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# Electrical Safety

- *29 CFR 1910 Subpart S*



# Objectives

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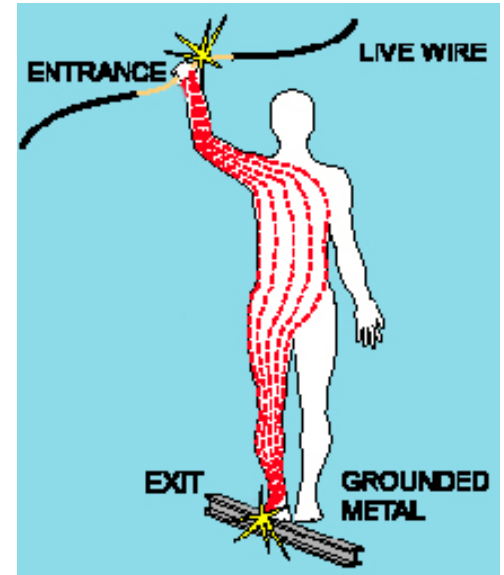
In this course, we will discuss the following:

- Recent changes to the regulation
  - Common electrical hazards
  - Electrical equipment defects/hazards
  - Tools/techniques used in identifying hazards
  - Safe working practices
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# Electrical Hazards

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- Electric shock/electrocution occurs when current flows through the body causing damage
- Burns are caused by arc blast or hot conductors:
  - Thermal
  - Electrical
- Indirect falls from ladders, scaffolds or other walking working surfaces



# Electrical Hazards

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- Explosions are caused when electricity provides a source of ignition for an explosive mixture in the atmosphere.
- Fires are caused by overloading circuits or excessive current flowing through faulty wiring; setting fire to insulation and surrounding materials.



# Electrical Utilization Systems

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1910.302(a)

- **Scope and application**

- Electrical installations and utilization equipment installed or used within or on buildings, structures and other premises:
    - » Yards
    - » Carnivals
    - » Parking and other lots
    - » Mobile homes
    - » Recreational vehicles
    - » Industrial substations
    - » Conductors that connect the installations to a supply of electricity
    - » Other outside conductors on the premises
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# Electrical Utilization Systems

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1910.302(a)

- **Not covered**

- Installations in ships
  - Installations underground in mines
  - Installations of railways for generation exclusively for signaling and communication purposes
  - Installations of communication equipment under the exclusive control of communication utilities
  - Installations under the exclusive control of electric utilities for the purpose of communication or metering
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# Extent of Application

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1910.302(b)

- These requirements are applicable to all installations, regardless of when they were designed or installed §§1910.302 (b)(1).
  - Installations made after March 15, 1972, shall comply with the provisions of §§1910.302 through 1910.308, except paragraphs (b)(3) and (b)(4) of this section.
  - Requirements applicable to installations made after April 16, 1981 §§1910.302 (b)(1) and §§1910.302 (b)(3).
  - Requirements applicable to installations made after August 13, 2007 §§1910.302 (b)(1), §§1910.302 (b)(3) and §§1910.302 (b)(4).
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# General Requirements

1910.303(b)(1)

- **Examination, installation, and use of equipment**
  - Electrical equipment must be free from recognized hazards:
    - » Cables exposed to sharp edges
    - » Splices
    - » Bare conductors





# General Requirements

1910.303(b)(2)

- Listed or labeled equipment shall be installed and used in accordance with its listing and labeling.



Applied Research Laboratories, Inc. (ARL)



Canadian Standards Association (CSA)



Communication Certification Laboratory, Inc. (CCL)



Curtis-Straw LLC (CSL)



Electrical Reliability Services, Inc. (ERIS)



FM Global Technology LLC (FM)



Intertek Testing Services NA, Inc. (ITSA)



MET Laboratories, Inc. (MET)



National Technical Systems, Inc. (NTS)



SOS U.S. Testing Company, Inc. (SOSUS)



Southwest Research Institute (SWRI)



NSF International (NSF)



TÜV America, Inc. (TUVAM)



TÜV Rheinland of North America, Inc. (TUV)



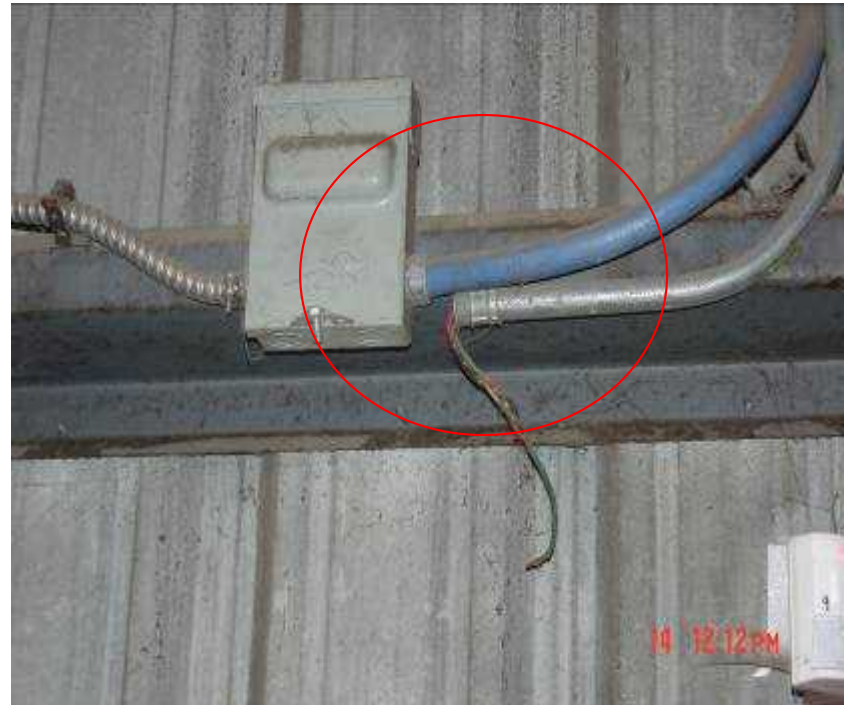
Underwriters Laboratories, Inc. (UL)

