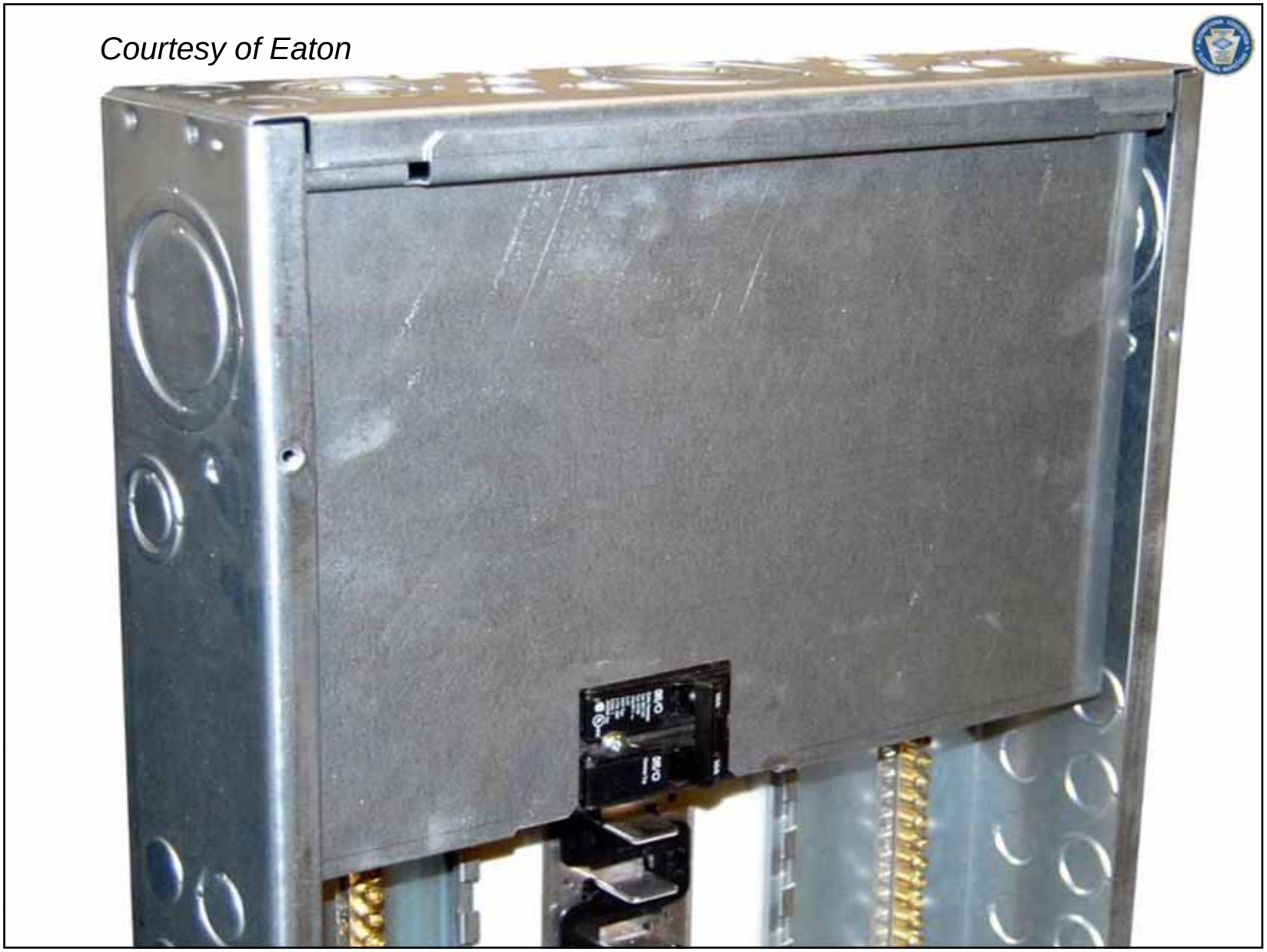
408.3(A)(2)
Barriers at Service Panelboards

- New requirements added for **barriers** to be placed in all **service panelboards** such that no uninsulated, ungrounded service busbar or service terminal be exposed to inadvertent contact by persons
- Identified as a safety concern by installers and proponents of electrical safety in the workplace
- An **exception** was also added eliminating the barriers at panelboards installed to comply with the requirements of **408.36, Ex. No. 1, 2, and 3**
- Exceptions to 408.36 address the "**six means of disconnect**" rules and the old "**split-bus**" panelboards that could be present


Courtesy of Eaton

408.3(A)(2) Barriers at Service Panelboards

Barriers required in all service panelboards, switchboards, and switchgear such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations

Courtesy of Schneider Electric

Exception: This requirement shall not apply to service pane/boards with provisions for more than one service disconnect within a single enclosure as permitted in 408.36, Exceptions No. 1, 2, and 3

Article 411 Low-Voltage Lighting

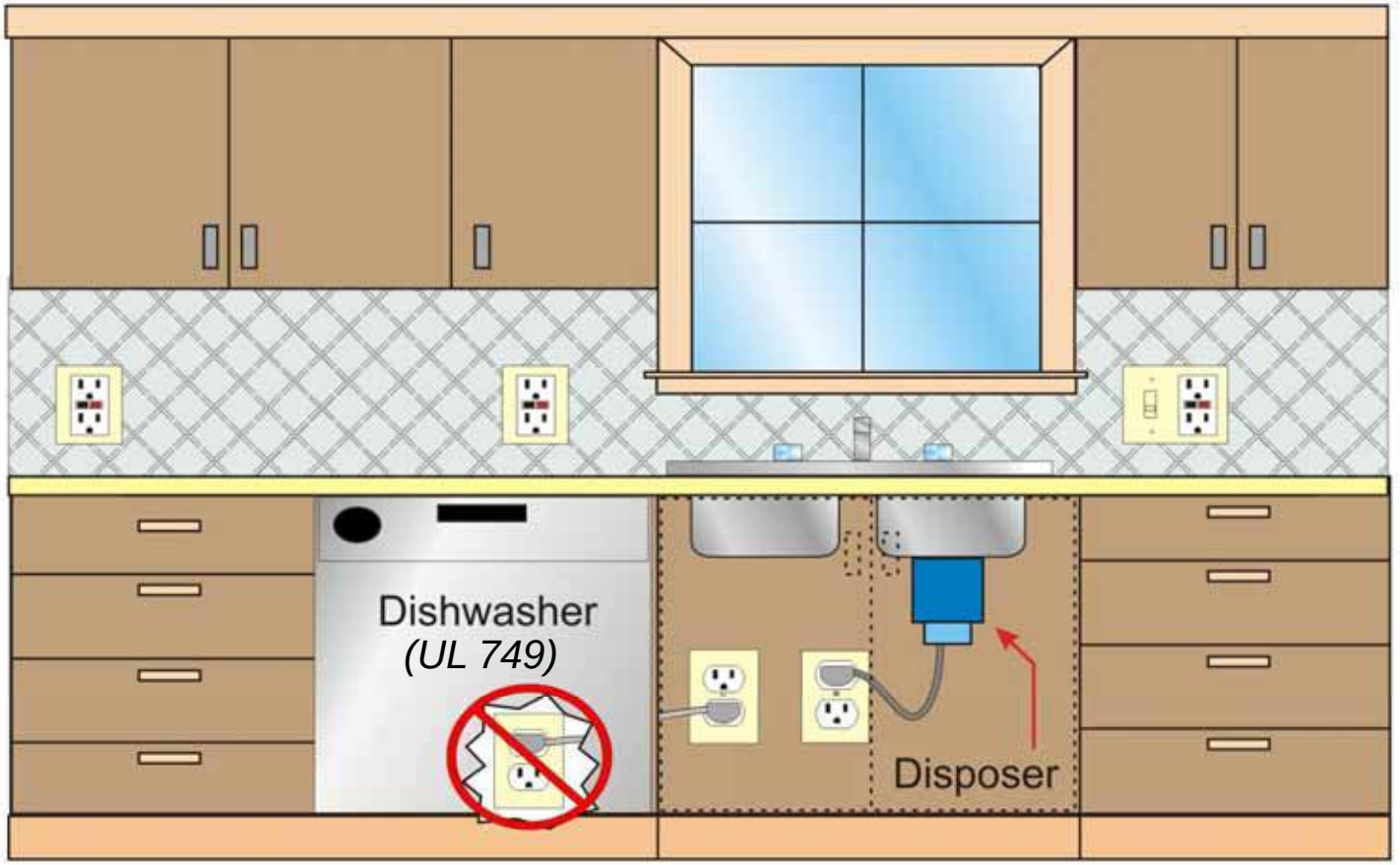
- Article 411 was re-organized and renamed
- Title changed from "~~Lighting Systems Operating at 30 Volts or Less and Lighting Equipment Connected to Class 2 Power Sources~~" to simply "**Low-Voltage Lighting**"
- Limitations of 411.3(A) and (B) for low-voltage lighting systems operating at **30 volts or less** and the limitations of Class 2 low-voltage lighting systems conforming to *NEC* Chapter 9, Table 11(A) or Table 11(B) was **removed**
- Low-voltage lighting systems addressed by Article 411 are now basically limited by the maximum rating of **25 amperes for the output circuits** of the power supply under all load conditions

422.6 Listing Required *(Appliances)*

- New section has been added to Article 422 requiring all appliances operating at **50 volts or more** must be **listed**
- All appliances should be listed to help determine the proper classification of the equipment and to ensure application of proper product standard installation requirements
- Listing requirement for appliances helps ensure equipment is installed and used in accordance with any instructions included in the listing or labeling of that particular piece of equipment *[see 110.3(B)]*
- Relying *NEC* definitions and industry terms or product marketing information can and often does result in misinterpretation and misapplication of requirements for appliances


TYPE 042 ELECTRIC OVEN
120V~ 60Hz 1300W
www.hamiltonbeach.com
c UL US
READ INSTRUCTION BOOK BEFORE USE
POUR USAGE DOMESTIQUE SEULEMENT
LIRE LE LIVRE D'INSTRUCTIONS AVANT L'USAGE
PARA USO DOMESTICO SOLAMENTE
LEA EL LIBRO DE LA INSTRUCCION ANTES DE USAR
MADE IN CHINA FABRIQUE EN CHINE HECHO EN CHINA
MODEL: 31507 SERIES: A

422.16(B)(2) Built-In Dishwashers



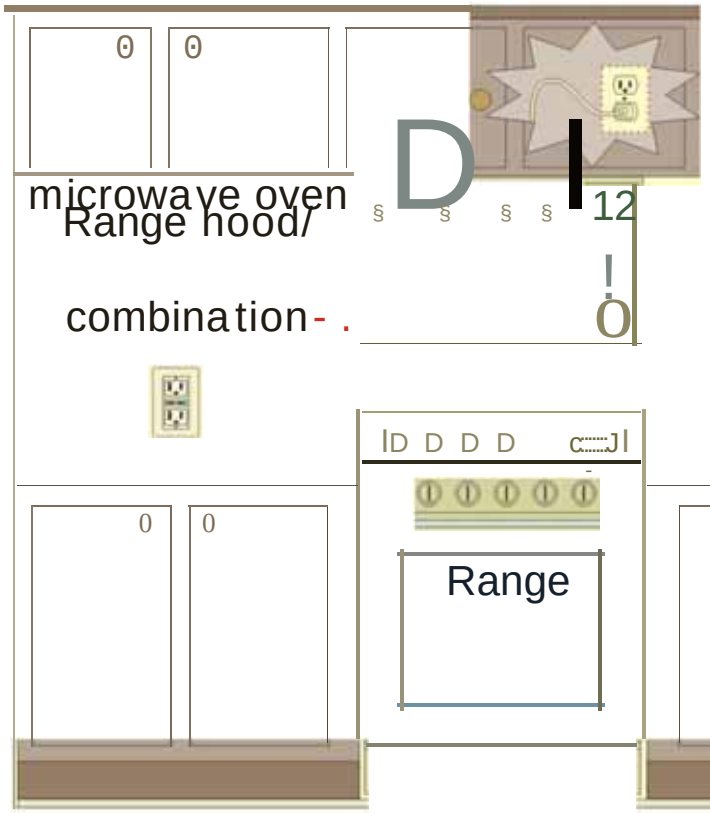
Receptacle outlet for cord-and-plug connected built-in dishwasher required to be located in the space adjacent to the space containing the dishwasher only with the length of a cord for a built-in dishwasher lengthened from 1.2 m (4 ft) to 2.0 m (6½ ft)

422.16(B)(4) Range Hoods

- The maximum length of a flexible cord for a cord-and-plug-connected range hood has been increased from 900 mm (36 in.) to **1.2 m (4 ft)**
- With some of the designs of the newer range hoods, the previous maximum length of 900 mm (36 in.) was simply **not sufficient**
- Putting undue stress and strain on the cord in order to reach the mating receptacle outlet
- The height *(top to bottom)* of some of the newer **chimney-type range hoods** is a concern for cord length as well

422.16(8)(4) Range Hoods

Range hoods permitted to be cord-and-plug connected where identified on installation instructions by manufacturer and meets the following:



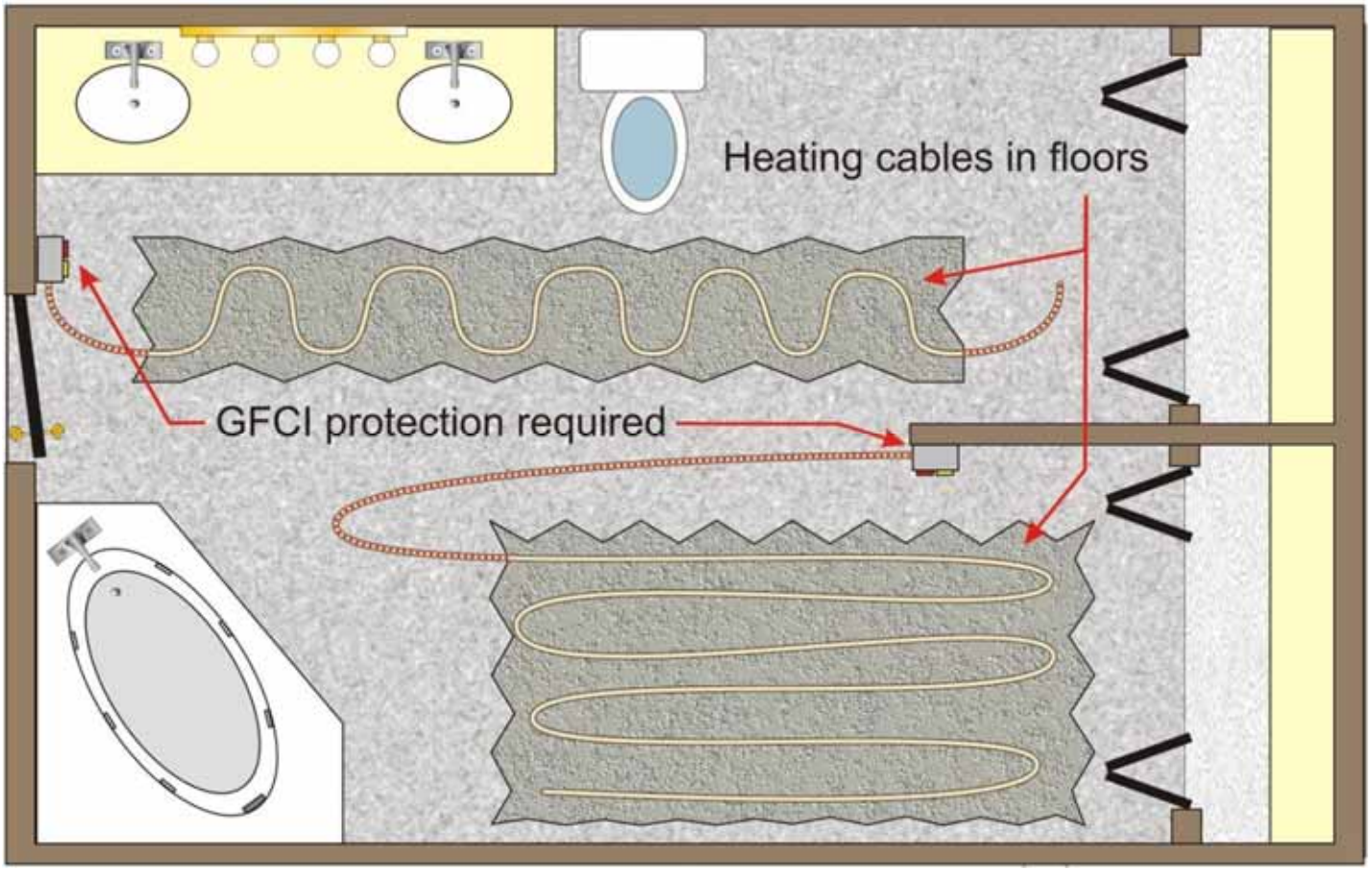
- Cord terminates in a grounding type plug
- Cord length is at least 450 mm (18 in.) and not more than 1.2 m (4 ft)
- Receptacle located to avoid physical damage to the cord
- Receptacle is accessible
- Receptacle is supplied by an individual branch circuit

Length of cord for cord-and-plug connected range hoods increased from 900 mm (36 in.) to 1.2 m (4 ft)

424.45
Heating Cables Under Floor Coverings

- New requirements added for the installation of **heating cables installed under floor coverings**
- Not new to the electrical industry, but installation requirements for these under flooring heating cables is **new for Article 424**
- Heating cables and heating panels have become very similar in terms of installation and use
- Previously the *Code* did not specifically mention under floor coverings for heating cables, which left some users of the *Code* unclear if heating cables installed under floor covering was permitted or not permitted

424.45 Heating Cables Under Floor Coverings



New requirements added in Part V of Article 424 giving specific instruction for the installation of heating cables installed under floor coverings

Article 424 Part X Low-Voltage Fixed Electric Space-Heating Equipment

- A new **Part X** was added to Article 424 for **low-voltage fixed electric space-heating equipment**
- Previous editions of the *NEC* did not exclude these low voltage heating products, but did not address provisions for low voltage heating cables or heating panel products
- Without these new requirements, a "low-voltage" piece of equipment would have to meet all the same requirements as 120 volt or 240 volt rated equipment
- New requirements in Part X of Article 424 are very similar to provisions already in place in the *NEC* in Article 411 for low-voltage lighting systems

Article 424 Part X Low-Voltage Fixed Electric Space-Heating Equipment *(cont.)*

- For low-voltage fixed electric space-heating equipment addressed in Part X of Article 424, the rated output is limited to **25 amperes**, **30 volts (42.4 volts peak) ac**, or **60 volts dc** under all load conditions
- The **30-volt ac** and **60-volt dc** levels correlate with accepted levels considered by many to be a threshold of reduction in risk of electric shock
- Also aligns with the voltage levels for Class 2 ac and Class 2 dc voltage levels in **Chapter 9, Tables 11(A) and 11(B)**
- **25 ampere maximum output** current added to limit secondary current levels to levels associated with most low-voltage fixed electric space-heating equipment


USG FIBEROCK

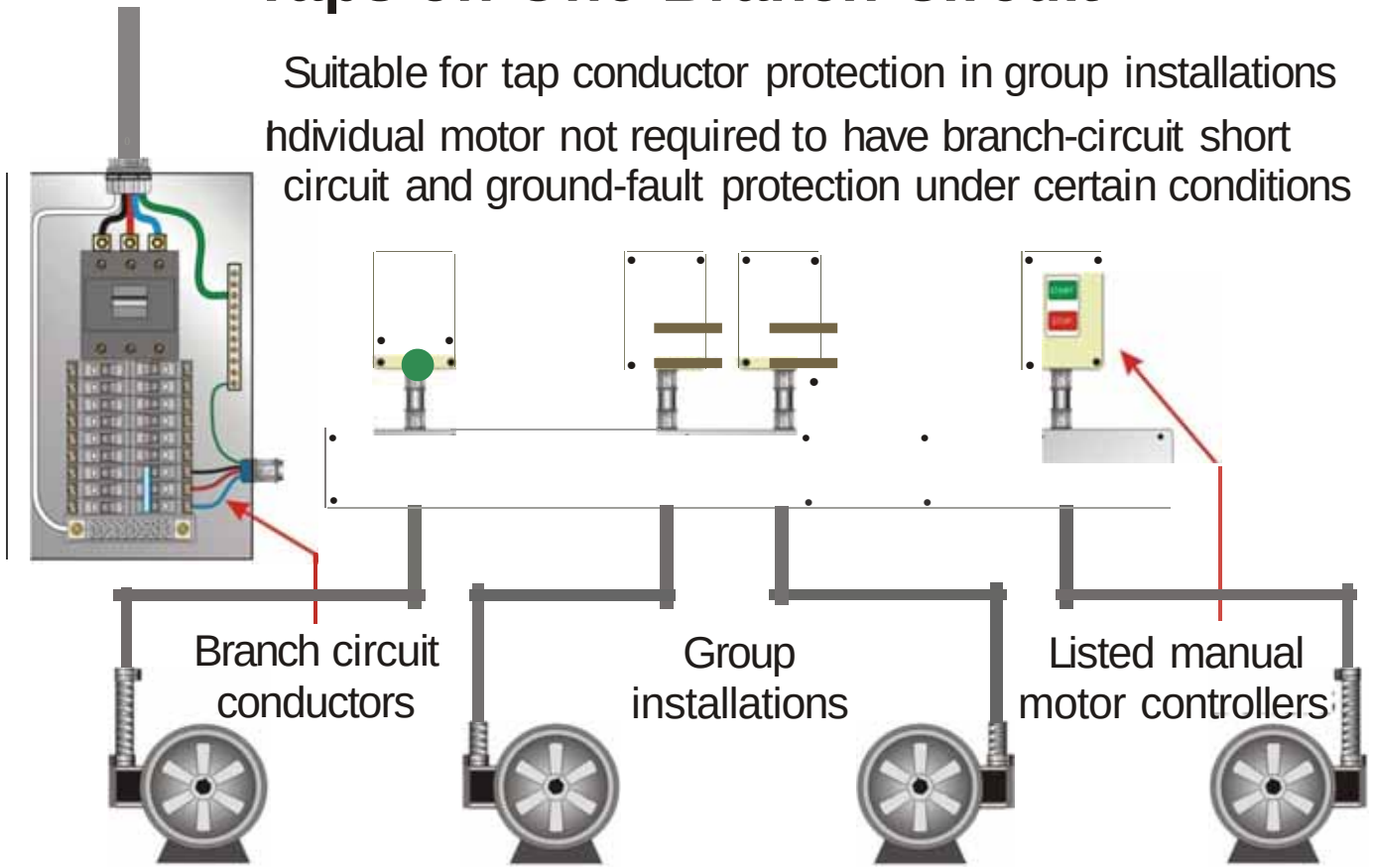
430.53(D)(4)
Single Motor Taps on One Branch Circuit

- New tap rule for single motor allows **7.5 m (25 ft) taps** with the same conditions as is allowed in other areas of the *NEC*
- The ampacity cannot be less than **one-third** that of the branch-circuit conductors
- Previous provisions allowed these taps to have an ampacity not less than **one-tenth** the rating or setting of the branch-circuit short-circuit and ground-fault protective device with the maximum length of **3 m (10 ft)**
- 7.5 m (25 ft) tap allowance for single motor taps is a natural progression for the *NEC*

430.53(0)(4) Single Motor Taps on One Branch Circuit

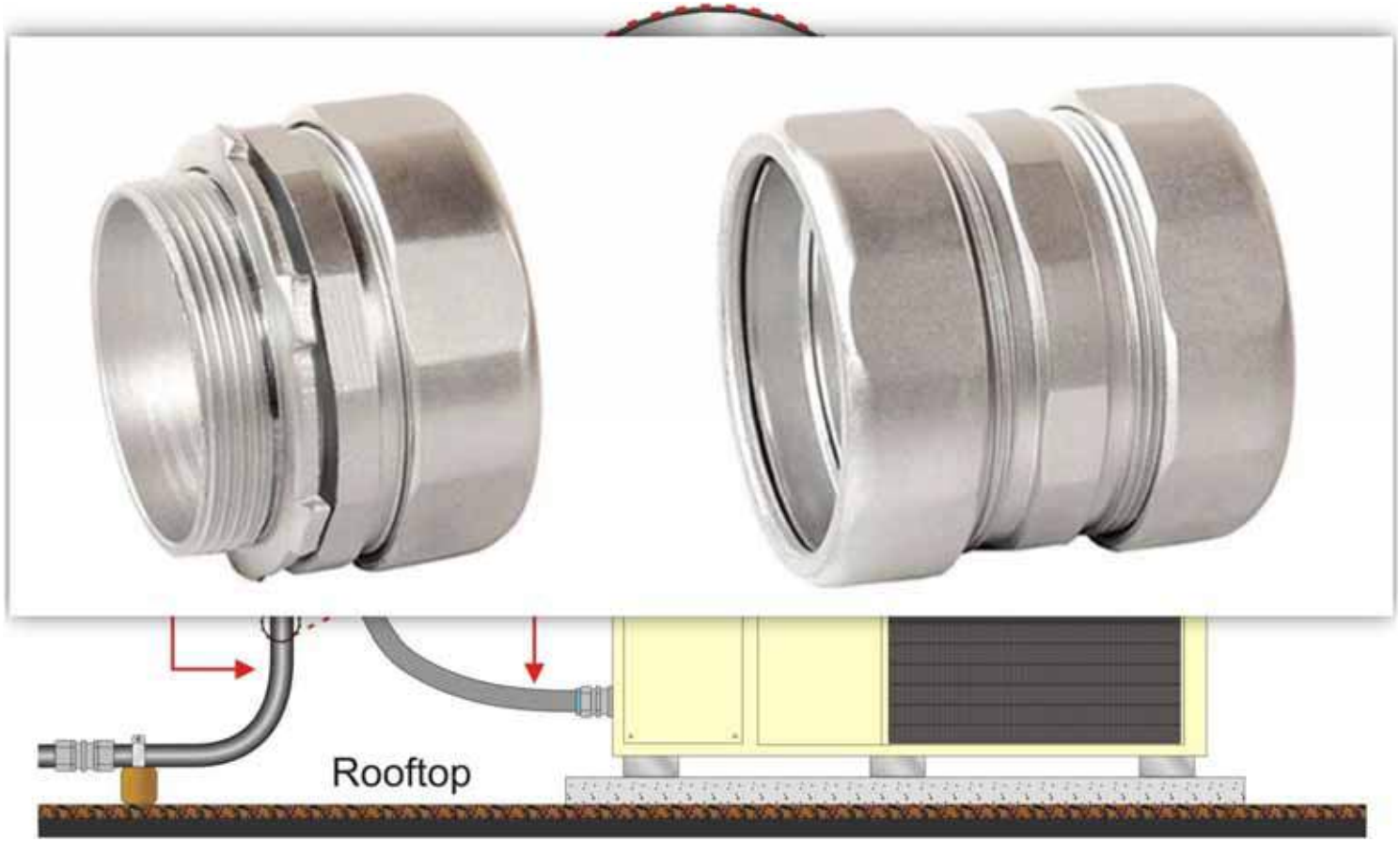
Suitable for tap conductor protection in group installations

hdividual motor not required to have branch-circuit short circuit and ground-fault protection under certain conditions



