PROFESSIONAL REGULATION COMMISSION

BOARD OF ELECTRICAL ENGINEERING

Philippine Electrical Code Part 1 2017 Ed. – Highlights and Impacts

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Board of Electrical Engineering

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- How many new Articles where included in the PEC 2017 that are not in the PEC 2009?
- How will you know if these Article or Section where the new changes in PEC 2009?
- For PEC 2017?

Philippine Electrical Code Part I 2017 Edition

- The Energy Regulatory Commission adopts the PEC Part 1 and Part 2 set by the Professional Regulation Commission as Safety Standards for Generation Companies, Transmission Providers , Distribution Utilities and Suppliers in the Philippine Grid Code (PGC) and Philippine Distribution Code (PDC).
- Also adopted in the Occupational Safety and Health Standards by the BWC-DOLE as a "Electrical Safety Standard" (Rule 1210-Electrical Safety).

RULE 1210: ELECTRICAL SAFETY

- What standards on Electrical Safety must be adopted to safeguard any person employed in any workplace?

  - *The **Philippine Electrical Code** is hereby adopted & the standards contained therein shall be considered safety standards*

The Philippine Grid/Distribution Codes

Performance Standards & Connection Req'ts

- *Power Quality*
- *Reliability*
- *System Loss*

The Philippine Electrical Code Part 1 & 2

Safety Standards

- *Design and Specifications*
- *Installation*
- *Operation & Maintenance*

GRID/DISTRIBUTION ELECTRICAL DESIGN & INSTALLATIONS

Philippine Electrical Code Part I 2017 Edition

- Based on 2017 National Electrical Code (NFPA 70)
- The Philippine Electrical Code Part 1 2009 Edition was based on NEC 2005
- The Fire Code for the Safe Use of Electricity
- Minimum Electrical Safety Standard

The National Electrical Code

- The first documented case of a Code as a requirement of rules was published on 16th Nov. 1881 entitled "The Dangers of Electric Lighting".
- The first NEC was developed in 1897, eighteen after the invention of incandescent light bulb by Thomas A. Edison.
- Since 1911, the NFPA of Quincy, Massachussets, has been responsible for the maintenance and publication of the NEC.
- Regularly revised (every three years) to reflect the evolution of products, materials, and installation techniques.
- 21 Separate Committee, each consisting of 15-20 persons. Members of each committee meet several times, discuss proposed changes, accepting some and rejecting others, and rewrite (as required) the sections of the Code that were assigned to their committee.

Philippine Electrical Code Part I 2017 Edition

- Based on 2017 National Electrical Code (NFPA 70)
- The Philippine Electrical Code Part 1 2009 Edition was based on NEC 2005
- Regularly revised (every three years) to reflect the evolution of products, materials, and installation techniques.
- NEC 2008, NEC 2011, NEC 2014 & NEC 2017
- NEXT NEC REVISION: NEC 2020, 2023, 2026, 2029

THE PHILIPPINE ELECTRICAL CODE KEY TO ELECTRICAL SAFETY AND FIRE PREVENTION

PURPOSE OF PEC

The primary objective of the code is to establish basic materials quality and electrical works standards for the safe use of electricity for light, heat, power, communications, signaling and for other purposes.

" Practical safeguarding of persons and property from hazards arising from the use of electricity "

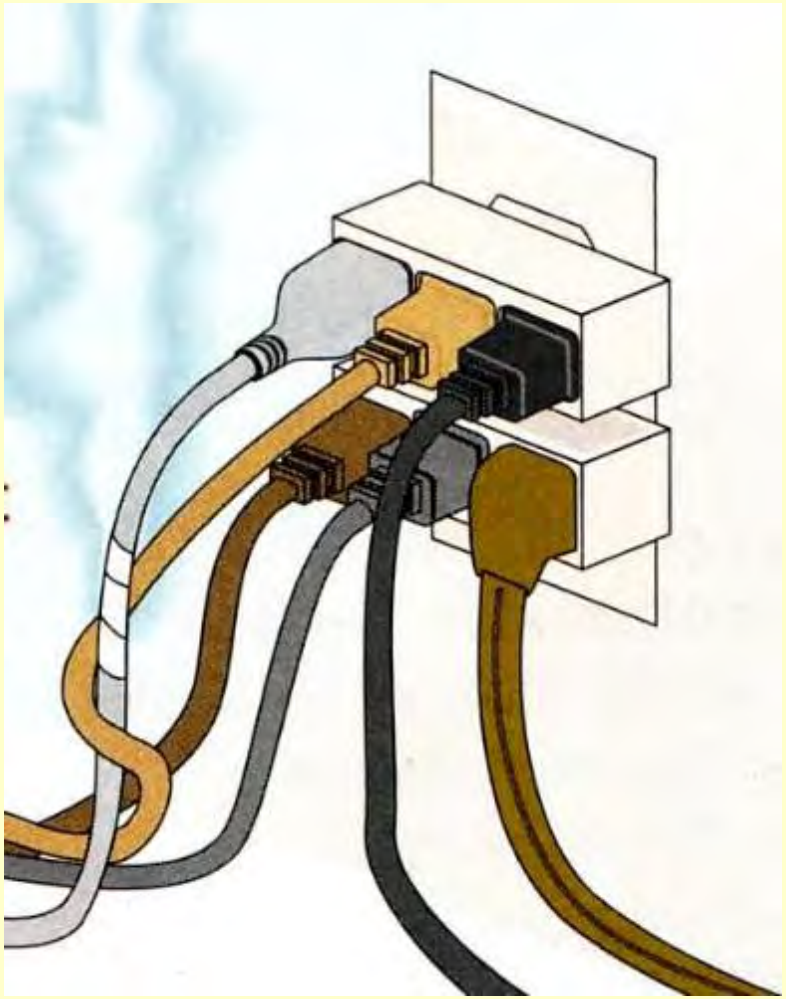
COMPLIANCE TO THE PEC WILL ENSURE SAFETY AND PREVENT ELECTRICAL FIRES

Philippine Electrical Code Part I 2017 Edition

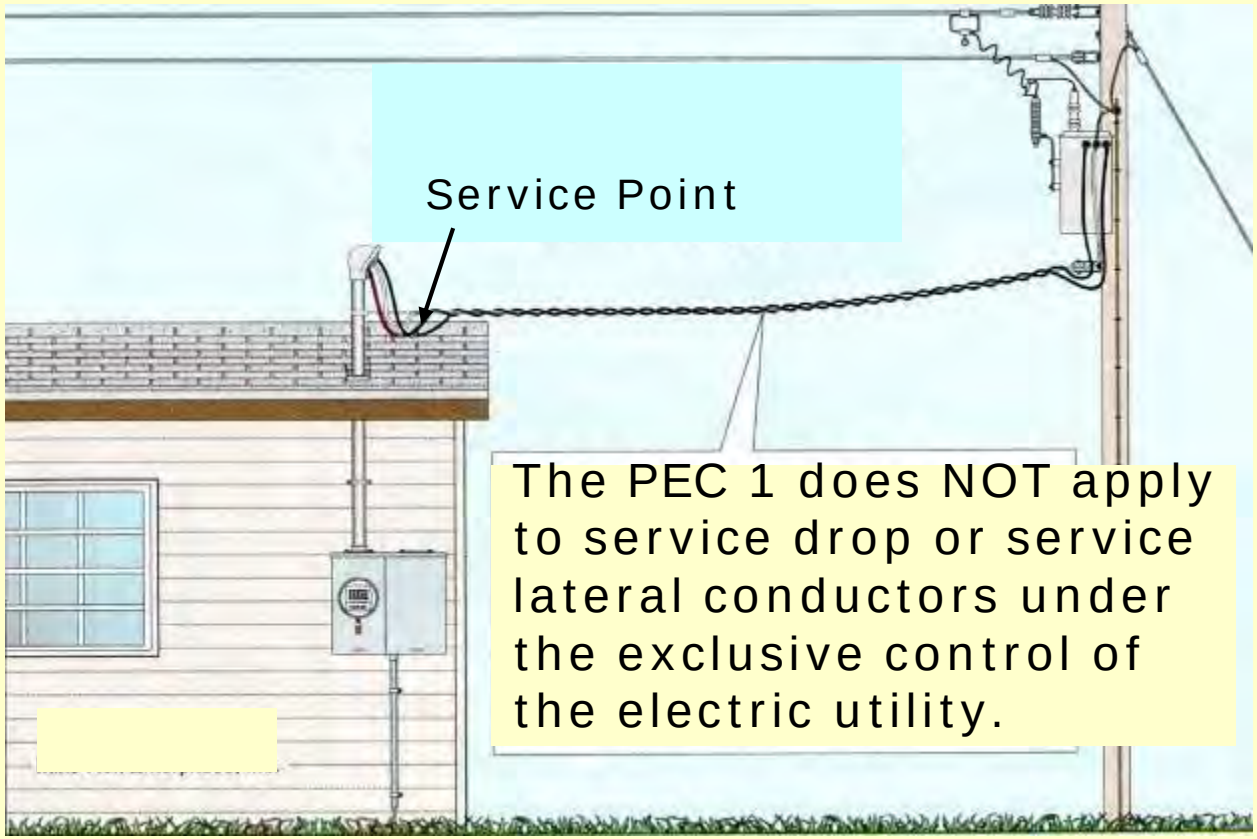
This Code is intended as a design specification or an instruction manual for qualified persons. Electrical designs must comply with the requirements of Code to ensure safety.

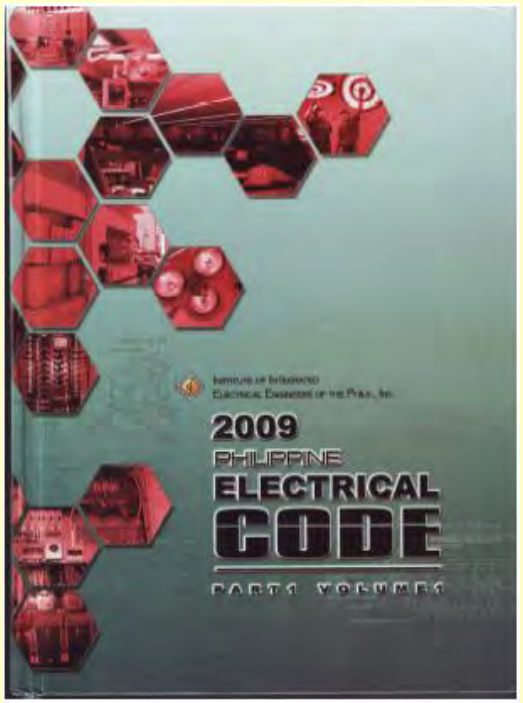
Energy management, maintenance, and power quality issues aren't within the scope of the Code.

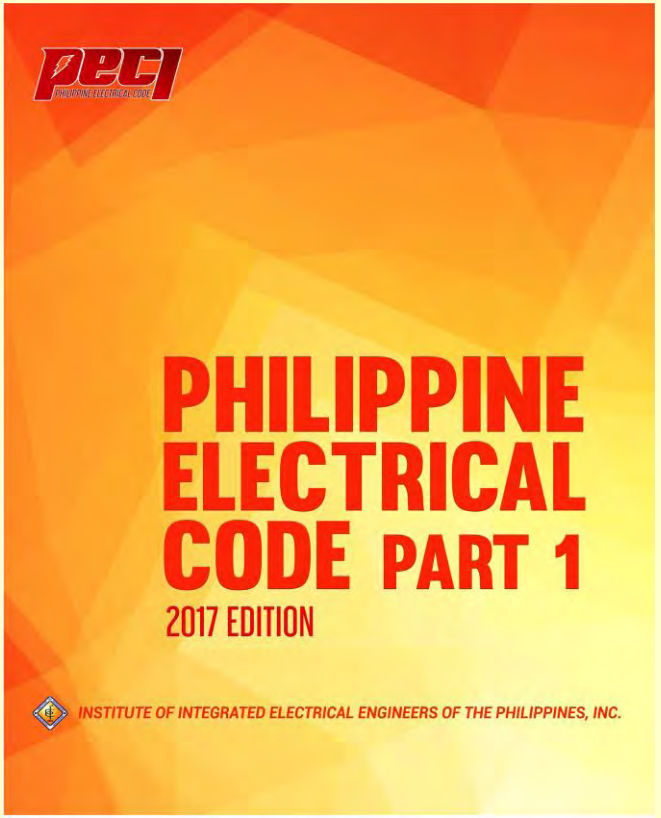
Consideration should be given for future expansion of electrical systems but this is not a Code requirement.



Boundary: PEC 1 and PEC 2







No more Part Ia and Part Ib;
In A4 size of paper!
Large font size!

PRBEE Res. No. 18 Series of 2017

- Adoption of the 9th Edition of the Revised Philippine Electrical Code Part 1 as part of the rules and regulations governing the practice of electrical engineering and as referral code in accordance with the National Building Code.
- The resolution was signed by the Chairman FVM and Member JVM on 10 Nov. 2017.

PRBEE Res. No. 18 Series of 2017

- Approved by the Professional Regulatory Commission : Chairman Teofilo S. Pilando Jr., Commissioner Yolanda D. Reyes and Commissioner Jose Y. Cueto, Jr.
- The resolution and Annex shall take effect after fifteen (15) days following their full and complete publication in the Official Gazette.
- Date of Publication in the Official Gazette: Nov. 17, 2017.
- Date of Effectivity: December 2, 2017.

Changes in Chapter I

1.0.1.1 (C)

This Code is intended as a design specification or an instruction manual for qualified persons.

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This Code is intended for the exclusive use of licensed electrical practitioners. This Code is not intended as a design specification nor an instruction manual for a non-licensed electrical practitioner, unless under the supervision of a licensed electrical practitioner.

Chapter 1. General
Article 1.0- Introduction

Impacts of Art. 1.0.1.1 ©

- The Code are now not for exclusive used of licensed electrical practitioners.
- It more accessible even to non-electrical personnel. Remember : "SAFETY is EVERYBODY Business"
- Qualified Person –One who has qualifications, 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.

1.0.1.4 Enforcement

(A) This Code is intended for mandatory application by the Office of the Building Official/EE over electrical installations.

(a) This Code is intended for mandatory application by government bodies exercising legal jurisdiction over electrical installations.

1.0.1.4 Enforcement

(B) The Office of the Building Official/EE shall have the responsibility of implementing the provisions of this Code.

(b) These government bodies, only through a licensed electrical practitioner, shall have the responsibility of implementing of this Code provision in deciding on the approval of equipment and for granting the special permission contemplated in this Code, where it is assured the equivalent objectives can be achieved by establishing and maintaining effective safety.

1.0.1.4 Enforcement

(C) This Code may require new products, constructions, or materials that may not yet be available at the time this Code is adopted. In such event, the Office of the Building Official/EE may permit the use of the products, constructions, or materials that comply with the most recent previous Edition of this Code adopted by the National Building Code.

(d) This Code may require new products, constructions, or materials that may not yet be available at the time this Code is adopted. In such event, the authority having jurisdiction may permit the use of the products, constructions, or materials that comply with the most recent previous Edition of this Code adopted by the National Building Code.

1.0.1.4 Enforcement

Deleted provision on PEC 2009 Part 1

(c) The authority having jurisdiction may waive specific requirements in this Code or permit alternate methods where it is assured that equivalent objectives can be achieved by establishing and maintaining safety.

Impacts On Enforcement

- The Office of the Building Official are given the clear authority to implement all the provisions of the Code.
- Needs for capacity building of the OBO.
- BOSH and COSH mandatory to all OBO personnel.
- Competency Training on the PEC Part I
- IIEE will provide free training for the OBO as part of its corporate social responsibility and in concerns for public safety. Others industry stakeholders like MERALCO, VECO, CEPALCO, and Davao Light can assists in the capacity building of the OBO.
- JVM – ISR.

1.0.1.6 Interpretation

- Interpretation of this Code shall be by licensed electrical practitioners. In case of conflicting interpretations, these may be referred to the PEC Part 1 Committee for interpretation. Should disagreement remain, thereafter, the Committee's interpretation shall be referred to the Board of Electrical Engineering who shall render the final decision.

- Upon the recommendation of the Code Committee, the Board of Electrical Engineering shall render the final decision in the interpretation of any portion of the PEC Part 1, in case of controversy.

Three-Level of Interpretation

A. Licensed Electrical Practitioners

In case of conflicting interpretation/s

B. PEC Part I Committee

For Final Interpretation/s

C. Board of Electrical Engineering

New Provisions

1.0.1.10 Apprenticeship

(A) RA 7920 or the national electrical engineering law requires apprenticeship as one of the qualifications to the registration and licensure examinations for Registered Master Electrician (RME), in order to practice electrical engineering in the Philippines. Knowledge and understanding of the PEC1 , and PEC2 form part of the examination given.

New Provisions

1.0.1.10 Apprenticeship

(B) An apprentice shall undergo training under a person holding a valid certificate of registration and a valid professional license for the practice of electrical engineering under RA 7920 or the national electrical engineering law.

New Provisions

1.0.1.11 Services of Licensed Electrical Practitioners

For decisions and actions involving a knowledge of electrical engineering and/or training in electrical installations and practices, the services of a licensed electrical practitioner is required.

Art. 1.3- Electrical Plans and Specifications

(F) Design Analysis

Design analysis shall be included on the drawings or shall be submitted on separate sheets of standard size, and shall show:

(1) Branch circuits, sub-feeders, feeders, busways, and service entrance;

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Art. 1.3- Electrical Plans and Specifications

(F) Design Analysis

(2) Types, rating, and trip setting of overload protective devices;

(3) Calculation of voltage drops;

(4) Calculation of short circuit current for determining the interrupting capacity of overcurrent device for residential, commercial, and industrial establishment

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(2) Types, rating, and trip setting of overload protective devices;

(3) Calculation of short circuit current for determining the interrupting capacity of overcurrent device for residential, commercial, and industrial establishment;

(4) Calculation of voltage drops.

Art. 1.3- Electrical Plans and Specifications

(F) Design Analysis

(5) Protection coordination of overcurrent protective devices;

(6) Arc-Flash Hazard Analysis to determine the required personal protective equipment in other than dwelling place.

(F) Design Analysis

None!!!!

Impact of Art. 1.3- Electrical Plans and Specifications

- OBO will NOT accept electrical plans without Technical Analysis.
- Mandatory to all electrical plans
- All Electrical Practitioners needs to know the requirements for Technical Analysis

Highlights of the NEC 2008

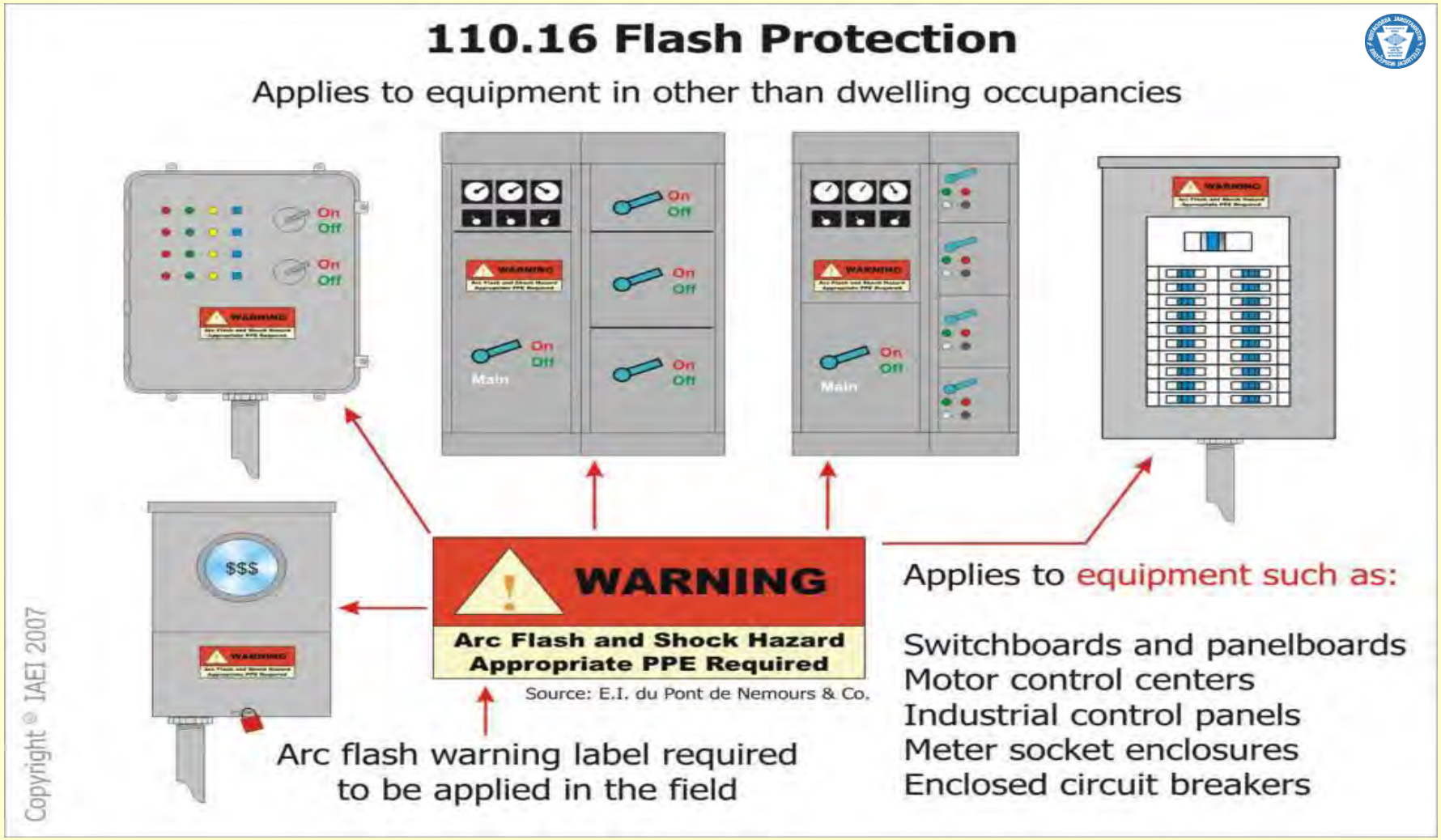
❑ Article 2.50 on Grounding and Bonding

- In Article 100, **grounding and bonding terms** have been redefined and simplified for clarity and improved usability.
  - Bonded (Bonding) – *Revised*
  - Ground – *Revised*
  - Grounded (Grounding) – *Revised*
  - Grounded, Effectively – **Deleted**
  - Grounding Conductor, Equipment (EGC) – *Revised*
  - Grounding Electrode – *Revised*
  - Grounding Electrode Conductor – *Revised*
  - Ungrounded – **New**
  - Neutral Point– **New**
  - Neutral Conductor - **New**

Highlights of the NEC 2008

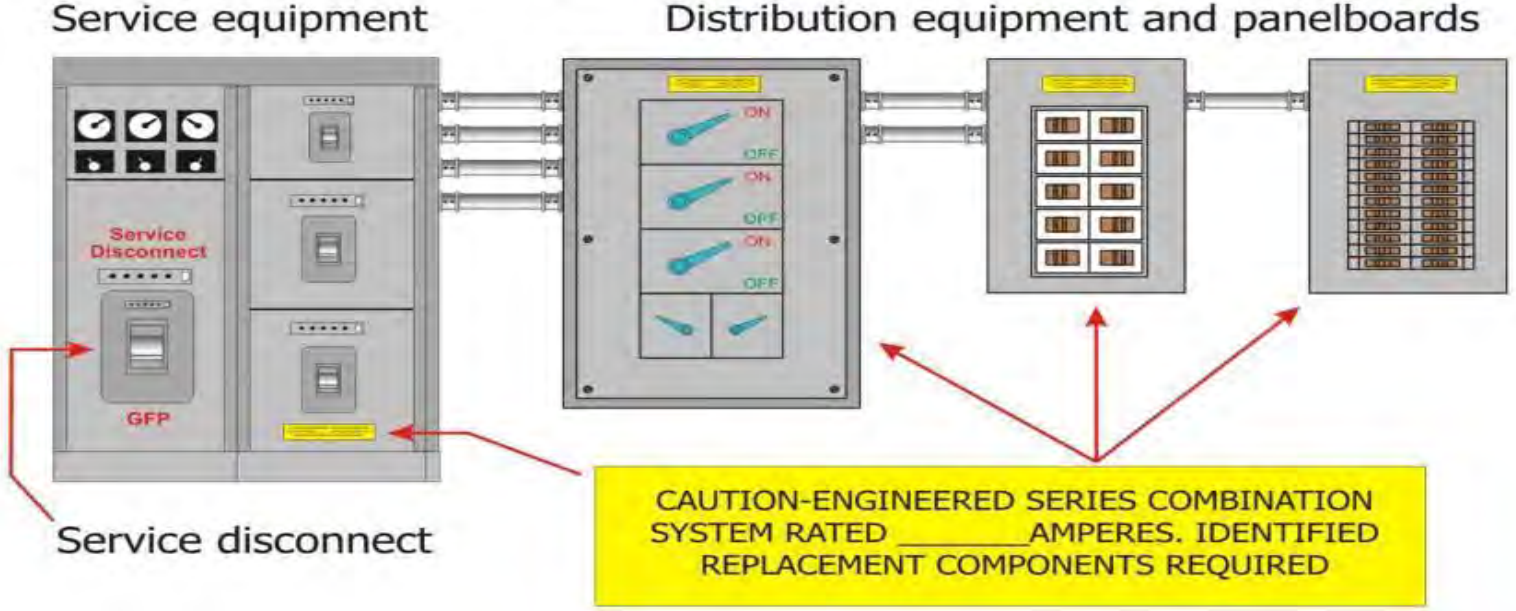
- **Article 7.80** Closed-Loop and Programmed Power Distribution **has been deleted.**
- Four New Articles had been added –
  - **Article 3.55** Reinforced Thermosetting Resin Conduit: Type RTRC
  - **Article 5.22** Control Systems for Permanent Amusement Attractions
  - **Article 6.26** Electrified Truck Parking Space Equipment
  - **Article 7.8** Critical Operations Power Systems (COPS)

Highlights of the NEC 2008



Highlights of the NEC 2008

110.22 Identification of Disconnecting Means



Equipment containing circuit breakers or fuses applied in engineered series combination ratings in accordance with 240.86(A) shall be field marked. The marking is required to be readily visible, located as directed by the engineer, and shall include the specific text shown on the above label example.

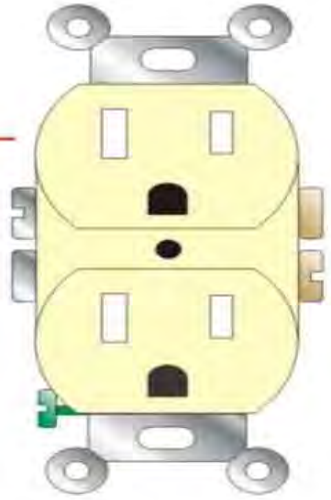
Note that Section 240.86(A) applies to existing installations only.

Highlights of the NEC 2008

406.11 Tamper-Resistant Receptacles in Dwelling Units

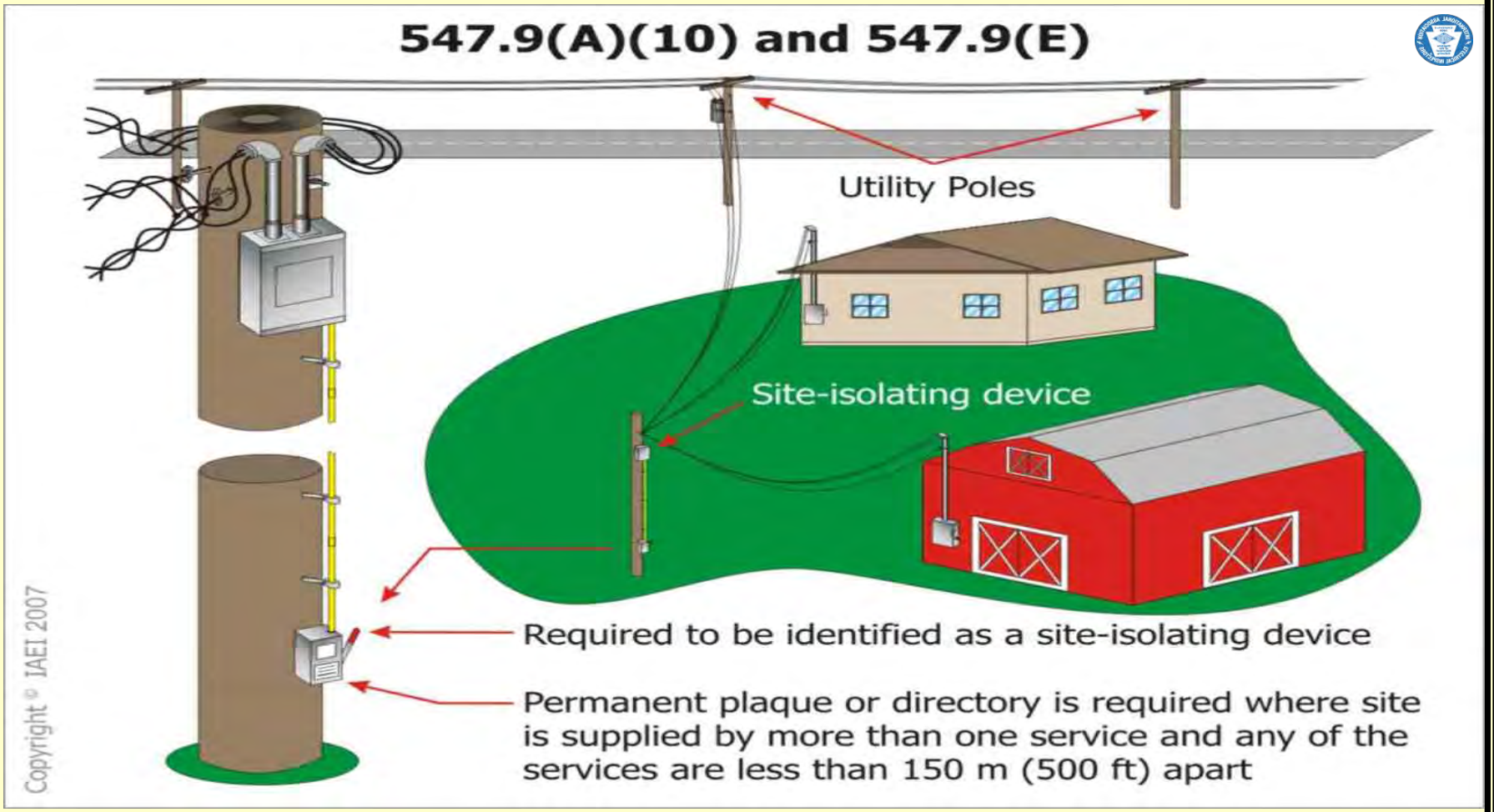
All 125-volt, 15- and 20-ampere receptacles installed in areas specified by 210.52 shall be listed tamper-resistant type.

Dwelling Unit



Tamper-resistant receptacles

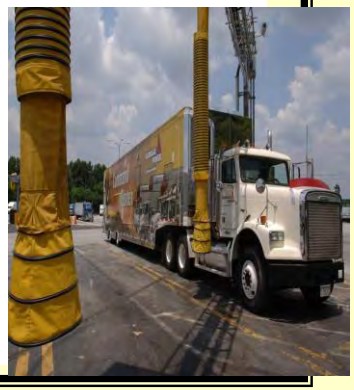
Highlights of the NEC 2008



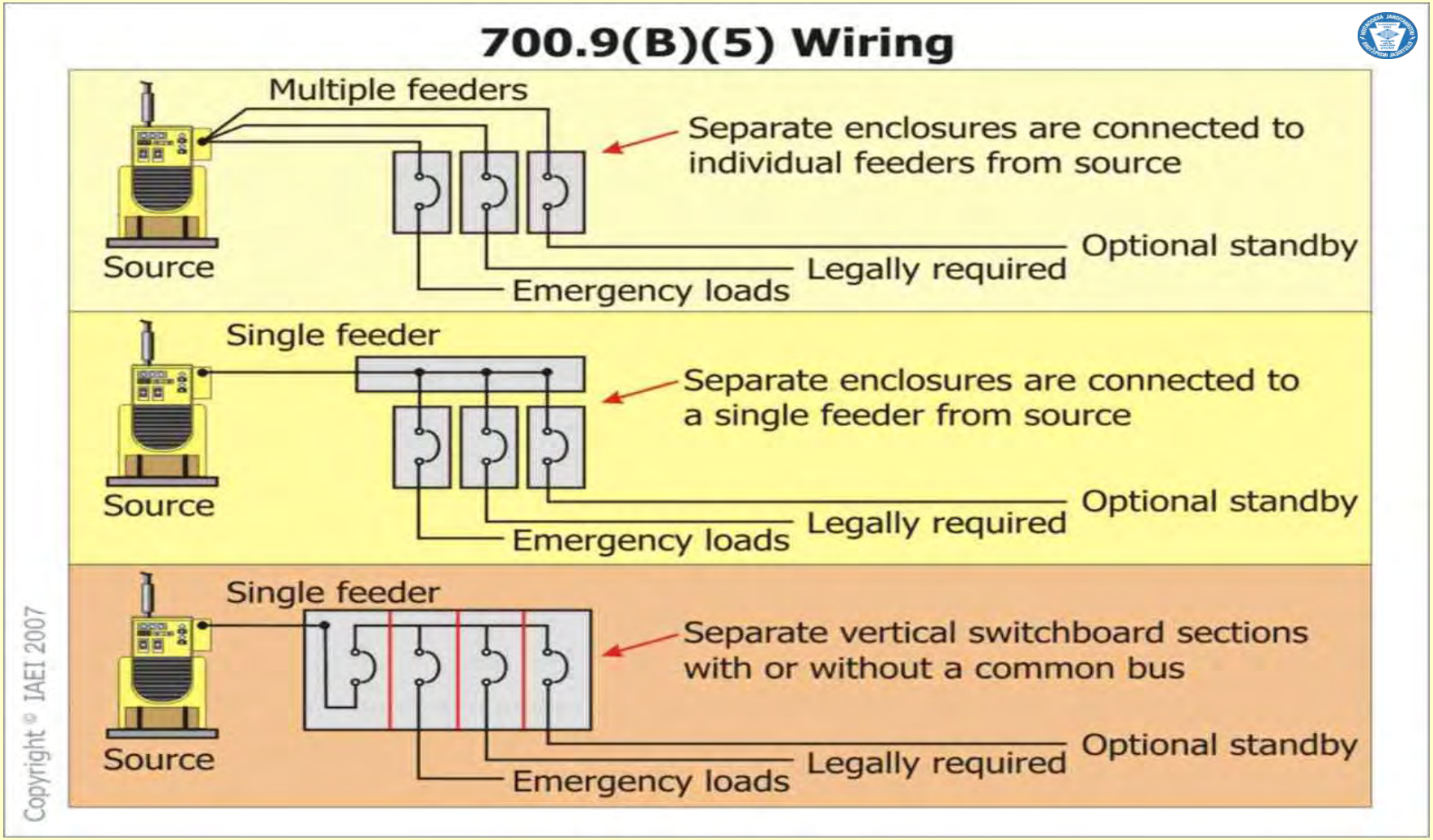
Highlights of the NEC 2008

Article 626 Electrified Truck Parking Space

- This new article resulted from concerns of regulatory agencies and environmental groups about reducing idling truck emissions.
- Part I. General
- Part II. Electrified Truck Parking Space Electrical Wiring Systems
- Part III. Electrified Truck Parking Space Supply Equipment
- Part IV. Transport Refrigerated Units (TRUs)



Highlights of the NEC 2008



Highlights of the NEC 2008

Article 708 Critical Operations Power Systems (COPS)

- This new article is the result of work by the NEC TCC-assigned Task Group on Emergency and Standby Power Systems for Homeland Security.
- The objectives were to identify current minimum requirements that do not adequately address the level of integrity and quality for power sources, power distribution, and signaling systems required due to threats and/or acts of terrorism, manmade disasters and natural disasters.
- Article 708 Critical Operations Power Systems (COPS)

  Part I. General
  Part II. Circuit Wiring and Equipment
  Part III. Power Sources and Connection
  Part IV. Overcurrent Protection
  Part V. System Performance and Analysis

Highlights of the 2011 NEC (Cont'd.)

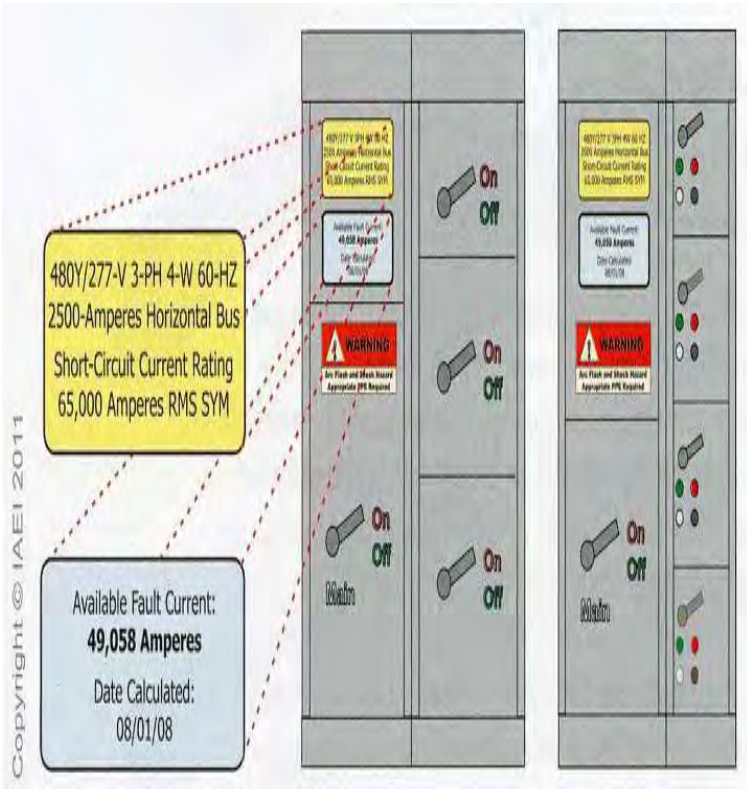
Highlights of the NEC 2011

Article 110:

110.24 Available Fault Current.

(A) Field Marking. 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.

(B) Modifications. When modifications to the electrical installation occur that affect the maximum available fault current at the service, the maximum available fault current shall be verified or recalculated as necessary to ensure the service equipment ratings are sufficient for the maximum available fault current at the line terminals of the equipment. The required field marking(s) in 110.24(A) shall be adjusted to reflect the new level of maximum available fault current.



Exception: The field marking requirements in 110.24(A) and 110.24(B) shall not be required in industrial installations.

Highlights of the NEC 2011

- Three New Articles had been added.
  - Article 3.99– Outdoor, Overhead Conductors Over One Thousand V
  - Article 6.94 – Small Wind Electric Systems
  - Article 840 – Premises-Powered Broadband Communication Systems

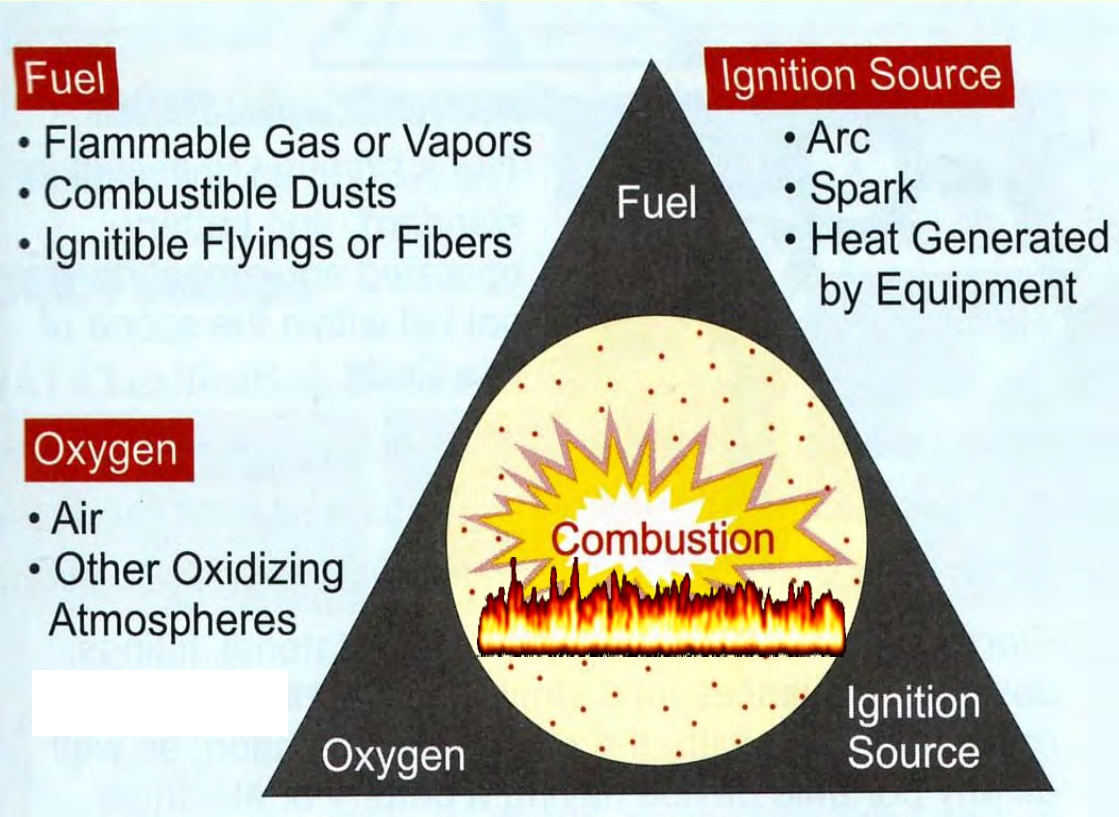
Highlights of the NEC 2014

- Four New Articles were added:
  - Article 3.93 Low Voltage Suspended Ceiling Power Distribution
  - Article 6.46 Modular Data Centers
  - Article 7.28 Fire Resistive Cable Systems
  - Article 7.50 Energy Management Systems

Highlights of the NEC 2017

- Five New Article
  - Article 4.25 Fixed Resistance And Electrode Industrial Process Heating Equipment
  - Article 6.91 Large Scale PV Electric Power Production Facility
  - Article 7.6 Energy Storage System
  - Article 7.10 Stand Alone System
  - Article 7.12 DC Microgrids

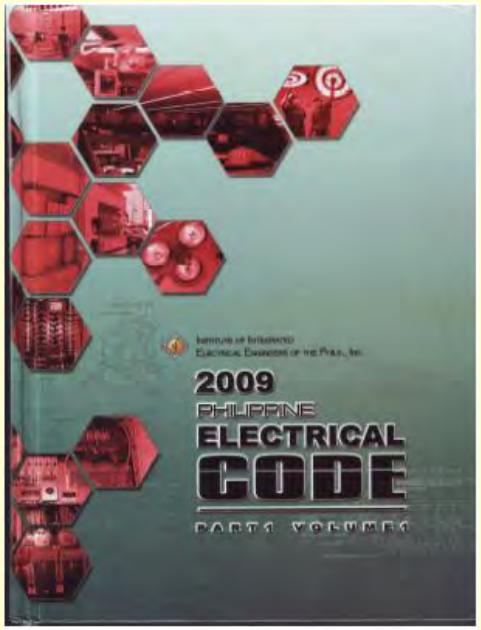
Components that Create a Fire or Explosion



In the Installation Rules , one element of the Triangle of Fire is removed to make the installation safe.

