

## National Electrical Code® 2011

- Presentation based on the 2011 edition of the National Electrical Code®
- Other editions of the NEC® may be in effect in your jurisdiction
- The electrical inspector can enforce only the latest edition of the NEC® that has been legally adopted in their jurisdiction



*Courtesy of NFPA*

## Presenter: Phil Simmons

- Member NEC CMP-5 (Acting Chair 1999 NEC), previously on CMP-1, CMP-19 (Chair), CMP-17
- Past IAEI International President (1987) and Executive Director
- Past Chief Electrical Inspector State of Washington
- Master Electrician and former electrical contractor
- Author of several authoritative books including:
  - Electrical Grounding and Bonding (Delmar 2004, 2007 and 2010)
  - Electrical Wiring Commercial and Electrical Wiring Residential (Delmar 2010)
  - Significant Changes in 2005 NEC (Delmar 2004)
  - Soares Grounding and Bonding (IAEI)

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## Simon Sez



- The NEC doesn't say what you say it sez!
- The NEC doesn't say what I say it sez!
- The NEC says what it sez!
- Read it again!

## *Objectives*

- Review definitions related to “Services” from Article 100 of NEC®
- Review requirements related to installing services in compliance with the Article 230 of the NEC®.
- Ask a few questions
- Answer a few questions!

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## *Some Issues*

- Several terms are not defined and the AHJ must interpret the rules
  - “Enhanced reliability” in 230.2(A)(6)
  - “Large buildings” in 230.2(B)(2)
  - “Nearest the point of entrance” in 230.70(A)(1)
  - What a “Location” means in 230.71(A)
  - How far away for “remote” service disconnecting means in 230.72(B)

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## ***First Things First!***

- What's covered by the NEC [90.2(A)]
  - Most everything related to the electrical installation!
- What's not covered by the NEC [90.2(B)(5)(a)]
  - ... service drops or service laterals, and associated metering ...

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## ***90.2(B)(5) Not Covered.***

- (5) Installations under the exclusive control of an electric utility where such installations
- a. Consist of service drops or service laterals, and associated metering, or
  - b. Are on property owned or leased by the electric utility for the purpose of communications, metering, generation, control, transformation, transmission, or distribution of electric energy, or

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## **90.2(B)(5) Not Covered.**

- (5) Installations under the exclusive control of an electric utility where such installations
- c. Are located in legally established easements, or rights-of-way, or
  - d. Are located by other written agreements either designated by or recognized by public service commissions, utility commissions, or other regulatory agencies having jurisdiction for such installations. These written agreements shall be limited to ...

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From the "Small" (temporary construction service) ...



... to the large 2, 69 kV Services





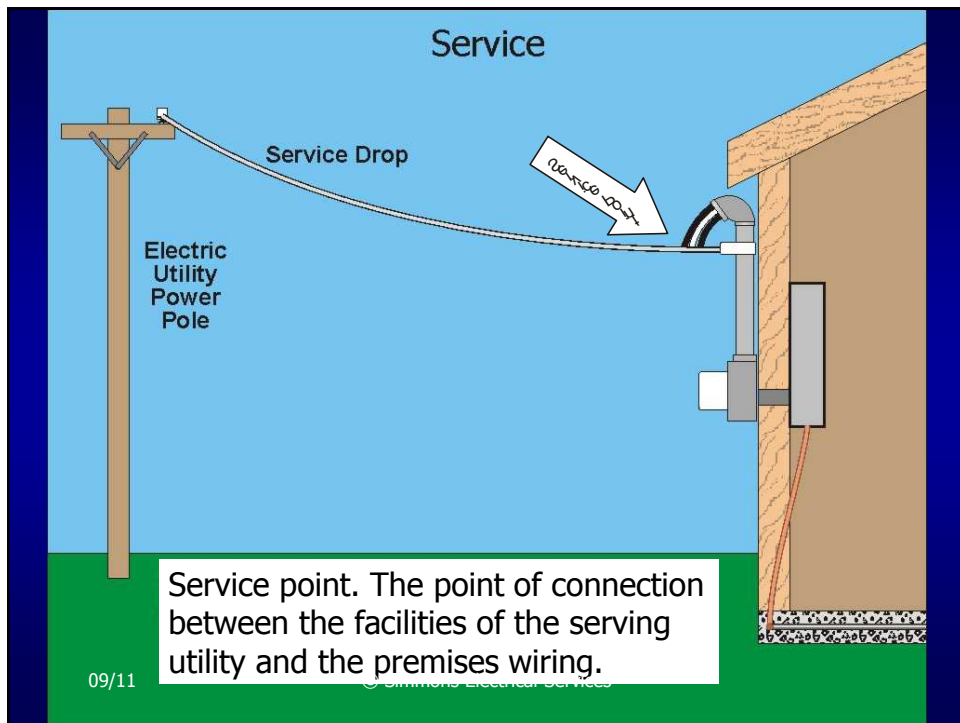
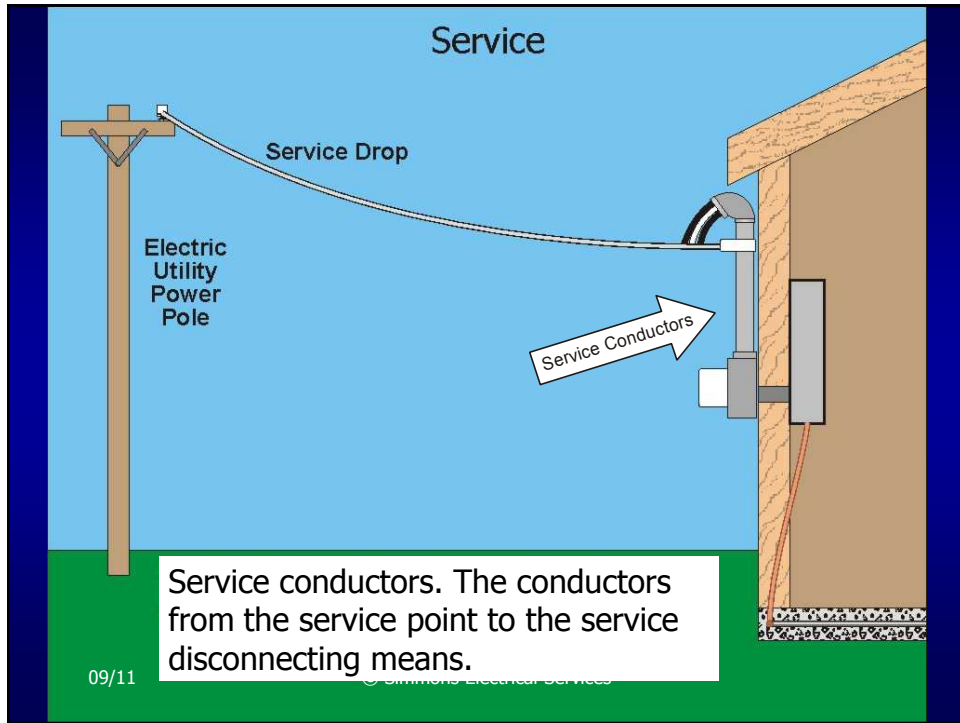


## *Definitions NEC<sup>®</sup> Article 100*

- **Service Conductors.** The conductors from the service point to the service disconnecting means.
- **Service Point.** The point of connection between the facilities of the serving utility and the premises wiring.

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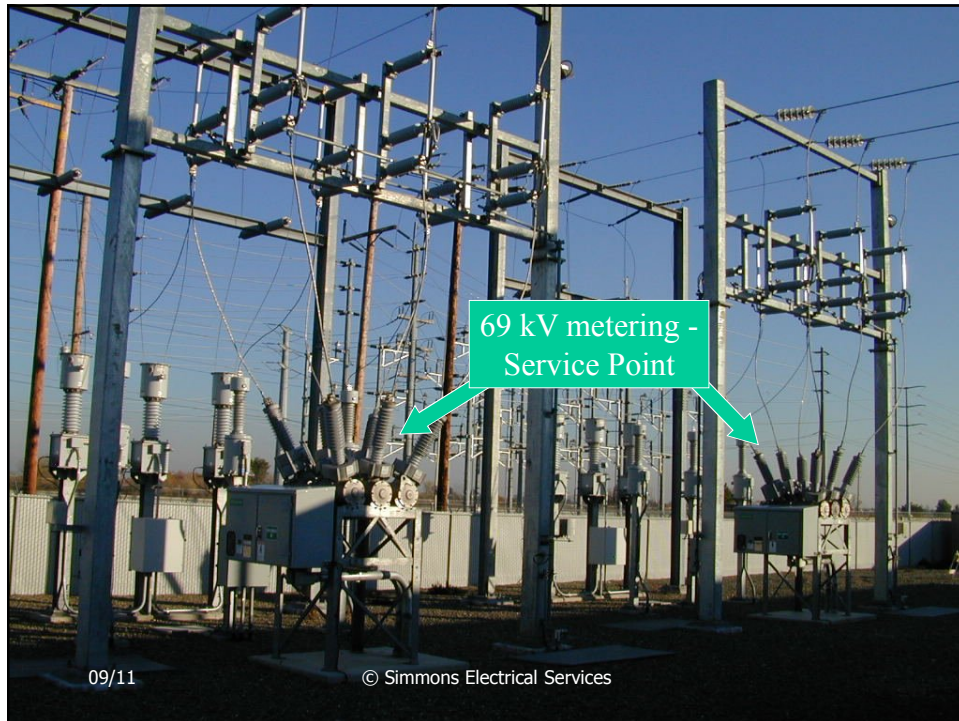


## ***“Service Point” I Note***

- The service point can be described as the point of demarcation between where the serving utility ends and the premises wiring begins. The serving utility generally specifies the location of the service point based on the conditions of service.

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## *Definitions NEC® Article 100*

- **Service Drop.** The overhead service conductors between the utility electric supply system and the service point from the last pole or other aerial support to and including the splices, if any, connecting to the service entrance conductors at the building or other structure.

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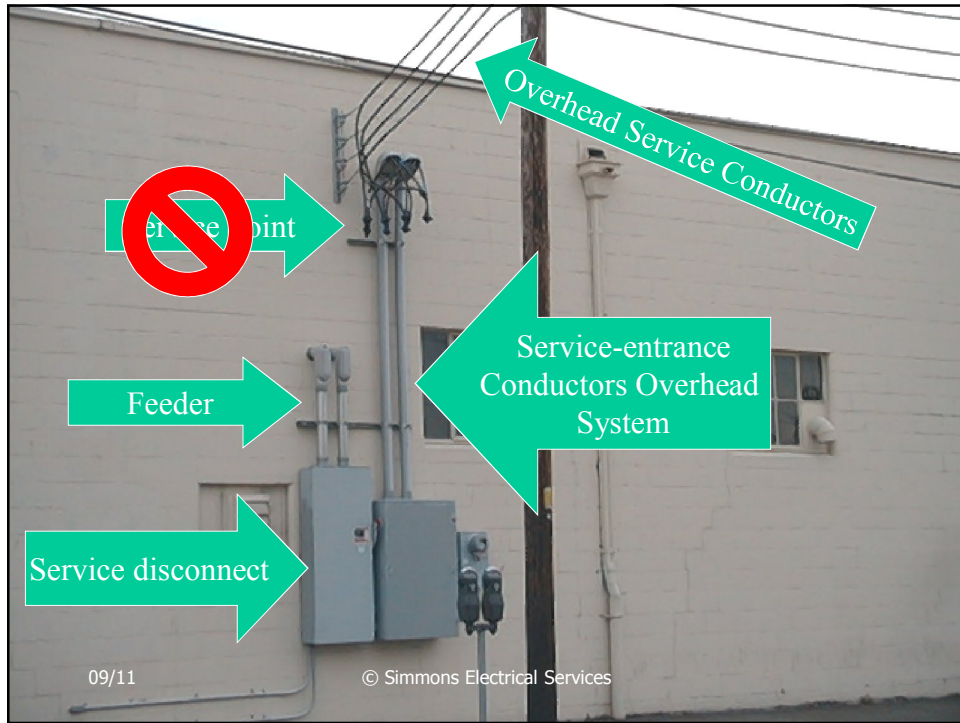


## ***Definitions NEC® Article 100***

- **Service Conductors, Overhead.** The overhead conductors between the service point and the first point of connection to the service-entrance conductors at the building or other structure.

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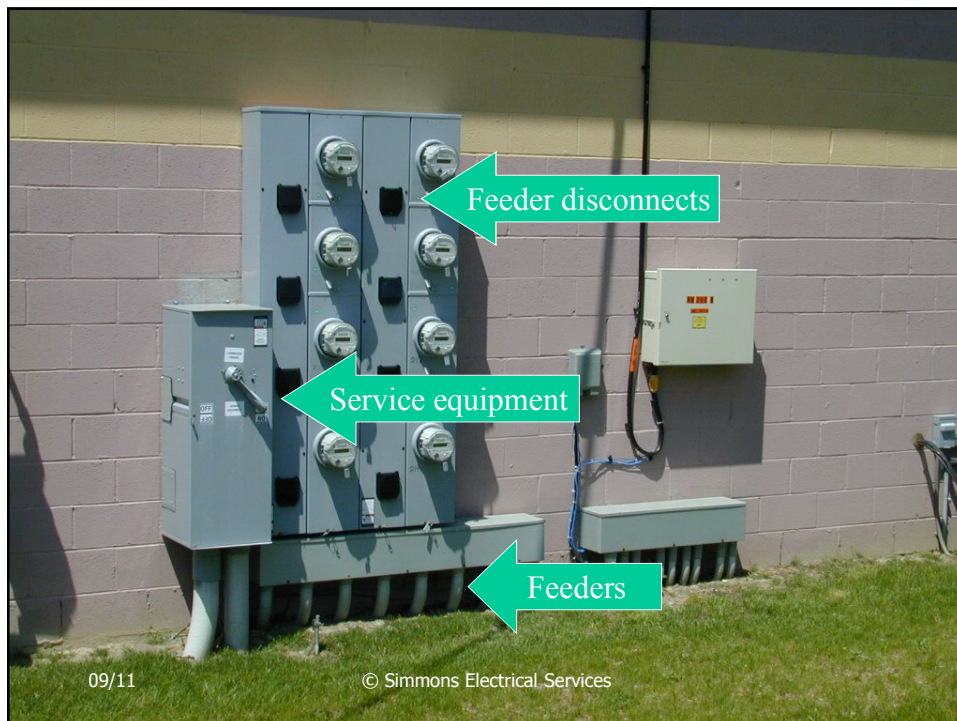


## Definitions NEC® Article 100

- **Service Equipment.** The necessary equipment, usually consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the load end of service conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply.

