Construction Industry
Electrical Hazards

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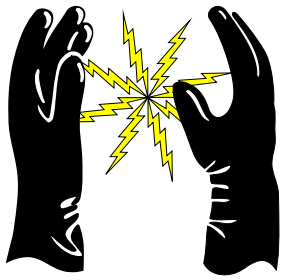
Electrical

Learning Objectives

- Understand why electricity is a hazard
- Understand the key provisions of the OSHA construction electrical standards
- Understand the most frequently cited electrical standards
- Understand general requirements and identify construction electrical hazards
- Understand hazardous locations



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Learning Objectives (con't)

- Understand the control of hazardous energy provisions
- Understand training requirements
- Understand impact of letters of interpretation
- Through a case study inspection, identify construction electrical hazards and how to cite for those hazards
- Understand the basics of NFPA 70E

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Course Agenda

- **Day 1:** Class Pre-Test
  Classroom Instruction
  Case Study Exploration
  Team Presentations

- **Day 2:** Project Site Visit- Mock Inspections by Teams
  Team Presentations of Results of Inspection
  Class Post Test

Electrical

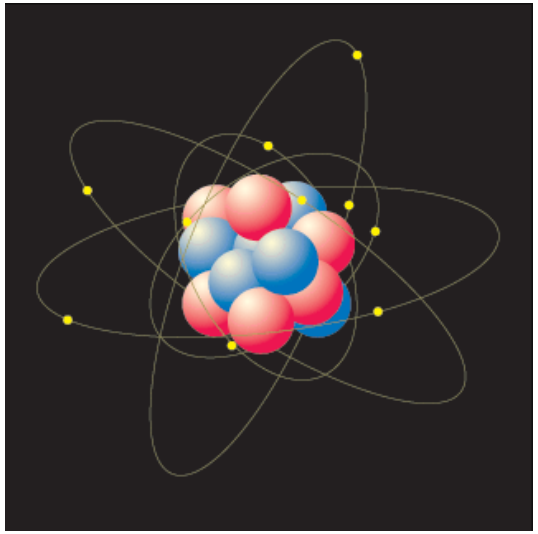
- **Rules of the course**
  - This is an open discussion course
  - Relax and learn
  - Ask questions
  - Participate in discussions
  - Share experiences
  - Share best practices
  - Enjoy yourself

Electrical

- **Why is it a Hazard?**

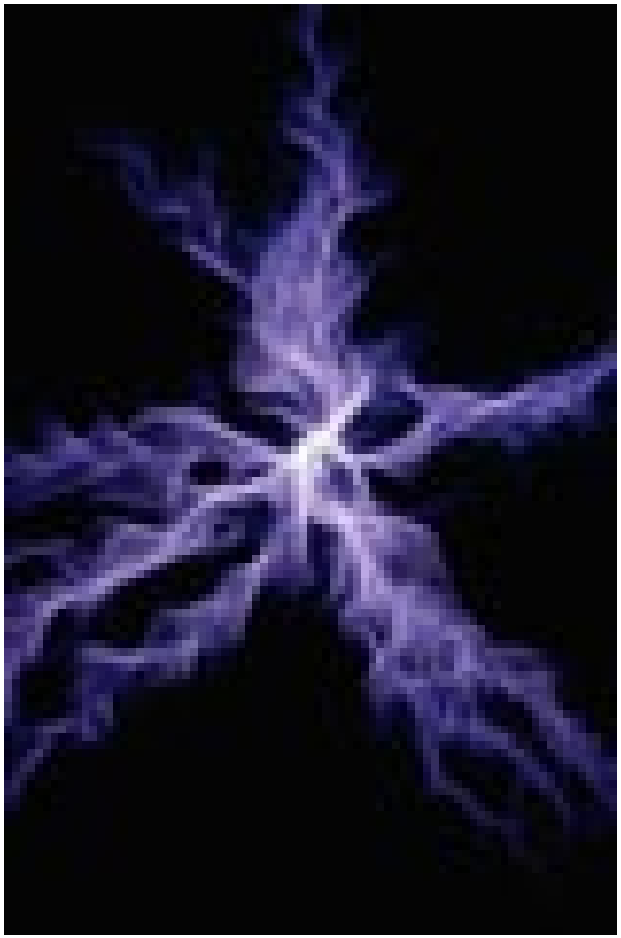
Definition - Electricity

- A physical agency caused by the motion of electrons, protons, and other charged particles, manifesting itself as an attraction, repulsion, magnetic, luminous, and heating effects, etc.



2 Kinds of Electricity

- **STATIC (Stationary)**
- **DYNAMIC (Moving)**



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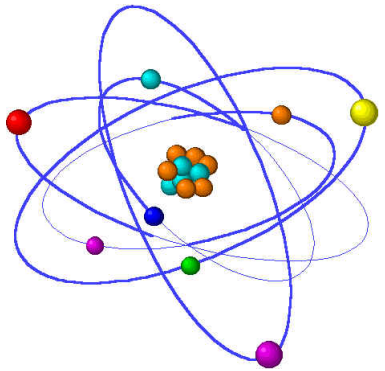
Elements and Atoms

- Every known substance – solid, liquid or gas is composed of elements
- An atom is the smallest particle of an element that retains all the properties of that element
- Each element has its own kind of atom



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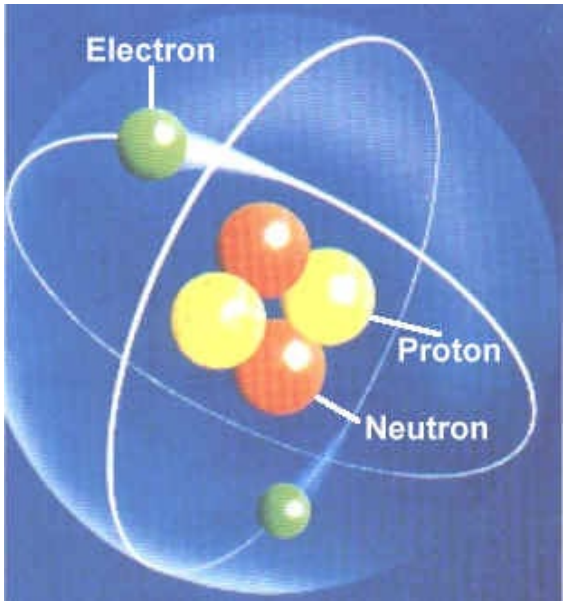
Atoms

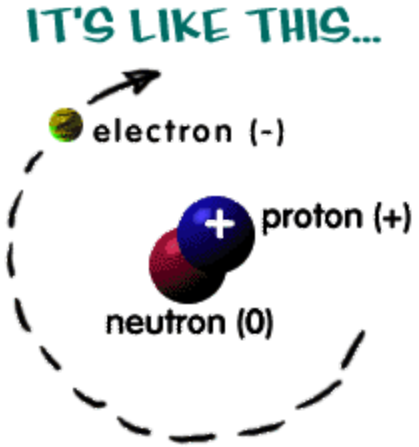
- Inner part composed of protons and neutrons
- Outer part composed of electrons
- Protons = positive charge
- Neutrons = no charge
- Electrons = negative charge



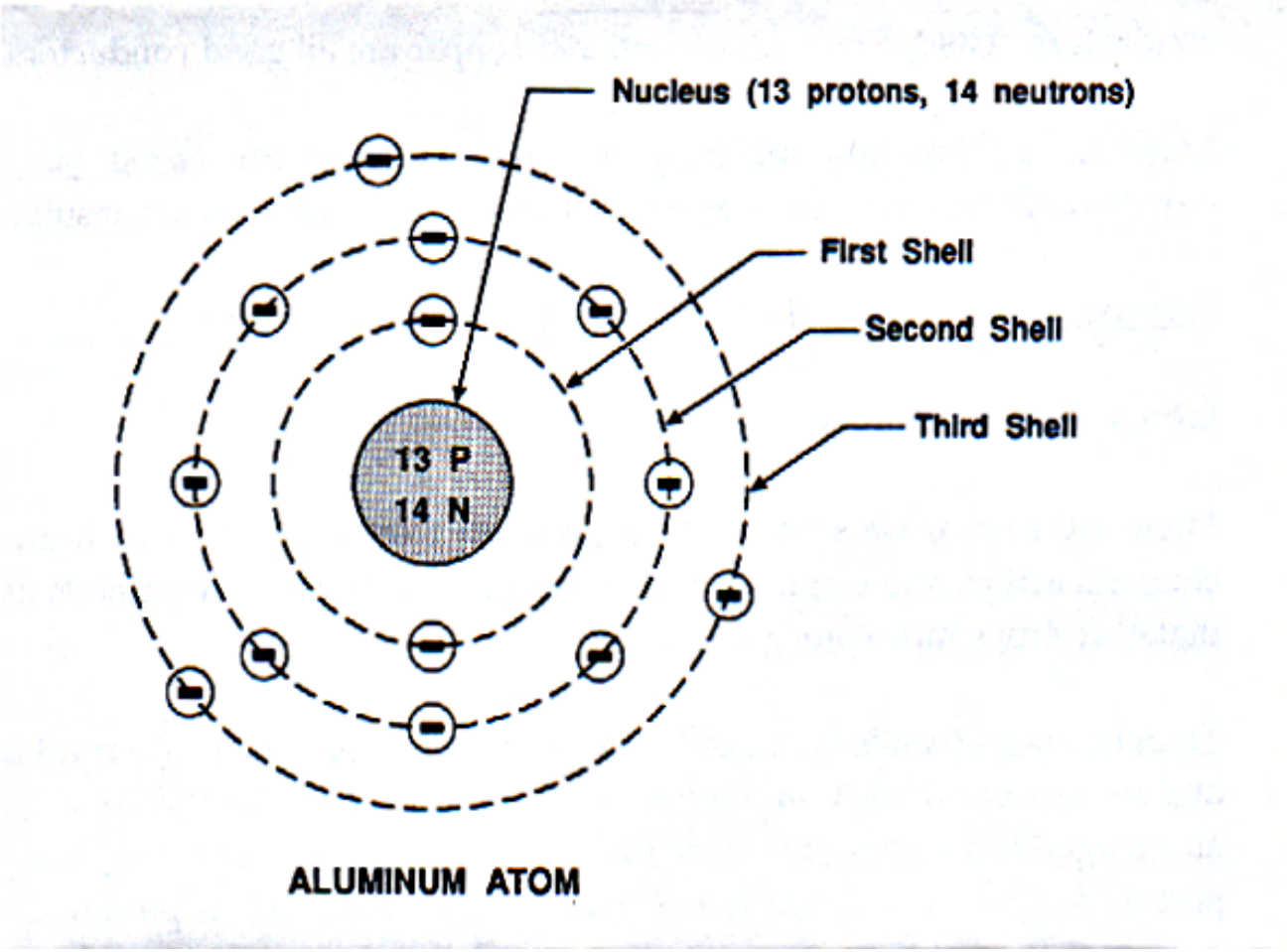
Atoms

- Each Atom has a definite number of electrons ----and the same number of protons

- They are oppositely charged and therefore attract each other. This tends to hold the electrons in orbit around the atom.