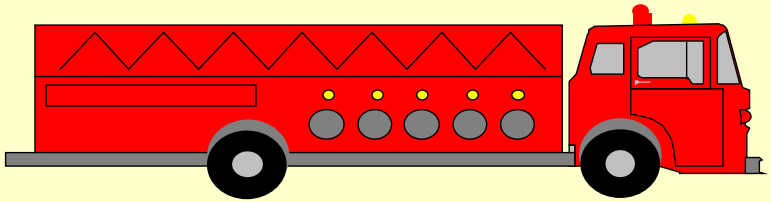
Why Change the PEC ?

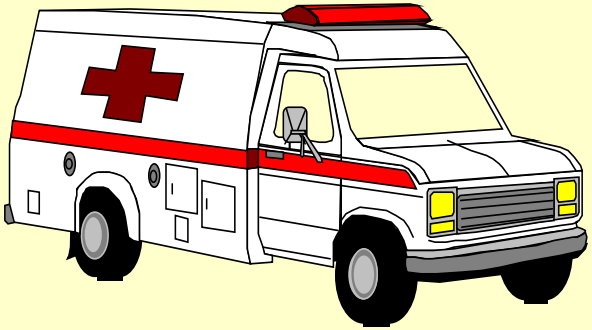
- A need is identified!
- Changes are necessary for:
  - Editorial improvements
  - Improve clarity and usability
  - Technical revisions
  - Existing provision became unsafe
  - New technologies and requirements
  - New products and equipment
- Electrical safety is the deciding factor!



Why Changes Are Necessary?

- Hazards to persons or property
  - Fire
  - Electric Shock
  - Safety





Changes are necessary for:

- Editorial improvements
- Device
  - A unit of an electrical system that is intended to carry or control but not utilize electric energy. (2009 PEC)
  - A unit of an electrical system that carries or controls electric energy as its principal function. (PEC 2017)

Change Significance

- The definition of device has been editorially revised for usability and clarity.
- The revision is intended to clarify that a device has the primary function of carrying and controlling electric energy or current.
- For example, this revision clarifies that a snap switch with a pilot light is a device because its principal function is to carry and control electrical energy.

Changes are necessary for:

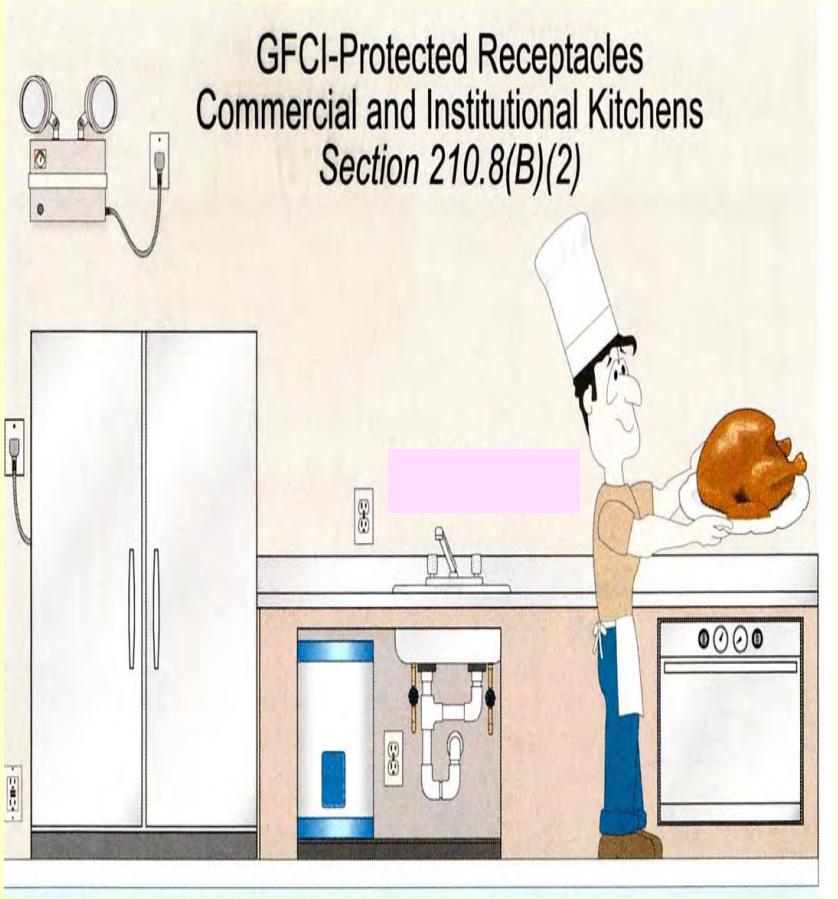
- Improve clarity and usability
  - Bonded (Bonding)- The permanent joining of metallic parts to form an electrically conductive path that ensures electrical continuity and the capacity to conduct safely any current likely to be imposed. (PEC 2009)
  - Bonded (Bonding)- Connected to establish electrical continuity and conductivity. (PEC 2017)

Change Significance

- The revision provides clarity by simply describing the purpose and function of bonding.
- The purpose of bonding is to connect two or more conductive objects together to:
  1. Ensure the electrical continuity of the fault current path
  2. Provide the capacity and ability to conduct safely any fault current likely to be imposed, and
  3. Minimize potential differences between conductive components.

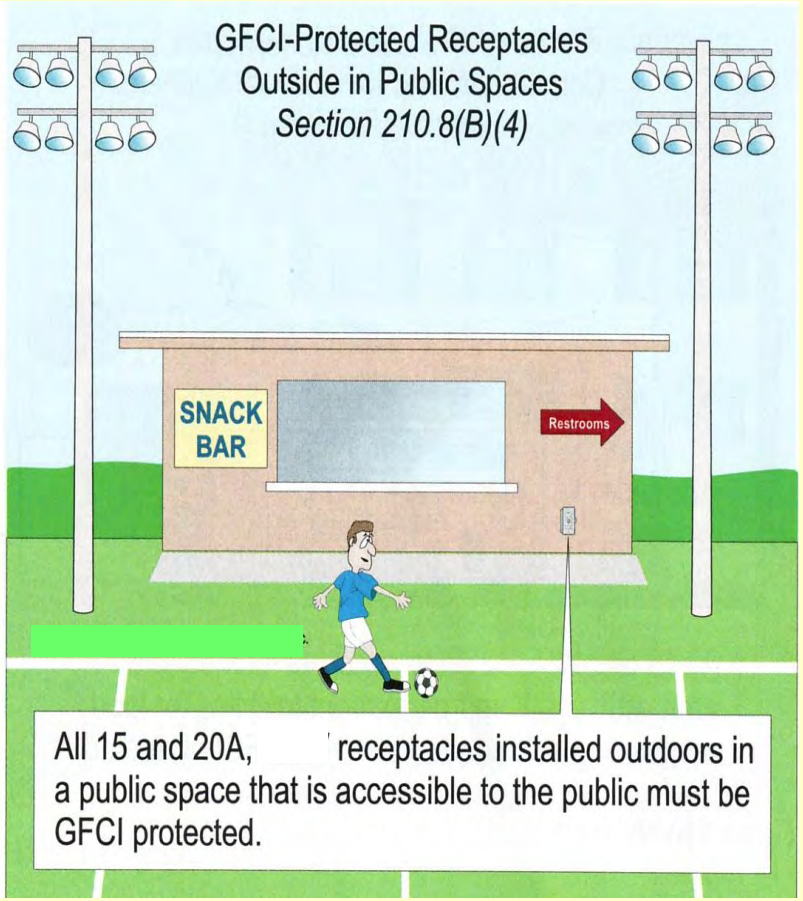
Changes are necessary for:

- New Provision
- 2.10.1.8(b)(2) –GFCI Protection Other than Dwelling (PEC 2017)
  - Commercial and institutional kitchens – for the purposes of this section, a kitchen is an area with a sink and permanent facilities for food preparation and cooking. (Culinary Schools)



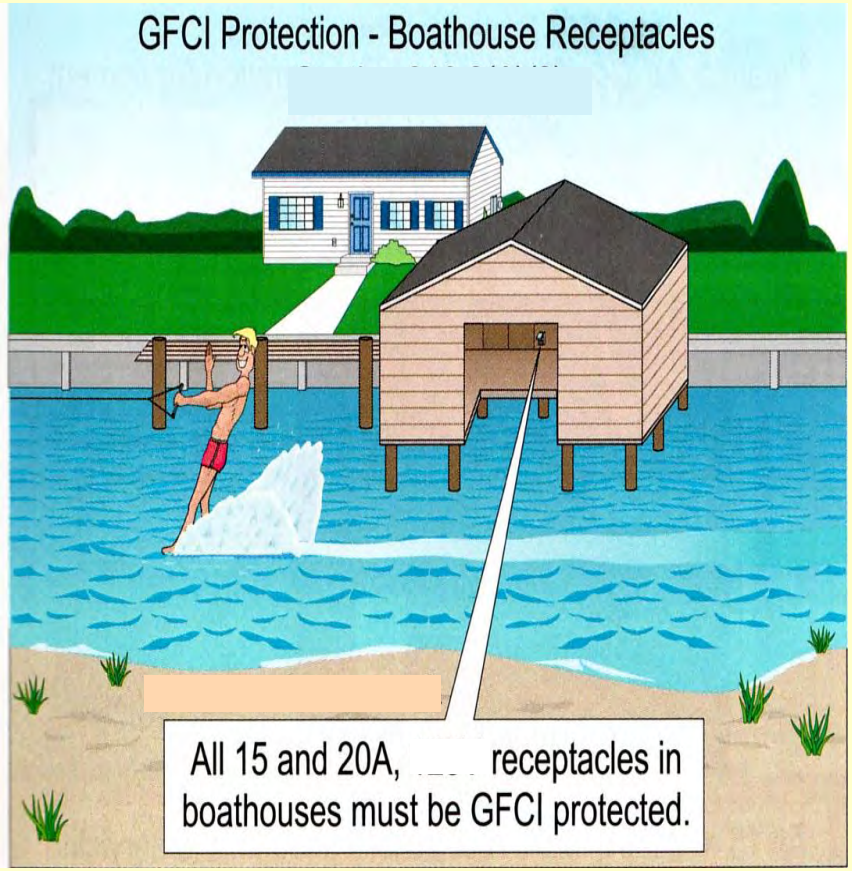
Changes are necessary for:

- New Provision
- 2.10.1.8(b)(4) –GFCI Protection Other than Dwelling
  - Outdoor in Public Spaces – for the purpose of this section a public space is defined as any space that is for use by, or is accessible to the public.



Changes are necessary for:

- New Provision
- 2.10.1.8(c)Boat Hoists
  - GFCP for personnel shall be provided for outlets that supply boat hoists installed in dwelling unit locations

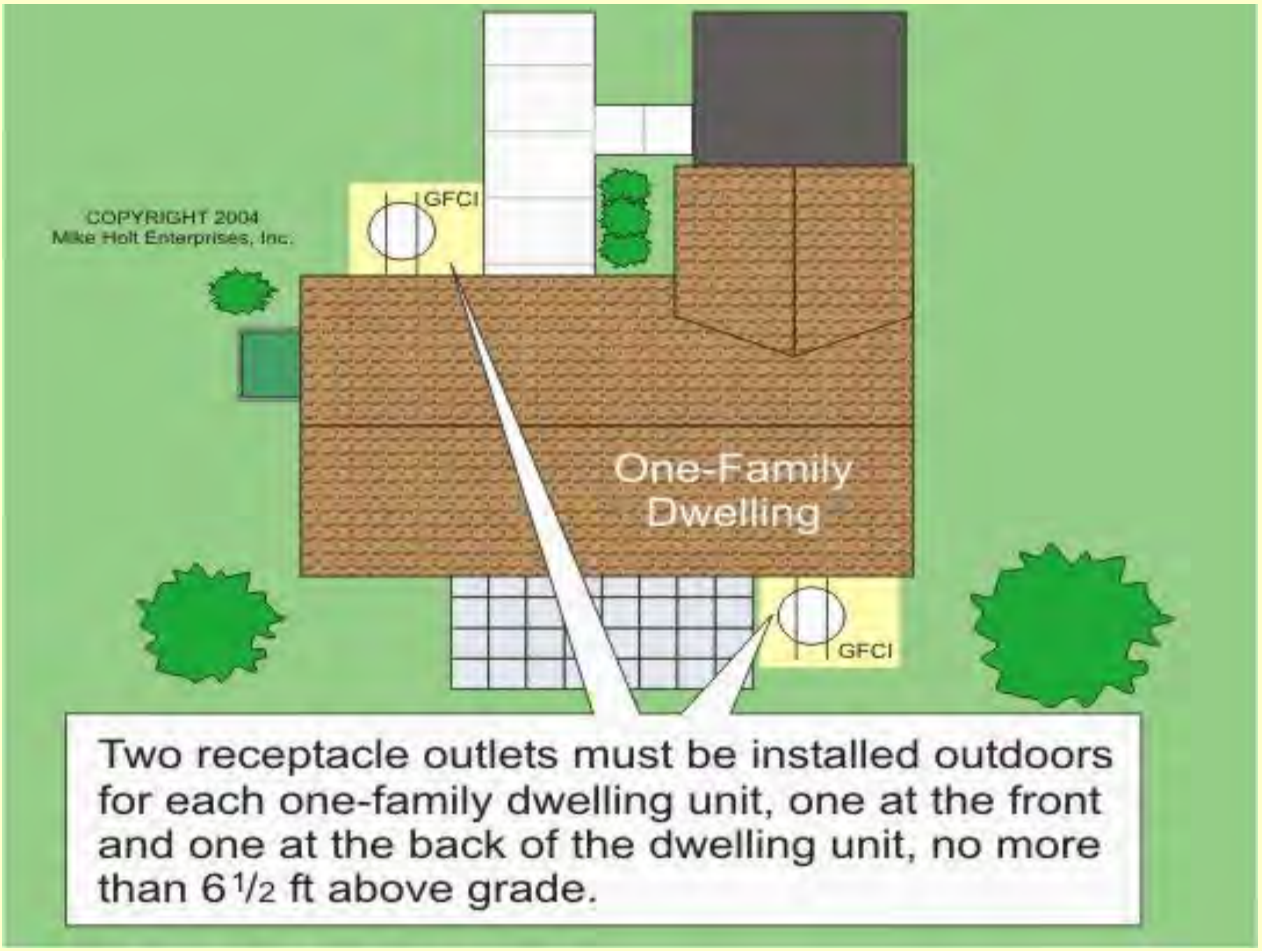


Changes are necessary for:

- New Provision
- 2.10.1.8(b)(5) –GFCI Protection Other than Dwelling
  - (5)Outdoor , where installed to comply with 2.10.3.14 Heating, Air-conditioning, and Refrigeration Outlet

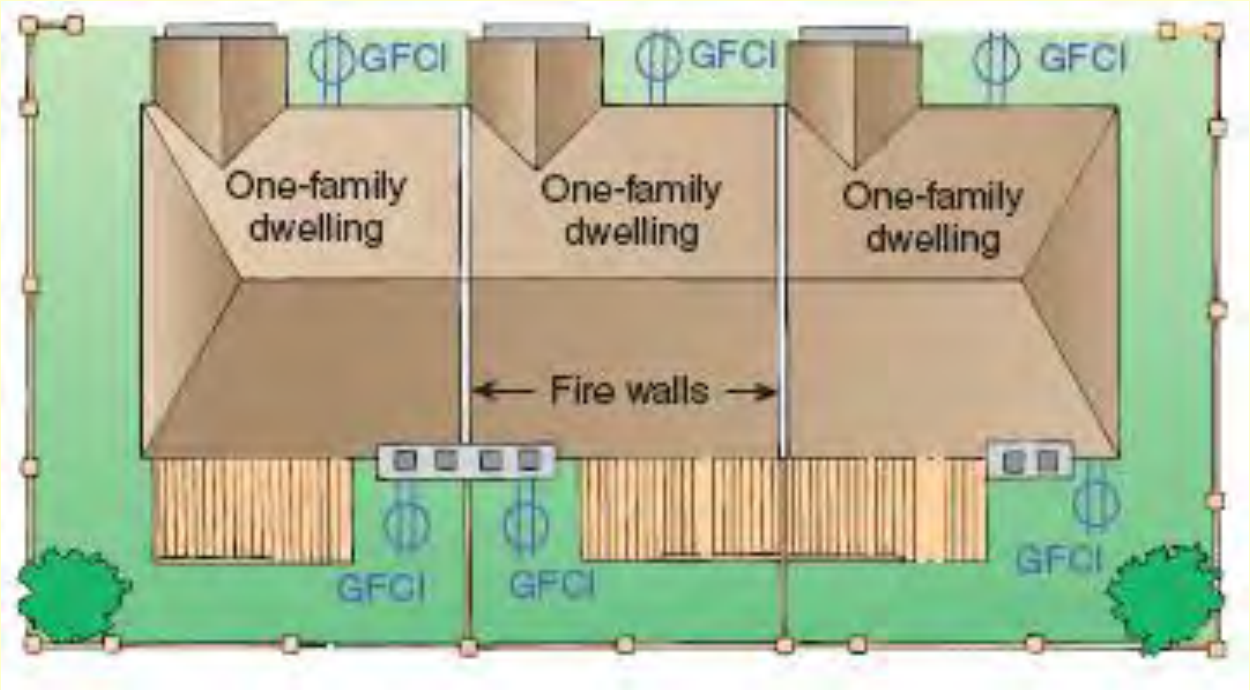
Changes are necessary for:

- New Provision-Outdoor receptacle Outlets for One Family Dwelling



Changes are necessary for:

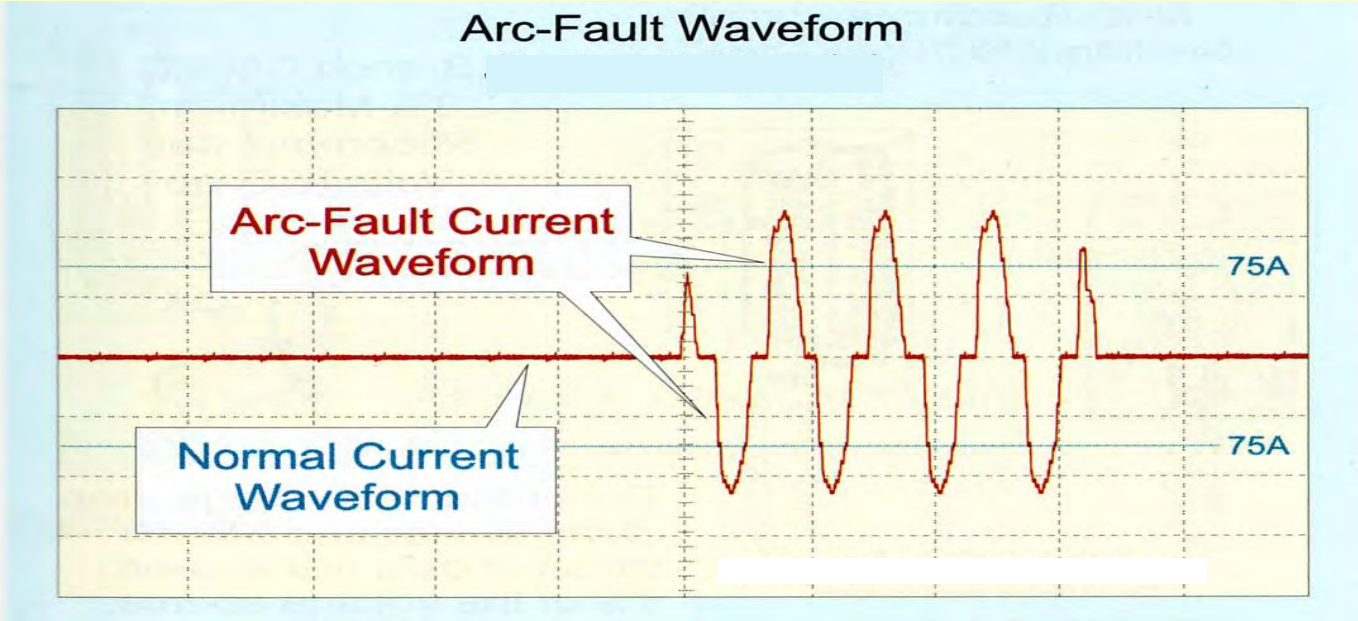
- New Provision



Row Housing with GFCI-protected receptacles located at the front and the back of each one family dwelling, as required by 210.52(E)

Changes are necessary for:

- New technologies and requirements
- Arc-Fault Circuit Interrupter

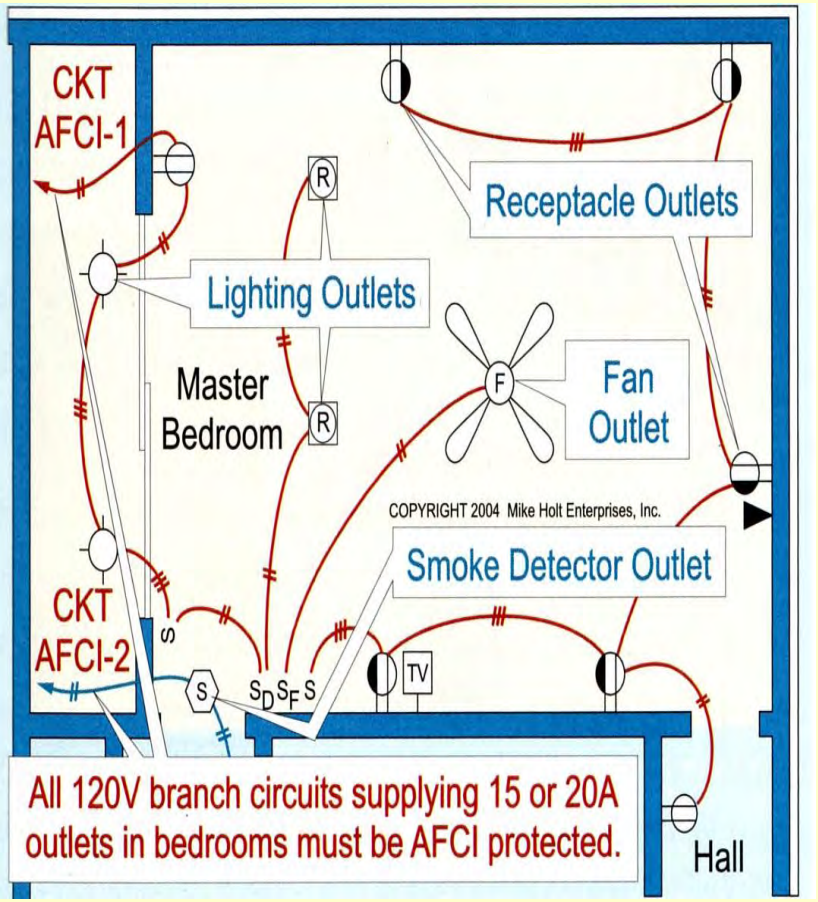


An AFCI is a device intended to open the circuit when it detects the current waveform characteristics that are unique to an arcing fault.

Changes are necessary for:

- New technologies and requirements
- 2.10.1.12.Arc-Fault Circuit Interrupter Protection

  (b) Dwelling Unit Bedrooms – All single phase, 15 and 20 A branch circuits supplying outlets installed in dwelling unit bedrooms shall be protected by a listed AFCI. Combination type installed to provide protection of the branch circuit.



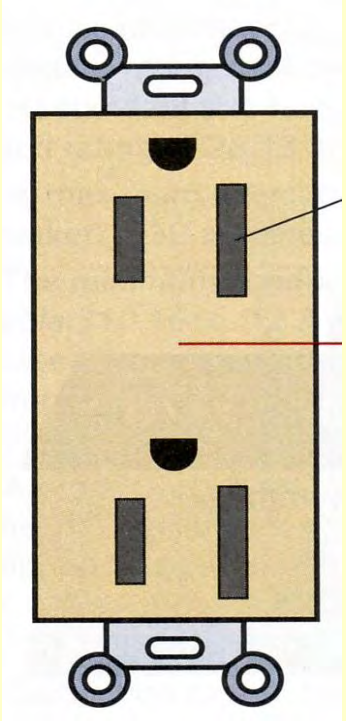
AFCI

Tamper-Resistant Receptacles

- 406.12 All 15- and 20-A 230V nonlocking-type receptacles in the following areas shall be listed tamper-resistant receptacles
  1. Dwelling Units
  2. Guest rooms and guest suites of hotels and motels
  3. Child care facilities
  4. Preschools and elementary education facilities
  5. Business offices, corridors, waiting rooms and the like in clinics, medical and dental offices and out patient facilities
  6. Places of waiting transportation, gymnasiums, skating rinks, and auditoriums
  7. Dormitories

Changes are necessary for:

- New products and equipment
- Resistant Receptacles in Dwellings Unit (NEC 2017-406.12)



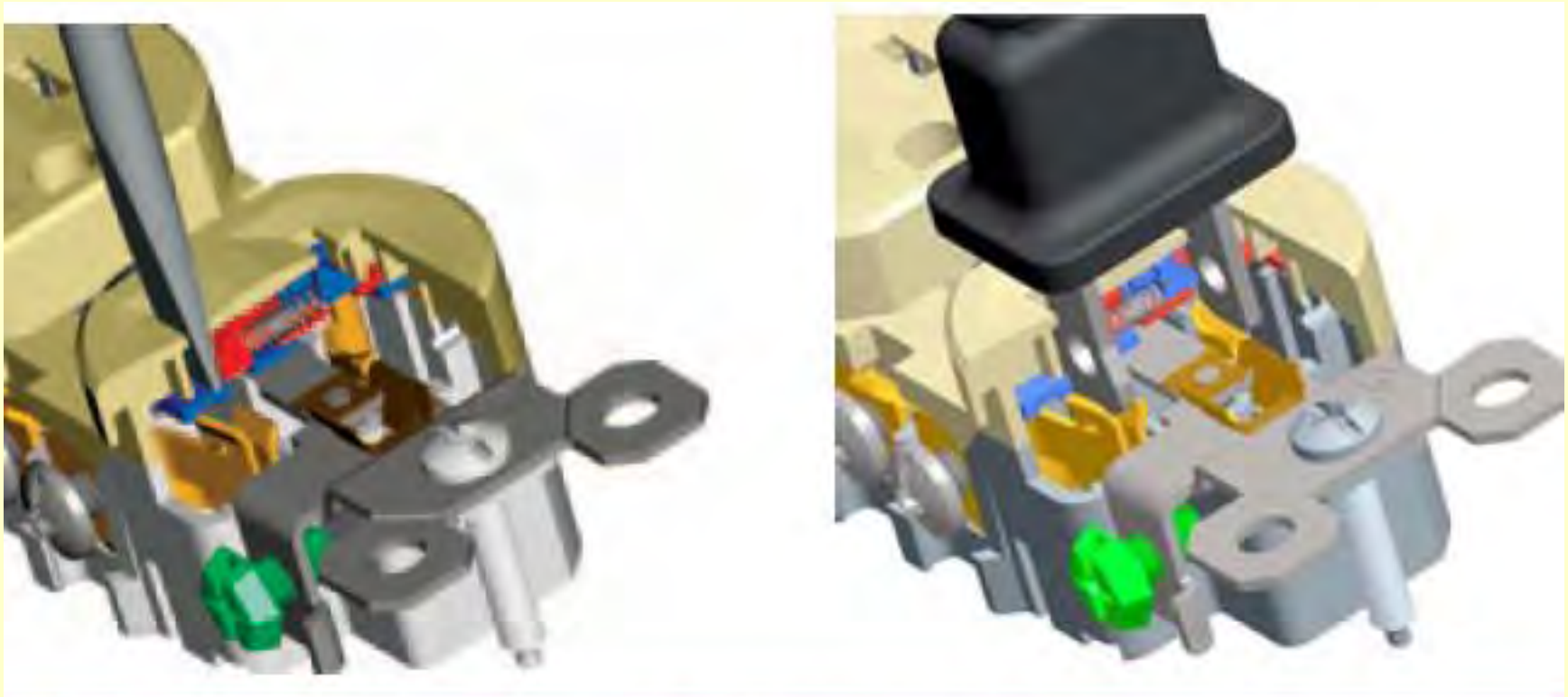
Why do you think it is a tamper-resistant receptacle?

…..To increase safety for children.

…..maybe that your son, daughter, or grandchildren that you will save…

Changes are necessary for:

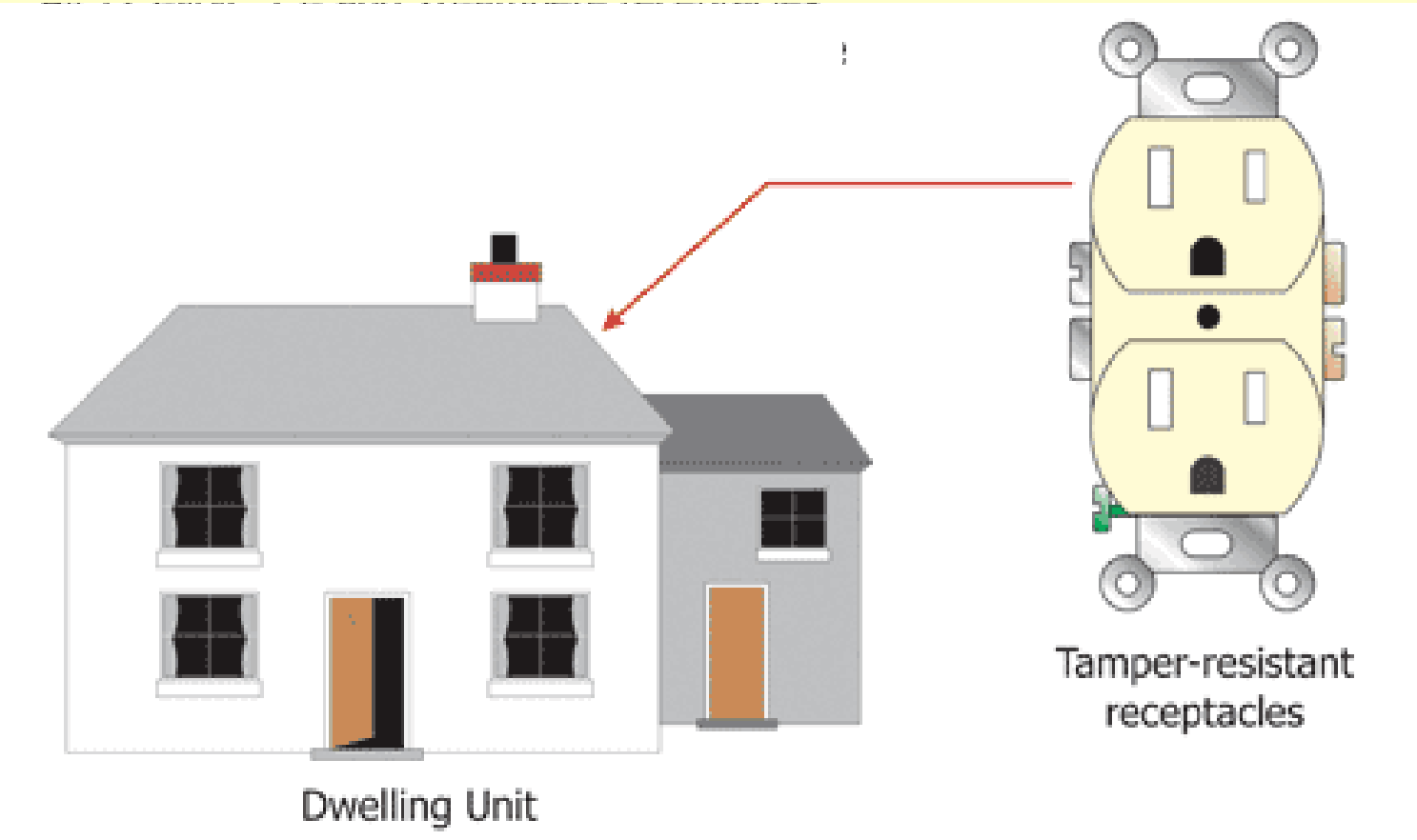
- New products and equipment



ibit 406.6 Tamper-resistant receptacle. Insertion of an object in any one side does not open shutter (left), but a two-bladed plug or grounding plug compresses the spring and simultaneously ns both shutters (right). (Courtesy of Pass & Seymour/Legrand®)

Changes are necessary for:

- New products and equipment (NEC 2008)



Changes are necessary for:

- Deleted Term
- Effectively Grounded
  - Intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to prevent the buildup of voltages that may result in undue hazards to connected equipment or to persons. (PEC 2009)
  - The definition of the term has been deleted in NEC 2008. The use of this term is subjective and without defined values or parameters for one to judge grounding as either "effective" or "ineffective".
  - "Effective" is described in Section 250.4(A) and (B), but it relates to the effective ground-fault current path as a performance criterion.

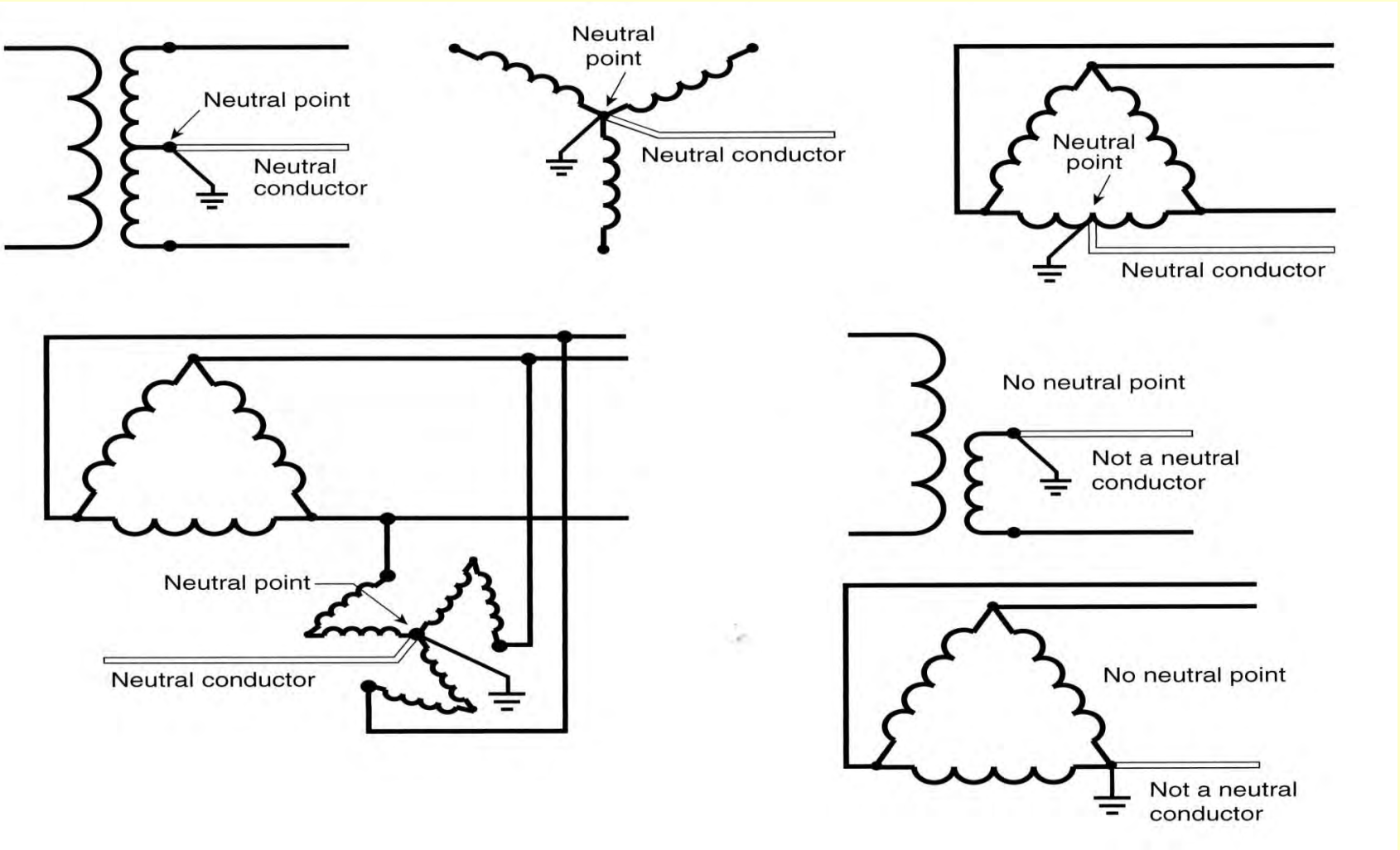
Changes are necessary for:

- New Terms Neutral Point
  - The common point on a wye connection in a polyphase system or midpoint of a single – phase, 3-wire system, or midpoint of a single-phase portion of a 3-phase delta system, or midpoint of a 3-wire, direct current system.
  - This is a new definition for the PEC 2017. The term "neutral" has been used in the PEC for many editions but was never defined.

Changes are necessary for:

- New Term
- Neutral Conductor- the conductor connected to the neutral point of a system that is intended to carry current under normal conditions.

Neutral Point & Neutral Conductor – PEC 2017



Art. 690.12

- No provisions for a rapid shutdown of PV systems existed in the PEC 2009
- A new 690.12 entitled "Rapid Shutdown of PV System on Buildings" was added in PEC 2017. This new section applies to PV system installed on building roofs and would required that PV source circuits be de-energized from all sources within 10 seconds or when the utility supply is de-energized or which the PV power source disconnecting means is opened.

Hazards of Rooftop Solar PV

Firefighters typically use rooftop venting techniques when battling a blaze (Photo courtesy of Matthew Paiss, San Jose (CA) Fire Department).

Meanwhile, in the wake of attention-getting fires in buildings equipped with rooftop PV systems, lawmakers are stepping up efforts to address PV system safety through

Firefighters sometimes have to contend with fires within PV system arrays (Photo courtesy of Matt Paiss, San Jose Fire Department).

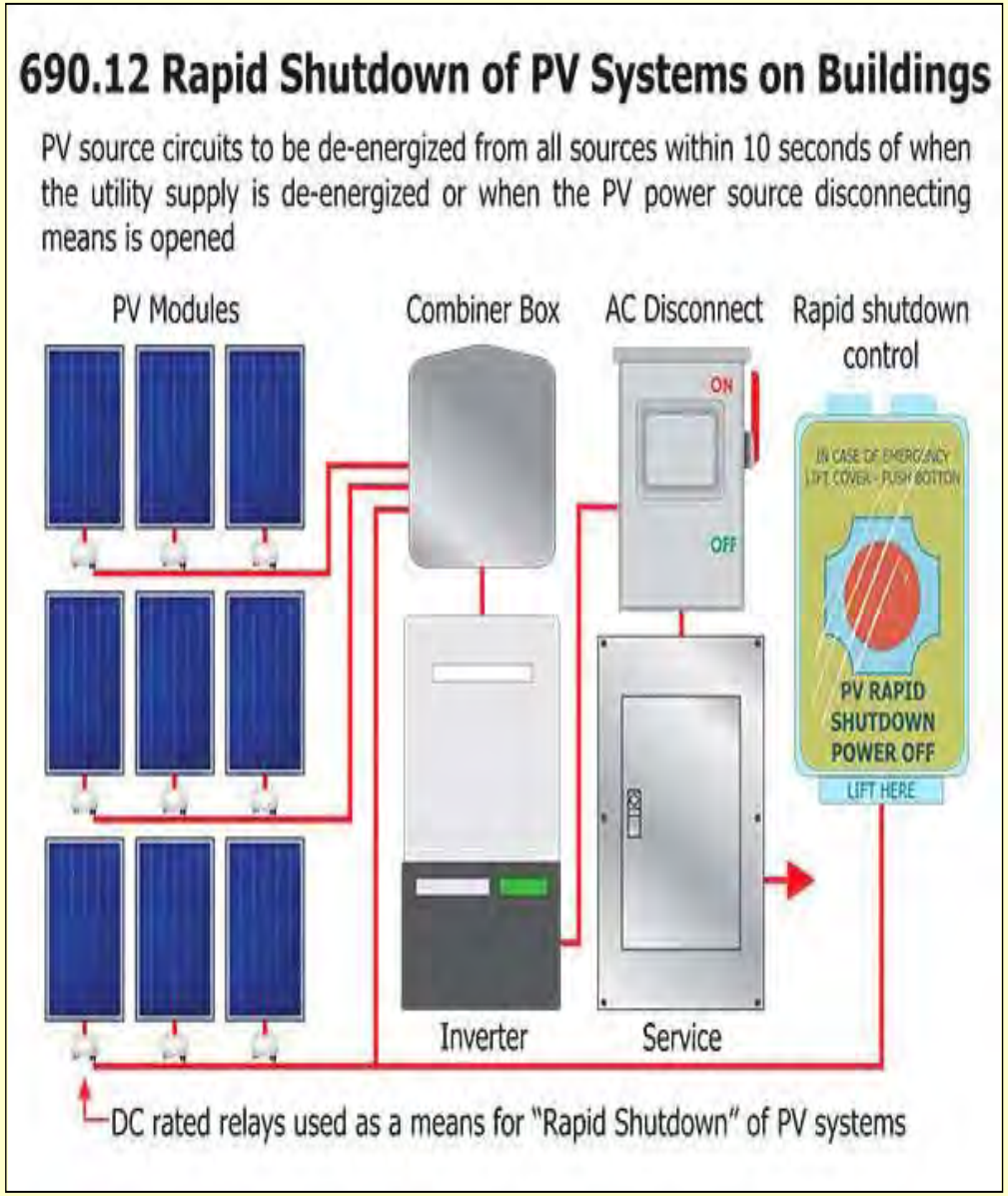
Settling for less

Firefighter advocates started out seeking a bigger margin of safety through a module

Hazards of Rooftop Solar PV

Covering panels with a heavy tarp is one approach that firefighters use to reduce voltage on a PV system (Photo courtesy of Matthew Paiss, San Jose (CA) Fire Department).

In Stamford, Conn., city officials are considering regulations that would require rooftop panels to be spaced in a fashion that would give firefighters room to safely move around a structure's roof. Wider pathways between arrays would allow



(C) **Facilities with Rapid Shutdown.** Buildings or structures with both utility service and a PV system, complying with 690.12, shall have a permanent plaque or directory including the following wording:

PHOTOVOLTAIC SYSTEM EQUIPPED
WITH RAPID SHUTDOWN

The plaque or directory shall be reflective, with all letters capitalized and having a minimum height of 9.5 mm (⅜ in.), in white on red background.

690.12 Rapid Shutdown of PV Systems on Buildings

PV system circuits installed on or in buildings shall include a rapid shutdown function that controls specific conductors in accordance with 690.12(1) through (5) as follows.

(1) Requirements for controlled conductors shall apply only to PV system conductors of more than 1.5 m (5 ft) in length inside a building, or more than 3 m (10 ft) from a PV array.

(2) Controlled conductors shall be limited to not more than 30 volts and 240 volt-amperes within 10 seconds of rapid shutdown initiation.

(3) Voltage and power shall be measured between any two conductors and between any conductor and ground.

(4) The rapid shutdown initiation methods shall be labeled in accordance with 690.56(B).

(5) Equipment that performs the rapid shutdown shall be listed and identified.

First responders must contend with elements of a PV system that remain energized after the service disconnect is opened. This rapid shutdown requirement provides a zone outside of which the potential for shock has been mitigated. Conductors more than 5 feet inside a building or more than 10 feet from an array will be limited to a maximum of 30 V and 240 VA within 10 seconds of activation of shutdown. Ten seconds allows time for any dc capacitor banks to discharge. Methods and designs for achieving proper rapid shutdown are not addressed by the *NEC* but instead are addressed in the product standards for this type of equipment.