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## *Definitions NEC® Article 100*

- **Service Lateral.** The underground service conductors between the utility electrical supply system and the service point street main, including any risers at a pole or other structure or from transformers, and the first point of connection to the service-entrance conductors in a terminal box or meter or other enclosure, inside or outside the building wall. Where there is no terminal box, meter, or other enclosure, the point of connection is considered to be the point of entrance of the service conductors into the building.

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## *Definitions NEC® Article 100*

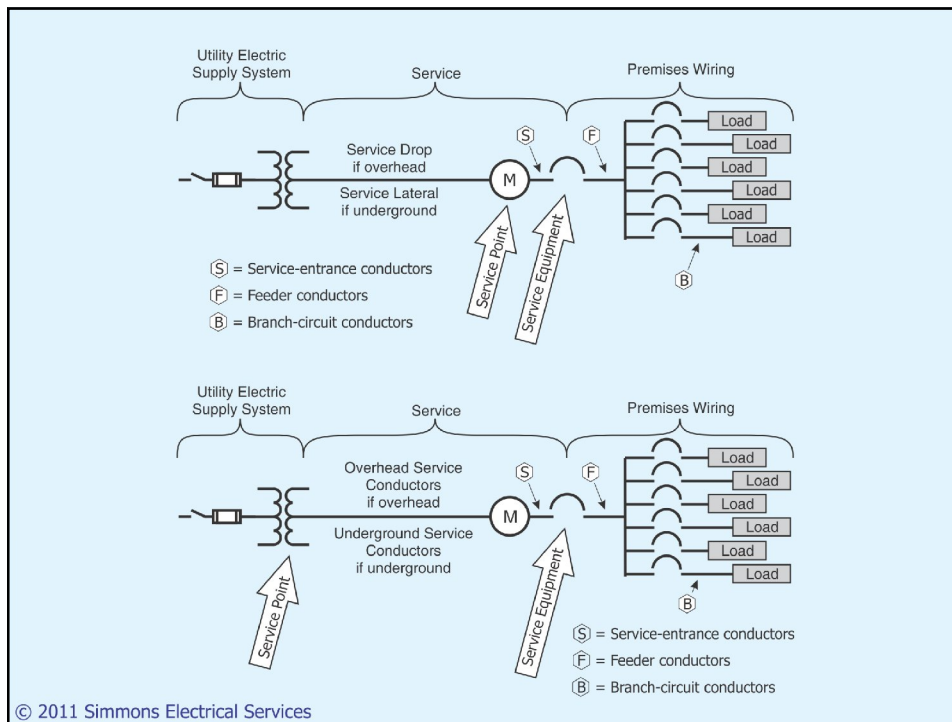
- **Service Conductors, Underground.** The underground conductors between the service point and the first point of connection to the service-entrance conductors in a terminal box, meter, or other enclosure, inside or outside the building wall.

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## 110.9 Interrupting Rating.

- Equipment intended to interrupt current at fault levels shall have an interrupting rating not less than the nominal circuit voltage and the current that is available at the line terminals of the equipment.
- Equipment intended to interrupt current at other than fault levels shall have an interrupting rating at nominal circuit voltage not less than the current that must be interrupted.

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## Determining Available Fault Current

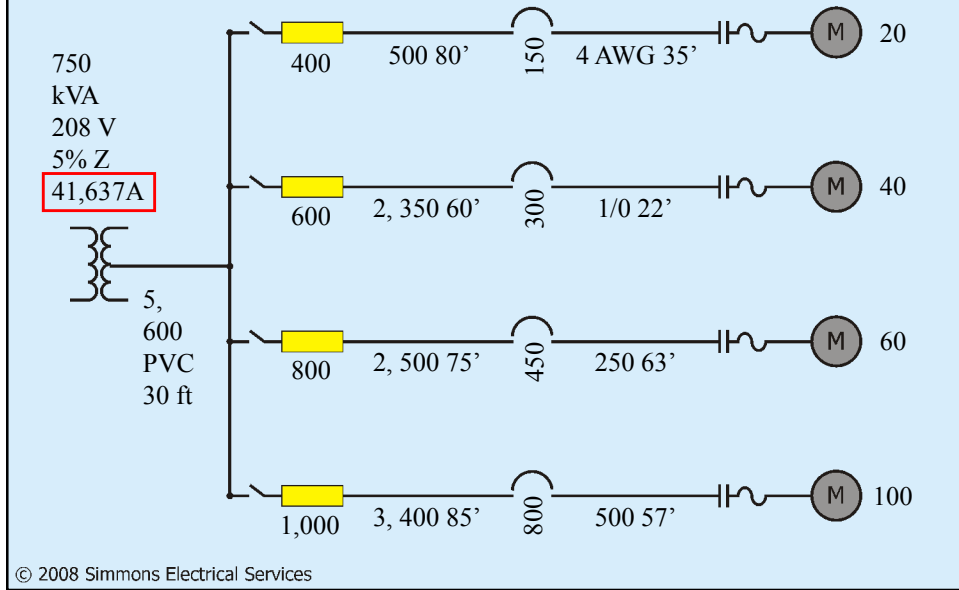
- Obtain short-circuit current at utility transformer from utility
- Perform short-circuit current study of premises wiring system
- Use point-to-point or ohmic method for each component of distribution system
- Equipment intended to interrupt current at fault level must be rated for short-circuit current available at line terminals

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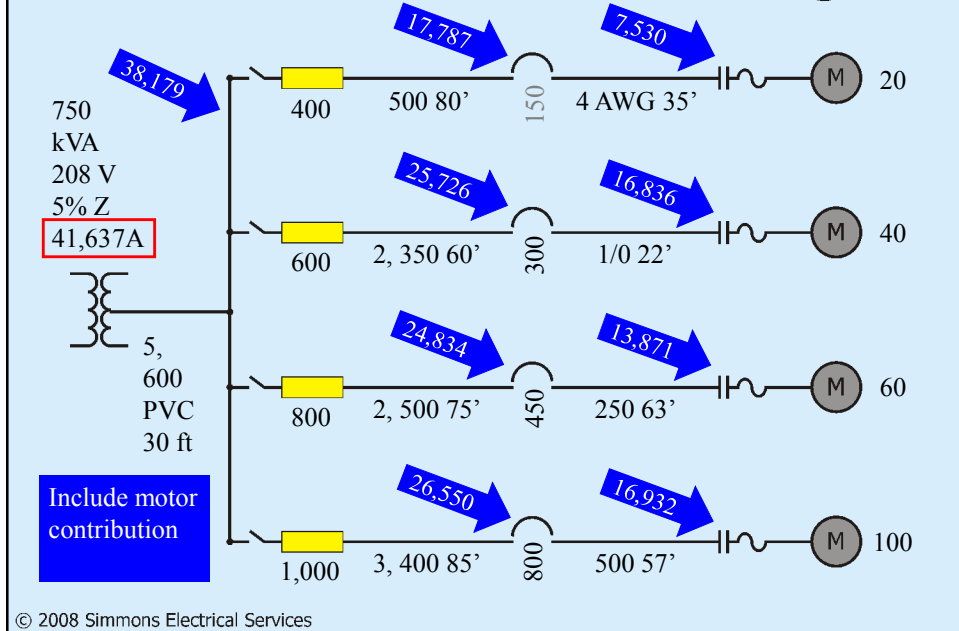
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## 110.9 Short-Circuit Current Ratings

All conductors copper in EMT (kcmil or AWG)



## 110.9 Short-Circuit Current Ratings

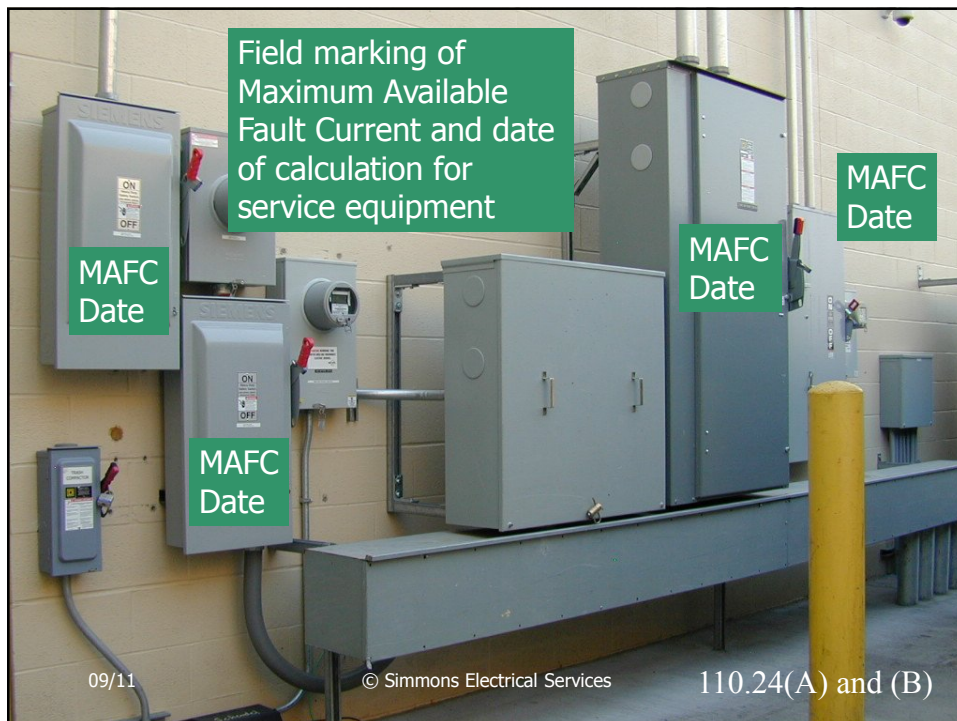


## Determining Available Fault Current

- Commercial software is available
- [www.bussmann.com](http://www.bussmann.com) has on-line calculator
- [www.mikeholt.com](http://www.mikeholt.com) has Excel spreadsheet available for free download
- IAEI Firm's Fast Finder Index book has lots of calculations done
- May need to consider motor contribution for large electrical systems

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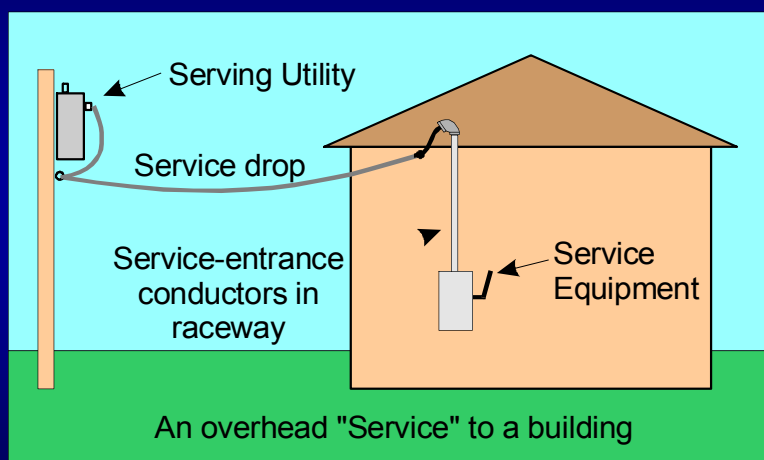
## 230.2. Number of Services

- A building or other structure served shall be supplied by only one service unless permitted in 230.2(A) through (D).

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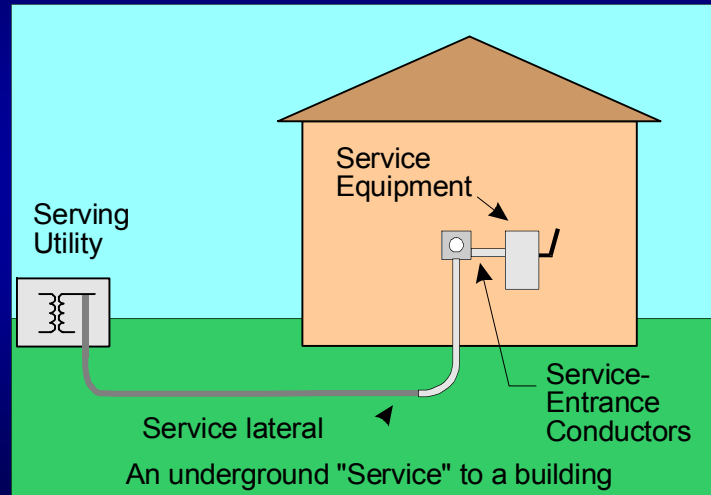
## One "Service"



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## One "Service"



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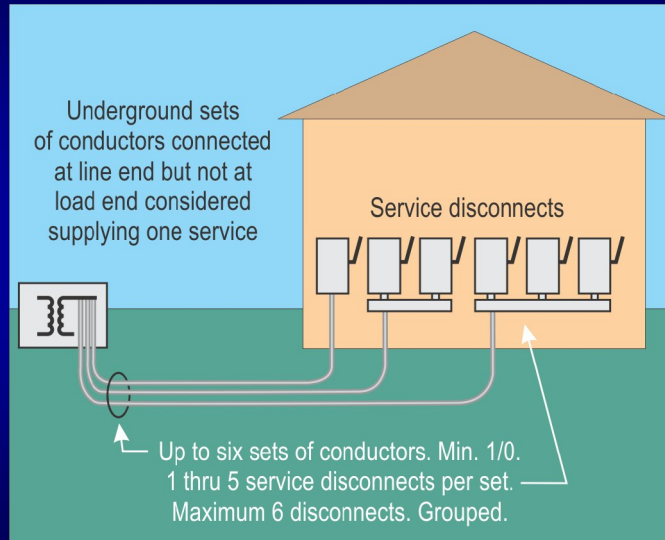
## 230.2. Number of Services

- A building or other structure served shall be supplied by only one service unless permitted in 230.2(A) through (D).
- For the purpose of 230.40, Exception No. 2 only, underground sets of conductors, 1/0 AWG and larger, running to the same location and connected together at their supply end but not connected together at their load end shall be considered to be supplying one service.