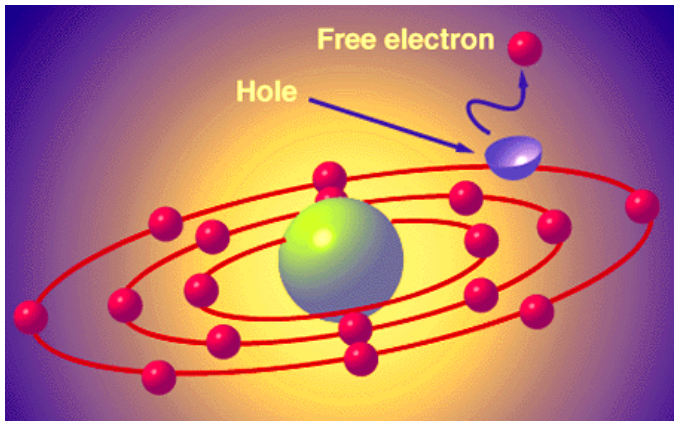


Electrically Balanced Atom



Free Electrons

- Some electrons are easily moved out of orbit
- The ability to move or flow is the basis of current electricity
- If channeled in a given direction, a flow of electrons occurs --- when flowed through a conductor it is **dynamic electricity**



Electrical Materials

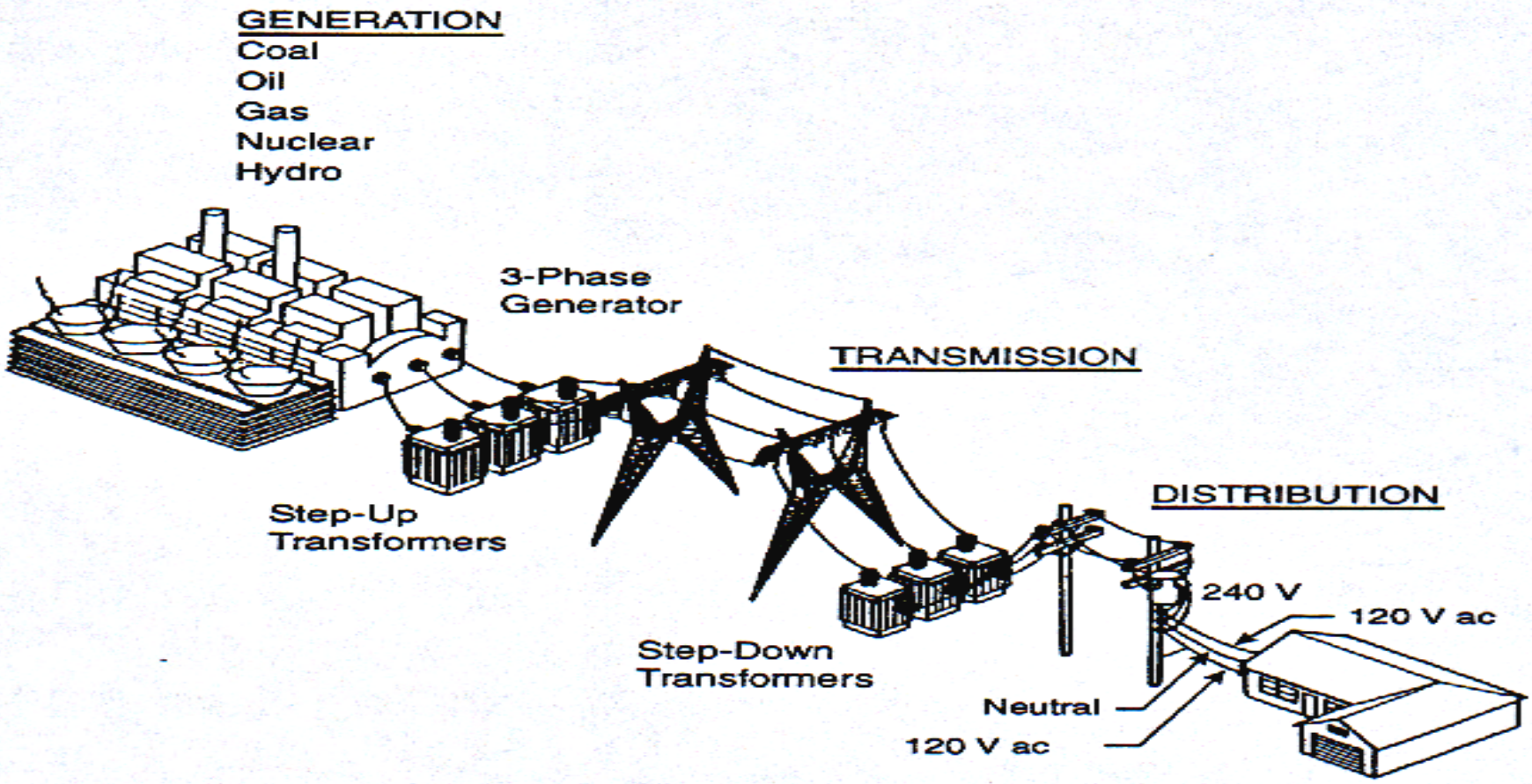
- **CONDUCTOR** – contains many free electrons --- gold, copper, silver, aluminum

- **INSULATOR** – contains few free electrons- usually non-metallic such as wood, rubber, glass, etc

Generating Electricity

- Friction, pressure, heat, light, chemical reaction, and magnetism
- Magnetism is most practical and inexpensive method
- Electricity is produced when a magnet is moved past a piece of wire, or wire is moved through a magnetic field

ELECTRIC POWER GENERATION, TRANSMISSION AND DISTRIBUTION



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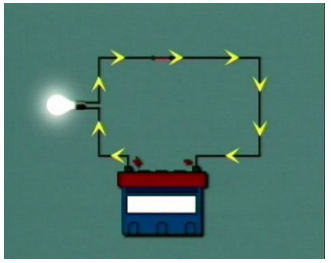
Voltage, Current, and Resistance

- **Voltage** – unit of measurement of electromotive force (EMF)
- **Current** - Continuous movement of electrons past a given point. (measured in amperes)
- **Resistance** – Opposition to movement of electrons. Makes it possible to generate heat, control current flow, and supply correct voltage to devices



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Voltage, Current, and Resistance

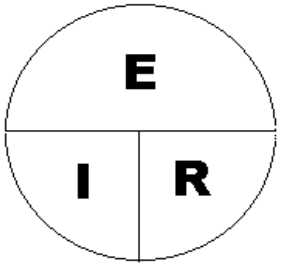
Ohm's Law

Where:

I =Current (Amps)
V=Voltage (Volts)
R=Resistance

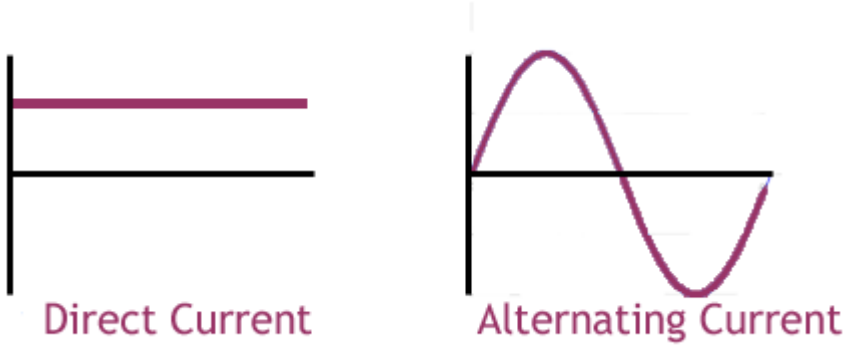
I = V/R or…

"One Ohm is that resistance in which a potential difference of one volt produces a current of one ampere"



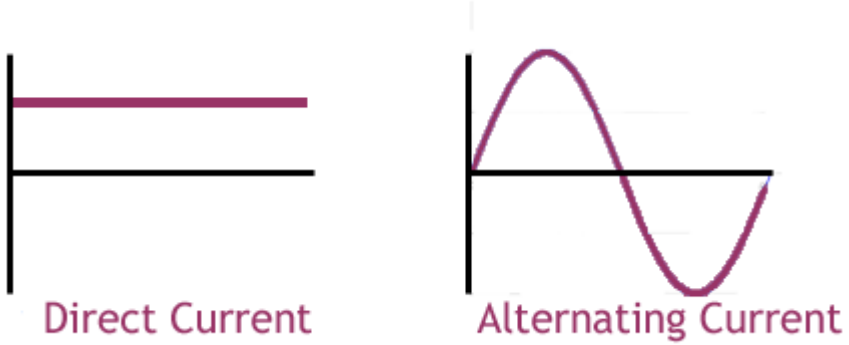
Direct Current

- Always flows in one direction
- Used to charge batteries, run some motors, operate magnetic lifting devices and welding equipment.



