## Introduction to the 2011 National Electric Code

1

## Welcome

- Instructors
  - Paul Costello
  - Rick Massicott

2

## Paul Costello

- Director of Apprenticeship & Training
- CT CEU Instructor
- OSHA Outreach
- CPR / First Aid
- NEC CMP 18

3

## Rick Massicott

- JATC Instructor
- CT CEU Instructor
- OSHA Outreach
- CPR / First Aid

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## House Keeping

- **Emergency Exits**
- Please silence cell phones
- Men's Room left
- Ladies room right

## DISCLAIMER

**The views expressed here are not the views of the following:**

- IBEW Local 90
- IBEW
- NECA
- NJATC
- NFPA
- NEMA
- ANSI
- IAEI
- UL
- CT Dept. of Consumer Protection
- CT Dept. of Labor
- CT Dept. of Construction Services
- CT General Assembly
- International Code Council
- Any Manufacturer
- Rick's Wife
- My Dog Jake

## Which Edition

- Significant changes to the 2008 NEC will be represented with the 2008 NEC in the upper left corner of the slide.
- Significant changes to the 2011 NEC will be represented with the 2011 NEC in the upper left corner of the slide.

## How Many Changes Since 2005 ?

| | Proposals | Comments |
|---|---|---|
| 2008 | 3,688 | 2,349 |
| 2011 | 5,016 | 2,910 |
| Total | 8,704 | 5,259 |

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## *Code* -Wide Changes (cont.)

- Four new articles have been added to the 2008 *NEC*
  - Article 355 Reinforced Thermosetting Resin Conduit: Type RTRC
  - Article 522 Control Systems for Permanent Amusement Attractions
  - Article 626 Electrified Truck Parking Space Equipment
  - Article 708 Critical Operations Power Systems (COPS)

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## *Code* -Wide Changes (cont.)

- *Code*-wide revisions to grounding and bonding definitions and rules resulted from the efforts of an assigned *TCC Grounding and Bonding Task Group*.
- References for "fixtures," "light fixtures," and "lighting fixtures" were removed from Article 410 and the *NEC*.
- *Neutral conductor* and *neutral point* definitions and terms throughout the *NEC* resulted from the efforts of an assigned TCC Task Group on Neutral Conductors.
- Shift in responsibilities for *NEC* definitions in Article 100

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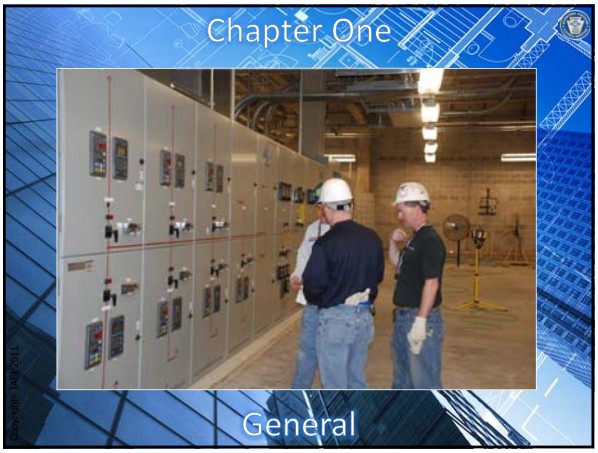
## The Start of a Bad Day at Work



## 90.3 Code Arrangement

- Chapter 1 - General
- Chapter 2 - Wiring and Protection
- Chapter 3 - Wiring Methods and Materials
- Chapter 4 - Equipment for General Use

} Applies generally to all electrical installations

Supplements or modifies Chapters 1 through 4 {
- Chapter 5 - Special Occupancies
- Chapter 6 - Special Equipment
- Chapter 7 - Special Conditions

Chapter 8 - Communication Systems } Chapter 8 is not subject to the requirements of Chapters 1 through 7 except where the requirements are specifically referenced in Chapter 8.

Chapter 9 - Tables } Applicable as referenced

Annex A through Annex H } Information only not mandatory

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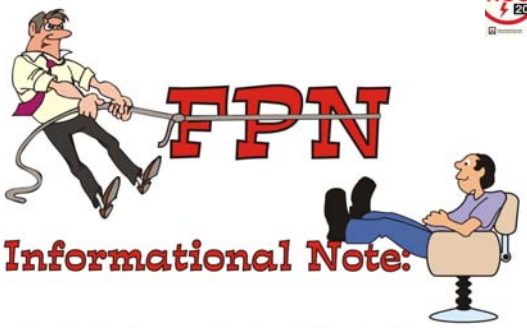
## Article 100 Definitions

- Many existing definitions have been revised.
- Several new definitions have been added.
- Definitions specific or unique to any code-making panel are assigned to that particular panel.
- Definitions that are general in nature will be under the responsibilities of Panel 1.



## 90.5(C) Explanatory Material




"Fine Print Notes" are now referred to as "Informational Notes" and a new Item (D) Informative Annexes has been added

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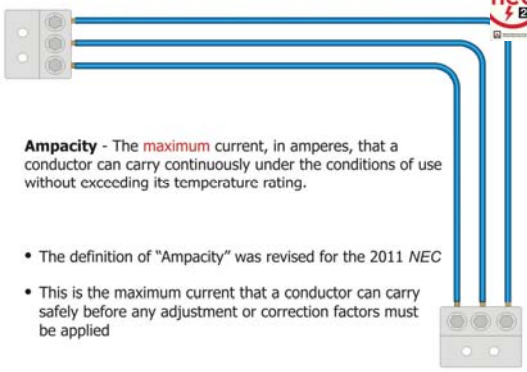
## 90.5(C) and (D) Explanatory Material and Informative Annexes

- "Fine Print Notes" are now referred to as "Informational Notes"
- This revision will more clearly define the adoptable and enforceable requirements of the *NEC* from these non-mandatory, but important forms of information
- The term "fine print" in some legal documents does not necessarily make the text unenforceable requirements
- New subdivision (D) (Informative Annexes) has been added referencing the informational annexes contained in the *NEC*
- Nonmandatory information relative to the use of the *NEC* is provided in informative annexes



## Article 100 Definitions: Ampacity



**Ampacity** - The maximum current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

- The definition of "Ampacity" was revised for the 2011 *NEC*
- This is the maximum current that a conductor can carry safely before any adjustment or correction factors must be applied

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## Article 100 Definition Arc-Fault Circuit Interrupter (AFCI)

DETOUR AHEAD
Relocate

- Section 2.2.2.1 of the NEC Style Manual indicates that terms appearing in more than one article be defined in Article 100.
- The term arc-fault circuit-interrupter appears in multiple articles of the NEC.
- The revision results in the definition of arc-fault circuit interrupter (AFCI) having global NEC application in all articles where it is used.

# Article 100 - Definitions

- Definitions of "Automatic" and "Nonautomatic" have been revised
  - **Automatic** - Performing a function without the necessity of human intervention
  - 2008 *NEC* : Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current, pressure, temperature, or mechanical configuration
  - **Nonautomatic** - Requiring human intervention to perform a function
  - 2008 *NEC* : Action requiring personal intervention for its control. As applied to an electric controller, nonautomatic control does not necessarily imply a manual controller, but only that personal intervention is necessary

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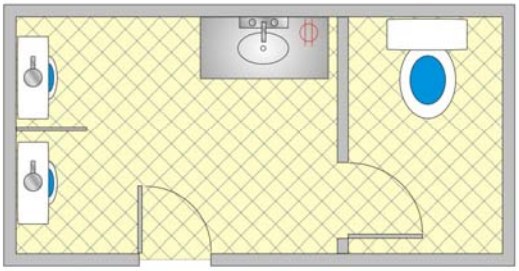
## Article 100 Definitions: Bathroom

**Bathroom** - An area including a basin with one or more of the following: a toilet, a urinal, a tub, a shower, a bidet, or similar plumbing fixtures



The definition of a bathroom has been revised to include areas with a basin and such things as a urinal

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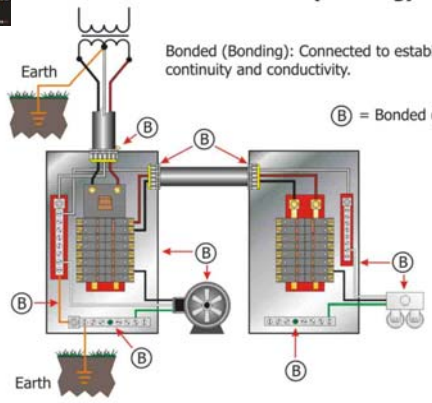
## Article 100 Bonded (Bonding)

Bonded (Bonding): Connected to establish electrical continuity and conductivity.

Ⓑ = Bonded (Bonding)

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## Article 100 Branch-Circuit Overcurrent Device

- A device capable of providing protection for service, feeder, and branch circuits and equipment over the full range of overcurrents between its rated current and its interrupting rating.
- Branch-circuit overcurrent protective devices are provided with interrupting ratings appropriate for the intended use but no less than 5,000 amperes.

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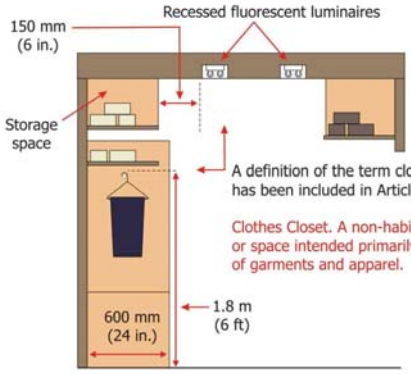
## Article 100 Clothes Closet




A definition of the term clothes closet has been included in Article 100.

Clothes Closet. A non-habitable room or space intended primarily for storage of garments and apparel.

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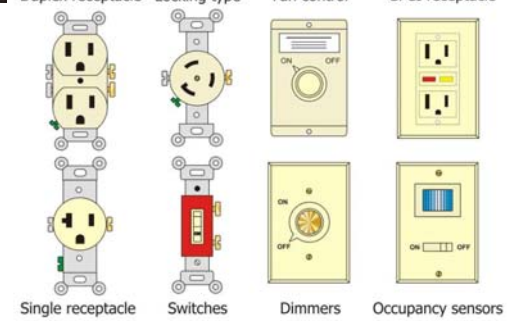
## Article 100 Device




A device is a unit of the electrical system that carries or controls electrical energy as its principal function.

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## Article 100 "Electrical Power Production and Distribution Network"

- Based on the definition in UL1741
- Location in Article 100 makes this definition global
- New definition will aid in the application of Articles 690, 692 & 705

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## Article 100 "Equipment"

- The term "equipment" includes "machinery"
- Industrial machinery falls under the scope of the NEC

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## Article 100 – Ground

- Ground. The earth.
- The term *ground* has been revised and simplified for clarity and improved usability.

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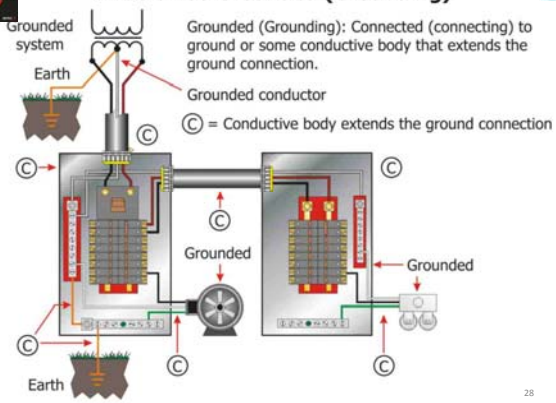
## Article 100 Grounded (Grounding)

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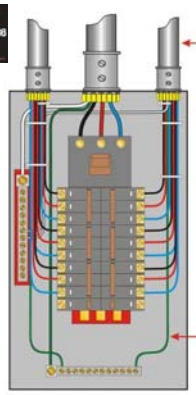
## Article 100 Grounding Conductor, Equipment (EGC)



The conductive path installed to connect normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both.

The EGC also performs bonding functions.

The EGC types are provided in 250.118.

Equipment grounding conductors sized in accordance with Table 250.122.

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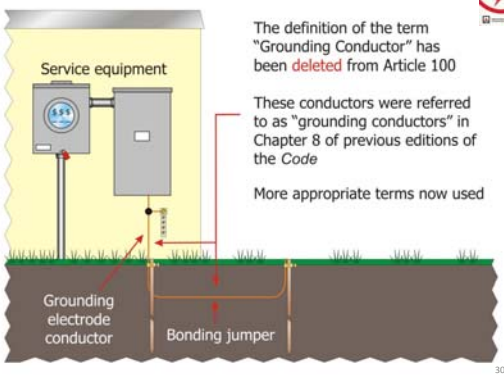
## Article 100: Grounding Conductor (Deleted)




The definition of the term "Grounding Conductor" has been deleted from Article 100

These conductors were referred to as "grounding conductors" in Chapter 8 of previous editions of the *Code*

More appropriate terms now used

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## Article 100 Definition Ground Fault

DETOUR AHEAD
Relocate

- The definition of the term ground fault has been relocated from Section 250.2 to Article 100.
- The term ground fault is used in more than one article of the NEC.
- Section 2.2.2.1 of the NEC Style Manual indicates that terms appearing in more than one article be defined in Article 100.
- This does not impact any term that may use ground fault as part of a larger term such as the term ground-fault circuit interrupter.

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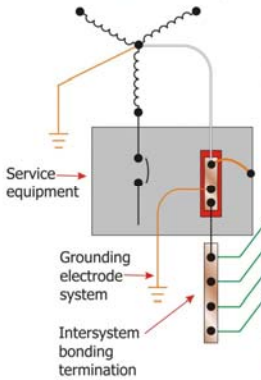
## Article 100: Intersystem Bonding Termination




The definition of "Intersystem Bonding Termination" was revised for simplicity and clarity

Communications
Radio and TV
CATV
NPBCS

**Intersystem Bonding Termination:** A device that provides a means for connecting communications systems to the grounding electrode system

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## Article 100 Definition Kitchen

REVISION

- The definition of the term kitchen has been revised by changing the word facilities to the word provisions.
- The revision aligns with the same wording used in the definition of the term dwelling unit.
- The provisions for cooking in kitchens may be in the form of a stove or range receptacle for attachment of a cord-and-plug connected appliance, which may not be permanent.
- Provisions related to something that is provided.

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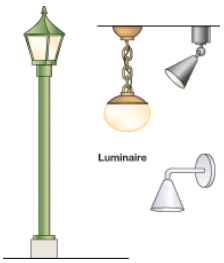
## Article 100 Luminaire




- References to "lighting fixture(s)" or "fixture(s)" after the word "luminaire" are deleted throughout the NEC.
- The definition of "luminaire" is revised to include lighting units without physical protection of the lamp and to clarify that a lampholder is not a luminaire.

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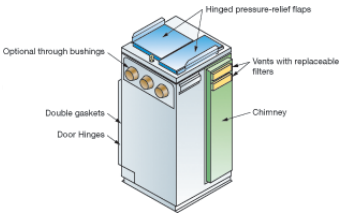
## Article 100 Metal-Enclose Power Switchgear




- A new last sentence in this definition informs the code user that "Metal-Enclosed Power Switchgear" is available in Non-arc Resistant or Arc Resistant constructions.

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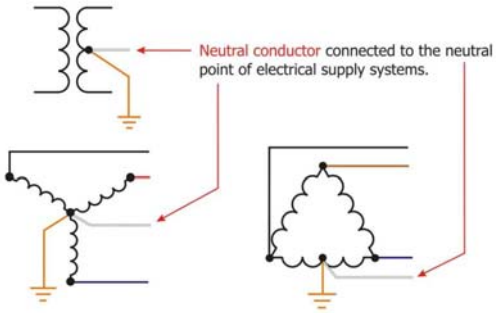
## Article 100 Neutral Conductor



Neutral conductor connected to the neutral point of electrical supply systems.

Neutral conductor is defined as the conductor connected to the neutral point of a system that is intended to carry current under normal conditions.

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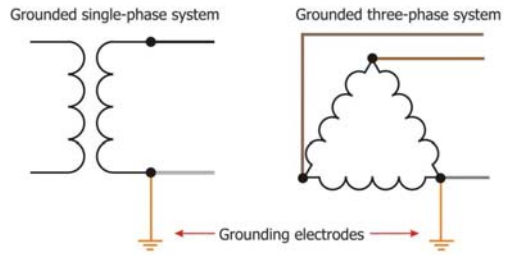
## Article 100 Grounded Conductors (Not Neutrals)




Grounded conductors are not always neutral conductors

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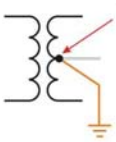
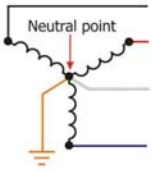
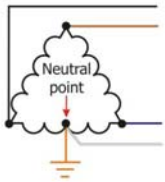
## Article 100 Neutral Point

Neutral point of an electrical system



Neutral point is defined as the common point on a wye-connection in a polyphase system, or the midpoint on a single-phase, 3-wire system, or the mid-point of a single-phase portion of a 3-phase delta system, or a midpoint of a 3-wire direct current system.

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## Article 100 Premises Wiring (System)

- All wiring and equipment downstream of the service point including batteries, solar photovoltaic systems, generators, transformers etc. are part of premises wiring.
- Clarification: Where no service point exists, all sources, wiring and equipment are premises wiring.

## Article 100 Qualified Person

The definition of the term *Qualified Person* has been revised in Article 100.

Qualified Person. One who has the skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.

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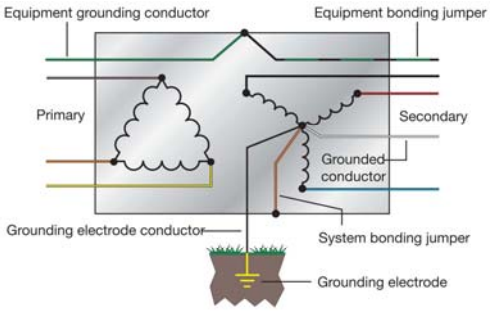


No direct connection from the circuit conductors of one system to the circuit conductors of another system other than connections through the earth, metal enclosures, metal raceways, or equipment grounding conductors

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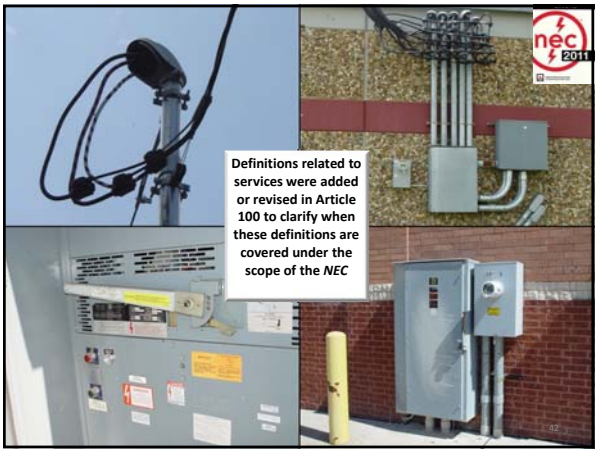


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## Article 100 Definition
## Service Conductors, Overhead

- This new definition applies to service conductors that are overhead and on the load side of the service point up to the service-entrance conductors of a building or structure served.
- This new definition is also more aligned with the revision to the term service drop which has been clarified to be on the load side of the utility supply and up to the service point location.
- Overhead service conductors as defined in Article 100 fall under NEC requirements.

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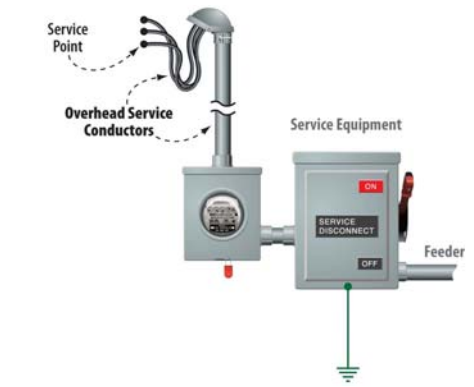


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## Article 100 Definition
## Service Conductors, Underground

- The definition of the term service lateral has been revised to clarify that a lateral is the underground conductors between the utility supply system and the service point.
- This new definition applies to service conductors that are underground and on the load side of the service point up to the service-entrance conductors of a building or structure served.
- Underground service conductors as defined in Article 100 fall under NEC requirements.

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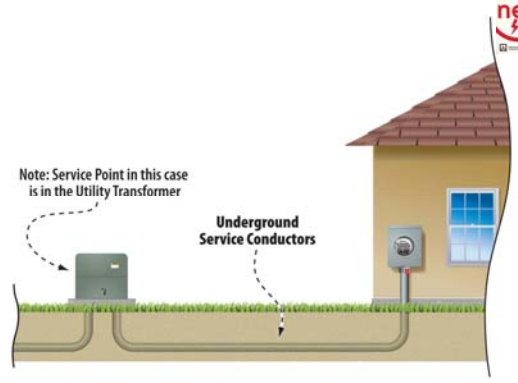


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## Article 100 Definition
## Service Drop

- The definition has been revised to clarify that service drops are always under the control and rules of the serving utility company.
- The new definition of the term overhead service conductors provides the demarcation point necessary to assist users in understanding where the NEC has application and where other rules such as the NESC apply to service installations.