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## One "Service"



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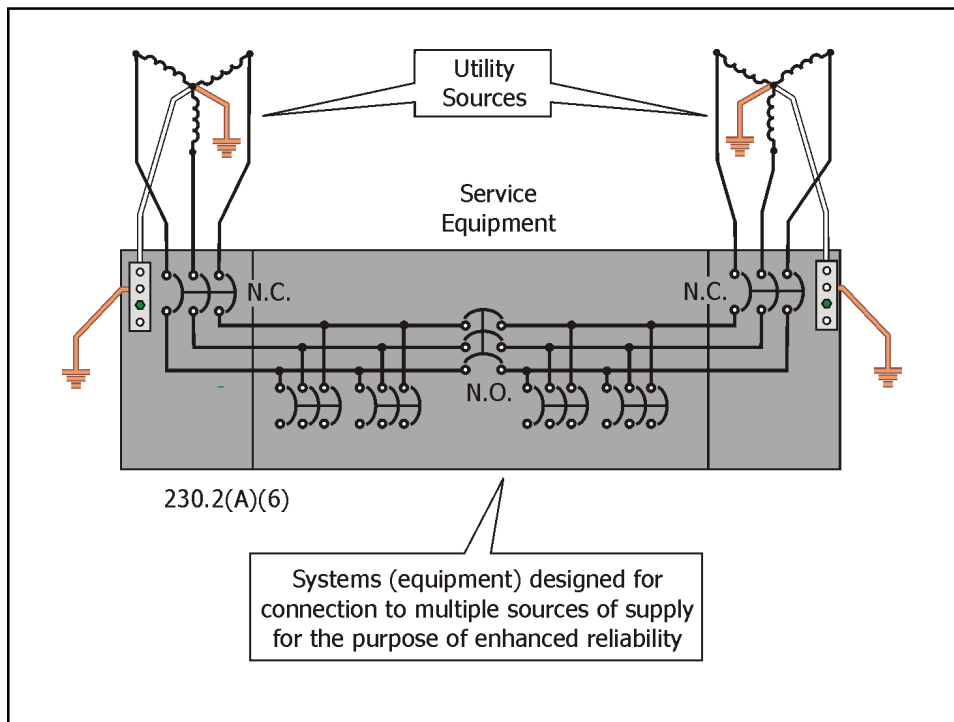
## 230.2(A) Special Conditions

- Under special conditions, additional services permitted for:
  1. Fire pumps
  2. Emergency systems
  3. Legally required standby systems
  4. Optional standby systems
  5. Parallel power production systems
  6. Systems designed for connection to multiple sources of supply for the purpose of enhanced reliability

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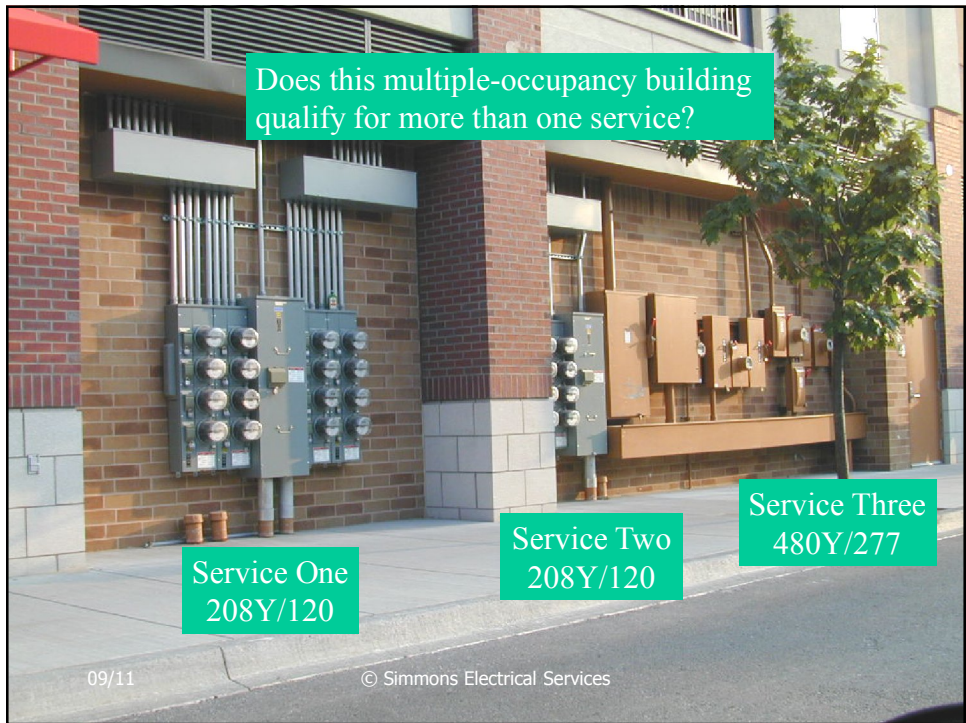


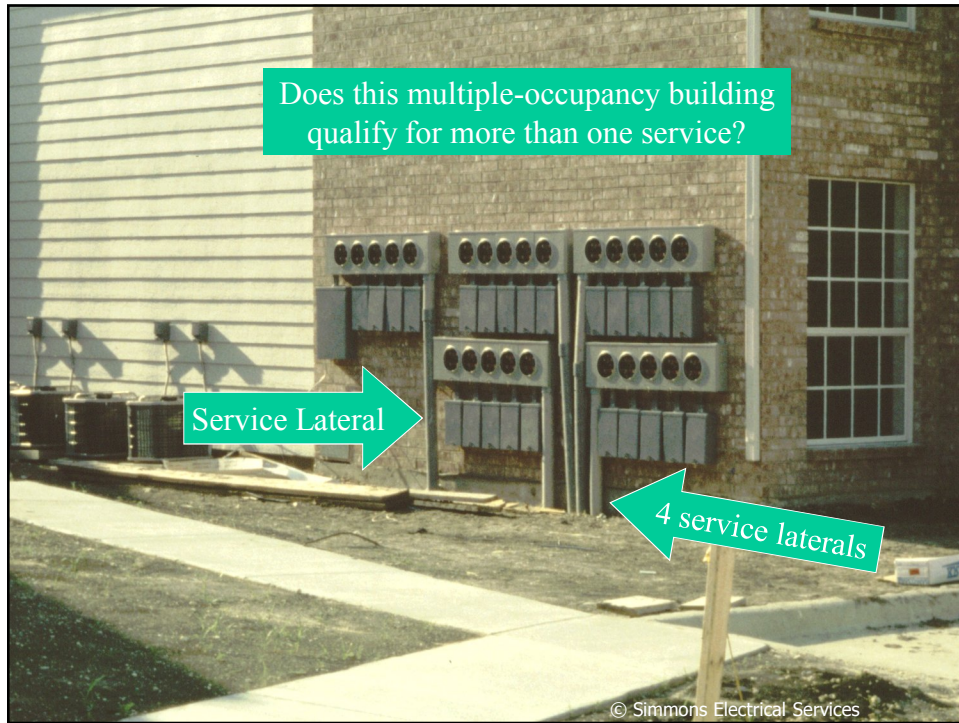
## 230.2(B) Special Occupancies

- (1) By special permission (written consent of AHJ), additional services permitted for:
  - Multiple occupancy buildings where there is no space for service equipment accessible to all occupants
    - (Think about typical apartment buildings – is there adequate space for service disconnecting means to be installed at one location?)
  - Is it possible to locate up to six service disconnects at one location and feeders to distribution equipment elsewhere?

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## **230.2(B) Special Occupancies**

- (2) A single building or other structure sufficiently large to make two or more services necessary
  - No indication in NEC as to what "structure sufficiently large" means
  - How about when excessively oversized feeders have to be installed to compensate for voltage drop?

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## ***(C) Capacity Requirements***

- Additional service(s) permitted where:
- Capacity requirements are in excess of 2,000 amperes at 600 volts or less
- Load requirements of single-phase installation are greater than serving utility normally supplies
- Special permission (written consent of the AHJ) (relates only to capacity requirements not generally)

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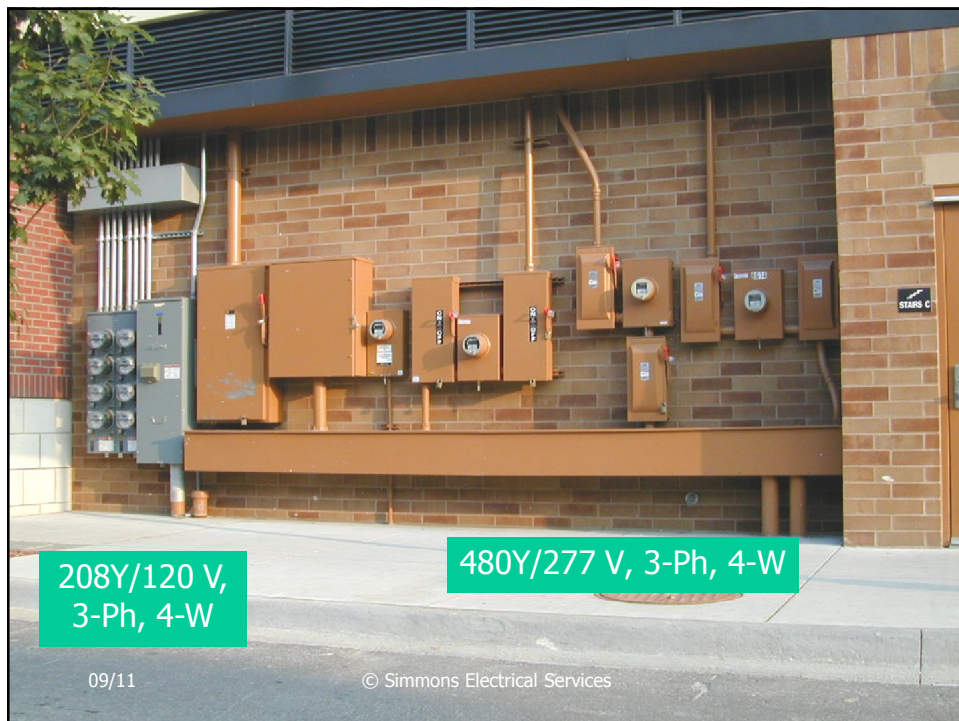
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## 230.2(D) Different Characteristics

- (D) Different Characteristics. Additional services are permitted for different voltages, frequencies, or phases, or for different uses, such as for different rate schedules.

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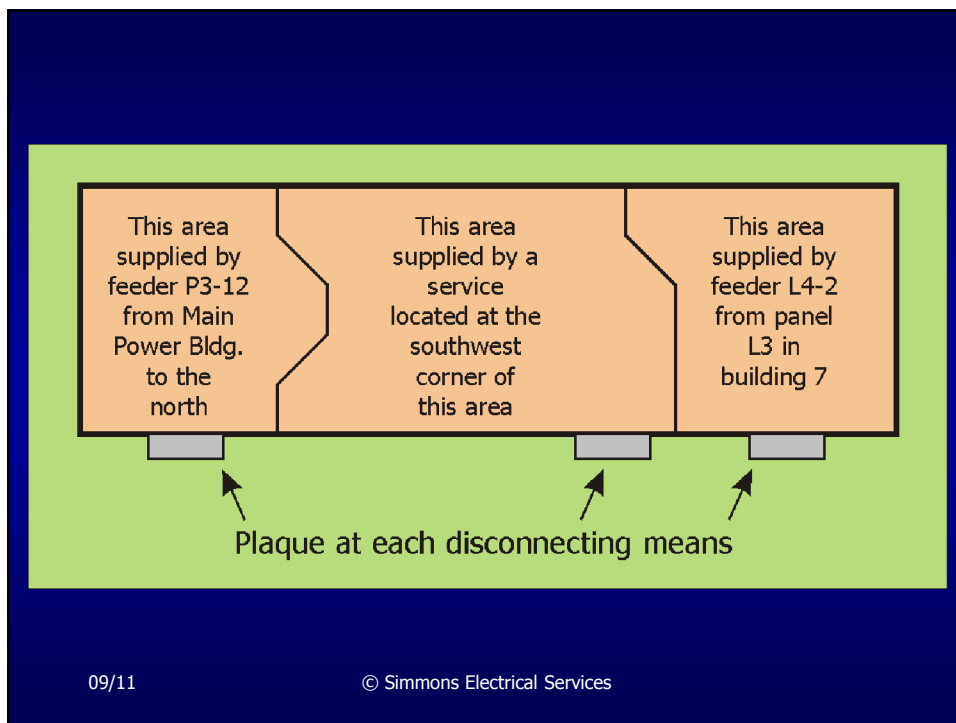
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## 230.2(E) Identification

- (E) Identification. Where a building or structure is supplied by more than one service, or any combination of branch circuits, feeders, and services, a permanent plaque or directory must be installed at each service disconnect location denoting all other services, feeders, and branch circuits supplying that building or structure and the area served by each. See 225.37.