New 430.53(0)(4) increases the maximum length of the conductors of any tap supplying a single motor to 7.5 m (25 ft) when the ampacity is not less than one-third that of the branch-circuit conductors

440.9 Grounding and Bonding-Rooftop Equipment



Where multimotor 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

445.20 GFCI Protection for Receptacles on 15-KW or Smaller Portable Generators

- **Listed cord sets** are now permitted to be used to incorporate ground-fault circuit-interrupter *(GFCI)* protection for portable generators manufactured or rebuilt prior to Jan 1, 2015
- GFCI requirements have been separated into two different categories for these generators:
  - **Unbonded** *(floating neutral)* generators and
  - **Bonded** neutral generators
- Unbonded *(floating neutral)* generators requires GFCI protection at all 125-volt, 15 and 20 ampere receptacles, but only where both 125-volt and 125/250-volt receptacles exist on the generator

445.20 GFCI Protection for Receptacles on 15-KW or Smaller Portable Generators *(cont.)*

- An exception for unbonded *(floating neutral)* generators eliminates GFCI protection where the 125-volt receptacle outlets(s) is interlocked such that it is not available for use when any 125/250-volt receptacle(s) is in use
- New 445.20(B) requires all 125-volt, 15 and 20 ampere receptacles on bonded neutral generators to be provided with GFCI protection
- An exception to 445.20(A) and (B) permits GFCI protection in the form of listed cord sets or devices incorporating listed GFCI protection if the generator was manufactured or remanufactured prior to January 1, 2015

445.20 GFCI Protection for Receptacles on 15-kW or Smaller Portable Generators

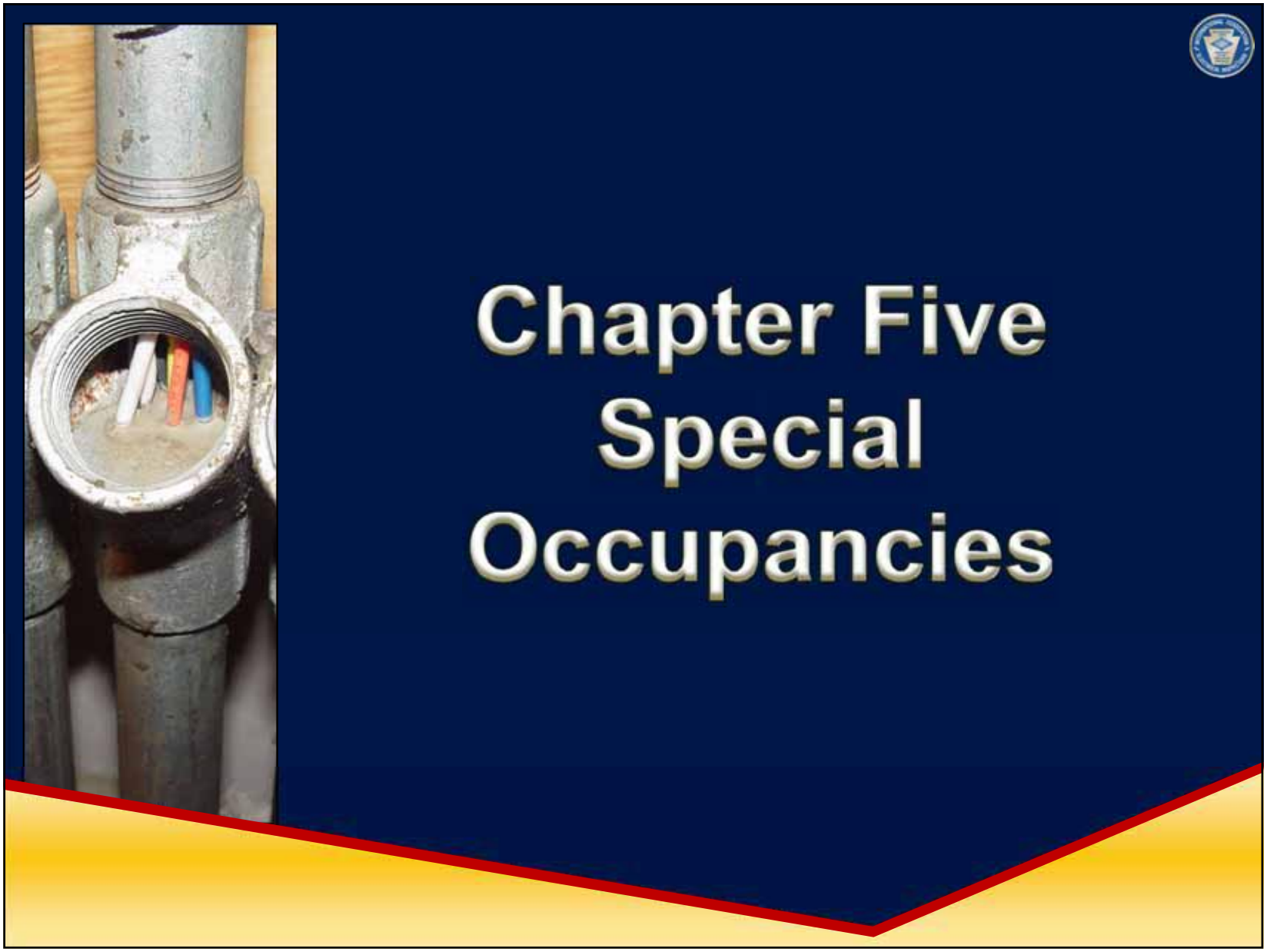
Receptacle outlets that are a part of a 15-kW or smaller portable generator shall have listed GFCI for personnel integral to the generator or receptacle

445.20(A): Unbonded (floating neutral) generators with both 125-volt and 125/250-volt receptacle outlets require GFCI protection integral to the generator or receptacle on all 125-volt and 15- and 20-ampere receptacle outlets

See exception where the 125-volt receptacle outlets(s) is interlocked such that it is not available for use when any 125\1250-volt receptacle(s) is in use)

f the generator was manufactured or remanufactured prior to January 1, 2015, listed cord sets or devices incorporating listed GFCI protection for personnel identified for portable use shall be permitted


GENERAC
GP7500E
Photo Courtesy of Generac


Chapter Five
Special
Occupancies

551.75(B) Grounding Electrode Requirements at RV Parks

- New provisions added to state that power outlets or RV site supply equipment *(other than those used as service equipment)* are **not required to have a grounding electrode established** at RV site pedestals *(electrical equipment)*
- New requirement has to be considered in direct collation with the revised definitions for a "building" and a "structure" found in Article 100
- A "**Structure**" is now defined as "that which is built or constructed, other than equipment"
- The addition of the phrase "other than equipment" at the end of the definition of "Structure" provides clarification that **structures do not include equipment**

551.75(B) Grounding Electrode Requirements at RV Parks *(cont.)*

- New “structure” definition establishes a difference between a “structures” and “equipment” for the purpose of establishing a grounding electrode system as compared to installing optional or auxiliary electrodes at something like an RV pedestal
- Equipment can be mounted on a structure, but the **equipment itself is not a structure**
- New provisions at 551.75(B) will make it clear that a grounding electrode system will not be required for feeders supplying RV site equipment *(RV pedestal)*
- Previous **informational note that referenced 250.32(A) has been deleted** as this reference implied that the installation of grounding electrode was required at the RV site electrical equipment such as an RV pedestal


31


40

Article 555 Marinas, Boatyards, and Commercial and Noncommerical Docking Facilities

- Title of Article 555 was changed from "Marinas and Boatyards" to "**Marinas, Boatyards, and Commercial and Noncommerical Docking Facilities**"
- Revisions to 555.1 make Article 555 relevant to **dwelling unit docking facilities** as well as commercial docking facilities
- As previously written, the *NEC* rules in Article 555 would not apply to residential boat docking facilities, yet the majority of the rules in Article 555 would be necessary for implication at residential boat docks associated with single-family and multi-family dwelling occupancies
- Article 555 will now apply to all wiring, equipment, and electrical systems installed at boat docking facilities regardless of its location

555.24 Signage - Marinas, Boatyards and Commercial/Noncommercial Docking Facilities

- New signage requirement for **precautionary signage** related to electric shock hazard in water around marinas and boatyards
- Gives notice of electrical shock hazard risks to persons using or swimming near a boat dock or marina
- Signage must comply with **110.21(B)(1)** and be clearly visible from all approaches to a marina or boatyard facility
- The signs shall state:

WARNING — POTENTIAL SHOCK HAZARD — ELECTRICAL CURRENTS MAY BE PRESENT IN THE WATER

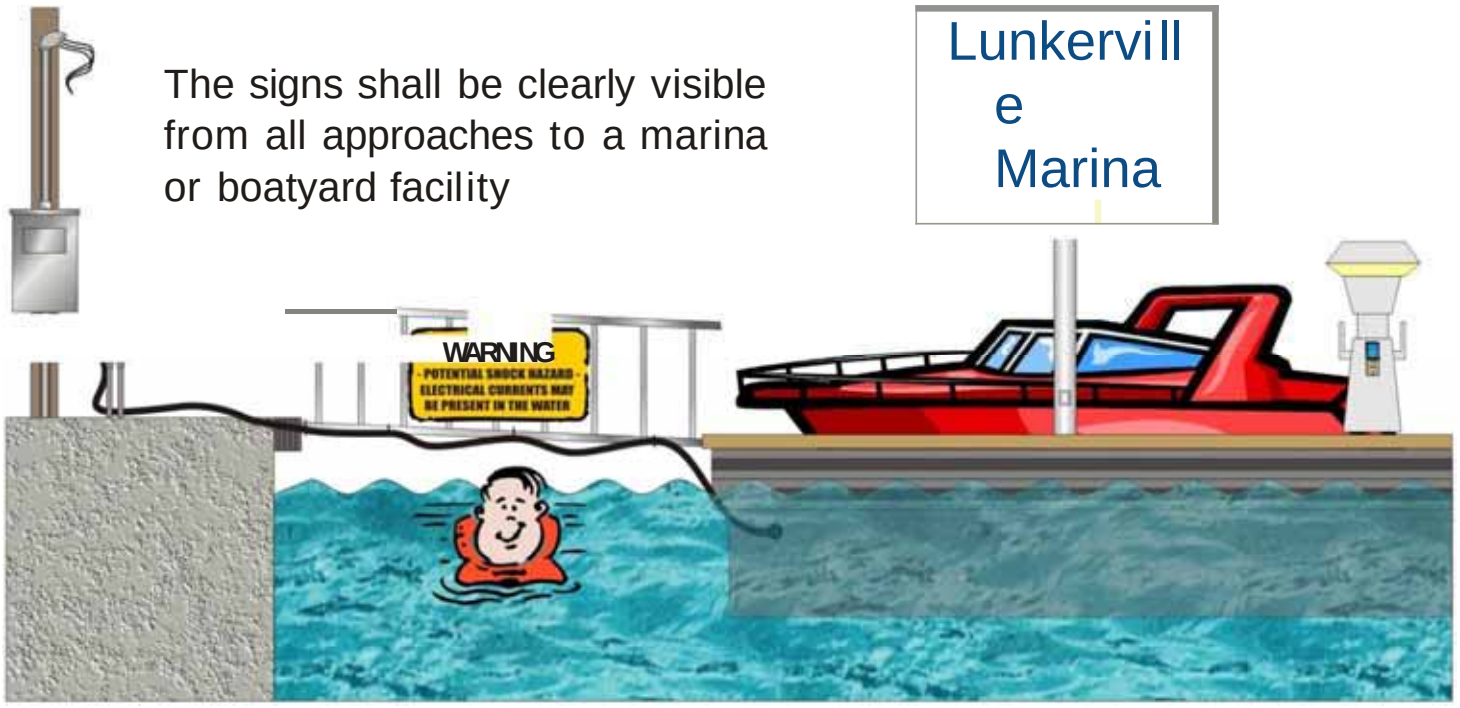
- Due to stray circulating currents in the water, swimming at marinas and boatyards presents a significant danger of **electric shock drowning (ESD)** to people engaging in aquatic activities

555.24 Signage at Marinas, Boatyards, Etc.

New requirements added for permanent safety signs to be installed to give notice of electrical shock hazard risks to persons using or swimming near a boat dock or marina