# General Requirements

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1910.303(b)(3)

- **Insulation integrity**
  - Completed wiring installations must be free from short circuits



# General Requirements

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1910.303(b)(4)

- **Interrupting rating**
  - Sufficient for the nominal circuit voltage and current available



# General Requirements

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1910.303(b)(6)

- **Deteriorating agents**

- Unless identified for use in the operating environment, no conductors or equipment shall be:
  - » Located in damp or wet locations
  - » Exposed to agents that have a deteriorating effect on the conductors or equipment
  - » Exposed to excessive temperatures

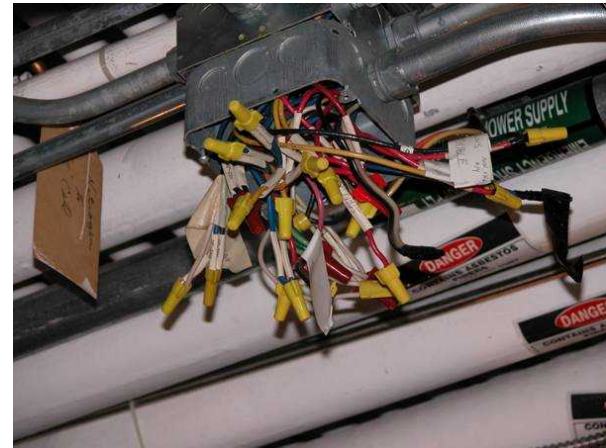


# General Requirements

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1910.303(b)(7)

- **Mechanical execution of work**
  - Equipment shall be installed in a neat workmanlike manner.

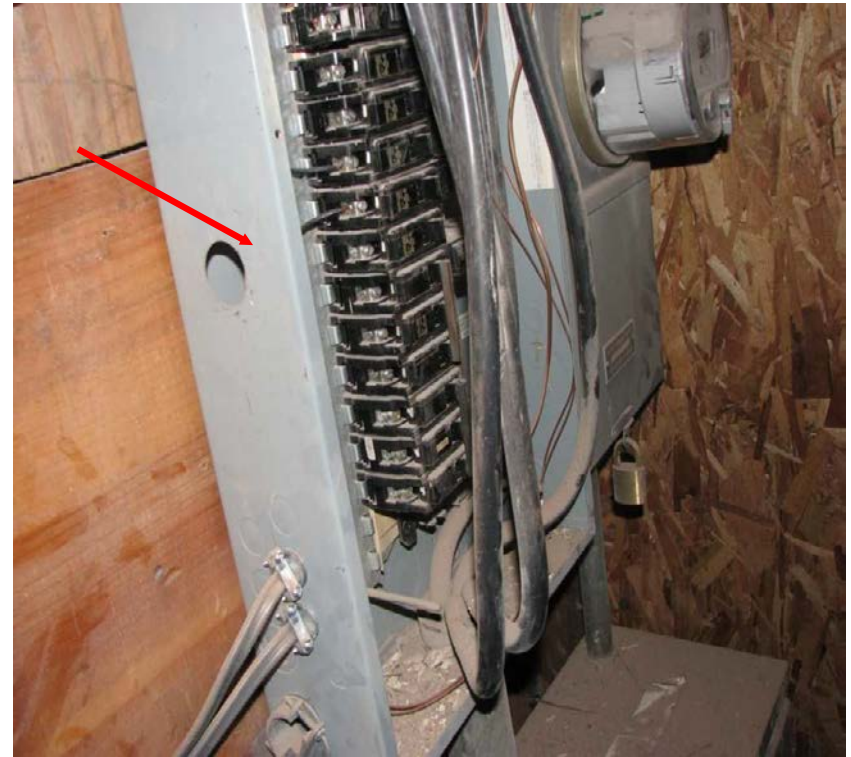


# General Requirements

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1910.303(b)(7)(i)

- Unused openings shall be effectively closed to afford protection substantially equivalent to the wall of the equipment.



# General Requirements

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1910.303(b)(7)(ii)

- Conductors shall be racked to provide ready and safe access in underground and subsurface for installation and maintenance.

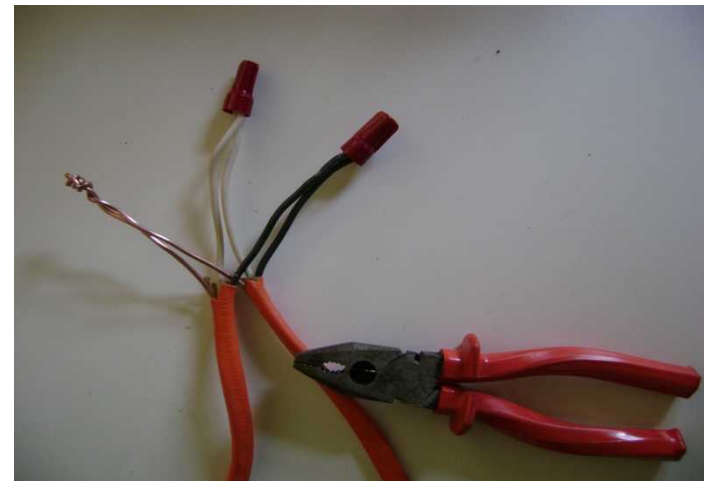
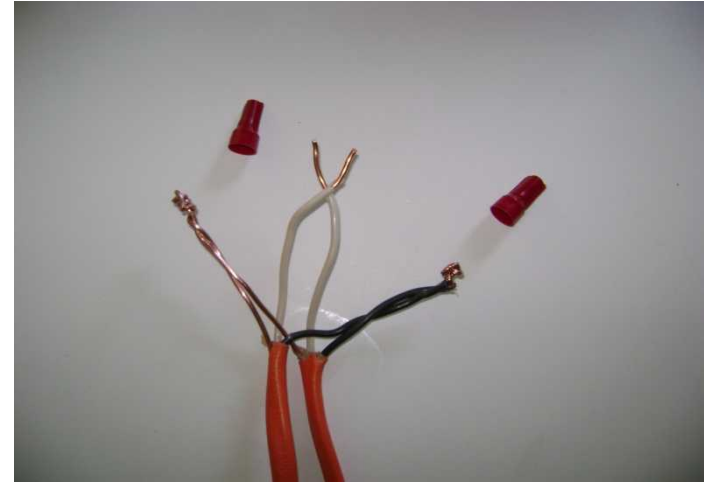