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## **230.6 Conductors Considered Outside the Building**

- Rules are provided to illustrate under what conditions service conductors, though physically located inside a building, are considered to be located outside the building
- These rules relate to 230.71(A)(1) where the service disconnecting means is required to be “or inside nearest the point of entrance of the service conductors”

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## **230.6 Conductors Considered Outside the Building**

- Conductors are considered outside of a building or other structure under any of the following conditions:
- (1) If installed under not less than 50 mm (2 in.) of concrete beneath a building or other structure
- (2) If installed within a building or other structure in a raceway that is encased in concrete or brick not less than 50 mm (2 in.) thick

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## ***230.6 Conductors Considered Outside the Building***

- (3) If installed in any vault that meets the construction requirements of Article 450, Part III
- (4) If installed in conduit and under not less than 450 mm (18 in.) of earth beneath a building or other structure

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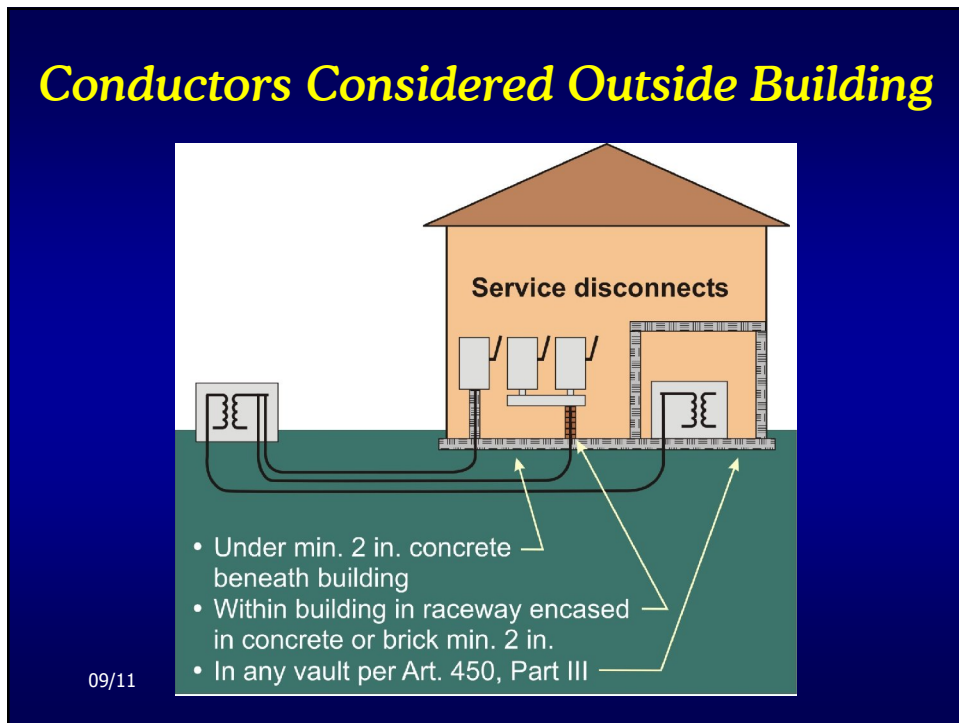
## ***230.6 Conductors Considered Outside the Building***

- (5) Where installed in overhead service masts on the outside surface of the building traveling through the eave of that building to meet the requirements of 230.24

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## **II. Overhead Service-Drop Conductors** **230.23 Size and Rating.**

- (A) General. Conductors shall have sufficient ampacity to carry the current for the load as computed in accordance with Article 220 and shall have adequate mechanical strength.
- (Remember, does not apply if under exclusive control of electric-utility)

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## **230.23 Size and Rating.**

- (B) Minimum Size. The conductors shall not be smaller than 8 AWG copper or 6 AWG aluminum or copper-clad aluminum.
- *Exception: Conductors supplying only limited loads of a single branch circuit — such as small polyphase power, controlled water heaters, and similar loads — shall not be smaller than 12 AWG hard-drawn copper or equivalent.*

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## ***230.23 Size and Rating.***

- (C) Grounded Conductors. The grounded conductor shall not be less than the minimum size as required by 250.24(C).

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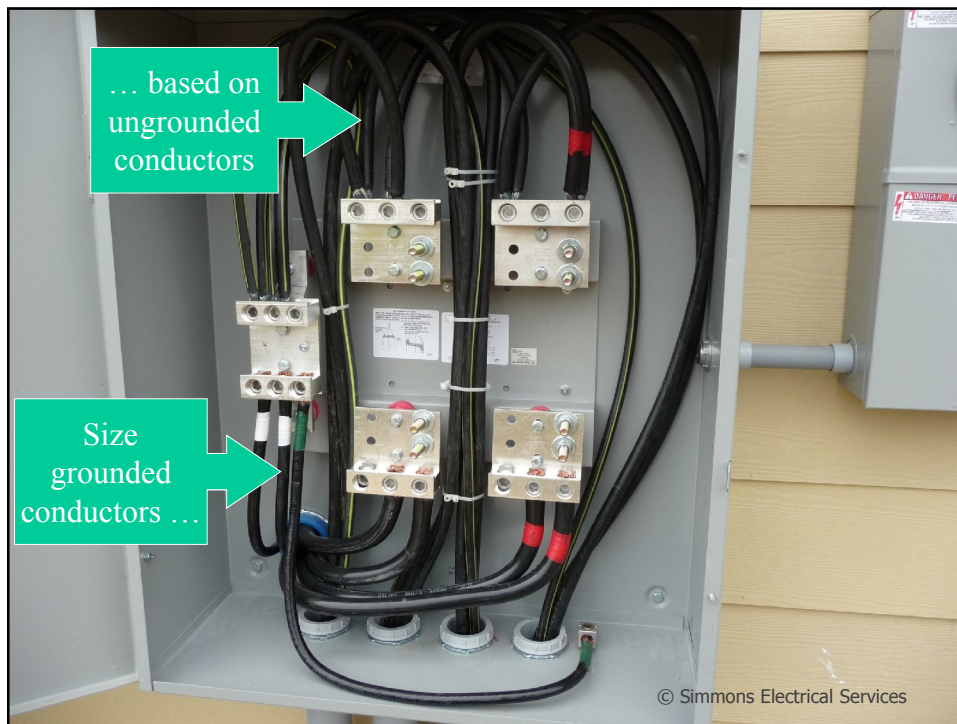
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## ***250.24(C) Size and Rating.***

- (C) Grounded Conductors. Rule ensures the grounded conductor is large enough to carry fault current back from the service to the source.
- Result: size grounded conductor for the largest of
  - Load calculation in 220.61
  - Size of grounding electrode conductor in Table 250.66 (use 12-1/2 % rule for larger conductors)

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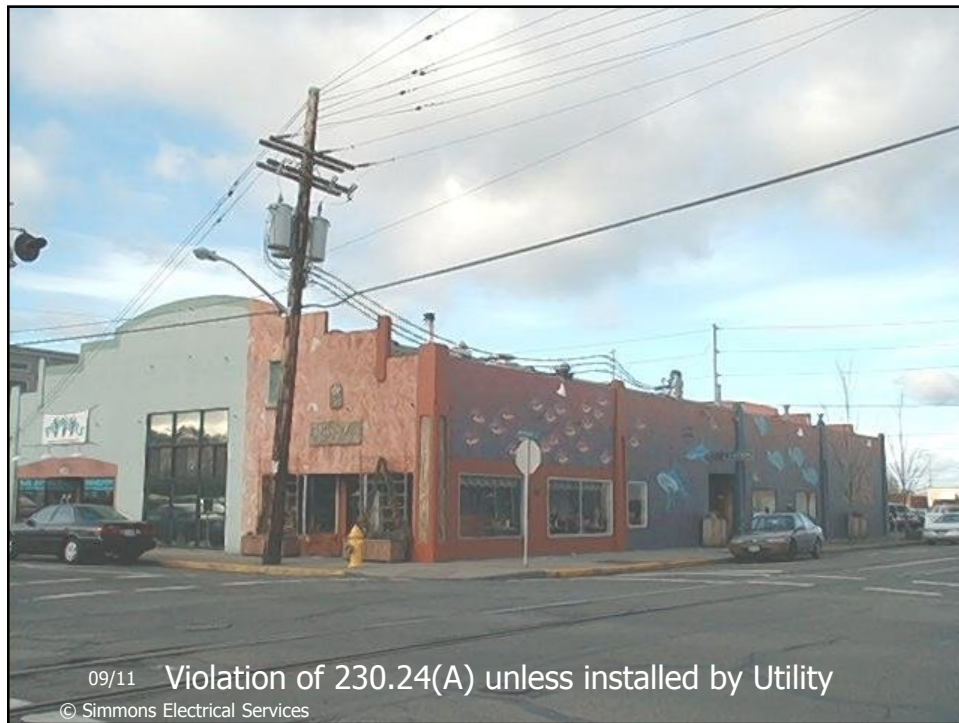
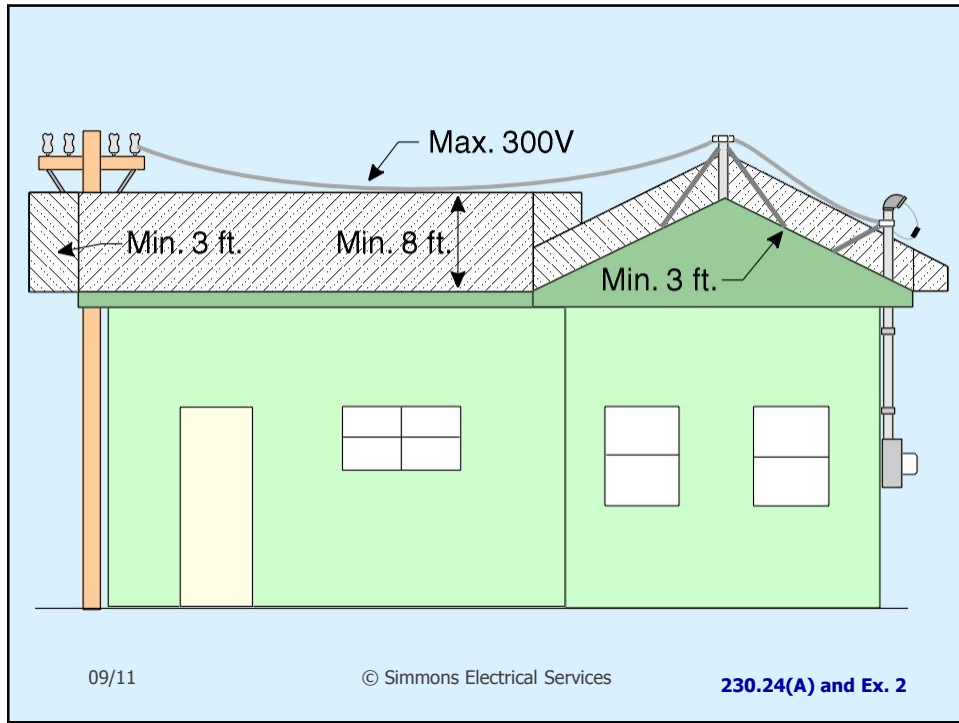


## ***230.24 Clearances, Overhead Service Conductors.***

- (A) Above Roofs. Conductors shall have a vertical clearance of not less than 2.5 m (8 ft) above the roof surface. The vertical clearance above the roof level shall be maintained for a distance of not less than 900 mm (3 ft) in all directions from the edge of the roof.

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## 230.24(A) Exceptions

- *Exception No. 1: The area above a roof surface subject to pedestrian or vehicular traffic shall have a vertical clearance from the roof surface in accordance with the clearance requirements of 230.24(B).*

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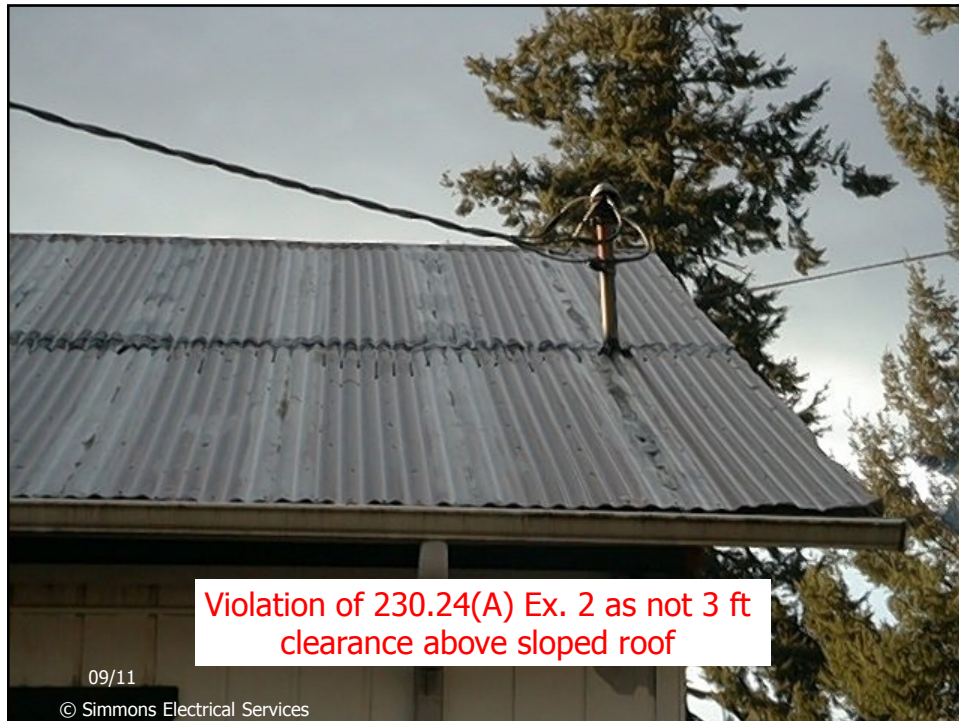
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## 230.24(A) Exceptions

- *Exception No. 2: Where the voltage between conductors does not exceed 300 and the roof has a slope of 100 mm (4 in.) in 300 mm (12 in.), or greater, a reduction in clearance to 900 mm (3 ft) shall be permitted.*

