Welcome to the 2019 Annual Conference Educational Sessions

Session: IAEI Residential Installations Conforming with Part 8 of the 2018 IRC
One- and Two Family Dwelling Electrical Systems – 2018 IRC

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Training Presentation by:
International Association of Electrical Inspectors
Presentation based on IAEI’s *One- and Two-Family Dwelling Electrical Systems*, 9th edition textbook.

This textbook is based on the requirements contained the **2017 NEC** and the **2018 IRC**.

*Cover for 9th Edition*
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ICC User Note:
About this chapter: Chapter 34 contains broadly applicable requirements including provisions for the protection of the structural elements of a building, inspection of work, general installation and conductor identification. This chapter requires that all electrical system components be listed and labeled by an approved agency. The electrical provisions of this code are identical to the intent of the NEC provisions except that this code requires all electrical system components be listed and labeled. The code does not contain unique electrical requirements. A dwelling built to the code will have electrical systems identical to those required by the respective edition of the NEC. This code addresses only those electrical systems that are common to dwelling construction, and the NEC is referenced for any subject not addressed in the code.
E3401.2 Scope

Electrical systems, equipment or components not specifically covered in these Chapters (34 - 43) shall comply with the applicable provisions of the NFPA 70.
Gray Areas ?
E3601.6.2 Service Disconnect Locations

Service equipment can be located **outside** of building...

Location of service disconnecting means

NEC 230.70(A)(1)
Officer Johnson runs into one of those "gray areas" of the law.
GFCI Requirements for Dwelling Units
Chapter 35: Definitions

- **Ground-Fault Circuit Interrupter (GFCI).** “A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device.”

- **NEC Informational Note:** Class A ground-fault circuit interrupters trip when the current to ground is 6 mA or higher and do not trip when the current to ground is less than 4 mA.

- For further information, see UL 943, *Standard for Ground-Fault Circuit Interrupters*
E3902.14 GFCIs in Readily Accessible Locations

All GFCIs for personnel must be installed in a **readily accessible** location.

*NEC 210.8*
GFCI Protection Required in Dwellings

- Bathrooms E3902.1
- Garages and Accessory Buildings E3902.2
- Outdoors E3902.3
- Crawl Spaces E3902.4
- Unfinished Basements E3902.5
- Kitchens E3902.6
- Sinks E3902.7
- Bathtub and Shower Stalls E3902.8
- Laundry Areas E3902.9
- Dishwashers E3902.10
- Boathouses E3902.11
- Boat Hoists E3902.12
- Electrically Heated Floors E3902.13
- Swimming Pools and Similar Installations Chapter 42

(Note: See Chapter 14 for additional information)
GFCI Principles of Operation

*Receptacle-type GFCI devices switch both the phase and neutral
All 125-volt, single-phase, 15- and 20-ampere receptacles installed in the following locations shall have GFCI protection for personnel:

1. **Bathrooms**

2. **Garages** (accessory buildings)

3. **Outdoors**

   Ex. to (3): Receptacles that are not readily accessible and are supplied by a dedicated branch circuit for electric snow-melting or deicing equipment [E4101.7]

4. **Crawl spaces** — at or below grade level

   *Note: These GFCI devices shall be installed in a readily accessible location*

   **NEC 210.8(A)**
All 125-volt, single-phase, 15- and 20-ampere receptacles installed in the following locations shall have GFCI protection for personnel:

5. **Unfinished basements**
   Ex. to (5): A receptacle supplying only a permanently installed fire alarm or burglar alarm system

6. **Kitchens** — where the receptacles are installed to serve the countertop surfaces

7. **Sinks** — [installed within 1.8 m (6 ft) of the outside edge of the sink]

8. **Bathtub and Shower Stalls** — [installed within 1.8 m (6 ft) of the outside edge of the bathtub or shower stall]

*Note: These GFCI devices shall be installed in a readily accessible location*
All 125-volt, single-phase, 15- and 20-ampere receptacles installed in the following locations shall have GFCI protection for personnel:

9. **Laundry Areas**

10. **Kitchen Dishwasher Branch Circuit** — outlets that supply dishwashers

11. **Boathouses**

12. **Boat Hoists** — for 240 volt or less outlets that supply boat hoist (readily accessible location)

13. **Electrically Heated Floors** — bathrooms, kitchens, hydromassage bathtub, spa and hot tub locations

*Note: These GFCI devices shall be installed in a readily accessible location*

*NEC 210.8(A)*
A new provision was added at the parent text of E3902.14 to indicate the measurement from receptacles to objects (such as a sink) that would qualify for GFCI protection.