1 2 3 4 5 6 7 8 9 Next >

LAST SPRING, PHILIP STITTLEBURG, chief of the fire department in La Farge, Wisconsin, and chair of NFPA's Board of Directors, contacted the association about a fire that had recently occurred in his town. On May 14, 2013, the La Farge Fire Department responded to an automatic fire alarm at an office building in its fire district. When the first responding units arrived, they found a fire in a concealed space within the building. But what may have appeared at first glance as a routine fireground operation turned out to be anything but ordinary.

Firefighters would soon learn that the building's concealed spaces were insulated with a recycled cotton-based denim material that was rapidly consumed by the growing fire, which eventually spread into an attic space constructed of lightweight wood trusses and equipped with automatic sprinklers. The building's pitched roof structure was covered with arrays of photovoltaic (PV) panels that made vertical ventilation of the attic space by the firefighters nearly impossible.

Over the course of 18 hours, the officers and firefighters from La Farge, along with those from numerous surrounding departments, were faced with a growing array of challenges, including the location of the fire, the materials used in the building's construction, the limitations of the town's firefighting infrastructure, and more. The fire would eventually destroy a significant portion of building, resulting in an estimated $13 million inproperty damage and related losses.

The Perfect Storm

LAST SPRING, PHILIP STITTLEBURG, chief of the fire department in La Farge, Wisconsin, and chair of NFPA's Board of Directors, contacted the association about a fire that had recently occurred in his town. On May 14, 2013, the La Farge Fire Department responded to an automatic fire alarm at an office building in its fire district. When the first responding units arrived, they found a fire in a concealed space within the building. But what may have appeared at first glance as a routine fireground operation turned out to be anything but ordinary.

Firefighters would soon learn that the building's concealed spaces were insulated with a recycled

Dietz & Watson Warehouse Blaze

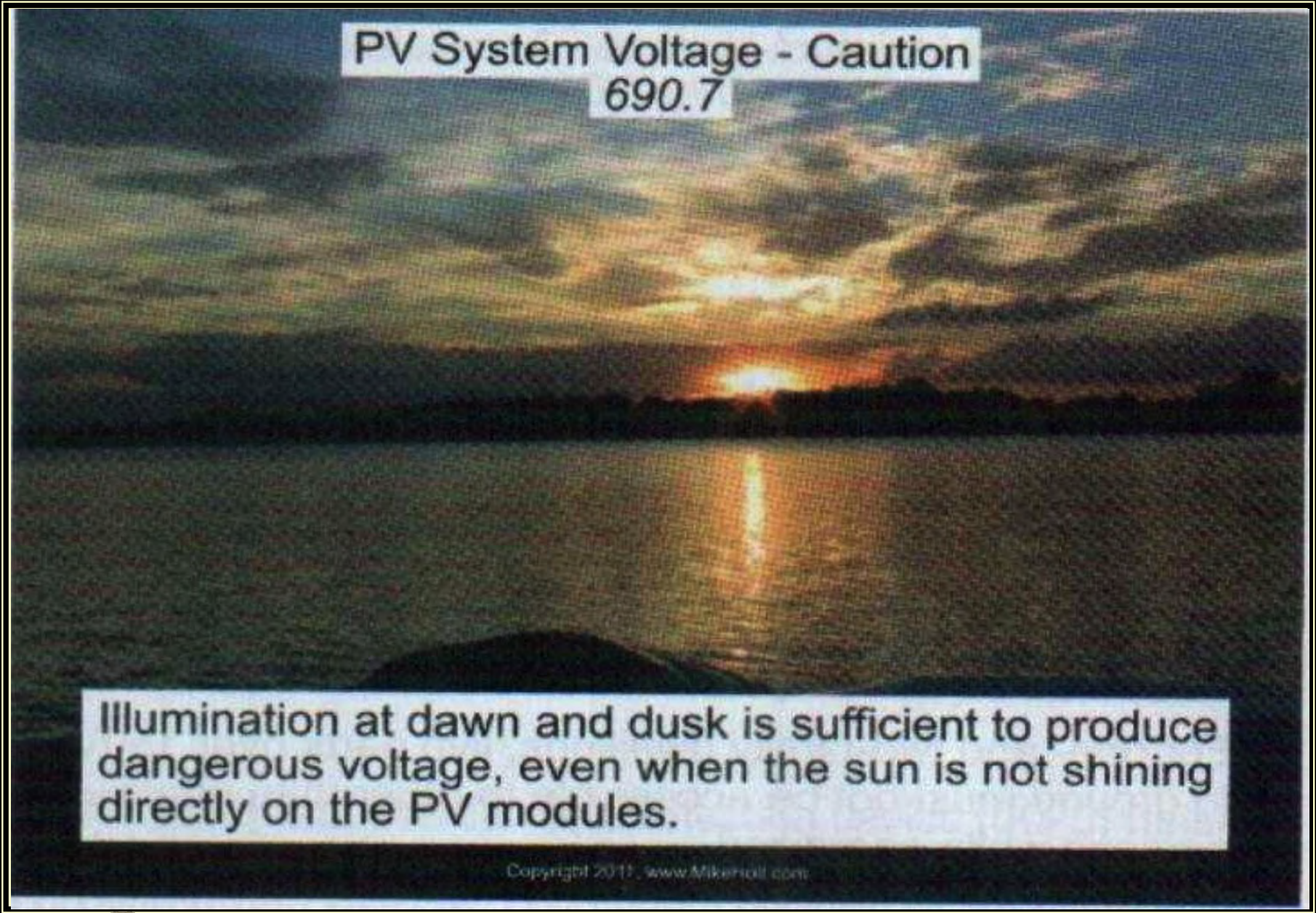
More than 7,000 solar panels on the roof of a burning warehouse in Burlington County proved too much of a hazard for firefighters, local officials said today.

"We may very well not be able to save buildings that have alternative energy," William Kramer, New Jersey's acting fire marshall, said after Delanco Fire Chief Ron Holt refused to send his firefighters onto the roof of the 300,000-square foot Dietz & Watson facility, ablaze since Sunday afternoon.

July 14, 2014

Solar panels are particularly hazardous to firefighters for a number of reasons, according to Ken Willette, a division manager with the National Fire Protection Association.

"There is a possibility of electric shock because the electricity to the panels can't be shut off," he


PV System Voltage - Caution
690.7
Illumination at dawn and dusk is sufficient to produce dangerous voltage, even when the sun is not shining directly on the PV modules.
Copyright 2011, www.Mikeholt.com

New Article

- 6.91 Large-Scale Photovoltaic Electric Power Production Facility
  - Covers installation of large-scale PV electric power production facilities with generating capacity of no less than 5000 kW and not under exclusive utility control.

New Article

6.94 Wind Electric Systems

- Applies to wind (turbine) electric systems that consist of one or more wind electric generators, and their related alternators, generators, inverters, controllers and associated equipment.

EXHIBIT 694.1 *A wind electric system consisting of a single wind turbine.*

New Articles

7.6-Energy Storage System

- Applies to all permanently installed energy storage systems operating at over 50 volts ac or 60 volts dc that may be stand-alone or interactive with other electric power production sources.

Energy Storage System (ESS). One or more components assembled together capable of storing energy for use at a future time. ESS(s) can include but is not limited to batteries, capacitors, and kinetic energy devices (e.g., flywheels and compressed air). These systems can have ac or dc output for utilization and can include inverters and converters to change stored energy into electrical energy.

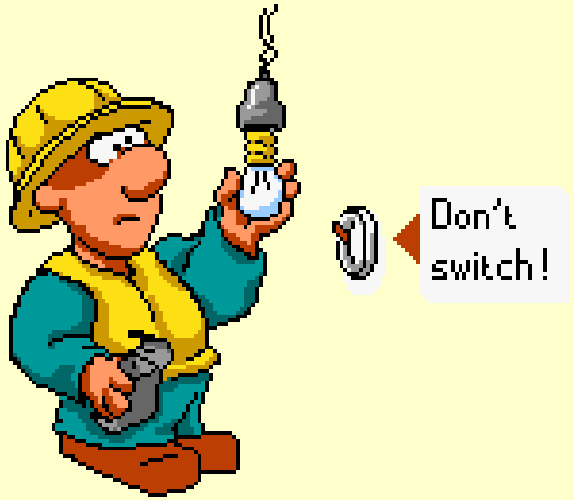
New Articles

❑ 7.12-Direct Current Microgrids

- Applies to direct current microgrids.

Direct Current Microgrid (DC Microgrid). A direct current microgrid is a power distribution system consisting of more than one interconnected dc power source, supplying dc-dc converter(s), dc load(s), and/or ac load(s) powered by dc-ac inverter(s). A dc microgrid is typically not directly connected to an ac primary source of electricity, but some dc microgrids interconnect via one or more dc-ac bidirectional converters or dc–ac inverters.

Electric Shock

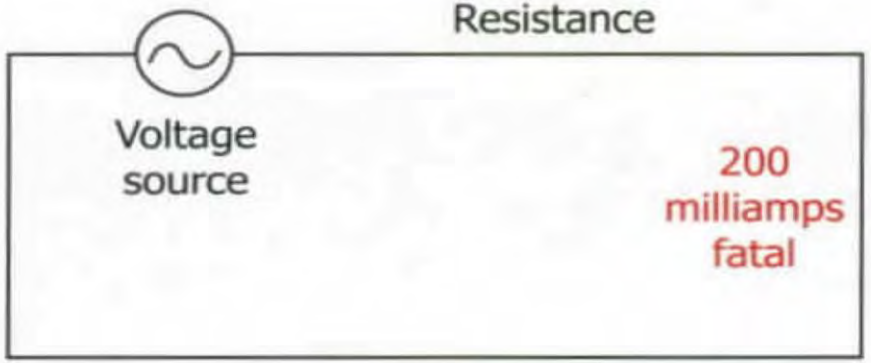


Effect of Electricity on Humans

The severity of electric shock is related to four elements

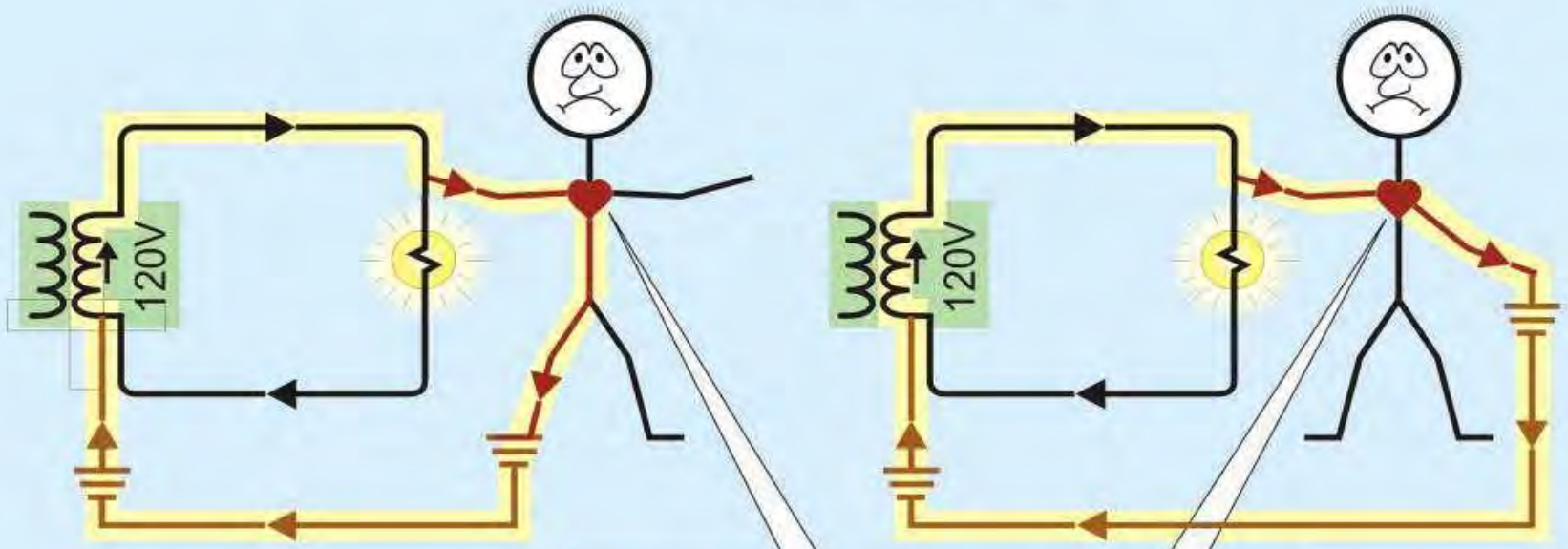
If the combination of these four elements is just right, the shock can be severe or lead to electrocution

1. Amount of current
2. Length of time current is present
3. Path of current through the body
4. Frequency of the current *(Hz)*



Amount of time current is allowed to pass through the body

Electrical Shock

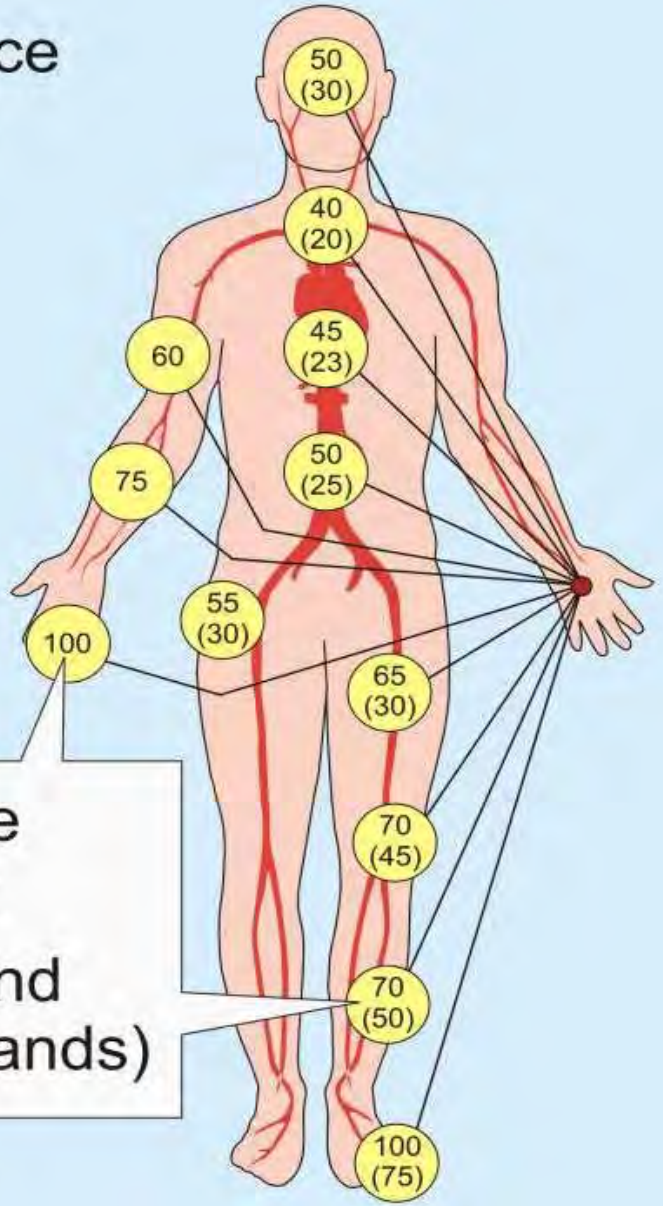


The body can become part of an electrical path.

People become injured or death can occur when voltage pushes electrons through the human body, particularly through the heart.

Body Impedance
CEI - 1984

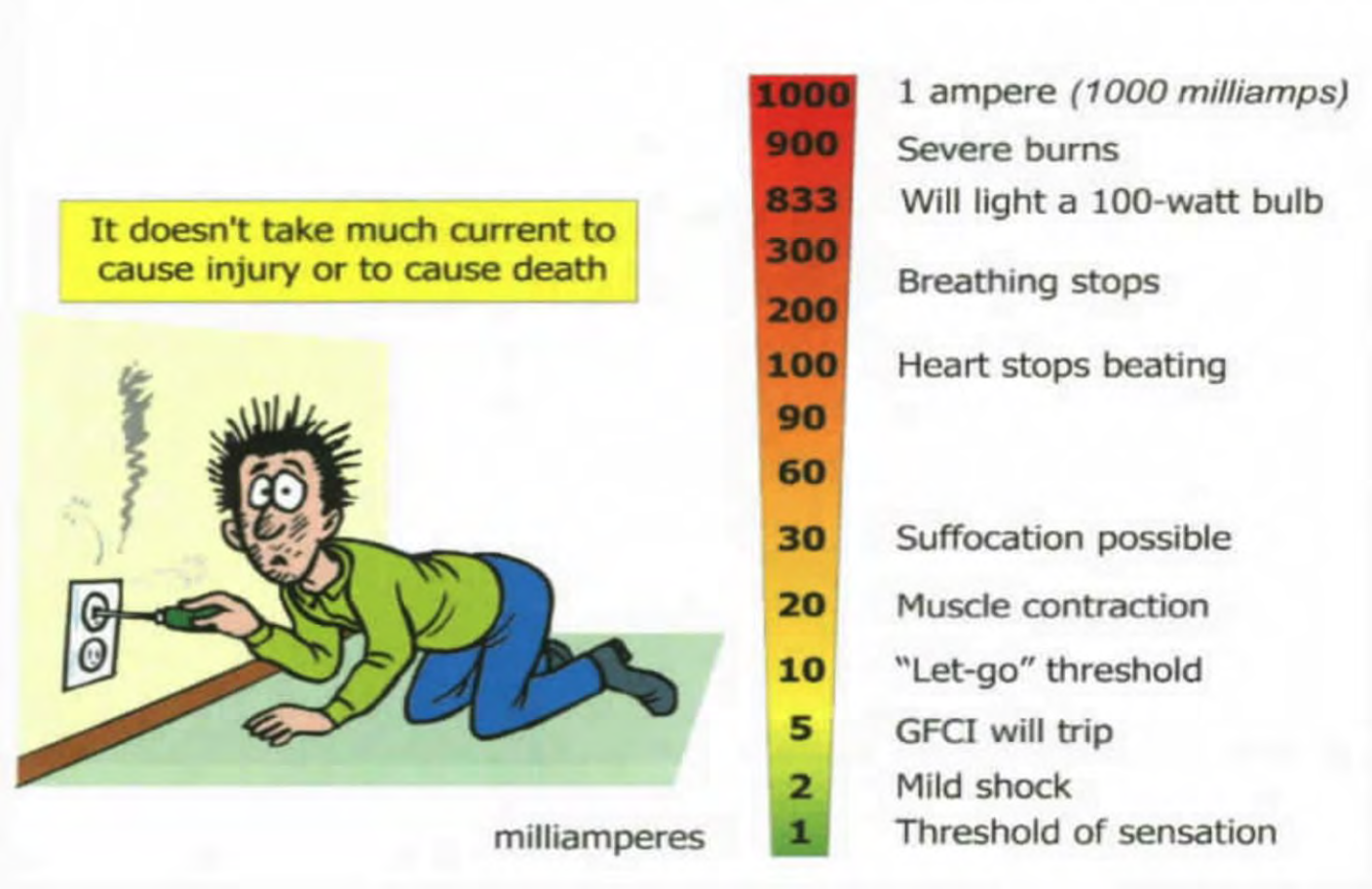
Resistance from one (or both) hands to various points in percent of total body impedance Z_T.



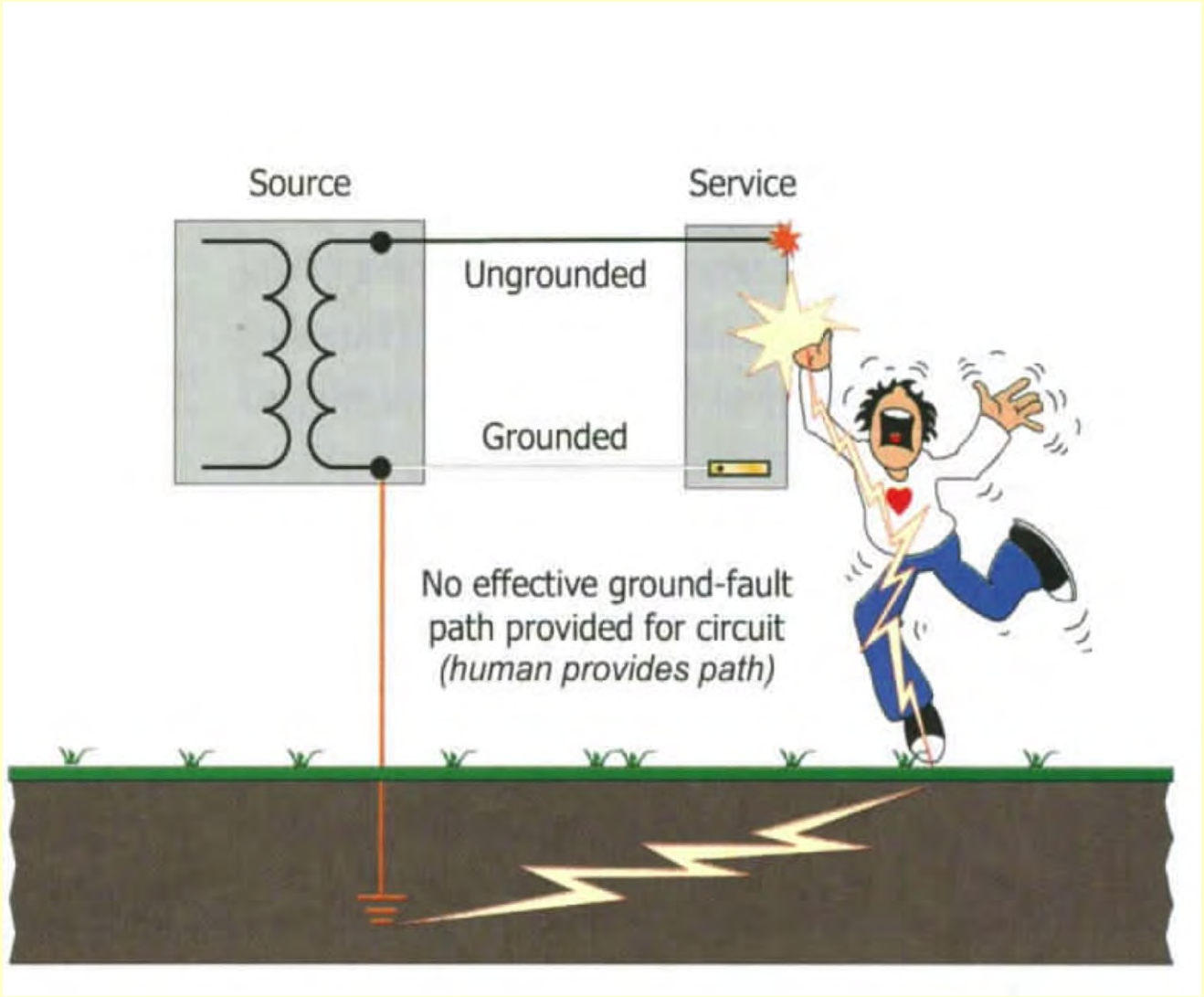
Numbers represent the percent of 1000 ohms

Resistance to One Hand (Resistance to Both Hands)

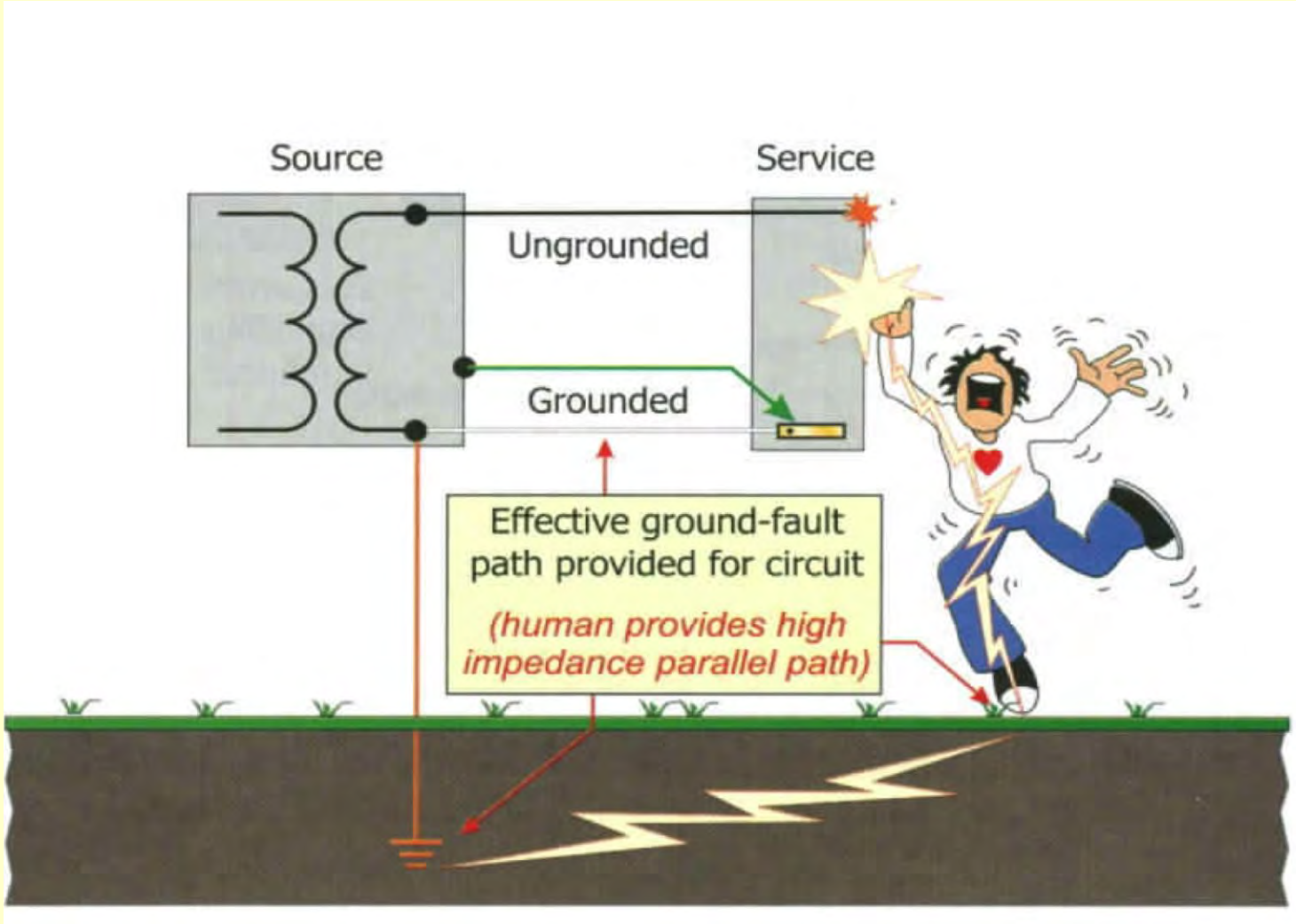
Effects of AC Electric Shock



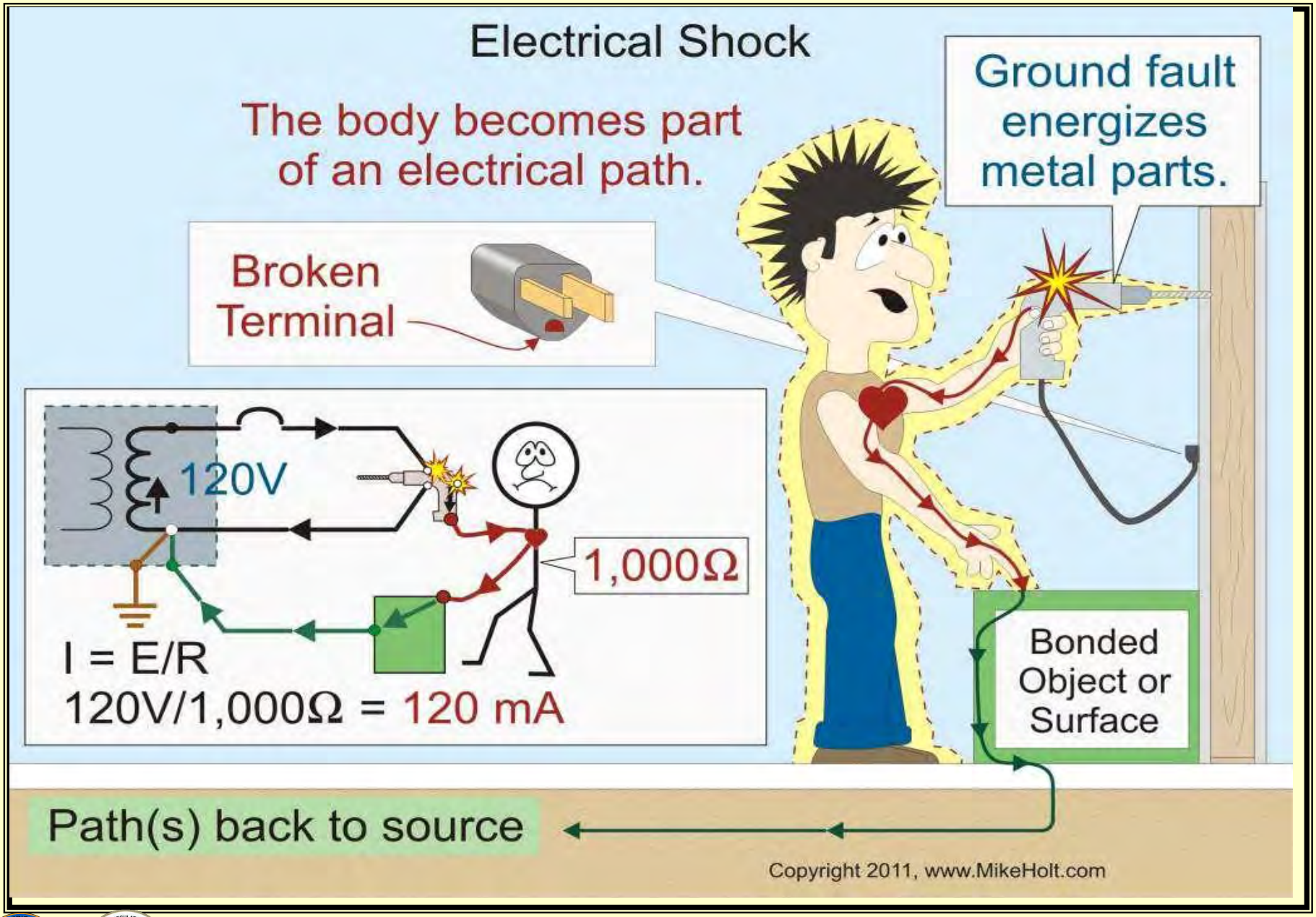
Level (in milliamperes) of current through the body



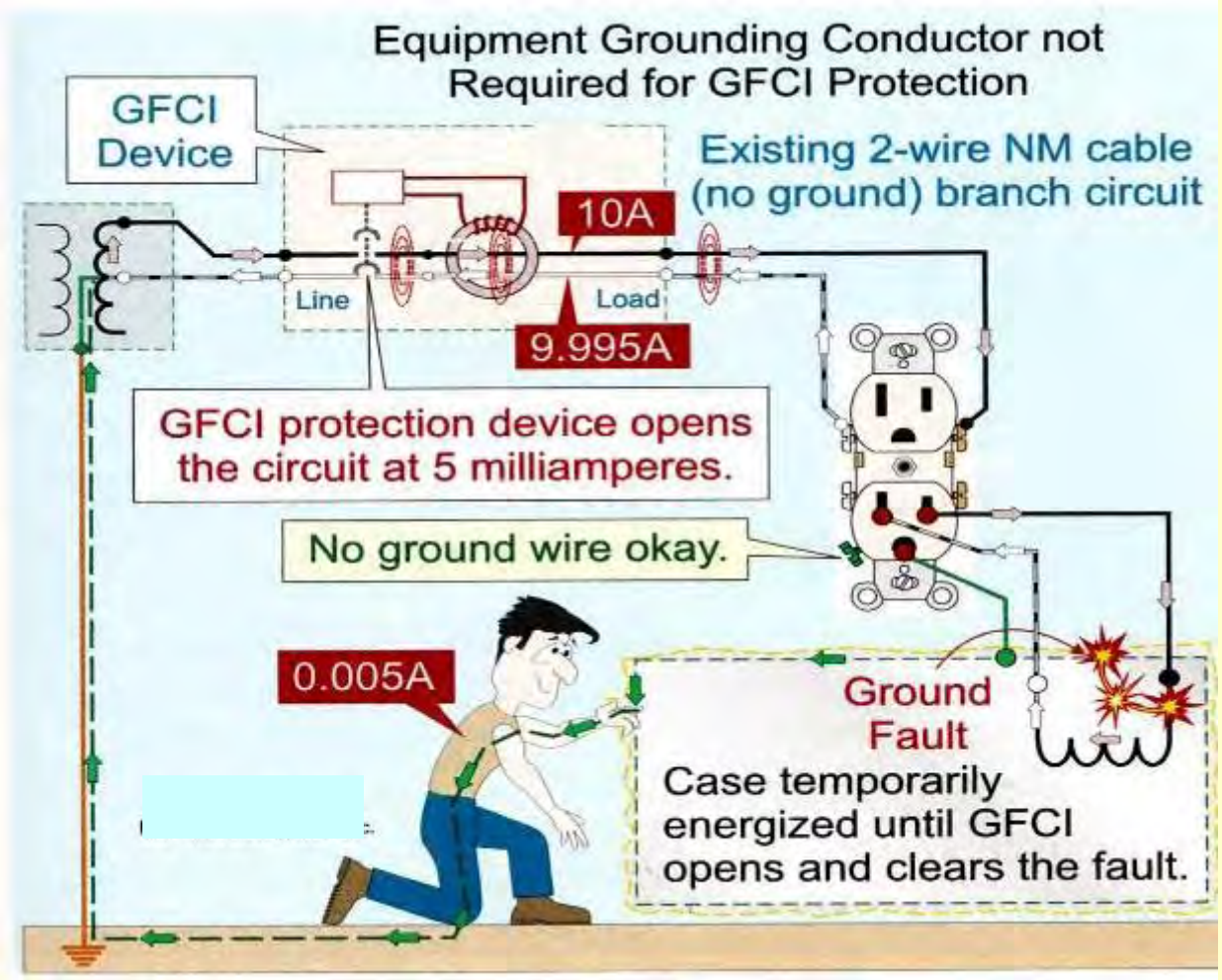
Human completing the path for current through the earth



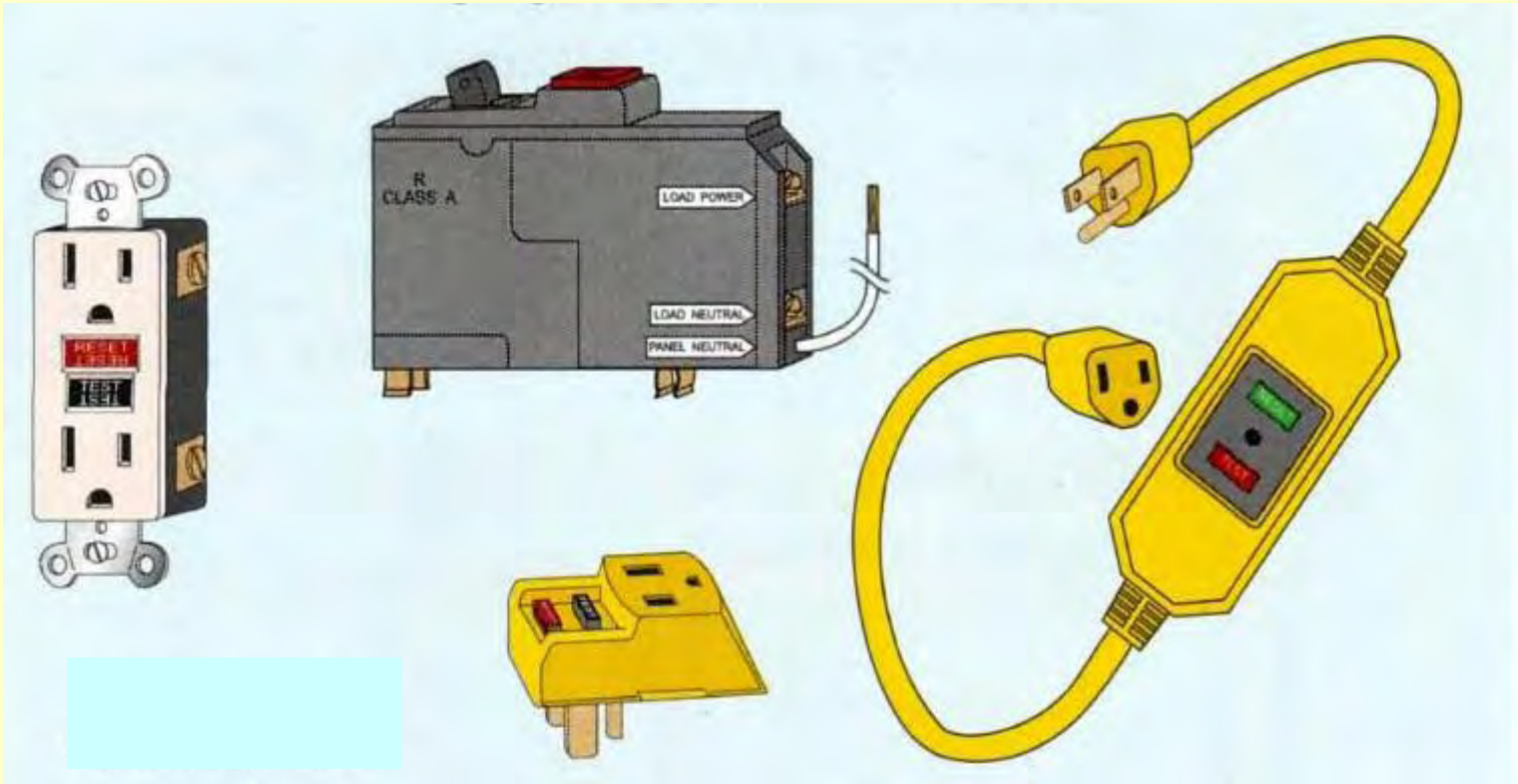
Human in parallel with equipment grounding conductor during ground fault


Electrical Shock
The body becomes part of an electrical path.
Ground fault energizes metal parts.
Broken Terminal
120V
1,000Ω
I = E/R
120V/1,000Ω = 120 mA
Bonded Object or Surface
Path(s) back to source
Copyright 2011, www.MikeHolt.com

Ground Fault Circuit Interrupter

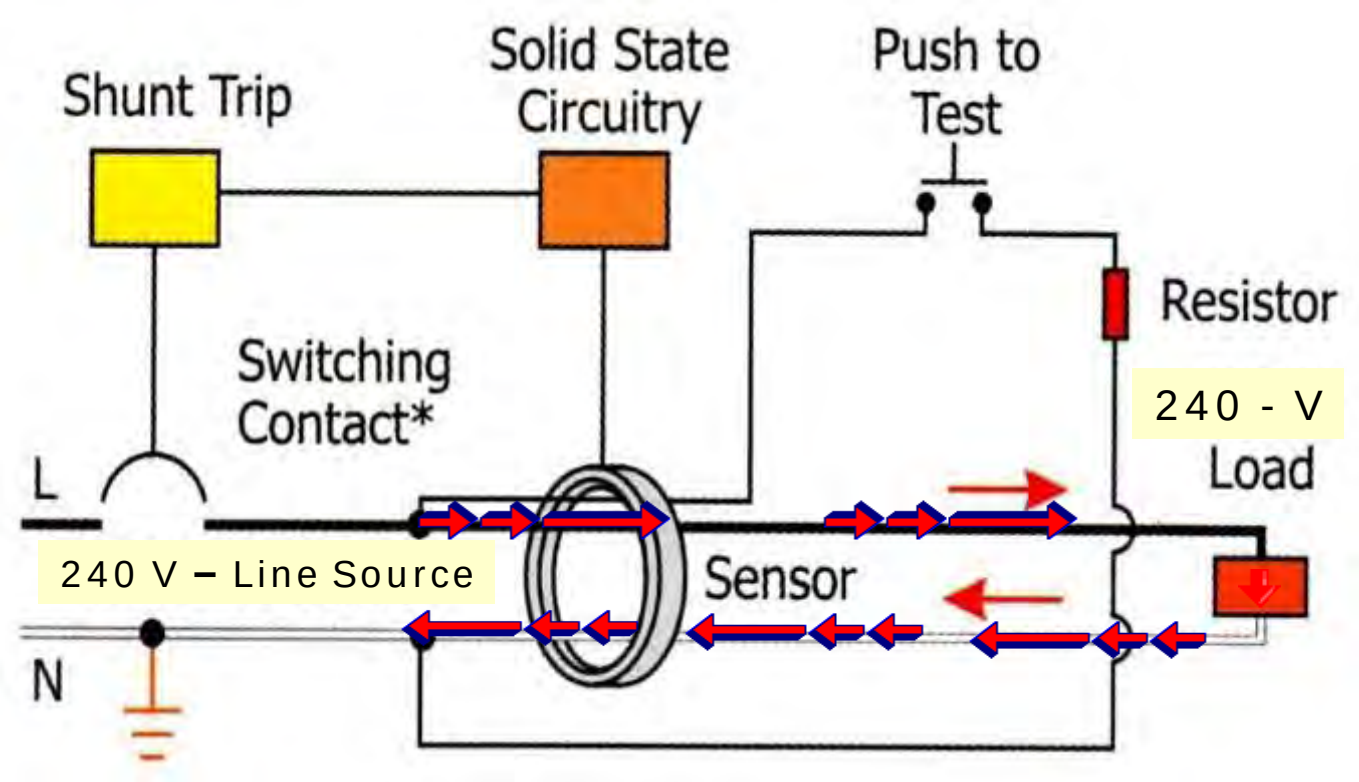


Ground Fault Circuit Interrupter



A GFCI is designed to protect persons against electric shock.
It operates on the principles of monitoring the unbalanced current
Between the ungrounded and the grounded neutral conductor.