Alternating Current

- More common in electrical work
- Changes rapidly in both direction and value
- Power companies produce power cheaper with alternating current



Electrical Hazards

- **Shock**
  - Electric shock occurs when the human body becomes part of the path through which current flows.
  - The direct result can be electrocution.
  - The indirect result can be injury resulting from a fall or movement into machinery because of a shock

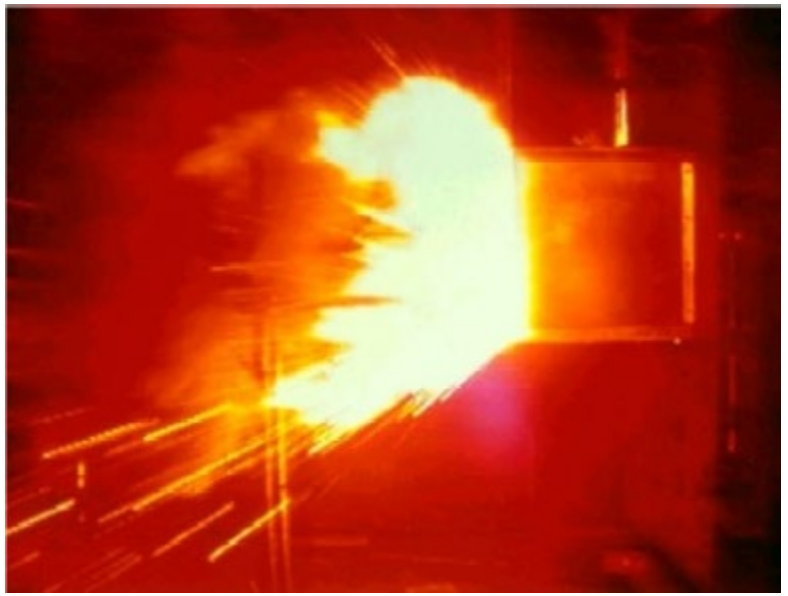
Electrical Hazards

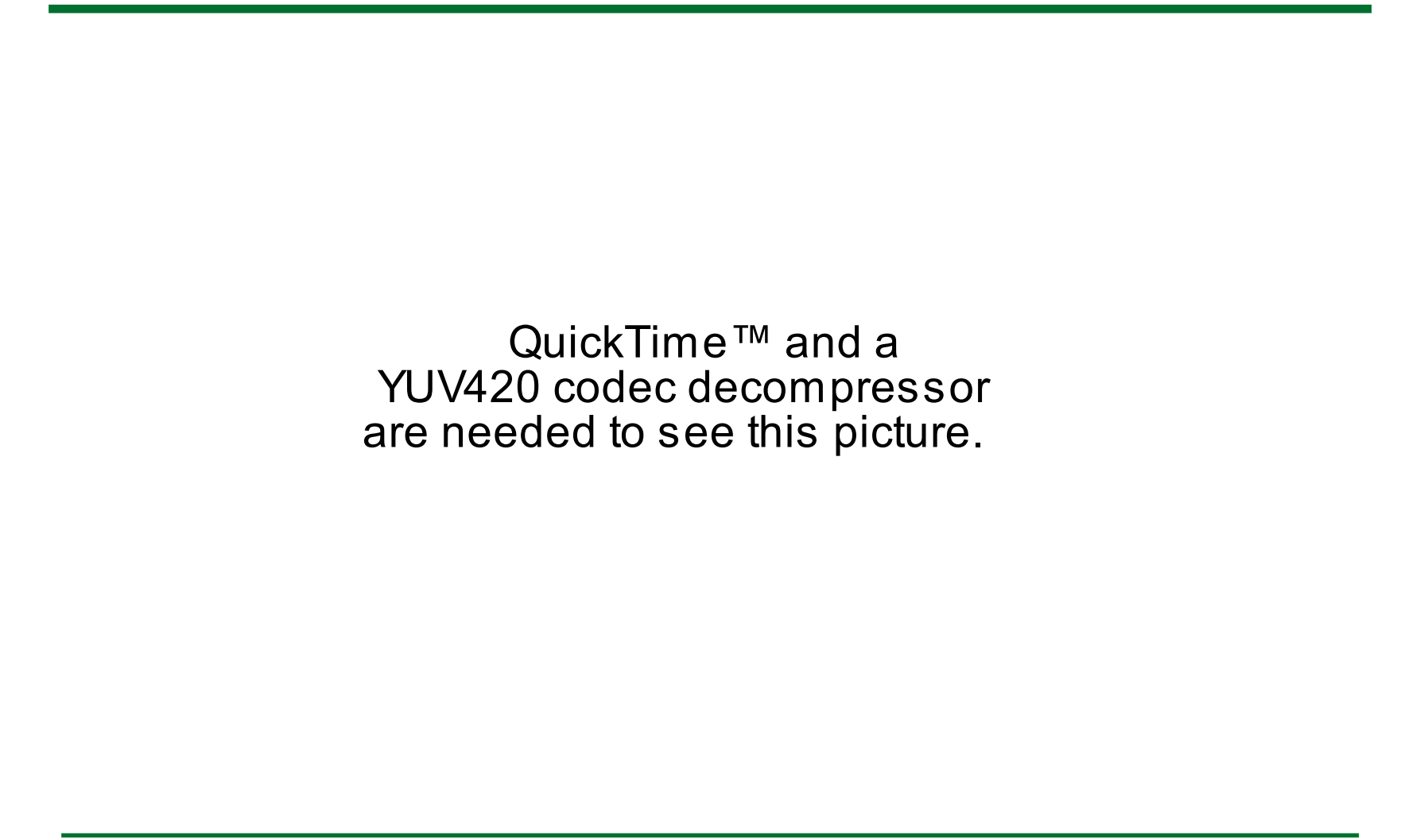
- **Burns**
  - Burns can result when a person touches electrical wiring or equipment that is energized.

- **Arc-blast**
  - Arc-blasts occur from high- amperage currents arcing through the air.
  - This can be caused by accidental contact with energized components or equipment failure.

Electrical Hazards

- **Arc-blast**
  - The three primary hazards associated with an arc-blast are:
    - » Thermal radiation
    - » Pressure wave
    - » Projectiles

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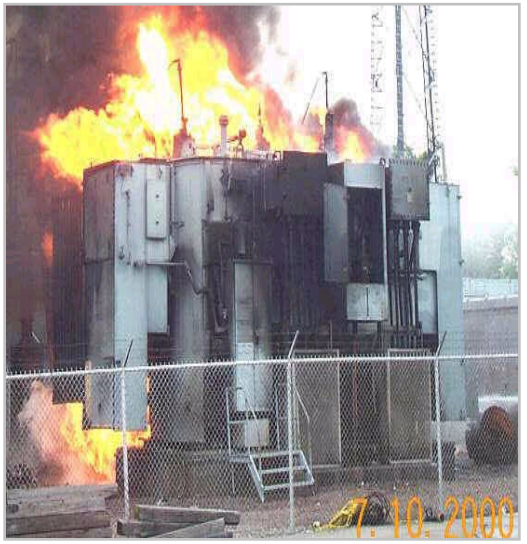
Electrical Hazards

- **Explosions**
  - Explosions occur when electricity provides a source of ignition for an explosive mixture in the atmosphere.

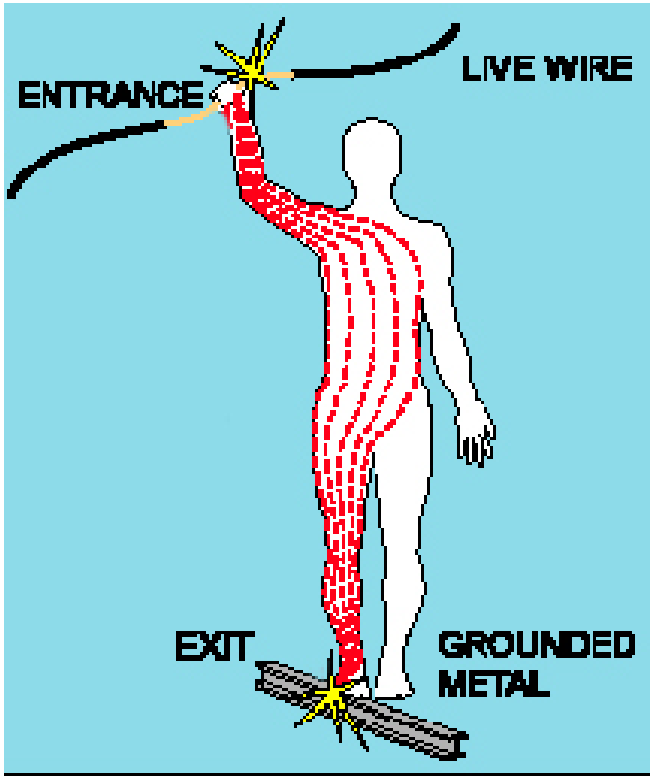
Electrical Hazards

- **Fires**
  - Electricity is one of the most common causes of fires both in the home and in the workplace.
  - Defective or misused electrical equipment is a major cause.



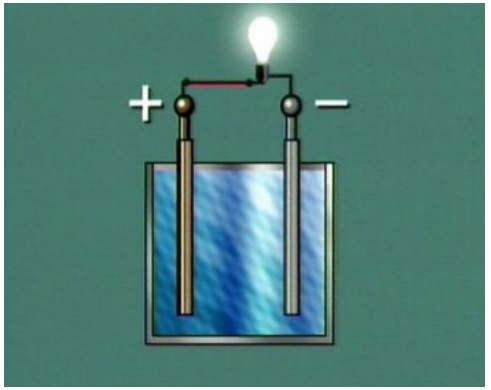
Effects on the Human Body

- **Depends on:**
  - Current and voltage
  - Resistance
  - Path through body
  - Duration of shock



Effects of AC Electricity

- **More than 3 mA** - Painful shock – can cause indirect accident
- **More than 10 mA** - Muscle contraction – “No Let Go” danger
- **More than 30 mA** - Lung paralysis, usually temporary



Effects of AC Electricity

- **More than 50 mA -** Ventricular fibrillation, usually fatal
- **100 mA to 4 A** - Certain ventricular fibrillation, fatal
- **Over 4 A -** Heart paralysis, severe burns

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- **Shocks -** occur when current flows through parts of the human body. Results can be direct (electrocution) or indirect (falls, etc.).