This distance should be measured as the “shortest path” a cord of an appliance connected to a receptacle would take without piercing a:

- Floor
- Wall
- Ceiling
- Fixed Barrier
- or passing through a door, doorway, or window
E3902.14 Measurement for GFCI Protection

GFCI protection shall be provided as required in 210.8(A) through (E) and installed in a readily accessible location.

Note: This illustration could be an office break room or a dwelling unit kitchen.

Outlet for disposer

Outlet for refrigerator not within 1.8 m (6 ft) of sink and does not serve countertop

When determining distance from receptacles, distance shall be measured as the “shortest path” the cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window.

NEC 210.8
E3902.1 GFCI Protection for Bathrooms

A bathroom is defined as “an area including a basin with one or more of the following: a toilet, a urinal, a tub, a shower, a bidet, or a similar plumbing fixtures”

A bathroom with (2) basins, a toilet, and a tub

NEC 210.8(A)(1)
E3902.2 GFCI Protection in Garages

1. All 125-volt, single-phase, 15- and 20-ampere receptacles installed in dwelling unit garages require GFCI protection.

2. Dryer receptacle would not require GFCI protection (typically rated at 240-volt, 30-ampere).

Garage and grade-level portions of accessory buildings.
E3902.3 GFCI Protection Outdoor Receptacles

All 125-volt, single-phase, 15- and 20-ampere receptacles installed outdoors shall have GFCI protection for personnel.

GFCI not required for 15- and 20-ampere receptacle dedicated for deicing or snow melting equipment (that is not readily accessible).
All 125-volt, single-phase, 15- and 20-ampere receptacles installed in crawl spaces (at or below grade level) shall have GFCI protection for personnel.
E3902.5 GFCI Protection Unfinished Basements

1. All 125-volt, single-phase, 15- and 20-ampere receptacles installed in unfinished basements require GFCI protection (one exception—see below)

2. Dryer receptacle would not require GFCI protection as this is typically rated at 240-volt, 30-ampere

3. A single receptacle supplying a permanently installed burglar/fire alarm system is not required to have GFCI protection

NEC 210.8(A)(5)
E3902.6 GFCI Kitchen Countertop Receptacles

GFCI protection not required if receptacles do not serve countertop surfaces and are not located within 1.8 m (6 ft) of any sink.

Receptacle outlets that serve countertop surfaces require GFCI protection for personnel.

2.5 m (8 ft)

NEC 210.8(A)(6) and (A)(7)
E3902.7 GFCI Required at Dwelling Unit Sinks

All 125-volt, single-phase, 15- and 20-ampere receptacles installed within 1.8 m (6 ft) of the outside edge of any dwelling unit sink now require GFCI protection.

NEC 210.8(A)(7)
E3902.7 GFCI Dwelling Unit Sinks

NEC 210.8(A)(7)

GFCI required for all 125-volt, single-phase, 15- and 20-ampere receptacles installed within 1.8 m (6 ft) of the outside edge of a dwelling unit sink (laundry, utility, mud room, kitchen, wet bar, etc.)
E3902 GFCI Protection at Sinks

2017 NEC

Mud Room (typical)

GFCI not required

GFCI required for all 125-volt, single-phase, 15- and 20-ampere receptacles installed within 1.8 m (6 ft) from the top inside edge of a dwelling unit sink (laundry, utility, mud room, kitchen, wet bar, etc.) without the measurement piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window.

NEC 210.8(A)(7)

Note: Same requirement at 210.8(B)(5) for non-dwelling unit sinks
All 125-volt, single-phase, 15- and 20-ampere receptacles installed within 1.8 m (6 ft) of the outside edge of a dwelling unit **bathtub or shower stall** requires GFCI protection.

NEC 210.8(A)(9)
GFCI protection required for all 125-volt, single-phase, 15- and 20-ampere receptacles located in a laundry room areas (with or without a sink present)
Ground-fault circuit-interrupter protection for personnel required to be provided for outlets that supply boat hoists installed in dwelling unit locations

Required for all outlets rated up to and including 240 volt branch circuits supplying dwelling unit boat hoists

Applies to both cord and plug connected and direct-wired

GFCI protection also required for all 125-volt, single-phase, 15- and 20-ampere receptacles installed at dwelling unit boathouses [E3902.11] [NEC 210.8(A)(8)]

NEC 210.8(C)
GFCI protection now required for all outlets that supply dishwasher installed in dwelling units

- Includes both receptacle and hard-wired outlet for dishwasher

Modern-day electronically controlled dishwashers can experience “end of life” failures that can result in increased risk of electrical shock

GFCI protection for outlets supplying dishwashers can mitigate these increased risk of electrical shock

NEC 210.8(D)
GFCI protection is now required for lighting outlets not exceeding 120 volts in crawl spaces where the space is at or below grade level.

- Applies to all crawl space, dwelling unit and non-dwelling unit alike.