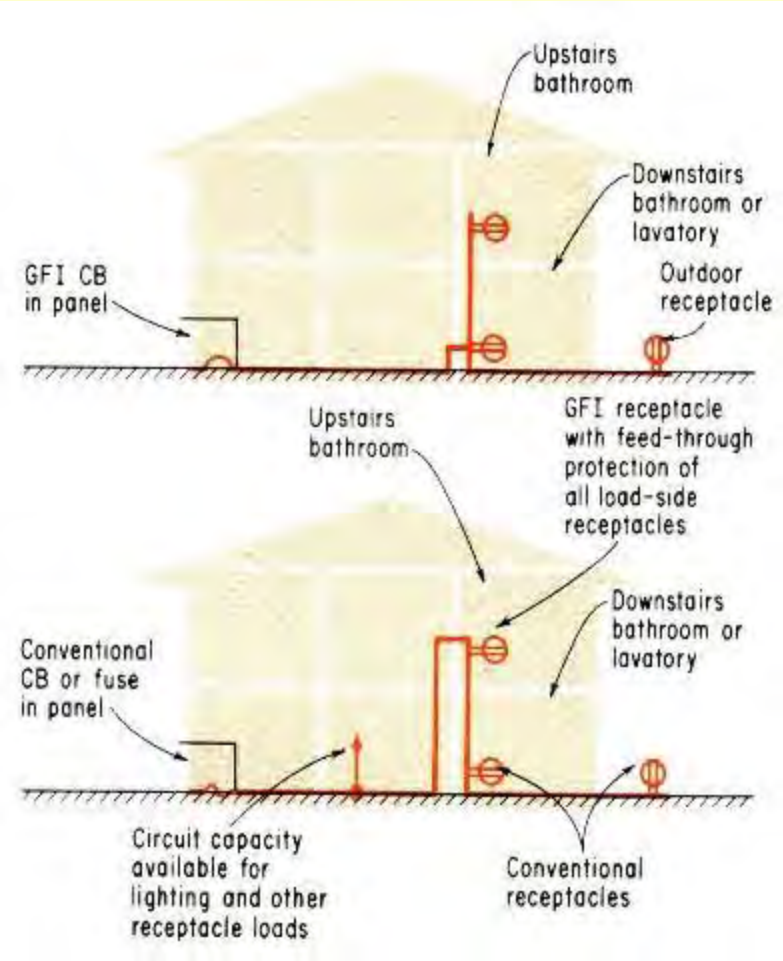
Ground Fault Circuit Interrupter



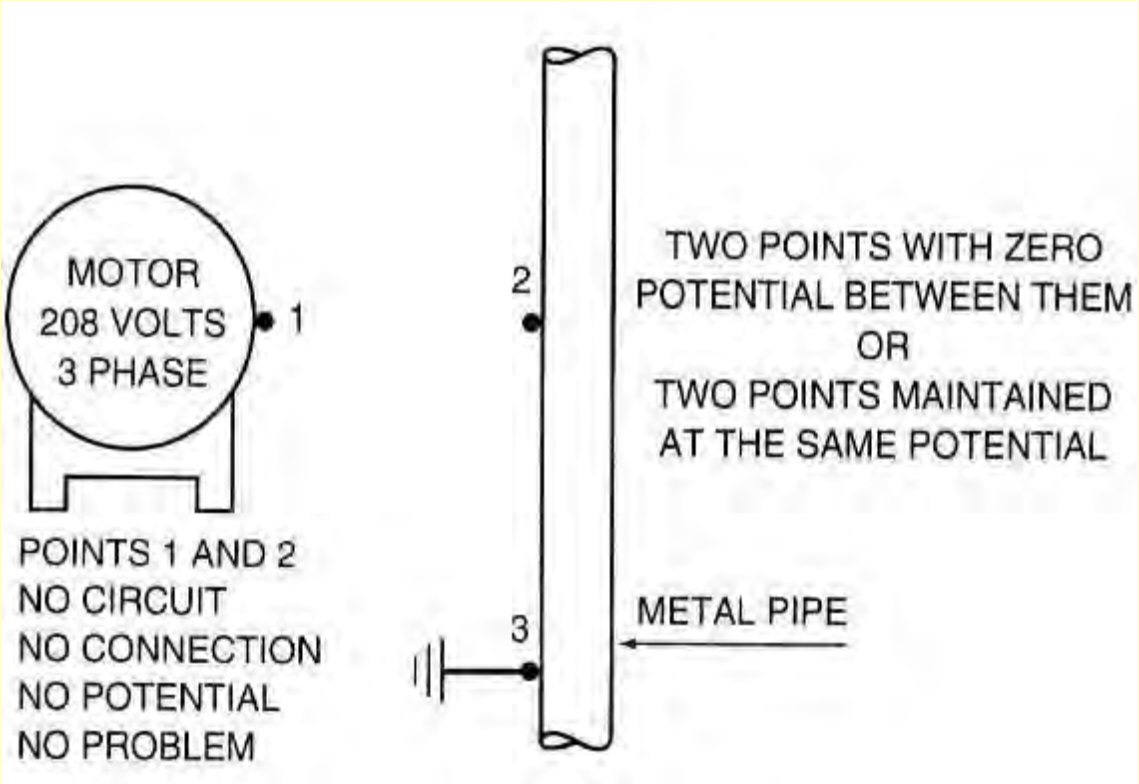
GFCI Protection for Personnel

PEC-2.10.1.8 (a)

a) Dwelling Units
1. Bathrooms
2. Garages
3. Outdoors
4. Crawl spaces at or below grade level
5. Unfinished basements
6. Kitchens for countertop appliances
7. Wet bar sinks

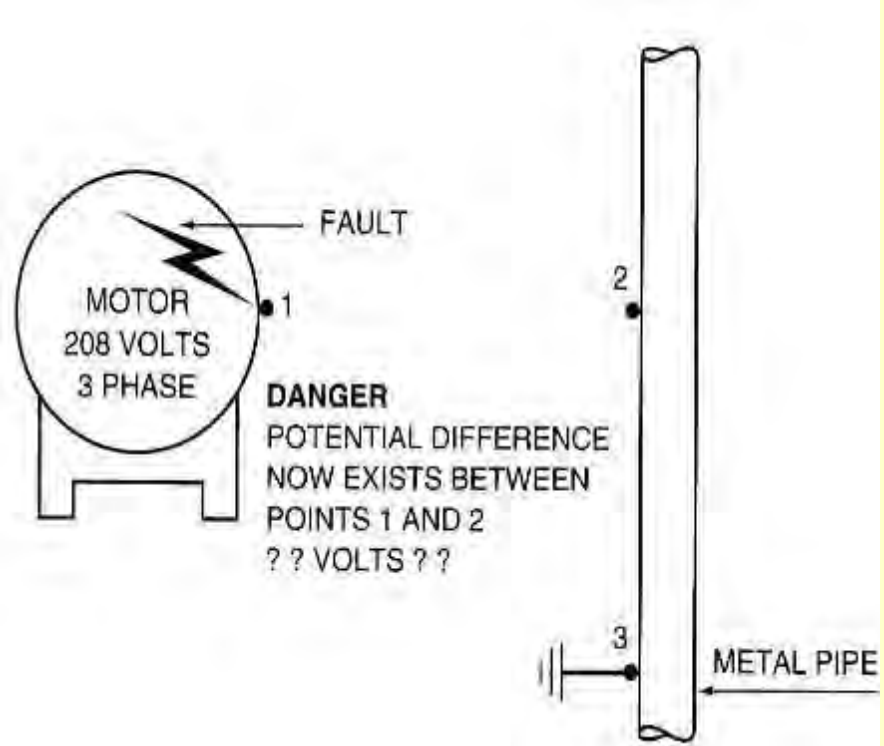


Potential Difference



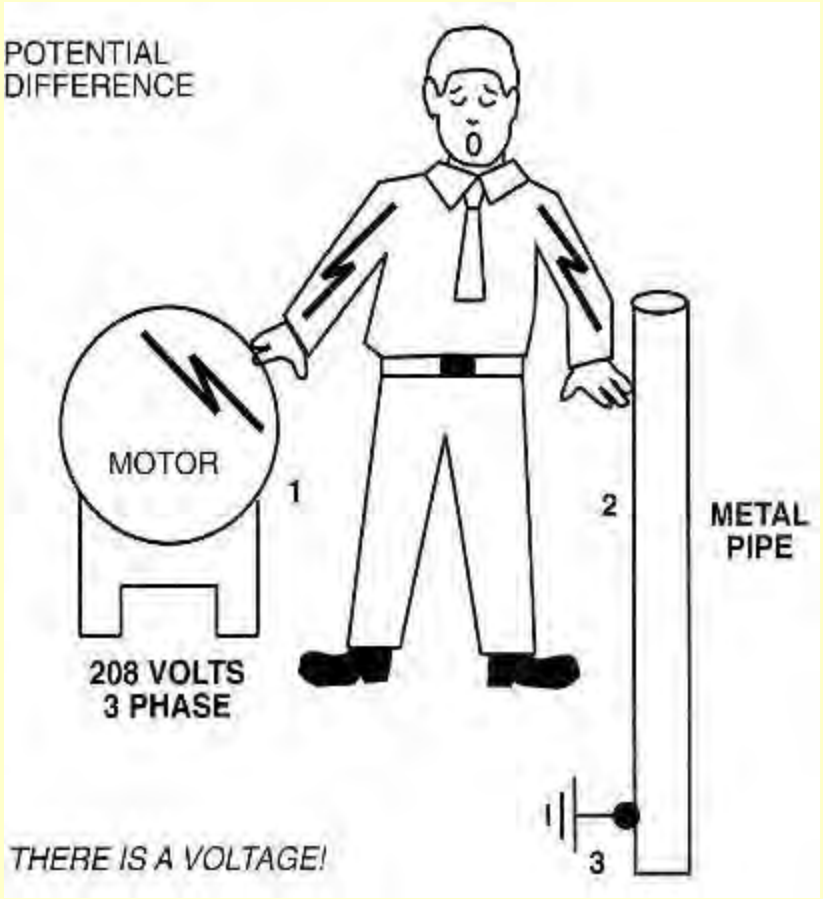
Potential difference between a grounded Water pipe and an ungrounded motor.

Potential Difference



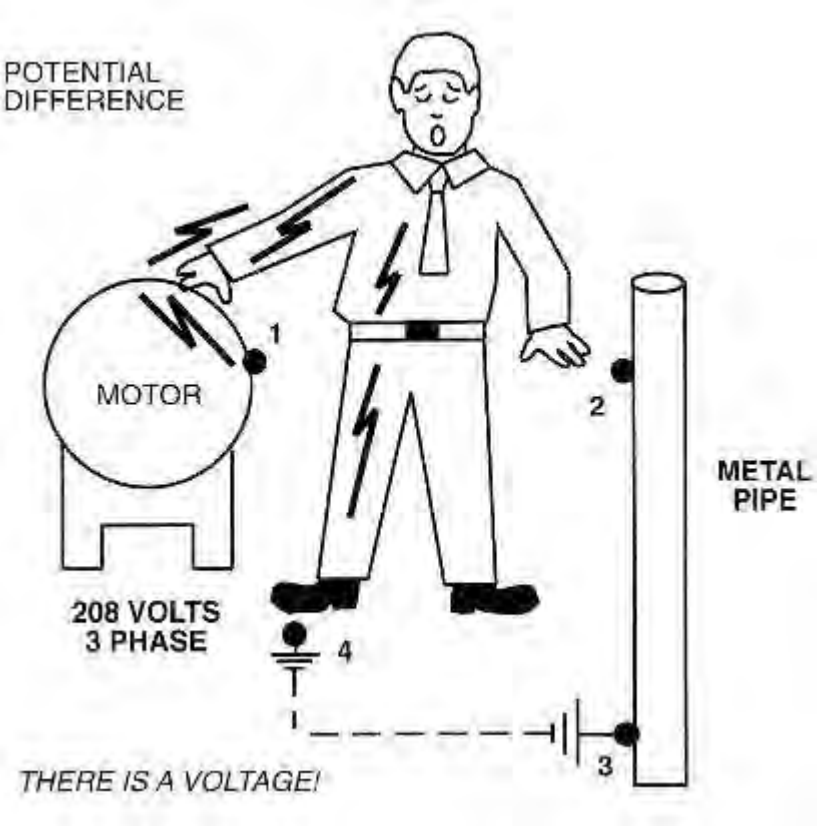
Motor ground-fault. A hazard now exists.

Potential Difference



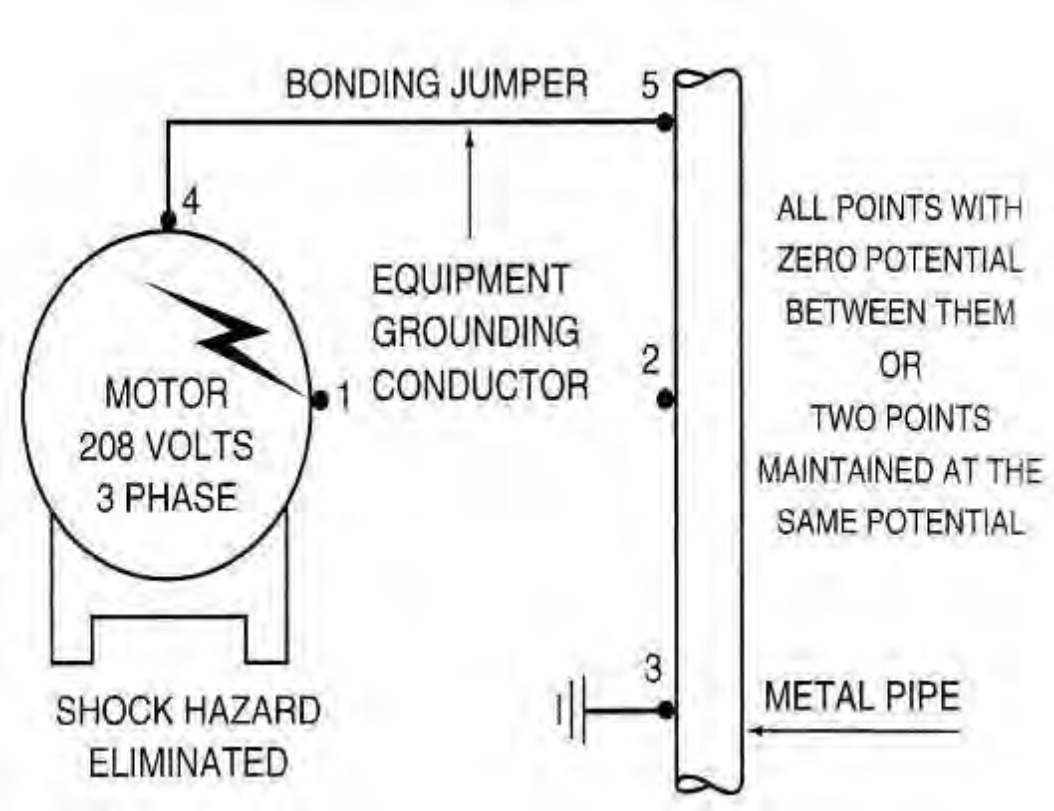
The hazard results in an electric shock.

Potential Difference



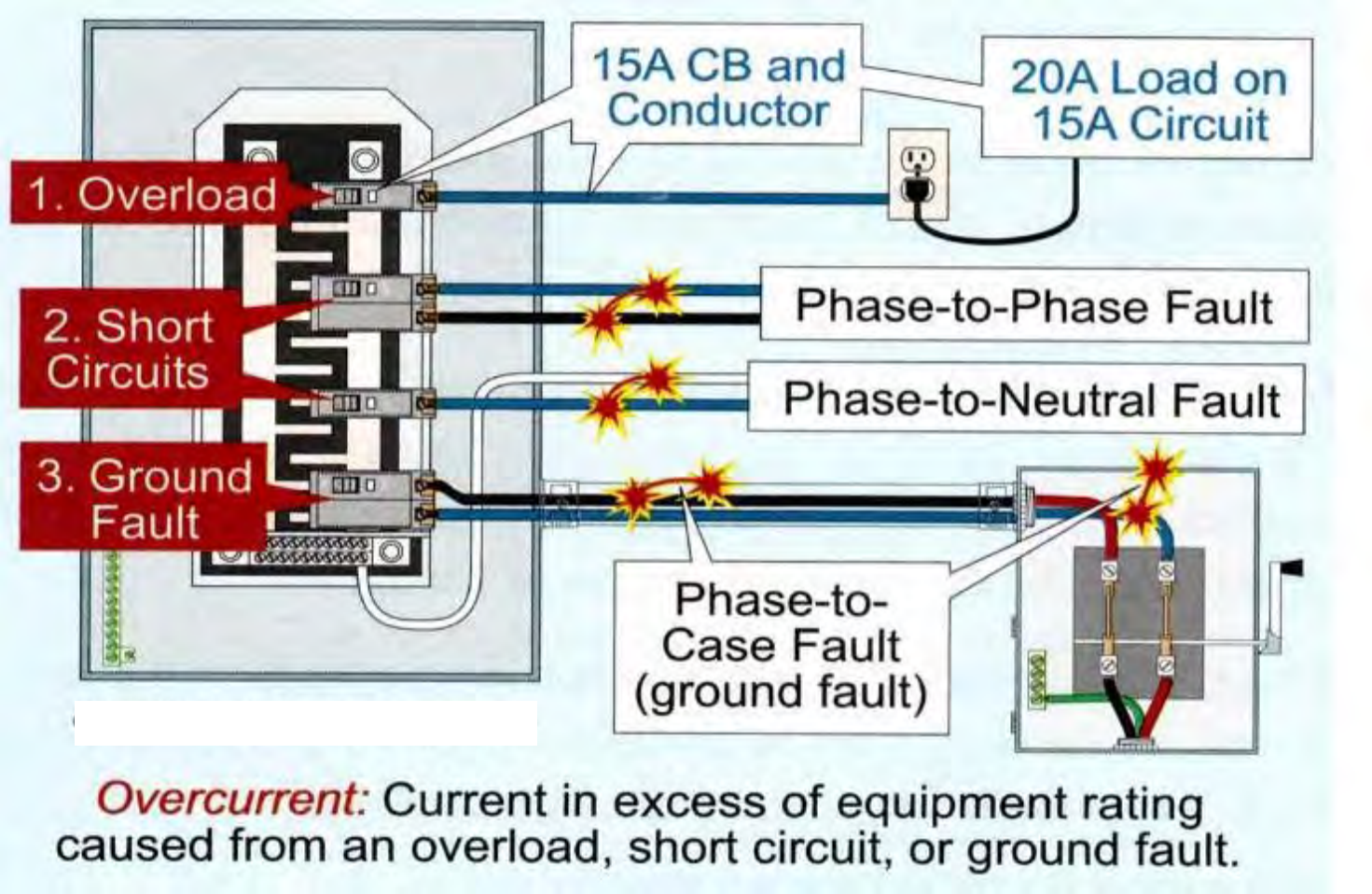
Another shock hazard exists.

Potential Difference



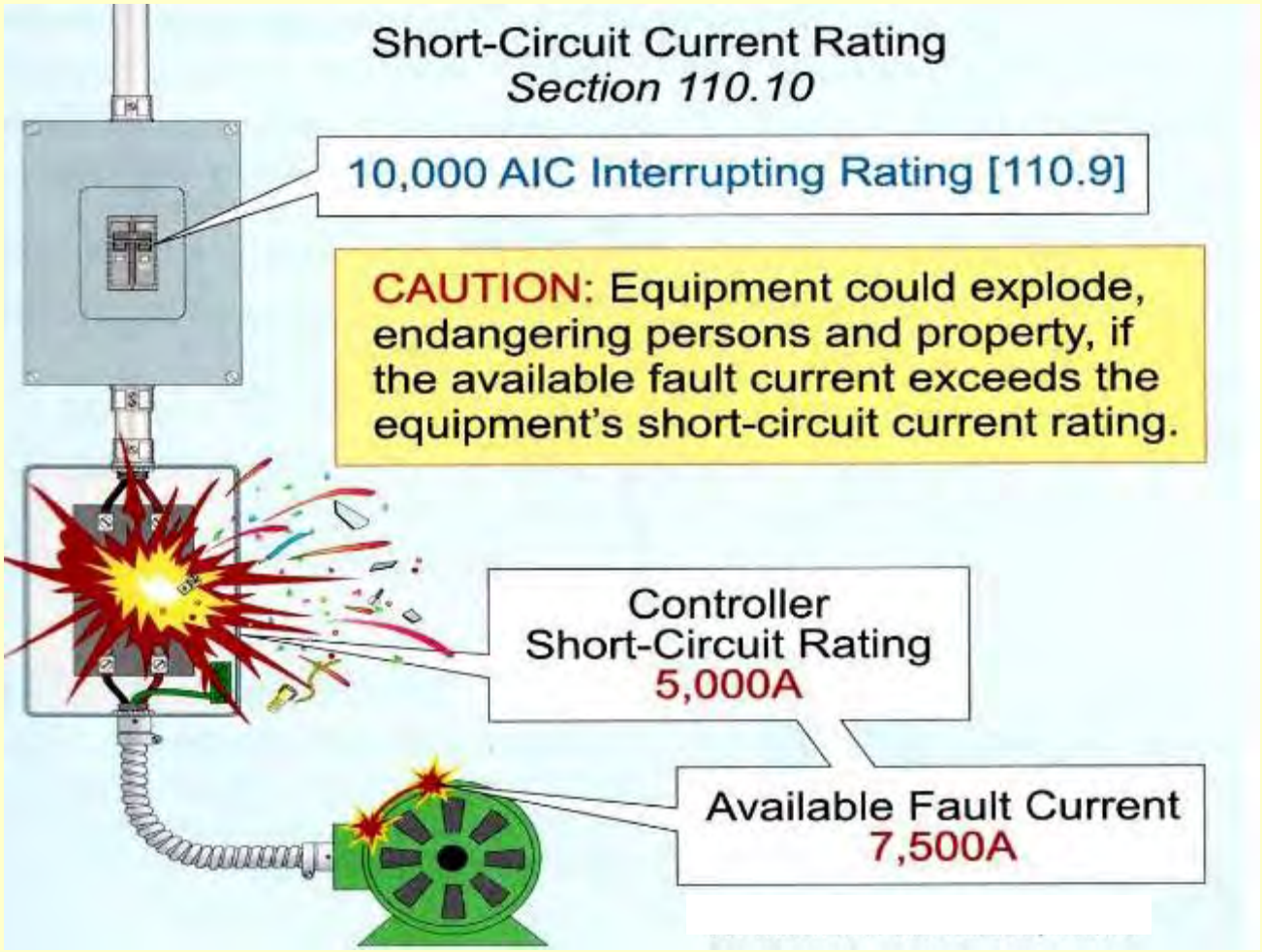
Shock hazard eliminated by installing a bonding jumper.

Faults Calculation

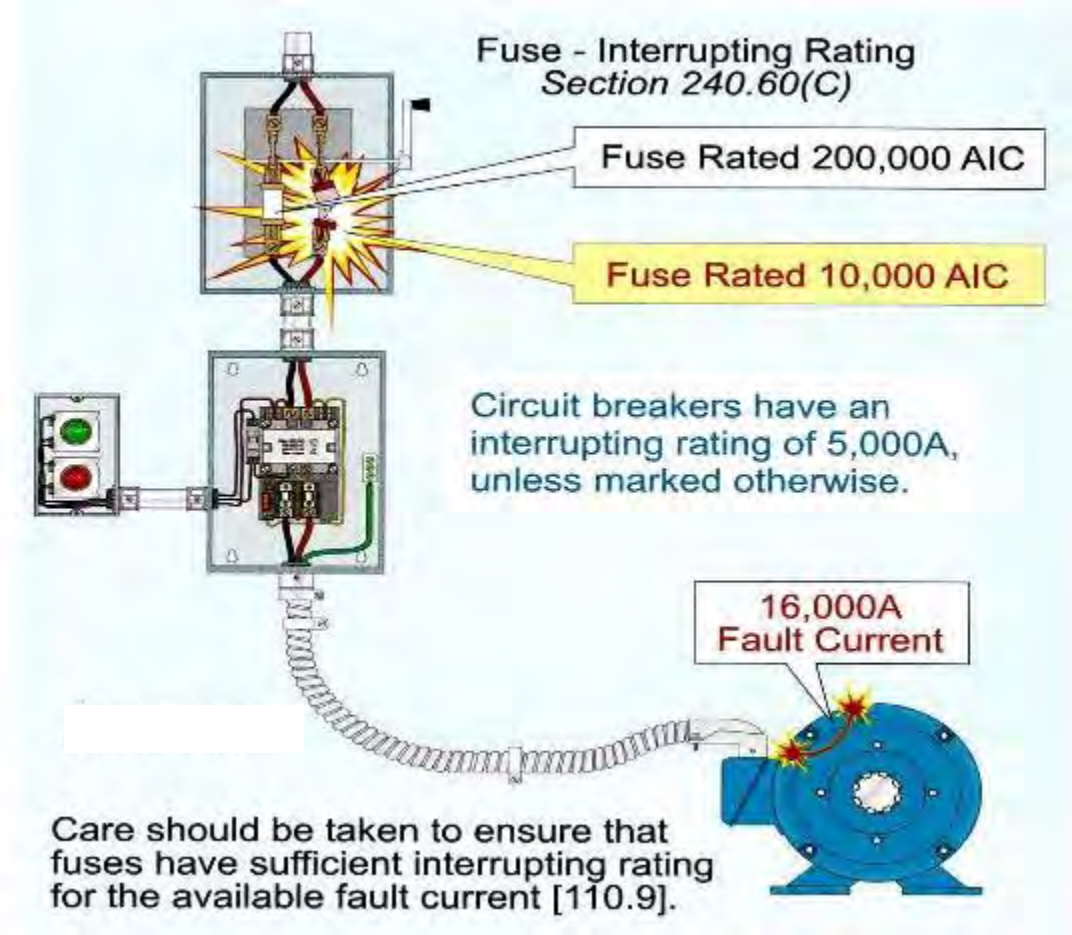


Overcurrent: Current in excess of equipment rating caused from an overload, short circuit, or ground fault.

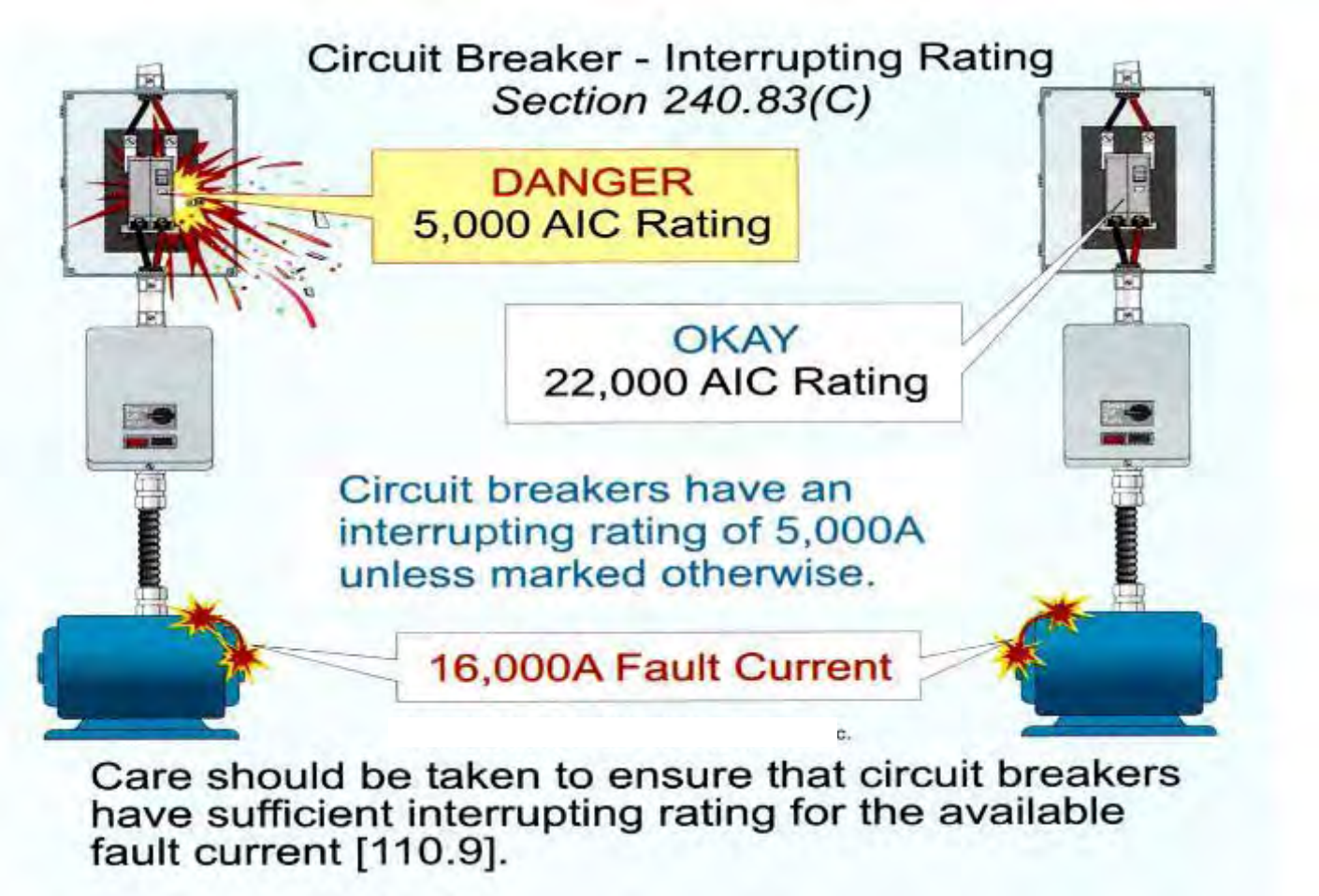
Faults Calculation



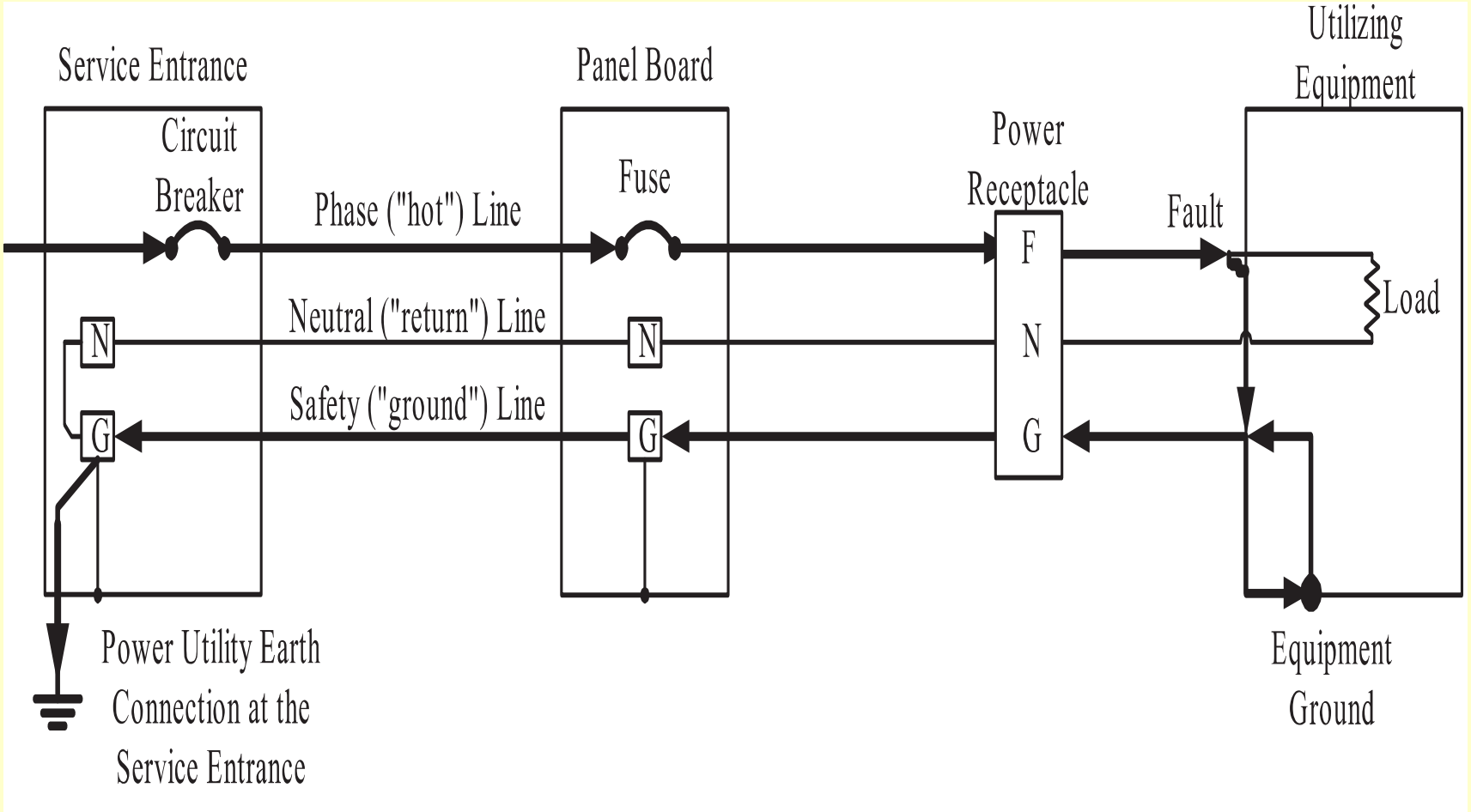
Faults Calculation



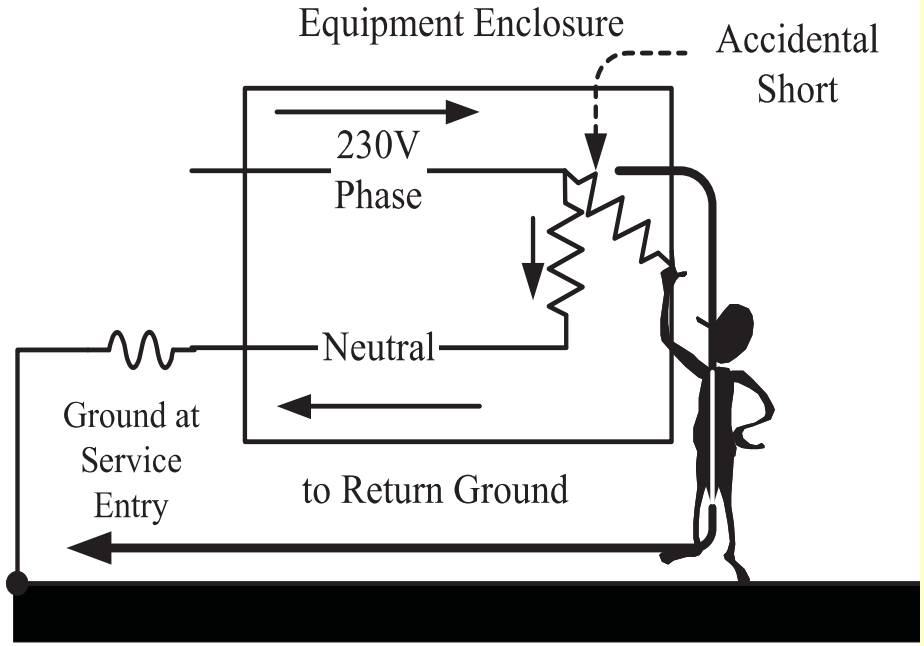
Faults Calculation



Proper Wiring Method for 230 V Line to Ground System -

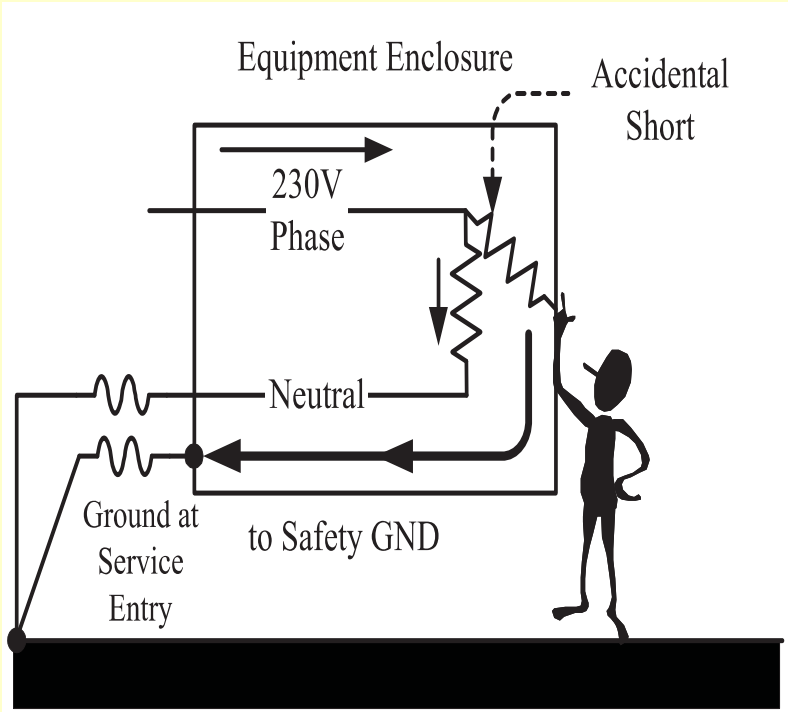


Why hazardous Condition?



(a) No Electrical Safety Ground Conductor

Hazardous Condition



(b) Electrical Safety Ground Conductor Protection

Safe Condition

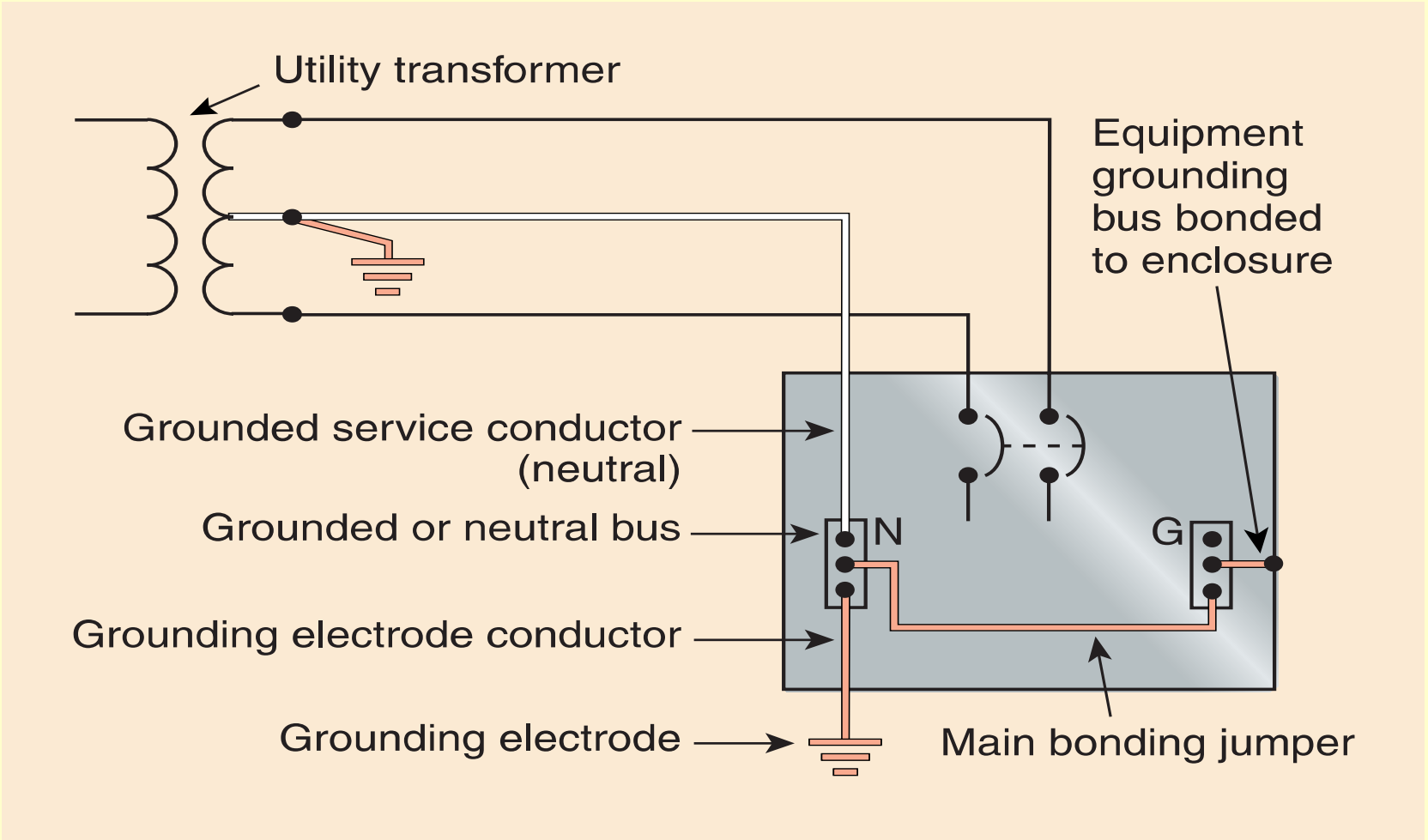
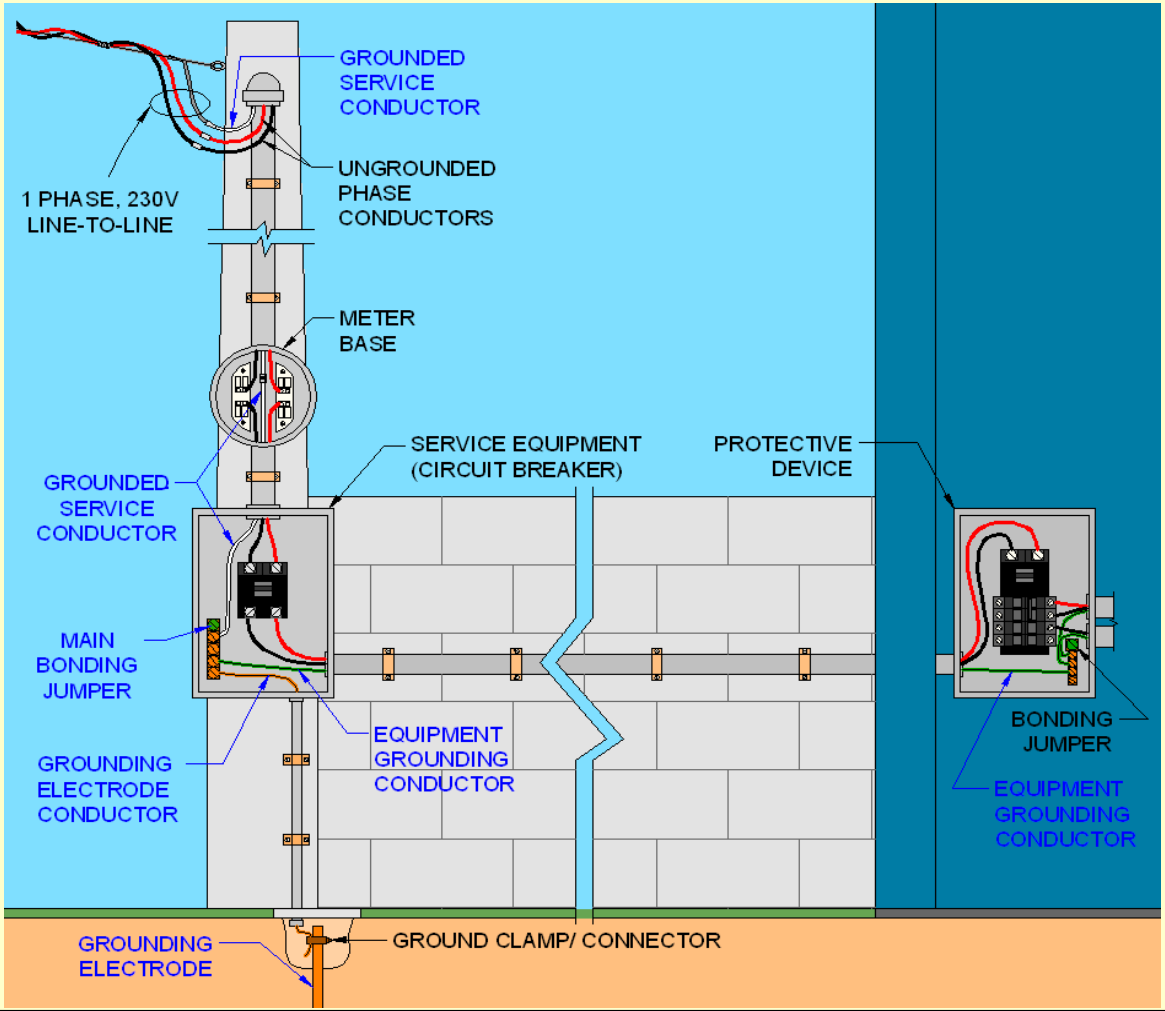


EXHIBIT 250.1 *Grounding and bonding arrangement for a single-phase, 3-wire service.*

Proper Wiring Method for 230 V Line to Line System -



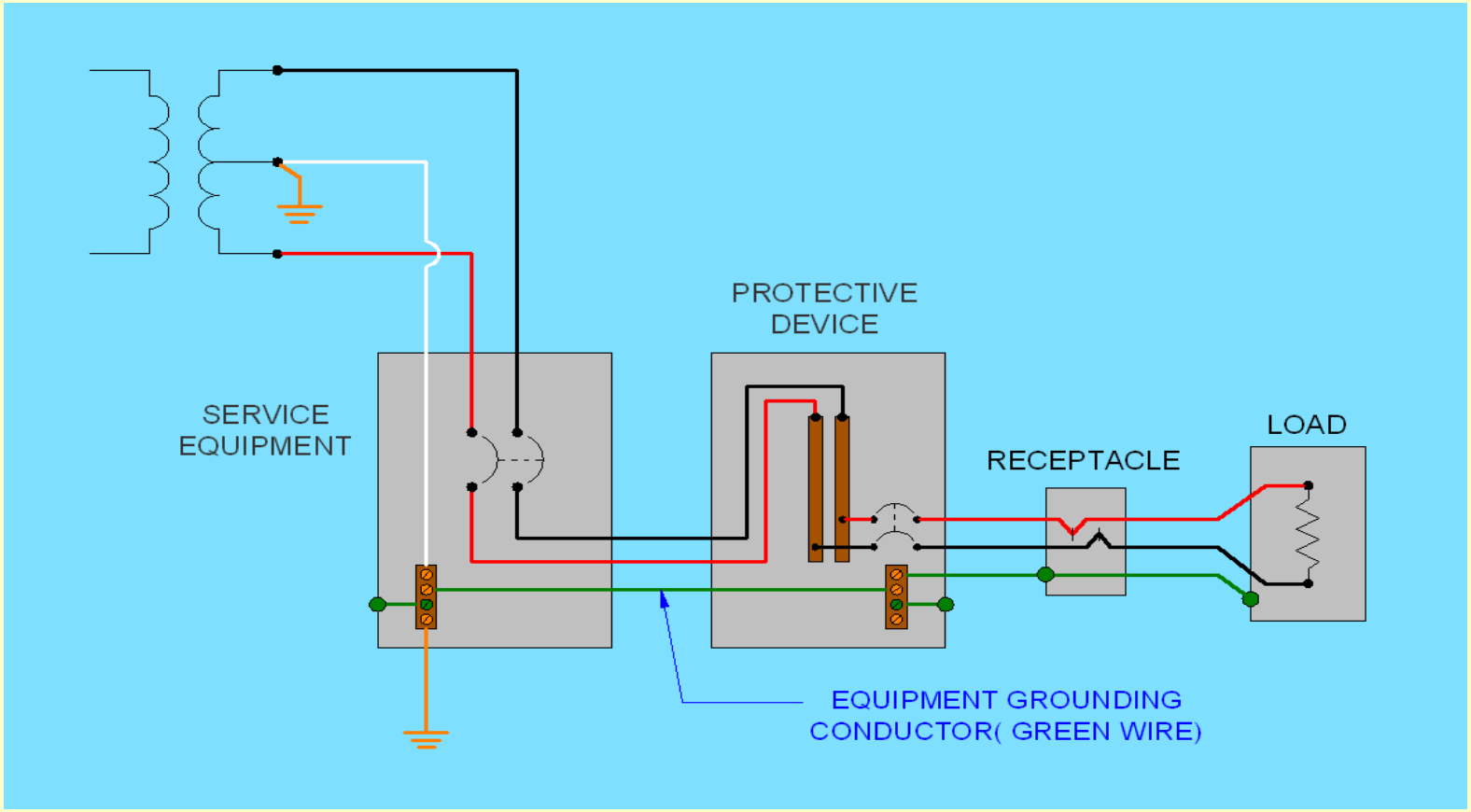


Figure 21

Note: Installation of the Equipment Grounding Conductor is beyond the scope of the Company's requirements for Low Voltage Services. Please refer to the Philippine Electrical Code (PEC) for specifications and installation requirements.