- **Burns -** usually caused by overly hot electrical conductors or by electrical arc blast.

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Electrical Hazards

- **Explosions -** can be caused when electricity provides an ignition source for an explosive mixture in the atmosphere.

- **Fires -** are most commonly caused by current flowing through high resistance due to faulty wiring igniting insulation and other material.

Electrical Definitions

- **Grounded -** A conducting connection between a circuit or equipment and the earth

- **Conductor -** Any material through which electrical current easily travels. (i.e., copper, aluminum and the human body)

- **Insulator -** Any material through which electrical current does not readily pass (i.e., glass, plastic, rubber, wood and air)

Electricity - Summary

- If you or your employees are exposed to electrical hazards, they must be trained and protected.
  - This is called: *“ Safety Related Work Practices”*

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Construction

Electrical - Subpart K
1926.400 - 1926.449

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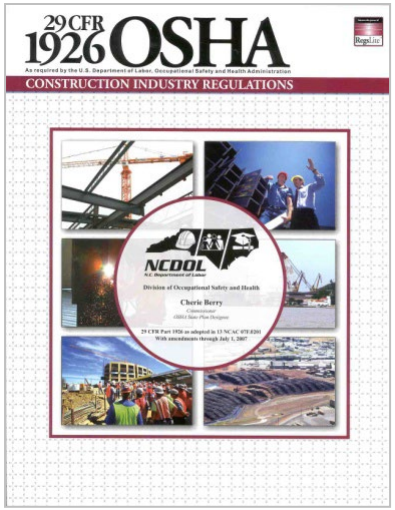
Most Frequently Cited…

Most Frequently Cited - 2010

- Scaffolding
- Fall Protection
- Hazard Communication
- Ladders
- Respiratory Protection
- Lockout Tagout
- Electrical Wiring Methods
- Powered Industrial Trucks
- Electrical Systems Design
- Machine Guarding



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Highest Penalties Issued - 2010

- Fall Protection
- Electrical, Construction
- Safety Training and Education
- Lockout Tagout
- Machine Guarding
- General Duty
- Excavations
- Lead
- Grain Handling
- Ladders

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Most Frequently Cited Electrical - 2010

- **404(f)(6)** - Grounding path (397)
- **404(b)(1)(i)** - General ground-fault protection (340)
- **403(b)(2)** - Equipment installation and use (203)
- **404(b)(1)(ii)** - Ground-fault circuit interrupters (148)
- **405(g)(2)(iv)** - Flexible cords – strain relief (139)

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Electrical Citation Classifications

Electrical Citation Classification - Types

- **Other than serious violation**
  - Normally would not cause death or serious injury
  - Not many electrical citations are classified as "other than serious"
- **Serious violation**
  - High probability of death or serious harm
  - Most electrical citations are classified as at least "serious"

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Electrical Citation Classification - Types

- **Willful Violation**
  - Employer knowingly commits with plain indifference to the law
  - Either knows action is a violation, or is aware of hazardous condition with no effort to eliminate
  - Electrical Citations can be classified as “Willful”
- **Repeat Violation**
  - State vs. Federal
  - Federal vs. State

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Key Elements of the Standard

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Electrical Standard

- **1926.403(b)(1) - Examination.**
  - The employer shall ensure that electrical equipment is free from recognized hazards that are likely to cause death or serious physical harm to employees. Safety of equipment shall be determined on the basis of the following considerations.

- **1926.403(e) - Splices.**
  - Conductors shall be spliced or joined with splicing devices designed for the use or by brazing, welding, or soldering with a fusible metal or alloy. Soldered splices shall first be so spliced or joined as to be mechanically and electrically secure without solder and then soldered. All splices and joints and the free ends of conductors shall be covered with an insulation equivalent to that of the conductors or with an insulating device designed for the purpose.

Electrical Standard

- **1926.403(g) - Marking.**
  - Electrical equipment shall not be used unless the manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified is placed on the equipment and unless other markings are provided giving voltage, current, wattage, or other ratings as necessary. The marking shall be of sufficient durability to withstand the environment involved

- **1926.403(i)(1) - Working space about electric equipment.**
  - Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.

0 -150: 3 ft. x 30 inches *151-600: 3-1/2 ft. x 30 inches*

Electrical Standard

- **1926.403(i)(2)(1)**
  - Except as required or permitted elsewhere in this subpart, live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact by cabinets or other forms of enclosures, or by any of the following means.

- **1926.403(j)(2)(i)**
  - Installations accessible to qualified persons only. Electrical installations having exposed live parts shall be accessible to qualified persons only and shall comply with the applicable provisions of paragraph (j)(3) of this section.

Electrical Standard

- **1926.403(j)(3)(ii) - Lighting outlets and points of control.**
  - The lighting outlets shall be so arranged that persons changing lamps or making repairs on the lighting system will not be endangered by live parts or other equipment. The points of control shall be so located that persons are not likely to come in contact with any live part or moving part of the equipment while turning on the lights

- **1926.404(a)(2) - Polarity of connections.**
  - No grounded conductor shall be attached to any terminal or lead so as to reverse designated polarity.

Electrical Standard

- **1926.404(b)(1)(i) - General.**
  - The employer shall use either ground fault circuit interrupters as specified in paragraph (b)(1)(ii) of this section or an assured equipment grounding conductor program as specified in paragraph (b)(1)(iii) of this section to protect employees on construction sites. These requirements are in addition to any other requirements for equipment grounding conductors.

Electrical Standard

- **1926.404(b)(1)(ii) - Ground-fault circuit interrupters.**
  - All 120-volt, single-phase 15- and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, shall have approved ground-fault circuit interrupters for personnel protection. Receptacles on a two-wire, single-phase portable or vehicle-mounted generator rated not more than 5kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, need not be protected with ground-fault circuit interrupters.

Electrical Standard

- **1926.404(b)(1)(iii)(C)**
  - Each cord set, attachment cap, plug and receptacle of cord sets, and any equipment connected by cord and plug, except cord sets and receptacles which are fixed and not exposed to damage, shall be visually inspected before each day's use for external defects, such as deformed or missing pins or insulation damage, and for indications of possible internal damage. Equipment found damaged or defective shall not be used until repaired.

Electrical Standard

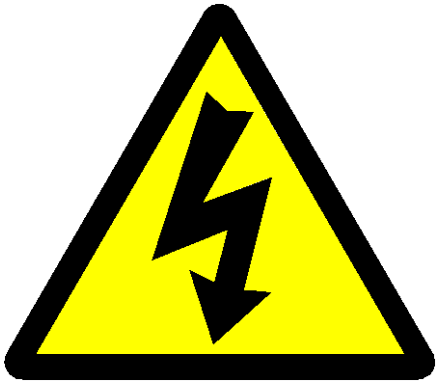
- **1926.404(c)(1)(iv) - Clearance over roofs.**
  - Conductors above roof space accessible to employees on foot shall have a clearance from the highest point of the roof surface of not less than 8 feet (2.44 m) vertical clearance for insulated conductors, not less than 10 feet (3.05 m) vertical or diagonal clearance for covered conductors, and not less than 15 feet (4.57 m) for bare conductors, except that:

- **1926.404(c)(1)(iv)(A)**
  - Where the roof space is also accessible to vehicular traffic, the vertical clearance shall not be less than 18 feet (5.49 m)

Electrical Standard

- **1926.404(d)(2)(ii) - Warning signs.**
  - Signs warning of high voltage shall be posted where unauthorized employees might come in contact with live parts.

- **1926.404(f)(1)(iv) AC systems, 50 volts to 1000 volts.**
  - AC systems of 50 volts to 1000 volts shall be grounded under any of the following conditions, unless exempted by paragraph (f)(1)(v) of this section.



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- **1926.404(f)(3)(i) - Portable generators.**
  - Under the following conditions, the frame of a portable generator need not be grounded and may serve as the grounding electrode for a system supplied by the generator.
- **1926.404(f)(6) - Grounding path.**
  - The path to ground from circuits, equipment, and enclosures shall be permanent and continuous.
- **1926.404(f)(7)(iv) - Equipment connected by cord and plug.**
  - Under any of the conditions described in paragraphs (f)(7)(iv)(A) through (f)(7)(iv)(C) of this section, exposed noncurrent-carrying metal parts of cord- and plug-connected equipment which may become energized shall be grounded.

Electrical Standard

- **1926.405(a)(2)(i) - Scope.**
  - The provisions of paragraph (a)(2) of this section apply to temporary electrical power and lighting wiring methods which may be of a class less than would be required for a permanent installation. Except as specifically modified in paragraph (a)(2) of this section, all other requirements of this subpart for permanent wiring shall apply to temporary wiring installations. Temporary wiring shall be removed immediately upon completion of construction or the purpose for which the wiring was installed.

- **1926.405(a)(2)(ii)(F)**
  - Temporary lights shall not be suspended by their electric cords unless cords and lights are designed for this means of suspension.

Electrical Standard

- **1926.405(a)(2)(ii)(G)**
  - Portable electric lighting used in wet and/or other conductive locations, as for example, drums, tanks, and vessels, shall be operated at 12 volts or less. However, 120-volt lights may be used if protected by a ground-fault circuit interrupter.

- **1926.405(a)(2)(ii)(J)**
  - Extension cord sets used with portable electric tools and appliances shall be of three-wire type and shall be designed for hard or extra- hard usage. Flexible cords used with temporary and portable lights shall be designed for hard or extra-hard usage.

Electrical Standard

- **1926.405(b)(1) - Conductors entering boxes, cabinets, or fittings.**
  - Conductors entering boxes, cabinets, or fittings shall be protected from abrasion, and openings through which conductors enter shall be effectively closed. Unused openings in cabinets, boxes, and fittings shall also be effectively closed.