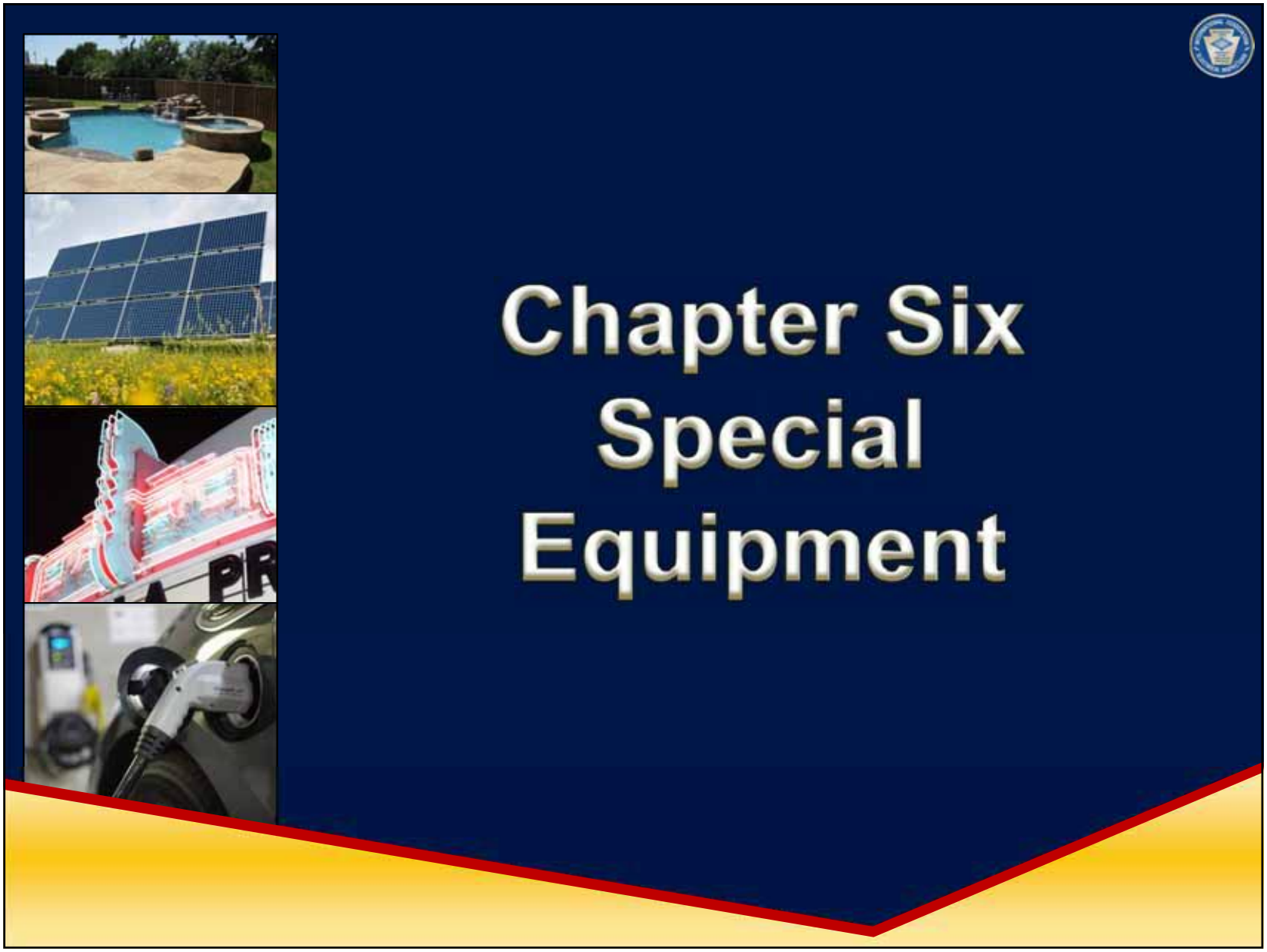
WARNING - POTENTIAL SHOCK HAZARD - ELECTRICAL CURRENTS MAY BE PRESENT IN THE WATER

The signs shall be clearly visible from all approaches to a marina or boatyard facility



590.6(A)(1) GFCI - Temporary Installations Receptacle Outlets Not Part of Permanent Wiring

- GFCI protection is permitted in the form of **portable GFCI cord sets in addition to** GFCI protection required for all 125-volt, single-phase, 15-, 20-, and 30-ampere receptacle outlets that are **not a part of the permanent wiring** of the building or structure
- This added language mirrors the added text by **TIA 70-14-6**
- Portable GFCI cord set devices cannot be used as a substitute for protecting temporary wiring, thus protecting the worker on the construction site from damaged supply cables
- If the GFCI protection were permitted at "splitting device" rather than at the source, there would be no GFCI protection for the temporary cable leading to the splitting device where damage often occurs


Chapter Six
Special
Equipment

625.2 Definitions – Electric Vehicle Charging Systems

- Two new definitions added:
  - **Wireless Power Transfer (WPT)**
  - **Wireless Power Transfer Equipment (WPTE)**
- New definitions support the new requirements added at **Part IV of Article 625** titled, "Wireless Power Transfer Equipment"
- These definitions derived from terminology as set forth in a **Society of Automotive Engineers (SAE)** standard, **SAE J2954**
- Wireless EV charging offers the advantage of **seamless charging** without having to physically connect the EV to the electrical grid for ease of customer use

625.2 Definitions - EV Charging Systems

Wireless Power Transfer (WPT). 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 a 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.

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

- A new Part IV of Article 625 titled, "**Wireless Power Transfer Equipment**" was added as well as two new definitions, "Wireless Power Transfer (WPT)" and "Wireless Power Transfer Equipment (WPTE)" added at 625.2
- Wireless EV charging creates a connection between a **transmitting pad** on ground level *(such as a garage floor)* and a **receiving pad** integrated on the bottom of the electric vehicle
- New Part IV of Article 625 consist of two sections:
  - **625.101** - requirements for grounding of the non-ferrous metal primary pad base plate *(or listed double-insulation system)*
  - **625.102** - construction requirements

Photo courtesy of Oak Ridge National Laboratory

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

- New definition for "**Electrically Powered Pool Lift**" along with a new **Part VIII** titled, "**Electrically Powered Pool Lifts**" was added to Article 680
- These lifts allow persons with disabilities to have access to public swimming pools, spas, and hot tubs
- Required components at public aquatic facilities by the **Department of Justice and the Americans with Disabilities Act (ADA)**
- At least two **accessible means of entry** must be provided for each public use and common use swimming pool *(ADA, Section 15.8.2)*

Art. 680 Part VI Electrically Powered Pool Lifts

80. General. Electrically powered pool lifts as defined in 680.2 shall comply with Part VI of Article 680

81. Equipment Approval.

82. Protection. (GFC)

83. Bonding.

84. Switching Devices.

85. Nameplate Marking.

New definition for "Electrically Powered Pool Lift" was added to 680.2 and a new Part VI titled, "Electrically Powered Pool Lifts" was added to Article 680

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

- Definition clarified with adding the term "**constructed on or above the ground**" before storable/portable “nonmetallic, polymeric or inflatable tubs, spas, or pools regardless of the dimension”
- Clarifies that storable/portable pool, spa, or hot tub with nonmetallic, molded polymeric walls or inflatable fabric walls regardless of dimension is always installed “**on or above the ground**”
- Any pool “constructed in the ground or partially in the ground, and all others capable of holding water in a depth greater than 1.0 m (42 in.)” are considered to be a **permanently installed** swimming, wading, immersion, or therapeutic pool

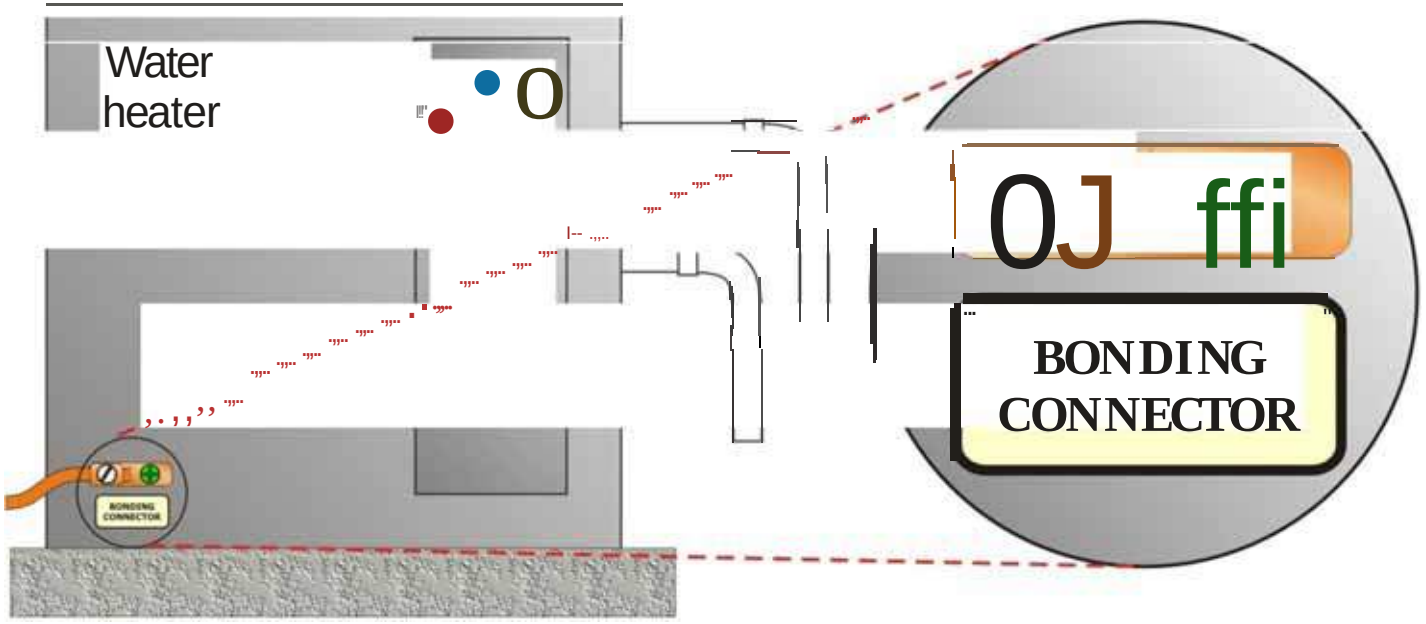

Lay-Z-Spa
Vegas

680.7 Grounding and Bonding Terminals

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

Field-installed 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




Bonding Connector.
Connecteur de Raccordement.
Conector de Enlac.4722n


BONDING CCNNECTOR

Previous Table 680.10 *(Deleted)* Underground Wiring Burial Depths

- Previous 680.10 *(Underground Wiring Location)* moved to 680.11 and previous **Table 680.10 was deleted**
- The minimum burial depth cover requirements around pools will now be facilitated by **Table 300.5**
- Underground wiring now permitted to be installed in **close proximity** of the pool regardless of its location to the pool and no consideration needs to be given as to whether this wiring is "**necessary to supply pool equipment**" or not
- Revised text will allow service lateral or underground feeder to be routed **within 1.5 m (5 ft)** or close proximity to the pool even though this service or feeder is not "necessary to supply pool equipment"

Table 680.10 Minimum Cover Depths (Deleted)

Previous 680.10 (Underground Wiring Location) moved to 680.11 and previous Table 680.10 Minimum Cover Depths was deleted

Table 680.10 was "kicked out" of the *Code*

Table 680.10 Minimum Cover Depths

Wiring Method	Minimum Burial mm	Minimum Burial in.
Rigid metal conduit	150	6
Intermediate metal conduit	150	6
Nonmetallic raceways listed for direct burial under minimum of 102 mm (4 in.) thick concrete exterior slab and extending not less than 162 mm (6 in.) beyond the underground installation	150	6
Nonmetallic raceways listed for direct burial without concrete encasement	450	18
Other approved raceways*	450	18

*Raceways approved for burial only where concrete encased shall require a concrete envelope not less than 50 mm (2 in.) thick

Table 300.5 burial depth requirements will now apply around swimming pools, spas, hot tubs, fountains, and similar installations

680.12 Equipment Rooms and Pits and 680.14 Corrosive Environments

- New requirement for **protection against a corrosive environment** for electrical equipment installed in equipment rooms and pits added at **680.12** and **680.14**
- Important to make sure that **proper drainage** is provided to prevent water accumulation at the electrical equipment during normal operation or maintenance
- Electrical equipment should not be installed in areas where the electrical equipment and metal components are going to be subject to a corrosive environment without proper corrosion protection being implemented

680.12 Equipment Rooms and Pits and 680.14 Corrosive Environments *(cont.)*

- Swimming pool and spa equipment is often subject to deteriorating chemicals, especially in rooms or pits
- New provisions added at **680.14** identify areas where pool sanitation chemicals are stored, as well as areas with circulation pumps, automatic chlorinators, filters, open areas under decks adjacent to or abutting the pool structure, and similar locations as being considered to be a **corrosive environment**
- **Chlorine** and other pool chemicals severely deteriorate electrical connections of conductors, and accelerate rust and deterioration of metal parts of electrical equipment