From: Handbook of Grounding and Bonding
of Low Voltage Services - MERLACO

Figure 1 shows an example of an electrical hazard that may happen in an electrical system.

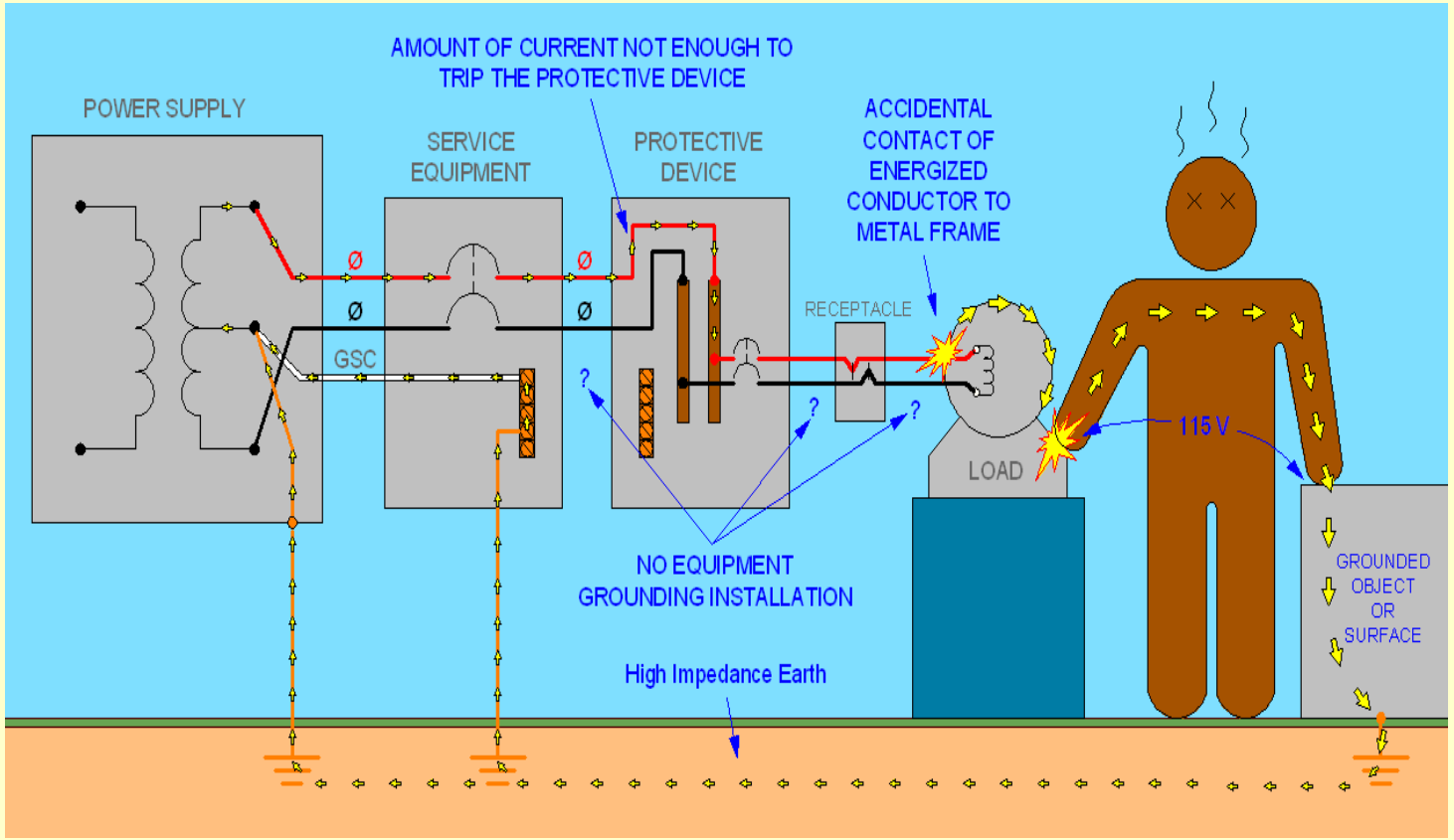


Figure 1: Electric Shock Hazard

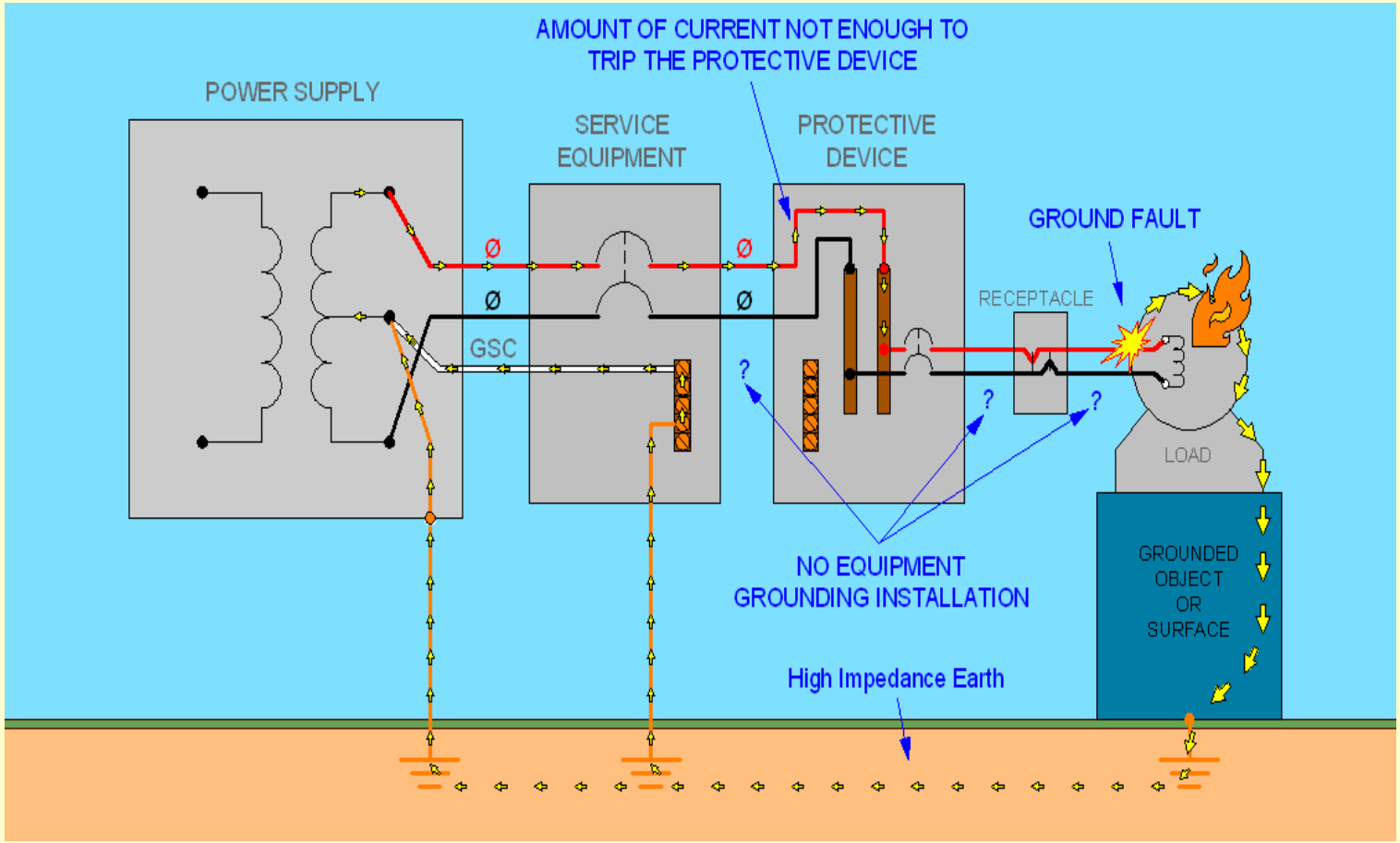


Figure 2: Fire Hazard

Effective grounding and bonding can solve these electrical hazards and other related problems because of these reasons:

Figure 3 shows the grounding and bonding of the electrical system that forms the low impedance path (also called the Effective Ground-Fault Current path). This path would permit sufficient current to flow back to the power supply to open the overcurrent protective device in the event of a ground fault.

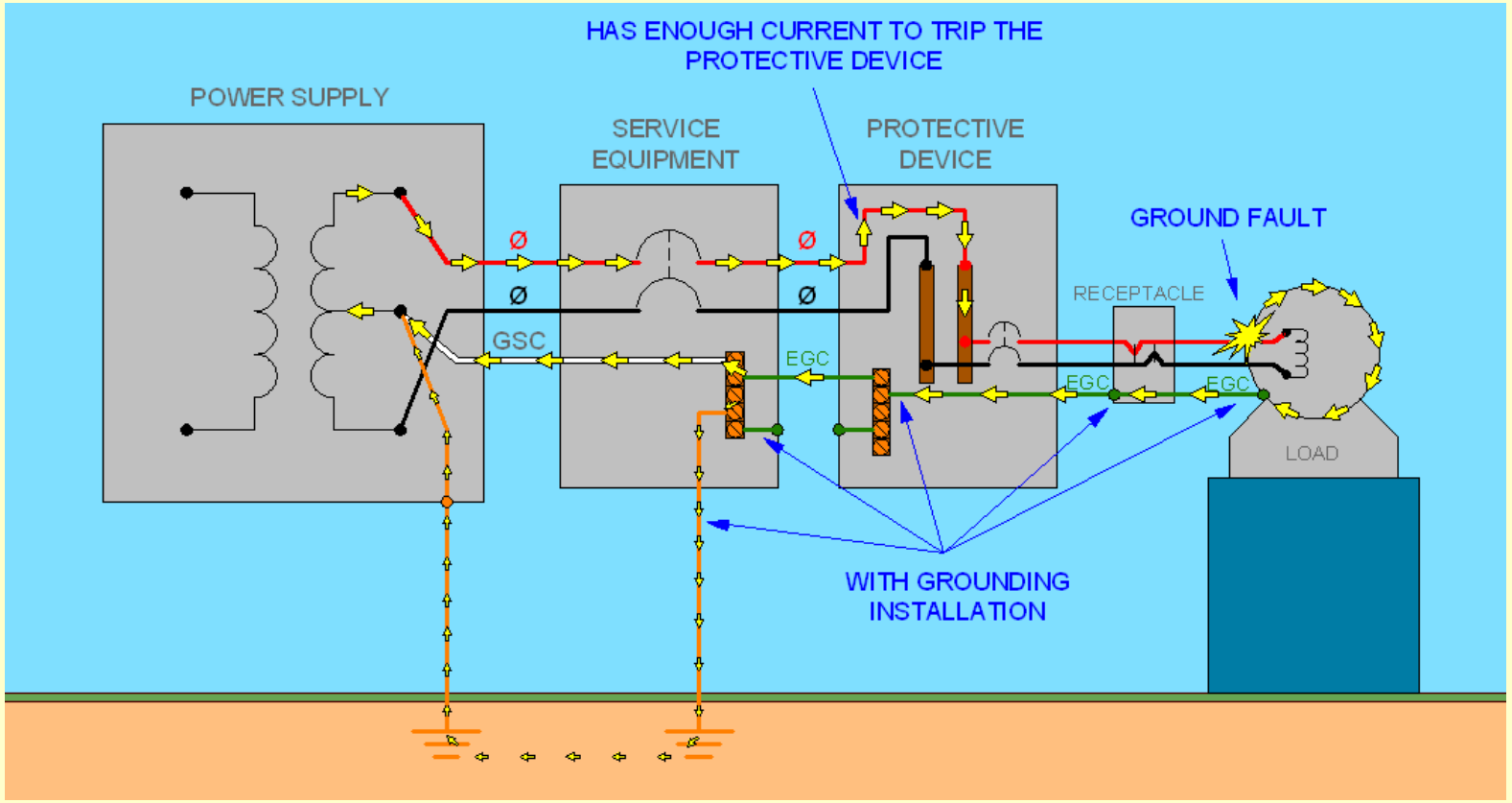


Figure 3 Effective Ground-Fault Current Path

Proper Wiring Starts with the Right Color Used in Conductor Wiring

	120/240 – V, Single Phase	208Y/120 – V, Three-Phase	480Y/277-V, Three-Phase
Phase A	Black	Black	Brown
Phase B	Red	Red	Orange
Phase C		Blue	Yellow
Neutral Conductor	White	White with red Stripe	Gray
Equipment Grounding Conductor	Green	Green	Green

SAFETY

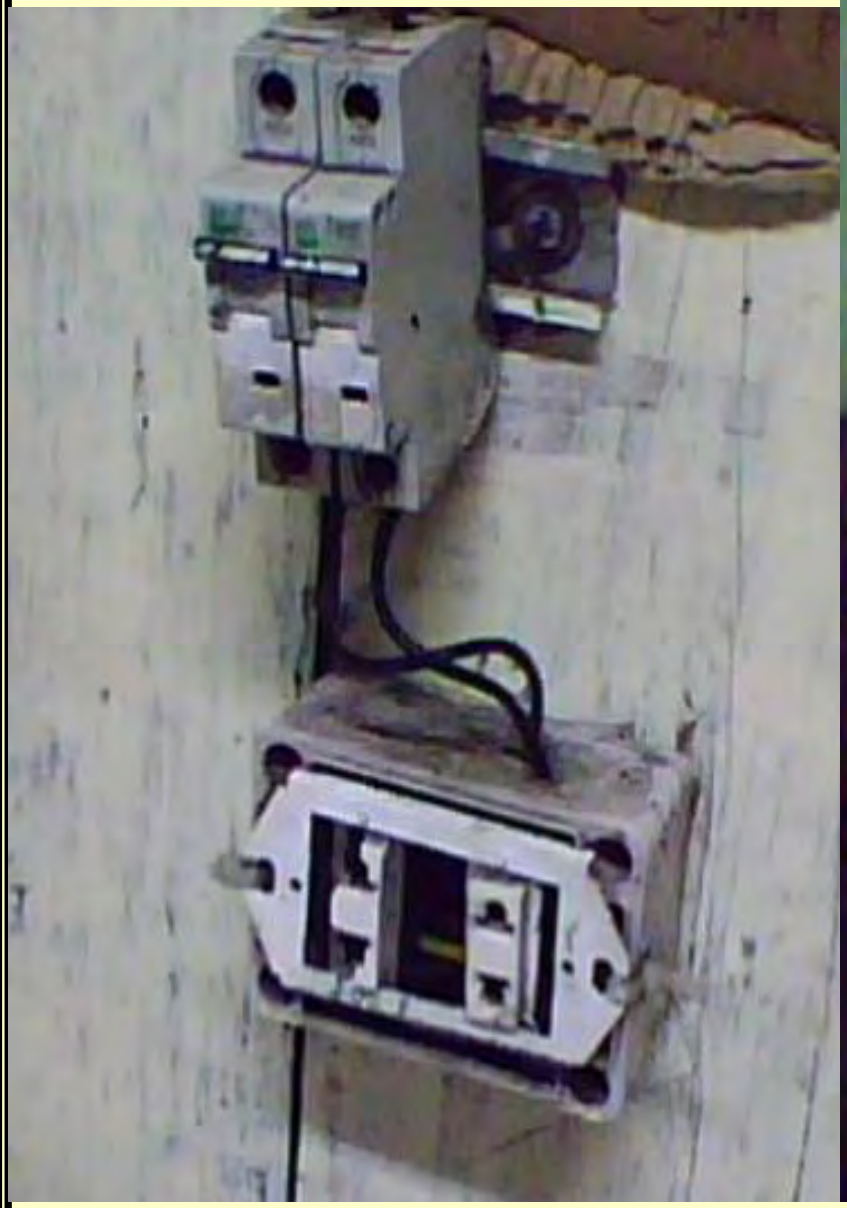
- Unsafe Conditions
  -
  -
  -
- Unsafe Acts
  -
  -
  -

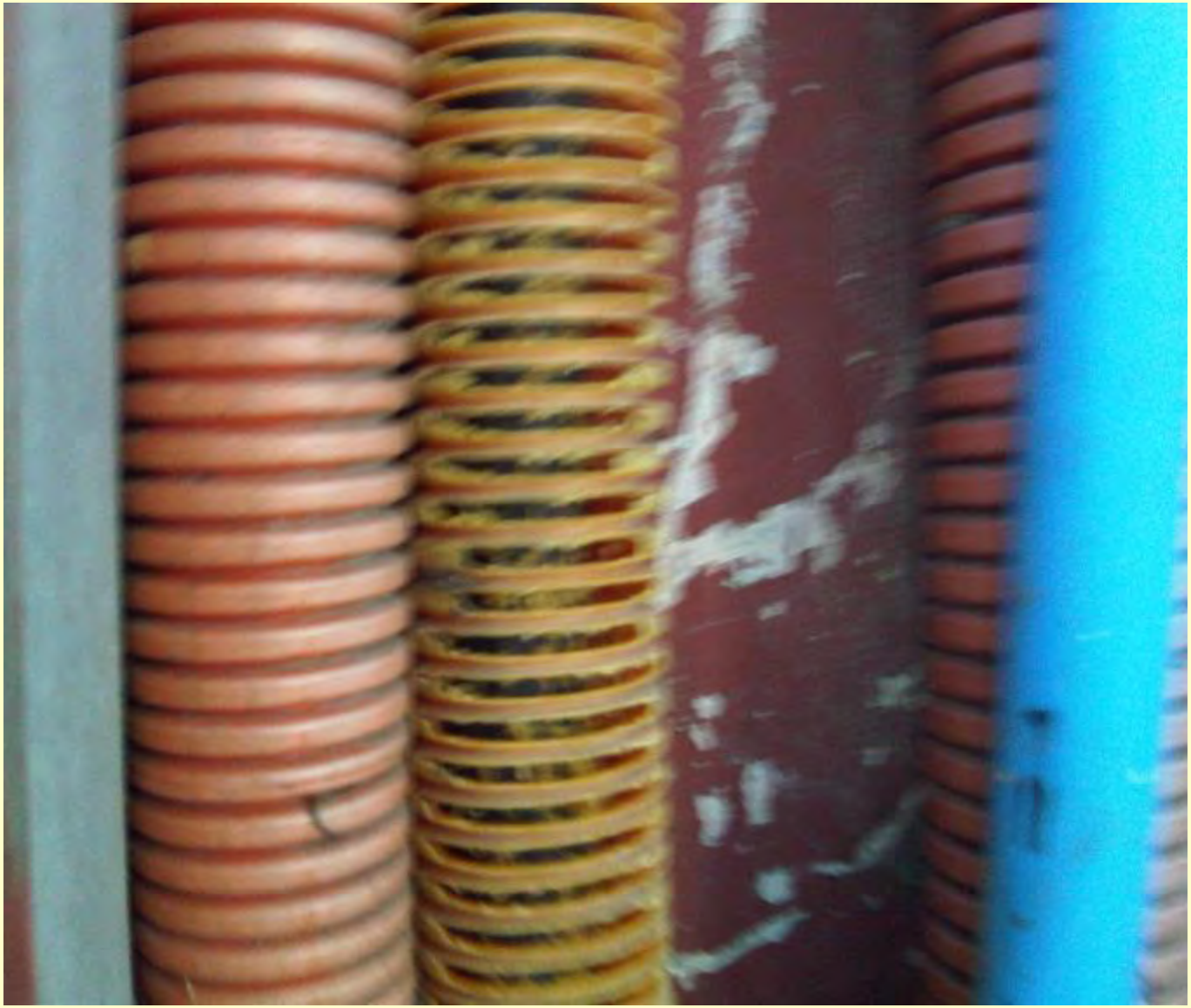
Unsafe Condition

Terminal Box will be subjected to environmental contamination.

Electrical Room as Storage Room

Unused Openings





Hazard Analysis

- Identify:
  - Inspection
  - Investigation
- Evaluate
  - Maximum Limit
  - Minimum Limit
- Control
  - Engineering Control
  - Administrative Control
  - PPE

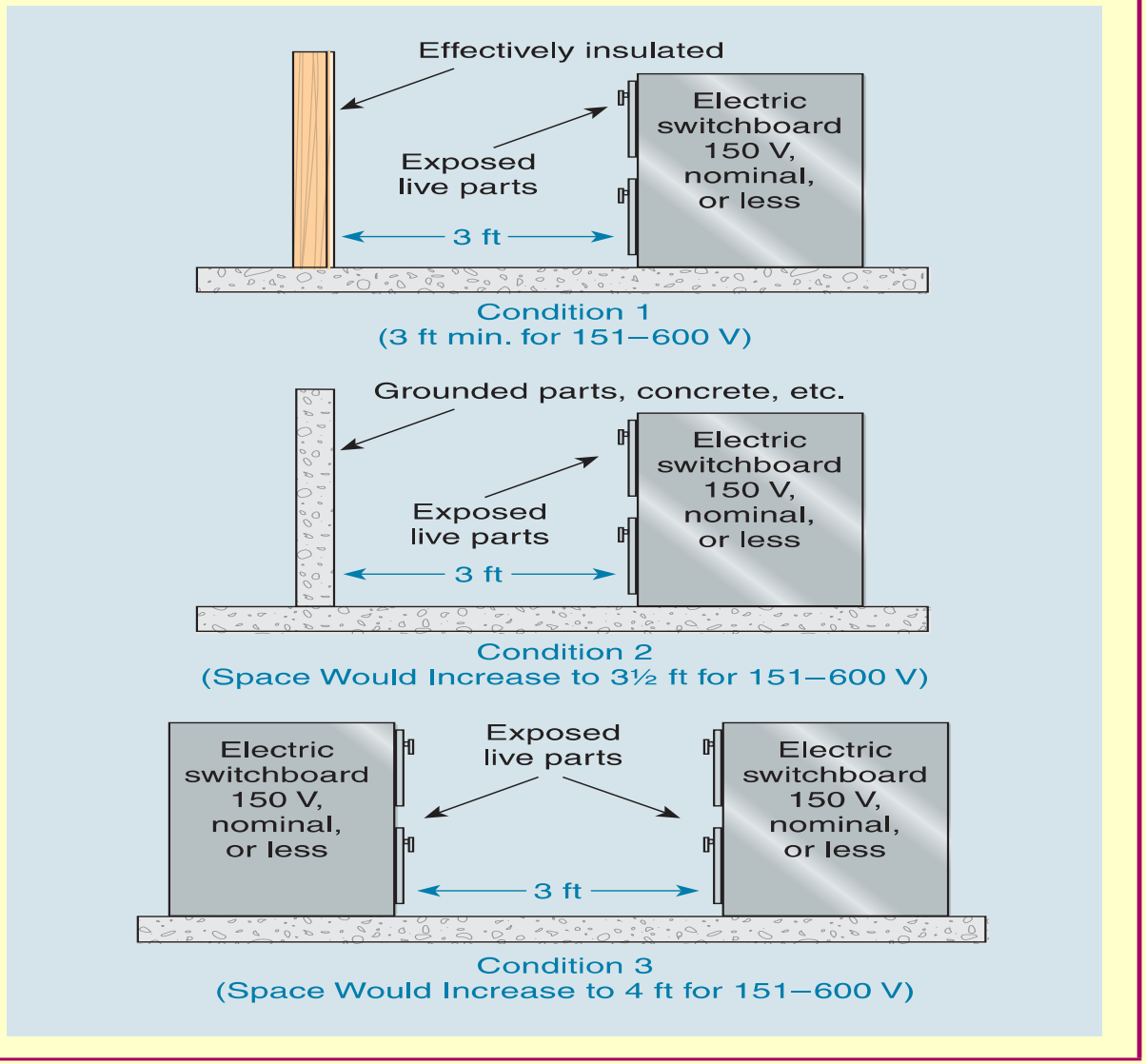


EXHIBIT 110.12 *Distances measured from the live parts if the live parts are exposed or from the enclosure front if the live parts are enclosed.*

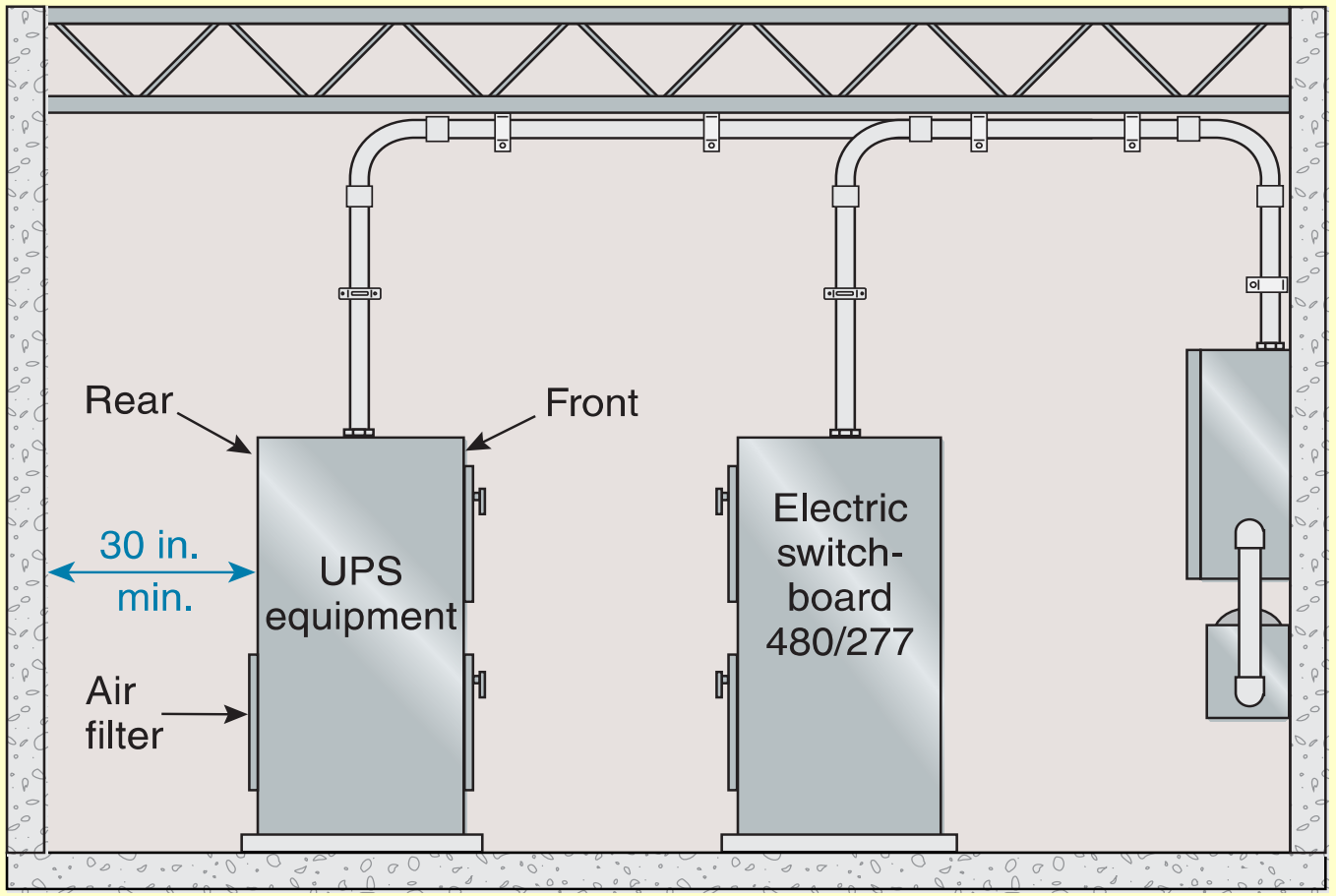


EXHIBIT 110.13 *An example of the 30-inch minimum working space at the rear of equipment to allow work on nonelectrical parts, such as the replacement of an air filter.*

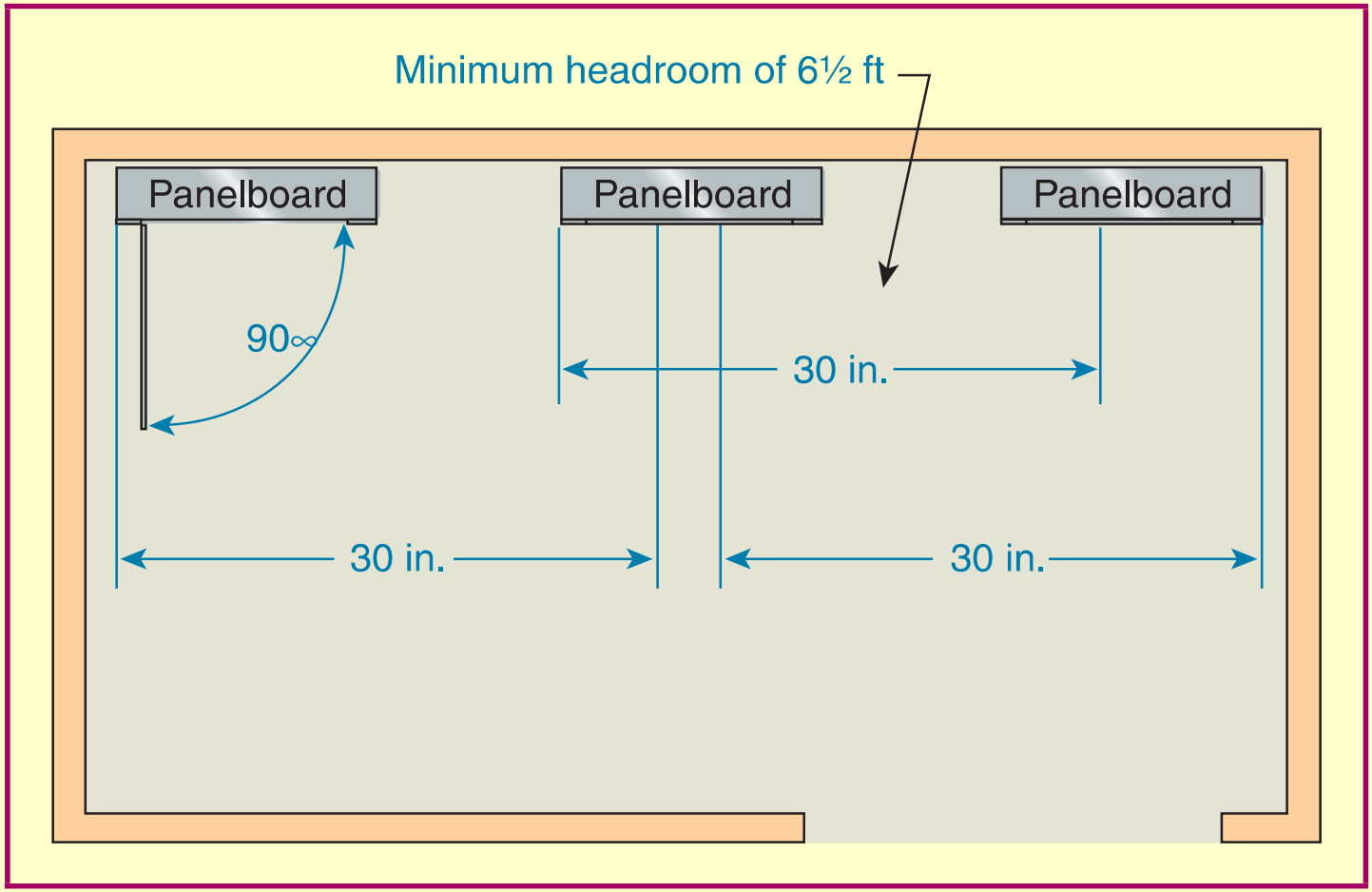


EXHIBIT 110.15 *The 30-inch-wide front working space, which is not required to be directly centered on the electrical equipment and can overlap other electrical equipment.*

EXHIBIT 110.16 *A full 90-degree opening of an equipment door in order to ensure a safe working approach.*

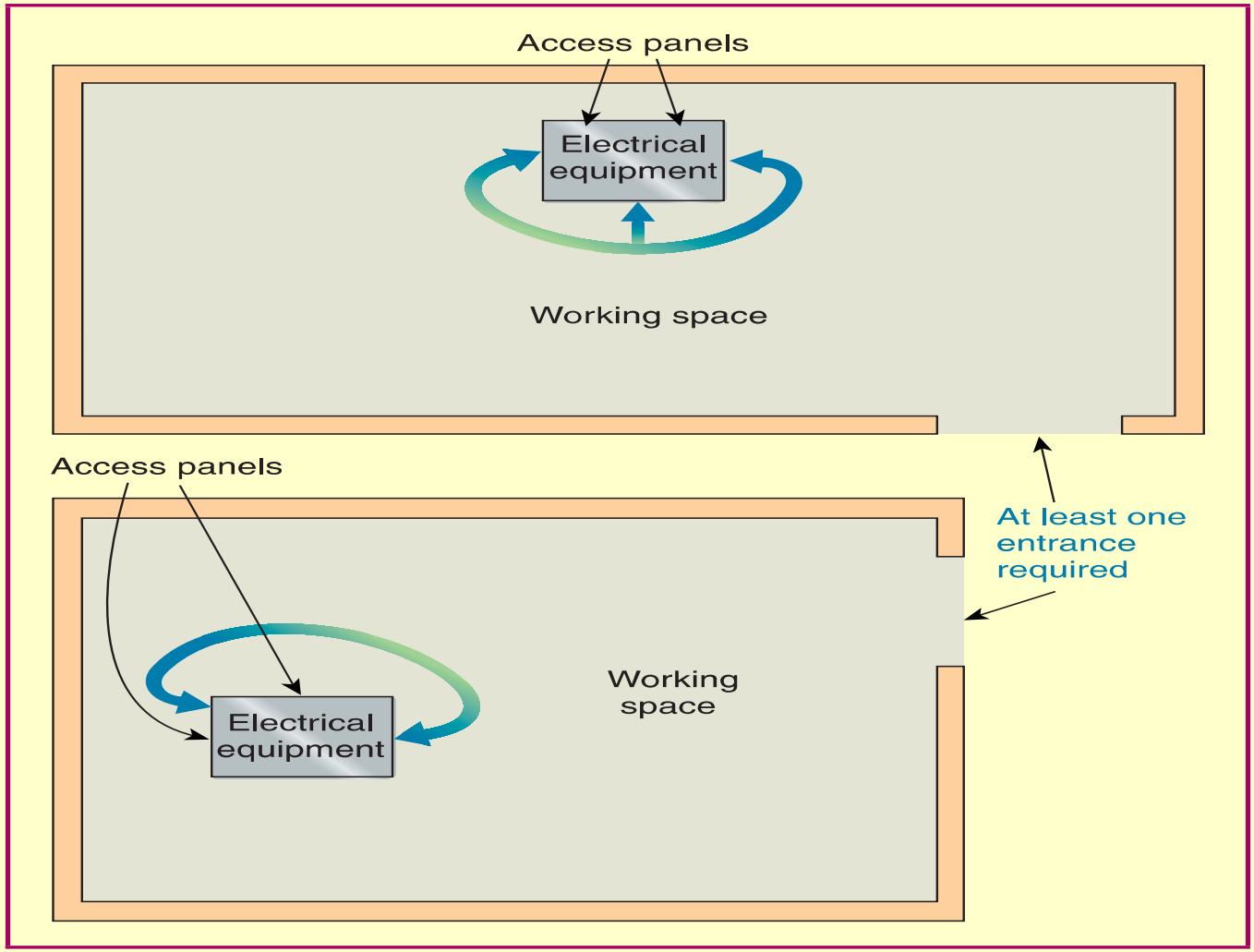


EXHIBIT 110.18 *At least one entrance is required to provide access to the working space around electrical equipment.*

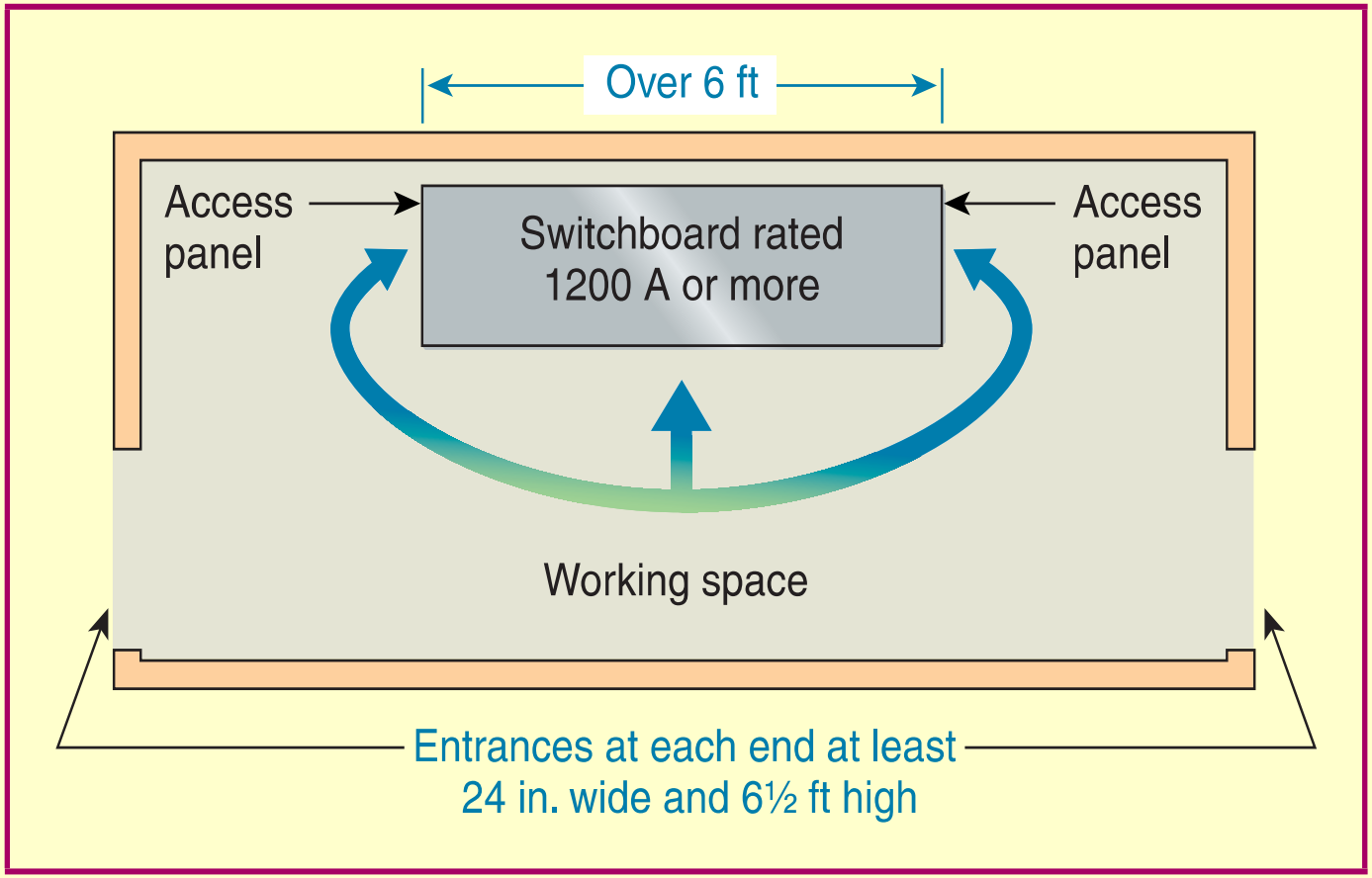


EXHIBIT 110.19 *For equipment rated 1200 amperes or more and over 6 feet wide, one entrance not less than 24 inches wide and 6½ feet high is required at each end.*

