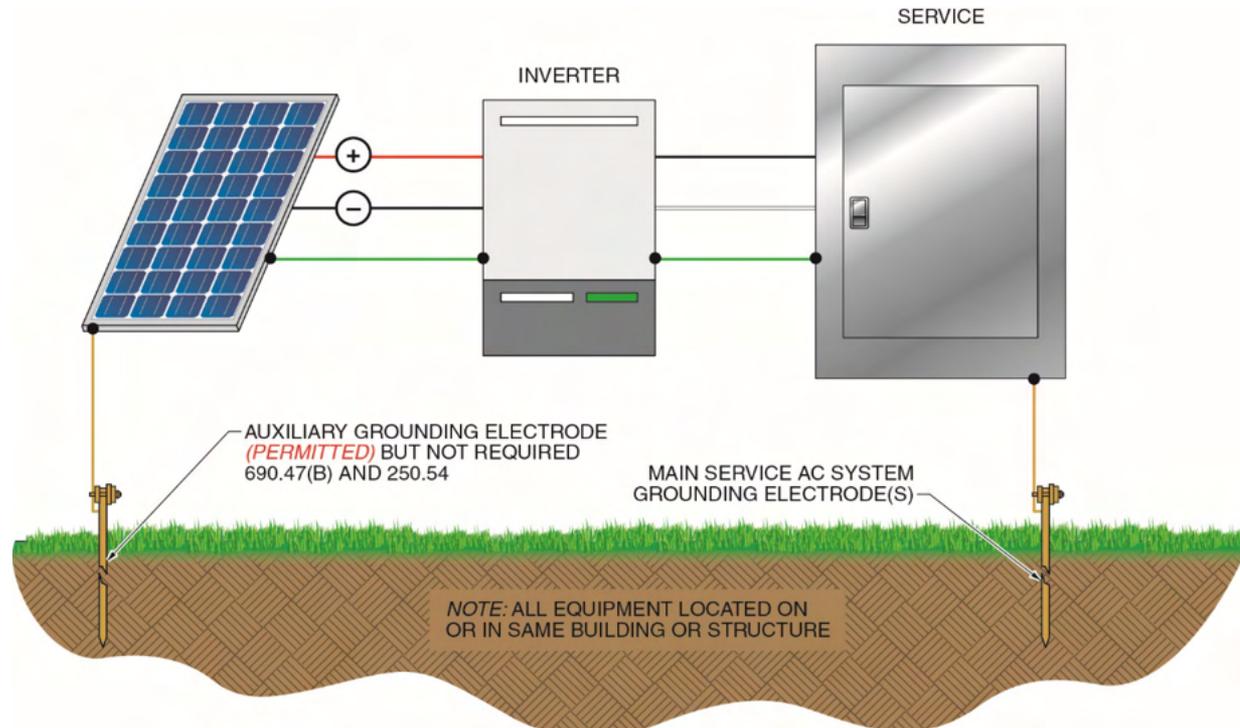


690.47 Grounding Electrode System for PV Systems

- ▶ Grounding requirements have been simplified
- ▶ PV array equipment grounding conductor required to be connected to building grounding electrode system
- ▶ Refer to Part VII of Article 250 rather than repeating it
- ▶ Grounding electrodes shall be permitted to be installed for PV arrays
 - ▶ Not required

690.47 Grounding Electrode System

- A building or structure supporting a PV system shall have grounding electrode system. Basically installed at service.
- Auxiliary grounding electrodes connected to the PV system shall be permitted but are not required (new section).