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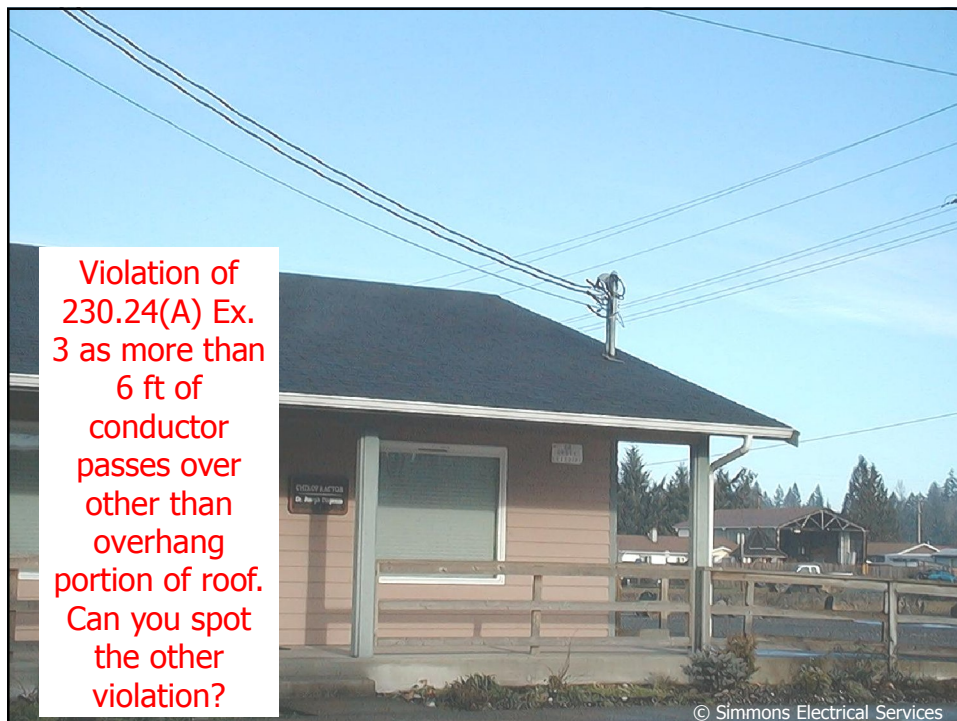
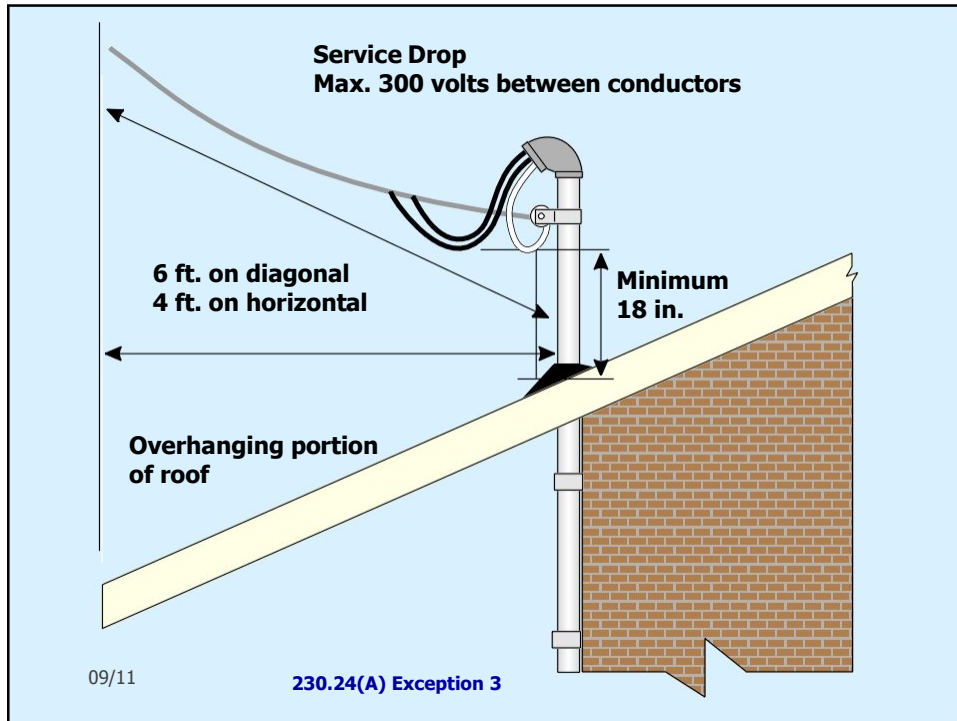


## 230.24(A) Exceptions

- *Exception No. 3: Where the voltage between conductors does not exceed 300, a reduction in clearance above only the overhanging portion of the roof to not less than 450 mm (18 in.) shall be permitted if (1) not more than 1.8 m (6 ft) of overhead service-drop conductors, 1.2 m (4 ft) horizontally, pass above the roof overhang, and (2) they are terminated at a through-the-roof raceway or approved support.*
- FPN: See 230.28 for mast supports.

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## 230.24(A) Exceptions

- *Exception No. 4: The requirement for maintaining the vertical clearance 900 mm (3 ft) from the edge of the roof shall not apply to the final conductor span where the service drop is attached to the side of a building.*

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## 230.24(B) Vertical Clearance from Ground.

- Overhead service-drop conductors, where not in excess of 600 volts, nominal, shall have the following minimum clearance from final grade:
  1. 3.0 m (10 ft) — at the electric service entrance to buildings, also at the lowest point of the drip loop of the building electric entrance, and above areas or sidewalks accessible only to pedestrians, measured from final grade or other accessible surface only for service-drop cables supported on and cabled together with a grounded bare messenger where the voltage does not exceed 150 volts to ground

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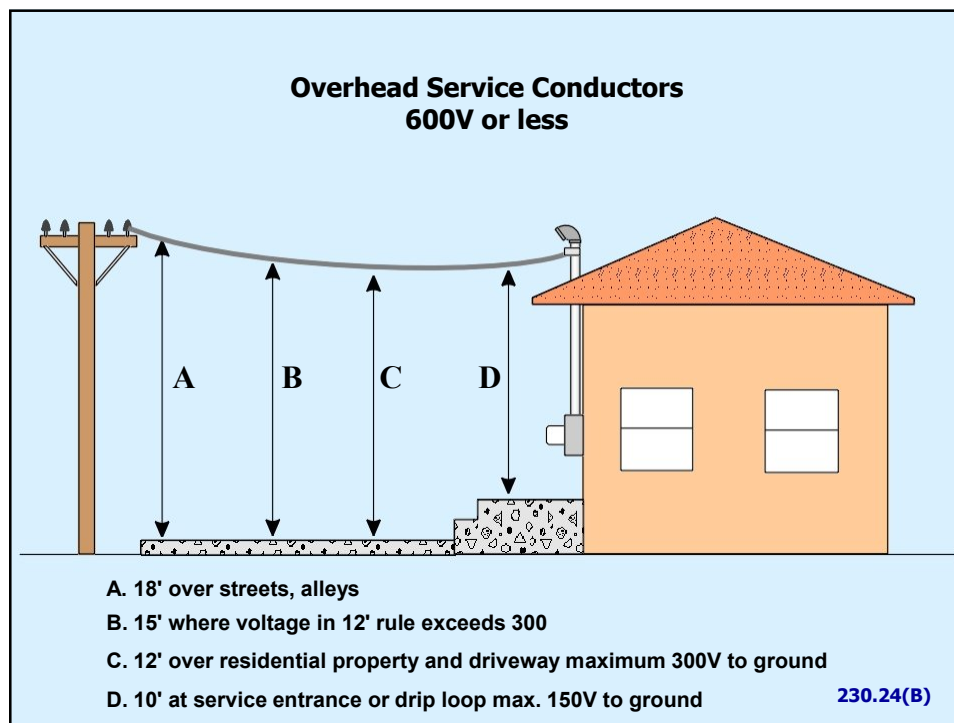
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## 230.24(B) Vertical Clearance from Ground.

2. 3.7 m (12 ft) — over residential property and driveways, and those commercial areas not subject to truck traffic where the voltage does not exceed 300 volts to ground
3. 4.5 m (15 ft) — for those areas listed in the 3.7 m (12 ft) classification where the voltage exceeds 300 volts to ground
4. 5.5 m (18 ft) — over public streets, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land such as cultivated, grazing, forest, and orchard

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## ***230.26 Point of Attachment***

- The point of attachment of the service-drop conductors to a building or other structure shall provide the minimum clearances as specified in 230.9 and 230.24. In no case shall this point of attachment be less than 3.0 m (10 ft) above finished grade.

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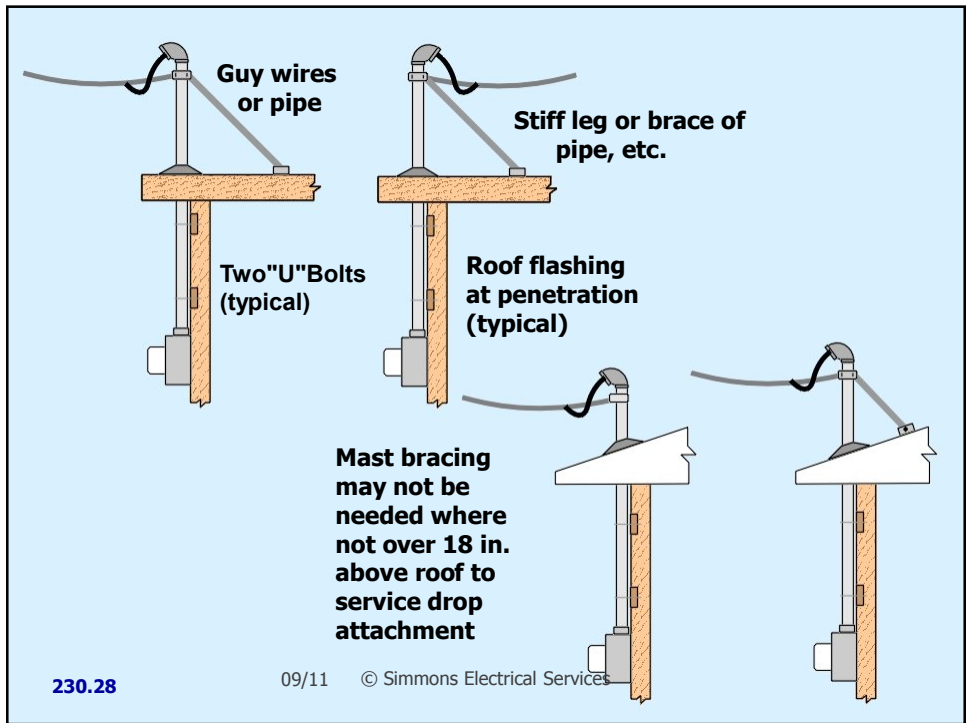


## ***230.28 Service Masts as Supports.***

- If a service mast is used for the support of service-drop conductors, it shall be of adequate strength or be supported by braces or guys to withstand safely the strain imposed by the service drop.
- If raceway-type service masts are used, all raceway fittings shall be identified for use with service masts.
- Only power service-drop conductors are permitted to be attached to a service mast.

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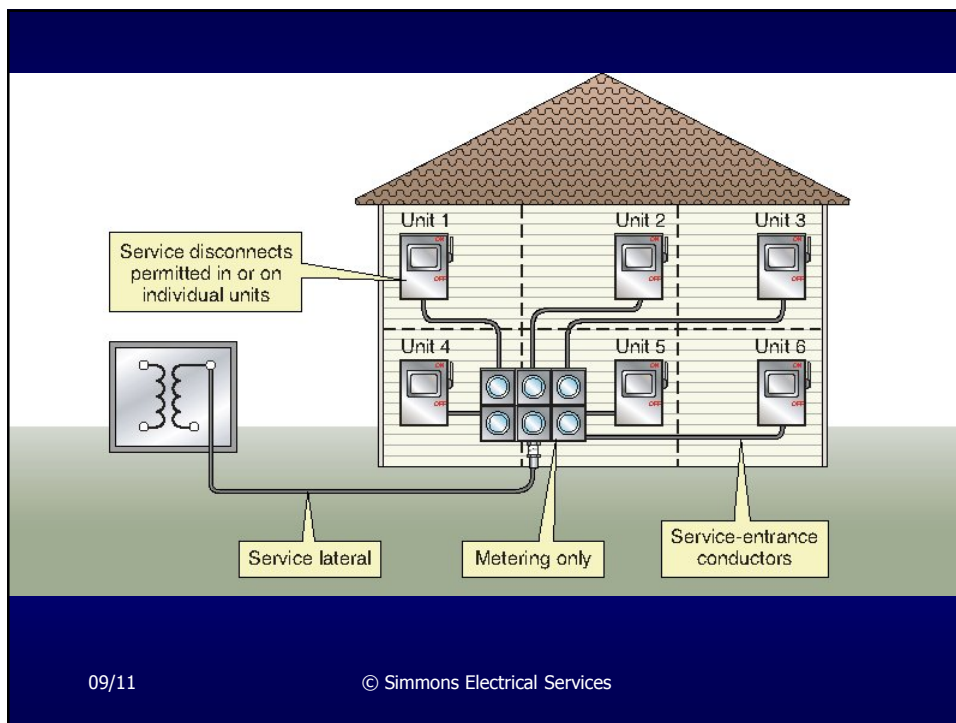
## Part IV. Service-Entrance Conductors

### 230.40. Sets of SE Conductors

- Each service drop, set of overhead service conductors, set of underground service conductors, or service lateral shall supply only one set of service-entrance conductors.
- *Exception No. 1: A building with more than one occupancy is permitted to have one set of service-entrance conductors for each service, as defined in 230.2, run to each occupancy or group of occupancies.*