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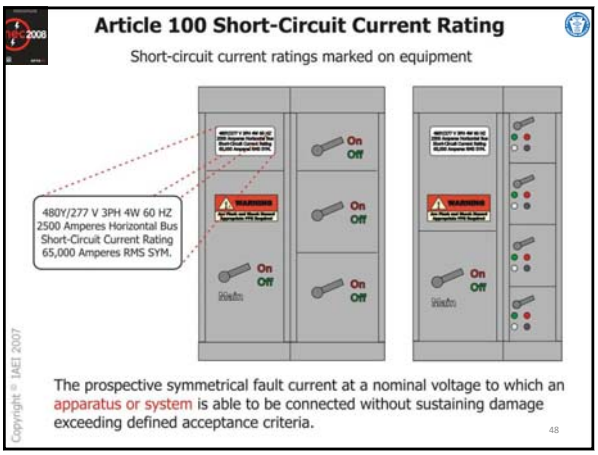

## Article 100 Surge Arrester & Surge Protective Devices (SPDs)

- The definition of "Surge Arrester" has been relocated into Article 100 from 280.2.
- The definition of Transient Voltage Surge Protector (TVSS)" is deleted in 285.2 and is replaced with a new definition of "Surge Protective Devices (SPDs)" in Article 100.

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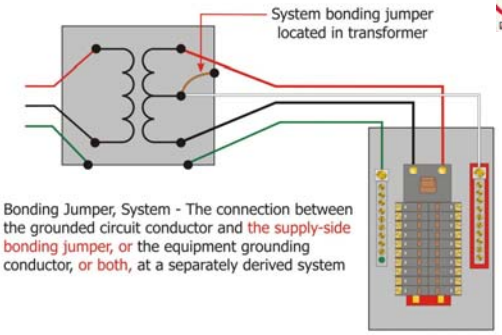
## Article 100: System Bonding Jumper




Bonding Jumper, System - The connection between the grounded circuit conductor and the supply-side bonding jumper, or the equipment grounding conductor, or both, at a separately derived system

The definition of "System Bonding Jumper" has been revised to include the new term "supply-side bonding jumper" and has been relocated to Article 100

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## Article 100 Ungrounded

Ungrounded. Not connected to ground or to a conductive body that extends the ground connection.

Typical portable generator

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## Article 100 - Definitions

- **Uninterruptible Power Supply -** A power supply used to provide alternating current power to a load for some period of time in the event of a power failure
- **Informational Note:** In addition, it may provide a more constant voltage and frequency supply to the load, reducing the effects of voltage and frequency variations

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## Article 100 Utility-Interactive Inverter & Interactive System

- The definition of "Interactive System" is relocated to Article 100 from Article 705 as it applies in Articles 690, 692 and 705.
- A new definition of "Utility-Interactive Inverter" is added to Article 100 as it applies in Articles 690, 692 and 705.

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## 110.3(A)(1) Examination of Equipment

- Information related to special conditions of equipment has been added to the Informational Note

**(A) Examination.** In judging equipment, considerations such as the following shall be evaluated:

**(1)** Suitability for installation and use in conformity with the provisions of this *Code*.

**Informational Note:** Suitability of equipment use may be identified by a description marked on or provided with a product to identify the suitability of the product for a specific purpose, environment, or application. Special conditions of use or other limitations and other pertinent information may be marked on the equipment, included in the product instructions or included in the appropriate listing and labeling information.

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## 110.11 Deteriorating Agents

- Expansion of types of equipment requiring protection from weather.
- New FPN to reference NEMA markings
- New 110.20 lists NEMA markings

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## 110.12 Mechanical Execution of Work (A) Unused Openings

- List items deleted
- The term equipment is all inclusive.
- All unused openings included, not just cable & raceway.
- Openings for mounting and ventilation of equipment excluded.

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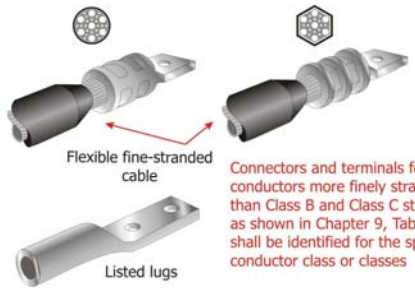
## 110.14 Electrical Connections




General requirements for terminating flexible, fine-stranded cables and conductors have been added to 110.14

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## 110.16 Flash Protection

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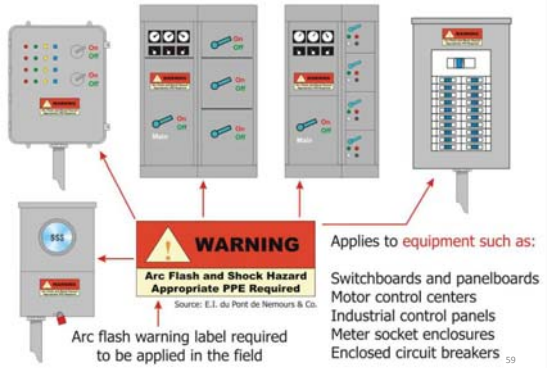
## 110.16 Flash Protection

Applies to equipment in other than dwelling occupancies

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## 110.16 Arc-Flash Hazard Warning

- The title of Section 110.16 has been changed from "Flash Protection" to "Arc-Flash Hazard Warning."
- Flash Protection is not addressed in this requirement and is addressed in NFPA 70E.
- The field marking required by this section relates to a warning of potential arc-flash hazards.
- This rule does not apply to individual dwelling units, but usually applies to services and equipment in a large building that contains multiple individual dwelling units.

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## 110.20 Enclosure Types

| For Outdoor Use | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Provides a degree of protection against the following environmental conditions | Enclosure Type Number | | | | | | | | | |
| | 3 | 3R | 3S | 3X | 3RX | 3SX | 4 | 4X | 6 | 6P |
| Incidental contact with the enclosed equipment | X | X | X | X | X | X | X | X | X | X |
| Rain, snow, and sleet | X | X | X | X | X | X | X | X | X | X |
| Sleet | - | - | X | - | - | X | - | - | - | - |
| Windblown dust | X | - | X | X | - | X | X | X | X | X |
| Hose-down | - | - | - | - | - | - | X | X | X | X |
| corrosive agents | - | - | - | X | X | X | - | X | - | X |
| Temporary submersion | - | - | - | - | - | - | - | - | X | X |
| Prolonged submersion | - | - | - | - | - | - | - | - | - | X |

| For Indoor Use | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Provides a degree of protection against the following environmental conditions | Enclosure Type Number | | | | | | | | | |
| | 1 | 2 | 4 | 4X | 5 | 6 | 6P | 12 | 12K | 13 |
| Incidental contact with the enclosed equipment | X | X | X | X | X | X | X | X | X | X |
| Falling dirt | X | X | X | X | X | X | X | X | X | X |
| Falling liquids and light splashing | - | X | X | X | X | X | X | X | X | X |
| Circulating dust, lint, fibers, and flyings | - | - | X | X | - | X | X | X | X | X |
| Setting airborne dust, lint, fibers and flyings | - | - | X | X | X | X | X | X | X | X |
| Hose-down and splashing water | - | - | X | X | - | X | X | - | - | - |
| Oil and coolant seepage | - | - | - | - | - | - | - | X | X | X |
| Oil or coolant spraying and splashing | - | - | - | - | - | - | - | - | - | X |
| Corrosive agents | - | - | - | X | - | - | X | - | - | - |
| Temporary submersion | - | - | - | - | - | X | X | - | - | - |
| Prolonged submersion | - | - | - | - | - | - | X | - | - | - |

[1]Mechanism shall be operable when ice covered.

*Reproduction of Table 110.20 (in part)*

Typical enclosures

Table 430.91 has been relocated to section 110.20.

Enclosure type designations apply to electrical enclosures beyond those for motor controller enclosures and those enclosures shall be marked.

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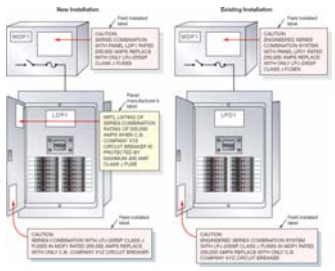
## 110.22 Identification of Disconnecting Means

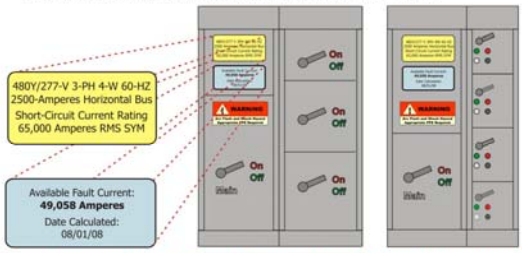



- Series rated systems selected under Engineering Supervision are now recognized in Chapter 1 for marking requirements



## 110.24 Available Fault Current

Non-dwelling unit service equipment required to be field-marked with the amount of available fault current when installed or modified




Service equipment in other than dwelling units shall be legibly marked in the field with the maximum available fault current

The field marking(s) shall include the date the fault current calculation was performed and be of sufficient durability to withstand the environment involved

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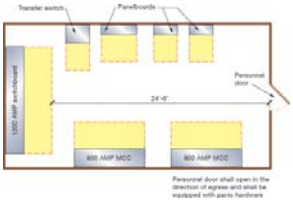
## 110.26

### Spaces About Electrical Equipment

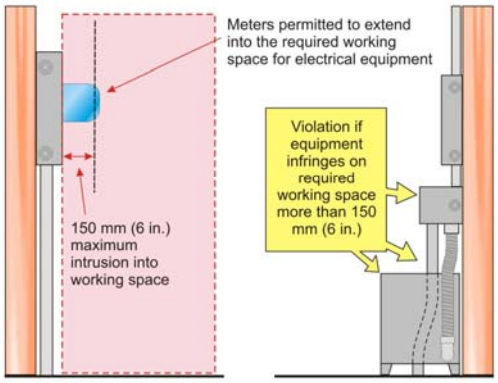
(C) Entrance to <u>and Egress From</u> Working Space




- Panic hardware is required for doors within 25-feet of the working space footprint
- Large equipment addressed in (C)(2) must be over 6-feet wide



## 110.26(A)(3), Ex. No. 2 Height of Working Space

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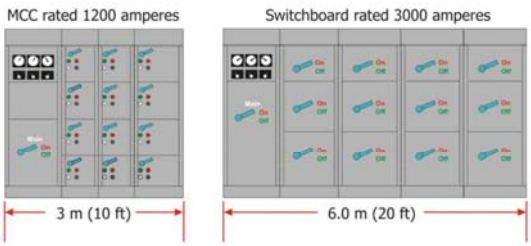
## 110.26(C)(2) Large Equipment




Large equipment rated at 1200 amperes or more and over 1.8 m (6 ft) in width requires access and egress from the working space at both ends of the equipment.

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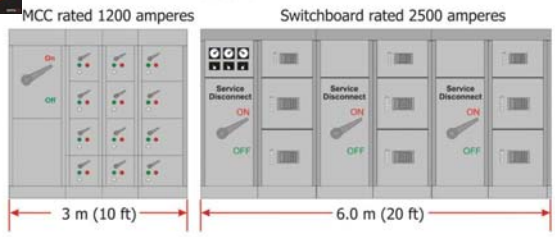
## 110.26(C)(3) Personnel Doors




Where equipment rated 1200A or more that contains overcurrent devices, switching devices, or control devices is installed and there is a personnel door(s) intended for entrance to and egress from the working space less than 7.6 m (25 ft) from the nearest edge of the working space, the door(s) shall open in the direction of egress.

The door shall be equipped with panic bars, pressure plates, or other devices that are normally latched but open under simple pressure.

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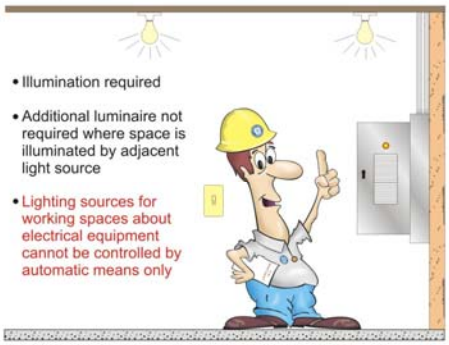
## 110.26(D) Illumination About Electrical Equipment



- Illumination required
- Additional luminaire not required where space is illuminated by adjacent light source
- Lighting sources for working spaces about electrical equipment cannot be controlled by automatic means only

Illumination shall be provided for all working spaces about service equipment, switchboards, panelboards, or motor control centers installed indoors

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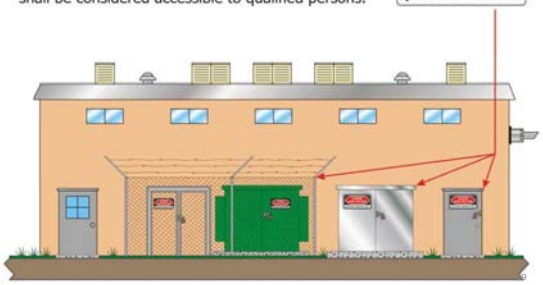
## 110.26(G) Locked Electrical Rooms or Enclosures

Locked Electrical Equipment Rooms or Enclosures.

Electrical equipment rooms or enclosures housing electrical apparatus that are controlled by a lock(s) shall be considered accessible to qualified persons.



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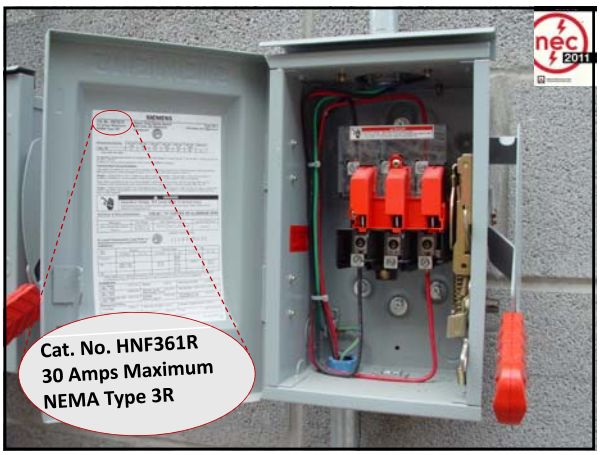
## 110.28 Enclosure Types

- List of items that are required to be marked with an enclosure-type number from Table 110.28 have been expanded
- 110.28 relocated from 110.20
- Enclosures of switchboards, panelboards, industrial control panels, motor control centers, meter sockets, enclosed switches, transfer switches, power outlets, circuit breakers, adjustable-speed drive systems, pullout switches, portable power distribution equipment, termination boxes, general purpose transformers, fire pump controllers, fire pump motors, and motor controllers shall be marked with an enclosure-type number as shown in Table 110.28

70




## 110.31(C) Outdoor Installations

- Fine Print Note referencing the National Electrical Safety Code has been deleted
- High Voltage installations on the load side of the service point are governed by the NEC

72

## 110.31 Electrical Vaults

- This section has been revised and expanded to provide a more logical layout.
- This section applies to vaults for equipment over 600 volts, including transformer vaults.
- As revised, this section now closely correlates with the transformer vault requirements in Part III of Article 450.
- By, exception, the 3-hour fire rating requirements in list items (1), (2), and (3) are reduced to 1 hour if the vault is provided with an automatic fire-suppression system.

73

## 110.33 Entrance to Enclosures and Access to Working Space

- (A) Entrance. At least one entrance to enclosures for electrical installations as described in 110.31 not less than 610 mm (24 in.) wide and 2.0 m (6 1/2 ft) high shall be provided to give access to the working space about electric equipment.
- (3) Personnel Doors. Where there is a personnel door(s) intended for entrance to and egress from the working space less than 7.6 m (25 ft) from the nearest edge of the working space, the door(s) shall open in the direction of egress and be equipped with panic bars, pressure plates, or other devices that are normally latched, but open under simple pressure.

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## 200.2 Use and ID of Grounded Conductors

- 2008 *NEC*
  - All premises wiring systems, other than circuits and systems exempted or prohibited by 210.10, 215.7, 250.21, 250.22, 250.162, 503.155, 517.63, 668.11, 668.21, and 690.41, Exception, shall have a grounded conductor that is identified in accordance with 200.6. The grounded conductor shall comply with 200.2(A) and (B).
- 2011 *NEC*
  - Grounded conductors shall comply with 200.2(A) and (B).

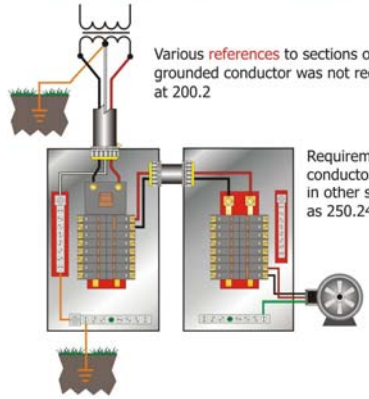
76

## 200.2(A) and (B) General

- This section no longer includes a list of multiple NEC sections.
- Requirements to included a grounded conductor with the other conductors of a circuit are addressed effectively with other rules throughout the NEC, such as 250.24(C) and 250.30.
- A new informational note refers Code users to Section 300.13(B) relative to required continuity of grounded conductors installed with feeders and multiwire branch circuits.

77

## 200.2 General Use of Grounded Conductors

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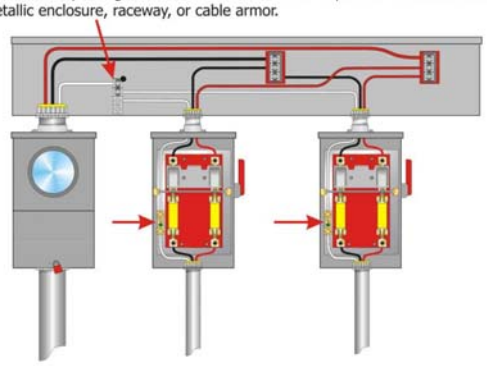
## 200.2(B) Continuity

The continuity of a grounded conductor shall not depend on a connection to a metallic enclosure, raceway, or cable armor.



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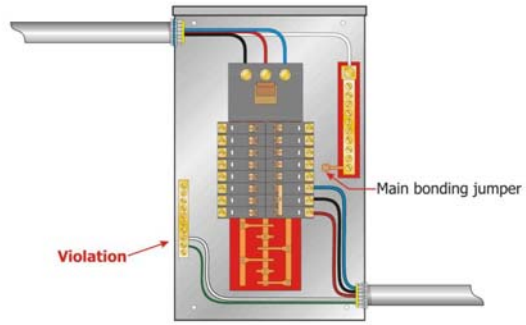
79

## 200.2(B) Continuity

The continuity of a grounded conductor shall not depend on a connection to a metallic enclosure, raceway, or cable armor.

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## 200.4 Neutral Conductors

NEW!

- This new rule prohibits using a common neutral for more than a single branch circuit, multiwire branch circuit, or for more than a single set of ungrounded feeder conductors is generally prohibited.
- The NEC generally prohibits this type of shared neutral use, except for specific installations that are covered in the Code.
- The new rule correlates with the definitions of the terms neutral conductor and neutral point.

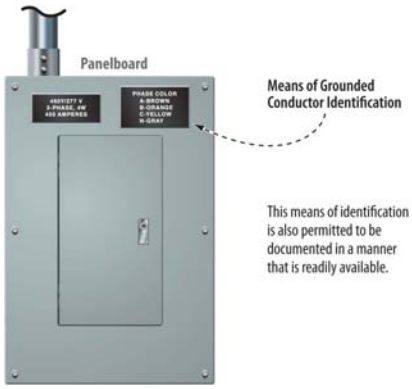
81

## 200.6(A) and (B) Means of Identifying Grounded Conductors

REVISION

- The means of posting identification now applies to equipment where the branch circuit originates and includes readily available documentation as an alternative requirement.
- Readily available documentation for identification of conductors is achievable by industrial facilities and other facilities having controlled conditions of use and operation.
- Documentation addressed in (D) should be in method that is acceptable to the AHJ.