# General Requirements

1910.303(c)(3)

- **Splices**

- Splicing devices suitable for use
- Brazing, welding, or soldering
- Splices must be joined mechanically and electrically secure before soldering





# General Requirements

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1910.303(d)

- **Arcing parts**
  - Parts of electric equipment that produce arcs, sparks, flames, or molten metal shall be enclosed or separated and isolated from all combustible material.



# General Requirements

1910.303(e)

## ● Marking

- Electrical equipment must have the manufacturer's name, trademark, or other descriptive marking.
- Markings must provide voltage, current, wattage, or other ratings as necessary.
- Markings must have sufficient durability to withstand the environment involved.





# General Requirements

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1910.303(f)(4)

- **Capable of accepting a lock**
  - Disconnecting means shall be capable of being locked in the open position.



# Space About Electrical Equipment 1910.303(g)(1)

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- Sufficient access and working space must be provided and maintained to permit ready and safe operation and maintenance of equipment.





# Working Space About Electrical Equipment

1910.303(g)(1)(i)(A)

TABLE S-1.— MINIMUM DEPTH OF CLEAR WORKING SPACE AT ELECTRIC EQUIPMENT, 600 V OR LESS

Nominal voltage to ground	Minimum clear distance for condition <sup>2,3</sup>					
	Condition A		Condition B		Condition C	
	m	ft	m	ft	m	ft
0 - 150	10.9	13.0	10.9	13.0	0.9	3.0
151 - 600	10.9	13.0	1.0	3.5	1.2	4.0

**Condition A** — Exposed live parts on one side and no live or grounded parts on the other side of the working space

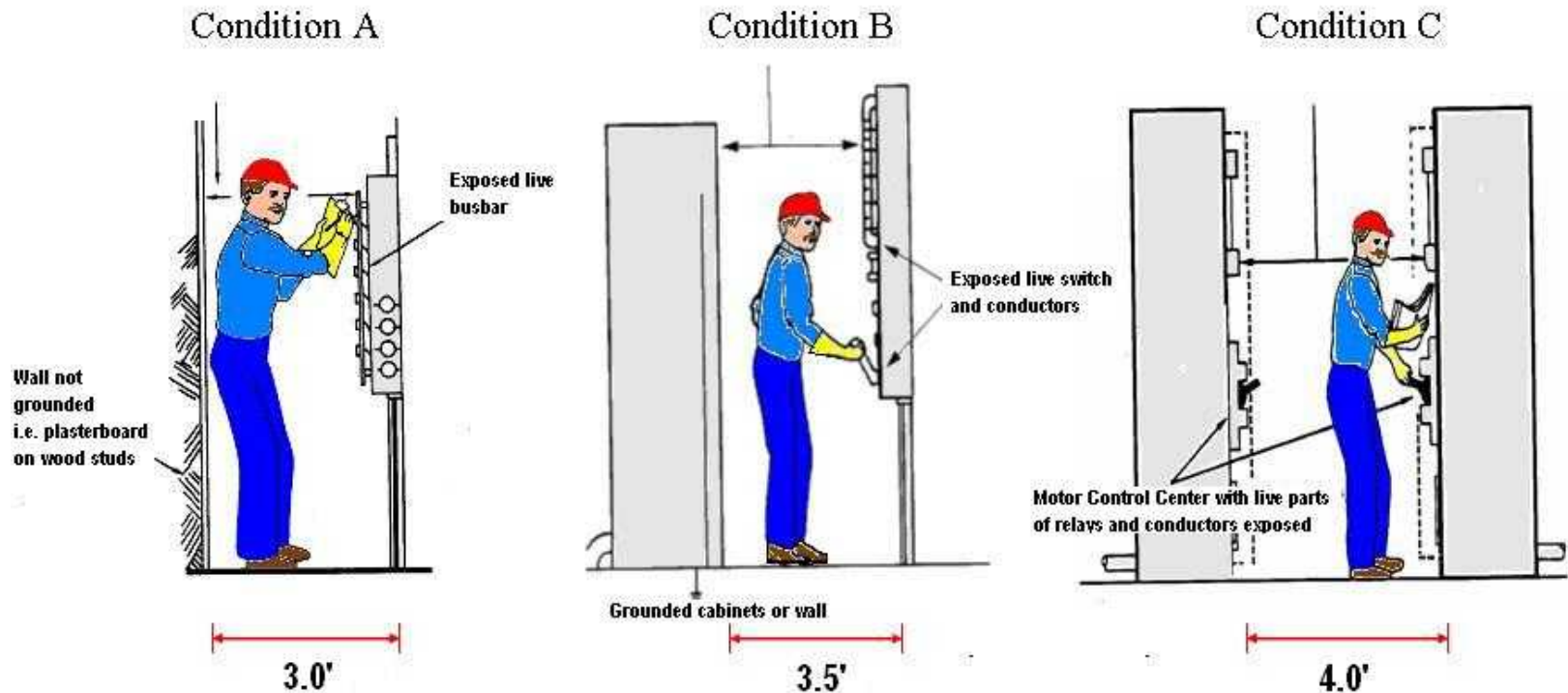
**Condition B** — Exposed live parts on one side and grounded parts on the other side