690.56(C) Identification of Power Sources for Buildings with Rapid Shutdown

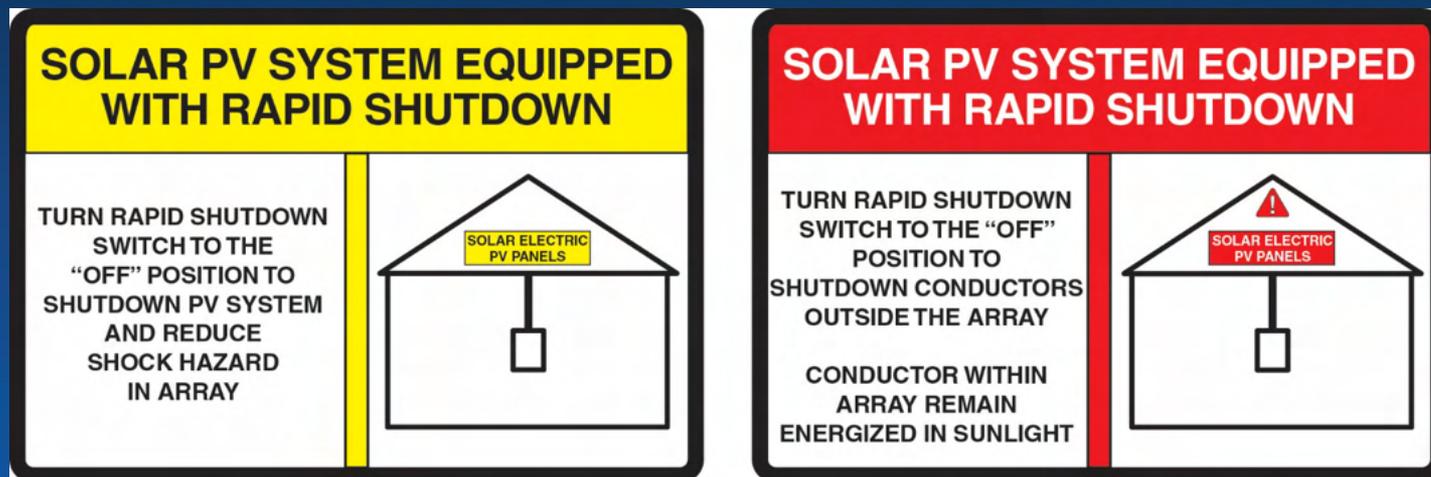
- Facilities with stand alone systems have a
 - Permanent plaque or directory
 - Located on the Exterior of building
 - In a readily visible location
- Facility with utility service and PV systems
 - Shall have a Plaque or directory per 705.10

690.56(C) Identification of Power Sources for Buildings with Rapid Shutdown (cont.)

- Building with rapid shutdown shall have a
 - Detailed plaque
 - Located within 3 feet of rapid shutdown
 - Detailed plaque showing area **not** shut down with rapid shut down switch
 - Clearly designating energized and unenergized areas for emergency personnel

690.56(C) Identification of Power Sources with Rapid Shutdown

- A label is required on buildings depending on type of rapid shutdown on the building.
- Two different types.
- Plaques or directories are required within 1m (3 ft) of service.
- Requires any building with rapid-shutdown PV system to have plaque to indicate to first responders that rapid-shutdown is provided.