82

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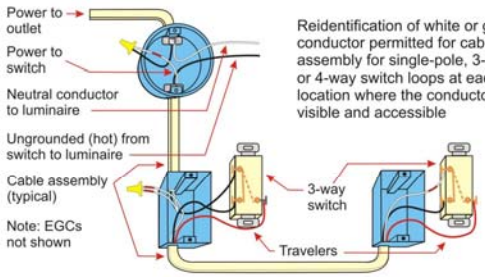
## 200.7(C)(1) Reidentifying of White/Gray Conductor




Must be permanently reidentified by marking tape, painting, or other effective means to indicate its use at its terminations

Reidentified white or gray conductors (or three continuous white stripes) must be used only for the supply to the switch - not as a return conductor from the switch to the outlet

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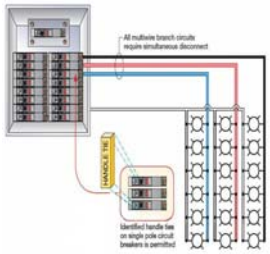
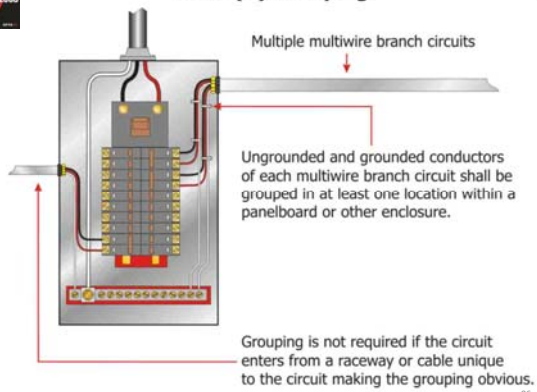
# 210.4 Multiwire Branch Circuits




- All multiwire branch circuits must originate from the same panelboard or distribution equipment
- Simultaneous means of disconnect required for all ungrounded conductors of a multiwire branch circuit

85

## 210.4(D) Grouping

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## 210.4(B) Disconnecting Means

- New informational Note refers to Section 240.15(B) and addresses use of single-pole breakers equipped with identified handle ties.
- 240.15(B)(1) – Single-pole breakers/line-to-neutral load
- 240.15(B)(2) – Single-pole breakers/line-to-line loads
- 240.15(B)(3) Two- and three-phase systems
- Multi-pole breakers meet this requirement
- 277-volt breakers are restricted from the handle tie use.

87

## 210.5(C) Ungrounded Conductors

- Where a premises wiring system is supplied by more than one nominal voltage system, each branch circuit is required to be identified by phase or line and system.
- This identification shall be used at all termination, connection, and splice points.
- The means of identification is required to be permanently posted at each branch-circuit panelboard or similar branch-circuit distribution equipment.

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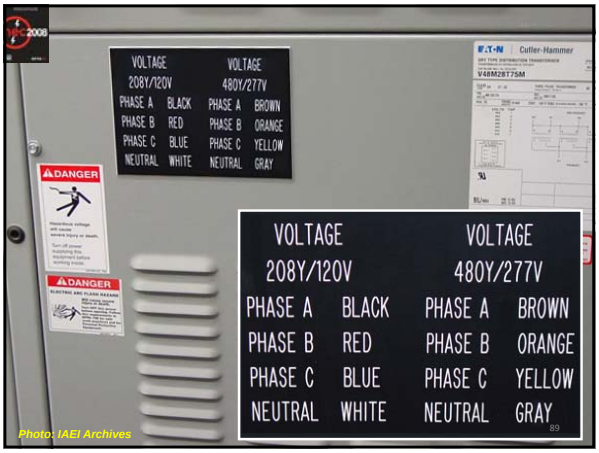


Photo: IAEI Archives

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## 210.6(C) Light-Emitting Diodes (LEDs)

- Throughout the entire NEC, listed light-emitting diode type luminaires (LEDs) are now recognized.
- This new lighting technology has been incorporated into existing Code requirements addressing luminaires as provided in Article 410.
- New LED rules are also provided in Article 600 covering electric signs and outline lighting systems.

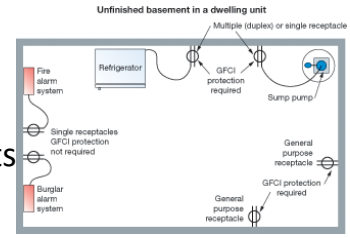
90

## 210.6(D) 600 Volts Between Conductors

- Permits luminaires powered from dc systems at voltages above 277 volts to ground and not exceeding 600 volts between conductors.

91

## 210.8(A) Dwelling Units




- All 125-volt, single-phase, 15- and 20-ampere receptacles installed in garages and unfinished basements must be GFCI protected.
- *Exception*: those supplying a permanently installed fire alarm or burglar alarm systems.
- New FPN references Article 760 prohibiting GFCI/AFCI protection of branch circuits supplying fire alarm systems.

92

## 210.8(A)(2) and (A)(5) Exceptions Deleted

- Dwelling unit GFCI Exceptions Nos. 1 and 2 to Section 210.8(A)(2) and (A)(5) have been deleted.
- Additional text added to 210.8(A)(5) indicates that any receptacles installed under the exceptions to 210.8(A)(5) shall not be considered as meeting the requirements of 210.52(G).
- Deleting the two exceptions creates consistency between the requirements in 210.8(A)(2) and 210.8(A)(7).
- The revision enhances the level of shock protection for persons where leakage levels in appliances could develop and present shock hazards.

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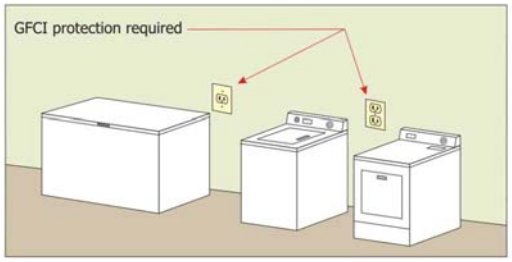
## 210.8(A)(2) & (A)(5) Exceptions No. 1 and 2 Deleted

All 125-volt, single-phase, 15- and 20-ampere receptacles in dwelling unit garages, accessory buildings, and basements are required to have ground-fault circuit-interrupter protection.




See exception to 210.8(A)(5) for a receptacle for fire alarm or burglar alarm system located in basements.

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## 210.8 Ground-Fault Circuit-Interrupter Protection for Personnel

- Dwelling Units. Ground-fault circuit interrupter devices shall be installed in a readily accessible location.
- Other than Dwelling Units. Ground-fault circuit interrupter devices shall be installed in a readily accessible location.
- GFCI devices have to be installed in a readily accessible location for ready access to test and reset functions of the device.
- The term readily accessible is defined in Article 100.

95

## 210.8 Ground-Fault Circuit-Interrupters

- All GFCIs for personnel must be installed in a readily accessible location
- This applies to 210.8(A), (B), and (C)

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## 210.8(A)(7) GFCI - Dwelling Unit Sinks

GFCI is now 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 (not just laundry, utility or wet bar sinks)

GFCI requirements for kitchen sinks still covered by 210.8(A)(6)

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## 210.8(B) Other Than Dwelling Units

- All 125-volt, single-phase, 15- and 20-ampere receptacles installed in the locations specified in (1) through (5) shall have ground-fault circuit-interrupter protection for personnel.

(1) Bathrooms
(2) Kitchens
(3) Rooftops
(4) Outdoors

See *Code* text for exceptions.



## 210.8(B)(2) "Kitchens" Other Than Dwelling Units

- All occupancies with a food preparation area meeting the definition of "kitchen" must provide GFCI protection for all 125-volt, single-phase, 15- and 20-ampere receptacles installed in the kitchen.

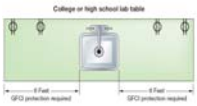


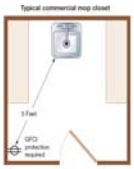
## 210.8(B)(4) Other Than Dwelling Units

- GFCI protection is required on all 15- and 20-ampere outdoor receptacles installed in the locations specified in (1) through (5).
- Exception No. 2 to (4) applies to industrial establishments only, where conditions of maintenance and supervision ensure that only qualified persons are involved, an assured equipment grounding conductor program as specified in 590.6(B)(2) shall be permitted for only those receptacle outlets used to supply equipment that would create a greater hazard if power is interrupted or having a design that is not compatible with GFCI protection.



## 210.8(B)(5) "Sinks" Other Than Dwelling Units





- All 125-volt, single-phase, 15- and 20-ampere receptacles installed within six feet from the outside edge of a nonresidential sink are required to be GFCI protected.
- Exceptions for industrial laboratories and for patient care areas of health care facilities.



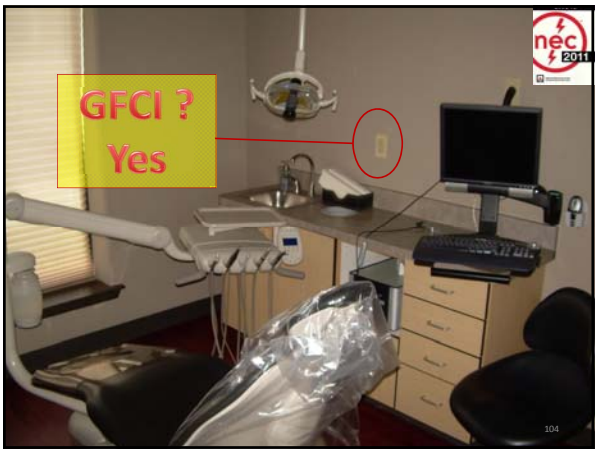
## 210.8(B)(5) Exception No. 1

- Exception No. 1 to (5): In industrial laboratories, receptacles used to supply equipment where removal of power would introduce a greater hazard shall be permitted to be installed without GFCI protection.

## 210.8(B)(5), Ex. No. 2 to(5) GFCI - Sinl

- Receptacles located around sinks at a dentist's or doctor's office or clinic do require GFCI protection
  - **(B) Other Than Dwelling Units -** All 125-volt, single-phase, 15- and 20-ampere receptacles installed in the locations specified in (1) through (8) shall have ground-fault circuit-interrupter protection for personnel
  - **(5) Sinks** — where receptacles are installed within 1.8 m (6 ft) of the outside edge of the sink
  - **Exception No 2 to (5):** For receptacles located in patient bed locations of general care or critical care areas of health care facilities other than those covered under 210.8(B)(1) *(Bathrooms)*, GFCI protection shall not be required

103

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## 210.8(B)(6) & (7)
Indoor Wet Locations and Locker Rooms with Associated Showering Facilities

REVISION

- GFCI protection requirements have been expanded to indoor wet locations in other than dwelling units.
- Receptacles installed in locker rooms with adjacent shower facilities also require GFCI protection.

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## 210.8(B)(6) GFCI - Indoor Wet Locations

GFCI protection required for all 125-volt, 15- and 20-ampere receptacl installed at non-dwelling unit indoor wet locations

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## 210.8(B)(7) GFCI - Locker Rooms

- Receptacles installed in locker rooms now require GFCI protection
  - **(B) Other Than Dwelling Units.** All 125-volt, single-phase, 15- and 20-ampere receptacles installed in the locations specified in (1) through (8) shall have ground-fault circuit-interrupter protection for personnel.
  - **(7)** Locker rooms with associated showering facilities

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## 210.8(B)(8) Garages, Service Bays, and Similar Areas

- The GFCI requirements for other than dwelling units have been expanded to include "garages, service bays, and similar areas."
- This revision is a significant expansion of the present GFCI requirement for similar areas in 511.12.
- This rule applies to areas such as buildings (other than a dwelling unit) where a vehicle can be driven in and worked on, but the building is not typically classified as a commercial repair garage.

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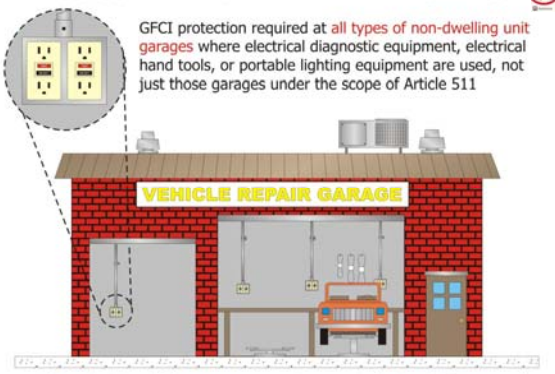
## 210.8(B)(8) GFCI Required: Non-Dwelling Garages

GFCI protection required at all types of non-dwelling unit garages where electrical diagnostic equipment, electrical hand tools, or portable lighting equipment are used, not just those garages under the scope of Article 511




125-volt, 15- and 20-ampere receptacles required to be GFCI-protected

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## 210.8(C) Boat Hoists

- GFCI protection shall be provided for outlets not exceeding 240 volts that supply boat hoists installed in dwelling unit locations.

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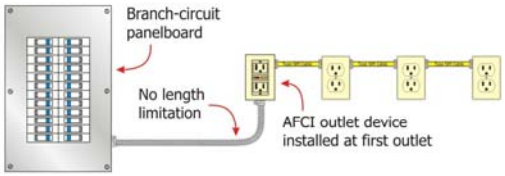
## 210.12 Arc-Fault Circuit-Interrupter Protection

- In general, all 120-volt, single phase, 15- and 20-ampere branch circuits in dwelling units shall have combination type AFCI protection.
- The exception has been modified to eliminate the 6 foot requirement for metal raceway or a cable with a metallic sheath.
- Two new Fine Print Notes provide informational references for smoke detectors and fire alarm systems.

113

## 210.12(A) Ex. No. 1 Outlet Type AFCI

Main rule at 210.12(A) requires AFCI combination-type protection installed to provide protection of the entire branch circuit




**Ex. No. 1:** If RMC, IMC, EMT, Type MC or steel armored Type AC cables meeting the requirements of 250.118 and metal outlet and junction boxes are installed for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, it shall be permitted to install a outlet branch-circuit Type AFCI at the first outlet to provide protection for the remaining portion of the branch circuit.

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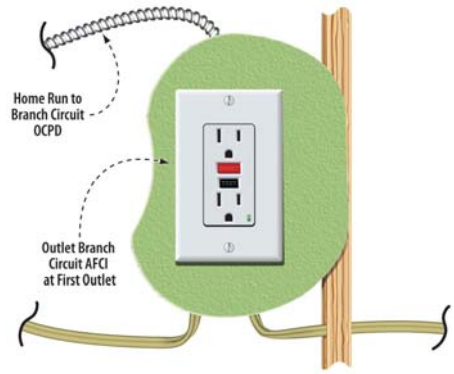
## 210.12(A) Exception Nos. 1 and 3 Arc-Fault Circuit-Interrupter Protection

- The use of type MC cable is now permitted where Exceptions No. 1 and No. 3 are applied.
- Exception No.1 has been modified to recognize the use of an outlet branch circuit type AFCI device installed at the first outlet.
- Exception No. 3 now relaxes the AFCI requirement for only an individual branch circuit installed for a fire alarm system.

115

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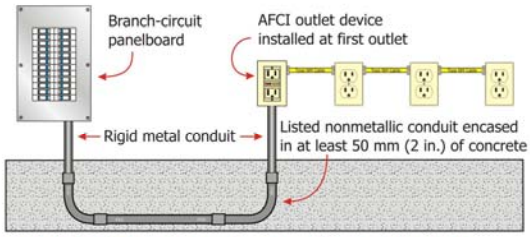
## 210.12(A) Exception No. 2 Conduit/Tubing in Concrete

- A new exception has been added to Section 210.12(A).
- The new exception permits the use of an outlet branch circuit AFCI device at the first outlet where listed metal or nonmetallic conduit or tubing is encased in not less 2 inches of concrete.
- The exception applies to the portion of the branch circuit between the overcurrent device and the first outlet in the run.

117

## 210.12(A) Ex. No. 2 Outlet Type AFCI

Main rule at 210.12(A) requires AFCI combination-type protection installed to provide protection of the entire branch circuit




**Ex. No. 2:** Where a listed metal or nonmetallic conduit or tubing is encased in not less than 50 mm (2 in.) of concrete (that portion of the branch circuit between the overcurrent device and the first outlet), it shall be permitted to install a outlet branch-circuit AFCI at the first outlet to provide AFCI protection for the remaining portion of the branch circuit

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## 210.12(B) Dwelling Units

- Dwelling Units. All 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets installed in dwelling unit family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways , or similar rooms or areas shall be protected by a listed arc-fault circuit interrupter, combination-type, installed to provide protection of the branch circuit.

5/12/2013

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## 210.12(B) Arc-Fault Circuit-Interrupter Protection

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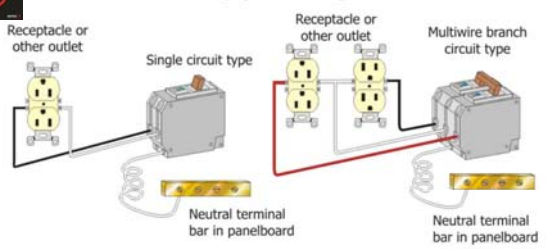
## 210.12(B) Dwelling Units




AFCI protection required for 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets installed in dwelling unit family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sun rooms, recreation rooms, closets, hallways, or similar rooms or areas.

A listed arc-fault circuit interrupter, combination-type, shall be installed to provide protection of the branch circuit.

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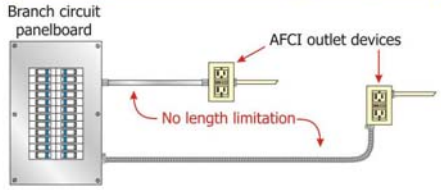
121

## 210.12(B) Exception No. 1

AFCI protection required to be a combination type January 1, 2008




Device-type AFCI protection is permitted at first outlet where the branch circuit is installed using RMC, IMC, EMT, or Type AC cable meeting the requirements in 250.118 and using metal junction and outlet boxes.

Combination-type listed AFCI device is required to be installed at the first outlet to provide protection for the remaining portion of the branch circuit.

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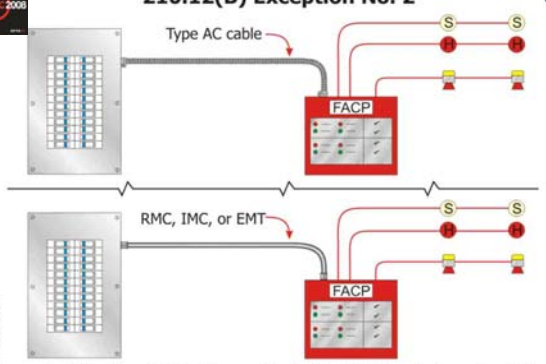
## 210.12(B) Exception No. 2




Individual branch circuit is permitted without AFCI protection where it is installed using RMC, IMC, EMT, or a Type AC cable assembly.

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## 210.12(B) Branch Circuit Extensions or Modifications – Dwelling Units

NEW!

- This new requirement applies to branch circuit extensions or modifications.
- A listed combination-type AFCI device (breaker) must be provided at the origin of the branch circuit or…
- A listed outlet branch circuit type (receptacle AFCI device) be provided at the first receptacle outlet of the existing branch circuit.

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## 210.12(B) and 406.4(D)(4) Arc-Fault Circuit-Interrupter Protection

Listed Outlet Branch-Circuit Type AFCI Device

*Courtesy of Pass & Seymour/Legrand*

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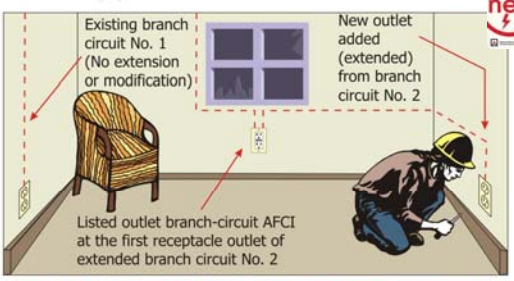
## 210.12(B) AFCI - Extensions or Modifications




In any of the areas specified in 210.12(A), 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

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## 210.19(A)(1) Exception No. 2

- Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100% of the continuous and non-continuous load.

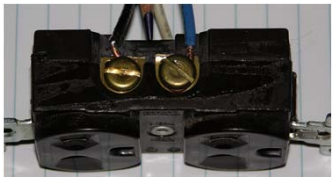
## 210.25 Branch Circuits Buildings With More Than One Occupancy

Addresses common area branch circuits in:

- two-family dwelling units
- multifamily dwelling units
- multi-occupancy buildings of all types



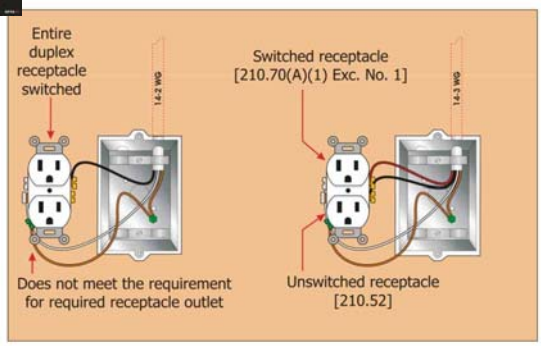
## 210.52 Dwelling Unit Receptacle Outlets



- All receptacles required shall not be:
  - part of a lighting fixture or appliance
  - controlled by a wall switch where permitted in 210.70(A)(1) Exception No. 1
  - located within cabinets or cupboards
  - located more than 5 1/ 2 ft above the floor



## 210.52 Dwelling Unit Receptacle Outlets




Switched receptacles do not count as receptacle outlets required by 210.52

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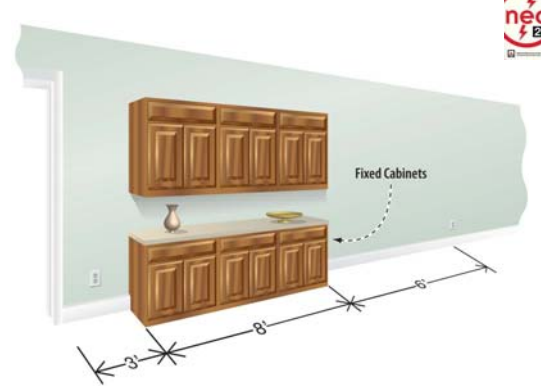
## 210.52(A)(2) Wall Space

REVISION

- New text has been added to 210.52(A)(1) to clarify that where fixed cabinets are installed, that portion of the wall space is excluded from this receptacle outlet requirement.
- This requirement includes any space 2 feet or more in width, including space measured around corners unbroken along the floor line by doorways and similar openings, fireplaces, and fixed cabinets.
- The addition of "fixed cabinets" clearly removes these spaces from the requirements of 210.52(A)(1).