- **1926.405(e)(1) - Cabinets, fittings, and boxes.**
  - Cabinets, cutout boxes, fittings, boxes, and panelboard enclosures in damp or wet locations shall be installed so as to prevent moisture or water from entering and accumulating within the enclosures. In wet locations the enclosures shall be weatherproof.

Electrical Standard

- **1926.405(j)(1)(i) - Live parts.**
  - Fixtures, lampholders, lamps, rosettes, and receptacles shall have no live parts normally exposed to employee contact. However, rosettes and cleat-type lampholders and receptacles located at least 8 feet (2.44 m) above the floor may have exposed parts.

- **1926.405(j)(3)(iii) - Rating.**
  - Each appliance shall be marked with its rating in volts and amperes or volts and watts.

Electrical Standard

- **1926.407(b) - Electrical installations.**
  - Equipment, wiring methods, and installations of equipment in hazardous (classified) locations shall be approved as intrinsically safe or approved for the hazardous (classified) location or safe for the hazardous (classified) location. Requirements for each of these options are as follows:

- **1926.407(b)(1) - Intrinsically safe.**
  - Equipment and associated wiring approved as intrinsically safe is permitted in any hazardous (classified) location included in its listing or labeling.

Electrical Standard

- **1926.416(a)(1)**
  - No employer shall permit an employee to work in such proximity to any part of an electric power circuit that the employee could contact the electric power circuit in the course of work, unless the employee is protected against electric shock by deenergizing the circuit and grounding it or by guarding it effectively by insulation or other means.

Electrical Standard

- **1926.416(a)(3)**
  - Before work is begun the employer shall ascertain by inquiry or direct observation, or by instruments, whether any part of an energized electric power circuit, exposed or concealed, is so located that the performance of the work may bring any person, tool, or machine into physical or electrical contact with the electric power circuit. The employer shall post and maintain proper warning signs where such a circuit exists. The employer shall advise employees of the location of such lines, the hazards involved, and the protective measures to be taken.

- **1926.416(d) Fuses**.
  - When fuses are installed or removed with one or both terminals energized, special tools insulated for the voltage shall be used.

Electrical Standard

- **1926.416(e)(1)**
  - Worn or frayed electric cords or cables shall not be used.
- **1926.416(e)(2)**
  - Extension cords shall not be fastened with staples, hung from nails, or suspended by wire.
- **1926.417(a) Controls**.
  - Controls that are to be deactivated during the course of work on energized or deenergized equipment or circuits shall be tagged.

Electrical Standard

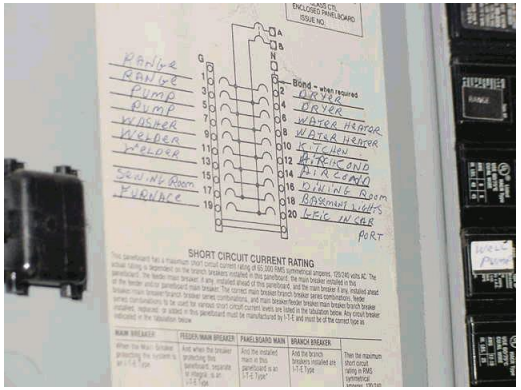
- **1926.417(b) Equipment and circuits.**
  - Equipment or circuits that are deenergized shall be rendered inoperative and shall have tags attached at all points where such equipment or circuits can be energized.

- **1926.417(c) Tags.**
  - Tags shall be placed to identify plainly the equipment or circuits being worked on.

General Requirements and Hazard Examples

General Requirements

- Equipment must be inspected before installation and suitable for purpose.
- Listed, labeled, and certified equipment to be used per manufacturer's instructions.
- All breakers must be labeled.



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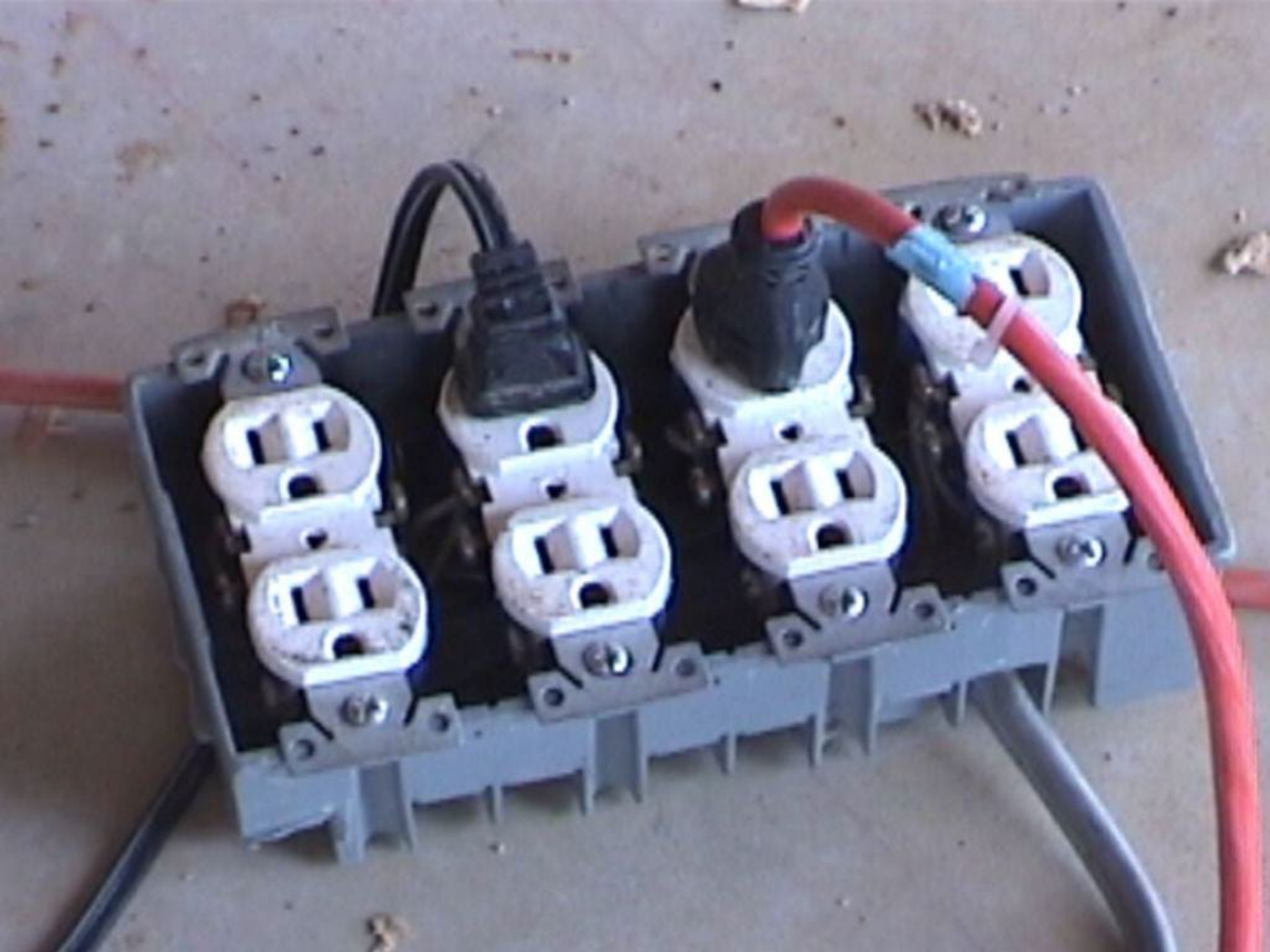
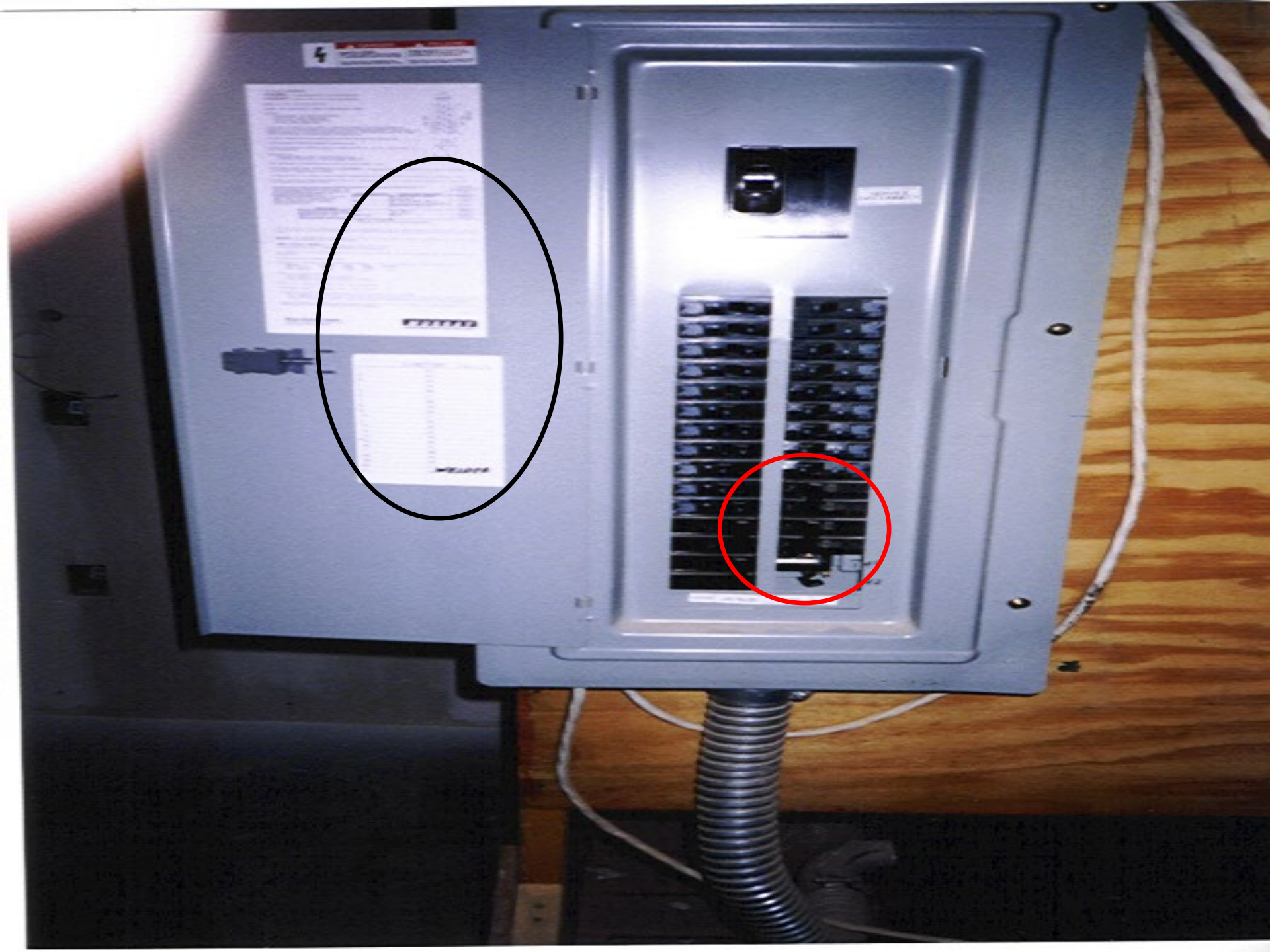