**Condition C** — Exposed live parts on both sides of the work space with the operator between

# Working Space About Electrical Equipment

1910.303(g)(1)(i)(A)

If the nominal voltage to ground is from 151 - 600 V:





# Working Space About Electrical Equipment

1910.303(g)(1)(i)(A)



Working Space



# Working Space About Electrical Equipment

1910.303(g)(1)(i)(B)

- Width of working space in front of the electric equipment shall be the width of the equipment or 762 mm (30 in.), whichever is greater.



3 feet



30 inches

# Guarding of Live Parts

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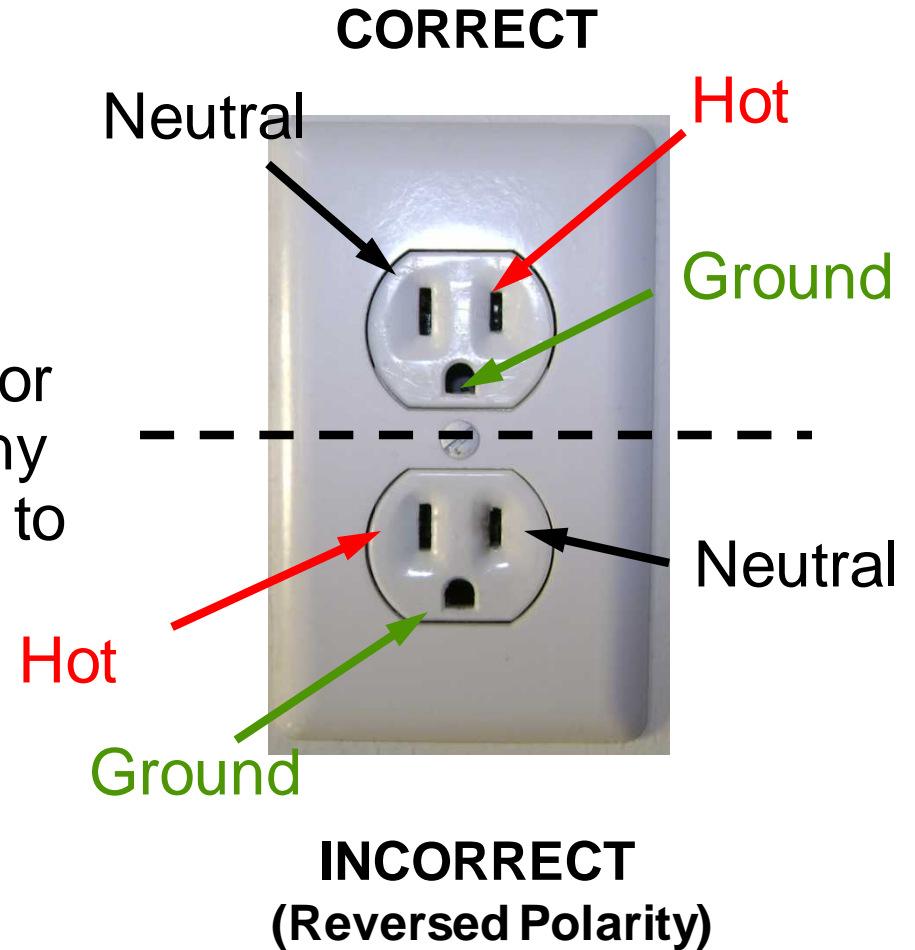
1910.303(g)(2)(i)

- Live parts of electric equipment operating at 50 volts or more must be guarded.