- The new GFCI requirements for lighting outlets was predicated on a fatality of a worker in a crawl space (broken incandescent light bulb of a keyless lampholder).

- Numerous open-bulb keyless or pull chain lampholders installed in crawl spaces are constantly being damaged.

*NEC 210.8(E)*
Lighting outlets in crawl spaces require GFCI protection
Table E3803.1 GFCI Residential Burial Depth

120 volt branch circuits installed under residential driveways and lawn areas generally must be installed at least 450 mm (18 in.) to 600 mm (24 in.) below grade.

If underground conductors are protected by an overcurrent device rated at not more than 20 amperes and provided with GFCI protection, the burial depth may be reduced to 300 mm (12 in.).

NEC Table 300.5
Electric heating cables installed in floors in bathrooms, kitchens, and in hydromassage bathtubs locations required to be GFCI protected

NEC 424.44(G)
There are several ground-fault circuit-interrupter (GFCI) requirements in IRC Chapter 42 [NEC Article 680] pertaining to swimming pools, spas, hot tubs, etc.

These GFCI requirements are discussed in great detail in Chapter 14 of this presentation.
E4209.1 GFCI for Hydromassage Bathtubs

- Hydromassage bathtubs and their associated electrical components are required to have ground-fault circuit interrupter (GFCI) protection.

- This GFCI protection shall comply with the following:
  - Be on an individual branch circuit(s)
  - GFCI device shall be readily accessible

- All 125-volt, single-phase 15-, 20-, and 30-ampere receptacles located within 1.83 m (6 ft) of the inside walls of a hydromassage tub require GFCI protection.

*NEC 680.71*
Hydromassage bathtub electrical equipment requires GFCI protection from individual branch circuit.

GFCI device required to be readily accessible.

All 125-volt, single phase receptacles (up to 30 ampere) located within 1.83 m (6 ft) of hydromassage tub require GFCI protection.
AFCI
Requirements
for Dwelling Units
AFCI is a device intended to provide protection from the effects of arcing type faults.

AFCI recognizes the characteristics that are unique to arcing.

The entire branch circuit is required to be protected.

Required for all 125-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets and devices installed in dwelling unit in the following locations:

- kitchens
- living rooms
- dens
- recreation rooms
- laundry areas

- family rooms
- parlors
- bedrooms
- closets
- similar rooms or areas

- dining rooms
- libraries
- sun rooms
- hallways

NEC 210.12(A)
E3902.16 AFCI Protection Required

Green shaded area = AFCI required area

AFCI protection is required for all 125 volt, single-phase, 15- and 20-ampere branch circuits supplying outlets and devices in several areas of a dwelling unit (including 125 volt, single-station smoke alarms)

NEC 210.12(A)
AFCI Circuit Breaker – Cut-A-Way View

- Latch Lever
- AFCI Test Button
- AFCI Detection Circuitry
- Load Terminal (Line)
- Load Terminal (Neutral Conductor)
- Line Terminal
- Contacts
- Trip Mechanism
- “Pigtail” Connection to Panelboard Grounded Terminal Bar
E3902.16 Arc-Fault Circuit-Interrupter Protection

Listed Outlet Branch-Circuit Type AFCI Devices

Listed Combination Overcurrent Protection Type AFCI Device

Courtesy of Pass & Seymour/Legrand

Courtesy of Eaton Corporation

NEC 210.12
Dual Function AFCI/GFCI Protection

- Square D QO™ and HomeLine™ Dual Function Circuit Breaker
- Dual-Function Arc Fault and Ground Fault protection, in a single, easy-to-install device

Courtesy of Schneider Electric
E3902.16 AFCI Protection

All 120-volt, single phase, 15- and 20-ampere branch circuits supplying outlets or devices installed in specified areas of dwelling unit shall be protected by any of the means described in (1) through (6):

1. A listed combination type arc-fault circuit interrupter, installed to provide protection of the entire branch circuit
E3902.16 AFCI Protection

All 120-volt, single phase, 15- and 20-ampere branch circuits supplying outlets or devices installed in specified areas of dwelling unit shall be protected by any of the means described in (1) through (6):

1. Branch-circuit panelboard
2. Type NM cable
3. Branch/Feeder AFCI circuit breaker
4. OBC type AFCI device (Outlet marked to indicate it is the first outlet)

(2) A listed branch/feeder type AFCI installed at the origin of the branch circuit in combination with a listed outlet branch circuit type AFCI installed at the first outlet box on the branch circuit (first outlet marked to indicate that it is the first outlet)

NEC 210.12(A)
E3902.16 AFCI Protection

All 120-volt, single phase, 15- and 20-ampere branch circuits supplying outlets or devices installed in specified areas of dwelling unit shall be protected by any of the means described in (1) through (6):