Photo Courtesy of Dave Williams, Michigan

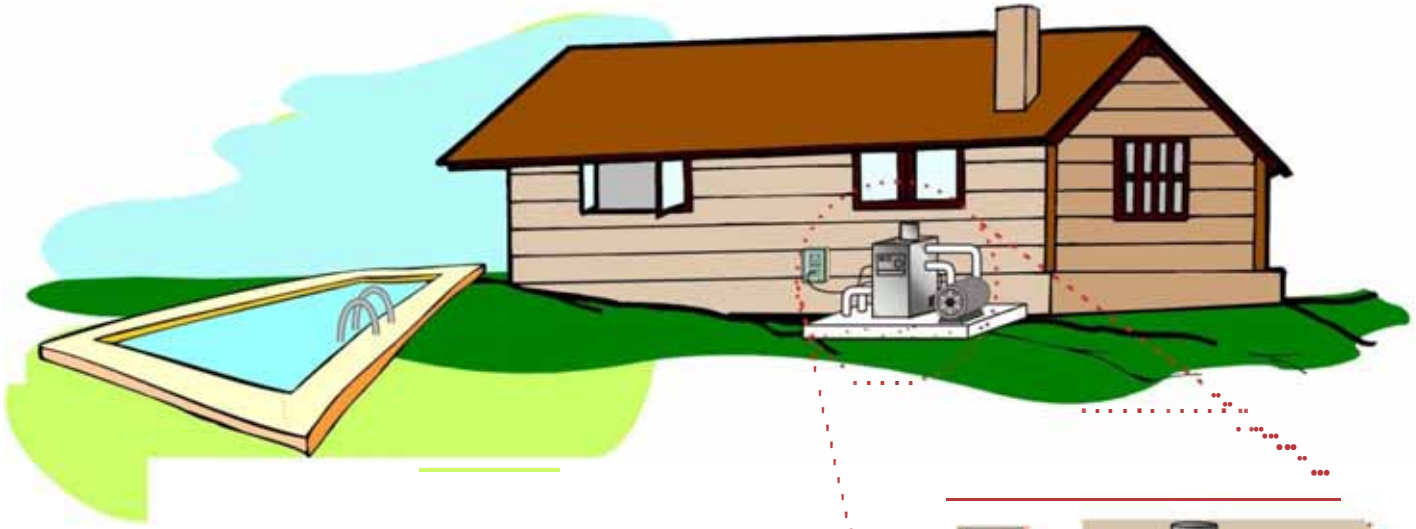
Photo Courtesy of Dave Williams, Michigan

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

- Restricted wiring methods previously described at 680.21(A) will now only apply in areas where **protection from physical damage** is needed or where **protection from environmental conditions** associated with wet, damp, and corrosive conditions are present
- Where installed in **noncorrosive environments** *(such as in the interior of a dwelling unit)*, branch circuits wiring methods for permanently installed pool pump motors need only comply with requirements of the ***NEC* Chapter 3 wiring methods**
- Distinctions for noncorrosive environments no longer needed as new text added at 680.21(A)(1) now indicates that "where installed in noncorrosive environments, branch circuits shall comply with the general requirements in Chapter 3"

680.21(A) Wiring Methods (Motors)

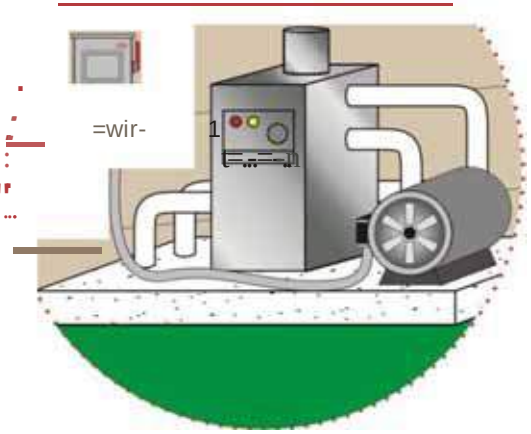
Where installed in noncorrosive environments, branch circuits wiring methods for permanently installed swimming pool pump motors are to comply with the general requirements of *NEC* Chapter 3 wiring methods



Restricted wiring methods will now only apply in areas where:

(1)protection from physical damage is needed

(2)protection from environmental conditions associated with wet, damp, and corrosive conditions are present



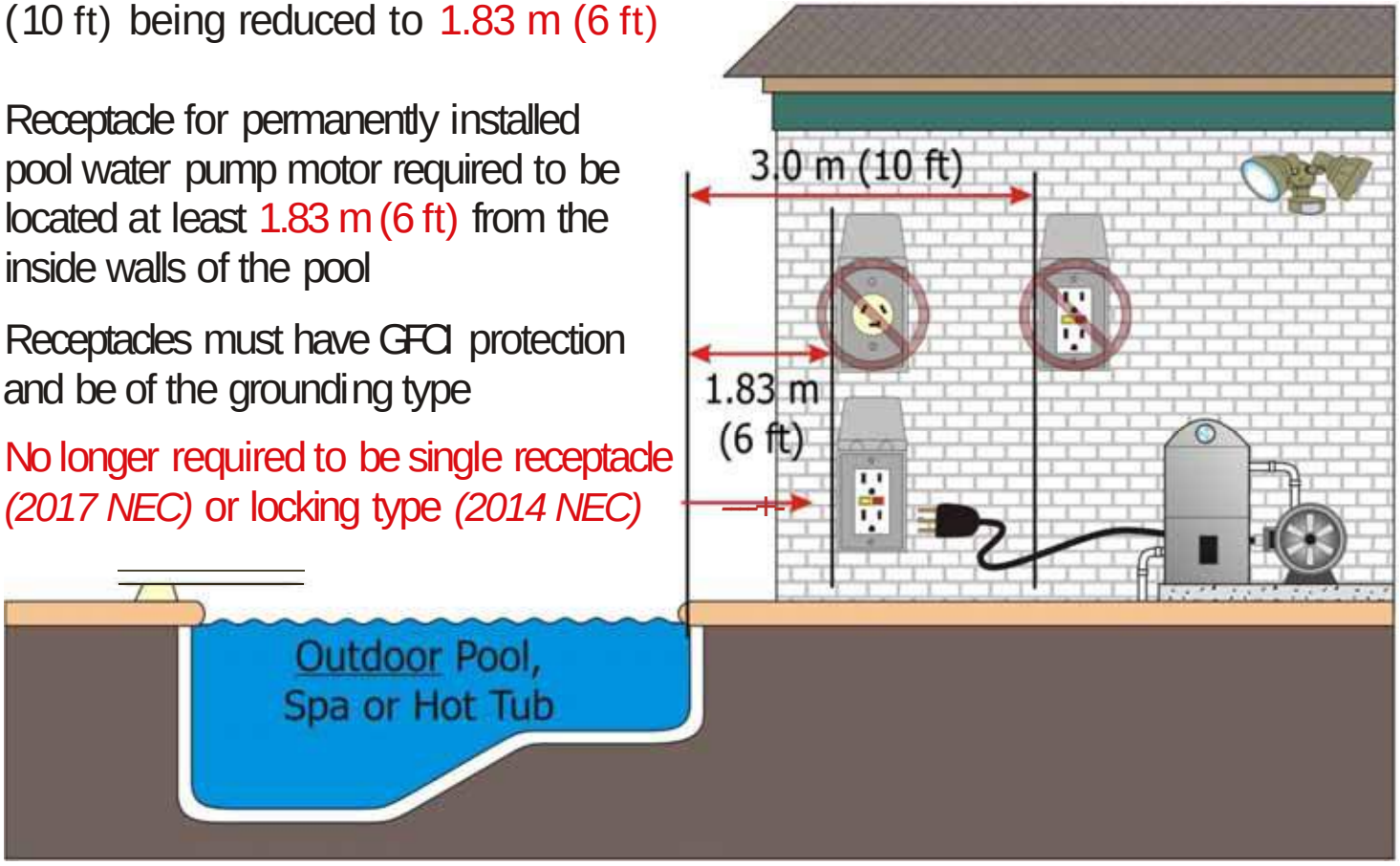
680.22(A)(2) Circulation and Sanitation Receptacle - Location

Requirements for the pool pump motor receptacle were revised with single receptacle requirement removed and minimum distance from the pool of 3.0 m (10 ft) being reduced to 1.83 m (6 ft)

Receptacle for permanently installed pool water pump motor required to be located at least 1.83 m (6 ft) from the inside walls of the pool

Receptacles must have GFCI protection and be of the grounding type

No longer required to be single receptacle *(2017 NEC)* or locking type *(2014 NEC)*



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

- New provisions 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 need 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(8)(7} Low-Voltage Gas-Fired Equipment

New requirements added for low-voltage gas-fired luminaires, decorative fireplaces, fire pits, and similar equipment

Listed low-voltage gas-fired luminaires, decorative fireplaces, fire pits, and similar equipment using low-voltage ignitors with outputs that do not exceed the low-voltage contact limit shall be permitted to be located less than 1.5 m (5 ft) from the inside walls of a permanently installed pool

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

- New provisions added requiring branch circuits serving **gas-fired swimming pool and spa water heaters** operating at voltages **above the low-voltage contact limit** to be provided with GFCI protection for personnel
- GFCI protection not required for electric water heaters with proper grounding provisions *[see 680.6(3)]* and the listing installation requirement for the use of "**current collectors**"
- Current collectors are not present with a gas-fired swimming pool heater
- 125-volt branch circuit to a gas-fired water heater is susceptible to loss of current and ground-fault condition as much as any other piece of electrical equipment


MasterTemp 400
Pentair
78
SERVICE HEATER
SERVICE SYSTEM
HEATING

680.74
Bonding of Hydromassage Bathtubs

- Bonding requirements for hydromassage bathtubs was reformatted into a **list format**
- New exception added to exempt bonding of "**small conductive surfaces**"
- A list of metallic items located "**within 1.5 m (5 ft) of the inside walls of the tub**" were added to the required items required to be bonded:
  - All metal-sheathed cables, metal raceways, metal piping, and all exposed metal surfaces
  - All electrical devices and controls that are not associated with the hydromassage tub

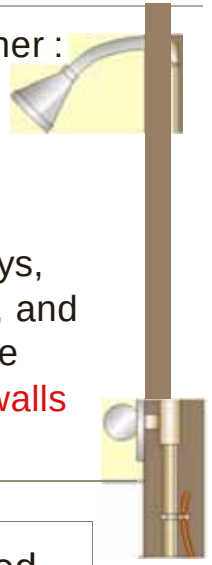
680.74
Bonding of Hydromassage Bathtubs *(cont.)*

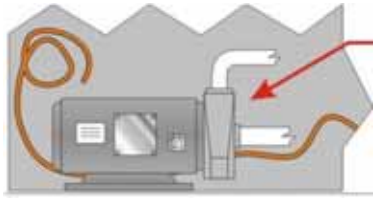
- Besides the metal parts of electrical equipment associated with the tub water circulating system, **all metal fittings within or attached to the tub structure** that are in contact with the circulating water are now required to be bonded together
- New exception added to exempt "**small conductive surfaces not likely to become energized**" from hydromassage bathtub bonding requirements:
  - Isolated air and water jets, supply valve assemblies, and drain fittings not connected to metallic piping
  - Towel bars, mirror frames, and similar nonelectrical equipment not connected to metal framing
- This "small conductive surfaces" exception is very similar to the "exception" in the parent text of 680.26(B)(5)

680.74 Hydromassage Bathtub - Bonding

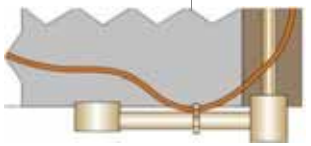
The following parts shall be bonded together :

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





Double insulated pump motor



Bonding requirements for hydromassage bathtubs was reformatted into a list format

New exception was added to exempt "small conductive surfaces not likely to become energized" from hydromassage bathtub bonding requirements

690.12 Rapid Shutdown of PV Systems on Buildings

- The requirements for "**Rapid Shutdown**" for PV systems have been revised and divided into four sub-sections
- Revision emphases the primary existence of the rapid shutdown requirements is to **reduced shock hazard for emergency responders** *(not intended to provide electrical isolation for electrical worker safety as addressed by NFPA 70E and disconnecting means requirements in Part III of Article 690)*
- Revision answers questions regarding the functionality of the PV rapid shutdown device itself
- Controlled rapid shutdown conductors outside the "**array boundary**" must comply with new 690.12(B)(1) ***[305 mm (1 ft)*** *from the array in all directions]*

690.12 Rapid Shutdown of PV Systems on Buildings *(cont.)*

- Controlled conductors located outside the array boundary to be limited to not more than **30 volts** within **30 seconds** of rapid shutdown initiation *(was 10 second initiation in the 2014 NEC)*
- Controlled rapid shutdown conductors located inside the array boundary or not more than 1 m (3 ft) from the point of penetration of the surface of the building are limited to not more than **80 volts** within **30 seconds** of rapid shutdown initiation *(future effective date of January 1, 2019)*
- Rapid shutdown initiator device to be located on the **outside** of the building for **one- and two-family dwellings**

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

- Provisions for identifying a PV "**Rapid Shutdown System**" have been extensively revised
- **Two new figures** with illustrated labels have been added to indicate to first responders that rapid-shutdown is provided
  - **Figure 690.56(C)(1)(a):** Label for PV Systems that Shut Down the Array and the Conductors Leaving the Array
  - **Figure 690.56(C)(1)(b):** Label for PV Systems that Shut Down the Conductors Leaving the Array Only
- **Detailed roof diagram** required in certain situations showing each different PV system and a "dotted line" around areas that remain energized after rapid shutdown initiated

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

- Rapid shutdown switch to have a **label** located directly on the **rapid shutdown initiator (RSI)** or no more than **1 m (3 ft)** from the rapid shutdown switch that includes the words:

RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM

- Anything that is not touch safe should be labeled as energized
- Revisions direct firefighters and first responders to the **location of the RSI switch** and it clearly identifies what equipment is still live after the system has been shut down
- Allows proper precautions to be taken when responding to an **emergency situation** on a building or structure involving a PV system and a rapid shutdown device

690.56(C) ID of Power Sources Buildings with Rapid Shutdown

Two different labels are required on buildings depending on what type of rapid shutdown system is on the building