- **Polarity of connections**

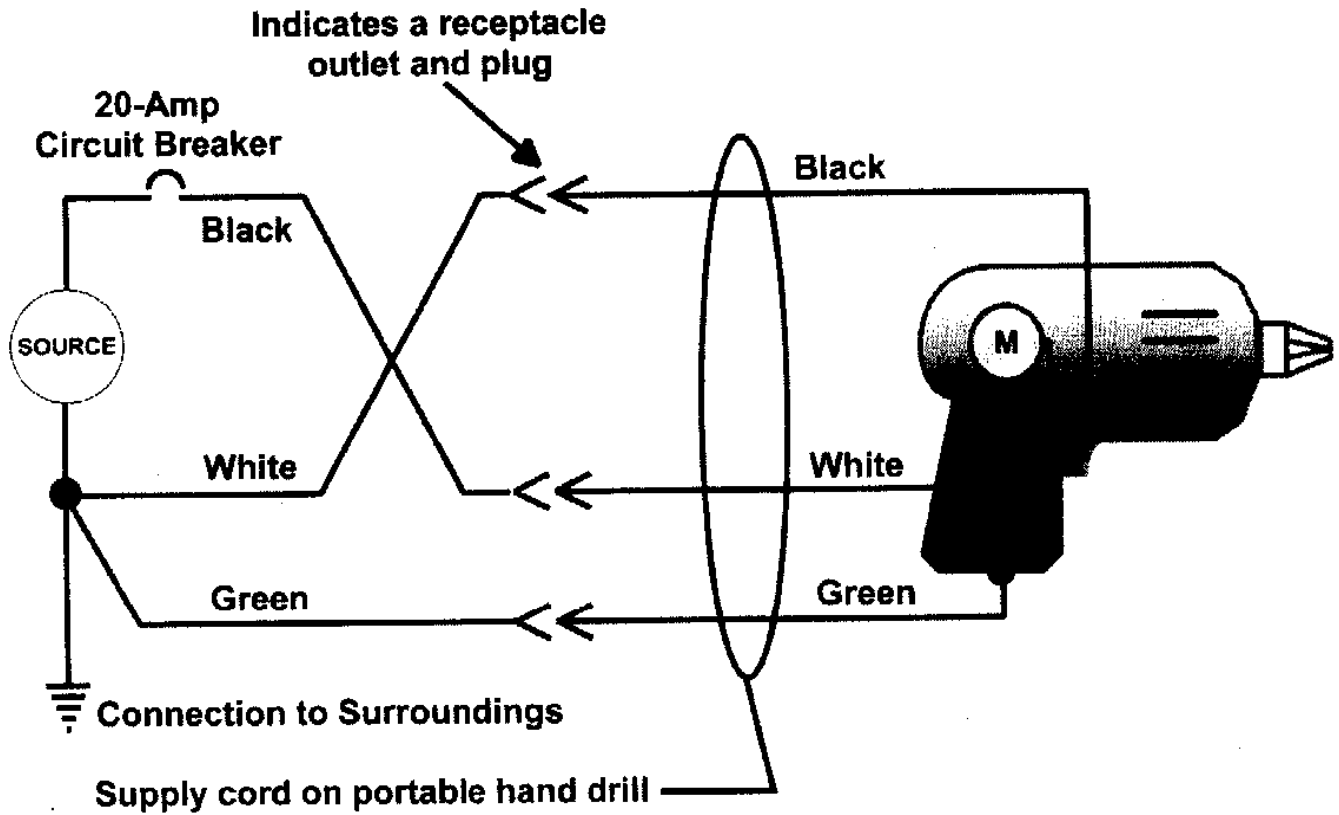
- No grounded conductor may be attached to any terminal or lead so as to reverse designated polarity.



# Wiring Design and Protection

1910.304(a)(2)

**FIGURE 13B.** Incorrect wiring of duplex receptacles. Figure 13B represents reversed polarity, a situation where the ungrounded and grounded conductors are interchanged and the current path is reversed.



# Receptacles and Cord Connectors

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1910.304(b)(2)(i)

- Receptacles installed on 15- and 20- ampere branch circuits shall be of the grounding type:
  - Except as permitted for replacement receptacles in paragraph (b)(2)(iv).



# Receptacles and Cord Connectors

1910.304(b)(2)(iv)(C)(2)

- A nongrounding - type receptacle may be replaced with a “**GFCI Protected**” type receptacle and shall be marked “**GFCI Protected**” and “**No Equipment Ground**”.
- Equipment grounding conductor may not be connected to such grounding-type receptacles.



Marked “GFCI Protected”  
and “No Equipment Ground”



# GFCI Protection for Personnel

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1910.304(b)(3)(i)

- All 125 volt receptacles installed in bath rooms or on rooftops shall have GFCI protection.

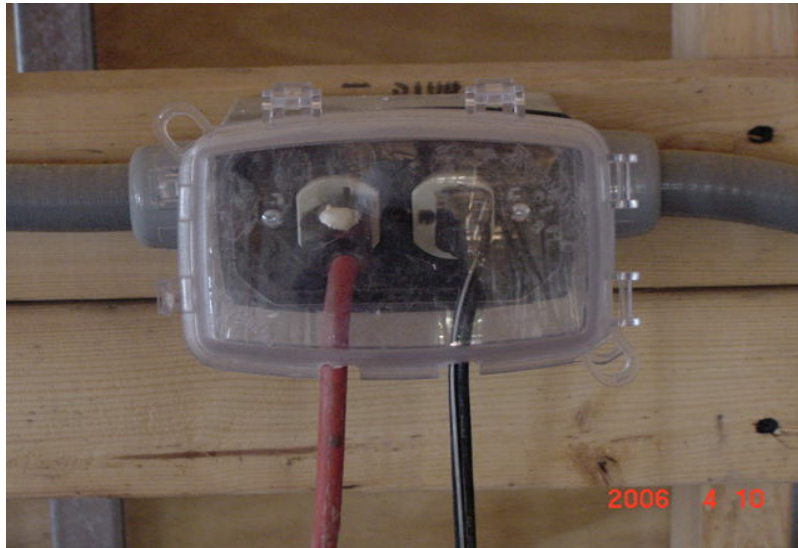


# GFCI Protection for Personnel 1910.304(b)(3)(ii)(A)

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- **Temporary wiring installations**

- All 125 volt, single phase, 15 - 20 ampere, shall be GFCI protected during maintenance, remodeling or construction like activities.







# GFCI Protection for Personnel

1910.304(b)(3)(ii)(A)

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- Portable GFCI



# GFCI Protection for Personnel 1910.304(b)(3)(ii)(A)

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- Note 2 to paragraph (b)(3)(ii)(A) of this section:
  - Cord sets and devices incorporating the required ground - fault circuit - interrupter that are connected to the receptacle closest to the source of power are acceptable forms of protection.



# GFCI Protection for Personnel 1910.304(b)(3)(ii)(B)

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- **Temporary wiring installations**

- Receptacles other than 125 volt, single phase, 15-20 ampere, shall be GFCI protected.



GFCI / 240 VAC

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# Outlet Devices

1910.304(b)(4)(ii)(B)

- A receptacle shall not be over loaded:
  - As specified in table S-4.