1. Branch-circuit panelboard
2. Type NM cable
3. OBC type AFCI device (Outlet marked to indicate it is the first outlet)
4. Supplemental arc protection circuit breaker

(3) A listed supplemental arc protection circuit breaker installed at the origin of the branch circuit in combination with a listed outlet branch circuit type AFCI installed at the first outlet box on the branch circuit (with three limiting conditions)

NEC 210.12(A)
E3902.16 AFCI Protection

All 120-volt, single phase, 15- and 20-ampere branch circuits supplying outlets or devices installed in specified areas of dwelling unit shall be protected by any of the means described in (1) through (6):

- Branch-circuit panelboard
- Type NM cable
- OBC type AFCI device (Outlet marked to indicate it is the first outlet)
- Listed branch circuit OCPD (circuit breaker or fuse)

(4) System Combination Type AFCI. A listed outlet branch circuit type AFCI installed at the first outlet in combination with a listed branch circuit overcurrent protective device (with four limiting conditions) (OCPD & OBC AFCI device must be identified and listed as "System Combination" type AFCI)
E3902.16 AFCI Protection

All 120-volt, single phase, 15- and 20-ampere branch circuits supplying outlets or devices installed in specified areas of dwelling unit shall be protected by any of the means described in (1) through (6):

(5) A listed outlet branch-circuit type AFCI device (first outlet) is permitted with RMC, IMC, EMT, Type MC, steel armored Type AC cables, metal wireways, or metal auxiliary gutters and metal outlet and junction boxes installed for the portion of the branch circuit between the OCPD and the first outlet.
E3902.16 AFCI Protection

All 120-volt, single phase, 15- and 20-ampere branch circuits supplying outlets or devices installed in specified areas of dwelling unit shall be protected by any of the means described in (1) through (6):

(6) Where a listed metal or nonmetallic conduit or tubing or Type MC cable is encased in not less than 50mm (2 in.) of concrete for the portion of the branch circuit between the OCPD and the first outlet, it shall be permitted to install an a listed outlet branch circuit type AFCI at the first outlet.

NEC 210.12(A)
E3902.12 AFCI Protection

All 120 volt, single phase, 15- and 20-ampere branch circuits supplying outlets installed in dwelling unit bedrooms and other areas of the dwelling are required to be protected by a listed combination arc-fault circuit interrupter device.

AFCI protection required to be of the combination type.

Combination type AFCI detects both parallel and series arc faults.

**Parallel Arc Fault** = Direct contact of two opposite polarities

**Series Arc Fault** = An arc across a break in a conductor

NEC 210.12(A)
E3902.16 (1.) Combination AFCI Protection

All 120 volt, single phase, 15- and 20-ampere branch circuits supplying outlets or devices installed in dwelling unit bedrooms and other areas of the dwelling are required to be protected by a listed combination arc-fault circuit interrupter device when E3902.16 (1.) is employed.

AFCI protection required to be of the combination type.
Combination type AFCI detects both parallel and series arc faults.

- **Parallel Arc Fault** = Direct contact of two opposite polarities
- **Series Arc Fault** = An arc across a break in a conductor

*NEC 210.12(A)(1)*
E3902.16 Exception  Fire Alarm System

Individual branch circuit is permitted without AFCI protection where it is installed using metal outlet boxes and RMC, IMC, EMT, Type MC or steel armored Type AC cable for permanently installed fire alarm systems

NEC 210.12(A), Ex.
E3902.17 AFCI for Extensions or Modifications

In any of the areas specified in E3902.16, where branch-circuit wiring is modified, replaced or extended, the branch circuit shall be protected by:

1. A listed combination AFCI located at the origin of the branch circuit, or
2. A listed outlet branch-circuit AFCI located at the first receptacle outlet of the existing branch circuit

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

NEC 210.12(B)
E3902.17 AFCI for Extensions or Modifications

In any of the areas specified in E3902.16, where branch-circuit wiring is modified, replaced or extended, the branch circuit shall be protected by:

(1) A listed combination AFCI located at the origin of the branch circuit, or

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

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

NEC 210.12(B)
AFCI Protection Required? – YES (E3902.11)
Power-Limited Fire Alarm (PLFA) Circuits

AFCI Protection Required? - NO (NEC 760.41)
Combination Type AFCI
Branch Circuit/Feeder Type AFCI
Tamper-Resistant Receptacle Requirements for Dwelling Units
All nonlocking 125-volt, 15- and 20-ampere receptacles in areas of a dwelling unit referred to in 210.52 are required to be listed tamper-resistant receptacles.