LIGHTS

INSIDE4

UTSIDE2

OFF 20

OFF 30A

OFF 20A

ON 20 OFF

ON OFF 20A

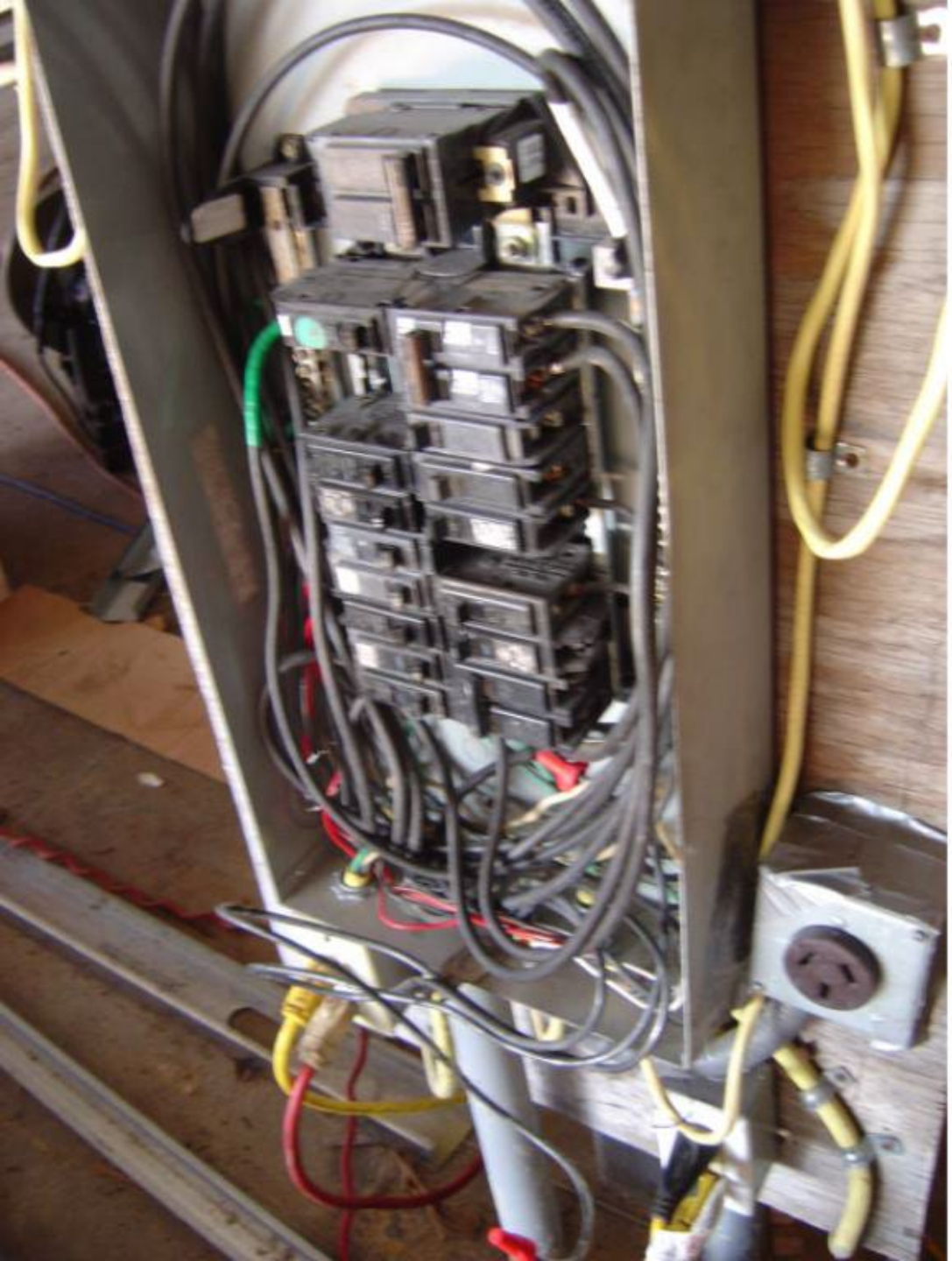
20 ON TRIP OFF

PUSH TO TEST

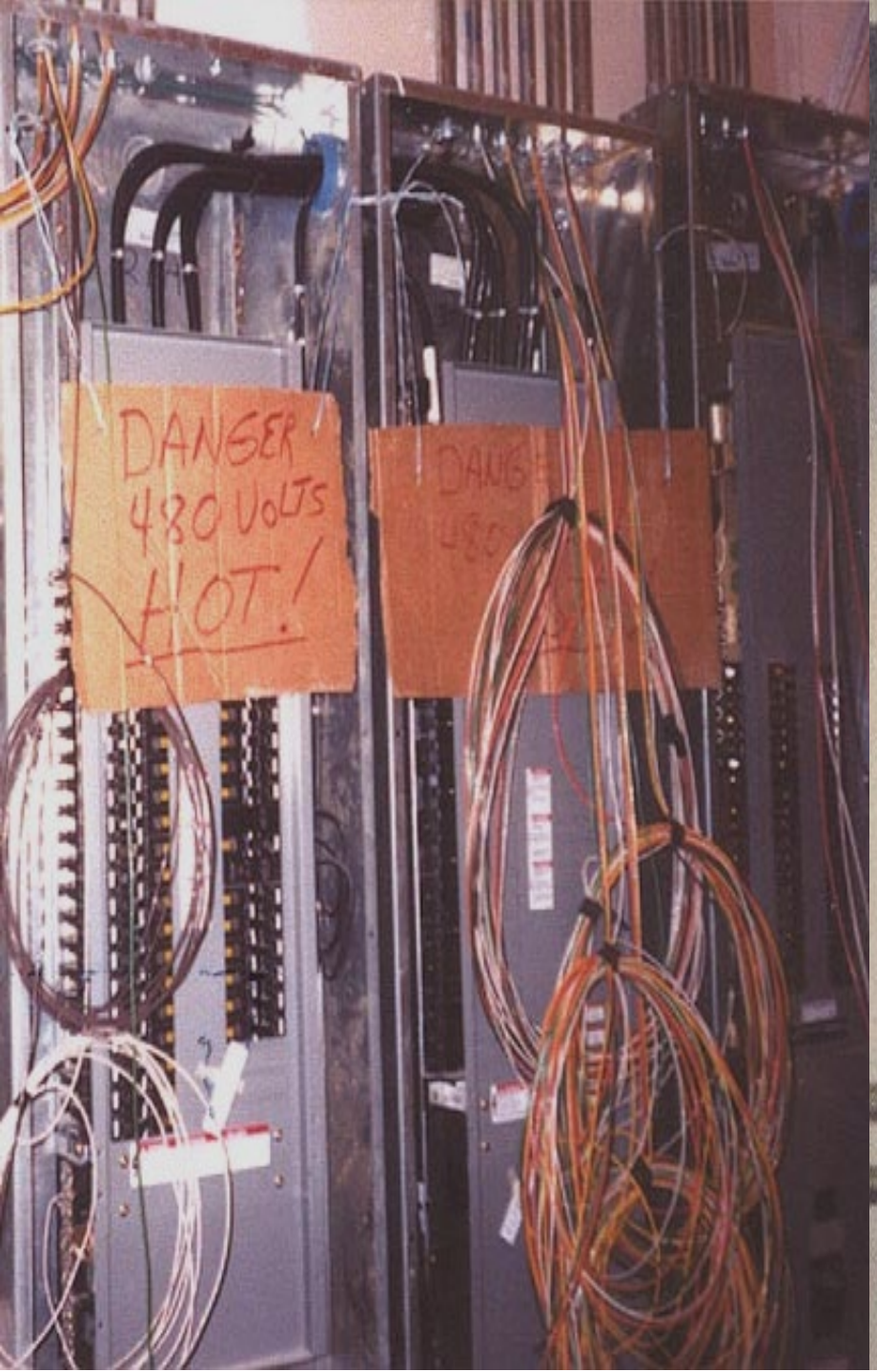
Guarding of Live Parts

- Live parts **50 volts or greater** must be guarded by:
  - Location in a room or enclosure accessible only to qualified persons (electricians).
  - Partitions or screens with access only to qualified persons.
  - Location on balcony or platform that excludes access by unqualified persons.
  - Elevation of 8 feet or more above floor or working surface.

This exposed electrical equipment is guarded by an 8-foot fence.



Open panel with exposed live parts


DANGER
480 VOLTS
HOT!


DANGER
DANGER
HOT
480V
Keep Out!!!
DANGER
DANGER
DANGER
HOT
480V
Keep Out
DANGER


DANGER
HOT
PANEL
DANGER
DO NOT TOUCH!

Guarding of Live Parts

- Where electrical equipment is exposed to physical damage, enclosures or guards must used.