Systems with multiple rapid shutdown types will be required to have a detailed directory as simple sign will not be sufficient to clarify the levels of hazard

Plaque or directory required within 1 m (3 ft) of service

Revision requires any building with a rapid-shutdown PV system to have a plaque to indicate to first responders that rapid-shutdown is provided

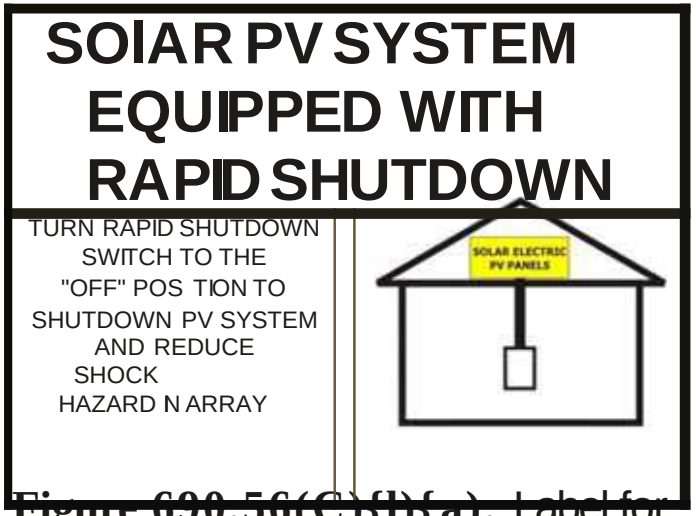


Figure 690.56(C){l){a): Label for PV Systems that Shut Down the Array and the Conductors Leaving the Array

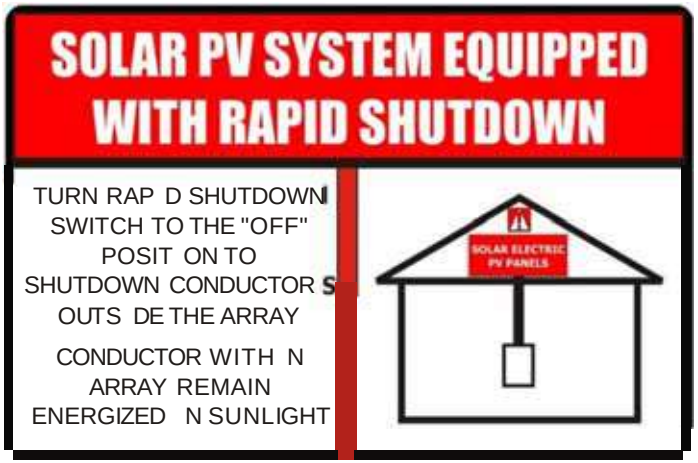


Figure 690.56(C){l){b): Label for PV Systems that Shut Down the Conductors Leaving the Array Only

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

SOLAR PV SYSTEM EQUIPPED WITH RAPID SHUTDOWN

TURN RAPID SHUTDOWN SWITCH TO THE "OFF" POSITION TO SHUTDOWN PV SYSTEM AND REDUCE SHOCK HAZARD IN ARRAY

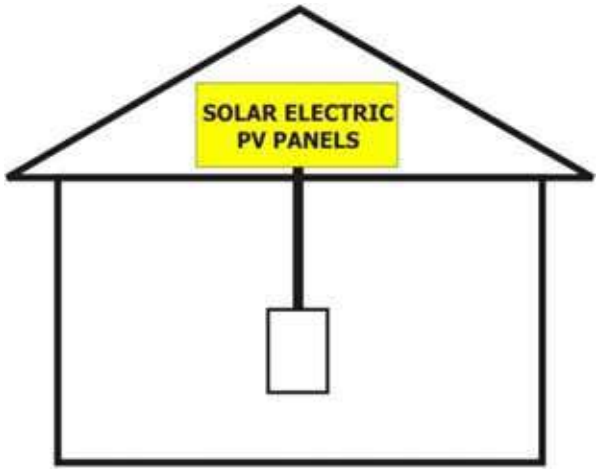
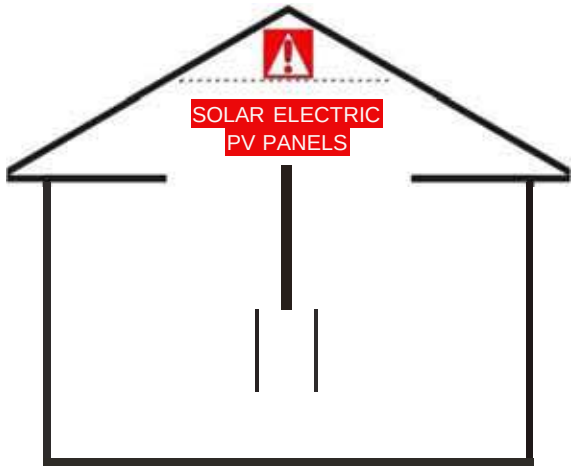


Figure 690.56(C)(1)(b): Label for PV Systems that Shut Down the Conductors Leaving the Array Only

SOLAR PV SYSTEM EQUIPPED WITH RAPID SHUTDOWN

TURN RAPID SHUTDOWN SWITCH TO THE "OFF" POSITION TO SHUTDOWN CONDUCTORS OUTSIDE THE ARRAY

CONDUCTOR WITHIN ARRAY REMAIN ENERGIZED IN SUNLIGHT



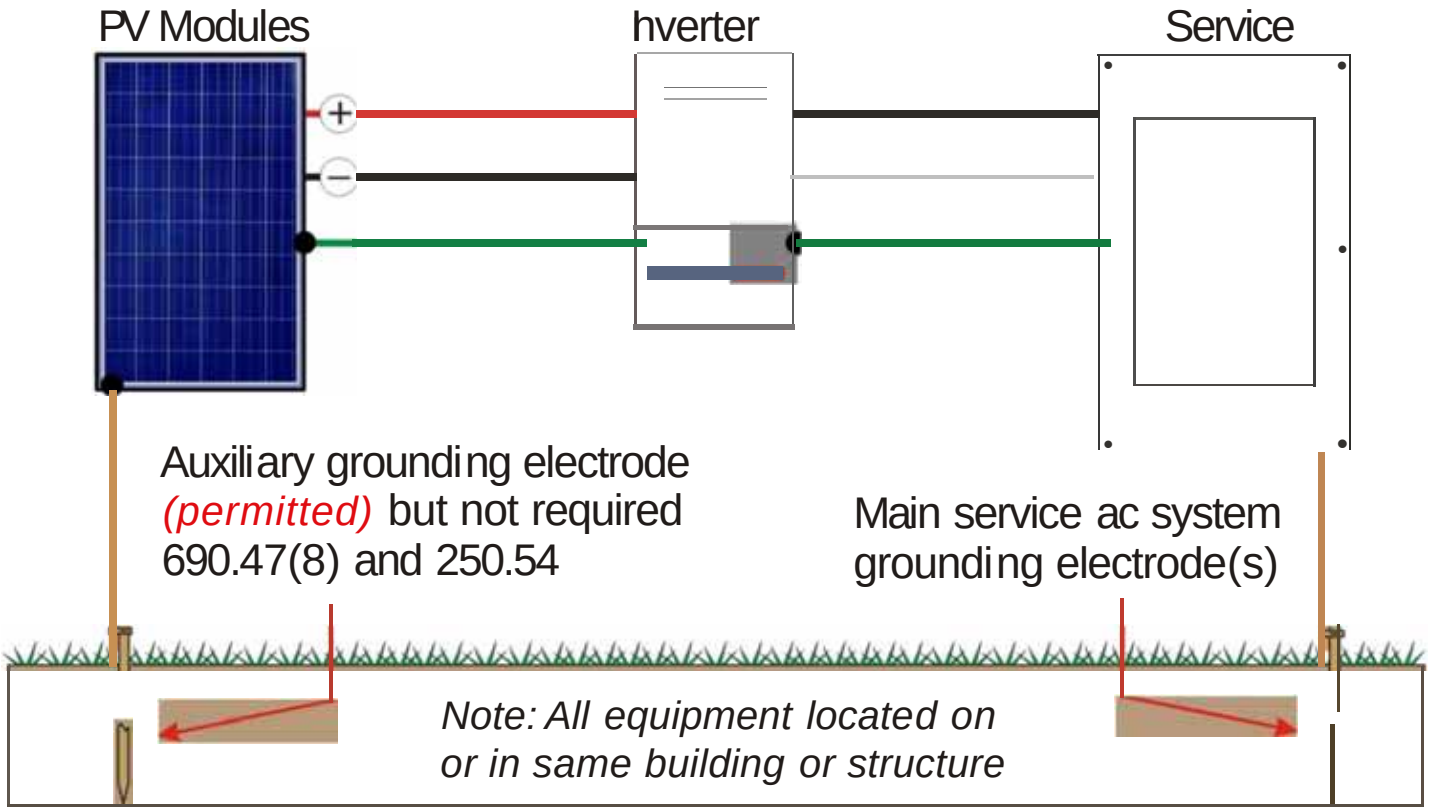
690.47 Grounding Electrode System for PV Systems

- Requirements for the installation of grounding electrodes and grounding electrode conductors for PV systems have been **simplified**, while increasing the safety of PV systems
- 690.47(A) now refers to sections or parts of **Article 250** without repeating the specific grounding electrode rules
- Further simplified to only require a GEC to be attached to solidly grounded PV systems
- Safety provisions of former 690.47(B) reworded and moved to parent text of 690.47(A) while 690.47(B) was deleted
- New ground-mounted PV system will require a new grounding electrode system *(as will a building-mounted system)*, but only if that building did not previously have a GE system

690.47 Grounding Electrode System for PV Systems *(cont.)*

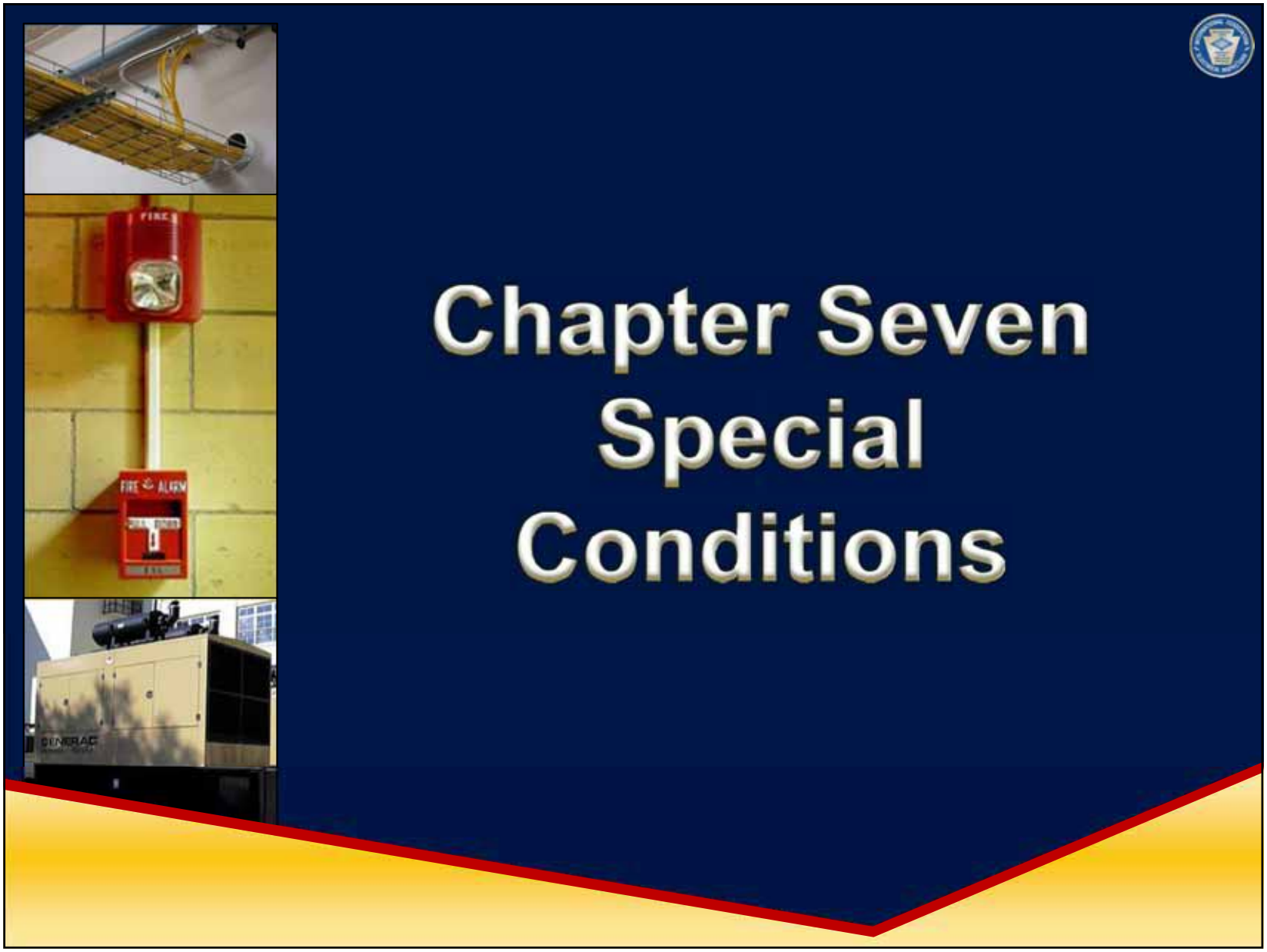
- Text for auxiliary electrodes for PV array grounding has been revised to ***permit*** an auxiliary electrode *(not require one)*
- Auxiliary grounding electrode system helps to minimize the effects of such things as a lightning strike
- Primary purpose of an auxiliary grounding electrode is to maintain the frames of the PV array to as close to local earth voltage potential as possible
- This can also be achieved through a properly installed **equipment grounding conductor** back to an established grounding electrode system for the building or structure