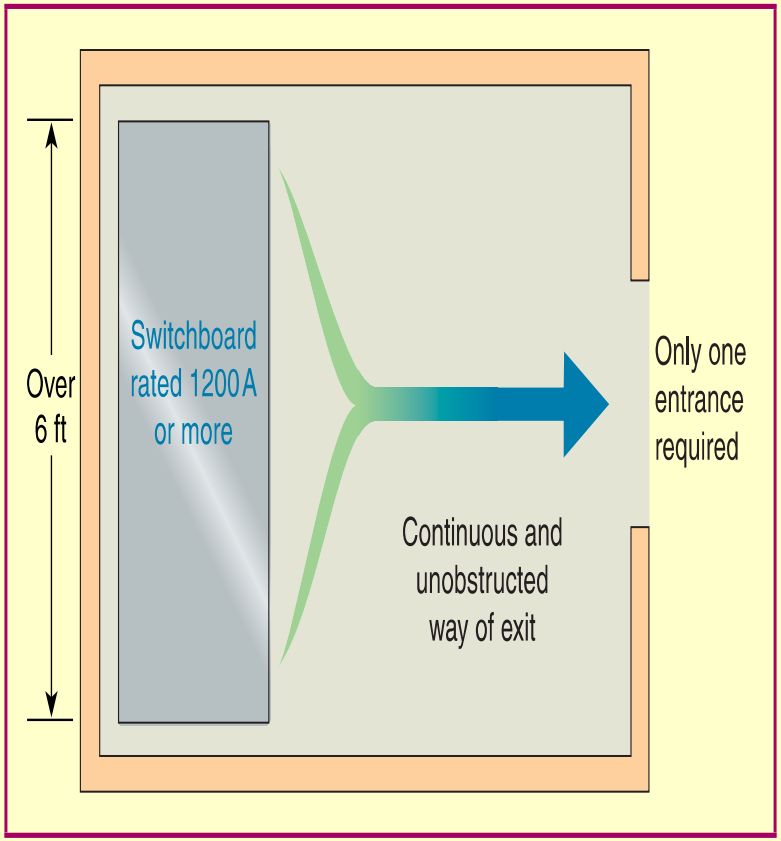


EXHIBIT 110.21 *An equipment location that allows a continuous and unobstructed way of exit travel.*

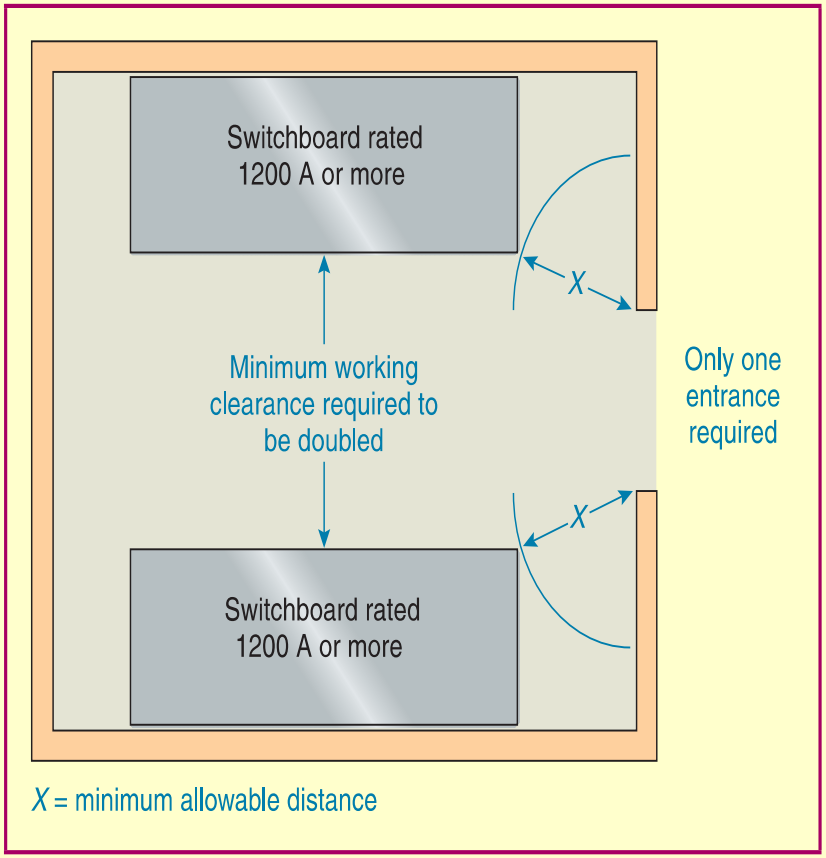


EXHIBIT 110.22 *A working space with one entrance, which is permitted if the working space required by 110.26(A) is doubled [see Table 110.26(A)(1) for permitted dimensions of X].*

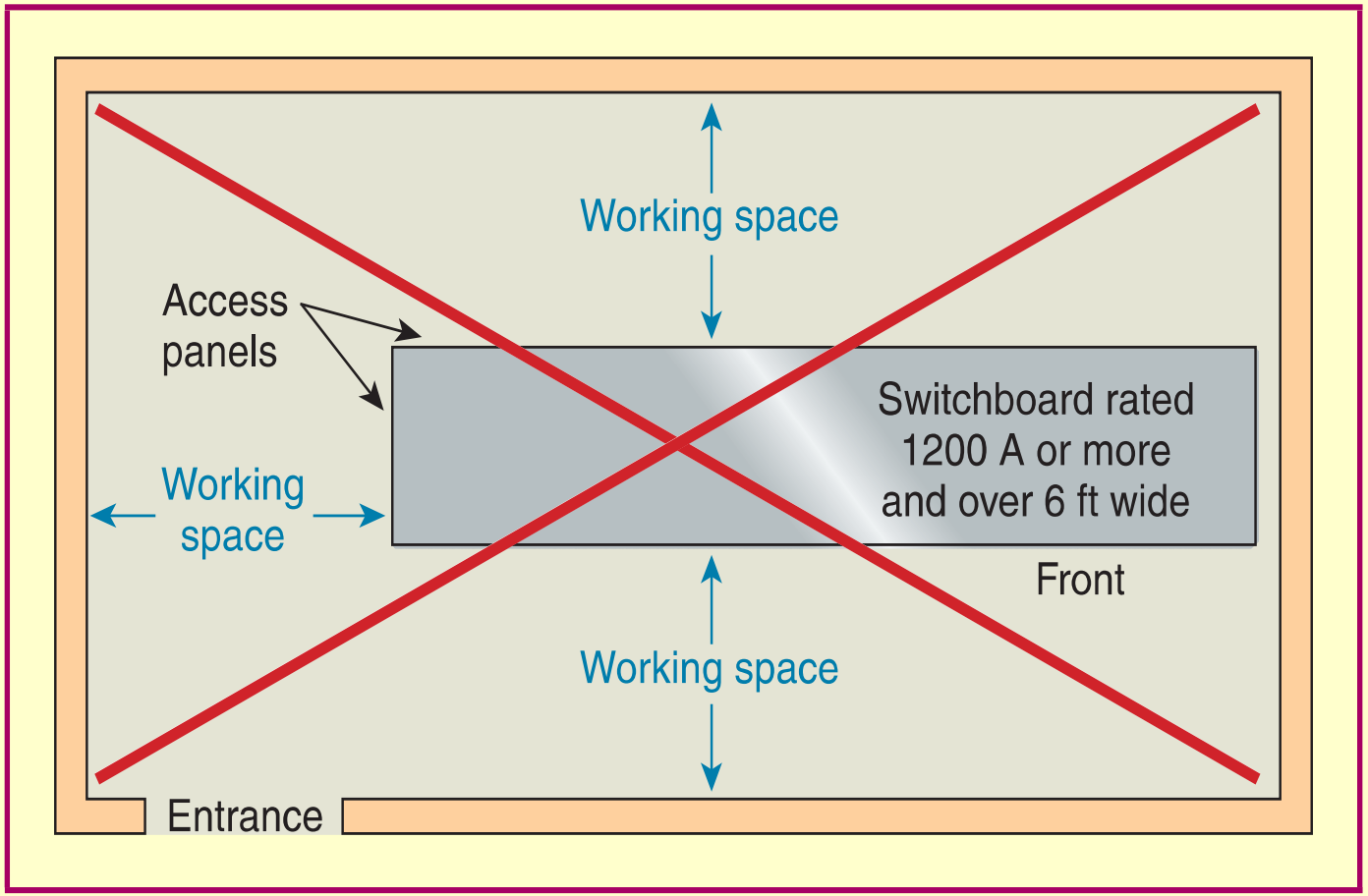
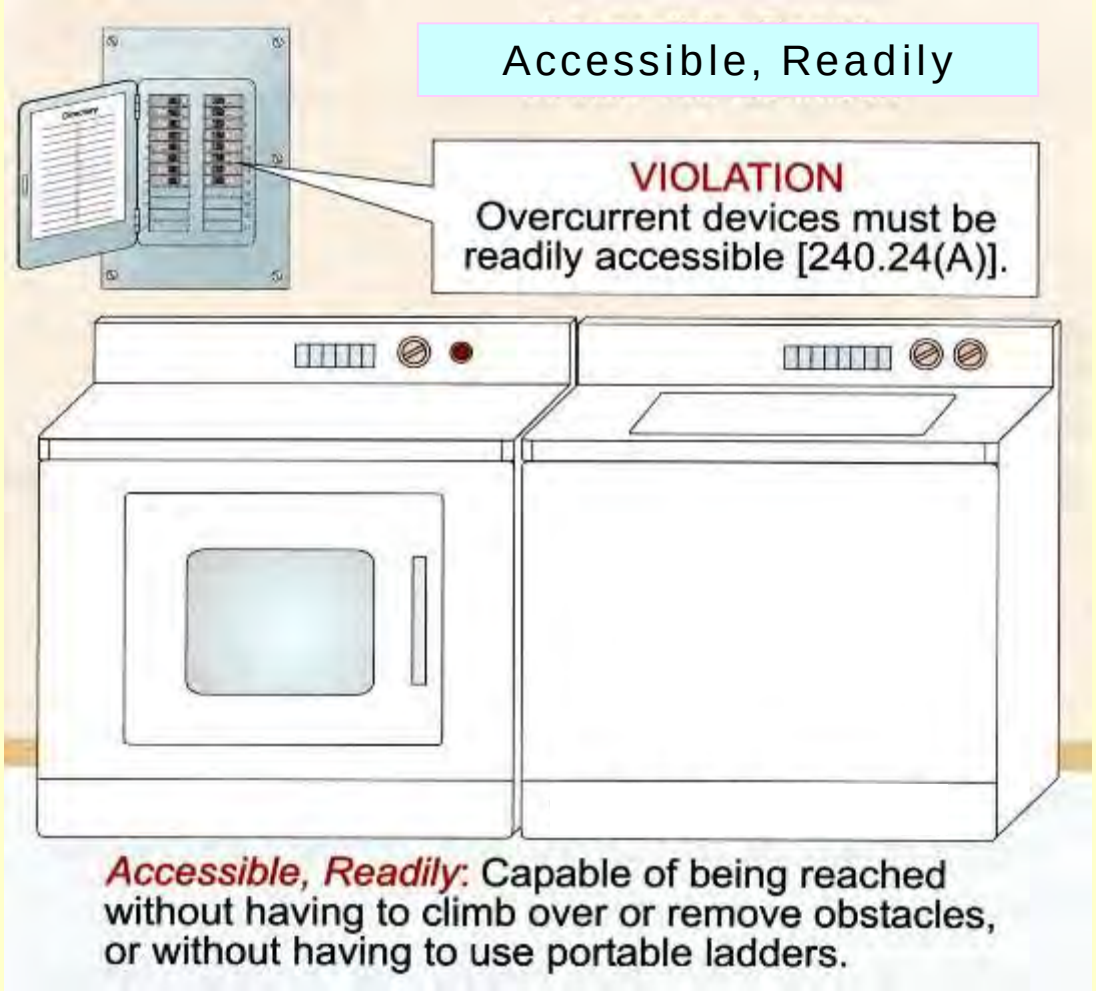
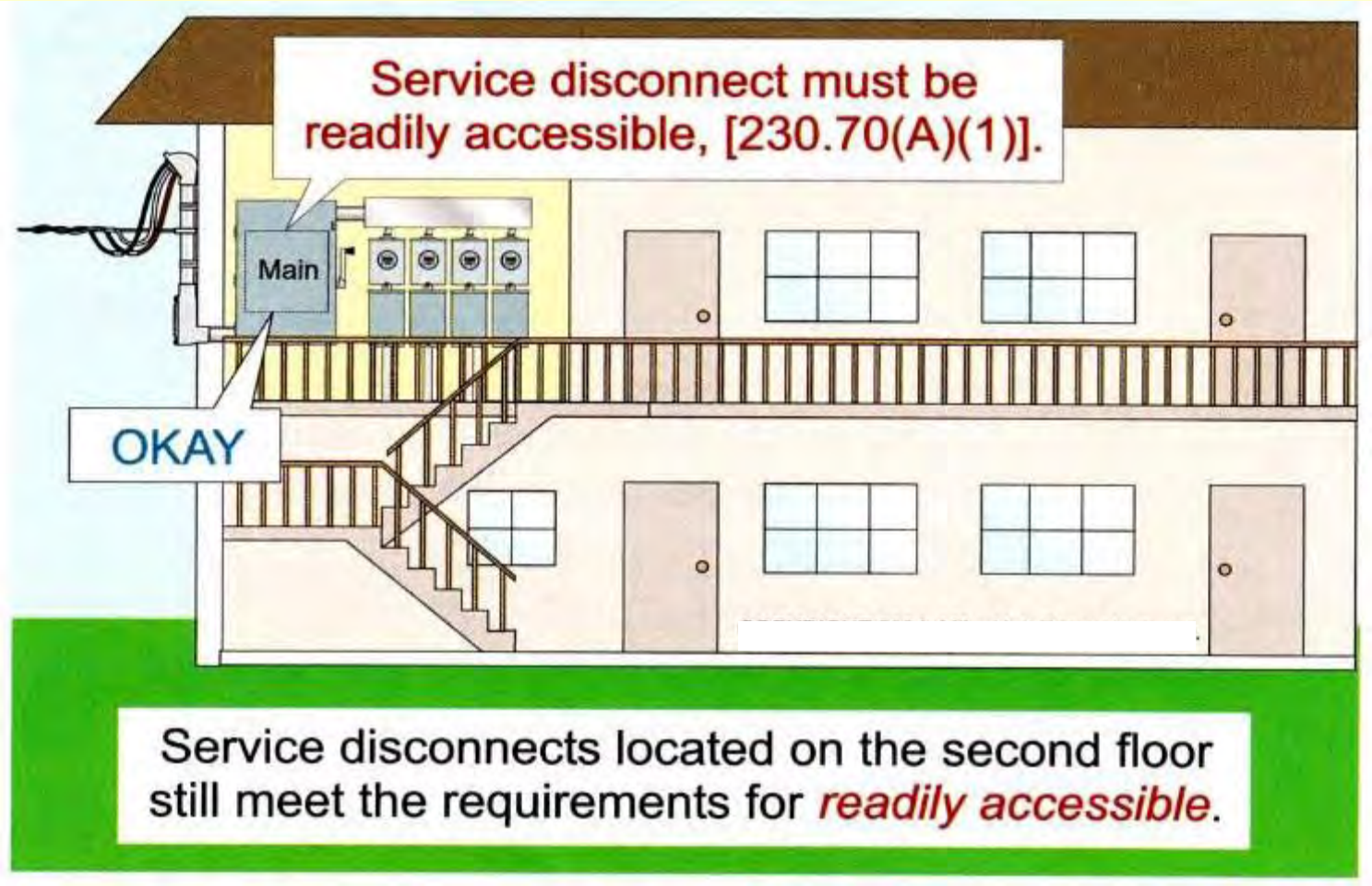


EXHIBIT 110.20 *An unacceptable arrangement of a large switchboard in which a worker could be trapped behind arcing electrical equipment.*

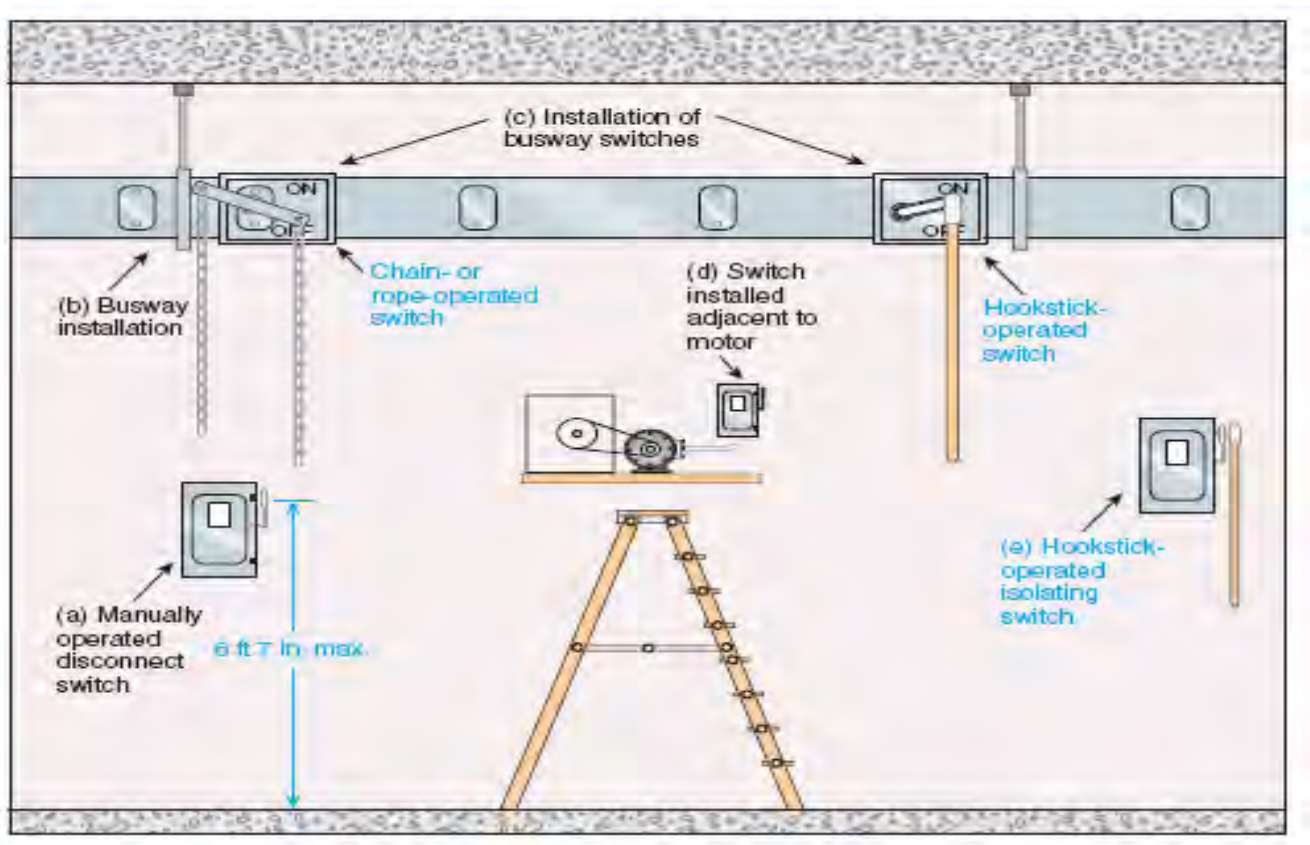
Accessible, Readily



Accessible, Readily

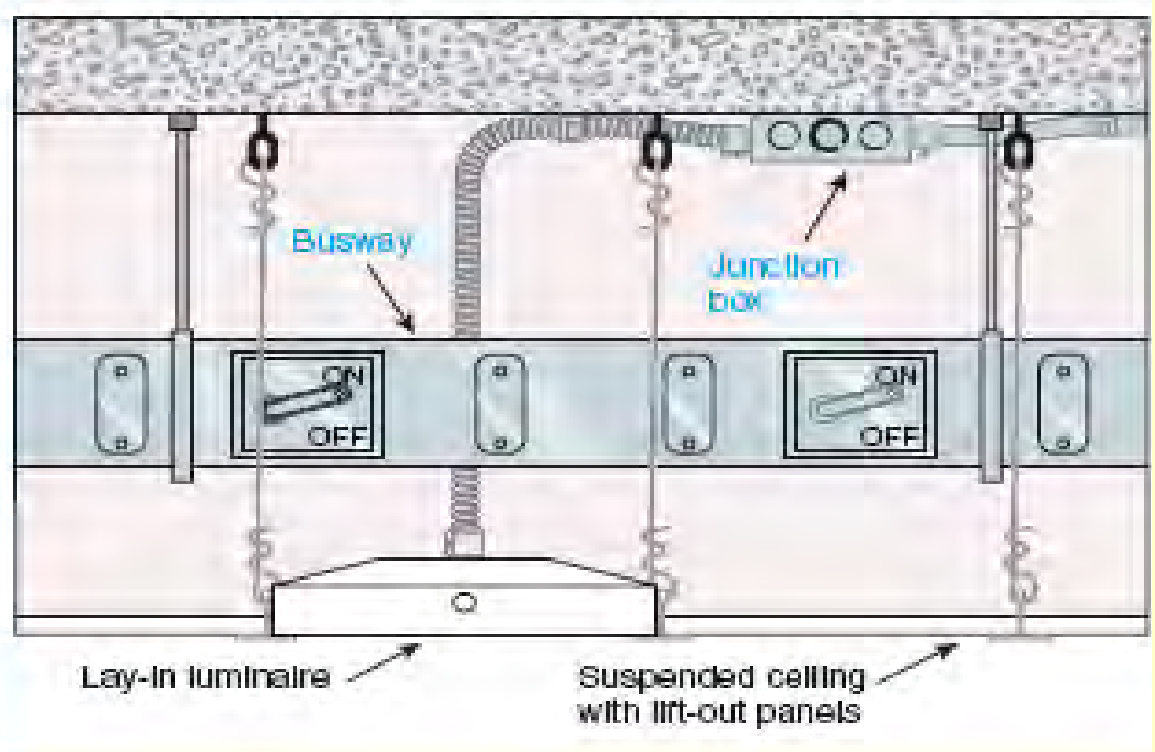


Accessible



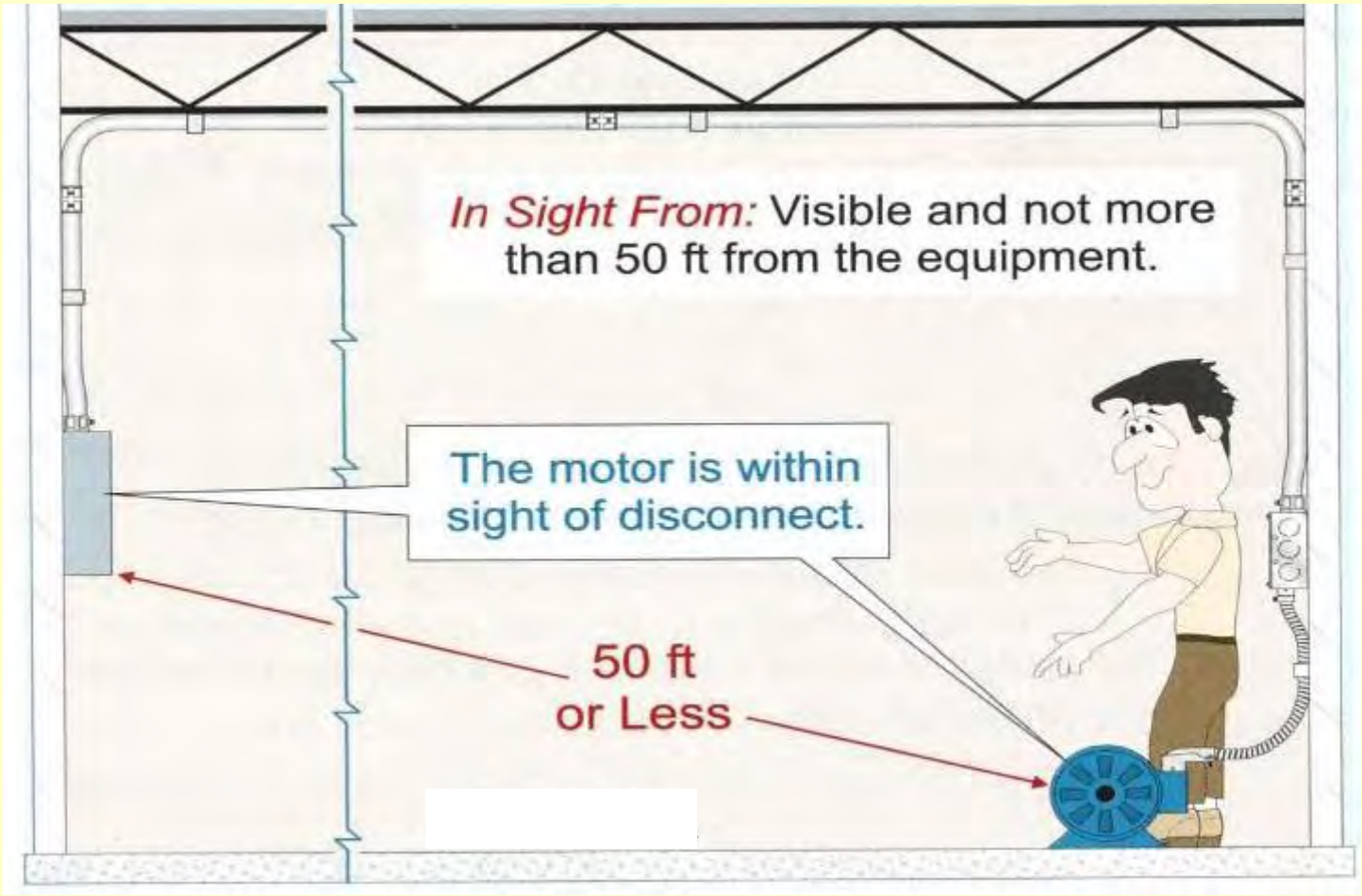
Accessible (as applied to equipment) – Admitting close approach; not guarded by locked doors, elevation, or other effective means.

Accessible

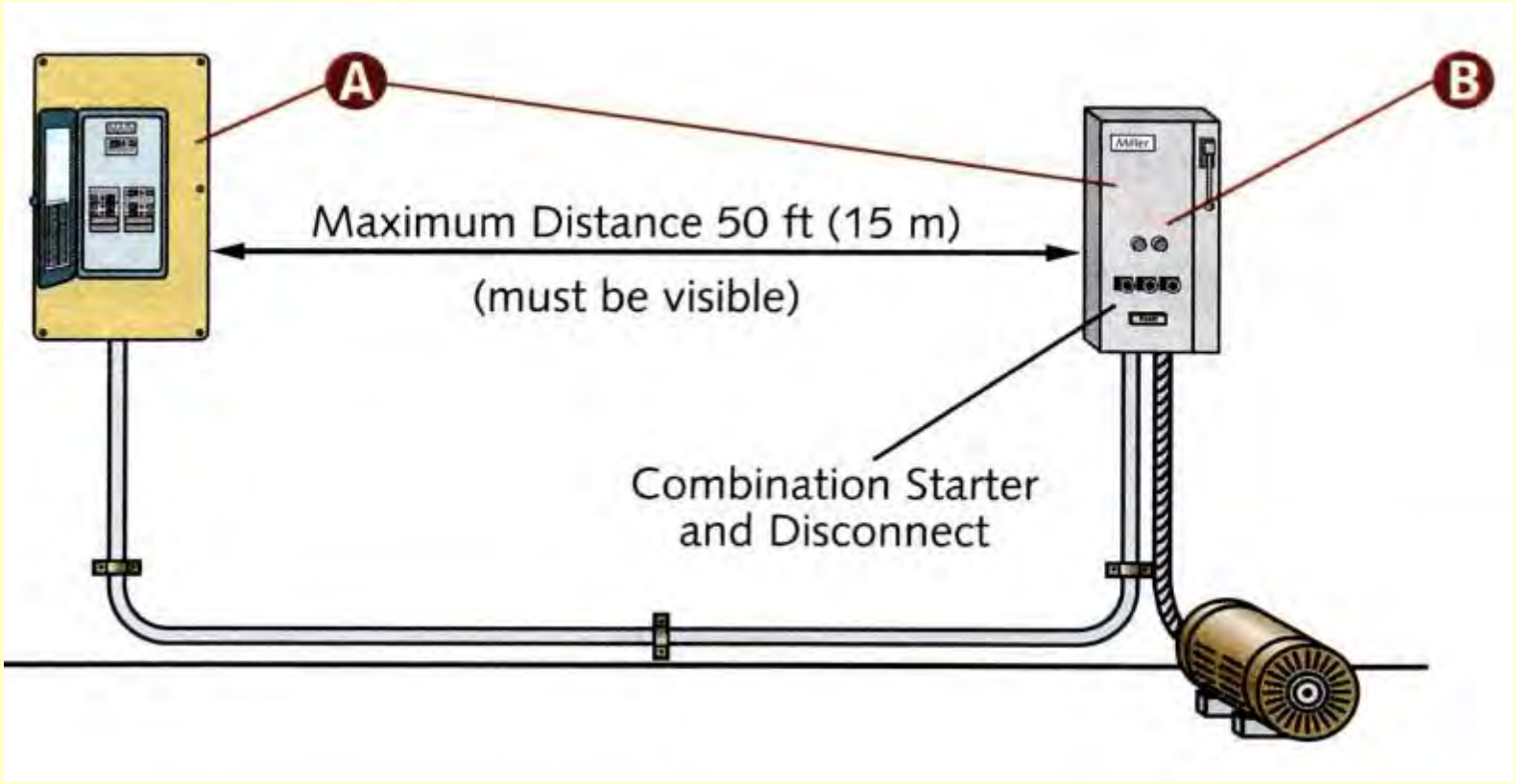


Accessible (as applied to wiring methods) – Capable of being removed or exposed without damaging the building structure or finish or not permanently closed in by structure or finish of the building.

Within Sight



In Sight From, Within Sight from

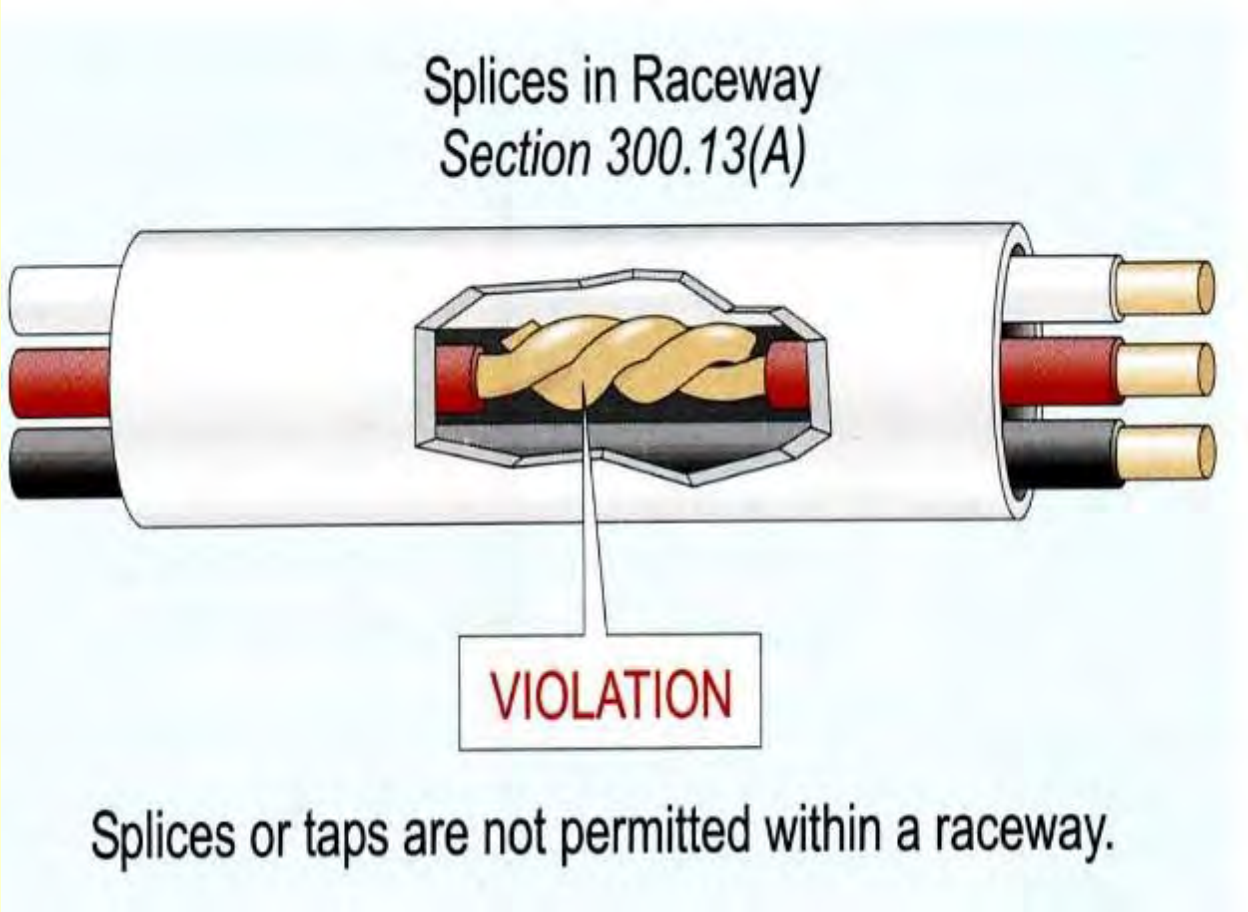


B – A motor controller disconnecting means must be located in sight from the controller location as required by 430.102(A)

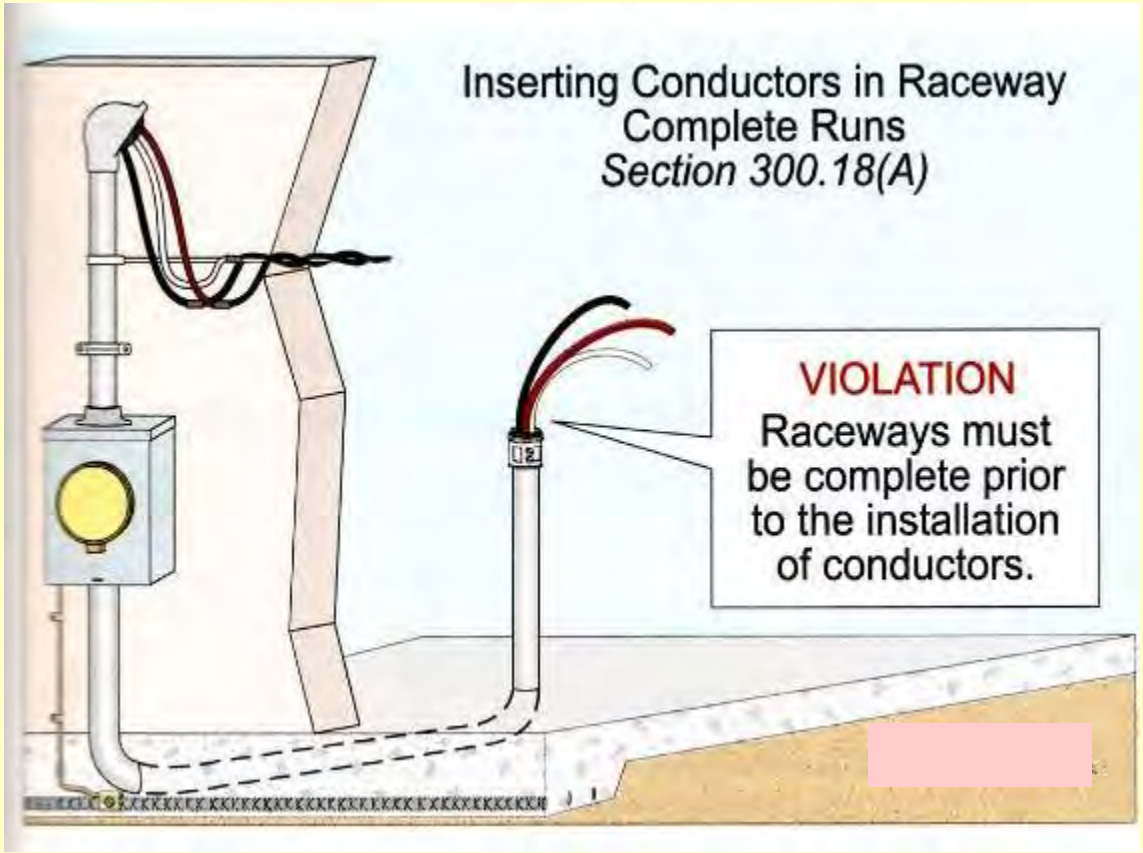
Qualified Person

Qualified Person: One who has knowledge and skill related to the construction, operation, and installation of electrical equipment, including safety training on the hazards involved with electrical systems.

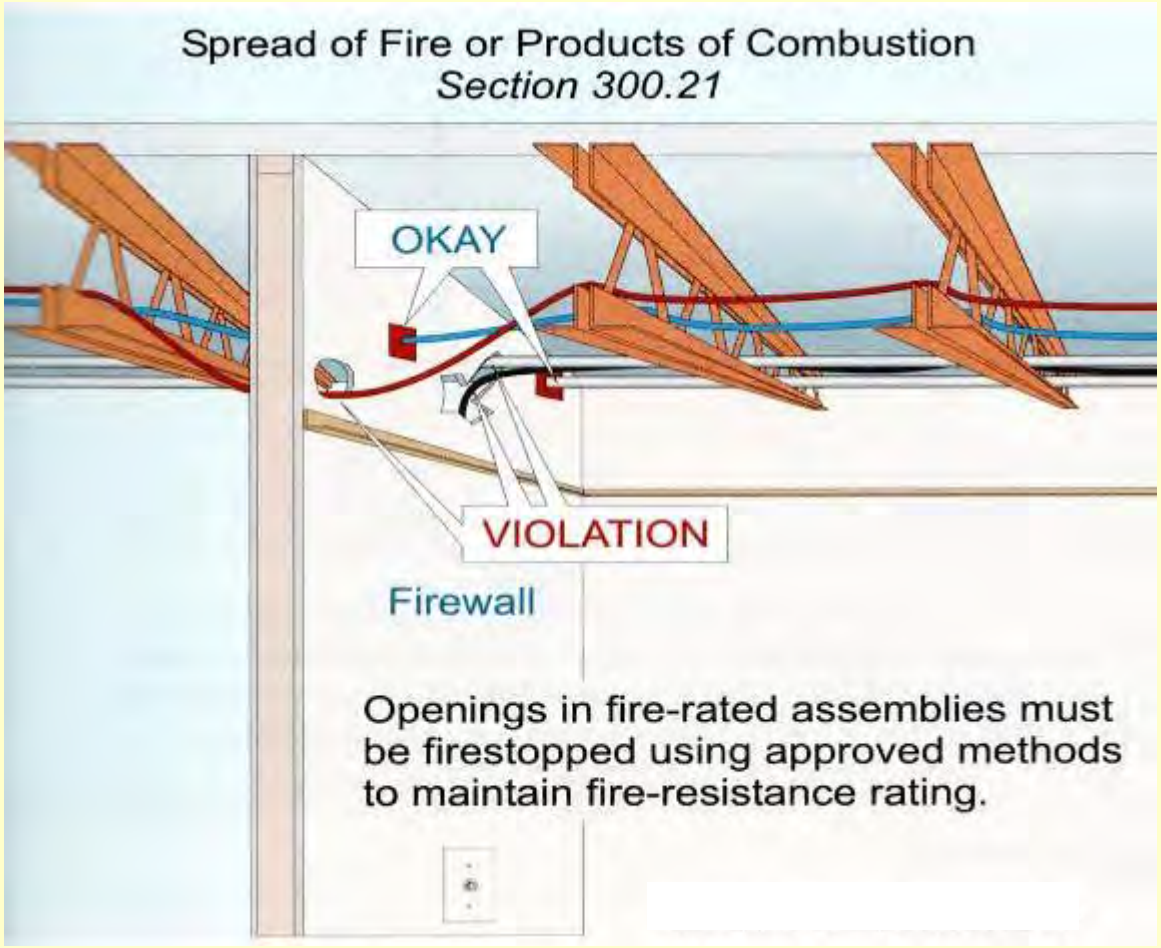
Wiring Methods



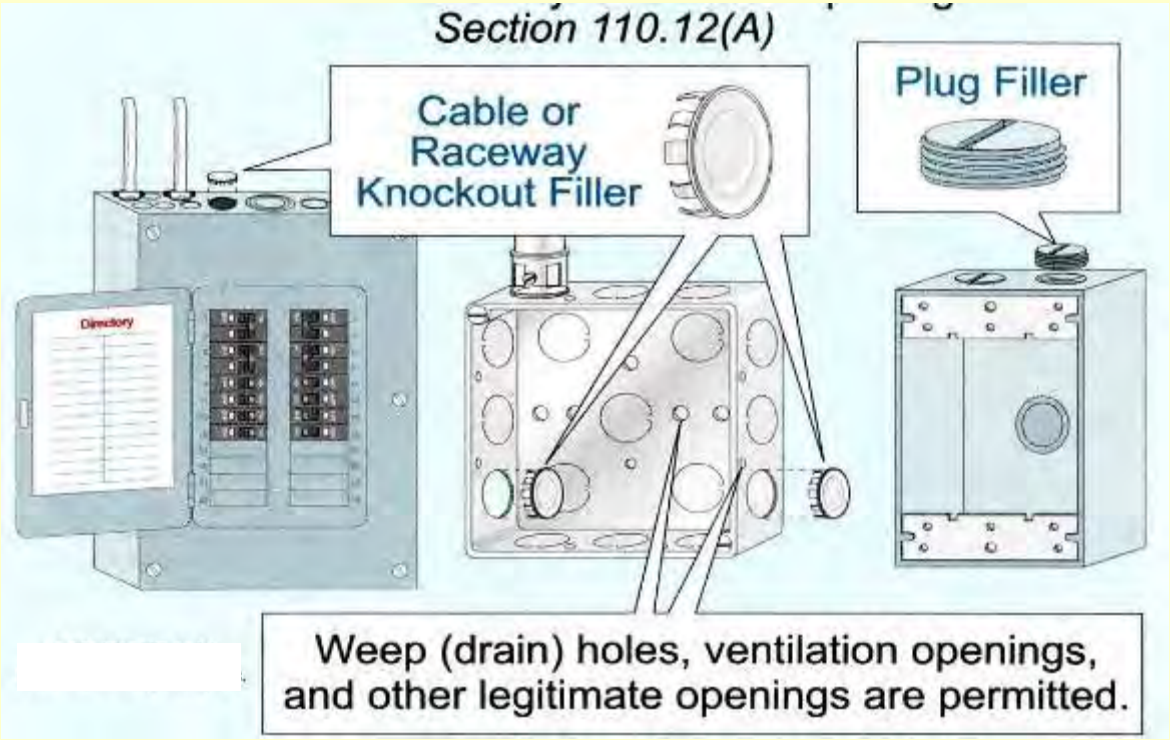
Wiring Methods



Wiring Methods

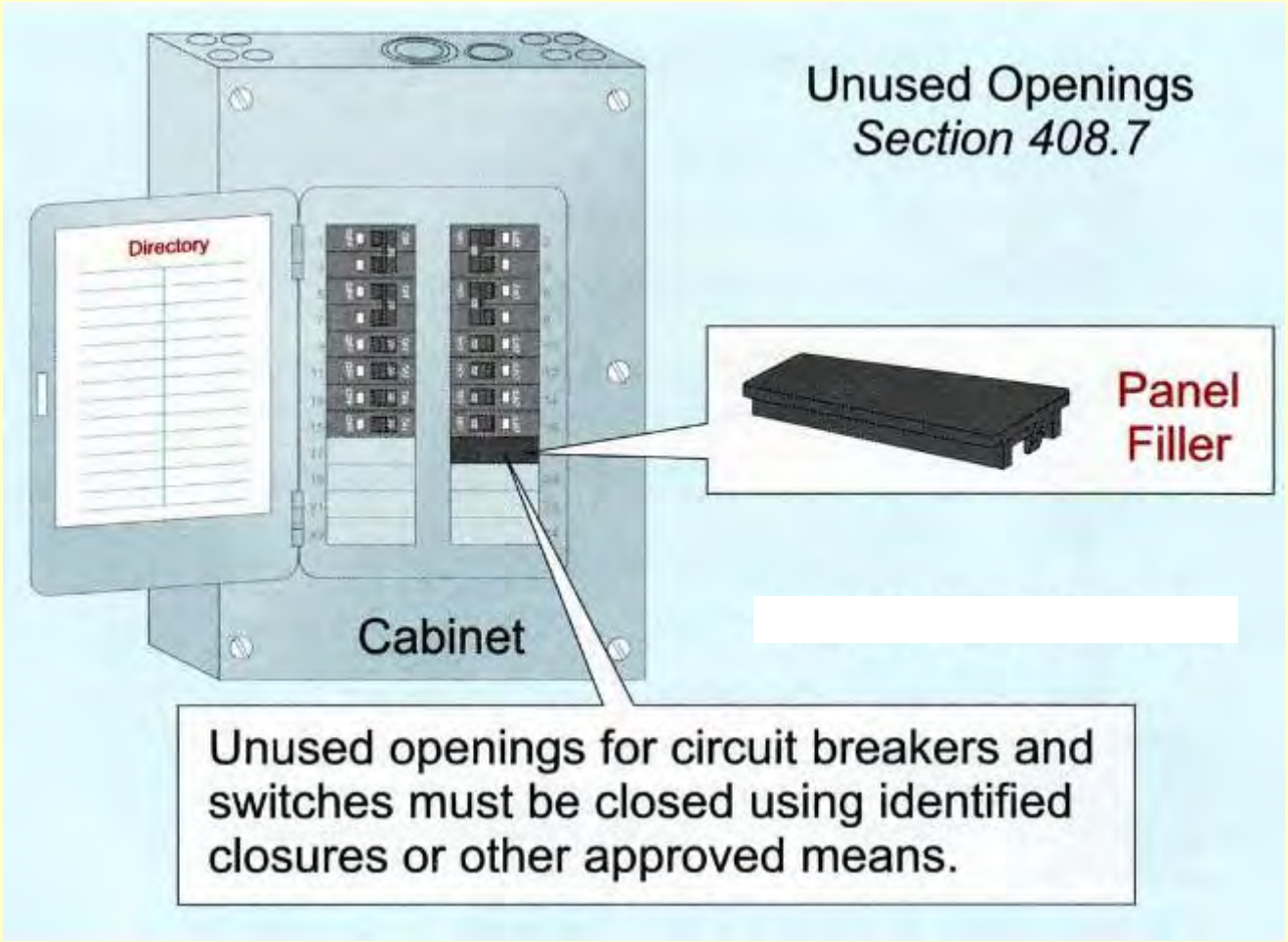


Unused Raceway and Cable Openings

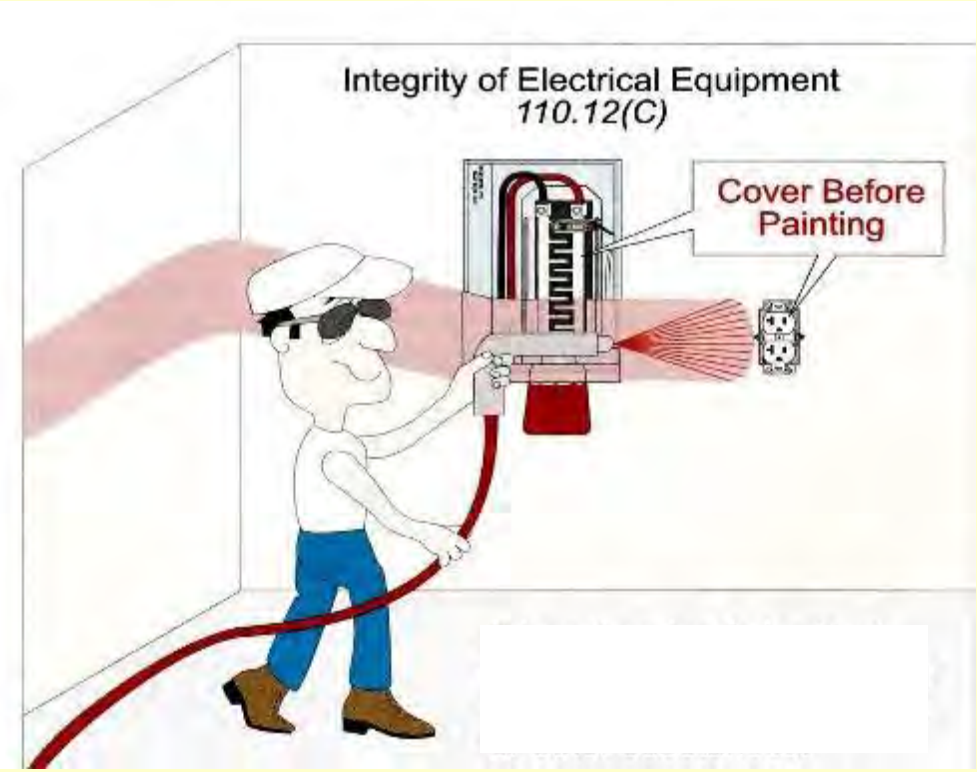


Unused cable or raceway openings must be closed with a fitting that provides equivalent protection.