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## 210.52(A)(4) Countertop Receptacles

NEW!

Receptacles installed to serve countertops in kitchens, pantries, breakfast rooms, dining rooms, and similar areas of dwelling units as required by 210.52(C) may not be counted as a receptacle when applying the rule in 210.52(A) for general wall spaces.

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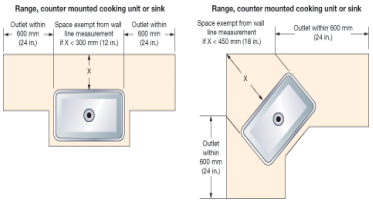
## 210.52(C) Dwelling Unit Receptacle Outlets




- The space directly behind a wall countertop mounted cooking unit or sink is exempt from the wall line measurement in 210.52(C)(1).
- The term "rangetop" has been deleted to clarify the intent which is a range, sink or counter mounted cooking-unit.
- A peninsular countertop with a range, sink or counter mounted cooking unit installed may create an island countertop.
- Expanded to include countertops in pantries, breakfast rooms and similar areas in addition to kitchens and dining rooms.

135

## 210.52(C)(5) Receptacles On or In Countertops

REVISION

- This revision will now permit a countertop receptacle to be installed on the countertop.
- Receptacle outlet assemblies that are manufactured and listed for the application are now permitted to be installed in countertops.
- A new informational note has been added to reference Section 406.5(E) which restricts receptacles from being installed in the face-up position in a countertop or similar surface.

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## 210.52(C)(5) and 210.52(D)

- Dwelling Unit Receptacle Outlet Locations:
  - Listed receptacle outlet assemblies are now permitted to be installed on or in kitchen and bathroom countertops to serve as the required countertop receptacles
  - Receptacle outlets must be located on, or above the countertop
  - Applies to countertops in bathrooms, kitchens, pantries, breakfast rooms, dining rooms, and similar areas of dwelling units
  - Receptacles shall not be installed in a face-up position in countertops or similar work surfaces *[406.5(E)]*

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## 210.52(D) Bathrooms

- The permitted location of receptacles in dwelling unit bathrooms has been expanded to include a tombstone style receptacle assembly or other method mounted directly on or in the basin countertop.
- The receptacle outlet assembly used in these applications must be listed for the application.

139

## 210.52(E) Dwelling Unit Receptacle Outlets

- Grade level receptacles are required to be accessible while standing at grade level.
- Balconies, decks and porches attached to dwelling units which are accessible from inside the dwelling shall have at least one receptacle outlet installed accessible from the balcony, deck or porch.

140

## 210.52(E)(3) Outdoor Outlets

(3) Balconies, Decks, and Porches. Balconies, decks, and porches that are accessible from the inside of the dwelling unit shall have at least one receptacle outlet installed within the perimeter of the balcony, deck, or porch.

The receptacle shall not be located more than 2.0 m (6 1/2 ft) above the balcony, deck, or porch.

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## 210.52(E) Exception to (3)

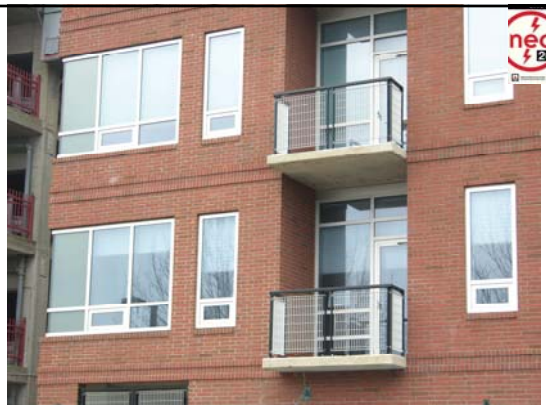
- Exception to (3): Balconies, decks, or porches with a usable area of less than 1.86 $m^2$ (20 $ft^2$) are not required to have a receptacle installed.

5/12/2013 142

## 210.52(E)(3) Balconies, Decks, and Porches

- Balconies, decks, and porches that are accessible from inside the dwelling unit required to have at least one receptacle outlet installed within the perimeter of the balcony, deck, or porch *(regardless of size)*
- Receptacle not be located more than 2.0 m (6½ ft) above the balcony, deck, or porch surface
- Exception for balconies, decks, or porches with a usable area of less than 1.86 $m^2$ (20 $ft^2$) has been deleted

143



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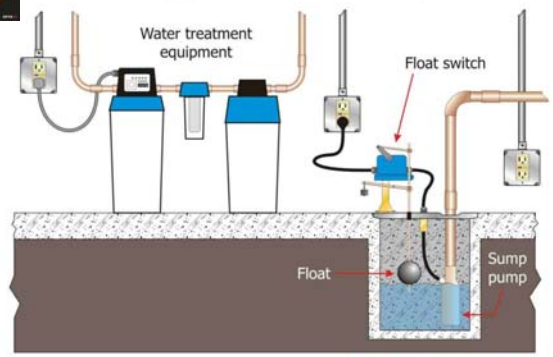
## 210.52(G) Basements, Garages, and Accessory Buildings

Accessory buildings for a one-family dwelling unit such as sheds, greenhouses, pool houses, or pole barns that are supplied with electricity are now required to have at least one receptacle outlet, in addition to those for any specific equipment installed.

145

## 210.52(G) Basements and Garages




At least one receptacle outlet shall be installed in addition to those for specific equipment.

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## 210.52(I) Foyers

Dwelling unit foyers 60 square feet or larger that are not part of a hallway will now be required to have a receptacle outlet installed in all wall spaces over 3 feet in length.

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## 210.60(A) Guest Rooms, Guest Suites, Dormitories, and Similar Occupancies

- Guest rooms or guest suites in hotels, motels, sleeping rooms in dormitories, and similar occupancies shall have receptacle outlets installed in accordance with 210.52(A) and 210.52(D).
- Guest rooms or guest suites provided with permanent provisions for cooking shall have receptacle outlets installed in accordance with all of the applicable rules in 210.52.

5/12/2013

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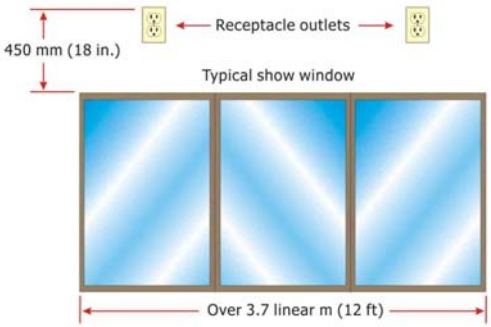
## 210.62 Show Windows

At least one receptacle outlet is required to be installed within 450 mm (18 in.) of the top of a show window for each 3.7 linear m (12 ft) or major fraction thereof measured horizontally at its maximum width.

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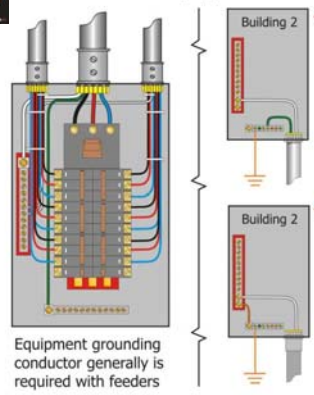
## 215.6 Feeder Equipment Grounding Conductor




250.32(B)

Grounding at separate building with equipment grounding conductor (EGC)

[All conductors not shown]

250.32(B) Exception

Grounding at separate building using grounded conductor by exception:

Existing installations only
No equipment grounding cond.
No continuous metallic paths
No supply-side GFPE

Equipment grounding conductor generally is required with feeders

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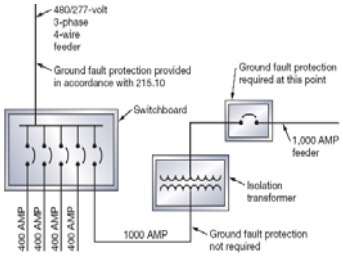
## 215.10 Ground-Fault Protection of Equipment

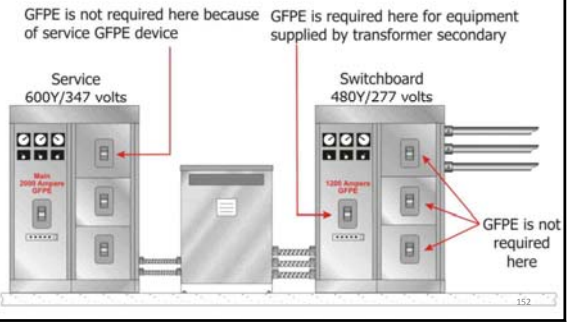



- The exception for fire pumps has been deleted. GFPE for fire pumps is prohibited in 695.6(H).
- Additional text has been added to exception No. 2 to provide clarity on the location of the GFPE.

151

## 215.10 Exception No. 2

Ground-fault protection for equipment (GFPE) is not required in feeders where it is provided on the supply side of the feeder and on the secondary of any transformer supplying the feeder.

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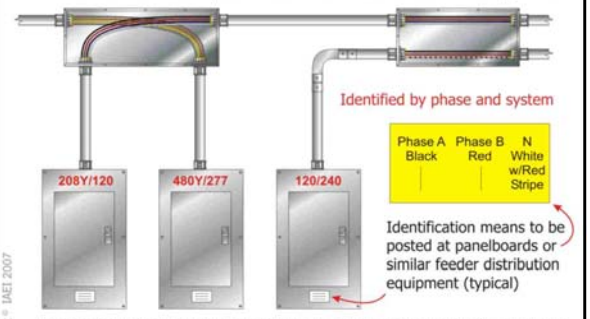
## 215.12(C) Ungrounded Conductors

Feeder identification is required where more than one nominal voltage exists




Means of identification are permitted to be by separate color coding, marking tape, tagging, or other approved means (applies to each system)

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## 220.43(B) Track Lighting

NEW!

- The calculation of feeder/service loads for track lighting in other than dwelling occupancies is now permitted to be based upon a the value of a current-limiting device in lieu of calculating at 150-va per each 2 feet of track.
- As indicated in the informational note to Section 410.151(B), this calculation rule does not limit the length of track that can be installed.

154

## 220.52 Small Appliance and Laundry Loads—Dwelling Unit

- All small appliance and laundry branch circuits installed must be included in the feeder/service load calculation.

155

## 220.82(B)(3) General Loads

(3) The nameplate rating of the following:

a. All appliances that are fastened in place, permanently connected, or located to be on a specific circuit.
b. Ranges, wall-mounted ovens, counter-mounted cooking units.
c. Clothes dryers that are not connected to the laundry branch circuit specified in (2).
d. Water heaters

Gas dryers can be connected to a laundry branch circuit without additional calculation.

5/12/2013

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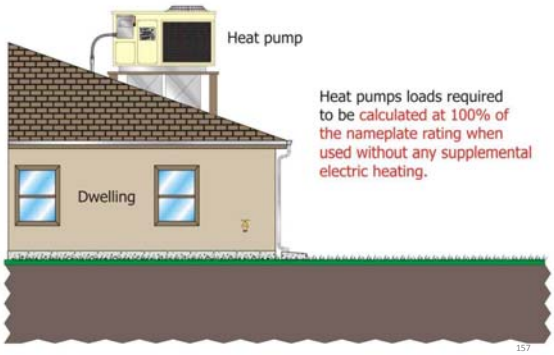
## 220.82(C)(2) Heating and Air-Conditioning Load

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## 225.7(C) 277 Volts to Ground

Deleted

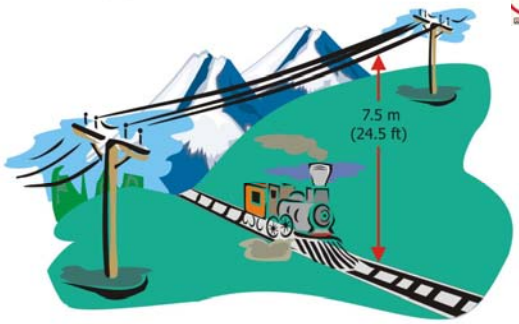
There is no longer a prohibition to mounting luminaires supplied by 208-, 240-, or 277-volt circuits less than 900 mm (3 ft) from windows, platforms, fire escapes, and the like.

## 225.18 Clearance for Overhead Conductors and Cables

- The term "Ground" is deleted in the title. This change clarifies that the clearance requirements for overhead conductors are measured from the finished or highest grade level.



## 225.18(5) Clearance for Overhead Conductors




Overhead spans of open conductors and open multiconductor cables of not over 600 volts, nominal, shall have a clearance of not less than 7.5 m (24.5 ft) over track rails of railroads

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## 225.18 Clearance of Overhead Conductors

- Overhead spans of open conductors and open multiconductor cables (not over 600 volts) shall have a clearance of not less than the following:
  - 3.0 m (10 ft) - above finished grade, sidewalks, etc. (not to exceed 150 volts)
  - 3.7 m (12 ft) - over residential property and driveways, and commercial areas not subject to truck traffic (not exceed 300 volts)
  - 4.5 m (15 ft) - areas listed in 3.7-m (12 ft) classification (voltage exceeds 300 volts to ground)
  - 5.5 m (18 ft) - over public streets, alleys, roads, etc.
  - 7.5 m (24.5 ft) - over track rails of railroads



## 225.22 Exception (deleted)

- Flexible metal conduit is no longer permitted to be used in wet locations.

Photo: IAEI Archives

## 225.27 Raceway Seal

NEW!

- This new section requires that all outdoor branch circuit and feeder raceways and spare raceways be sealed to prevent condensation and the entrance of water.
- This sealing requirement applies to the inside of the conduit containing the conductors in addition to fire sealing requirements around conduits, as may be required in Section 300.21.
- Provides consistency with the same sealing requirements currently provided in Section 230.8.

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## 225.27 Raceway Seal

A raceway seal is required at outside underground branch circuit and fee raceways entering a building

- Where a raceway enters a building or structure from an underground distribution system, it shall be sealed in accordance with 300.5(G)
- Spare or unused raceways shall also be sealed
- Sealants shall be identified for use with the cable insulation, shield or other components

Courtesy of Gardner Bender

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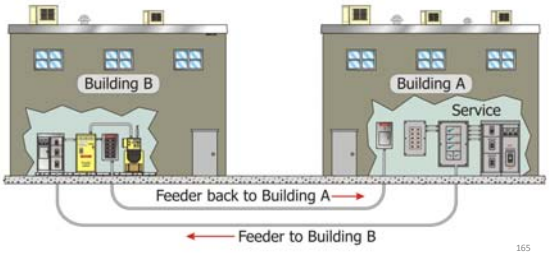
## 225.30 Number of Supplies

Where more than one building (same property, under single management) each additional building shall be supplied by only one feeder or branch circ

Where a branch circuit or feeder originates in the additional buildings, only one feeder or branch circuit is permitted to supply power back to the original building

*(See 225.30(A) through (E) for additional provisions)*

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## 225.33 Maximum Number of Disconnects

- The term "identified" is added to clarify that "handle ties" used on single pole switches or circuit breakers are intended for that function.

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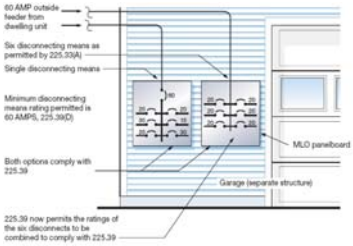
## 225.39 Rating of Disconnect




- The rating of an outside feeder or branch circuit disconnecting means is achieved by combining the ratings of multiple disconnects (not more than six) as permitted in 225.33.

167

## Article 225 – Outside Branch Circuits Feeders – Part III Over 600 Volts

- 225.50 Sizing of Conductors
- 225.51 Isolating Switches
- 225.52 Disconnecting Means
  - (A) Location
  - (B) Type
  - (C) Locking
  - (D) Indicating
  - (E) Uniform Position
  - (F) Identification

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## Article 225 – Outside Branch Circuits Feeders – Part III Over 600 Volts (cont.)

- 225.56 Inspections and Tests
  - (A) Pre-Energization and Operating Tests
    - (1) Instrument Transformers
    - (2) Protective Relays
    - (3) Switching Circuits
    - (4) Control and Signal Circuits
    - (5) Metering Circuits
    - (6) Acceptance Tests
    - (7) Relays and Metering Utilizing Phase Differences
  - (B) Test Report

169

## Article 225 – Outside Branch Circuits Feeders – Part III Over 600 Volts (cont.)

- 225.60 Clearances over Roadways, Walkways, Rail, Water, and Open Land
  - (A) 22 kV, Nominal, to Ground or Less
  - (B) Over 22 kV Nominal to Ground
  - (C) Special Cases
- Table 225.60 Clearances over Roadways, Walkways, Rail, Water, and Open Land
- 225.61 Clearances over Buildings and Other Structures
  - (A) 22 kV Nominal to Ground or Less
  - (B) Over 22 kV Nominal to Ground
- Table 225.61 Clearances over Buildings and Other Structures

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## Article 225 – Outside Branch Circuits Feeders – Part III Over 600 Volts (cont.)

- 225.70 Substations
  - (A) Warning Signs
  - (1) General
  - (2) Isolating Equipment
  - (3) Fuse Locations
  - (4) Backfeed
  - (5) Metal Enclosed and Metal Clad Switchgear

171

## 225.52(C) and (D) Locking and Indicating

NEW!

- Two new first-level subdivisions have been added to 225.52 to address disconnecting means over 600 volts.
- The new subdivisions address provisions for locking the switch and indicating the switch position.
- Section 225.52(C) requires a means to lockout the disconnecting means.
- Section 225.52(D) requires that a switch clearly indicate whether it is in the closed or open position.

172

## 225.52(E) and (F) Uniform Position and Identification

NEW!

- Two new requirements [Subdivisions (E) and (F)] have been added to Section 225.52.
- Section 225.52(E) requires a uniform position for these disconnects.
- Section 225.52(F) requires that a permanent plaque or directory be installed at the location of these disconnects where more than one feeder supplies or passes through a structure.

173

## 225.56 Inspections and Tests

NEW!

- A new section is added to require pre-energizing and operating tests for systems over 600 volts when first installed.
- Each protective, switching, and control circuit must be adjusted in accordance with the recommendations of the protective device study and tested by actual operation.
- A test report must be made available to the AHJ.

174

## 225.70 Substations

- New requirements have been added to Article 225 to address the installation of substations on the load side of the service point.
- Many of these installations are covered by the NESC or specific utility regulations, but some are not.
- This new section provides minimum requirements for substation installations that are covered by the NEC.
- The requirements include items such as general information, warning signage, fuse locations, backfeed, and so forth.

175

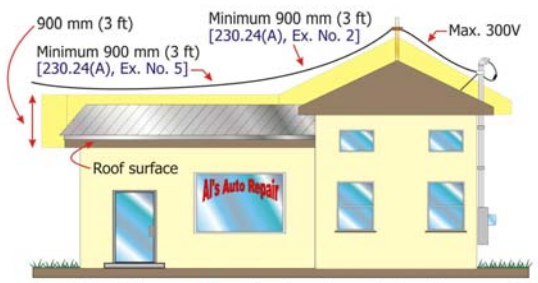
## 230.6 Conductors Considered Outside the Building

- New list item (5) clarifies that where a service mast passes through the eave of a building, the raceway and conductors are considered to be outside of the building.
- Applies only to service masts and not to service cable installations.

176

## 230.24(A) Ex. No. 5 Clearances Above Roofs

Service conductors are generally required to have a vertical clearance of not less than 2.5 m (8 ft) above the roof surface




A reduction of clearance for overhead service conductors above a roof of 900 mm (3 ft) is permitted where the roof area is guarded or isolated

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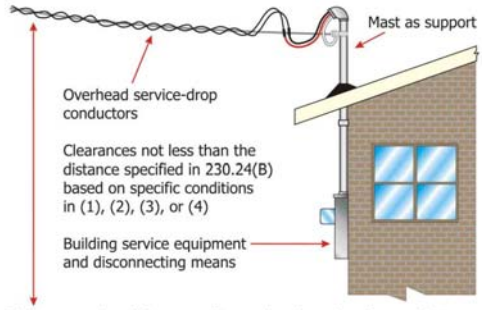
## 230.24(B) Vertical Clearance for Service-Drop Conductors




Minimum overhead clearances for overhead service-drop conductors are required from different grade levels, platforms, projections, earth, and so forth.

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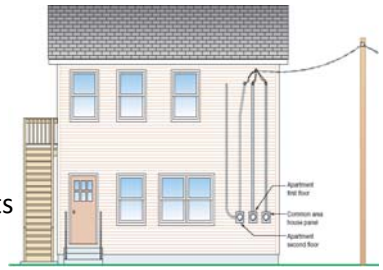
## 230.40 Number of Service-Entrance Conductor Sets



- Exception No. 1 applies to buildings with more than one occupancy, that are supplied with a single service drop or service lateral.