690.47 Grounding Electrode System



The requirements for the installation of a grounding electrode system for PV systems have been revised and simplified

Code language for auxiliary electrodes-for PV array grounding has been revised to *permit* an auxiliary electrode *(not to require one)*


Chapter Seven
Special
Conditions

702.12(C) Power Inlets for Portable Generators at Optional Standby Systems

- New requirements added for **power inlets used with optional standby generators** to ensure that disconnection of the power inlet **does not occur under load**
- New language requires optional standby equipment containing power inlets **rated 100 amperes or more** for the connection of a generator source to be **listed for the intended use** and be equipped with an **interlocked disconnecting means**
- Not uncommon to find **power inlet boxes** serving as gateway between inside need for electricity and outside supply source
- Disconnecting under load can present a safety hazard if the inlet is not rated for load break or the “intended use”

702.12(C) Power Inlets for Portable Generators at Optional Standby Systems *(cont.)*

- **Two new exceptions** were added omitting power inlet box from being listed for the intended use and being an interlocking disconnecting means:
  - First exception pertains to the power inlet device **rated as a disconnecting means** itself
  - Second exception pertains to **supervised industrial installations** where permanent space is identified for the portable generator to be located within line of sight of the power inlets
- New language intended to either require the power inlet devices used with portable outdoor generators be **load break rated** or be **interlocked with a disconnecting means**


PowerSwitch™
MECHANICAL
NTERLOCK
3 PHASE Y
120/208VAC
5100MB9W
IP67
ON
0
OFF
OVERCURRENT
PROTECTED
MADE IN SWEDEN

725.144 Transmission of Power and Data

(Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits)

- New **725.144** with accompanying **Table 725.144** added to introduce new cable **Type "LP" (Limited Power)** that provides the current limitation due to cable bundling
- Other installation considerations added for **Power over Ethernet (PoE)** type cables
- The **"-LP" cable designation** indicates cable has been evaluated to carry marked current under reasonable worst-case installation scenarios without exceeding the temperature rating of the cable
- These new provisions introduce special cable designs developed that might be used as alternatives to more traditional cables with less restrictions on cable designs and the installations

725.144 Transmission of Power and Data *(cont.)*

(Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits)

- Limited power (LP) cables must be **listed as suitable for carrying power and data circuits** up to a specified current limit for each conductor **without exceeding the temperature rating** of the cable *[see 725.179(I)]*
- Cables must also be marked with the suffix **"-LP"** with the **ampere limit** located immediately following the suffix LP *[example: CL2-LP (1.0A)]*
- New 725.144 and accompanying table added based on **UL Fact Finding Report on Power over Local Area Network Type Cables**
- No conductor (or cable) should be used in such a manner that its operating temperature exceeds its rated maximum temperature

Table 725.144

Table 725.144 Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 Data Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86° F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables

AWG	Number of 4-Pair Cables in a Bundle													
	1			2-7			8-19			20-37			38-61			62-91			92-192		
	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating		
	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
26	1	1	1	1	1	1	0.7	0.8	1	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2	2	2	1	1.4	1.6	0.8	1	1.1	0.6	0.7	0.9	0.5	0.6	0.7	0.4	0.5	0.6	0.3	0.4	0.5
23	2.5	2.5	2.5	1.2	1.5	1.7	0.8	1.1	1.2	0.6	0.8	0.9	0.5	0.7	0.8	0.5	0.7	0.8	0.4	0.5	0.6
22	3	3	3	1.4	1.8	2.1	1	1.2	1.4	0.7	0.9	1.1	0.6	0.8	0.9	0.6	0.8	0.9	0.5	0.6	0.7

Note 1: For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

Note 2: Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

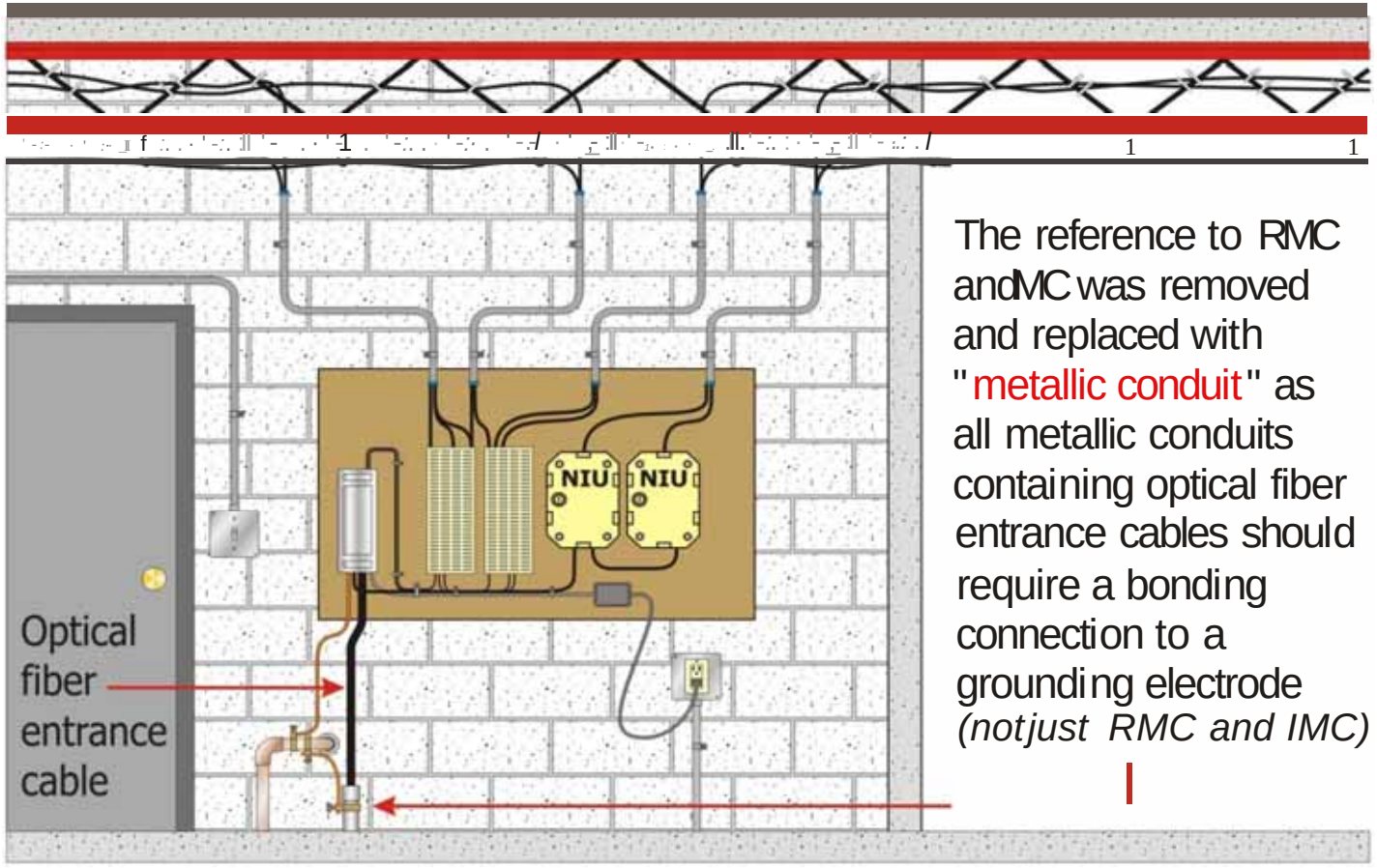
nformational Note: The conductor sizes in data cables in wide-spread use are typically 22- 26 AWG.

770.49 Metallic Entrance Conduit Grounding for Optical Fiber Cables and Raceways

- **All metallic conduit** *(not just RMC and IMC)* enclosing optical fiber entrance cable must be connected by a **bonding conductor** or **grounding electrode conductor** to a grounding electrode
- As previously written this only applied to rigid metal conduit (RMC) or intermediate metal conduit (IMC)
- Electrical metallic tubing (EMT) should also be grounded and bonded for electrical safety *(see uses permitted)*
- Same change occurred at **800.49** for communications circuits, **820.49** for community antenna television and radio distribution systems, and **830.49** for network-powered broadband communications systems

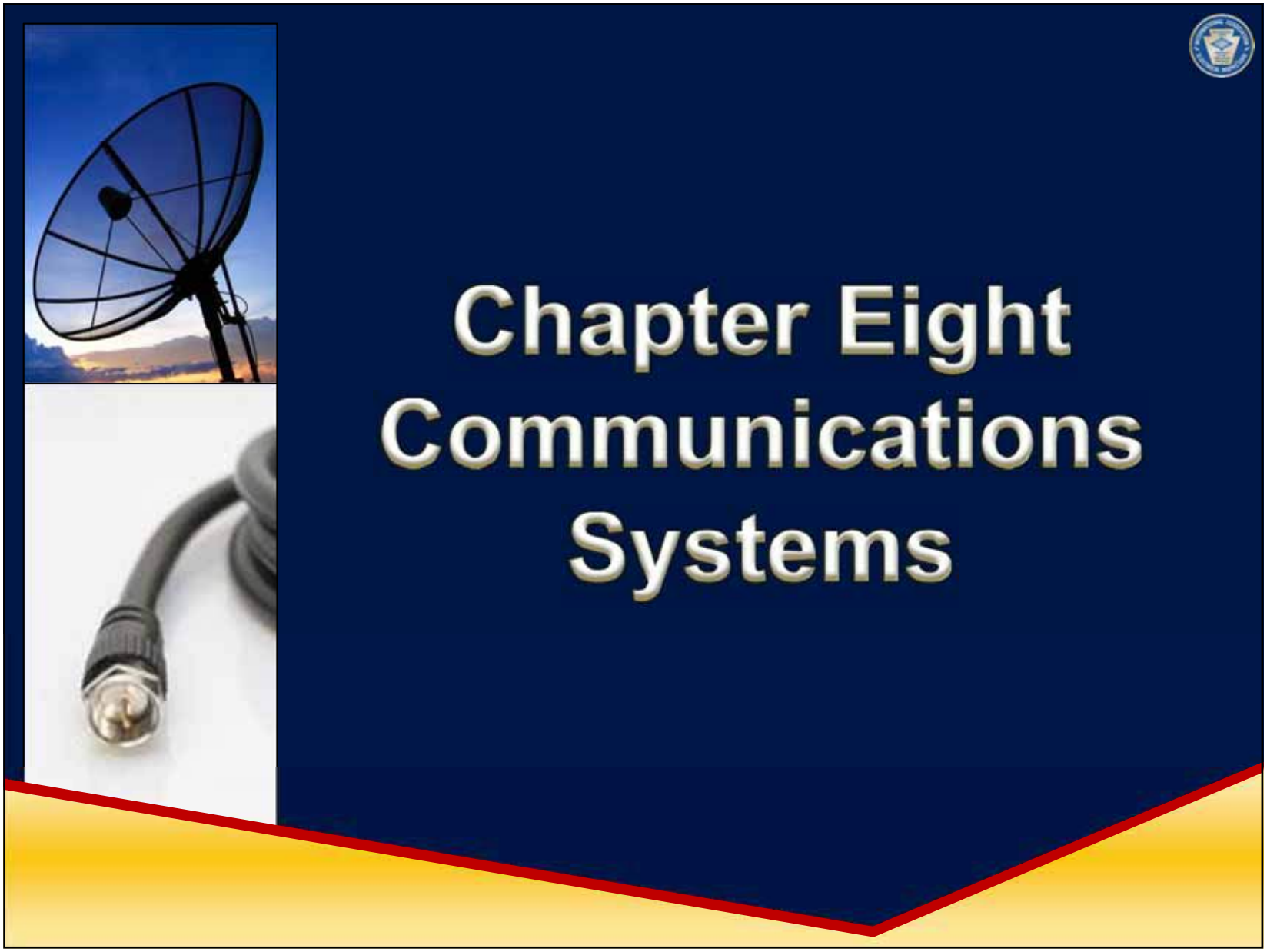
770.49 Metallic Entrance Conduit Grounding

Metallic conduit containing optical fiber entrance cable shall be connected by a bonding conductor or grounding electrode conductor to a grounding electrode in accordance with 770.lOO(B)



The reference to RMC andMC was removed and replaced with "metallic conduit" as all metallic conduits containing optical fiber entrance cables should require a bonding connection to a grounding electrode *(notjust RMC and IMC)*