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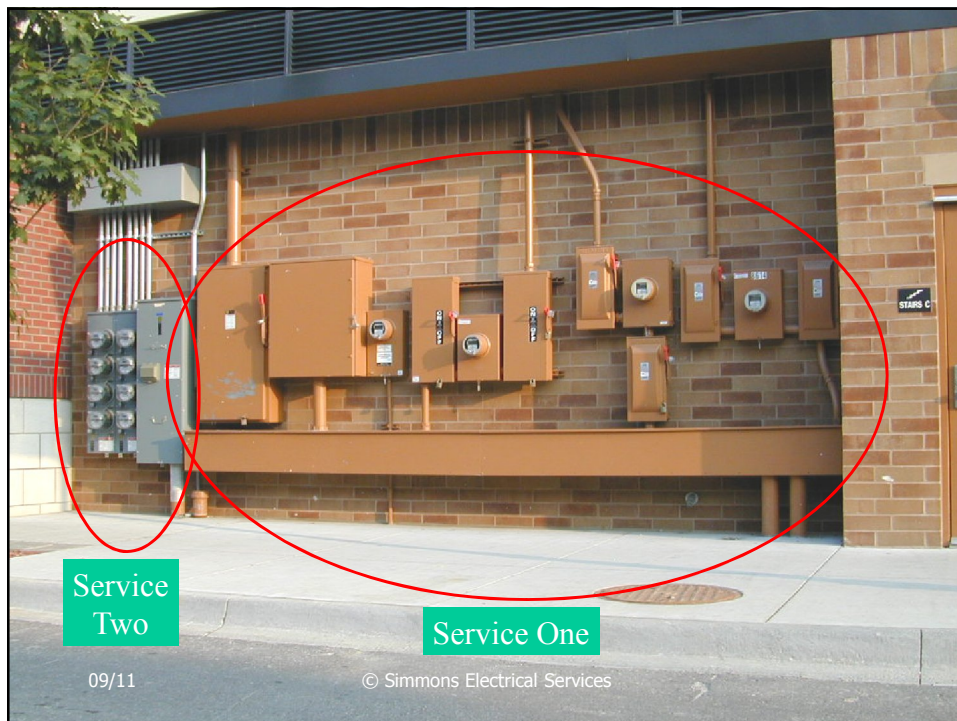
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## 230.40. Sets of SE Conductors

- *Exception No. 2: If two to six service disconnecting means in separate enclosures are grouped at one location and supply separate loads from one service drop or lateral (new terms added), one set of service-entrance conductors is permitted to supply each or several such service equipment enclosures.*

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## 230.42. Minimum Size

- (A) General. The ampacity of the service-entrance conductors before the application of any adjustment or correction factors shall not be less than either (1) or (2).
- Loads shall be determined in accordance with Article 220.
- Ampacity shall be determined from 310.15.
- The maximum allowable current of busways shall be that value for which the busway has been listed or labeled.

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## 230.42. Minimum Size

- 1) The sum of the noncontinuous loads plus 125 percent of continuous loads  
*Exception for grounded conductors that do not connect to an overcurrent device*
2. The sum of noncontinuous load plus the continuous load if the service-entrance conductors terminate in an overcurrent device where both the overcurrent device and its assembly are listed for operation at 100 percent of their rating

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## ***230.42. Minimum Size***

- (B) Specific Installations. In addition to the requirements of 230.42(A), the minimum ampacity for ungrounded conductors for specific installations shall be not less than the rating of the service disconnecting means in 230.79(A) through (D).

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## ***Rating of Service Disconnect 230.79***

- (A) One circuit – 15 amperes
- (B) Two-circuits – 30 amperes
- (C) One-Family Dwelling – 100 amperes, 3-wire
- (D) All others – 60 amperes

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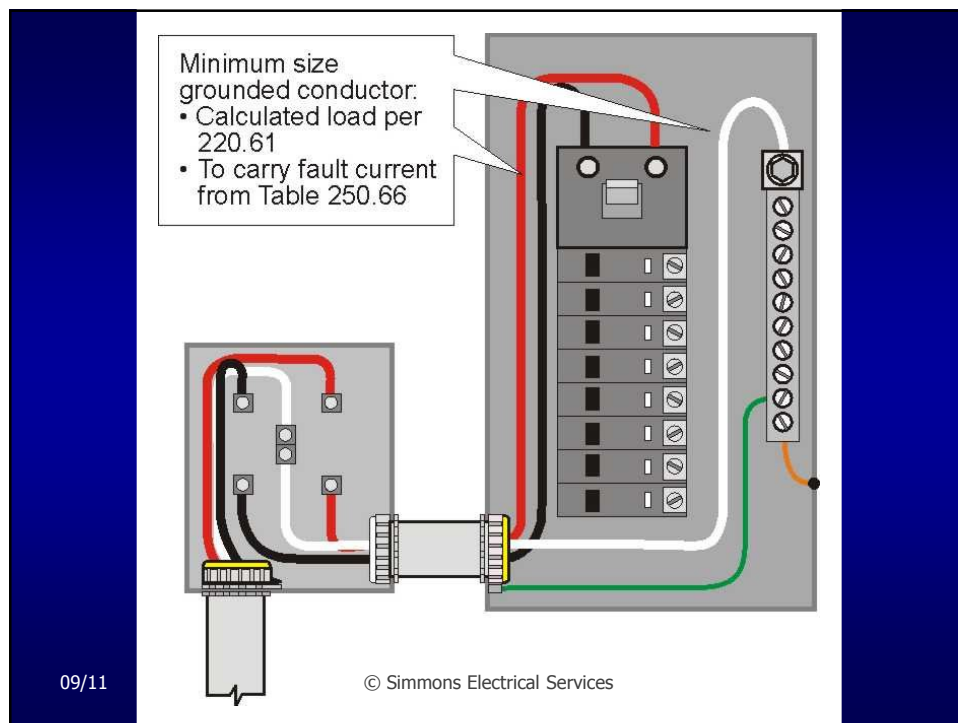
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## 230.42. Minimum Size

- (C) Grounded Conductors. The grounded conductor shall not be less than the minimum size as required by Section 250.24(C).
- 3-step process:
  - Calculate the unbalanced load per 220.61
  - Determine minimum size to carry fault current per 250.24(C)
  - Install the larger of the two sizes

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## **230.43 Wiring Methods**

1. Open wiring on insulators
2. Type IGS cable
3. Rigid metal conduit (RMC)
4. Intermediate metal conduit (IMC)
5. Electrical metallic tubing (EMT)
6. Electrical nonmetallic tubing (ENT) (Not exposed)
7. Service-entrance cables (Type SE)
8. Wireways
9. Busways
10. Auxiliary gutters

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## **230.43 Wiring Methods**

11. Rigid Nonmetallic Conduit (RNC)
12. Cablebus
13. Type MC cable (Type MC)
14. Mineral-insulated, metal-sheathed cable
15. Flexible metal conduit (FMC) not over 1.8 m (6 ft) long or liquidtight flexible metal conduit (LFMC) not over 1.8 m (6 ft) long between raceways, or between raceway and service equipment, with equipment bonding jumper routed with the flexible metal conduit or the liquidtight flexible metal conduit according to the provisions of 250.102(A), (B), (C), and (E)
16. Liquidtight flexible nonmetallic conduit (LFNC)

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## 230.43 Wiring Methods

- (17) High density polyethylene conduit (HDPE)
- (18) Nonmetallic underground conduit with conductors
- (NUCC)
- (19) Reinforced thermosetting resin conduit (RTRC)

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## 230.44 Cable Trays

- Cable trays are permitted to support service-entrance conductors.
  - Unless a barrier is installed, only service-entrance conductors are permitted in the cable tray
  - Then, labels denoting purpose of cable tray are required
- Can support Type SE cable, Type MC cable, Type MI cable, Type IGS cable, Single thermoplastic-insulated conductors 1/0 and larger with CT rating

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## ***230.46. Spliced SE Conductors***

- Service-entrance conductors shall be permitted to be spliced or tapped in accordance with 110.14, 300.5(E), 300.13, and 300.15.

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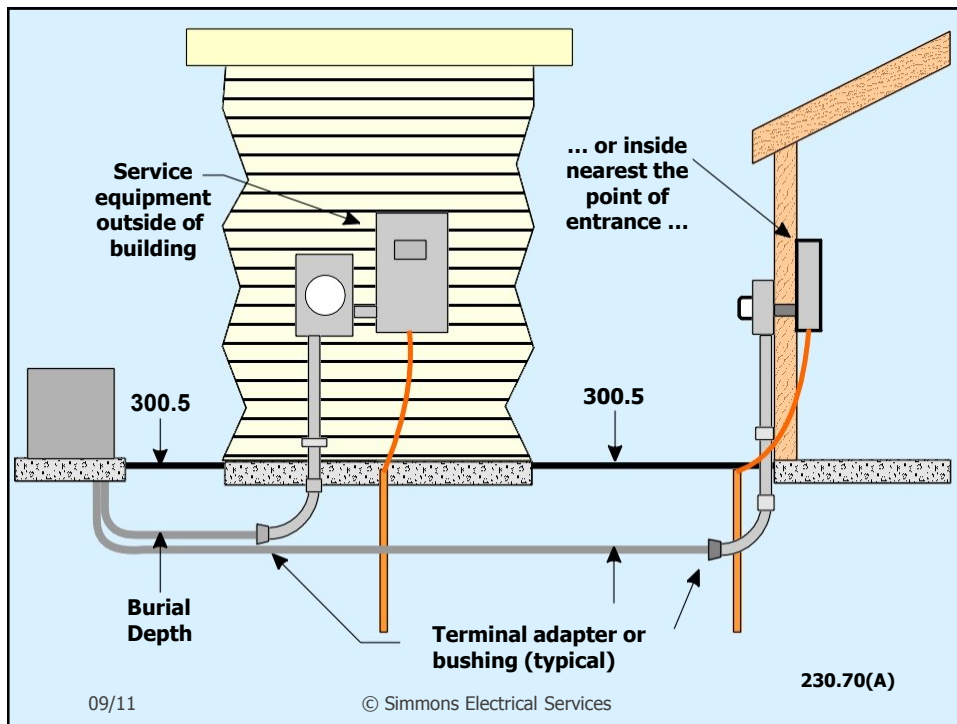
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## ***230.50 Protection Against Physical Damage***

- Protect as specified in (A) or (B).
- (A) Underground. Protect in accordance with 300.5.

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## ***230.50 Protection Against Physical Damage***

(B) All Others:

- Rigid Metal Conduit
- IMC
- Schedule 80 PVC
- EMT (Observe corrosion protection requirements)
- Other approved means

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## ***230.54 Overhead Service Locations***

- (A) Raintight service head required on service raceways at point of connection to service drop
- The service head shall comply with the requirement for fittings in 314.15.

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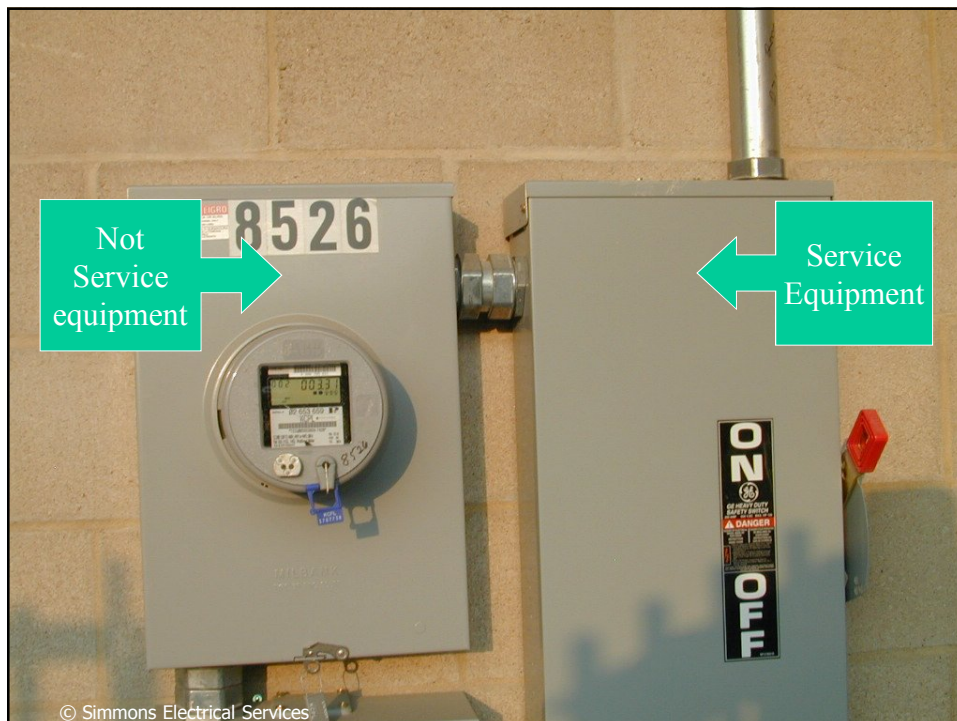


## *Part V. Service Equipment – General 230.66 Marking*

- Service equipment rated 600 volts or less must be marked to identify it as being suitable for use as service equipment. Usually identified “SUSE”
- All service equipment to be listed.
- Individual meter socket enclosures are not considered service equipment

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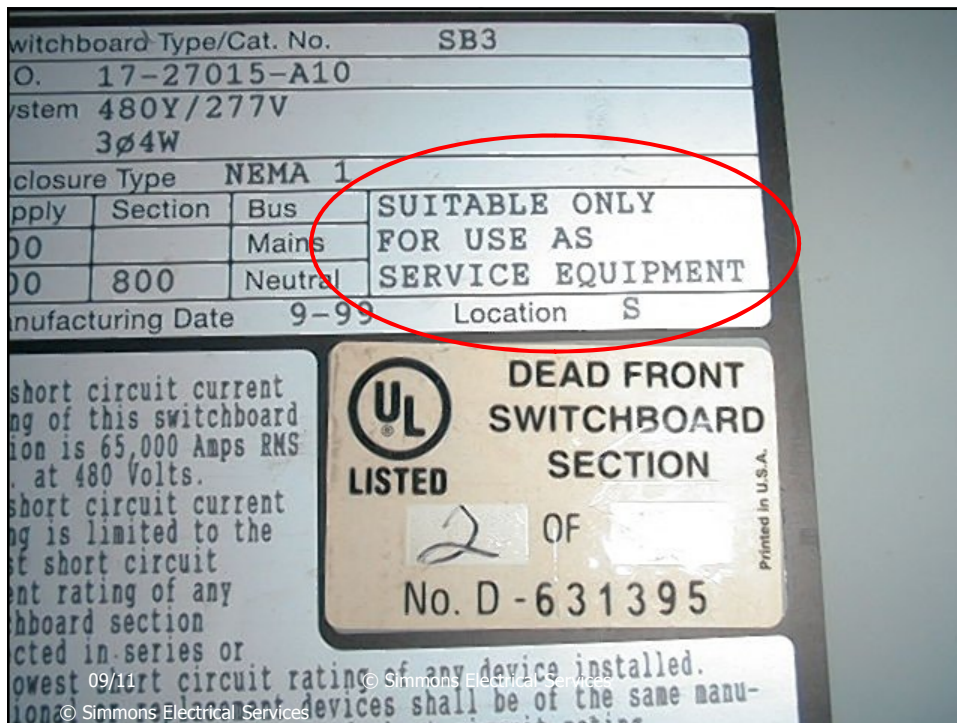


## Suitable Only For Use as Service Equipment

- When so marked, the neutral is bonded to the service enclosure
- Permitted to be used:
  - At the service position
  - As a separately derived system if the grounding and bonding rules of 250.30 are satisfied
  - For existing installations only, permitted as a building disconnecting means if the grounding rules of 250.32(B) Exception permit

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***Part VI. Service Equipment – Disconnecting Means  
230.70(A) Location***

- (1) Readily Accessible Location. The service disconnecting means is required to be installed at a readily accessible location either outside of a building or structure or inside nearest the point of entrance of the service conductors.
- (2) Bathrooms. Service disconnecting means are not permitted to be installed in bathrooms.