690.56(C)(1)(a): Label for PV Systems that Shut Down the Array

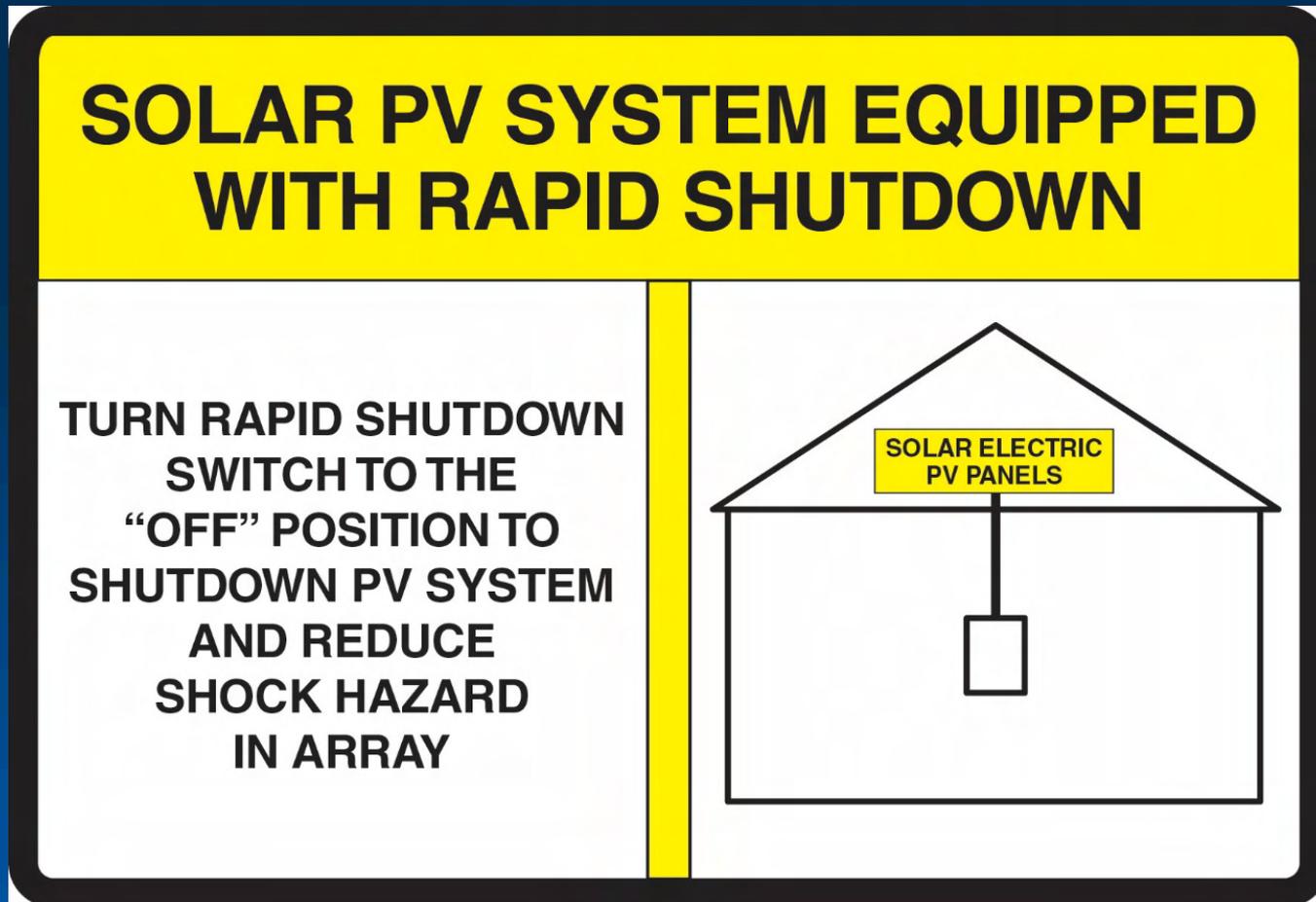
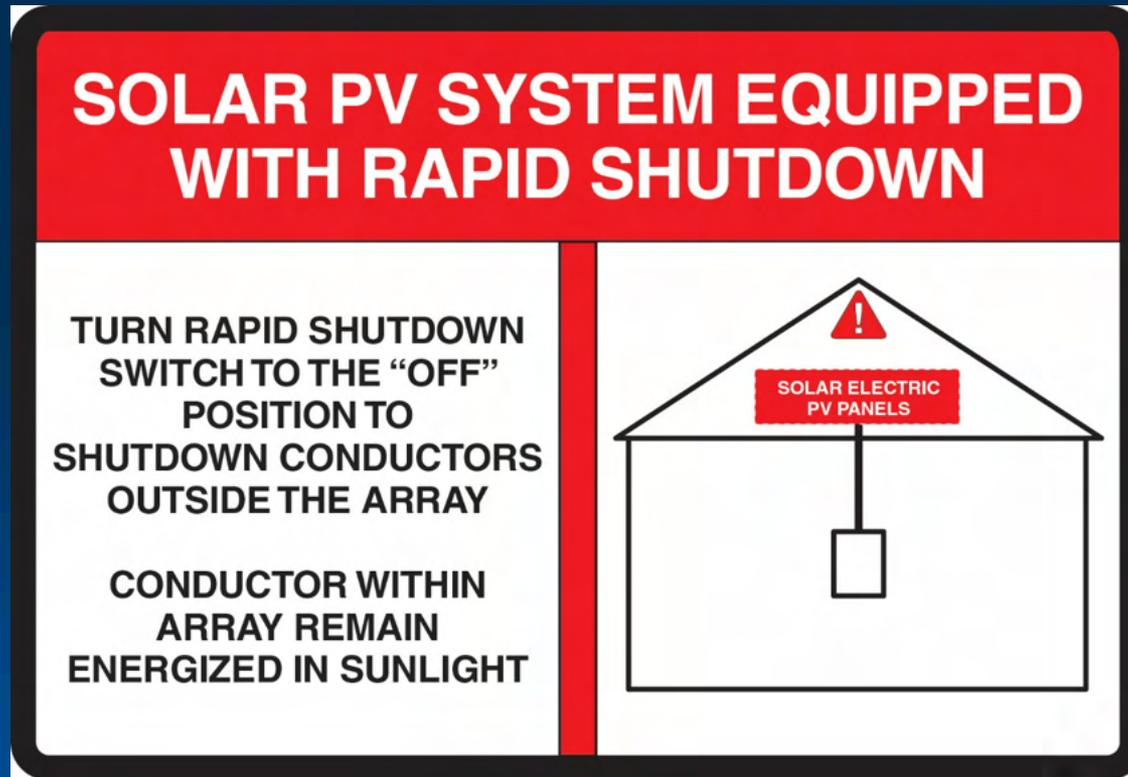


Figure 690.56(C)(1)(b) Label for PVS Systems that Shut Down the Conductors leaving the array only