Power Strip

Plug to another power strip

# Outlet Devices

1910.304(b)(4)(ii)(B)

- **Safety factor of 20%.**

TABLE S-4. — Maximum Cord- and Plug- Connected Load to Receptacle

<b>Circuit rating (amperes)</b>	<b>Receptacle rating (amperes)</b>	<b>Maximum load (amperes)</b>
15 or 20	15	12
20	20	16
30	30	24

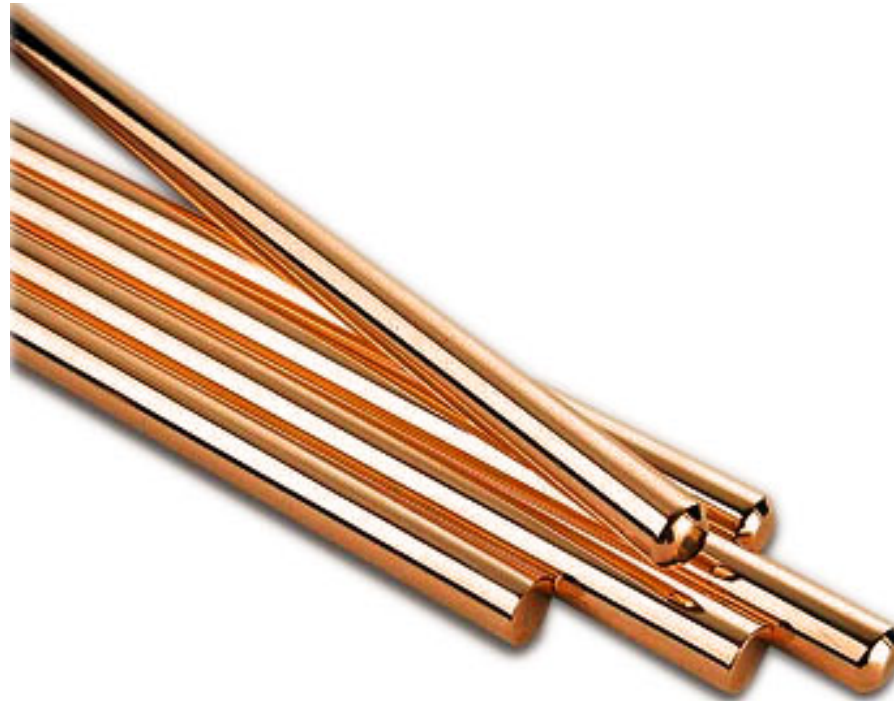


# Grounding Connections

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1910.304(g)(4)

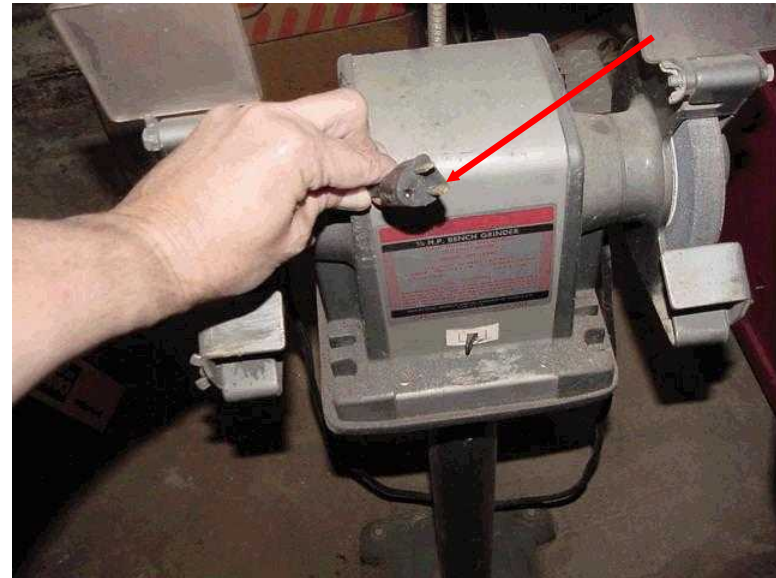
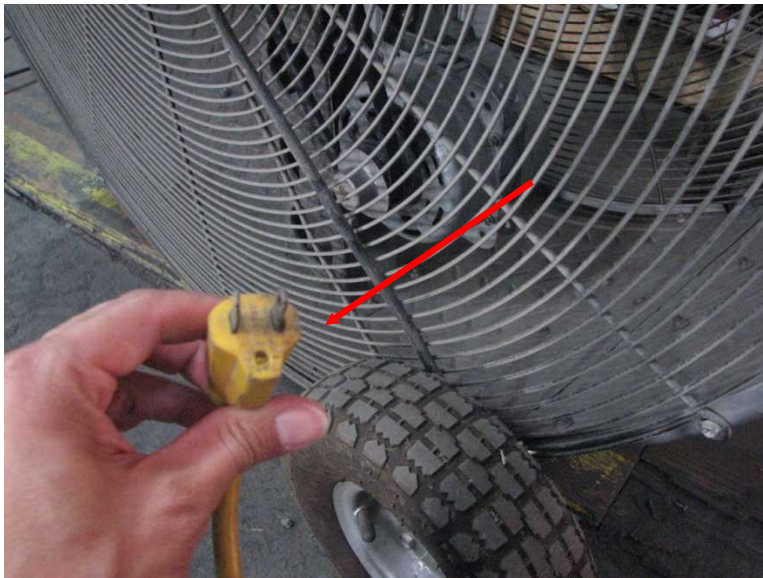
- A grounding electrode conductor shall be used.



# Grounding Path

1910.304(g)(5)

- The path to ground from circuits must be
  - Permanent
  - Continuous, *and*
  - Effective



# Grounding Path

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1910.304(g)(6)(iii)

- Frames of electric ranges
- Wall-mounted ovens  
counter-mounted cooking  
units
- Clothes dryers
- Metal outlet or junction  
boxes that are part of the  
circuit for these appliances  
shall be grounded.