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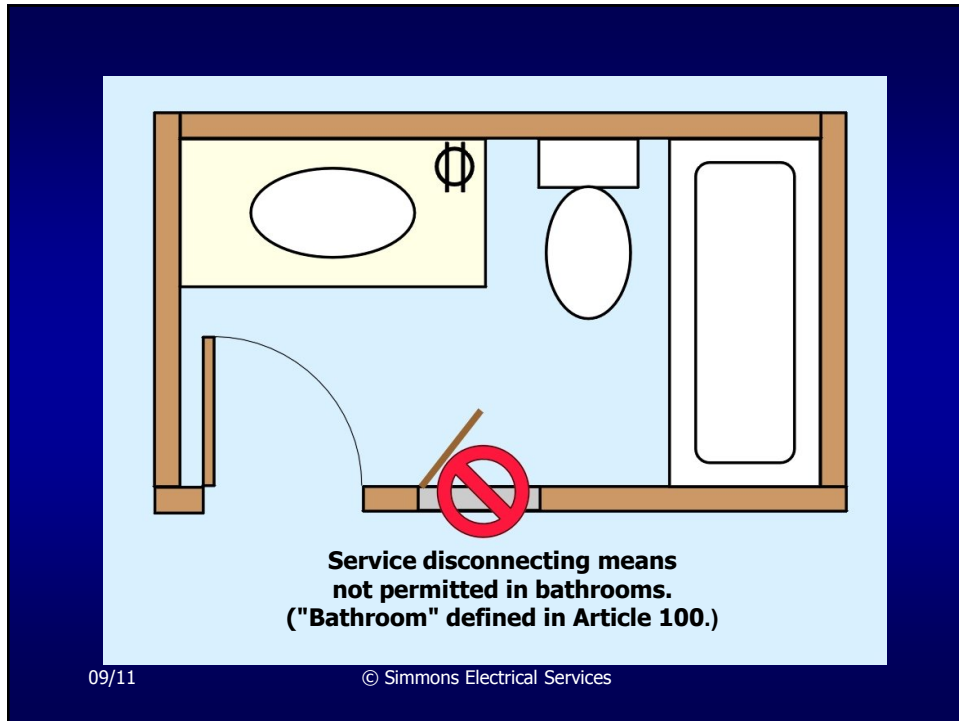
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***“Accessible, Readily” Article 100***

- Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, and so forth.

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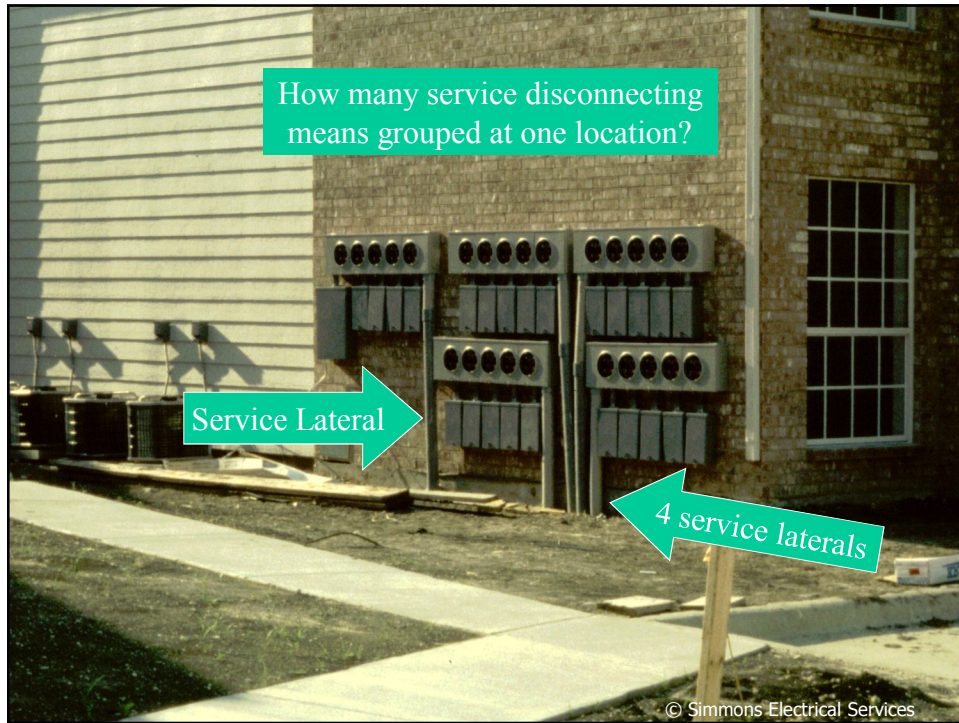
## **230.71, Max. No. Disconnects**

- (A) General. The service disconnecting means for each service permitted by Section 230.2, or for each set of service-entrance conductors permitted by Section 230.40, Exception Nos. 1, 3, 4, or 5, must consist of not more than six switches or six circuit breakers, or a combination of not more than six switches and sets of circuit breakers, mounted in a single enclosure, in a group of separate enclosures, or in or on a switchboard. There shall be no more than six disconnects per service grouped in any one location.

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## 230.72, Grouping of Disc.

- (A) General. The two to six disconnects as permitted in Section 230.71 must be grouped. Each disconnect must be marked to indicate the load served.
- *Exception: One of the two to six service disconnecting means permitted in Section 230.71, where used only for a water pump also intended to provide fire protection, is permitted to be located remote from the other disconnecting means.*

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## ***230.72, Grouping of Disc.***

- (B) Additional Service Disconnecting Means. The one or more additional service disconnecting means for fire pumps, emergency systems, legally required standby, or optional standby services permitted by 230.2 shall be installed remote from the one to six service disconnecting means for normal service to minimize the possibility of simultaneous interruption of supply.

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## ***230.79 Rating of Service Disconnecting Means***

- The service disconnecting means must have a rating not less than the calculated load to be carried, determined in accordance with Part III, IV, or V of Article 220, as applicable. In no case shall the rating be lower than specified in 230.79(A), (B), (C), or (D).
- (A) One-Circuit Installation. For installations to supply only limited loads of a single branch circuit, the service disconnecting means shall have a rating of not less than 15 amperes.

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## ***230.79 Rating of Service Disconnecting Means***

- (B) Two-Circuit Installations. For installations consisting of not more than two 2-wire branch circuits, the service disconnecting means shall have a rating of not less than 30 amperes.
- (C) One-Family Dwelling. For a one-family dwelling, the service disconnecting means shall have a rating of not less than 100 amperes, 3-wire.

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## ***230.79 Rating of Service Disconnecting Means***

- (D) All Others. For all other installations, the service disconnecting means shall have a rating of not less than 60 amperes.

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## ***230.82 Equipment Connected to Supply Side of Service Disconnect***

- Only the following equipment shall be permitted to be connected to the supply side of the service disconnecting means:
  - (1) Cable limiters or other current-limiting devices.
  - (2) Meters and meter sockets nominally rated not in excess of 600 volts, provided all metal housings and service enclosures are grounded and bonded per Article 250.

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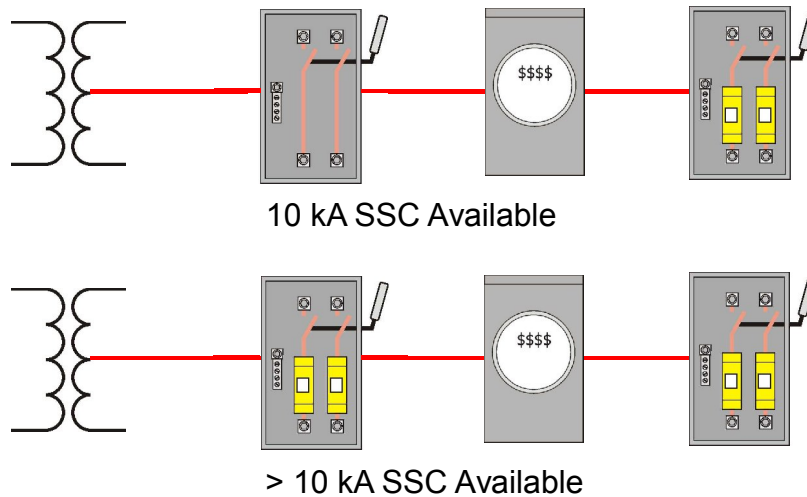
## 230.82 Equipment Connected to Supply Side of Service Disconnect

- (3) Meter disconnect switches nominally rated not in excess of 600 volts that have a short-circuit current rating equal to or greater than the available short circuit current, provided all metal housings and service enclosures are grounded and bonded
- Must be load-break rated

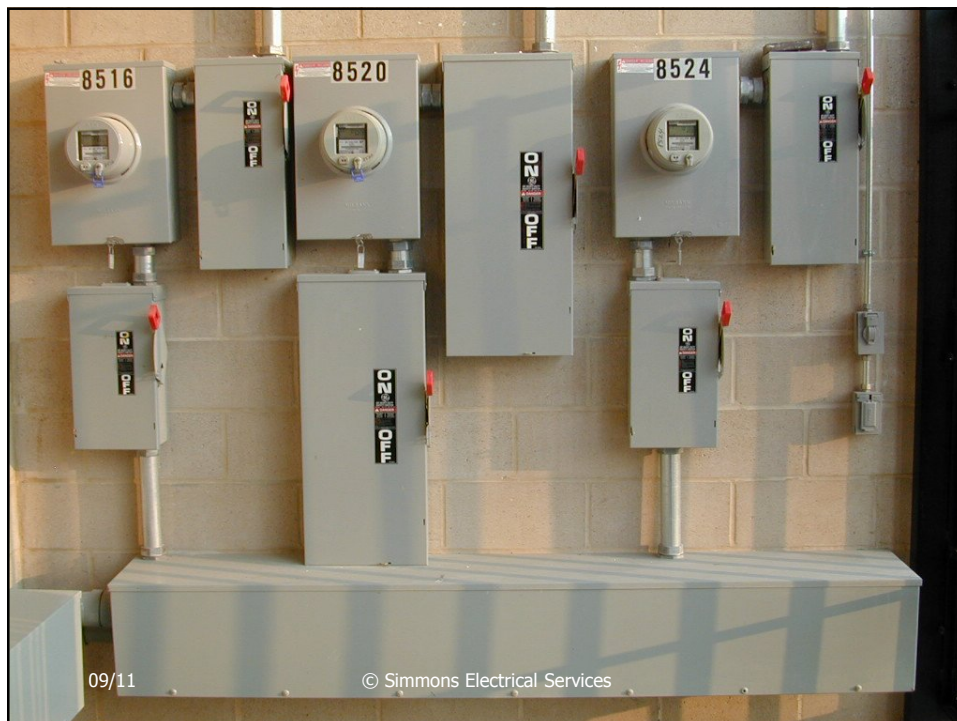
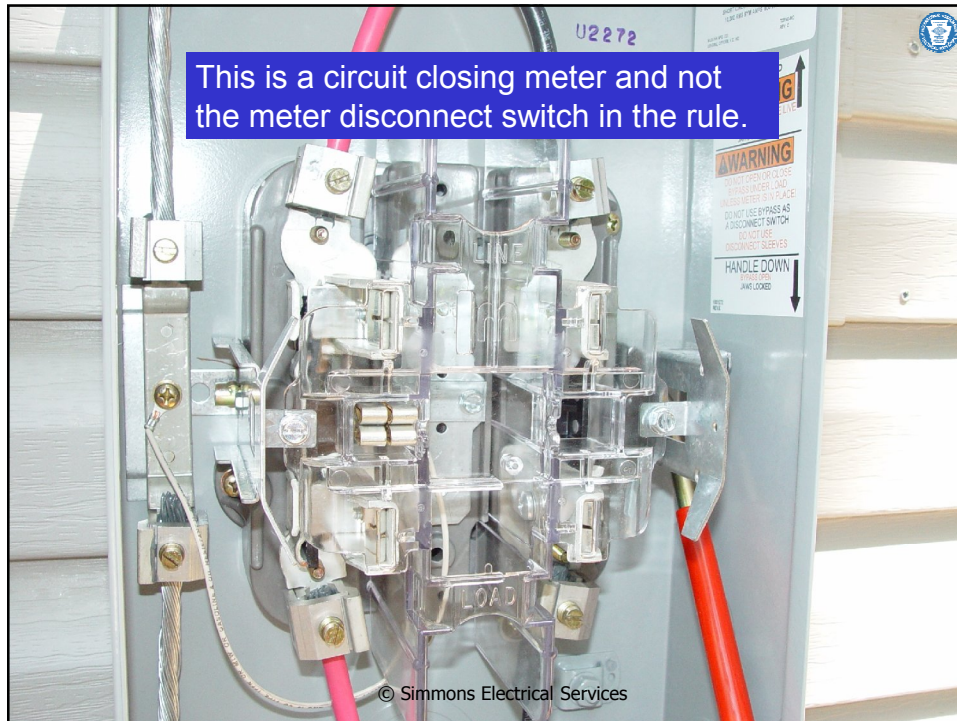
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### 230.82(3), The Rest of the Story!