Unused Openings

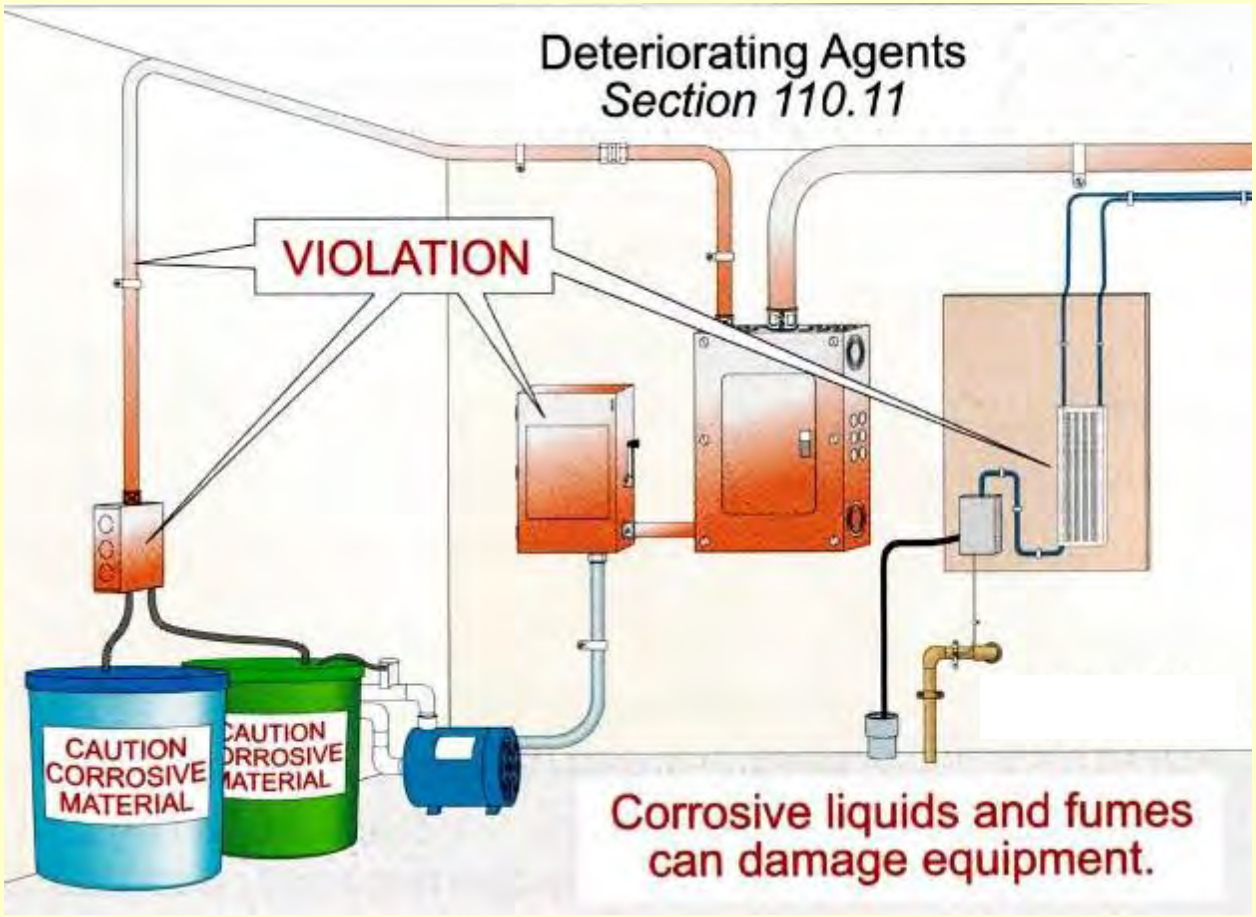


Integrity of Electrical Equipment

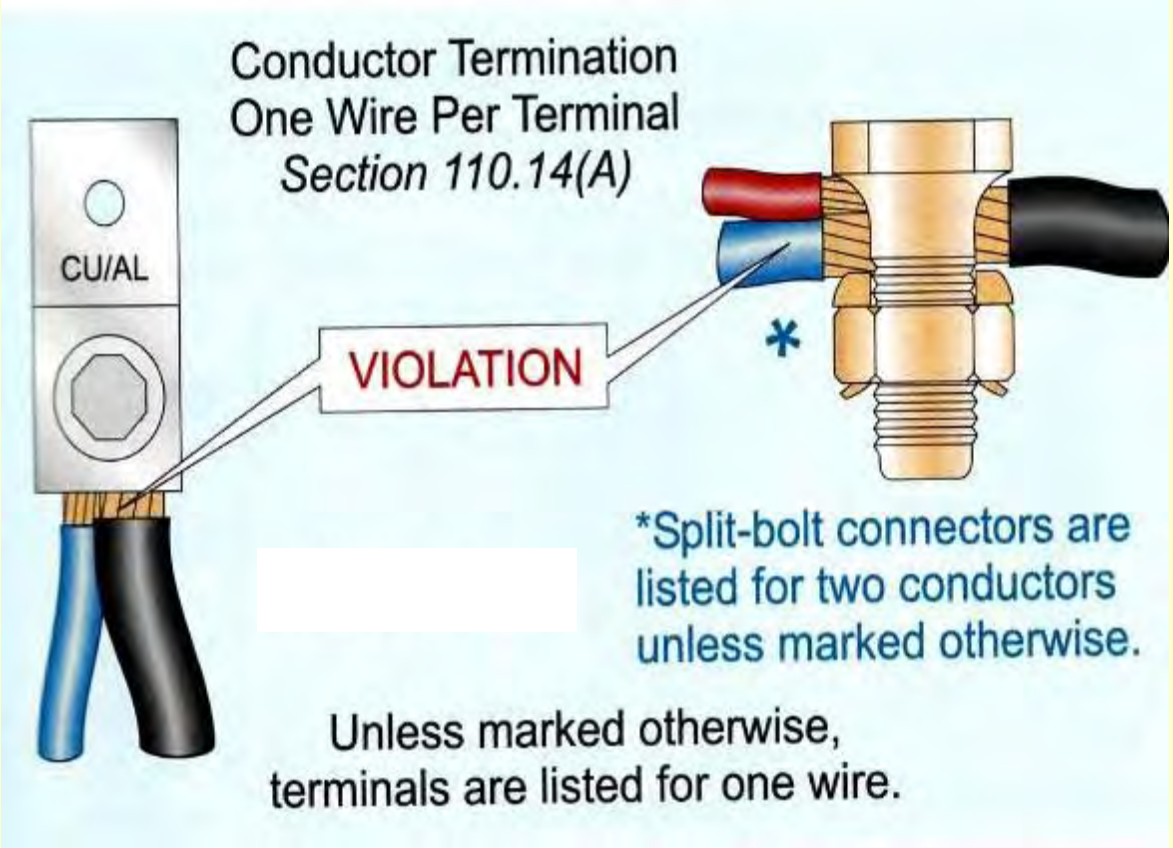


Internal parts of electrical equipment must be covered to avoid damage from paint or other substances.

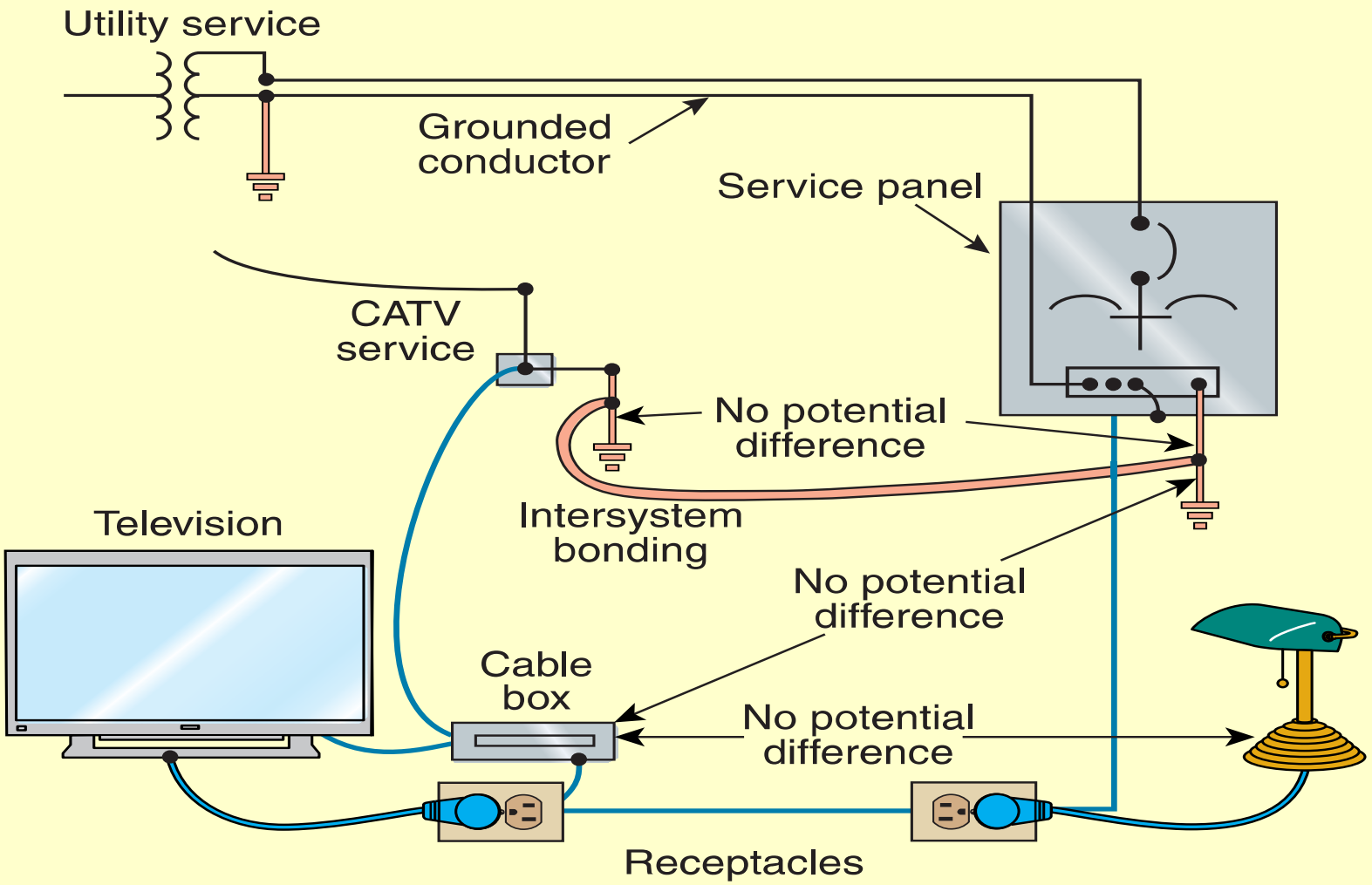
Deteriorating Agents



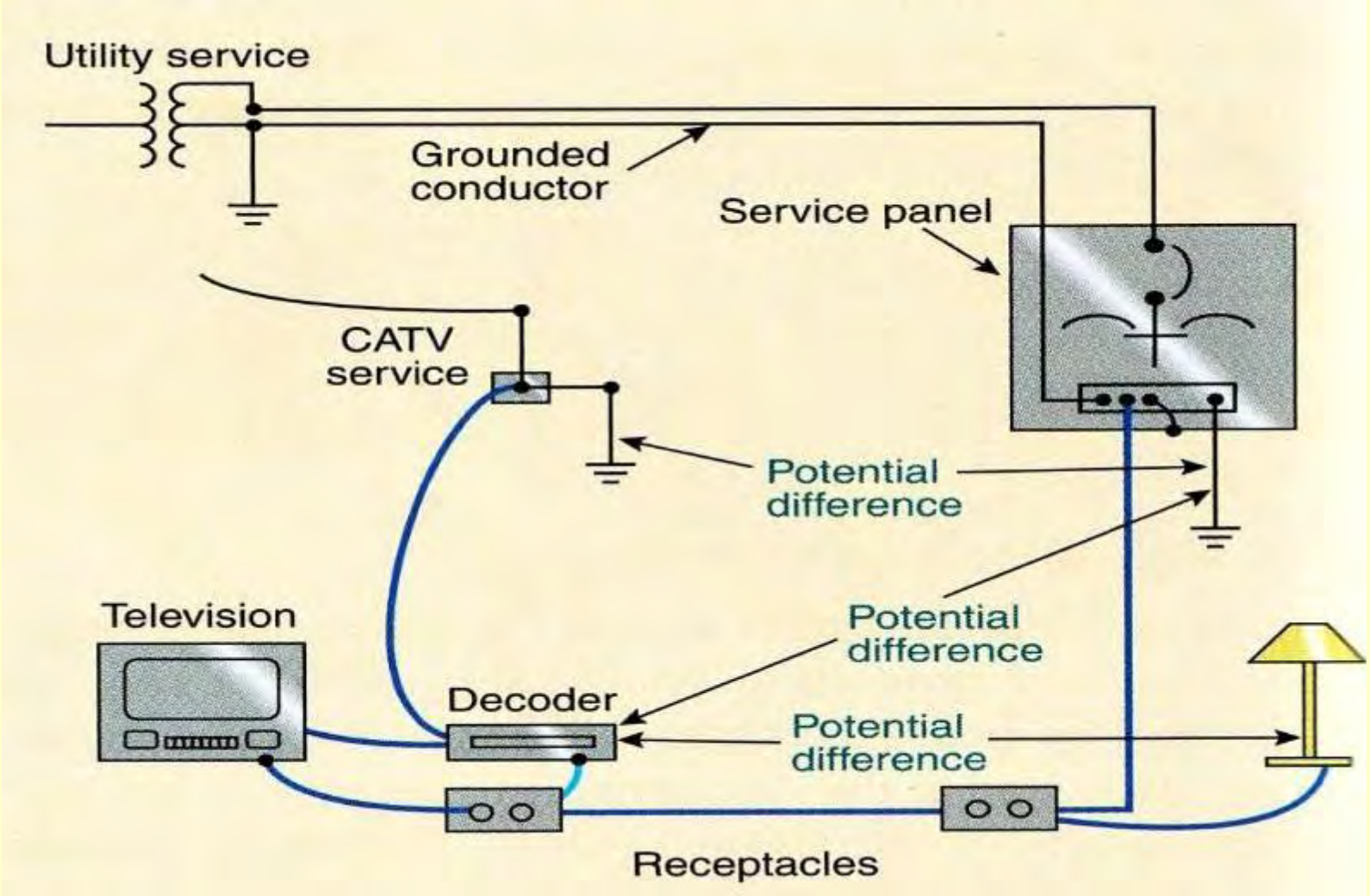
Conductor Termination



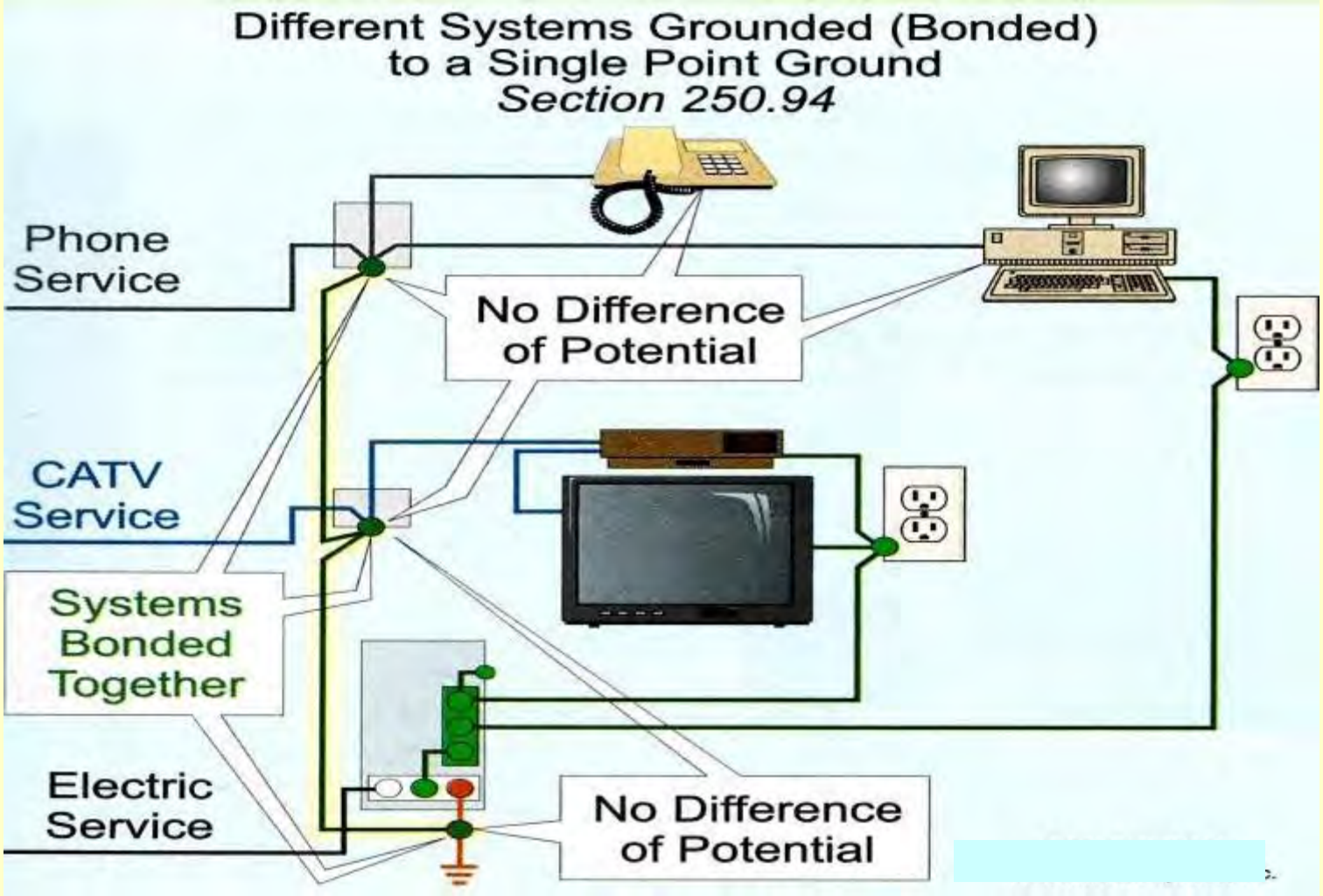
2.50.5.5 Bonding for Other Systems



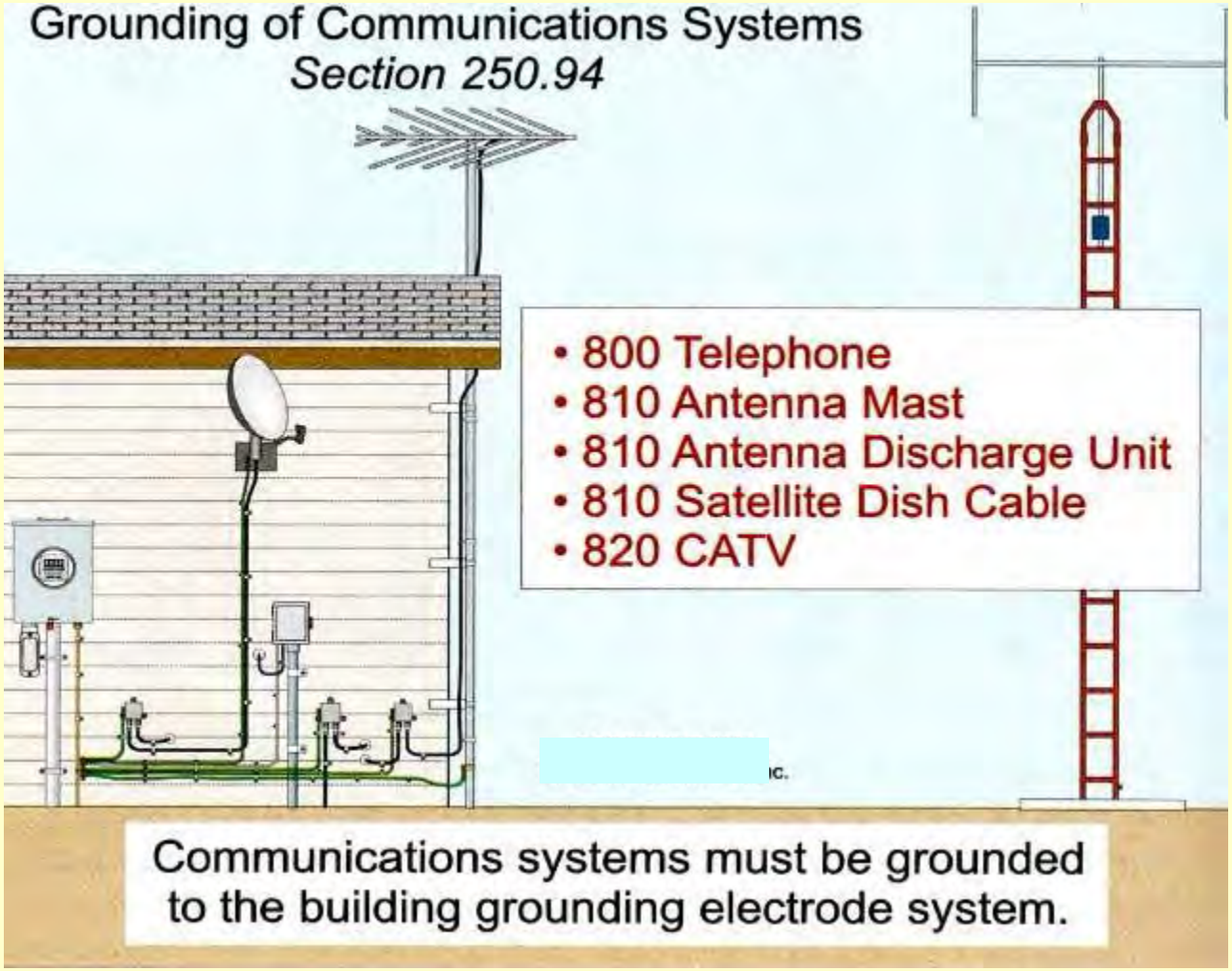
2.50.5.5 Bonding for Other Systems



2.50.5.5 Bonding for Other Systems



2.50.5.5 Bonding for Other Systems



2.50.5.7 Bonding Other Enclosures

(b) Isolated Grounding Circuits

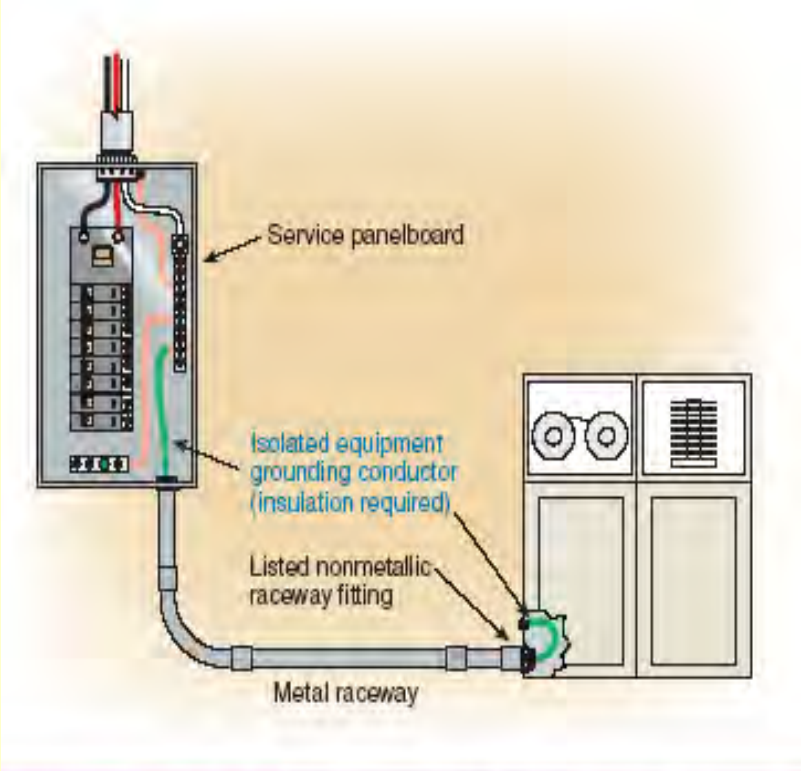


Exhibit 250.44 An installation in which the electronic equipment is grounded through the isolated equipment grounding conductor.

2.50.5.7 Bonding Other Enclosures

(b) Isolated Grounding Circuits

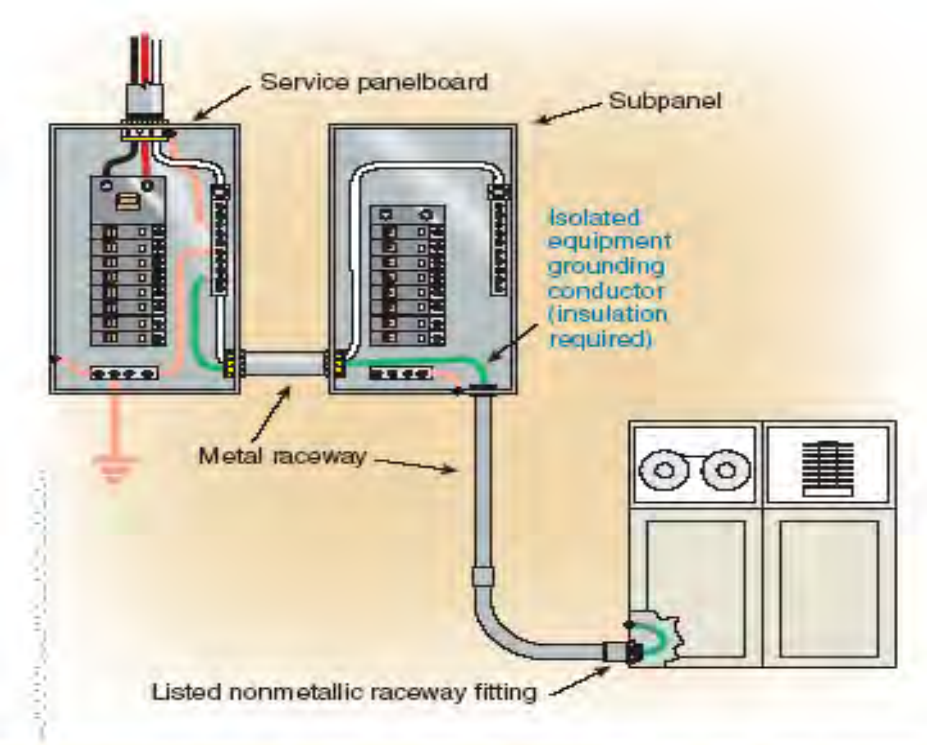
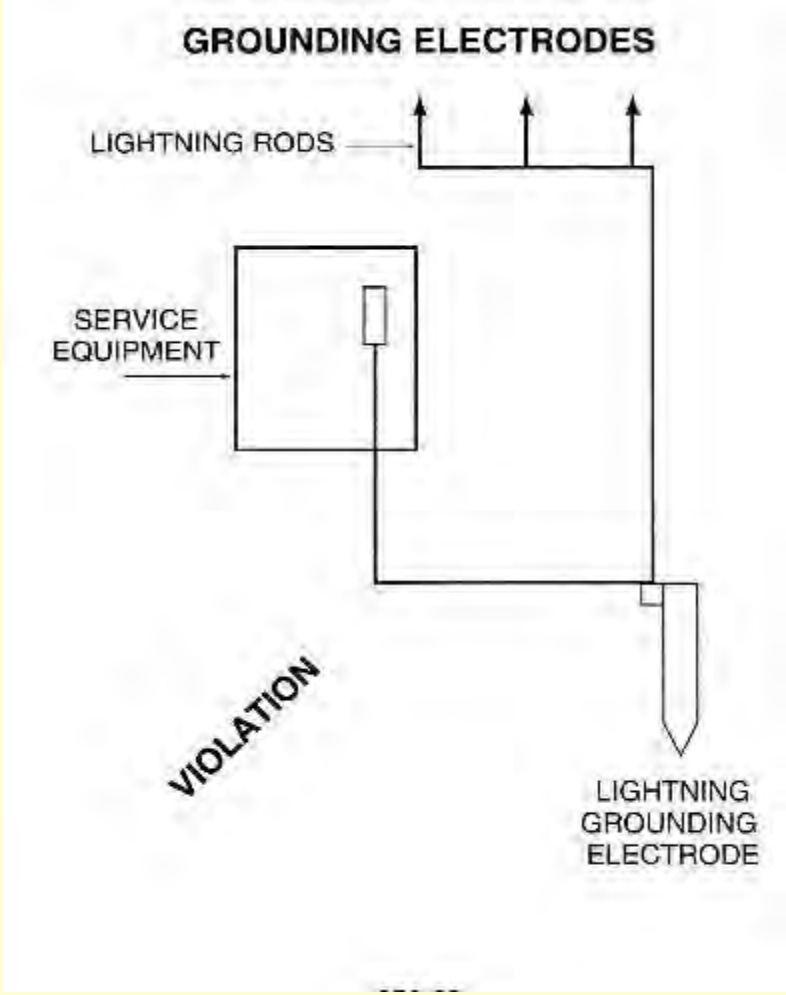


Exhibit 250.45 An installation in which the isolated equipment grounding conductor is allowed to pass through the subpanel without connecting to the grounding bus to terminate at the service grounding bus.

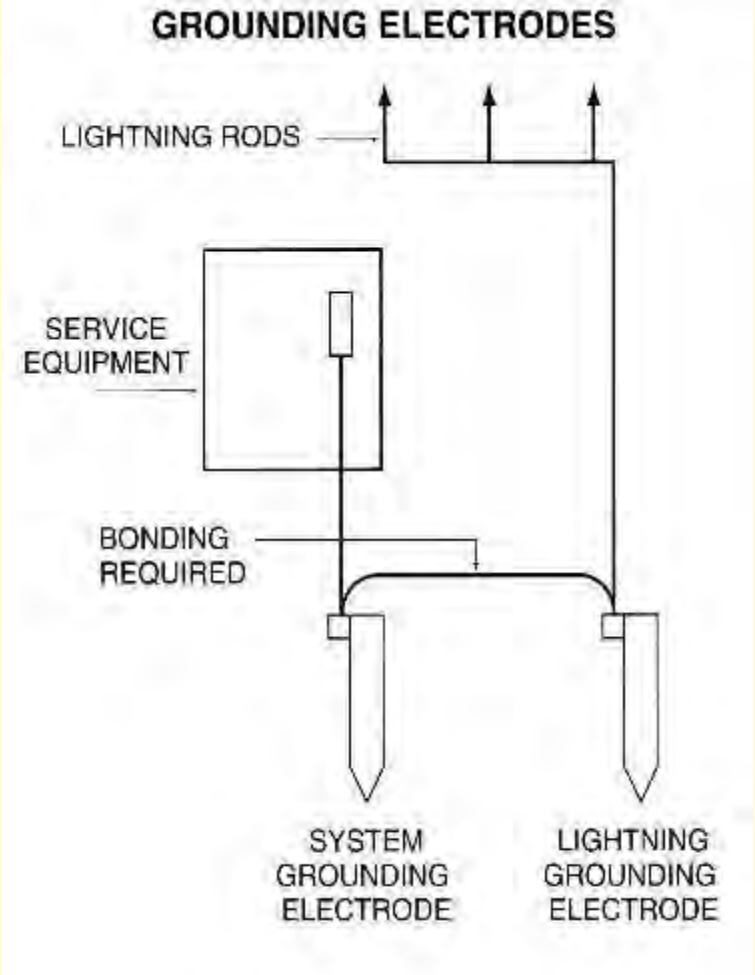
2.50.3 Grounding Electrodes

- A violation of Art. 2.50.3.11 which prohibits using the same grounding electrode for a lightning rod system and a system supply.



2.50.5.17 Lightning Protection Systems

- Art. 250.5.17 Lightning Protection System. The bonding of a system grounding electrode and a lightning rod grounding electrode.



6.95 Fire Pumps

- The general philosophy behind Code articles is that circuit protection will shut down equipment before letting the supply conductors melt from overload.
- Art. 6.95 Fire Pumps depart from this philosophy.
- The idea is that the fire pump motor must run, no matter what; it supplies water to facility's fire protection piping, which in turn supplies water to the sprinkler system and fire hoses.

Introduction

- Art. 6.95 contains many requirements to keep that supply of water uninterrupted.

For example:

1. Locating the pump so as to minimize its exposure to fire.
2. Ensuring that the fire pump and its jockey pump have a reliable source of power.
3. It makes sense to keep fire pump wiring independent.

Introduction

- Other requirements seem wrong at first glance, until you remember why the fire pump is there in the first place.

  For example:

  1. The disconnect must be lockable in the closed position.
  2. Fire pumps power circuits cannot have automatic protection against overload.

Introduction

- " It's better to run the fire pump until its winding melt, than to save the fire pump and lose the facility"
- And the intent of Article 6.95 is to save the facility.

6.95.1.1 Scope

a) Covered

1) Electric power sources and interconnecting circuits
2) Switching and control equipment dedicated to fir pump drivers

b) Not Covered

1) The performance, maintenance, and acceptance testing of the fire pump system, and the internal wiring of the components of the system
2) Pressure maintenance (jockey or makeup) pumps

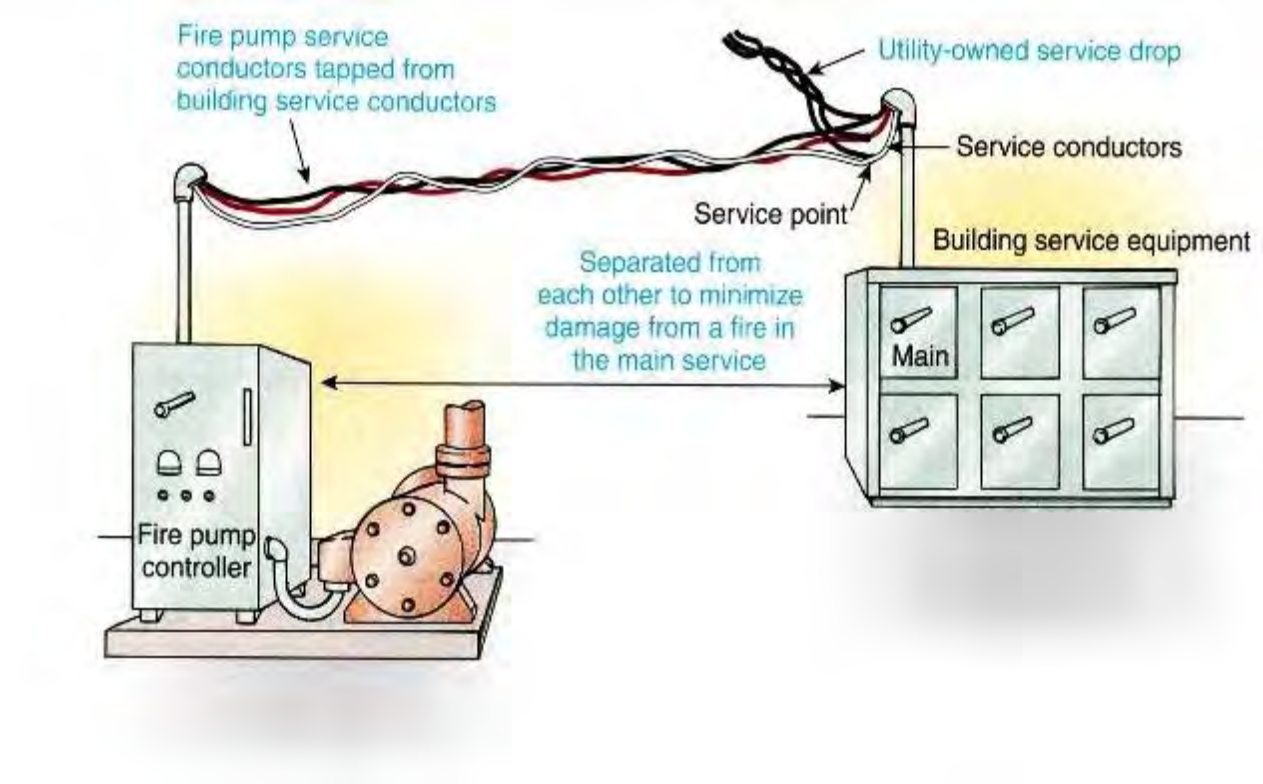
6.95.1.3 Power Sources for Electric-Motor Driven Fire Pumps

a) Individual Source

1) Electric Utility Service. A separate service from a connection located ahead of but not within the service disconnecting means.

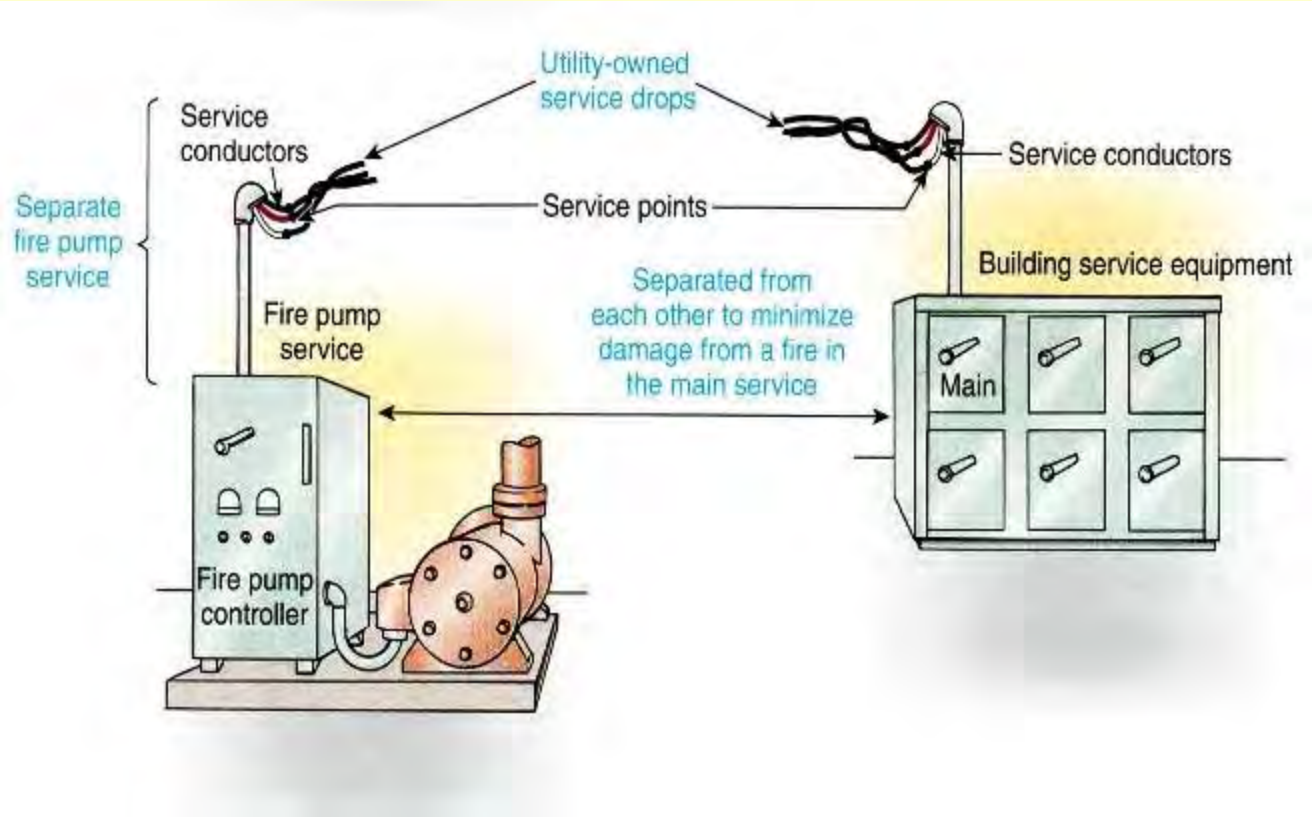
2) On-Site Power. An on-site power supply, such as generator, located and protected to minimize damage by fire is permitted to supply a fire pump.