Receptacles in the following locations shall not be required to be tamper-resistant:

- Receptacles located more than 1.7 m (5½ ft) above the floor
- Receptacles part of a luminaire or appliance
- Single or duplex receptacle for appliances located within dedicated appliance space (not easily moved)
- Nongrounding receptacles used for replacement of nongrounding-type receptacles

NEC 406.12(A)
E4002.14 Tamper-Resistant Receptacles

Tamper-resistant receptacles not required for receptacles:
- located more than 1.7 m (5½ ft) above floor
- that are part of a luminaire or appliance
- located within dedicated space for appliances
- replacement nongrounding type

In all areas specified in E3901.1, all nonlocking type 125-volt, 15- and 20-ampere receptacles required to be listed tamper-resistant receptacles.
The following areas of the dwelling are specifically referenced in 210.52 and require tamper-resistant receptacles:

- Kitchens
- Family rooms
- Dining rooms
- Living rooms
- Parlors
- Libraries
- Dens
- Sunrooms
- Bedrooms
- Recreation rooms
- Bathrooms
- Outdoors
- Laundry areas
- Basements
- Garages
- Accessory buildings
- Hallways
- Foyer

*Similar rooms or areas of dwelling unit

NEC 406.12(A)
E4002.14 Tamper-Resistant Receptacles

Tamper-resistant receptacles are available in a wide variety of models for various applications.

Courtesy of Pass & Seymour/Legrand

NEC 406.12(A)
Tamper-Resistant Receptacles
Smoke Alarm Requirements for Dwelling Units
Smoke alarm requirements are generally governed by local building codes.

Smoke alarms are generally required in the following locations:

- Sleeping quarters
- Hallways/corridors in the immediate vicinity of bedrooms
- Each level of the dwelling (*excluding crawl spaces/attics*)

Interconnected to all smoke alarms

Primary power source: premise wiring system (*with battery backup*)
R314.3 Smoke Alarm Locations

Smoke alarms are required in each sleeping room and in hallways leading to sleeping rooms.
IRC R314.3  Smoke Alarm Locations

Smoke alarms required at each level and must be interlocked so activation of one sounds all.

Building Codes will typically not require smoke alarms in crawl spaces or uninhabitable attics.
Smoke alarms are required in dwellings and no disconnecting means is permitted other than an overcurrent device.

Where multiple smoke alarms are installed, they must be wired so they are interconnected to sound all upon activation of a single device (physical interconnection not required where listed wireless alarms are installed and all alarms sound upon activation of one alarm).

Carefully follow the manufacturer’s installation and maintenance instructions.
Receptacle
Wall Spacing
Requirements
for Dwelling Units
Spacing rules call for installation of receptacle outlets so that no point along the floor line in any wall space is more than 1.8 m (6 ft) measured horizontally from an outlet in that space [E3901.2.1]

Includes 600 mm (2 ft) wall space and wall space occupied by fixed panels in exterior or interior walls [E3901.2.2]

Does not include sliding panels in exterior or interior walls [E3901.2.2]

Fixed room dividers are included in the 1.8 m (6 ft) measurement [E3901.2.2]
E3901.2 Receptacle Location and Spacing

NEC 210.52(A)
E3901.2 Receptacle Location and Spacing

Wall space shall include fixed room dividers, such as freestanding bar-type counters or railings.

NEC 210.52(A)(2)
E3901.2.3 Floor Receptacles

Floor receptacles must be within 450 mm (18 in.) of the wall to be counted as required receptacle

NEC 210.52(A)(3)
E3901.1 Dwelling Unit Receptacle Outlets

Entire duplex receptacle switched

Switched receptacle
[E3903.2 Ex. No. 1 or NEC 210.70(A)(1) Ex. No. 1]

Does not meet the requirement for required receptacle outlet

Unswitched receptacle [210.52] (OK for required receptacle outlet)

Switched receptacles do not count as receptacle outlets required by E3901.1

NEC 210.52
Fixed cabinets “that do not have countertops or similar work surfaces” was added as an item that will constitute a break in a wall space for receptacle spacing reasons in dwelling units.

This distinguishes “fixed cabinets” such as kitchen pantry-type cabinets (but not limited to kitchen cabinets) that do not have countertops or similar work surfaces from short desk-type cabinets with countertops that are clearly intended as work surfaces.

This change will ensure that receptacle outlets are required and installed for such things as lap top computers, printers, televisions, etc.

NEC 210.52(A)(2)
Any space 600 mm (2 ft) or more in width and unbroken along the floor line by doorways and similar openings, fireplaces, and fixed cabinets that do not have countertops or similar work surfaces.

**NEC 210.52(A)(2)**
Small Appliance Branch Circuit Requirements for Dwelling Units
Two or more 20-ampere small appliance branch circuits required to serve all receptacle outlets only in the kitchen, pantry, breakfast room, dining room or similar area of a dwelling unit.

The 20-ampere small appliance branch circuits are required to supply refrigeration equipment located in these areas as well.