179

## 230.40 Exception No. 1 Number of Service-Entrance Conductor Sets

- New text has been added to 230.40 Exception No. 1.
- As revised the exception requires that where a single service supplies any number of service disconnecting means in a building with more than one occupancy, the disconnects must be marked or plaques must be located in accordance with 230.2(E).
- The marking requirement applies to all service disconnects and groups of service disconnects that might be remote from each other as permitted in 230.2(E).

180

## 230.40 Exception No. 4 Number of Service-Entrance Conductor Sets

- Exception No. 4 to 230.40 now permits a single service to supply the "house panel" required by 210.25 for multiple-occupancy buildings as well as two-family dwellings and multifamily dwellings.
- This allowance now includes multiple-occupancy buildings such as a retail building with common areas.

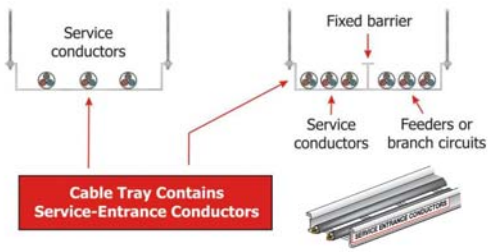
181

## 230.42(A)(1) Ex. Size and Rating of Service

- The ampacity of service-entrance conductors (before any adjustment or correction factors) shall not be less than either of the following:
  - The sum of the noncontinuous loads plus 125 percent of continuous loads
  - The sum of the noncontinuous load plus the continuous load if terminated in an overcurrent device (where both overcurrent device and assembly are listed for operation at 100 percent of their rating)
- *Exception: Grounded conductors not connected to an overcurrent device permitted to be sized at 100 percent of the continuous and noncontinuous load*

182

## 230.44 Cable Trays




Cable trays shall be identified with permanently affixed labels with the wording *Service-Entrance Conductors*.

The labels shall be located so as to be visible after installation and placed so that the service-entrance conductors may be readily traced through the entire length of the cable tray.

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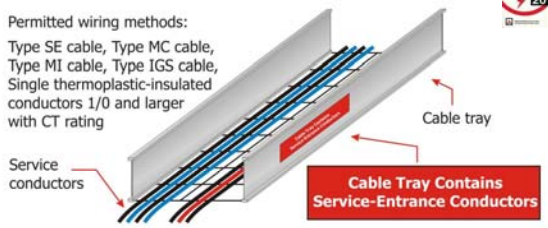
## 230.44 Cable Trays

Permitted wiring methods:

Type SE cable, Type MC cable, Type MI cable, Type IGS cable, Single thermoplastic-insulated conductors 1/0 and larger with CT rating




Cable trays containing service conductors shall be identified with permanently affixed labels with the wording ***Service-Entrance Conductors***

Labeling requirement for cable trays containing service conductors was moved from exception to mandatory language

A list of permitted wiring methods for cable trays containing service conductors was added

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## 230.50 Protection Against Physical Damage

- Sections 230.49 and 230.50 have been combined into one section and restructured to incorporate the provisions of both sections covering protection against physical damage.
- This section has also been restructured into a list format to add clarity and improve usability.

5/12/2013

185

## 230.50(B)(1) Protection Against Physical Damage

Reinforced thermosetting resin conduit Type RTRC is now recognized in new list item (5), for the protection of service-entrance conductors where they are subject to physical damage.

186

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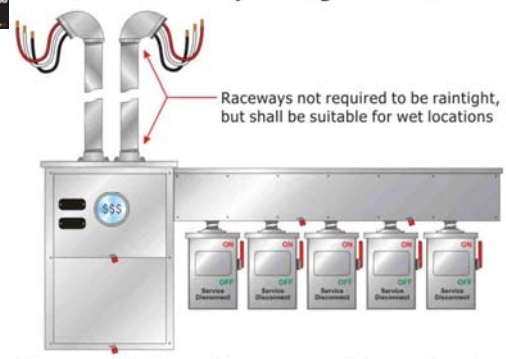
## 230.53 Raceways Arranged to Drain




Where exposed to the weather, raceways enclosing service-entrance conductors shall be suitable for wet locations and arranged to drain.

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## 230.54 Overhead Service Locations

- (A) Service Head. Service raceways shall be equipped with a service head at the point of connection to service-drop conductors. The service head shall comply with the requirements for fittings in 314.15.
- (B) Service Cable Equipped with Service Head or Gooseneck. Service cables shall be equipped with a service head. The service head shall comply with the requirements for fittings in 314.15.
- Service heads are required to be listed.



## 230.54 Overhead Service Locations

REVISION

- The newly defined term overhead service conductors has been added to provide clarity. The requirement for service heads in wet locations no longer references Section 314.15.
- Service heads (weather heads for cables or conduit systems) are required to be listed for use in wet locations.



## 230.66 Marking

REVISION

- All service equipment is now required to be listed as well as marked to identify it as being suitable for use as service equipment.
- This is a manufacturer's marking requirement in accordance with the applicable product standard.



## 230.71(A) General

- The last sentence of 230.71(A) has been structured into a list format and the words *installed as part of …and* have been added for clarity.
- 230.71(A) General. The service disconnecting means….in any one location. For the purpose of this section, disconnecting means installed as part of listed equipment and used solely for the following shall not be considered a service disconnecting means:

  (1) Power monitoring equipment
  (2) Surge-protective device(s)
  (3) Control circuit of the ground-fault protection system
  (4) Power-operable service disconnecting means

## 230.71, 230.82, and 230.94

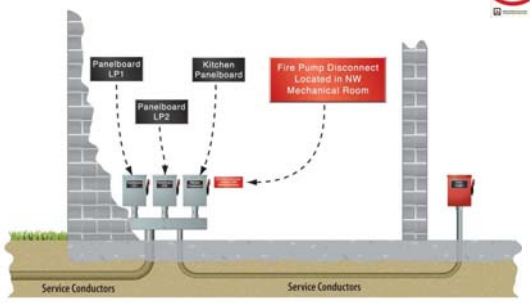
- The term *transient voltage surge suppressors* has been changed to *surge protective devices (SPDs)* in these three sections and in other sections throughout the *NEC*.
- A new definition of the term *surge protective devices* (SPDs) is included in Article 100.



## 230.72(A) Exception Grouping of Disconnects

- A new disconnecting means marking requirement is addressed in the exception.
- A plaque is required to be posted at the grouped service disconnects.
- Indicates that a service disconnect for a fire pump is remote and provides the location.



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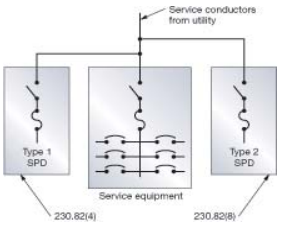
## 230.82

Equipment Connected to the Supply Side of Service Disconnect




- The term "transient voltage surge suppressors" is deleted and replaced with Type 1 or type 2 "surge protective devices."
- Reference to applicable parts of Article 250 are added with reference to meters, meter sockets and meter disconnect switches.
- Meter disconnect switches are required to be rated to interrupt the load served.



## 230.82(9) Equipment Connected to the Supply Side of Service Disconnect

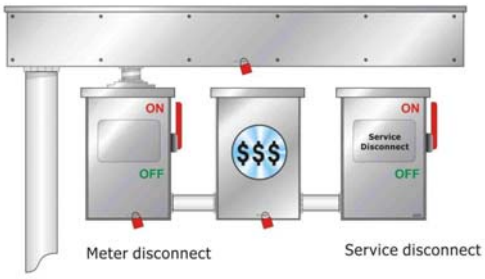
- A new list item (9) has been added to 230.82 to permit the connection of listed communications equipment on the supply side of the service disconnecting means.
- This is allowed where it is under the exclusive control of the serving electric utility and where suitable overcurrent protection and disconnecting means are provided.
- Activity related to "smart grid" installations and evolution will necessitate the use of smart meters and equipment connected on the supply-side of the utility meter.



## 230.82(3) Meter Disconnect Switches

Meter socket disconnects permitted on supply side of service under conditions

- Rated 600 volts or less
- Rated for at least the available short-circuit current
- Housings and service enclosures are grounded per 250 Part VII and bonded per 250 Part V and capable of interrupting the load served.

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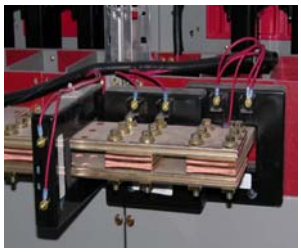
## 230.95 Ground-Fault Protection of Equipment



- The grounded conductor for the solidly grounded wye system, addressed in 230.95, shall be connected directly to ground "through a grounding electrode as specified in 250.50."

199

## 230.205(A) Location

- The service disconnecting means shall be located in accordance with 230.70.
- For either overhead or underground distribution systems on private property, the service disconnecting means shall be permitted to be located in a location that is not readily accessible.

5/12/2013 200

## 230.205(A) Location

REVISION

- This revision mandates that a readily accessible method to operate the disconnecting means be employed.
- While the disconnect is not required to be readily accessible, a means to operate the device mechanically or electronically must be readily accessible as follows:
  1. a mechanical linkage be installed and be readily accessible to allow persons to operate the switch from the pole base or
  2. the service disconnecting must be capable of being electrically operated by a readily accessible, remote control device.

201

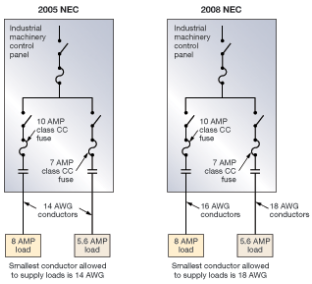
## 240.4 Protection of Conductors Informational Note

NEW!

- A new informational note has been added to 240.4 to reference ICEA P32-382 for information on allowable short-circuit currents for insulated copper and aluminum conductors.
- The informational note draws attention to the maximum short-circuit current withstand capabilities of insulated conductors.

202

## 240.4(D) Small Conductors




- Provisions for protection of 16 & 18 AWG copper conductors have been added to correlate with changes made in NFPA 79, the Electrical Standard for Industrial Machinery.

203

## 240.15 Ungrounded Conductors

- Section 240.20, covering requirements for overcurrent protection in series with ungrounded conductors and requirements for operational characteristics of circuit breakers, is relocated to Part I of Article 240 in a new Section 240.15.
- These provisions are more appropriate in Part I, which covers general requirement for overcurrent devices.
- No technical changes were made in this section, just relocated text.

5/12/2013 204

## 240.15(B) Circuit Breakers as OCP

- Revisions were made to the requirements for circuit breakers used as overcurrent devices and the use of identified handle ties
- Circuit breakers are generally required to open all ungrounded conductors manually and automatically
- For multiwire branch circuits, previous language did not require automatic opening of the circuits (common trip)
- Previous language permitted the use of identified handle ties on several systems that were excluded by the UL 489 Product Standard *(Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures)*
- Revisions will help prevent misapplication of circuit breakers, with the availability of three-pole handle ties

205

## 240.15(B) Circuit Breakers as OCP

- Circuit breakers must open all ungrounded conductors of the circuit unless otherwise permitted by the following:
  - Individual single-pole circuit breakers (with identified handle ties) of multiwire branch circuits permitted as OCP serving only single-phase line-to-neutral loads
  - In grounded systems, individual single-pole circuit breakers rated 120/240 volts ac (identified handle ties) permitted as OCP for line-to-line connected loads for single-phase circuits

206

## 240.15(B) Circuit Breakers as OCP (cont.)

- Circuit breakers must open all ungrounded conductors of the circuit unless otherwise permitted by the following:
  - For 4-wire, 3-phase systems or 5-wire, 2-phase systems, individual single-pole circuit breakers rated 120/240 volts ac (identified handle ties) permitted as OCP if the systems have a grounded neutral point and the voltage to ground does not exceed 120 volts
  - Individual single-pole circuit breakers rated 125/250 volts dc (identified handle ties) permitted as OCP for 3-wire, direct-current circuits supplied from a system with a grounded neutral where the voltage to ground does not exceed 125 volts

207

## 240.15(B)(1) and (2) Circuit Breaker as Overcurrent Device

REVISION

- The reference to 210.4(B) has been deleted in 240.15(B)(1) because 210.4(B) now requires all multiwire branch circuits to have a simultaneous disconnect and 240.15 addresses protection requirements.
- The permission for protection of a multiwire circuit without handle ties has been deleted, and the requirements of 240.15(B)(2) have been clarified to apply only to single-phase AC 120/240-volt circuits.

208

## 240.15(B)(3) 3-Phase and 2-Phase Systems and 3-Wire DC Systems

REVISION

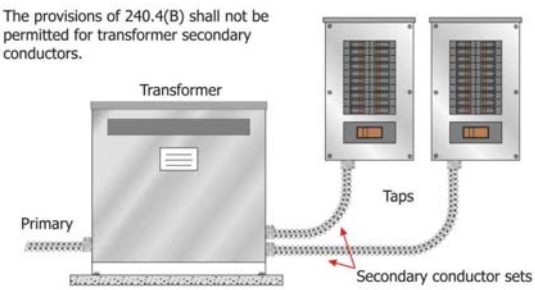
- The use of an identified handle tie on individual single-pole circuit breakers in a 3-phase system is now limited to single-pole circuit breakers rated 120/240 volts AC in systems with a voltage-to-ground not exceeding 120.
- Application of individual single pole circuit breakers rated 125/250 volts DC in 3-wire DC systems with a grounded neutral is now permitted with identified handle ties.

209

## 240.21(C) Transformer Secondary Conductors

Each set of conductors feeding a single load, or each set of conductors feeding separate loads are required to meet the requirements specified in 240.21(C)(1) through (6).

The provisions of 240.4(B) shall not be permitted for transformer secondary conductors.

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210

## 240.21(C)(2) Transformer Secondary Conductors Not Over 3 m (10 ft) Long

- The minimum size conductor requirements apply only to conductors installed in the field which leave the enclosure or vault.

211

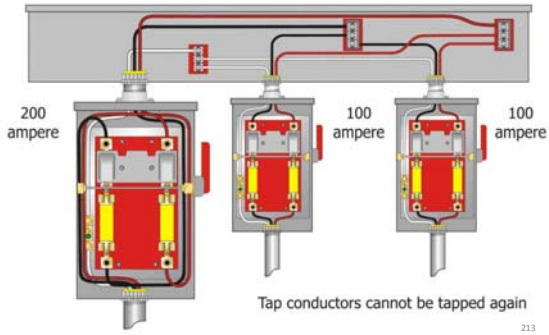
## 240.21(B)(1) FPN and 240.21(C)(2) FPN

- The fine print notes to each of these sections have been revised to correlate with revisions in 408.36 that remove references to lighting and appliance branch-circuit panelboards and power panelboards.
- FPN: For overcurrent protection requirements for panelboards, see 408.36

5/12/2013 212

## 240.21 Location in Circuit

Conductors supplied under the provisions of 240.21(A) through (H) shall not be permitted to supply another conductor except through an overcurrent protective device in accordance with 240.4.

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## 240.21(B)(1) and (C)(2) FPNs

- The Fine Print Notes (FPNs) to Sections 240.21(B)(1) and 240.21(C)(2) have been revised and simplified for correlation with Article 408.
- 240.21(B)(1) FPN: For overcurrent protection requirements for panelboards, see 408.36.
- 240.21(C)(2) FPN: For overcurrent protection requirements for panelboards, see 408.36.

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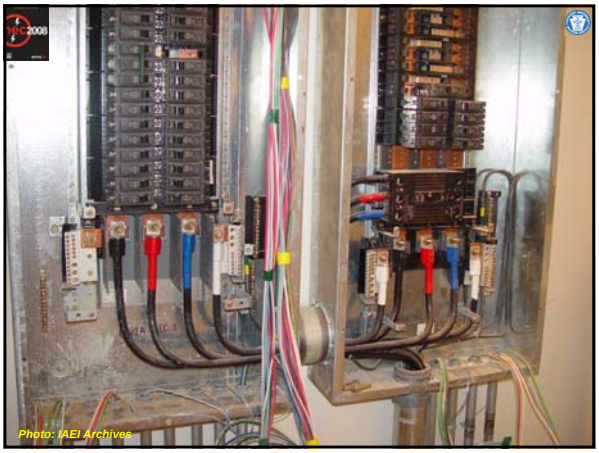



## 240.21(C)(2)(4) Transformer Secondary Conductors

- For field installations where the secondary conductors leave the enclosure or vault in which the supply connection is made, the rating of the overcurrent device protecting the primary of the transformer, multiplied by the primary to secondary transformer voltage ratio, shall not exceed 10 times the ampacity of the secondary conductor.
- This requirement clearly applies to transformer secondary conductors that leave an enclosure or transformer vault.

5/12/2013 216

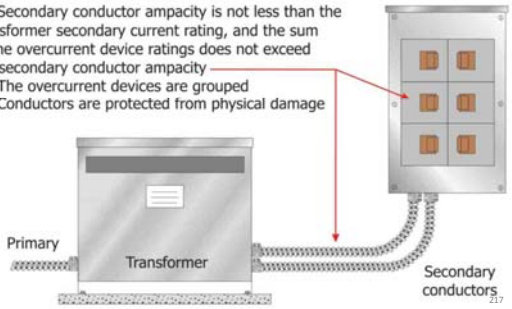
## 240.21(C)(3) Industrial Installation Secondary Conductors Not Over 7.5 m (25 ft) Long

(1) Conditions of maintenance and supervision ensure only qualified persons service the installation

(2) Secondary conductor ampacity is not less than the transformer secondary current rating, and the sum of the overcurrent device ratings does not exceed the secondary conductor ampacity

(3) The overcurrent devices are grouped

(4) Conductors are protected from physical damage

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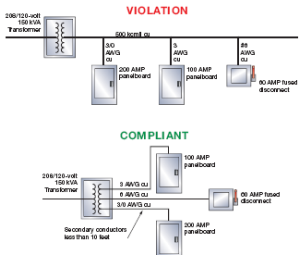
## 240.21 Location in Circuit



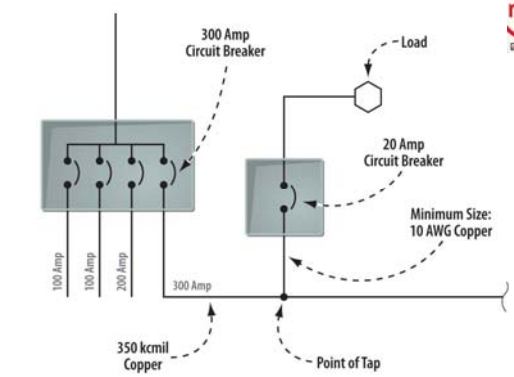

- 240.21 is editorially revised to clarify that it is prohibited to "tap a tap."

218

## 240.21(B)(1) Taps Not Over 3 m (10 ft) Long

- The prescriptive text of this section to determine the minimum size of the tap conductor has been simplified.
- Four requirements in list format are provided in this subdivision.
- List item (4) governs the minimum size for tap conductors and now correlates with the text in 240.21(B)(2)(1).

219

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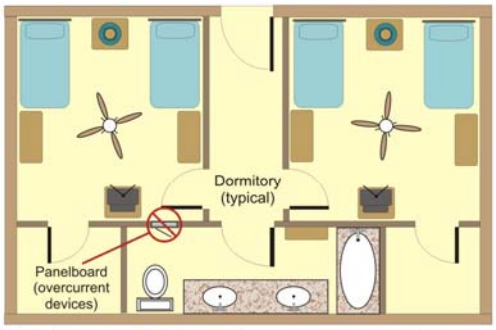
220

## 240.24(E) Not Located in Bathrooms

The prohibition of overcurrent devices in bathrooms has been extended to bathrooms in dormitories.

221

## 240.24(E) Overcurrent Devices-Not in Bathrooms




In dwelling units, dormitories, and guest rooms or guest suites, overcurrent devices, other than supplementary overcurrent protection, shall not be located in bathrooms

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## 240.21(H) Battery Conductors

- Location of overcurrent protection for battery conductors.



## 240.21(H) Battery Conductors

- A new subdivision (H) covering battery conductors has been added to 240.21.
- 240.21(H) Battery Conductors.
- Overcurrent protection shall be permitted to be installed as close as practicable to the storage battery terminals in a non-hazardous location. Installation of the overcurrent protection within a hazardous location shall also be permitted.



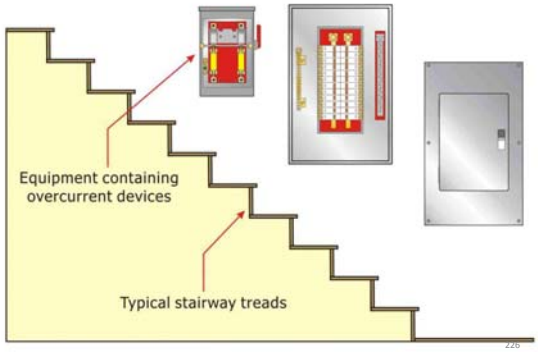
## 240.24(B) Occupancy

- The two exceptions have been rewritten into positive text and the section has been arranged to provide a more logical layout for improved clarity and application of the overcurrent device accessibility requirements.
- When electric service is provided by and continuously supervised by building management personnel, the branch-circuit overcurrent devices supplying guest rooms or guest suites without permanent provisions for cooking shall be permitted to be accessible to only authorized management personnel.