Photo Courtesy of Scott Humphrey


Chapter Eight
Communications
Systems

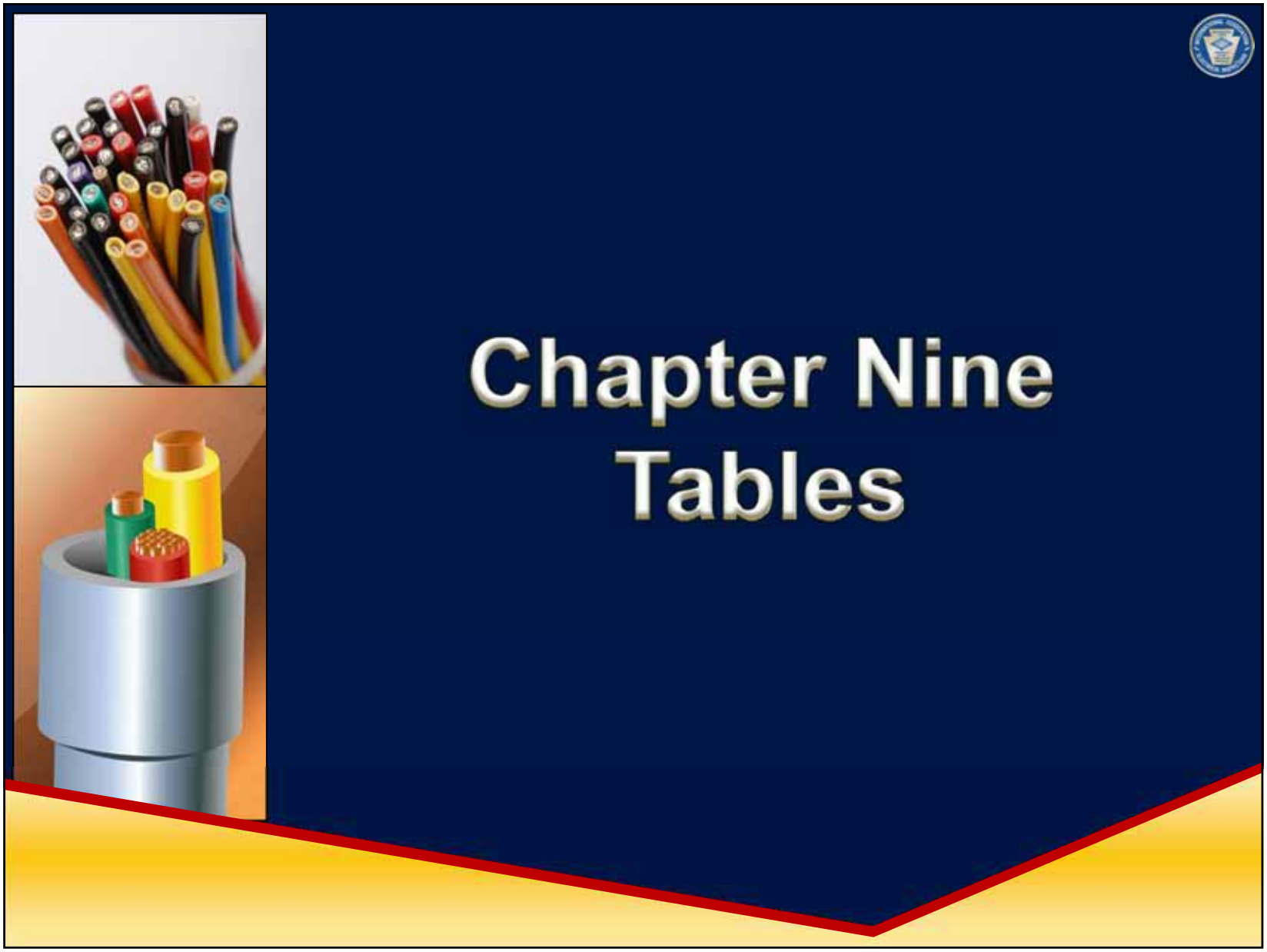
840.2 Definitions: ~~Optical~~ Network Terminal ~~(ONT)~~ *(Premises-Powered Broadband Communications Systems)*

- Definition of "Optical Network Terminal (ONT)" was revised to "**Network Terminal**"
- This more generic term of "Network Terminal" helps to expand the coverage of Article 840 to recognize **twisted-pair** and **coaxial cable** in addition to **optical fiber** based systems
- Types of **twisted-pair cable** include unshielded twisted-pair (UTP) and shielded twisted-pair (STP)
- The other transmission medium that was recognized was the **coaxial cable system** which can provide a higher transmission rate than twisted-pair

840.2 Definitions: Network Terminal

Optical Network Terminal (ONT). A device that converts an optical signal network-provided signals (optical, electrical, or wireless) into component signals, including voice, audio, video, data, wireless, optical, and interactive service electrical services, and is considered to be a network interface equipment device on the premises that is connected to a communications service provider and is powered at the premises.

Revisions occured throughout Article 840 to accommodate twisted pair based and coaxial cable-based systems in addition to optical fiber-based systems for premises-powered broadband communication systems


Chapter Nine
Tables

Chapter 9, Notes to Tables, Note 9

- New language added at Note 9 to specify assemblies of **single insulated conductors** without an overall covering are **not considered a cable** when determining conduit and tubing fill area
- Conduit or tubing fill for the assemblies is to be calculated **based upon the individual conductors**
- Note 9 of the notes to the tables of Chapter 9 directs users of the *Code* to treat multiconductor cables, optical fiber cables, or flexible cords of two or more conductors as a **single conductor** for calculating percentage conduit or tubing fill area
- If cable is an **elliptical-shaped cable** (such as nonmetallic-sheathed cable), cross-sectional area calculation shall be based on using the **major diameter of the ellipse as a circle diameter**

Chapter 9, Notes to Tables, Note 9 *(cont.)*

- Provision for conduit fill for cables is intended to allow the cable wiring methods in Chapter 3 to be considered as a **single entity when calculating conduit fill**
- Industry practice has developed of twisting several single conductors together and placing the assembly on one reel for shipping and installation
- This twisting action does not change the essential nature of the pull or the product or change the conduit fill properties of the individual conductors *(does not make this a cable)*
- This new language will provide clarity to this sometimes misinterpreted cable application

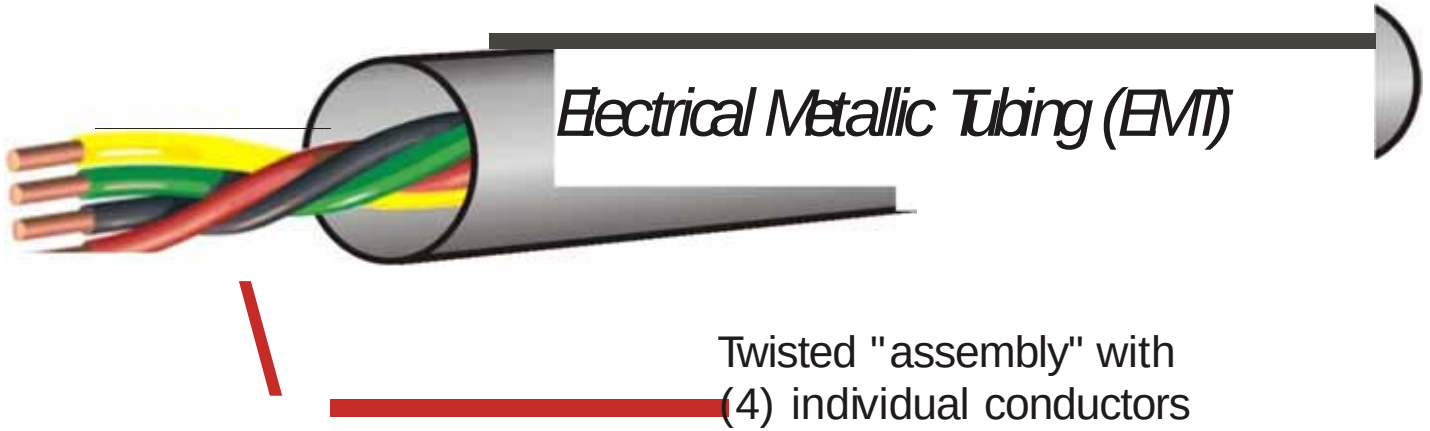
Chapter 9, Notes to Tables, Note 9

A multiconductor cable, optical fiber cable, or flexible cord of two or more conductors shall be treated as a single conductor for calculating percentage conduit or tubing fill area

For cables that have elliptical cross sections, the cross-sectional area calculation shall be based on using the major diameter of the ellipse as a circle diameter

Assemblies of single insulated conductors without an overall covering shall not be considered a cable when determining conduit or tubing fill area

The conduit or tubing fill for the assemblies shall be calculated based upon the individual conductors




Optional Load Calculation (220.82)
Example No. 2
Factor
Quantity
VA Unground
VA Neutral
Appliances (nameplate rating)
Other Loads (add largest only)
Load
Informative
Annexes

Informative Annex D, Example D7 Sizing of Service Conductors for Dwelling(s)

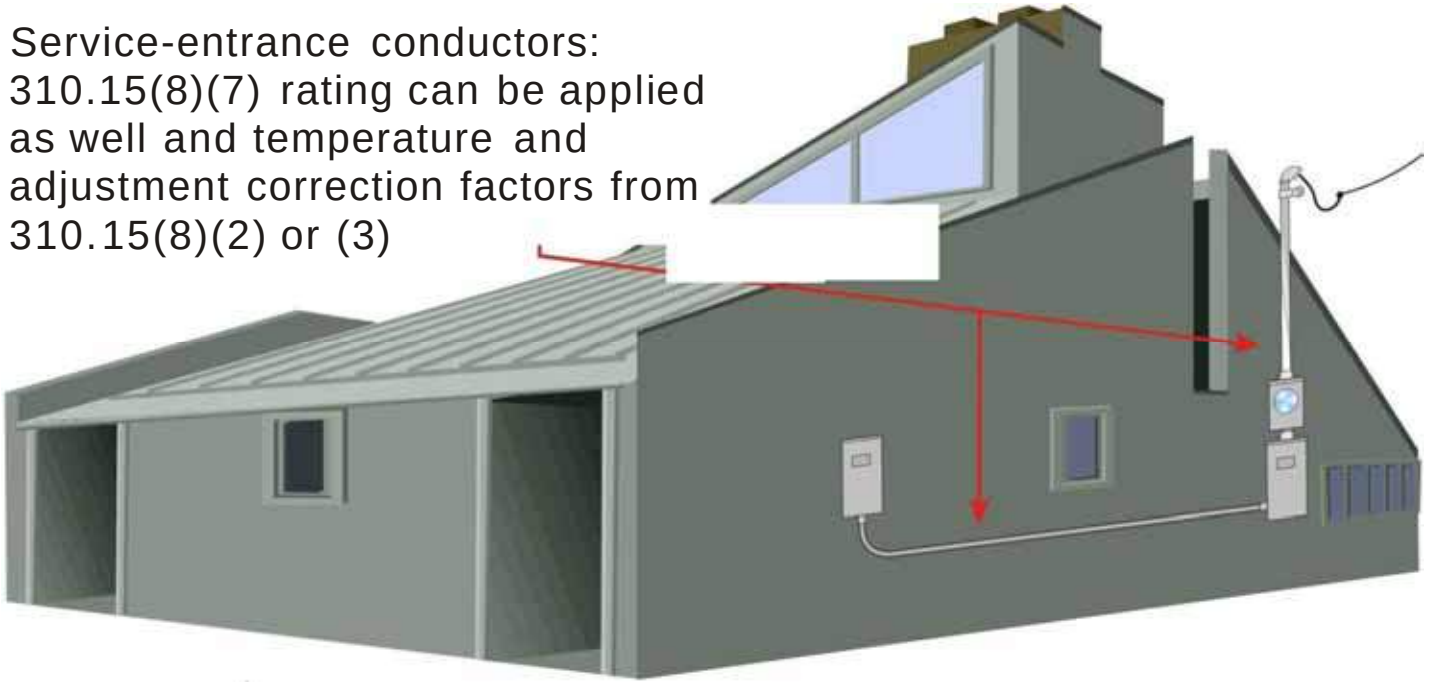
- Example for "**Sizing of Service Conductors for Dwelling(s)**" revised clarifying the use of **temperature corrections** and **adjustment factors**
- New text added at **310.15(B)(7)** indicates where correction or adjustment factors are required by **310.15(B)(2) or (3)**, they are **permitted to be applied** to the ampacity associated with the temperature rating of the conductor
- Example D7 now has two examples:
  - "With No Required Adjustment or Correction Factors"
  - "With Required Temperature Correction Factor"
- **Previous Table 310.15(B)(7)** inserted after the example for reference and use

hformative Annex Example 07 [310.15(8)(7)]

Sizing of Service Conductors for Dwelling(s)

Example 07 for "Sizing of Service Conductors for Dwelling(s)" has been revised clarifying the use of temperature corrections and adjustment factors along with the 83% adjustment from 310.15(8)(7)

Service-entrance conductors: 310.15(8)(7) rating can be applied as well and temperature and adjustment correction factors from 310.15(8)(2) or (3)



Previous Table 310.15(8)(7) was inserted after Example 07 for reference and use with sizing of dwelling unit service and main feeder conductors

hformative Annex D - Example 07

Sizing of Service Conductors for Dwelling(s)

[Former Table 310.15(8)(7)]

f no temperature correction or ampacity adjustment factors are required, the following table includes conductor sizes calculated using the requirements in 310.15(8)(7). This table is based on 75°C terminations and without any adjustment or correction factors.

Service or Feeder Rating (Amperes)	Conductor (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum
100	4	2
110	3	1
125	2	10
150	1	2/0
175	10	3/0
200	2/0	4/0
225	3/0	250
250	4/0	300
300	250	350
350	350	500
400	400	600

Analysis of Changes – 2017 *NEC*

Training Presentation by:

International Association of Electrical Inspectors