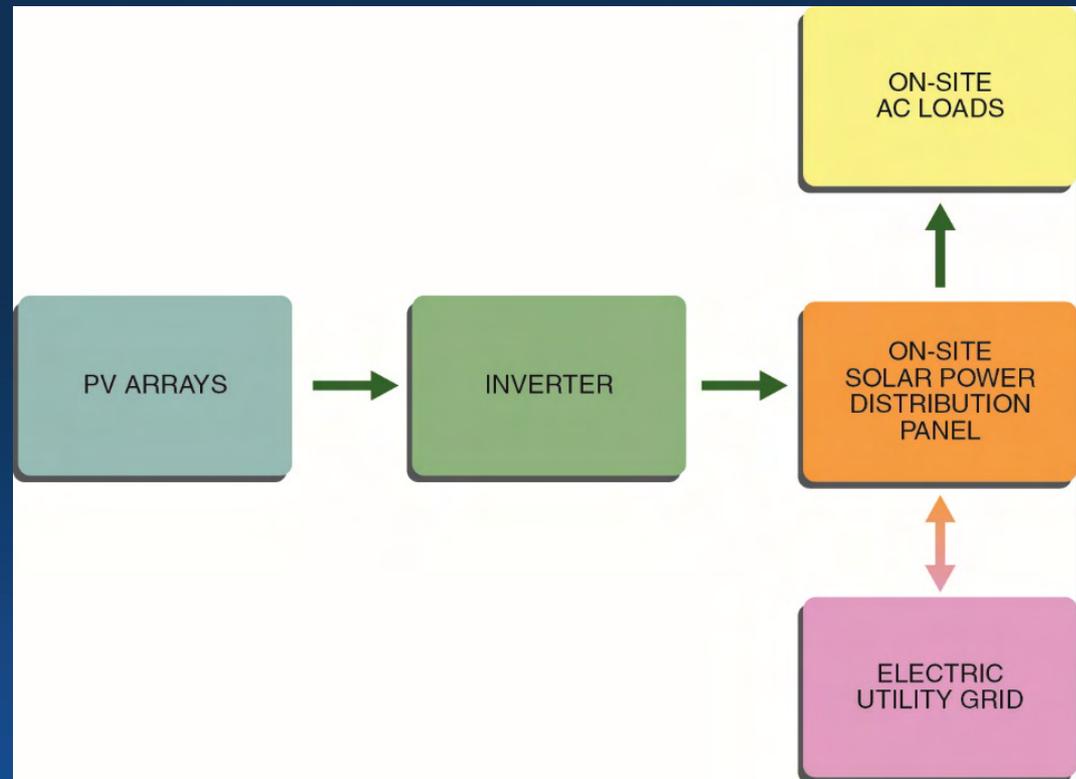
Article 690 Part VII – Connection to Other Sources [Solar Photovoltaic (PV) Systems]

- Article 690 Part VII was revised to clearly refer to Article 705 Parts I & II when PV systems connect to other sources
- 705 covers "Interconnected Electrical Power Production Sources"
 - Part I is "General" requirements
 - Part II is "Interactive Inverters"

Article 690 Part VII Connection to Other Sources

In 2014 Article 690 referred to connections to other power sources at 690.57 to 690.64.

In 2017 690.57 through 690.64 was deleted and replaced with one section 690.59 that directs the user of the NEC to [Article 705, Interconnected Electric Power Production Sources](#), for this information.



690.71 Energy Storage Systems – PV Systems

- Energy storage systems connected to PV systems shall be installed per Article 706
- 706 is a new article to cover "all permanently-installed energy storage systems (ESS) operating at over 50 volts AC or 60 volts DC that may be stand-alone or interactive with other electric power production sources"
706.1 scope
- 690 Part VIII helps remove redundancies in the Code by referring to Article 706



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

- New Article 691 "Large-Scale Photovoltaic (PV) Electric Power Production Facility"
- Covers facilities with a generating capacity of no less than 5000 kW
- Not under exclusive utility control
- Facilities typically connect a medium voltage (4.16 kV to 34.5 kV or at transmission voltage of 69 kV+)

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

- Typically connect to utility side of grid
- System shall be designed by a Licensed Professional Electrical Engineer
- Accessible only to authorized personnel and fenced
- Maintained and operated only by qualified personnel



695.6(G) Ground-Fault Protection Not Permitted for Fire Pumps

- Ground fault protection of equipment shall not be installed in any fire pump circuit
- Fire pumps are designed to run until they fail and are intended for protection of life and property
- Language was reworked to eliminate any confusion and removed the words "shall not be permitted"
 - Replaced with "shall not be installed"



695.15 Surge Protection for Fire Pumps

- Listed surge protection devices (SPD) are now required on all fire pump controllers
- Added protection for fire pump controllers from transient voltages cause by a voltage spike or surge
- Surge Protection Device (SPD) is defined in Article 100
 - There are 4 types of surge protection devices
- NFPA Research Foundation study "Data Assessment for Electrical Surge Protection Devices" showed 12% of fire pumps had damage due to voltage surges

695.15 Surge Protection (Fire Pumps)

A listed surge protective device (SPD) shall be installed in or on the fire pump controller.