## 240.24(F) Not Located Over Steps

Overcurrent protective devices shall not be located over steps of a stairway.

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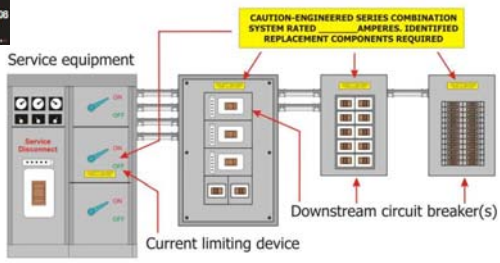
## 240.86(A) Selected Under Engineering Supervision




For calculated applications, the downstream circuit breaker(s) that are part of the series combination remain passive during the interruption period of the line side fully rated current-limiting device.

Note that Section 240.86(A) applies to existing installations only.

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## 240.87 Non-Instantaneous Trip Circuit Breaker

Where a circuit breaker is utilized without an instantaneous trip, documentation shall be available to those authorized to design, install, operate or inspect the installation as to the location of the circuit breaker(s)

Where a circuit breaker is utilized without an instantaneous trip one of the following or approved equivalent means shall be provided:

(A) Zone-selective interlocking

(B) Differential relaying

(C) Energy-reducing maintenance switching with local status indicator

New provisions were added to provide one of the three arc-flash energy reducing methods (or approved equivalent means) when power circuit breakers without instantaneous trip are used

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## 240.91 Protection of Conductors - Supervised Industrial Installations

- New provisions were added for limited "round up" conductor protection with overcurrent devices
  - rated over 800 amperes
  - in supervised industrial installations

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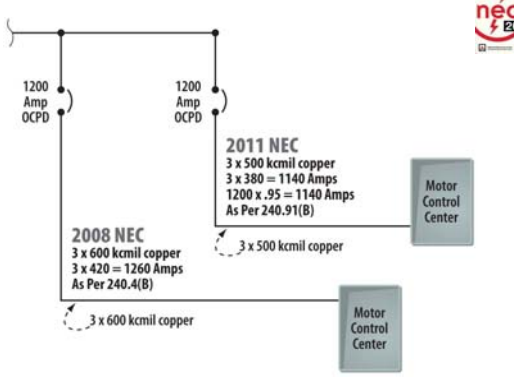
## 240.91 Protection of Conductors

NEW!

- This revision permits conductors in circuits over 800 amperes to have overcurrent protection applied above their rated capacity.
- It applies only to equipment listed and marked for this use where conductors are protected within the time/current conductor withstand ratings.
- Conductors must be sized equal to or greater than 95% of the OCPD rating.
- This allowance is limited to only supervised industrial installations covered by Part VIII of Article 240.

230

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## 240.92(B) Feeder Taps

For feeder taps specified in 240.21(B)(2), (B)(3), and (B)(4), the tap conductors shall be permitted to be sized in accordance with Table 240.92(B).

Table 240.92(B) Tap Conductors Short-Circuit Current Ratings (in part)

Tap conductors shall be considered to be protected under short-circuit conditions when their short-circuit temperature limit is not exceeded. Conductor heating under short-circuit conditions is determined by (1) or (2):

(1) Short-Circuit Formula for Copper Conductors

$(I^2/A^2)t = 0.0297 \log_{10}[(T^2 + 234)(T^1 + 234)]$

(2) Short-Circuit Formula for Aluminum Conductors

$(I^2/A^2)t = 0.0125 \log_{10}[(T^2 + 228)/(T^1 + 228)]$

*See Table 240.92(B) for complete Table and legend*

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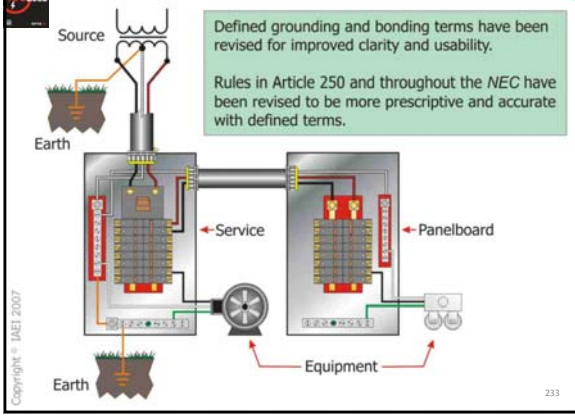
## Article 250 and *Code*-Wide Revisions

Defined grounding and bonding terms have been revised for improved clarity and usability.

Rules in Article 250 and throughout the *NEC* have been revised to be more prescriptive and accurate with defined terms.

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## 250.2 Definition: Supply Side Bonding Jumper

- New definition for "Supply Side Bonding Jumper" was added to 250.2
- SSBJ also introduced at 250.30(A)(2) for grounding of separately derived AC systems
- In the previous edition of the *Code*, the term "equipment bonding jumper" was used
- New definition of SSBJ necessary to ensure the proper identification and installation of bonding conductors installed within or on the supply side of service equipment and between the source of a separately derived system and the first disconnecting means
- Equipment bonding jumpers are installed on the load side of the overcurrent device

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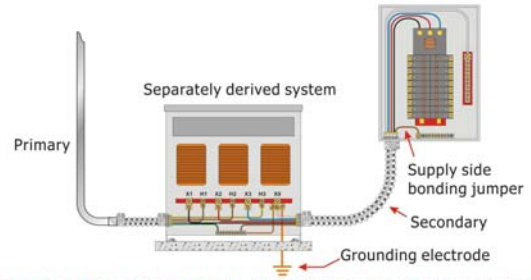
## 250.2 Definition: Supply Side Bonding Jumper




**Bonding Jumper, Supply Side -** A conductor installed on the supply side of a service or within a service equipment enclosure(s), or for a separately derived system, that ensures the required electrical conductivity between metal parts required to be electrically connected.

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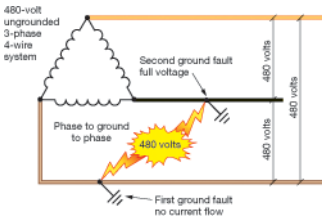
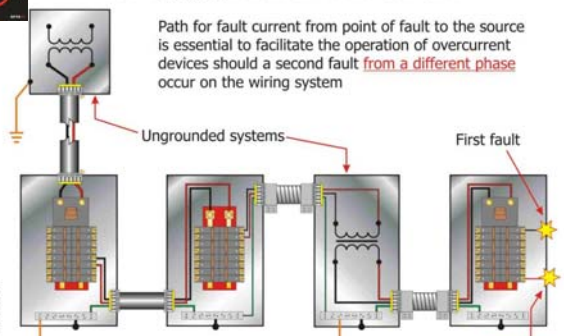
## 250.4(B) Ungrounded Systems




- Further explains a typical ground fault scenario in an ungrounded system.
- The term "permanent" is removed from this section as well as others in Article 250 where the ground fault return path is described.

## 250.4(B)(4) Path for Fault Current

Path for fault current from point of fault to the source is essential to facilitate the operation of overcurrent devices should a second fault from a different phase occur on the wiring system

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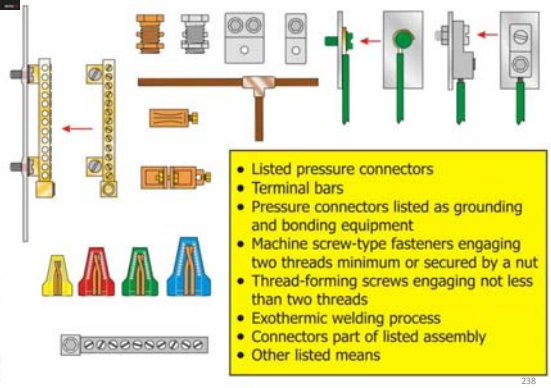
## 250.8 Grounding and Bonding Connections



- Listed pressure connectors
- Terminal bars
- Pressure connectors listed as grounding and bonding equipment
- Machine screw-type fasteners engaging two threads minimum or secured by a nut
- Thread-forming screws engaging not less than two threads
- Exothermic welding process
- Connectors part of listed assembly
- Other listed means

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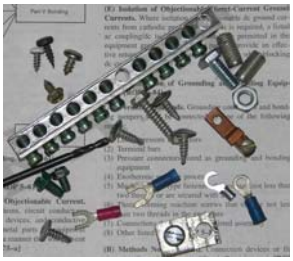
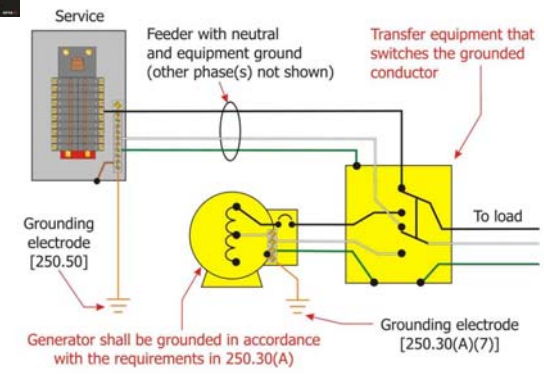
## 250.8 Connection of Grounding and Bonding Equipment



- Outlines permissible and non-permissible methods of connecting grounding and bonding equipment.
- The prohibition of sheet metal type screws is more clearly addressed with a list of permissible methods.

239

## 250.20 and FPN No. 1

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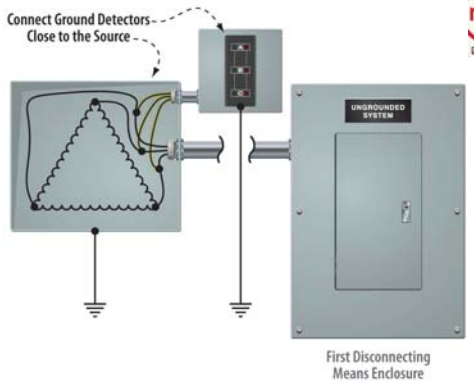
240

## 250.21(B) and (C) Ground Detectors

- Section 250.21(B) has been revised to address the sensing equipment installation location.
- The ground detector sensing equipment must be installed as close as practical to where the system receives its supply.
- A new subdivision (C) requires ungrounded systems to be marked at the source or first disconnecting means enclosure of the system.

241

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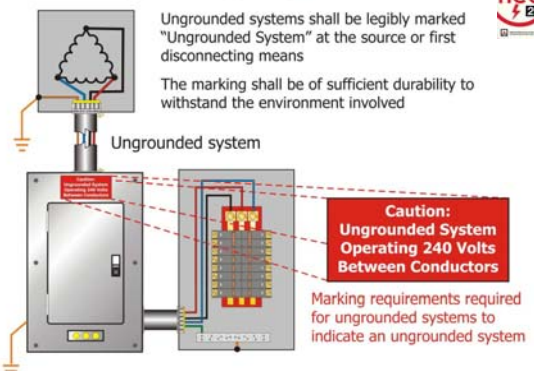
242

## 250.21(C) Marking - Ungrounded Systems

Ungrounded systems shall be legibly marked "Ungrounded System" at the source or first disconnecting means

The marking shall be of sufficient durability to withstand the environment involved

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## 250.22 Circuits Not to Be Grounded

- Requires secondary circuits of lighting systems for luminaires installed below the normal water level of a swimming pool, not be grounded.

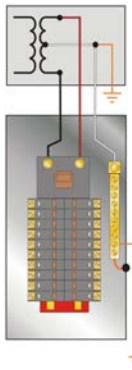
244

## 250.24(C) Grounded Conductor Brought to Service

- Rules for routing the grounded conductor at service equipment have been revised for clarity
- Requirements on routing the grounded conductor with ungrounded conductors were moved to 250.24(C) from Item (1) to clearly indicate that this routing rule applies to single or parallel raceways
- Separate sub-sections have been created for applications installed in a single raceway and conductors installed in parallel in separate raceways
- Rules for sizing grounded conductor of 3-phase systems have been located in a new Item (3)

245

## 250.24(C) Grounded Conductor Brought to Service



Grounded service conductor must be:

1. Routed with phase conductors
2. Run to each service disconnecting means
3. Connected to the grounded conductor terminal and bonded to service disconnecting means enclosure through the main bonding jumper
4. Sized no smaller than grounding electrode conductor
5. Sized at least 12½ percent of area of conductors where larger than given in Table 250.66
6. Based on equivalent area of ungrounded parallel service-entrance conductors
7. Installed in parallel where service is installed in parallel in two or more raceways
8. Must not have an ampacity rating less than the ungrounded conductor of a 3-phase, 3-wire delta service
9. Sized in accordance with minimum requirements of 220.61

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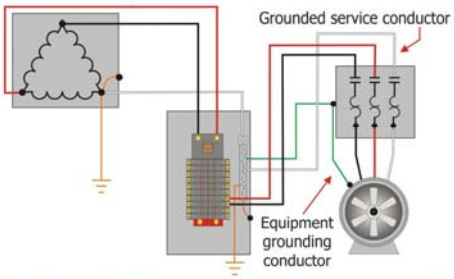
246

## 250.24(C) Grounded Conductor Brought to Service

Rules for routing the grounded conductor at service equipment have been revised for clarity




Ampacity of grounded conductor of a 3-phase, 3-wire delta service shall be not less than that of the ungrounded conductors

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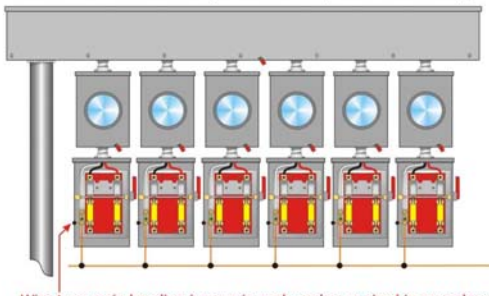
## 250.28 Main Bonding Jumper and System Bonding Jumper

- The requirements for sizing main and system bonding jumpers in 250.28(D) have been revised to address three scenarios.
  - Sizing of a single main or system bonding jumper.
  - Sizing of more than one main bonding jumper.
  - Sizing of more than one system bonding jumper.



## 250.28(D)(2) Main Bonding Jumper Size

Service with more than a single enclosure as permitted in 230.71(A)



Wire-type main bonding jumper in each enclosure sized in accordance with 250.28(D)(1) based on the largest ungrounded service conductor serving that enclosure

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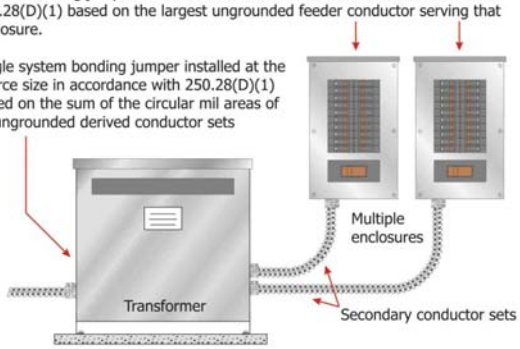
## 250.28(D)(3) System Bonding Jumper Size

System bonding jumpers in each enclosure shall be sized in accordance with 250.28(D)(1) based on the largest ungrounded feeder conductor serving that enclosure.

Single system bonding jumper installed at the source size in accordance with 250.28(D)(1) based on the sum of the circular mil areas of all ungrounded derived conductor sets

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## 250.30 Grounding Separately Derived Alternating-Current Systems

REVISION

- This section has been reorganized and revised and some technical revisions have been incorporated.
- The system bonding jumper cannot extend beyond the enclosure where it originates.
- The connection of a grounding electrode conductor tap to a common grounding electrode conductor must be made with a connector listed as grounding and bonding equipment.
- Outdoor sources require a grounding electrode connection at the source location outside the building.



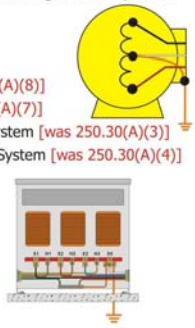
## 250.30 Grounding Separately Derived AC Systems

250.30 Grounding Separately Derived Alternating-Current Systems

(A) Grounded Systems
- (1) System Bonding Jumper
- (2) Supply-Side Bonding Jumper
- (3) Grounded Conductor [was 250.30(A)(8)]
- (4) Grounding Electrode [was 250.30(A)(7)]
- (5) GEC, Single Separately Derived System [was 250.30(A)(3)]
- (6) GEC, Multiple Separately Derived System [was 250.30(A)(4)]
- (7) Installation [was 250.30(A)(5)]
- (8) Bonding [was 250.30(A)(6)]

(B) Ungrounded Systems
- (1) Grounding Electrode Conductor
- (2) Grounding Electrode
- (3) Bonding Path and Conductor

(C) Outdoor Source



Reorganization and additions to the requirements for grounding of separately derived systems has been employed for usability and clarity

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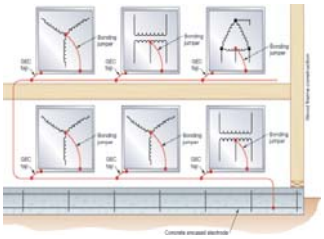
## 250.30(A) Grounded Systems

- Prescriptive requirements for terminating a grounded conductor on the load side of the "point of grounding" of separately derived systems.

253

## 250.30(A)(4) Grounding Electrode Conductor, Multiple Separately Derived Systems

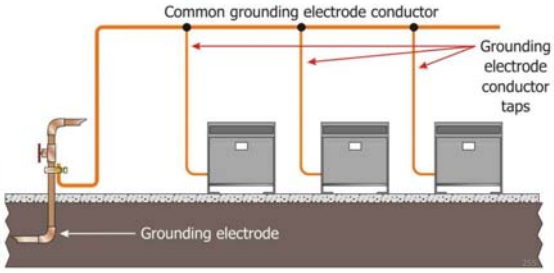


- The grounding electrode connection must be made at the same point the system bonding jumper is installed for separately derived systems installed with a common grounding electrode conductor.

254

## 250.30(A)(4) Multiple Separately Derived Systems

- Common grounding electrode conductor is required to be sized at minimum 3/0 copper or 250 aluminum.
- The grounding electrode conductor tap connection to the system is required to be located where the system bonding jumper is installed.

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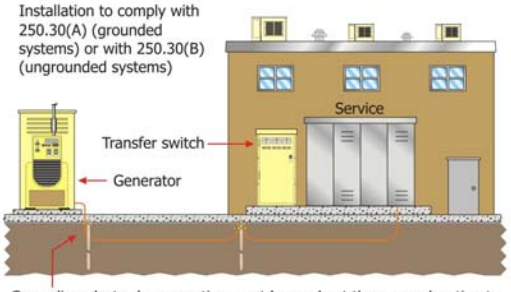
## 250.30(C) Outdoor Sources

New requirement added for grounding of separately derived systems located outside the building or structure supplied

Installation to comply with 250.30(A) (grounded systems) or with 250.30(B) (ungrounded systems)




Grounding electrode connection must be made at the source location to one or more grounding electrodes in compliance with 250.50

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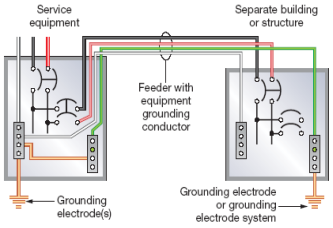
256

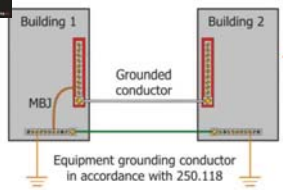
## 250.32 Buildings or Structures Supplied by Feeder(s) or Branch Circuit(s)




- The permission to use a grounded conductor as an equipment grounding conductor in a feeder or branch circuit to a building or structure has been removed. This method is now permissible in existing premises wiring systems only.