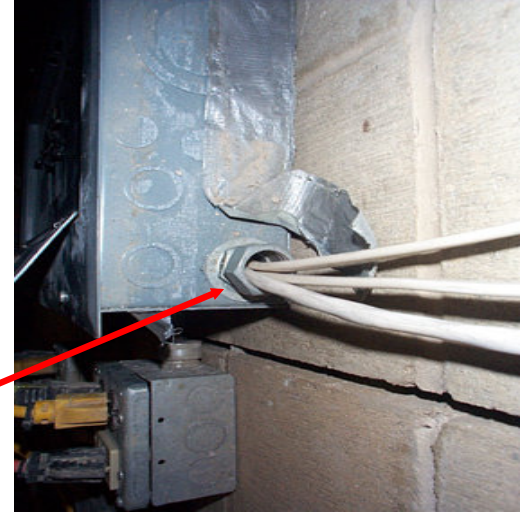


# Wiring Methods, Components, and Equipment

1910.305(b)(1)

- **Cabinets, boxes, and fittings**

- Conductors entering boxes, cabinets, or fittings shall be protected from abrasion.
- Openings through which conductors enter shall be effectively closed.



# Wiring Methods, Components, and Equipment

1910.305(e)(1)

- Enclosures for damp locations shall be installed so as to prevent moisture or water from entering and accumulating.

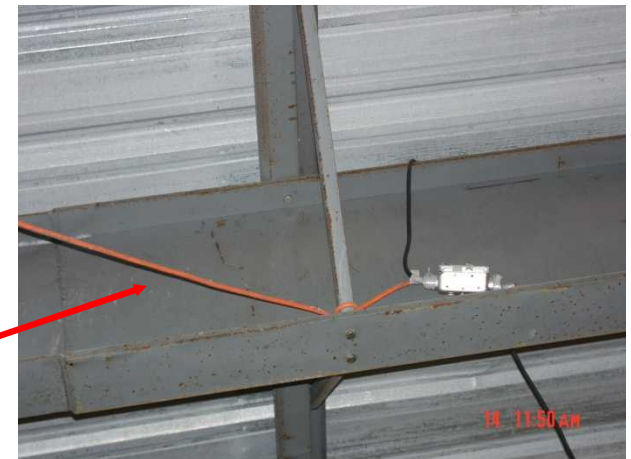
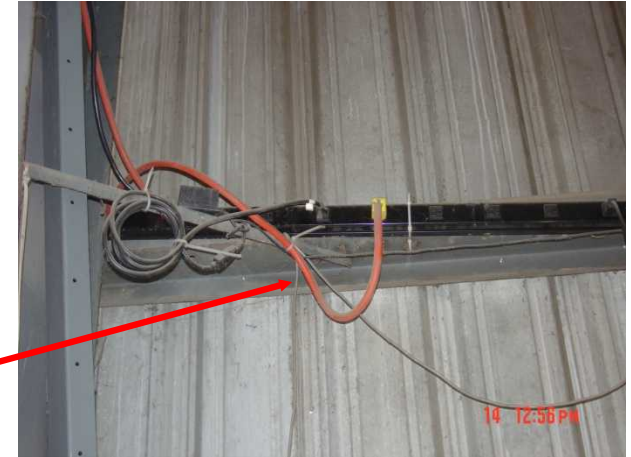


# Wiring Methods, Components, and Equipment

1910.305(g)(1)(ii)

## ● Flexible cords and cables

- May be used only for:
  - » Pendants
  - » Wiring of fixtures
  - » Connection of portable lamps or appliances
  - » Portable and mobile signs
  - » Elevator cables
  - » Wiring of cranes and hoists
  - » Connection of stationary equipment



# Wiring Methods, Components, and Equipment

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1910.305(g)(1)(iv)(b)

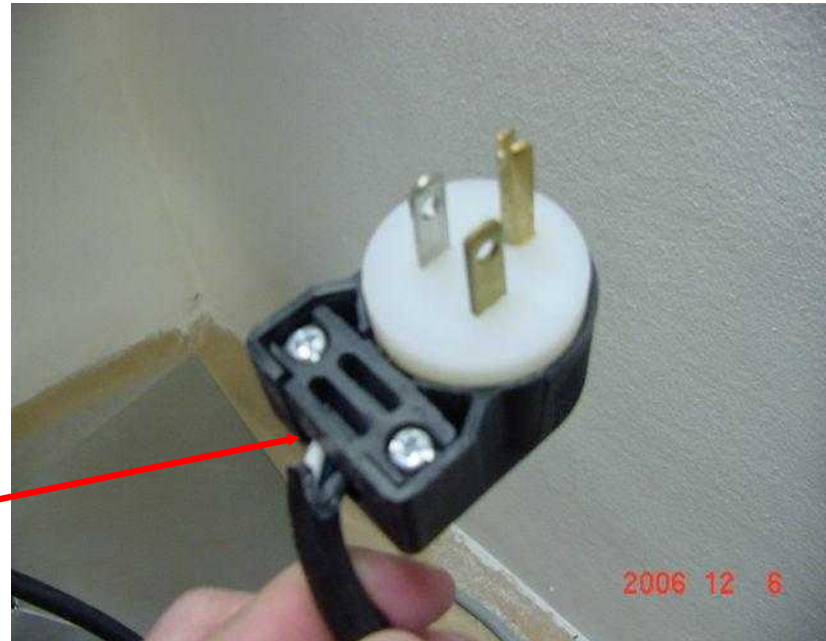
- Flexible cords and cables may not be used when run through holes in walls ceilings or floors.