- Exception permits an individual 15- or 20-ampere branch circuit for refrigeration equipment only.

Generally, the two or more small appliance branch circuits cannot have other outlets (outdoor, bedroom, etc.).

(cont. on next slide)
At least two of the 20-ampere small appliance branch circuits are required to serve the countertop surfaces in the kitchen.

Either or both of these two small appliance branch circuits can also supply other receptacle outlets in the same room or adjacent permitted areas such as a dining room or pantry receptacle outlets.

No small appliance branch circuit can serve more than one kitchen.
E3901.3 Small Appliance Receptacles

Minimum of two small appliance branch circuits limited to receptacle outlets only in kitchens, dining rooms, and similar areas

(See exceptions for clock outlet and gas appliances)

An additional dedicated 15-ampere or greater branch circuit permitted for refrigeration equipment

Other outlets such as outdoor receptacle outlets NOT permitted on small appliance branch circuits

NEC 210.52(B)
Refrigeration equipment generally required to be served by the two or more 20-ampere small-appliance branch circuits.

The receptacle outlet for refrigeration equipment is permitted to be supplied from an individual branch circuit rated 15 amperes or greater.
Any dwelling unit kitchen appliance is now permitted *(by the exception)* to be supplied by an individual branch circuit rated 15 amperes or greater.

E3901.3 requires receptacle outlet serving the refrigeration equipment be supplied from one of the 20-ampere rated small-appliance branch circuits.

Previous exception allowed refrigerator to be supplied by an individual branch circuit rated 15 amperes or greater *(why just refrigerator?)*

Revised exception will now allow an individual branch circuit 15 amperes or greater for kitchen appliances such as garbage disposal, dishwasher, or permanently installed microwave.
Refrigeration equipment generally required to be served by one of the two or more 20-ampere small-appliance branch circuits.

The receptacle outlet for any specific appliance is permitted to be supplied from an individual branch circuit rated 15 amperes or greater.

*GFCI not required unless located within 1.8 m (6 ft) of sink

*GFCI required but device cannot be located behind DW [see 422.16(B)(2)] or any location that is not readily accessible.
E3901.3.1 Ex. No. 1 & 2  No Other Outlets

Exhaust hoods not permitted

Power for electric clock permitted

Receptacle(s) for supplemental equipment and lighting for gas-fired ranges, ovens or counter-mounted units permitted on small appliance branch circuits

NEC 210.52(B)(2) Ex. No. 1 & 2
Base or Wall Mounted Countertops (E3901.4.1)

- Receptacle outlets shall be installed so that no point along the wall line is more than 600 mm **(24 in.)** measured horizontally from a receptacle outlet in that space.

- A receptacle outlet must be installed at each wall countertop space that is 300 mm **(12 in.)** or wider.

(See E3901.4.1 Exception)

- Countertop spaces separated by rangetops, refrigerators, or sinks shall be considered as separate countertop spaces (E3901.4.4)
Island and Peninsular Countertops

- At least one receptacle shall be installed at each island or peninsular countertop space with a long dimension of 600 mm (24 in.) or greater and a short dimension of 300 mm (12 in.) or greater \([E3901.4.2, E3901.4.3]\)

- A peninsular countertop is measured from the connecting edge \((of\ the\ base\ countertops)\)

- Where a range or sink is installed in an island or peninsular countertop and the width of the countertop behind the range or sink is less than 300 mm (12 in.), the range or sink is considered to divide the countertop space into two separate countertop spaces \(\text{NEC 210.52(C)(2) and (C)(3)}\)
All Kitchen Countertops

- Receptacle outlets shall be located above, but not more than 500 mm (20 in.) above, the countertop

- Receptacle outlet assemblies listed for the application shall be permitted to be installed in countertops

- Receptacle outlets rendered not readily accessible by appliances fastened in place, appliance garages, sinks, rangetops, or appliances occupying dedicated space are not considered as these required outlets

(NEC 210.52(C)(5)) (cont. on next slide)
All Kitchen Countertops

- Receptacle outlets permitted to be mounted not more than 300 mm (12 in.) below the countertop under one of two conditions:
  - Construction for the physically impaired
  - On island and peninsular countertops where the countertop is flat across its entire surface (no backsplashes, dividers, etc.) with no means to mount a receptacle within 500 mm (20 in.) above the countertop

*NEC 210.52(C)(5)*
E3901.4 Kitchen Receptacles at Counter Spaces

No point on wall countertop spaces more than 600 mm (24 in.) from a receptacle outlet (measured along the backsplash)

Receptacle outlet required for wall space 300 mm (12 in.) or greater

Counter spaces separated by range tops, refrigerators or sinks are considered as a separate counter space (receptacle outlet(s) required for each space)
At least one receptacle outlet to be installed at each peninsular countertop long dimension space with a long dimension of 600 mm (24 in.) or greater and a short dimension of 300 mm (12 in.) or greater.