257

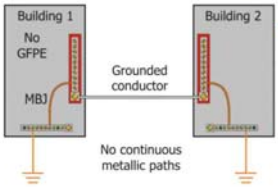
## 250.32(B) Exception




250.32(B)

Grounding at separate building or structure using the equipment grounding conductor

250.32(B) Exception




Grounding at separate building or structure using the grounded circuit conductor by exception as follows:

Existing installations only
No equipment grounding conductor
No continuous metallic paths
No supply-side GFPE

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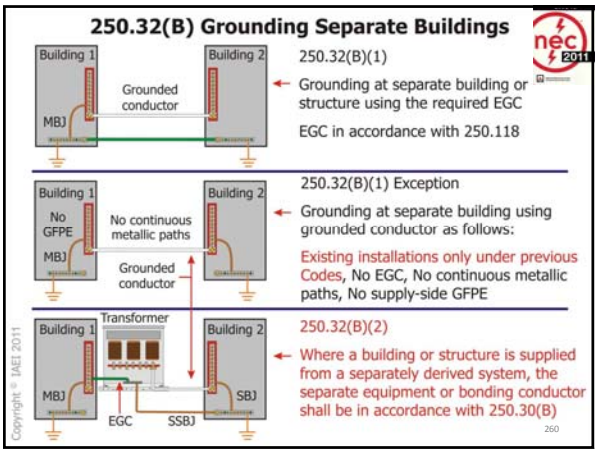
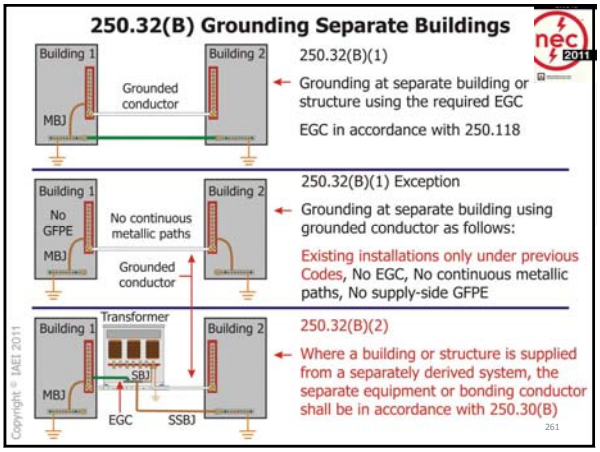
## 250.32(B) Grounded Systems

- List item (2) includes two smaller subdivisions (a) and (b) that address feeders from separately derived systems that do not have overcurrent protection and feeders from separately derived systems that are provided with overcurrent protection.
- The difference relates to sizing rules for either equipment grounding conductor or a supply-side bonding jumper.
- This results in clarification and use of either Table 250.66 (line-side sizing rules) or Table 250.122 (load-side sizing rules)

259




260

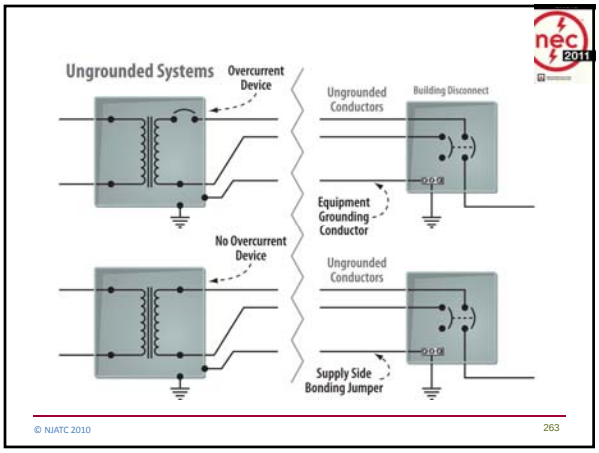



261

## 250.32(C) Ungrounded Systems

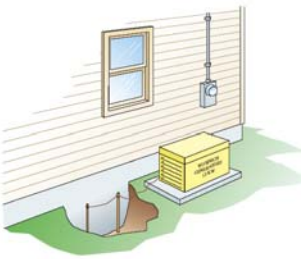
- List item (2) includes two smaller subdivisions (a) and (b) that address feeders from ungrounded separately derived systems that do not have overcurrent protection and feeders from ungrounded separately derived systems that are provided with overcurrent protection.
- The difference relates to sizing rules for either equipment grounding conductor or a supply-side bonding jumper.
- This results in clarification and use of either Table 250.66 (line-side sizing rules) or Table 250.122 (load-side sizing rules)

262



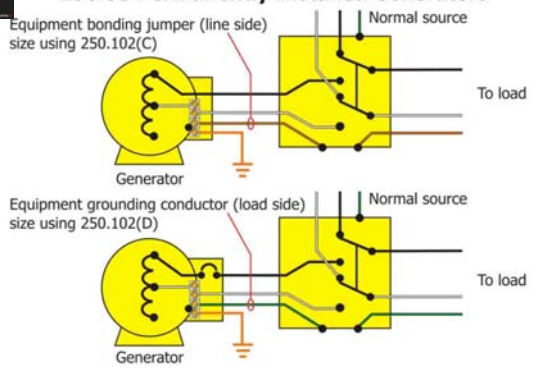

263

## 250.35 Permanently Installed Generators



- Requires an effective ground fault path from a permanently installed generator to the first disconnecting means.

## 250.35 Permanently Installed Generators




Generator separately derived systems shall be grounded in accordance with the requirements in 250.30(A).

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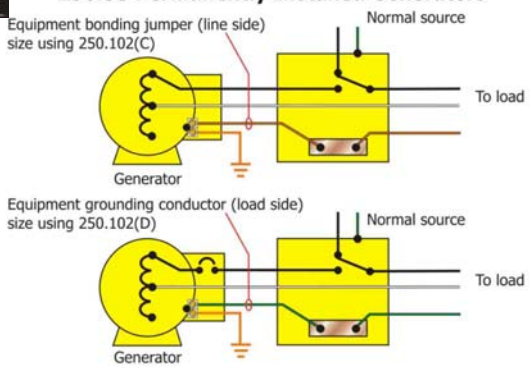
## 250.35 Permanently Installed Generators




Generator sources that are not grounded as separately derived systems.

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266

## 250.36 High-Impedance Grounded Neutral Systems

- The need for continuity of power is no longer a prerequisite for the installation of a high impedance grounded neutral system.

267

## 250.52(A)(1) Metal Underground Water Pipe

REVISION Relocate

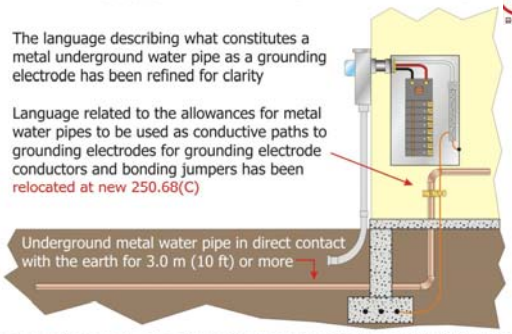
- The last sentence and the exception to this section have been relocated to a new 250.68(C).
- The description remaining in this section is now consistent with the definition of the term grounding electrode.
- Section 250.52(A) addresses grounding electrodes, not grounding electrode conductors or conductive paths (metal water piping) that connect to the grounding electrode system.

268

## 250.52(A)(1) Metal Underground Water Pipe

The language describing what constitutes a metal underground water pipe as a grounding electrode has been refined for clarity

Language related to the allowances for metal water pipes to be used as conductive paths to grounding electrodes for grounding electrode conductors and bonding jumpers has been relocated at new 250.68(C)




A metal underground water pipe in direct contact with the earth for 3.0 m (10 ft) or more and electrically continuous to the points of connection of the grounding electrode conductor and the bonding conductor(s) or jumper(s), if installed

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## 250.52(A)(2) Metal Frame of the Building or Structure

- The metal frame of a building or structure is not considered as a grounding electrode where it's connection to earth depends on a connection to an underground metal water pipe.

270

## 250.52(A)(2) Metal Frame of the Building or Structure

REVISION

- Section 250.52(A)(2) has been revised, and list items (3) and (4) have been removed and partially relocated to Section 250.68(C).
- The description remaining in this section is now consistent with the definition of the term grounding electrode.
- Section 250.52(A) addresses grounding electrodes, not grounding electrode conductors or conductive paths (metal building framing) that connect to the grounding electrode system.

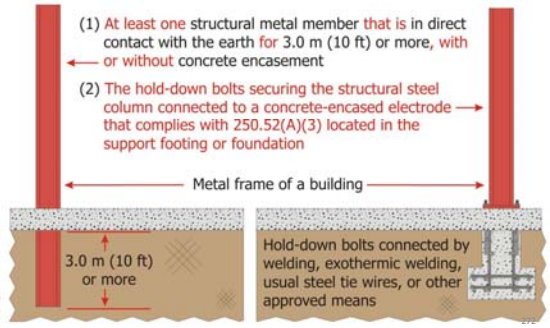
271

## 250.52(A)(2) Metal Frame of Building or Structure

The metal frame of the building permitted as grounding electrode where connected to the earth by one or more of the following methods:

(1) At least one structural metal member that is in direct contact with the earth for 3.0 m (10 ft) or more, with or without concrete encasement

(2) The hold-down bolts securing the structural steel column connected to a concrete-encased electrode that complies with 250.52(A)(3) located in the support footing or foundation

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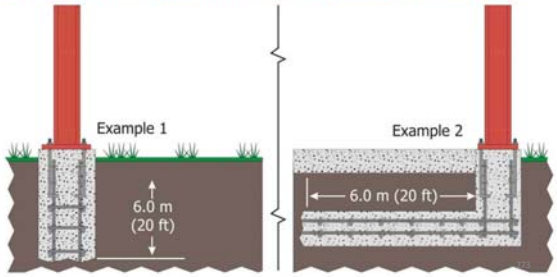
## 250.52(A)(3) Concrete-Encased Electrode

Encased by at least 50 mm (2 in.) of concrete, located horizontally near the bottom or vertically and within the portion of a concrete footing or foundation in direct contact with the earth.

Where multiple concrete-encased electrodes are present at a building or structure, it is permissible to bond one into the grounding electrode system.

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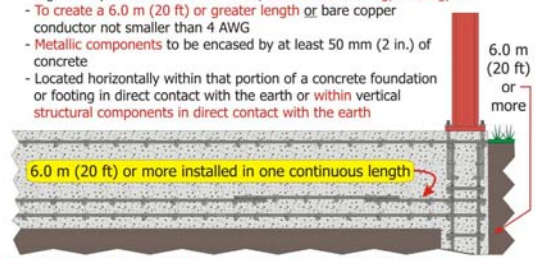
## 250.52(A)(3) Concrete-Encased Electrode

Concrete-encased electrode to consist of:

- At least 6.0 m (20 ft) of either one or more electrically conductive coated s reinforcing bars or rods of not less than 13 mm (½ in.) in diameter,
- Installed in one continuous 6.0 m (20 ft) length, or multiple pieces connected together by the usual steel tie wires, exothermic welding, welding, etc.
- To create a 6.0 m (20 ft) or greater length or bare copper conductor not smaller than 4 AWG
- Metallic components to be encased by at least 50 mm (2 in.) of concrete
- Located horizontally within that portion of a concrete foundation or footing in direct contact with the earth or within vertical structural components in direct contact with the earth




Requirements for a concrete-encased electrode to qualify as a grounding electrode has been refined for clarity

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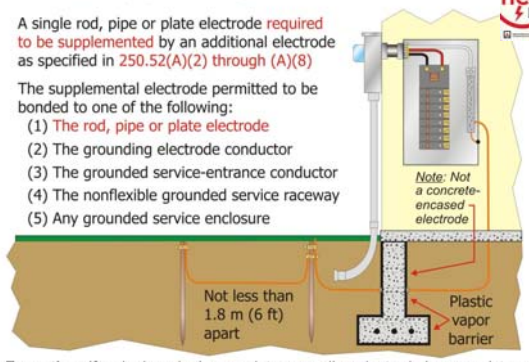
## 250.53(A) Rod, Pipe, and Plate Electrodes

A single rod, pipe or plate electrode required to be supplemented by an additional electrode as specified in 250.52(A)(2) through (A)(8)

The supplemental electrode permitted to be bonded to one of the following:

(1) The rod, pipe or plate electrode
(2) The grounding electrode conductor
(3) The grounded service-entrance conductor
(4) The nonflexible grounded service raceway
(5) Any grounded service enclosure




***Exception:*** *If a single rod, pipe, or plate grounding electrode has a resistance to earth of* ***25 ohms or less****, the supplemental electrode shall not be required*

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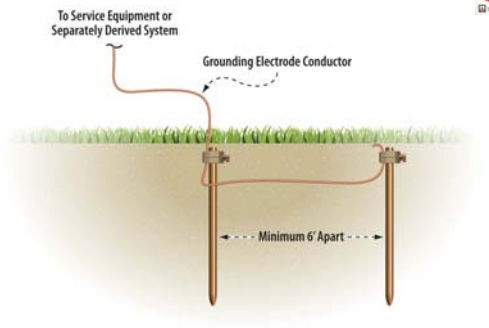
## 250.53(A)(2) Rod, Pipe, and Plate Electrodes

NEW! STOP Relocated

- A single rod, pipe, or plate electrode must be supplemented by an additional electrode of any type specified in 250.52(A)(2) through (A)(8).
- An exception still permits a single electrode that has a resistance to ground of 25 ohms or less.

276

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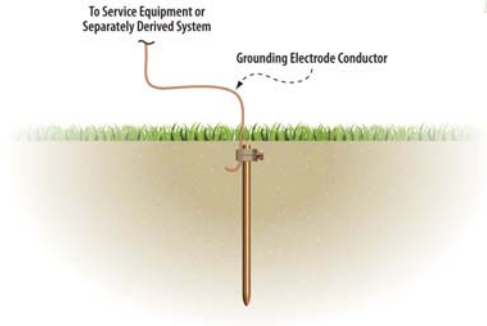


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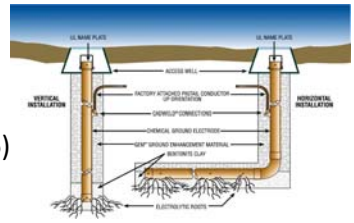
## 250.52(A)(5) Rod and Pipe Electrodes & (6) Other Listed Electrodes



- The requirements for rod and pipe electrodes are revised for clarity.
- Recognizes "other" listed electrodes which would include chemical or electrolytic type grounding electrodes.

279

## 250.52(A)(6) Other Listed Electrodes

Other listed grounding electrodes shall be permitted to be used.

Required to be listed as grounding and bonding equipment [UL 467]

*Courtesy of ERICO International*

280

## 250.54 Auxiliary Grounding Electrodes

- Where a grounding electrode is *not* required by the NEC, the term "auxiliary grounding electrode" clarifies that this electrode is not required and is installed for design purposes.

281

## 250.56 Resistance of Rod, Pipe, and Plate Electrodes

- Prohibits the metal frame of a building/structure or a concrete encased electrode from augmenting a rod, pipe or plate electrode which does not have a resistance to ground of 25 ohms or less.

282

250.64 Grounding Electrode Conductor Installation,
250.66 Size of Alternating-Current Grounding Electrode Conductor,
250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes

- New text is added to 250.64, 66 and 68 to clarify that those rules do not apply to grounding electrode conductor installations which may be installed for other reasons such as supplementary (auxiliary) grounding conductors installed for electromagnetic compatibility, lightning protection, establishing ground planes for antennas and other similar reasons.

283

## 250.64 Grounding Electrode Conductor Installation

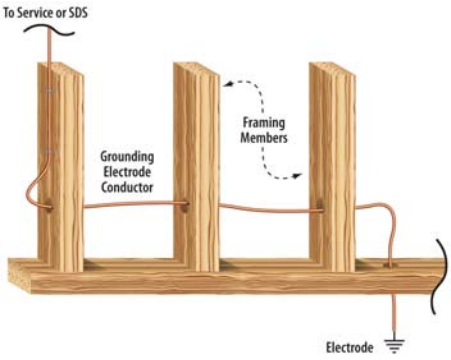
- Grounding electrode conductors shall be permitted to be installed on or through framing members.
- Ferrous metal enclosures for grounding electrode conductors must be bonded to such enclosures in accordance with one of the methods in 250.92(B)(2) through (B)(4).

284

## 250.64(B) Securing and Protection - GECs

- Where exposed, a grounding electrode conductor (GEC) or its enclosure shall be securely fastened to the surface on which it is carried
- GECs shall be permitted to be installed on or through framing members
- 4 AWG or larger copper or aluminum GEC must be protected if exposed to physical damage
- 6 AWG GEC free from exposure to physical damage permitted to be run along the surface of a building without metal covering or protection (if securely fastened to the construction)
- See 250.64(B) for list of acceptable wiring methods to provide physical protection

285

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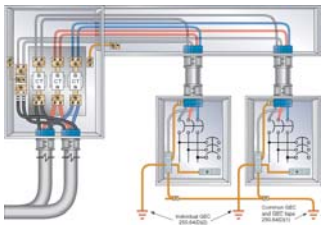
## 250.64(D) Service with Multiple Disconnecting Means Enclosures



- The installation of the grounding electrode conductor in a service with multiple disconnecting means enclosures are separated as follows:
  - (1) Grounding Electrode Conductor Taps
  - (2) Individual Grounding Electrode Conductors
  - (3) Common Location

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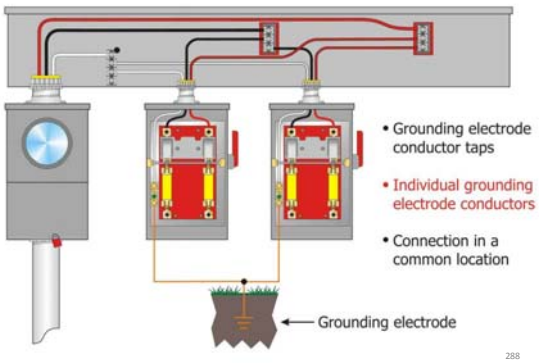
## 250.64(D) Service With Multiple Disconnecting Means Enclosures

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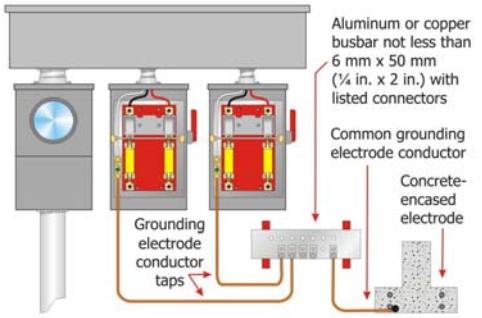
## 250.64(D)(1) GEC Installation - Multiple Disconnects

If service consists of more than one enclosure, a common grounding electrode conductor and associated tap conductors are permitted to be connected at an approved busbar

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## 250.64(F) To Electrode(s)

- Requirements for terminating bonding jumpers and grounding electrode conductors from grounding electrodes to copper and aluminum busbar are relocated here from 250.64(C).



## 250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding

- In general, "all mechanical elements," including hardware, used to terminate a grounding electrode conductor must be accessible.
- The exception for fireproofed metal has been revised to include all mechanical elements.



## 250.68 Exception No. 2

- Exception No. 2: Exothermic or irreversible compression connections used at terminations, together with the mechanical means used to attach such terminations to fireproofed structural metal whether or not the mechanical means is reversible, shall not be required to be accessible.

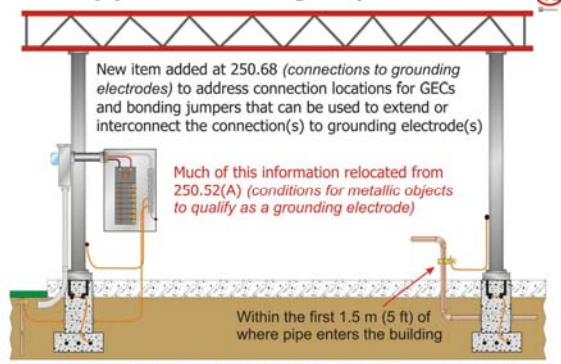
## 250.68(C) Metallic Water Pipe and Structural Metal

NEW! DETOUR AHEAD Relocate

- A new subdivision (C) titled "Metallic Water Pipe and Structural Metal" has been added to 250.68 and includes text that was removed from 250.52(A)(1) and (A)(2).
- No new technical requirements are included as part of this relocation and revision.
- The revision recognizes that structural metal building frames and metal water piping above ground are conductive paths to grounding electrodes and not grounding electrodes by definition.



## 250.68(C) GEC and Bonding Jumpers Connections




Structural metal frame of a building directly connected to a grounding electrode permitted as a bonding conductor to interconnect electrodes or as GEC

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## Slide 294

**k1** is permitted
kathryn, 9/8/2010

## 250.92(B)
## Method of Bonding at Service

- Bonding requirements were added for bonding around reducer washers at raceways containing service conductors
- Bonding jumpers must be used around impaired connections such as reducing washers or oversized, concentric, or eccentric knockouts
- Standard locknuts or bushings cannot be the only means for the bonding at services but permitted to be installed to make a mechanical connection of the raceway(s)
- Electrical continuity at service equipment, service raceways, and service conductor enclosures shall be ensured by bonding equipment to the grounded service conductor, threaded couplings or threaded hubs, bonding-type locknuts, bonding bushings, etc.

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## 250.94
## Bonding for Other Systems

- Requires an intersystem bonding termination.
- This device will be located and installed to create a dedicated and well-defined location for terminating the grounding conductors required in Articles 770, 800, 810, 820 & 830.