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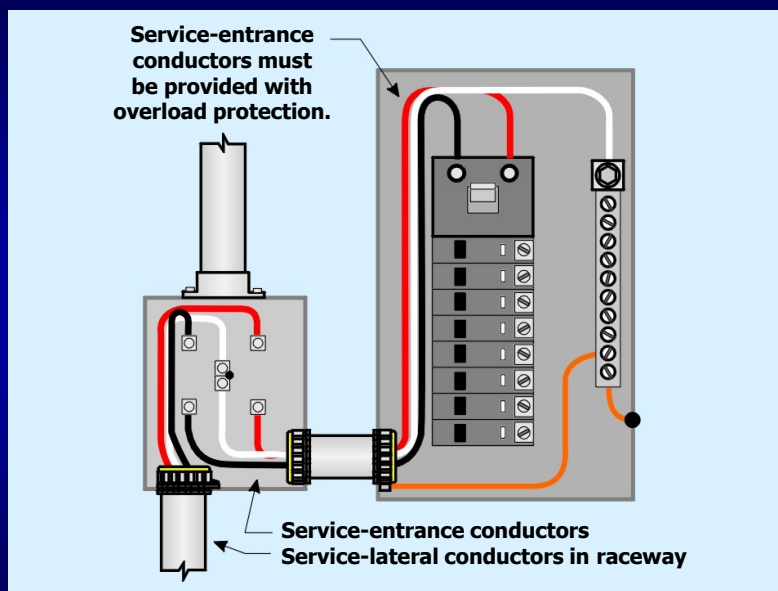
## Part VII. Service Equipment – Overcurrent Protection

### 230.90 Overload Protection

- Each ungrounded service conductor shall have overload protection.
- (A) Ungrounded Conductor. Such protection shall be provided by an overcurrent device in series with each ungrounded service conductor that has a rating or setting not higher than the allowable ampacity of the conductor.
- A set of fuses shall be considered all the fuses required to protect all the ungrounded conductors of a circuit.
- Single-pole circuit breakers, grouped in accordance with 230.71(B), shall be considered as one protective device.

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230-90(a)



## ***Outdoor Service-Entrance Conductors***

- Don't forget to derate those service-entrance conductors for ambient temperatures higher than 86°F
- See the Table 310.15(B)(2)(a) for Temperature Correction Factors

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**Table 310.15(B)(2)(a) Ambient Temperature Correction Factors Based on 30°C (86°F)**

For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate correction factor shown below.

Ambient Temperature (°C)	Temperature Rating of Conductor			Ambient Temperature (°F)
	60°C	75°C	90°C	
10 or less	1.29	1.20	1.15	50 or less
11–15	1.22	1.15	1.12	51–59
16–20	1.15	1.11	1.08	60–68
21–25	1.08	1.05	1.04	69–77
26–30	1.00	1.00	1.00	78–86
31–35	0.91	0.94	0.96	87–95
36–40	0.82	0.88	0.91	96–104
41–45	0.71	0.82	0.87	105–113
46–50	0.58	0.75	0.82	114–122
51–55	0.41	0.67	0.76	123–131
56–60	—	0.58	0.71	132–140
61–65	—	0.47	0.65	141–149
66–70	—	0.33	0.58	150–158
71–75	—	—	0.50	159–167
76–80	—	—	0.41	168–176
81–85	—	—	0.29	177–185

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## 230.90 Overload protection

- *Exception No. 1: For motor-starting currents, ratings that conform with 430.52, 430.62, and 430.63 are permitted.*
- *Exception No. 2: Fuses and circuit breakers with a rating or setting that conform with 240.4(B) or (C) and 240.6 are permitted.*

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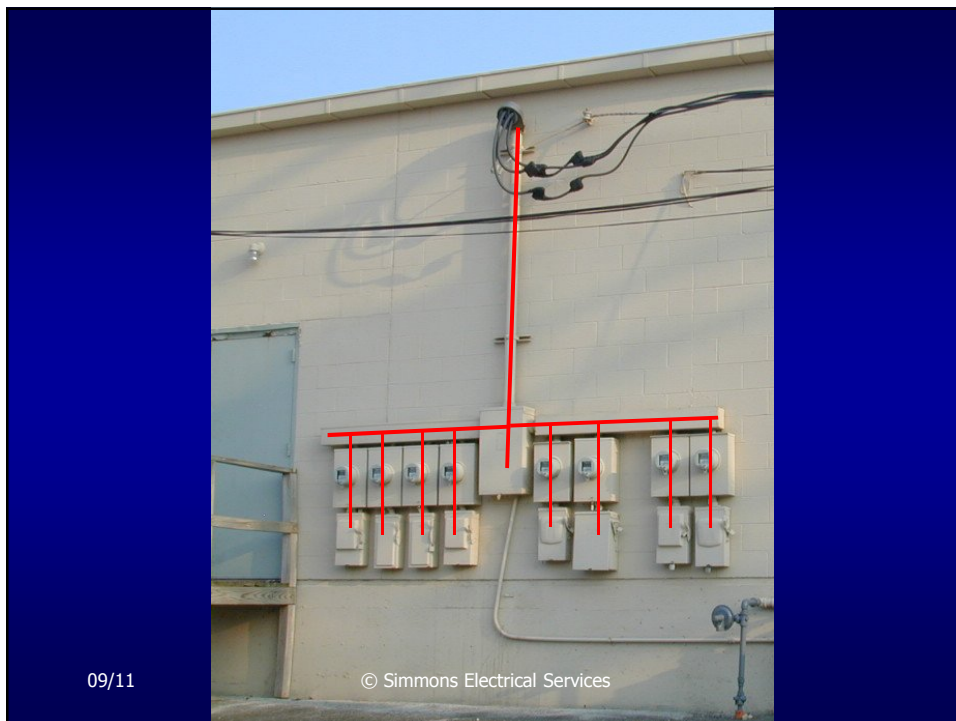
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## 230.90 Overload protection

- *Exception No. 3: Two to six circuit breakers or sets of fuses are permitted as the overcurrent device to provide the overload protection. The sum of the ratings of the circuit breakers or fuses are permitted to exceed the ampacity of the service conductors, provided the calculated load does not exceed the ampacity of the service conductors.*

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## 230.90 Overload protection

- *Exception No. 4: Overload protection for fire pump supply conductors must conform with 695.4(B)(1).*
- *Exception No. 5: Overload protection for 120/240-volt, 3-wire, single-phase dwelling services is permitted in accordance with the requirements of 310.15(B)(6).*

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**Table 310.15(B) (7)**

Table 310.15(B)(6) Conductors Types and Sizes for 120/240-Volt, 3-Wire, Single-Phase Dwelling Service and Feeders.

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

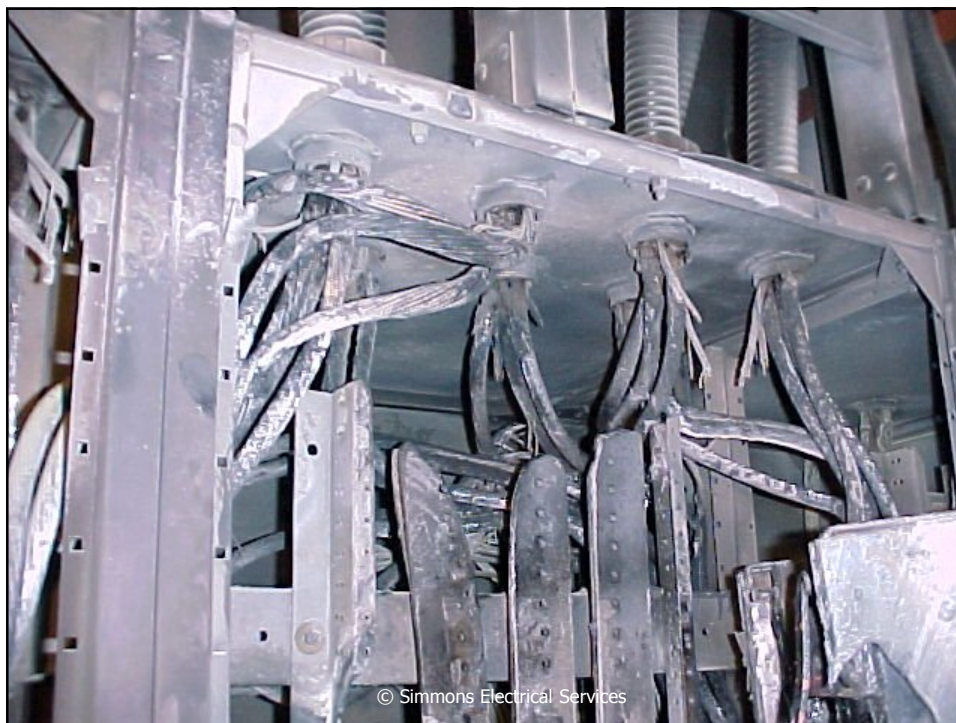
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## **230.95 Ground-Fault Protection of Equipment**

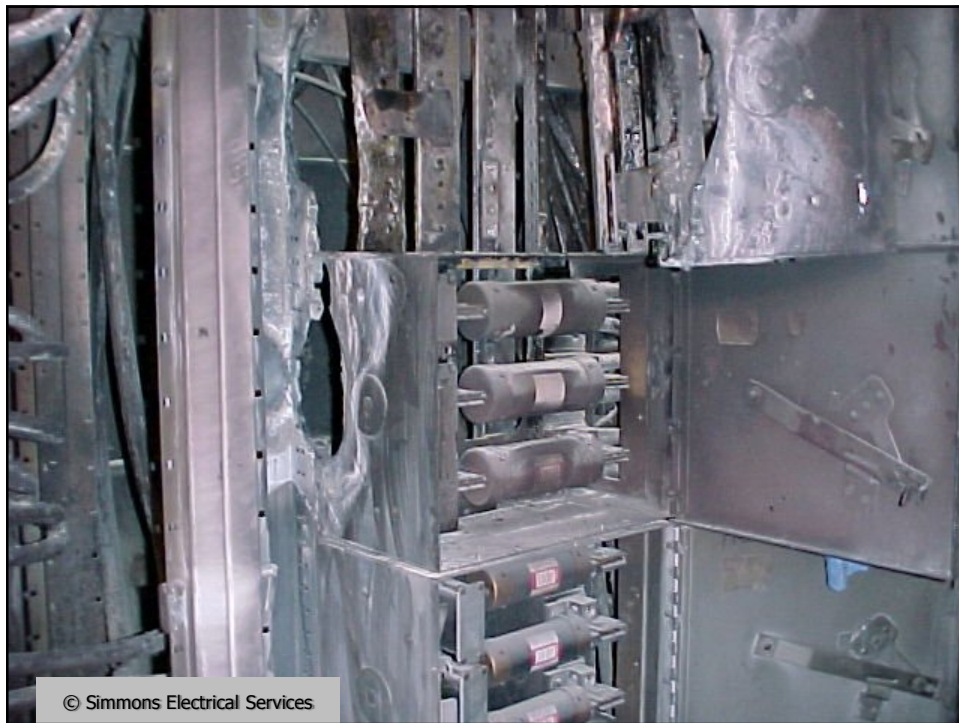
- Ground-fault protection of equipment must be provided for solidly grounded wye electrical services of more than 150 volts to ground but not exceeding 600 volts phase-to-phase for each service disconnect rated 1000 amperes or more.
- The grounded conductor for the solidly grounded wye system must be connected directly to ground through a grounding electrode system, as specified in 250.50, without inserting any resistor or impedance device.

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## **230.95 Ground-Fault Protection of Equipment**

- The rating of the service disconnect shall be considered to be the rating of the largest fuse that can be installed or the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted.

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## **230.95 Ground-Fault Protection of Equipment**

- *Exception: The ground-fault protection provisions of this section shall not apply to a service disconnect for a continuous industrial process where a nonorderly shutdown will introduce additional or increased hazards.*

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## *Article 100*

- Solidly Grounded — Definition.  
Connected to ground without inserting  
any resistor or impedance device.

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## **230.95 Ground-Fault Protection of Equipment**

- (A) Setting. The ground-fault protection system shall operate to cause the service disconnect to open all ungrounded conductors of the faulted circuit. The maximum setting of the ground-fault protection shall be 1200 amperes, and the maximum time delay shall be one second for ground-fault currents equal to or greater than 3000 amperes.

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## **230.95 Ground-Fault Protection of Equipment**

- (B) Fuses. If a switch and fuse combination is used, the fuses employed shall be capable of interrupting any current higher than the interrupting capacity of the switch during a time that the ground-fault protective system will not cause the switch to open.

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## **230.95 Ground-Fault Protection of Equipment**

- (C) Performance Testing. The ground-fault protection system must be performance tested when first installed on site.
- The test must be conducted in accordance with instructions that shall be provided with the equipment.
- A written record of this test must be made and shall be available to the authority having jurisdiction.

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## **Summary**

- Many definitions in Article 100 related to services have changed for the 2011 NEC
- Effort was made to more accurately align the NEC rules to the premises wiring system (on the load side of the "Service Point")
- While the general requirement is for "one service," many provisions are made for additional services

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## Summary

- Specific wiring methods are required to provide adequate protection of the service conductors.
- The location of service equipment inside a building or structure is restricted as the conductors do not have overcurrent protection.
- Following the requirements in Article 230 will result in an installation that is safe.

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## Acknowledgements

- I appreciate the contribution of IAEEI in supplying several of the photographs for this project.

*Phil Simmons*

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