- Entrances to electrical rooms containing exposed live parts must be marked with warning signs forbidding entrance by unqualified persons.

Signage

Door tied open to room with exposed live parts

General Requirements

- Conductors must be spliced with splicing devices designed for the use (wire nuts, crimp connectors) or by brazing, welding, or soldering.

- Electrical equipment must not be used unless the manufacture's name, trademark and other markings giving voltage, current, wattage, etc. are legible.

Working Spaces
600 Volts, Nominal, or Less

- Working spaces must not be used for storage.
- Sufficient access and working space must be provided and maintained around all electrical equipment.
- Minimum working clearances per Table K-1.
  - 3 feet – From front opening
  - No less than 30 inches wide

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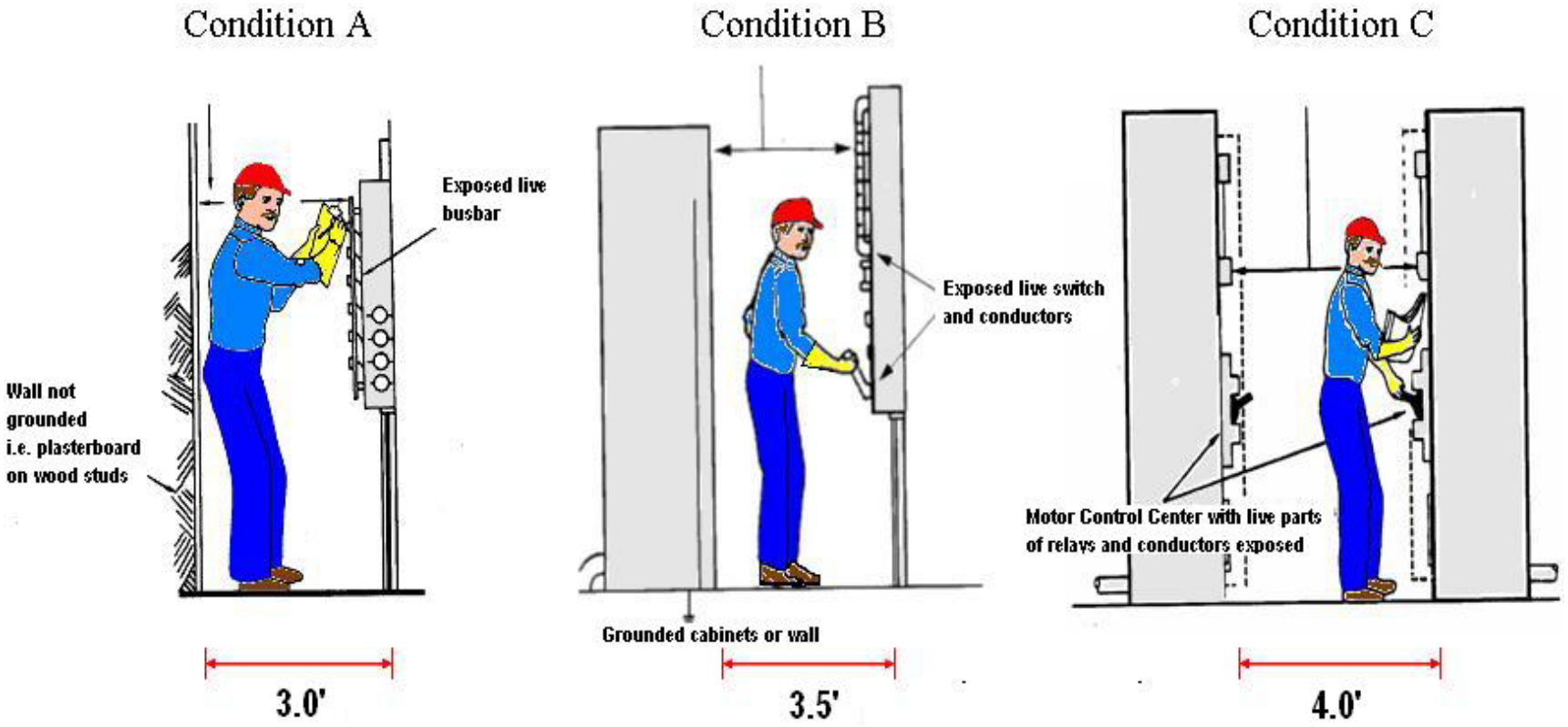
Working Spaces
600 Volts, Nominal, or Less



Electrical Violations

Working space blocked

Working Spaces Over 600 Volts

- Sufficient space must be provided and maintained to permit safe operation and maintenance.
- Refer to Table K-2 for working clearances (minimum 3 feet).

Ground Fault Circuit Interrupters

- Ground fault circuit interrupters or assured equipment grounding conductor program required for construction.
- GFCI protection required on all 120v 15-20 amp outlets that are not part of permanent wiring system.
- GFCI not required on permanent building power unless tool used with extension cord.


RESET
TEST


Portable GFCI
PORTABLE GFCI

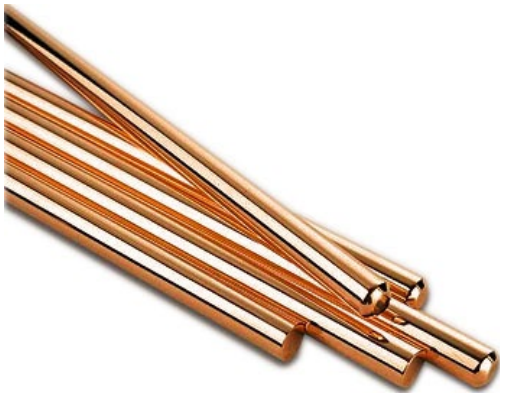
Assured Grounding

- Written program must be kept onsite.
- Implemented by a competent person.
- Covers all cords, power tools and outlets.
- Tested before 1st use, monthly, after service, and after possible damage.
- Must be color coded and keep written log.

Assured Grounding

- Properly complying with the assured grounding requirements means that: “The only thing you can be assured of …… is an OSHA citation.”

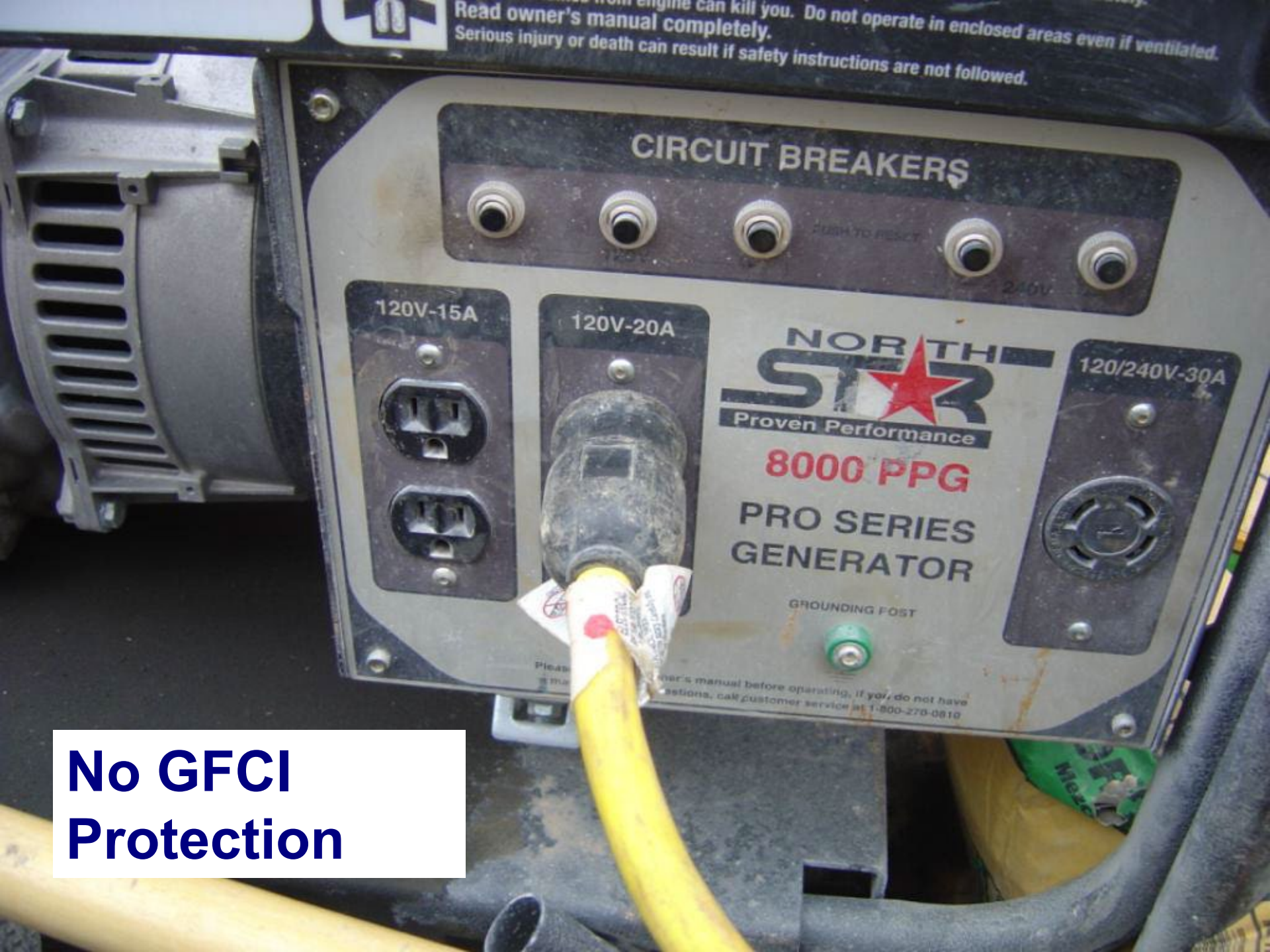
- Not recommended as the sole means of protection in construction.



GFCI - Portable Generators

- GFCI protection to be required on all portable generators 5kW (5000 watts) or greater.

- Protection can be built in or added as a “pig tail”.