Measurements to be measured from the “connected perpendicular wall”.
Figure E3901.4.1 Kitchen Countertop Receptacles

Where receptacle outlets are required to be provided

- Outlet within 600 mm (24 in.)
- Outlets not required if \( X < 300 \text{ mm (12 in.)} \)
- Outlet within 600 mm (24 in.)

Sink or range extending from face of counter

*NEC Figure 210.52(C)(1)*
Figure E3901.4.1 Kitchen Countertop Receptacles

Where receptacle outlets are required to be provided

Outlets not required if $X < 450$ mm (18 in.)

Outlet within 24 in.

Outlet within 24 in.

Sink or range mounted in corner

NEC Figure 210.52(C)(1)
E3901.4.4 Separate Spaces

Range, counter-mounted cooking units, or sinks create separate spaces.

One receptacle required for peninsular and island counter spaces with minimum dimensions as shown.

NEC 210.52(C)(4)
Maximum 500 mm (20 in.) above countertop surface in order to serve countertop
Not permitted face-up in work surface or countertop
Receptacles **NOT** to be located below countertop where countertop extends beyond the support base more than 150 mm (6 in.)

Maximum 300 mm (12 in.) below countertop only for:

1. Construction for the physically impaired
2. Where island or peninsular countertop is flat across entire surface (no backsplash) and no means for mounting receptacle above countertop within 500 mm (20 in.)

NEC 210.52(C)(5)
E3901.4.5 Receptacle Outlet Locations

Receptacle outlets shall be installed on or above the countertops.

Not permitted face-up in work surface or countertop.

Receptacle outlet assemblies listed for the application shall be permitted to be installed in countertops.

20 in.

> 6 in.
Other Receptacle Outlet (Areas) Requirements for Dwelling Units
E3901.6 Bathroom Receptacle Outlet

At least one receptacle outlet to be installed within 900 mm (3 ft) of outside edge of each basin (sink)

One receptacle centered between the basins and within 900 mm (3 ft) of each basin (sink) is permitted as well

NEC 210.52(D)
E3901.6 Bathroom Receptacle Outlet

Receptacle outlet must be located within 900 mm (3 ft) of the outside edge of the basin (sink).

Receptacle outlet permitted on wall or partition adjacent to basin
Receptacle outlet mounted on front or side of vanity can serve as required receptacle outlet if not more than 300 mm (12 in.) below the top of basin
Receptacle outlet assemblies permitted to be installed in the countertop

NEC 210.52(D)
E3703.4 Bathroom Branch Circuit

General lighting circuit
To other bathroom receptacle outlets

120-volt, 20-ampere branch circuit

One 120-volt, 20-ampere branch circuit to supply bathroom receptacles

Other outlets not permitted on 20-ampere bathroom receptacle circuit

Exception permits other equipment within the same bathroom to be supplied by the 20-ampere branch circuit where it supplies one bathroom only

NEC 210.11(C)(3)
E3901.7 Outdoor Receptacle Outlet(s)

At least one outdoor receptacle outlet required in front and back of dwelling (readily accessible from grade level)

NEC 210.52(E)(1)
Product Courtesy of Arlington Industries
E3901.7 Balconies, Decks, and Porches

At least one 125-volt, 15- or 20-ampere receptacle outlet must be installed at every attached balcony, deck, or porch that is accessible from inside the dwelling unit.

The receptacle outlet(s) must be accessible from the balcony, deck, or porch and shall not be located more than 2.0 m (6½ ft) above the walking surface.
Outlet no longer required to be installed “within the perimeter of the balcony, deck or porch”
At least one receptacle outlet shall be installed in areas designated for the installation of laundry equipment *(exception for multifamily dwellings with laundry facilities)* [E3901.8]

A 20-ampere branch circuit shall be provided to supply the laundry receptacle outlet(s) [E3703.3]

This circuit shall have no other outlets

Appliance receptacle outlet(s) installed for specific appliances *(such as laundry equipment)* must be installed within 1.8 m (6 ft) of the intended location of the appliance [E3901.5]

*NEC 210.52(F), 210.11(C)(2), and 210.50(C)*
E3901.8, E3901.5 Laundry Receptacle Outlet(s)

- General lighting circuit
- Laundry circuit
- Other circuits permitted
- Laundry circuit to serve laundry area receptacles only
- Dryer permitted on laundry circuit(s) if 120 volt
- Within 1.8 m (6 ft)

NEC 210.52(F), 210.50(C)
At least one receptacle outlet shall be installed in the areas specified in 210.52(G)(1) through (3)

- 210.52(G)(1) Garages
- 210.52(G)(2) Accessory Buildings
- 201.52(G)(3) Basements

These receptacles shall be in addition to receptacles required for specific equipment.