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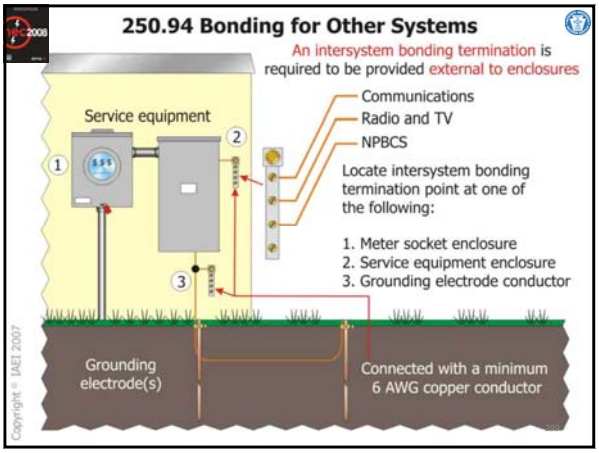


## 250.94
## Bonding for Other Systems

- Section 250.94 provides installation requirements for intersystem bonding terminations.
- This section has been restructured into a list format to improve clarity and usability.
- The revisions to this section do not affect the existing exception or the existing Informational Note No.1.
- Informational Note No. 2 has been revised to include references to grounding and bonding rules in Articles 770 and 830.

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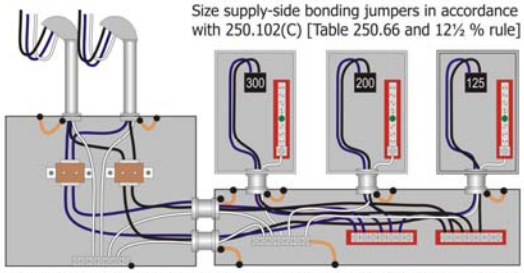
## 250.102(C) Size: Supply-Side Bonding Jumper

Sizing requirements for supply-side bonding jumpers have been revised and converted into a list format

Size supply-side bonding jumpers in accordance with 250.102(C) [Table 250.66 and 12½ % rule]




**Supply-Side Bonding Jumper:** A conductor installed on the supply side of a service or within a service equipment enclosure(s), or for a separately derived system, that ensures the required electrical conductivity between metal parts required to be electrically connected.

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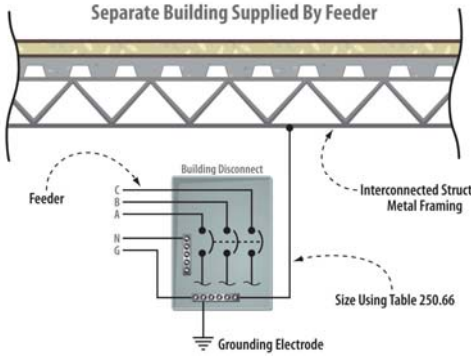
## 250.104(C) Structural Metal

REVISION

- The words "the disconnecting means for buildings or structures supplied by a feeder or branch circuit" have been added to the first sentence of 250.104(C).
- This revision clarifies that the bonding requirements for structural metal framing in buildings or structures apply whether the building is supplied by a service or a feeder(s) or branch circuit(s).



## Separate Building Supplied By Feeder

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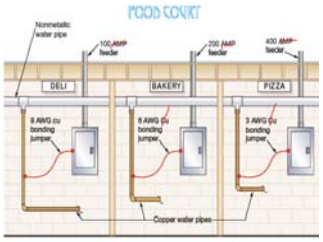
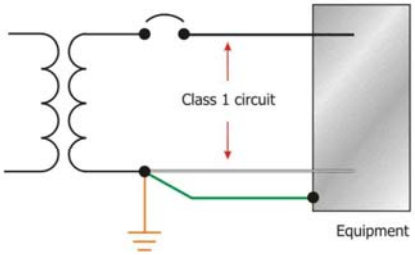
## 250.104(A)(2) Buildings of Multiple Occupancy




- Sizing of the bonding jumper specifies that the rating of the overcurrent protective device supplying the occupancy in Table 250.122 be applied.



## 250.112(I) Remote-Control, Signaling, and Fire Alarm Circuits




Equipment supplied by Class 1 circuits is required to be grounded unless the system operates at less than 50 volts.

Section 250.20(A) provides the conditions and requirements for grounding systems less than 50 volts.

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## 250.118 Types of Equipment Grounding Conductors

- A new fine print note has been added referencing the definition of *effective ground-fault current path* in 250.2.
- The words *for grounding* have been removed from 250.118(5) a. and 250.118(6) a.
- Flexible metal conduit fittings and liquidtight flexible metal conduit fittings have to be listed, not listed for grounding.
- Electrical continuity and conductivity (bonding) is addressed by the use of listed fittings required by these sections.

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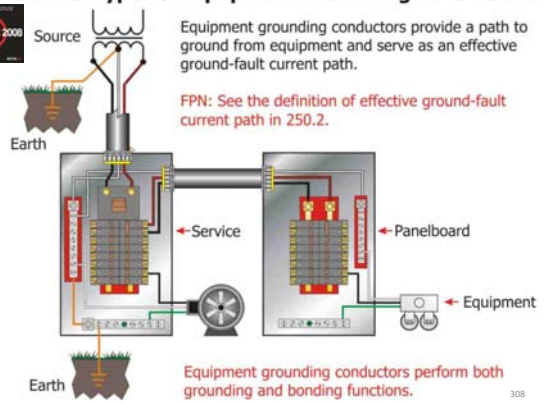
## 250.118 Types of Equipment Grounding Conductors




Equipment grounding conductors provide a path to ground from equipment and serve as an effective ground-fault current path.

FPN: See the definition of effective ground-fault current path in 250.2.

Equipment grounding conductors perform both grounding and bonding functions.

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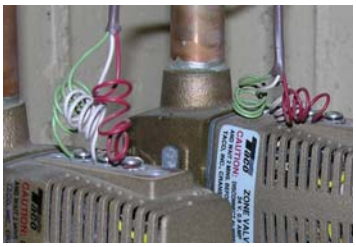
## 250.119 Identification of Equipment Grounding Conductors



- An exception is added to permit conductors with green insulation used in power limited Class 2 or Class 3 circuits operating at less than 50 volts to be used for other than equipment grounding purposes.
- The identification of equipment grounding conductors larger than 6 AWG is clarified by specifying the marking occur at the termination of the conductor.

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## 250.119 Identification of Equipment Grounding Conductors – Exception

- The significant revision in this exception is its expansion to apply to other limited energy cables, including and beyond those containing just Class 2 or Class 3 power-limited circuits.
- A conductor of these cable assemblies that is green or green with one or more yellow stripes can be used for other than equipment grounding purposes.
- This revision makes the exception current with actual practices in the field relative to manufacturing, installation, and use of these limited energy cables.

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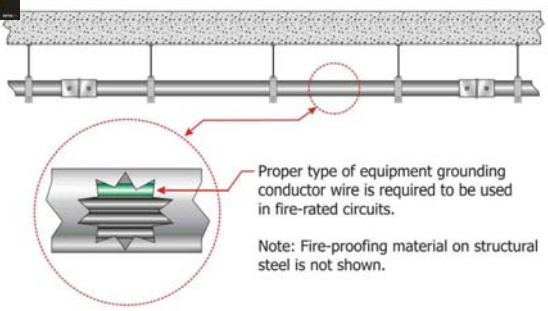
## 250.120(A) FPN



Proper type of equipment grounding conductor wire is required to be used in fire-rated circuits.

Note: Fire-proofing material on structural steel is not shown.

FPN: See the UL Guide Information on FHIT systems for equipment grounding conductors installed in a raceway that are part of an electrical circuit protective system or a fire rated cable listed to maintain circuit integrity.

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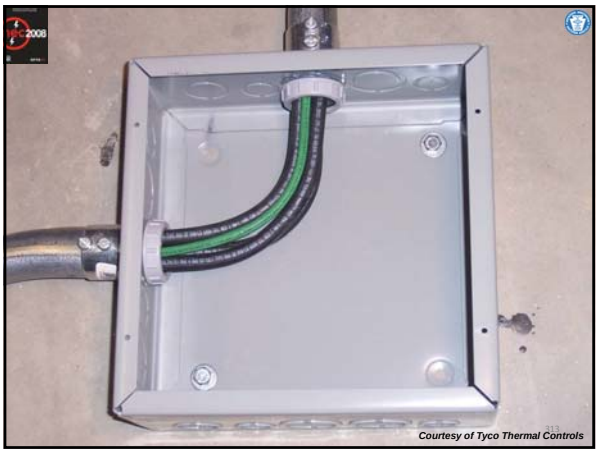
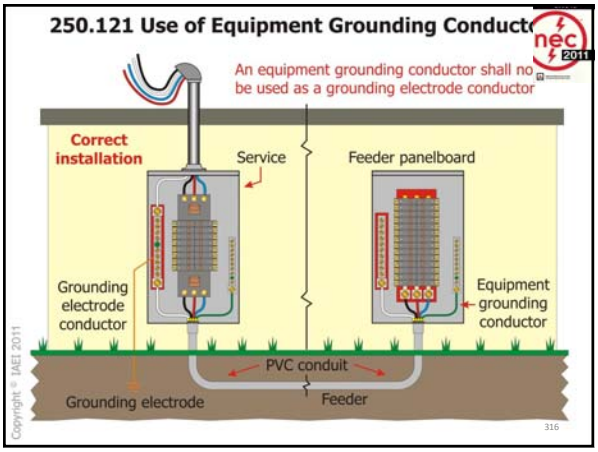
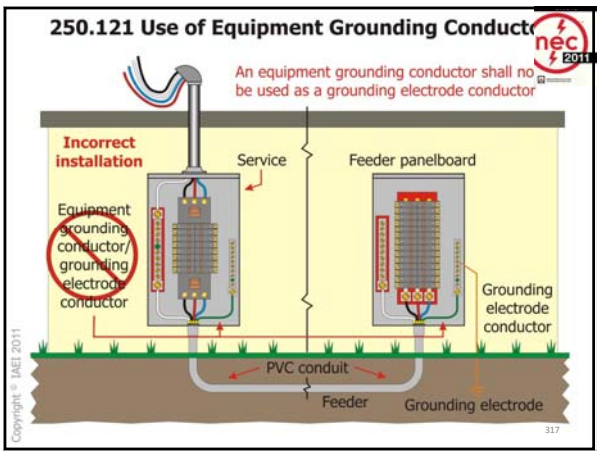


## 250.121 Use of Equipment Grounding Conductors

- A new section, 250.121 Use of Equipment Grounding Conductors, has been added to Part VI of Article 250.
- This new section clarifies that grounding electrode conductors and equipment grounding conductors serve different purposes, are sized differently, and have different installation requirements.
- Current may be present in grounding electrode conductors during normal operation while current should only be present in equipment grounding conductors in abnormal events such as a ground fault.




## Table 250.122

- Sizing requirements for wire type equipment grounding conductors is governed by 250.122 and Table 250.122
- Revision with the deletion of the “30” and “40” amperes rows in Table 250.122
- The heading above the ampere column in the table states “Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)”
- The “30” and “40” ampere figures were redundant and not needed

## Table 250.122 (in part)

Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment

| Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes) | Size (AWG or kcmil) | |
|---|---|---|
| | Copper | Aluminum or Copper-Clad Aluminum |
| 15 | 14 | 12 |
| 20 | 12 | 10 |
| ~~30~~ | ~~10~~ | ~~8~~ |
| ~~40~~ | ~~10~~ | ~~8~~ |
| 60 | 10 | 8 |
| 100 | 8 | 6 |
| 200 | 6 | 4 |
| 300 | 4 | 2 |
| 400 | 3 | 1 |
| 500 | 2 | 1/0 |
| 600 | 1 | 2/0 |

Note: Where necessary to comply with 250.4(A)(5) or 250.4(B)(4), the equipment grounding conductor shall be sized larger than given in this table.

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## Table 250.122

- The sizing requirement of an aluminum equipment grounding conductor for circuit conductors protected by a 4000-ampere rated overcurrent device was revised
- The minimum size for this aluminum equipment grounding conductor was changed from 800 kcmil to 750 kcmil
- A 500 kcmil copper conductor and a 750 kcmil aluminum conductor with equivalent insulation are equally capable of carrying the same fault current
- 750 kcmil aluminum conductors are a more common industry standard size than 800 kcmil

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## Table 250.122 (in part)

Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment

| Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes) | Size (AWG or kcmil) | |
|---|---|---|
| | Copper | Aluminum or Copper-Clad Aluminum |
| 800 | 1/0 | 3/0 |
| 1000 | 2/0 | 4/0 |
| 1200 | 3/0 | 250 |
| 1600 | 4/0 | 350 |
| 2000 | 250 | 400 |
| 2500 | 350 | 600 |
| 3000 | 400 | 600 |
| 4000 | 500 | 750 |
| 5000 | 700 | 1200 |
| 6000 | 800 | 1200 |

Note: Where necessary to comply with 250.4(A)(5) or 250.4(B)(4), the equipment grounding conductor shall be sized larger than given in this table.

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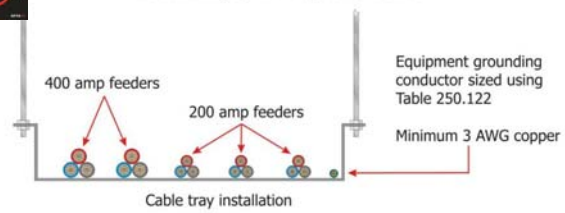
## 250.122(C) Multiple Circuits




A single equipment grounding conductor is permitted for multiple circuits installed in the same cable tray.

The equipment grounding conductor shall be sized based on the rating of the largest overcurrent device protecting the conductors in the tray.

Equipment grounding conductors installed in cable trays shall also meet the requirements in 392.3(B)(1)(c).

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## 250.122(D) Motor Circuits

- Provides specific guidance to determine adequate sizes of equipment grounding conductors for motor installations.

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## 250.122(F) Conductors in Parallel

- List item (2) has been deleted from this section. The remaining text has been editorially adjusted.
- The ground-fault protection for equipment previously addressed in this section is intended to protect electrical equipment, not equipment grounding conductors in raceways or cable assemblies.

## 250.122(F) Conductors in Parallel

- A new second sentence has been added 250.122(F). The last sentence of this section has been revised to refer to all of 250.122 rather than just the table.
- The revision clarifies that a single equipment grounding conductor can be installed in a cable tray that contains multiple sets of conductors installed to create a single feeder.
- The sizing requirements are based on Section 250.122.

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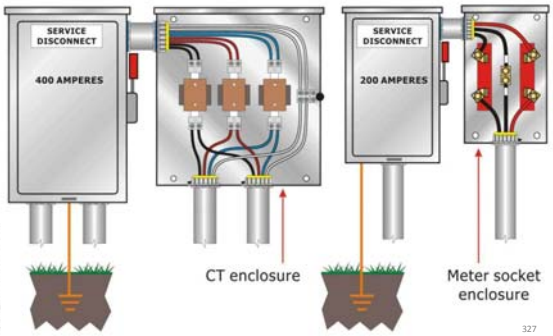
## 250.142(B) Exception No. 2 (2)

Exception No. 2(2) applies to all metering equipment enclosures including CT enclosures and meter socket enclosures.

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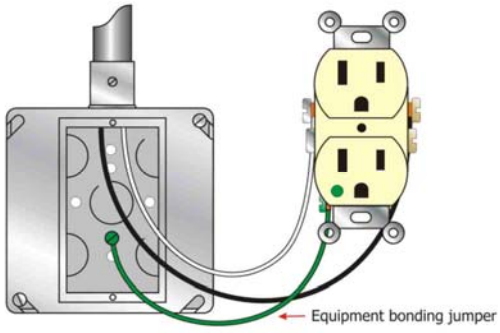
## 250.146 Connecting Grounding Terminal to Box




Equipment bonding jumper is sized based on the branch-circuit overcurrent device rating using Table 250.122.

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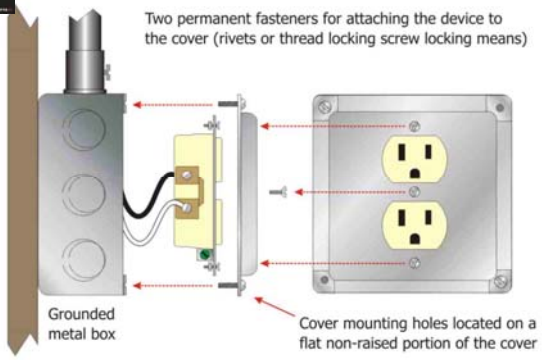
## 250.146(A) Surface-Mounted Box

Two permanent fasteners for attaching the device to the cover (rivets or thread locking screw locking means)




Listed exposed work cover is permitted as the grounding and bonding means

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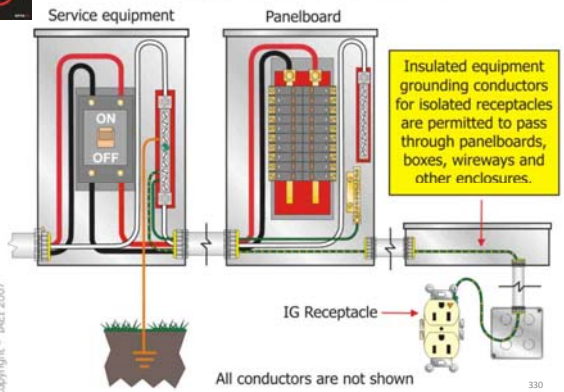
## 250.146(D) Isolated Receptacles




All conductors are not shown

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## 250.166
Size of Direct-Current Grounding Electrode Conductor

- The requirements for sizing grounding electrode conductors for DC systems have been clarified. The provisions of 250.166(A) or (B) shall apply unless an electrode of the types listed in 250.166(C), (D) or (E) are installed.

331

## 250.168
Direct Current System Bonding Jumper

- Where a DC system is to be grounded, a system bonding jumper is required

332

## 250.190 Grounding of Equipment

REVISION

- This revision expands this rule to include requirements for equipment grounding conductor use, sizing, and connections.
- Cable shielding is not permitted as an equipment grounding conductor unless it is rated for the clearing time settings of the protective relay for the circuit.

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## 250.190
Grounding of Equipment (cont.)

- This section has been revised to clarify that cable copper screen or ribbon shield or combination of both is not to be used as an equipment grounding conductor unless it is rated for the ground fault current.
- The revision clarifies when separate equipment grounding conductors must be installed with circuits of 1000 volts and greater.

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## 250.191
Grounding System at AC Substations

NEW!

- A new Section has been added to Part X and addresses substation grounding systems and requires the grounding system to be in accordance with Part III of Article 250.
- Many ac substations are now covered by NEC rules rather than the NESC or other utility regulations.
- The new informational note provides a reference to ANSI/IEEE 80-2000, IEEE Guide for Safety in AC Substation Grounding.
- IEEE 80 is commonly used in substation grounding design.

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## Article 280 Surge Arresters, Over 1 kV

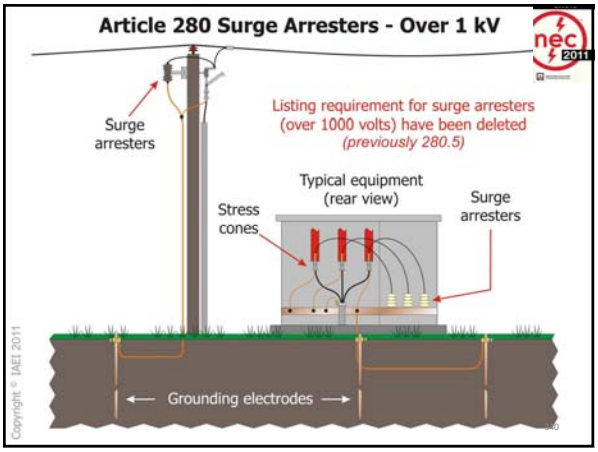
- Article 280 has been significantly revised limiting application to surge arrestors over 1 kV.



## Articles 280 Surge Arresters

- Article 280 was revised to cover surge arresters over 1000 volts and restructured to provide uniformity with revisions to UL 1449 *Standard for Surge Protective Devices*.
- The definition of the term *surge arrester* was relocated to Article 100.
- Other revisions throughout the *Code* where surge arresters are covered by rules such as those in Articles 100, 230, 250, 280, 285, 501, and 502.





Article 285
Surge
Protective
Devices (SPDs)
1kV or less

- Article 285 has been given a new title, "Surge Protective Devices (SPDs) 1kV or less"
- Expands application up to 1 kV

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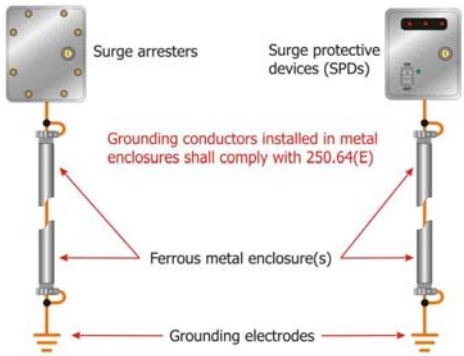
## 280.25 and 285.25 Grounding Conductor Connections and Enclosures

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## Article 285 Surge Protective Devices (SPDs)

- The title and scope of Article 285 have been revised, along with various requirements within the article.
- Other revisions throughout the *Code* where surge protective devices (SPDs) are covered by other *NEC* rules such as those in Articles 100, 230, 250, 280, 285, 501, and 502 and so forth.
- Transient voltage surge suppressors are now identified by the *NEC* as *surge protective devices* (SPDs).
- A new definition of the term *surge protective devices* (SPDs) is provided in Article 100.

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