# Wiring Methods, Components, and Equipment

1910.305(g)(2)(iii)

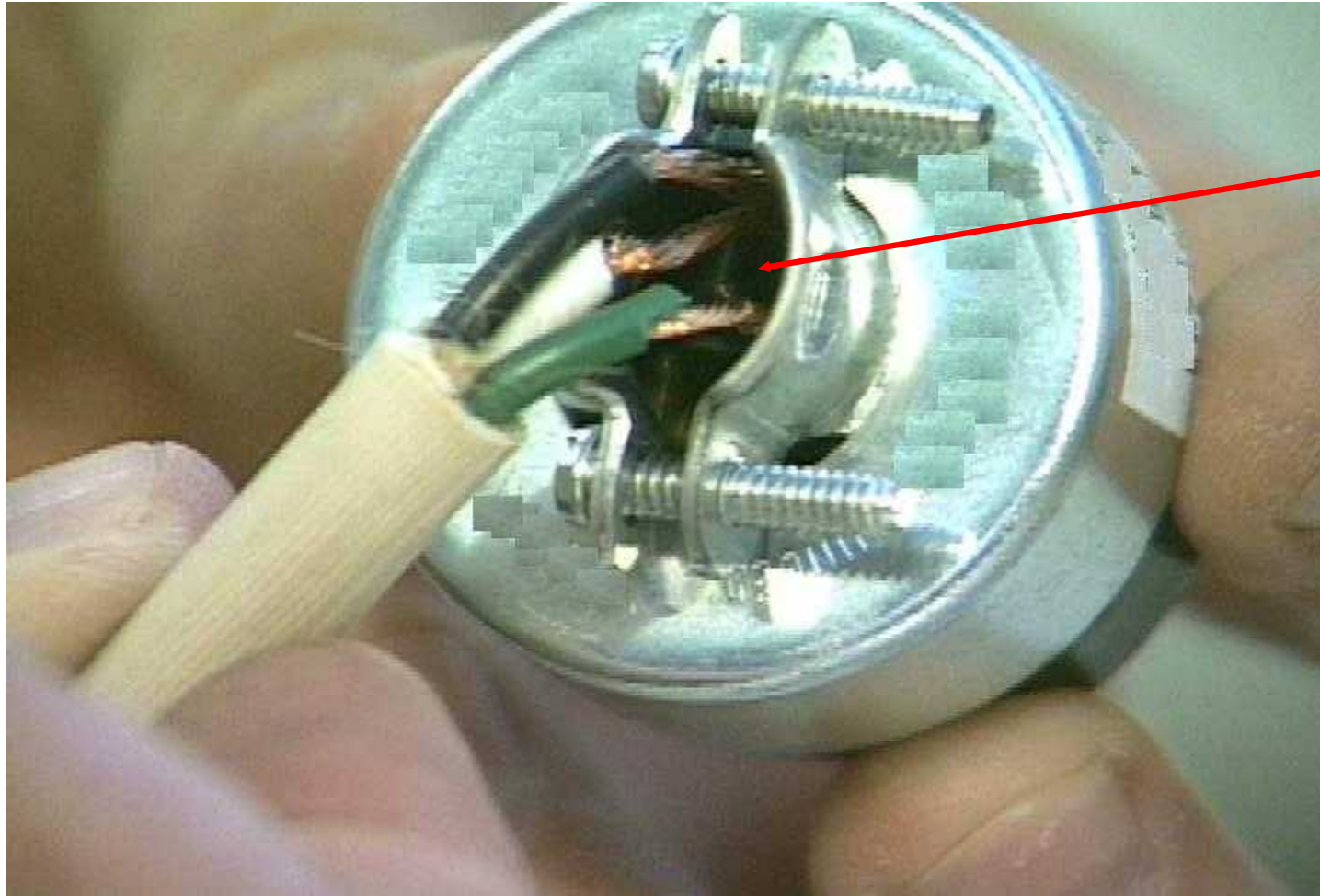
- Flexible cords must be connected to devices and fittings.
  - Strain relief must be provided to prevent pull from being directly transmitted to joints or terminal screws.



# Wiring Methods, Components, and Equipment

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1910.305(g)(2)(iii)



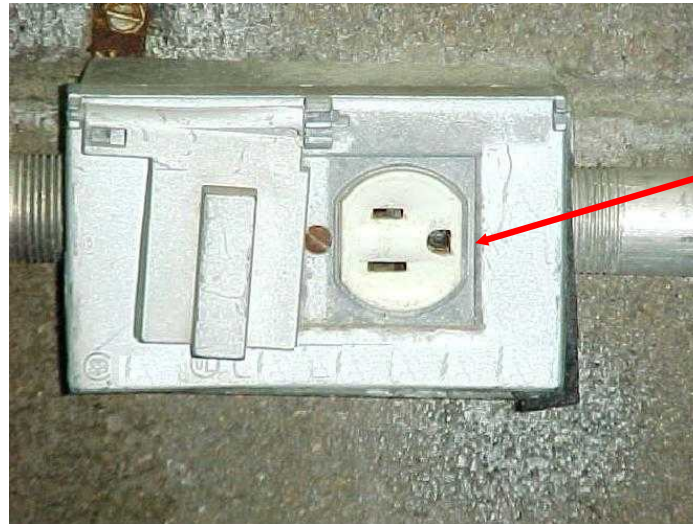
# Wiring Methods, Components, and Equipment

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1910.305(j)(2)(iv)

- **Wet or damp locations**

- A receptacle installed in a wet or damp location shall be suitable for the location.



# Safety Related Work Practices

1910.333(a)

- The employer must not permit an employee to work near or on energized equipment or circuits.
  - If employee could contact the power circuit, it must be deenergized.
  - If not possible to deenergize, other safety-related work practices must be used.



Dielectric safety mat



# Summary

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- In this course, we discussed:
    - Recent changes to the regulation
    - Common electrical hazards
    - Electrical equipment defects/hazards
    - Tools/techniques used in identifying hazards
    - Safe working practices
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**Thank You For Attending!**

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**Final Questions?**

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