Branch circuit supplying garage receptacle(s) shall not supply outlets outside the garage.

Receptacle required for each car space in a garage.

This is an effort to recognize the possibility of electric vehicle (EV) and plug-in hybrid electric vehicle (PHEV) charging in these garages.

NEC 210.52(G)
At least one 125-volt, 15- or 20-ampere receptacle outlet, in addition to those for specific equipment, shall be installed in areas specified below:

- Attached garages and in each detached garage with electric power (see specifics for garages on next slide)
- Accessory buildings with electric power
- Unfinished basements - each separate portion of the basement

NEC 210.52(G)
New requirement added for minimum rated 120 volt, 20 ampere branch circuit for dwelling unit garage receptacles

Garage receptacle outlet branch circuit prohibited from serving other outlets (*see exception*)

Exception for readily accessible receptacles located outdoors

15 ampere rated branch circuit in the modern dwelling unit garage is typically not sufficient for appliance and tools rated at 12 to 16 amperes

Lighting outlets in the dwelling unit garage required to be supplied by general lighting circuits

NEC 210.11(C)(4)
At least one 120-volt, **20-ampere** branch circuit shall be installed to supply receptacle outlets in dwelling unit garages (no other outlets). Exception permits supply of readily accessible outdoor receptacle outlets.

*See 210.52(G)(1) for placement of garage receptacles*
E3901.9  Dwelling Unit Garages

At least one receptacle outlet shall be installed in each attached garage and in each detached garage with electric power.

The branch circuit supplying this receptacle(s) shall not supply outlets outside of the garage.

At least one receptacle outlet shall be installed for each car space.

NEC 210.52(G)(1)
In each attached garage and in each detached garage with electric power, at least one receptacle outlet is required to be installed “in each vehicle bay and not more than 1.7 m (5½ ft) above the floor”

Note: See 210.11(C)(4) for garage branch circuit requirements
Hallway
Receptacle Outlet(s)
Foyers that are not part of a hallway having an area that is greater than 5.6 m² (60 ft²) are required to have a receptacle(s) located in each wall space 900 mm (3 ft) or more in width.

Doorways, door-side windows that extend to the floor, and similar openings shall not be considered wall space.

NEC 210.52(I)
Lighting in Clothes Closets for Dwelling Units
E4003.12 Luminaire Clearances in Clothes Closets

Surface incandescent, LED, or fluorescent

Surface incandescent or LED

Recessed incandescent, LED, or fluorescent

Surface fluorescent only

Storage area [shelf width or minimum 300 mm (12 in.)]

150 mm (6 in.) for fluorescent luminaires

300 mm (12 in.) for incandescent or LED luminaires

150 mm (6 in.) for incandescent or LED luminaires

Storage area [1.8 m (6 ft) or highest rod minimum 600 mm (24 in.) wide]

Surface-mounted fluorescent or LED luminaires permitted to be installed within the storage space where identified for this use

NEC 410.16
410.2 Definition: Closet Storage Space

**Closet Storage Space.** The volume bounded by the sides and back closet walls and planes extending from the closet floor vertically to a height of 1.8 m (6 ft) or to the highest clothes-hanging rod and parallel to the walls at a horizontal distance of 600 mm (24 in.) from the sides and back of the closet walls, respectively, and continuing vertically to the closet ceiling parallel to the walls at a horizontal distance of 300 mm (12 in.) or the width of the shelf, whichever is greater; for a closet that permits access to both sides of a hanging rod, this space includes the volume below the highest rod extending 300 mm (12 in.) on either side of the rod on a plane horizontal to the floor extending the entire length of the rod.

*Reproduction of NEC Figure 410.2*
E4003.12 Incandescent or LED Luminaires

- Recessed incandescent or LED with completely enclosed lamp:
  - 150 mm (6 in.)

- Surface-mounted incandescent or LED with completely enclosed lamp:
  - 300 mm (12 in.)

- Storage space:
  - 1.8 m (6 ft)
  - 600 mm (24 in.)

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NEC 410.16(C)
E4003.12 Fluorescent Luminaires

Surface-mounted fluorescent or LED luminaires permitted to be installed within the storage space where identified for such use

NEC 410.16(C)
12 in. ?
E4003.12 Luminaires Not Permitted in Closets

1. Pendant luminaires
2. Incandescent luminaires with open or partially open lamps
3. Lampholders

Luminaire types not permitted in clothes closets

NEC 410.16(B)
One- and Two Family Dwelling Electrical Systems – 2018 IRC

Training Presentation by:
International Association of Electrical Inspectors
Thank You For Attending