6.95.1.3 Power Sources for Electric-Motor Driven Fire Pumps



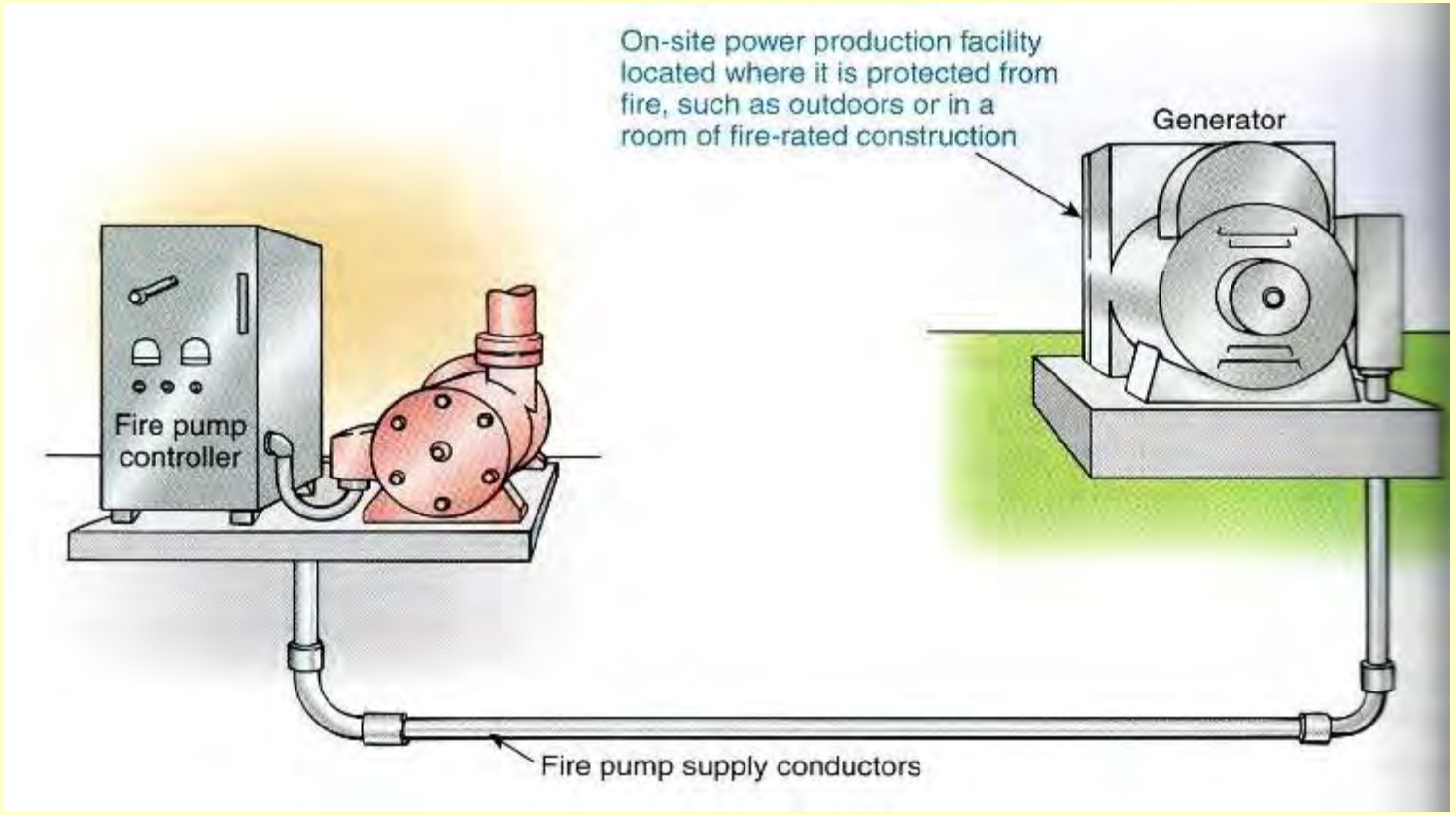
a) Electric-Utility Service Connection

6.95.1.3 Power Sources for Electric-Motor Driven Fire Pumps



a) Electric-Utility Service Connection

6.95.1.3 Power Sources for Electric-Motor Driven Fire Pumps



2) On-Site Power Production Facility

6.95.1.3 Power Sources for Electric-Motor Driven Fire Pumps

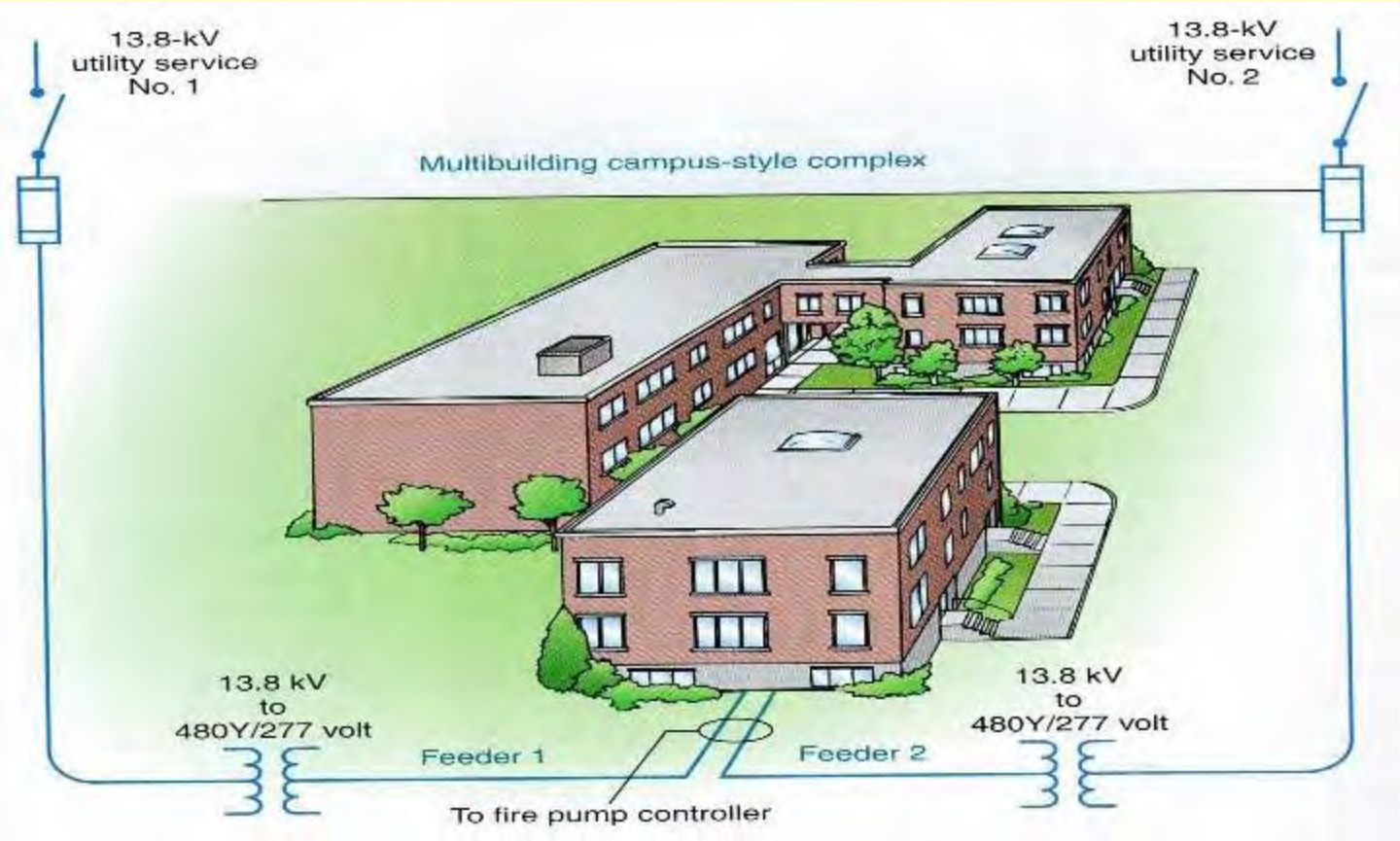
b) Multiple Sources

1) Generator Capacity. Shall have sufficient capacity to allow normal starting and running 0f the motor(s) driving the fire pump(s) while supplying other simultaneously operated load.

2) Feeder Sources.

3) Arrangement. The power sources shall be arranged so that a fire at one will not cause an interruption at the other source.

6.95.1.3 Power Sources for Electric-Motor Driven Fire Pumps

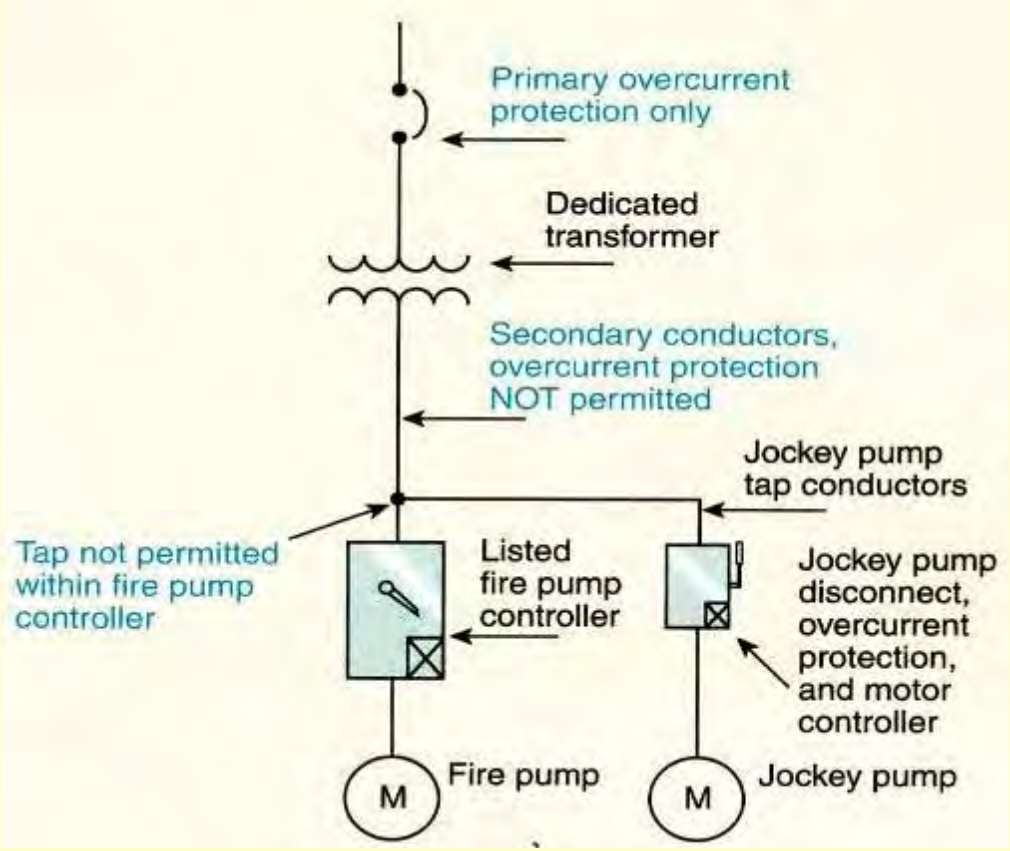


2) Feeder Sources

6.95.1.5 Transformers

- Dedicated transformer and overcurrent protection sizing can be broken down into three requirements.
  1. The transformer must be size to at least 125% of the sum of the loads.
  2. The transformer primary overcurrent device must be at least a specified minimum size.
  3. The transformer secondary must not contain any overcurrent device whatsoever.

6.95.1.5 Transformers



The overcurrent device in the primary of a transformer supplying a fire pump installation. The device is required to be sized to carry the locked-rotor current motor(s) and associated fire pump accessory equipment indefinitely.

6.95.1.6 Power Wiring

a) Service and Feeder Conductors.

Supply conductors must be physically routed outside buildings and must be installed in accordance with Article 2.30. Where supply conductors cannot be routed outside buildings, they must be encased in 2 inches or 50 mm of concrete or brick.

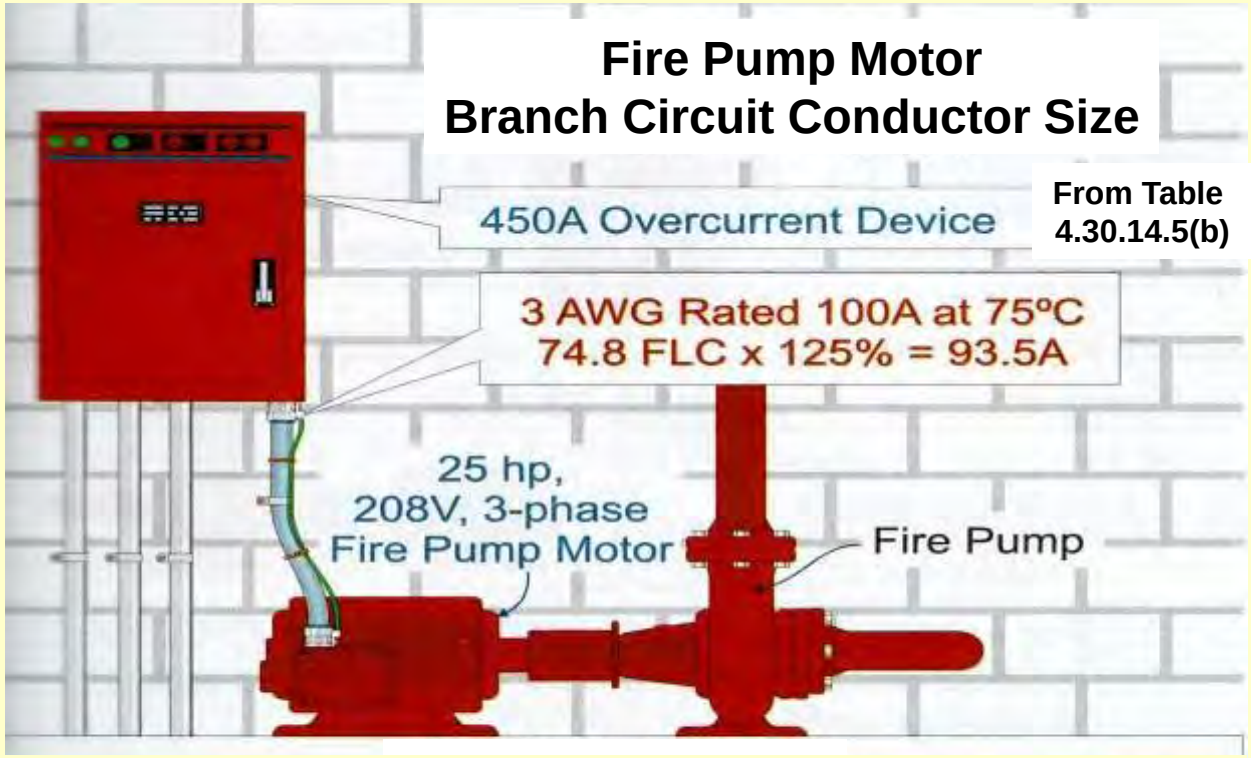
6.95.1.6 Power Wiring

b) Circuit Conductors.

Fire pump supply conductors on the load side of the final disconnecting means and overcurrent device(s) must be kept entirely independent of all other wiring. They can be routed through a building using one of the following methods:

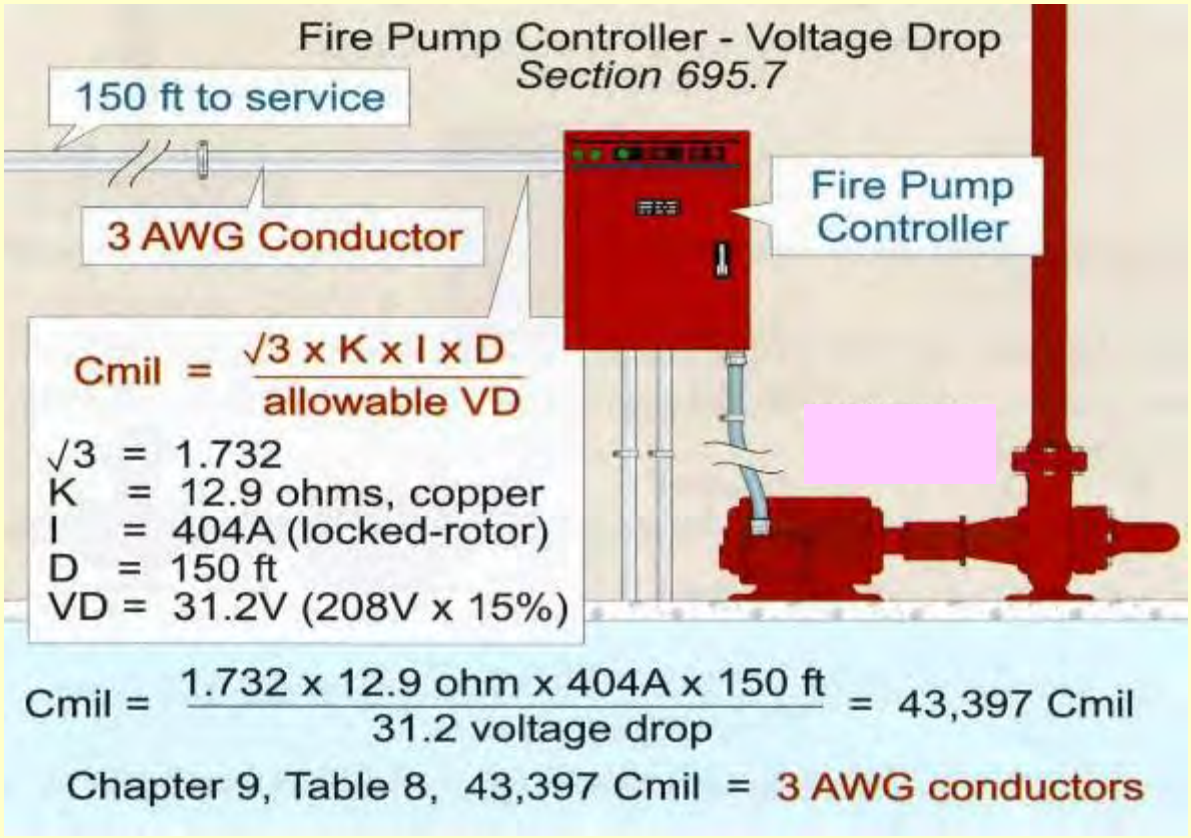
1) Be encased in a minimum 2 inches or 50 mm of concrete
2) Be within an enclosed construction dedicated to the fire pump circuit(s) and having a minimum of a 1-hour fire-resistant rating
3) Be listed electrical circuit protective system with a minimum 1-hour fire rating.

6.95.1.6(c)(2) BC Conductor Size



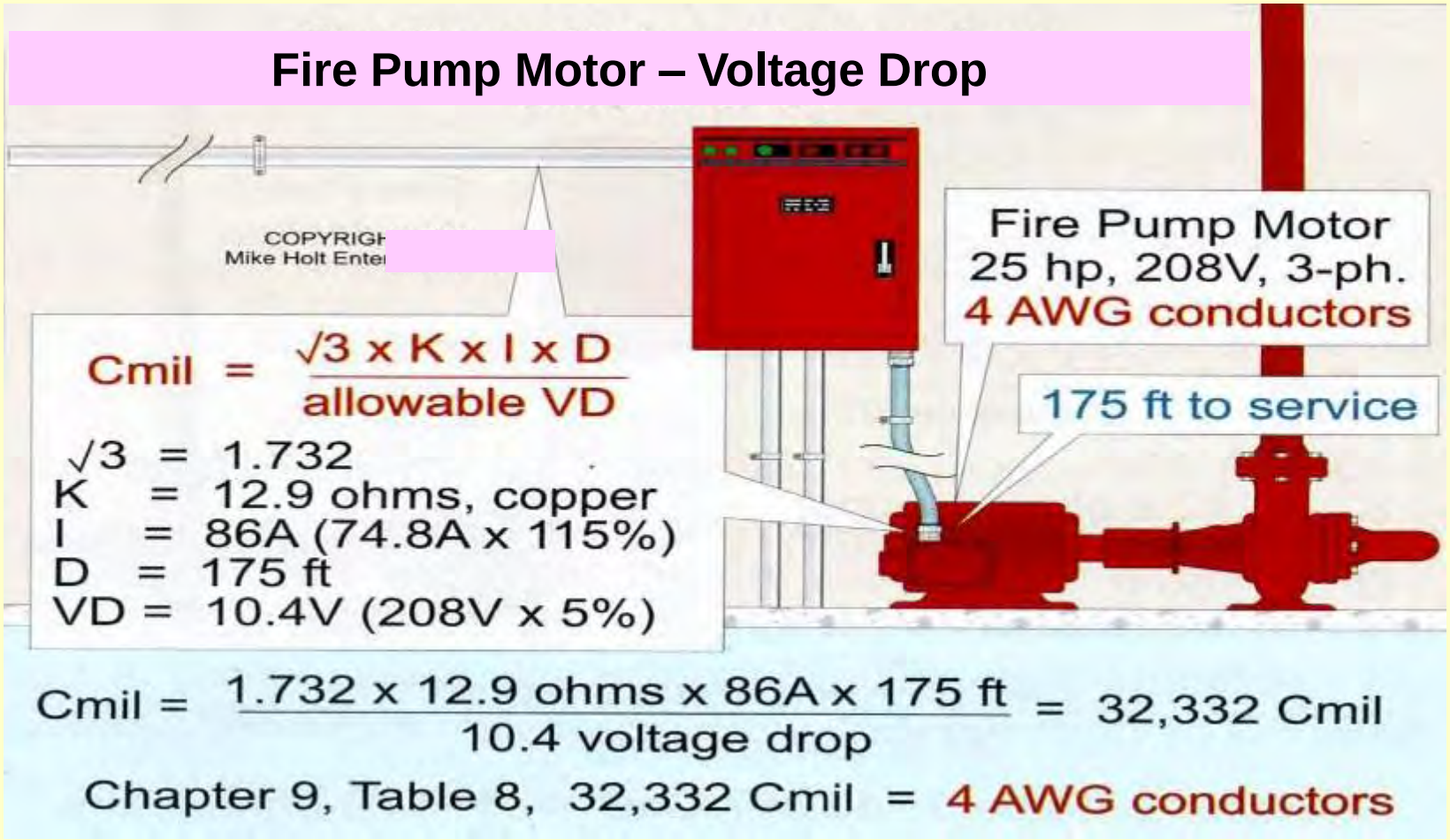
Branch circuit conductors to a single fire pump motor must have a rating not less than 125% of the motor
FLC as listed in Table 4.30.14.2 or 4.30.14.4

6.95.1.7 Voltage Drop

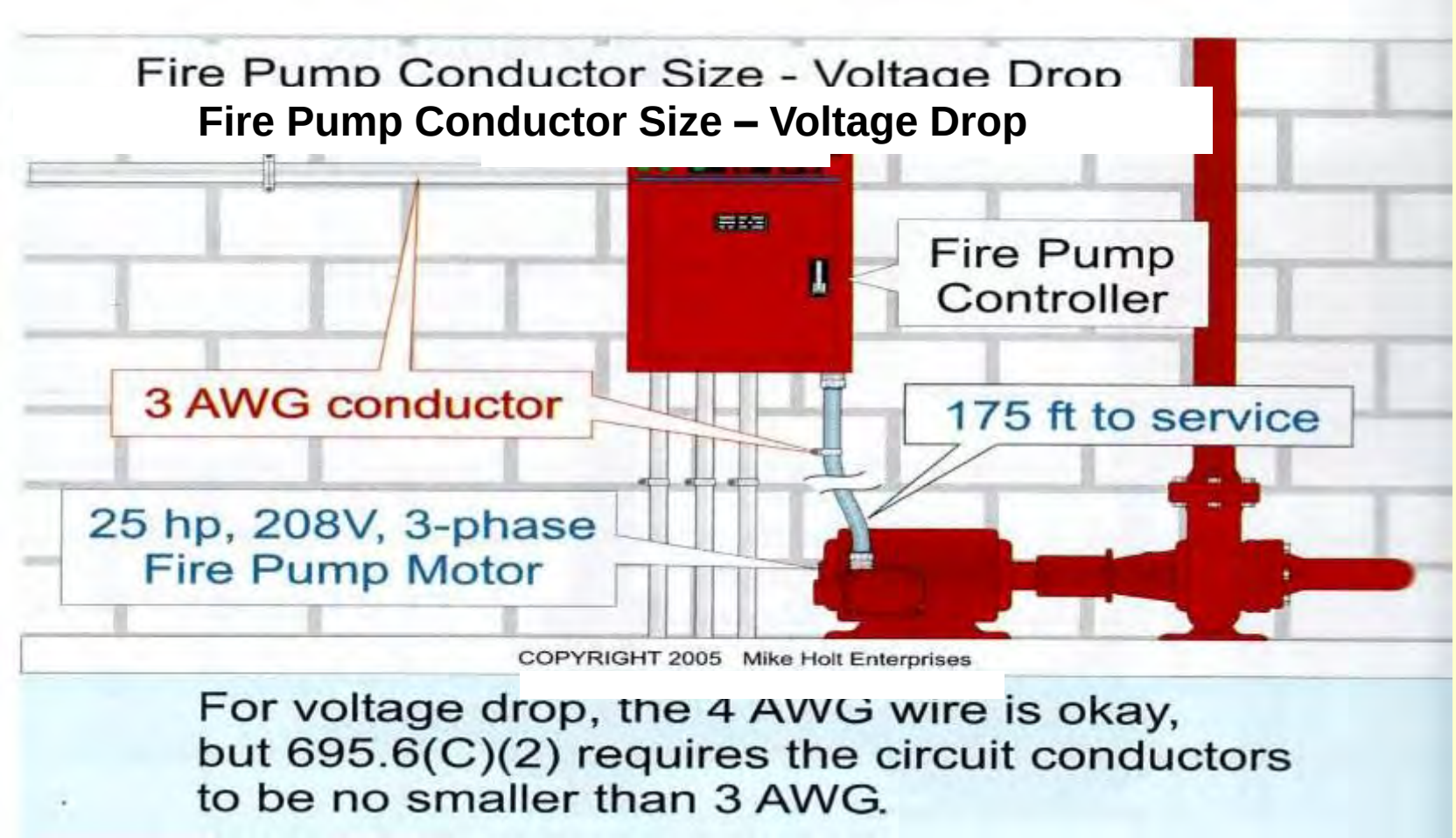


The voltage drop at the line terminals of the controller when the motor starts (locked-rotor current), must not drop more than 15% below the controller's rated voltage.

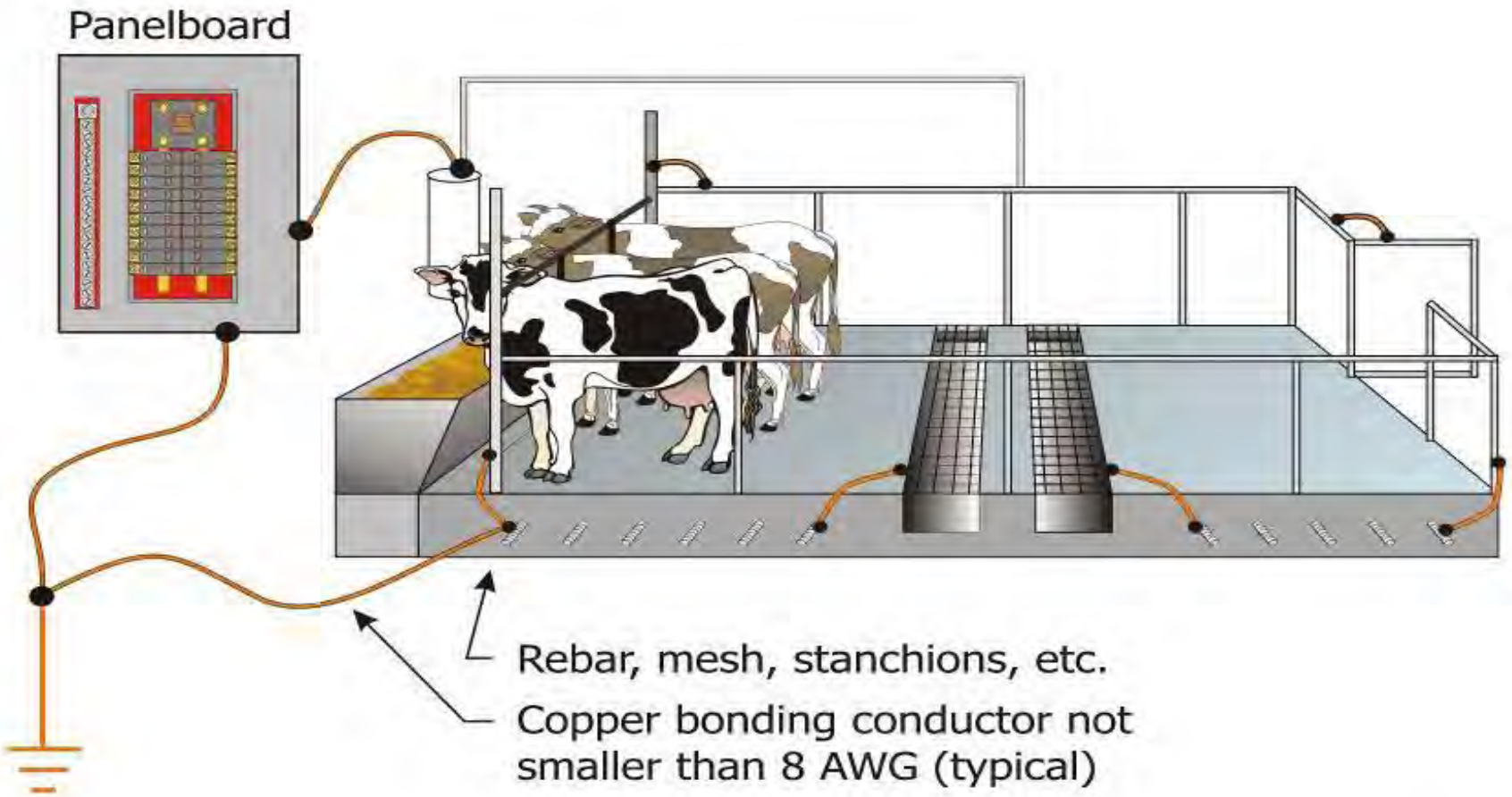
6.95.1.7 Voltage Drop



6.95.1.7 Voltage Drop



Equipotential Bonding Planes

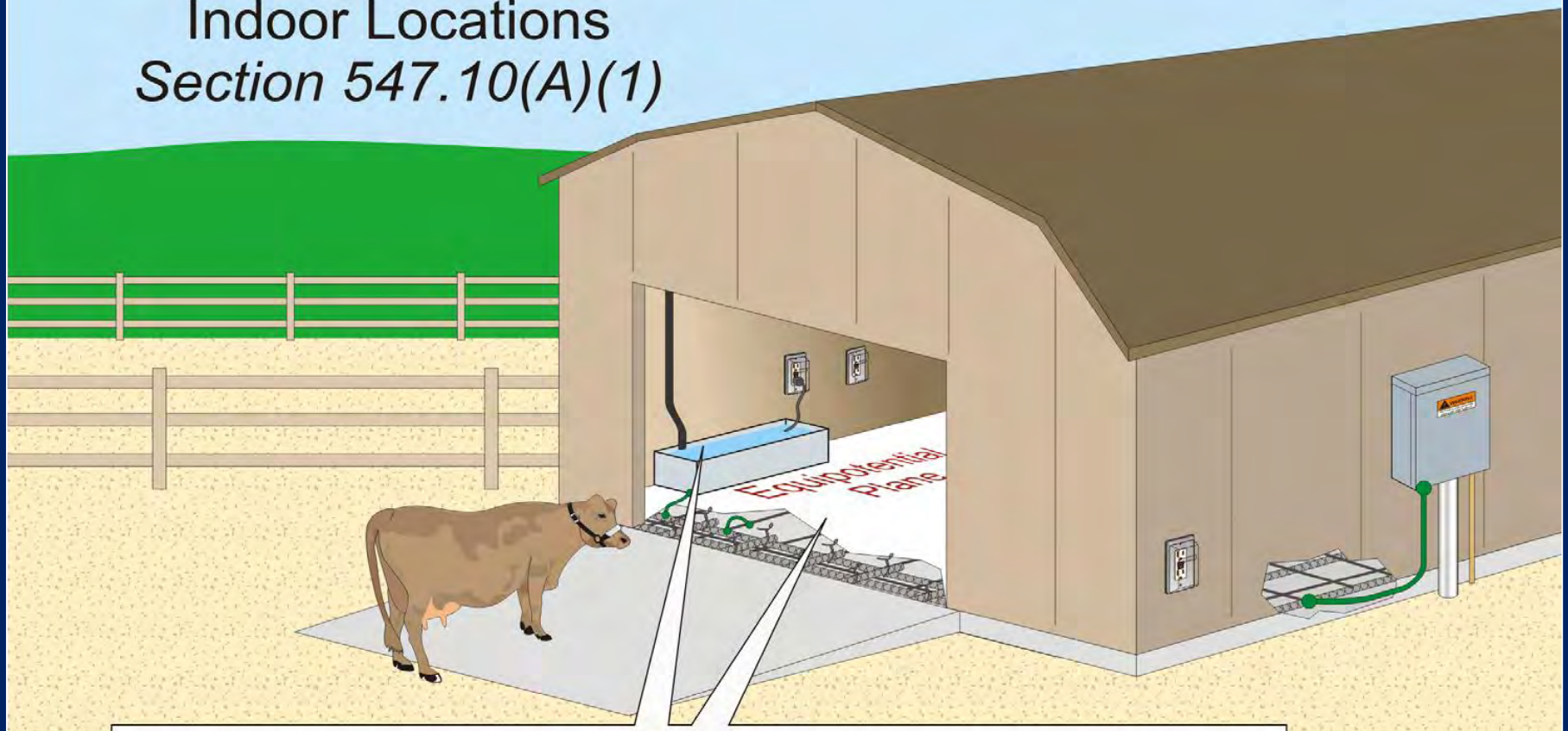


547.10

Equipotential Bonding in Animal Confinement Areas

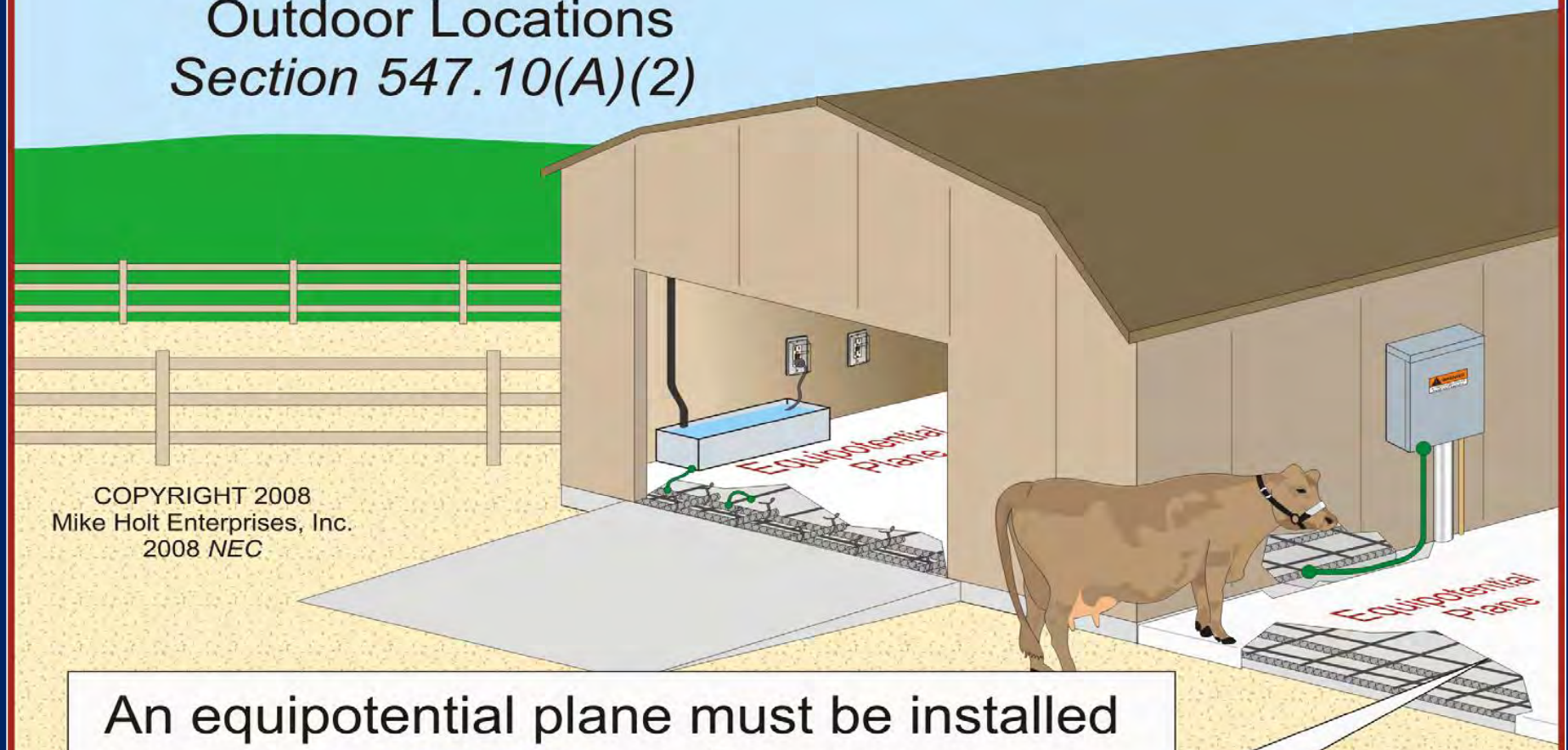
Equipotential bonding plane is required in animal confinement areas with concrete floors or slabs in indoor and outdoor locations

Equipotential Planes
Indoor Locations
Section 547.10(A)(1)



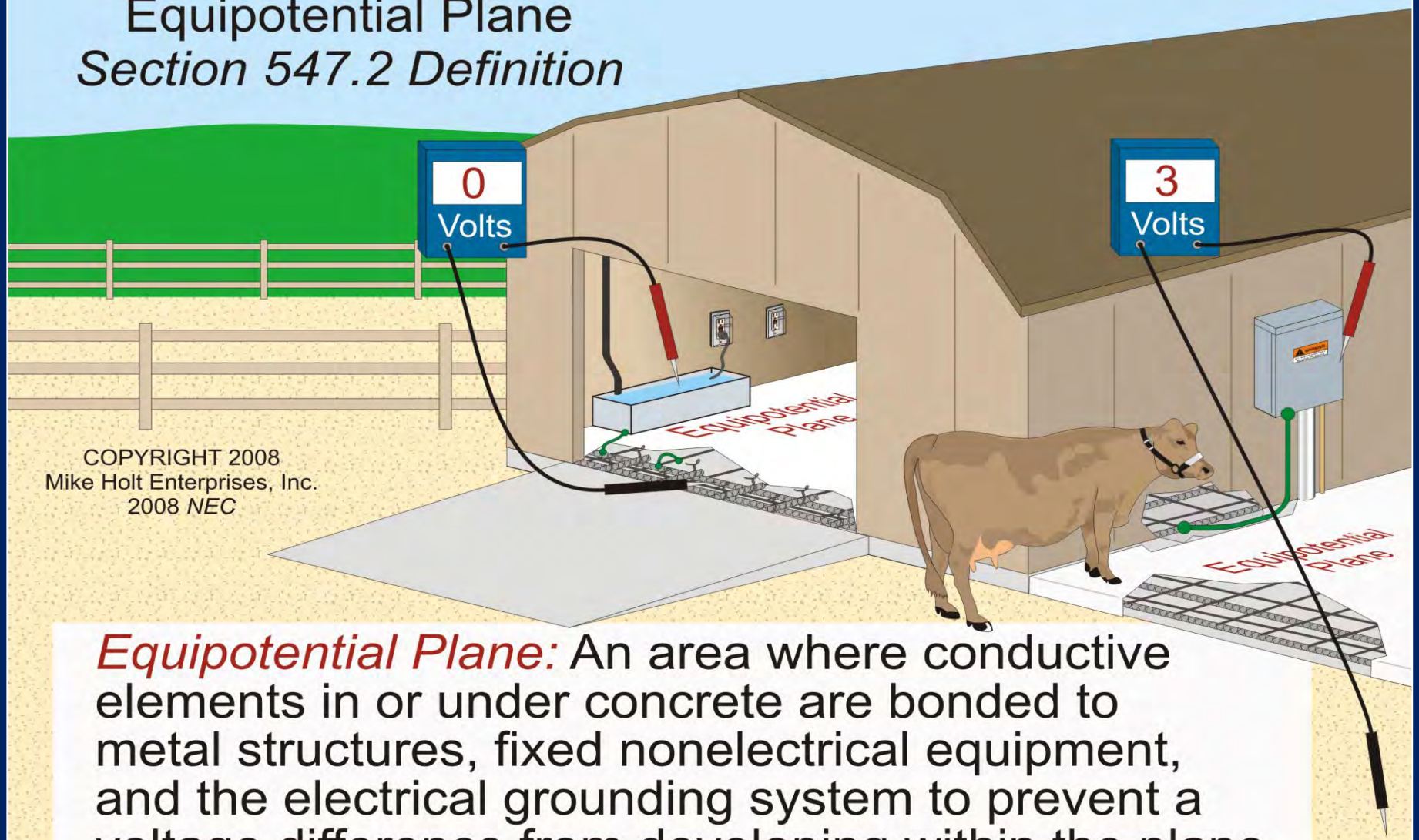
An equipotential plane must be installed in concrete floor confinement areas containing metallic equipment accessible to livestock.

Equipotential Planes
Outdoor Locations
Section 547.10(A)(2)



An equipotential plane must be installed in outdoor concrete confinement areas containing metallic equipment accessible to livestock.

Agricultural Buildings
Equipotential Plane
Section 547.2 Definition



Equipotential Plane: An area where conductive elements in or under concrete are bonded to metal structures, fixed nonelectrical equipment, and the electrical grounding system to prevent a voltage difference from developing within the plane.

Thank You

FOR NOT SLEEPING!!!

Q & A!