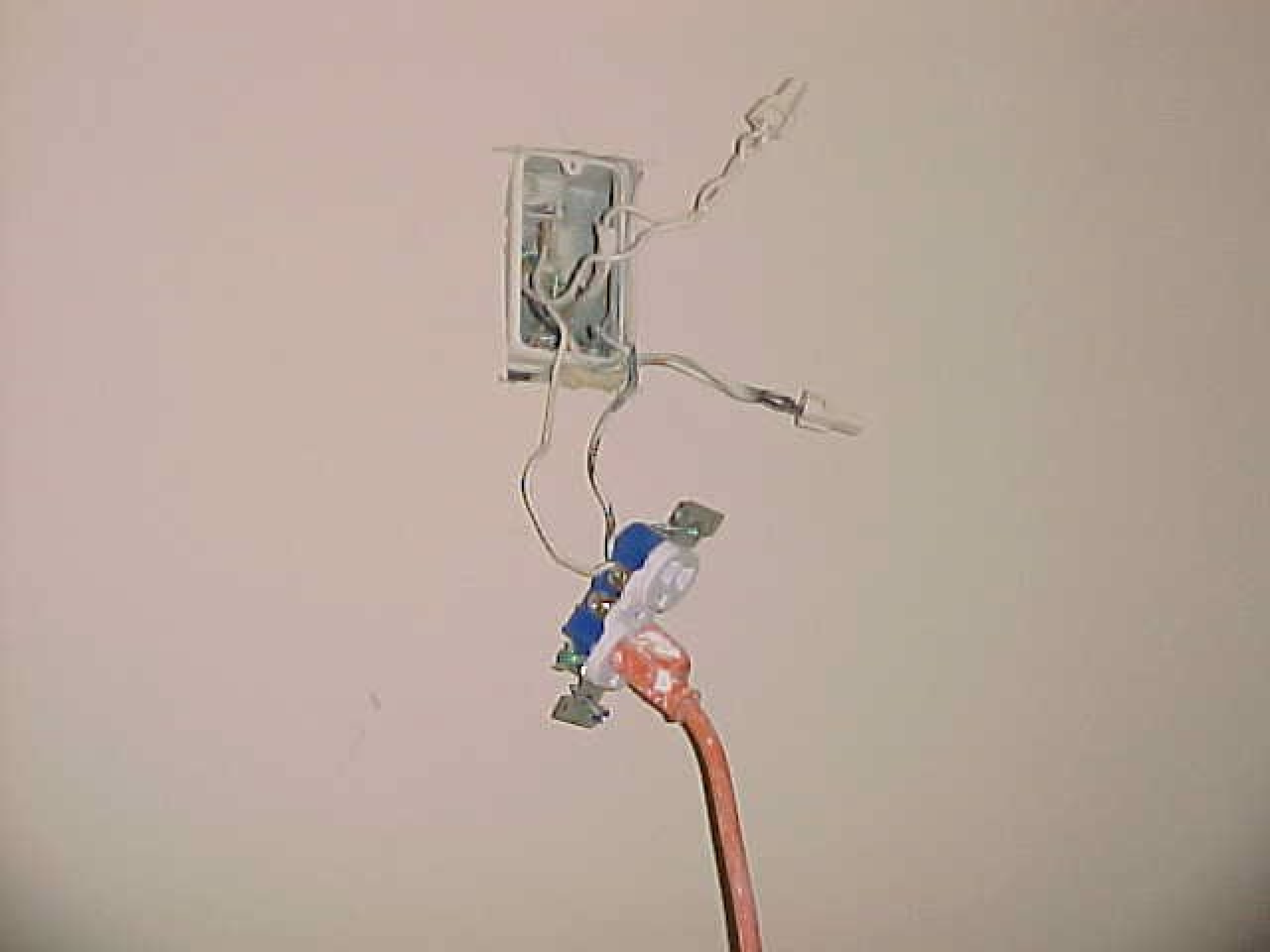
No GFCI Protection

Portable GFCI

GFCI Built In

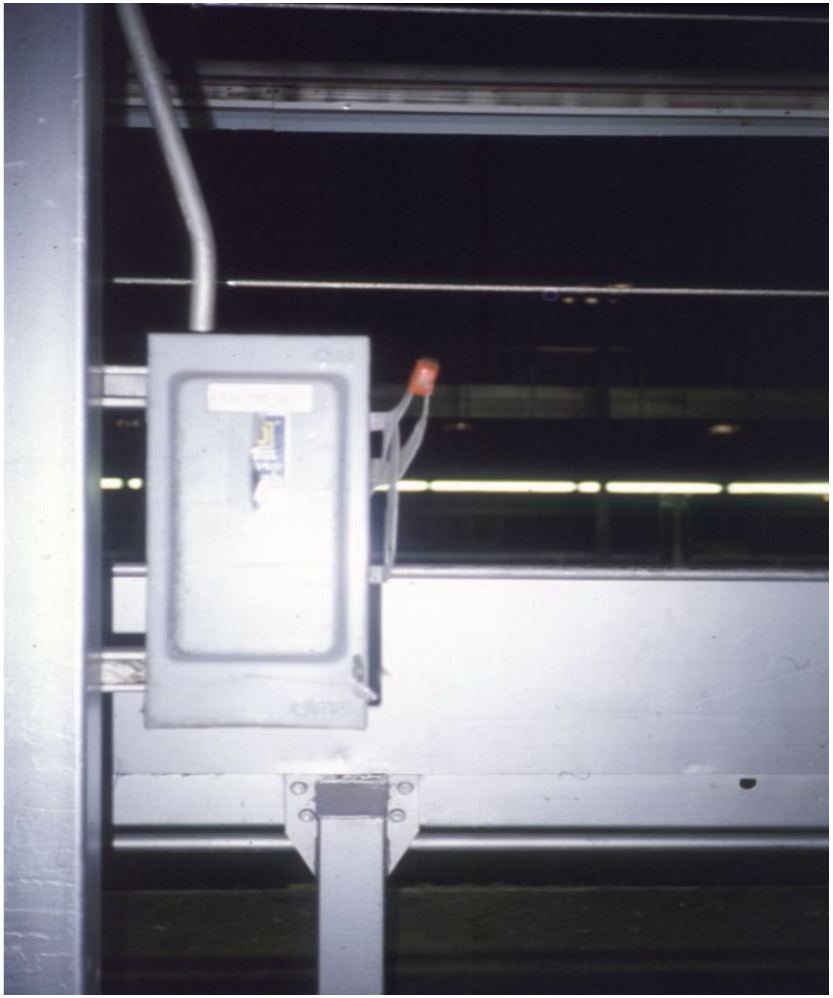
Wiring Design and Protection

- No grounded conductor can be attached to any terminal reversing its designated polarity.
- Path to ground must be continuous
- Cords - no missing ground pins
- Panels / Receptacles – All grounds must be attached and continuous



Wiring Design and Protection

- Must have a disconnect that allows all conductors to be disconnected from service entrance.



Wiring Methods

- Wiring for temporary power may be of a class less than required for permanent installation.

- Temporary wiring must be removed immediately upon completion of construction.

Wiring Methods

- Temporary lighting only allowed during construction.
- All lamps in temporary lights must be protected from contact or breakage (use bulb guards).
- Temporary lights not to be hung by wiring unless designed for this use.

Temporary lighting with no bulb guard


Lights should not
be hung by wiring

Wiring Methods

- All branch circuits to come from panel board and have breaker protection.
- Branch circuits cannot be run on floors.
- Covers required on all wall outlets.

Overcurrent Protection

600 Volts Nominal Or Less

- Conductors and equipment must be protected from overcurrent by:
  - Circuit breakers
  - Fuses
- Overcurrent devices must be readily accessible but not exposed to physical damage or in the vicinity of easily ignitable materials.

Wiring Methods

- Conductors entering boxes, cabinets, or fittings must be protected from abrasion.

- Unused openings must be effectively closed.


Fire Pro
Fire

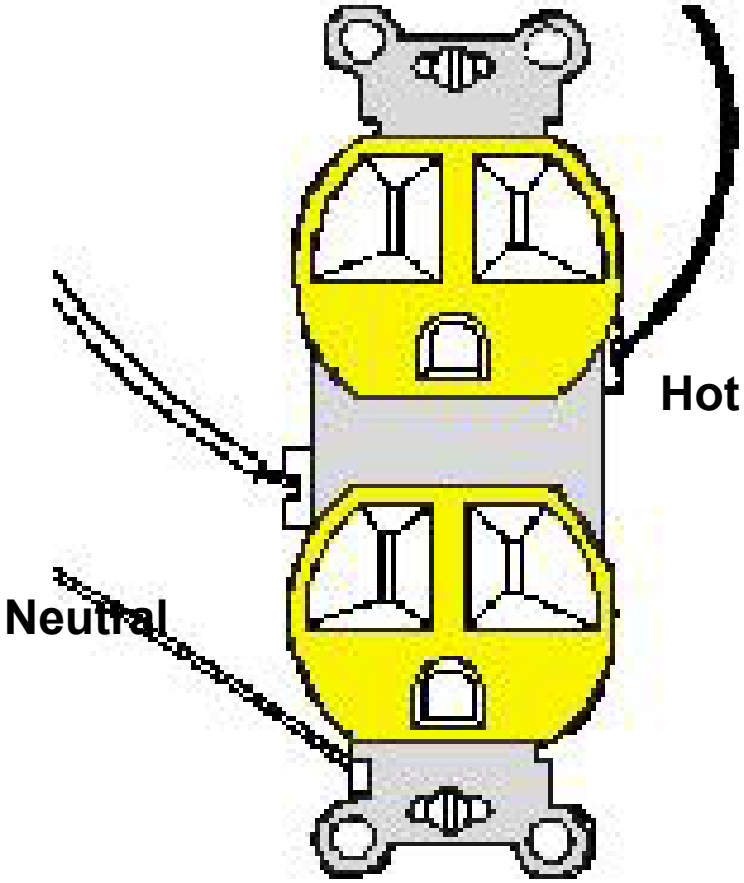

Unused openings must be closed

Wiring Methods

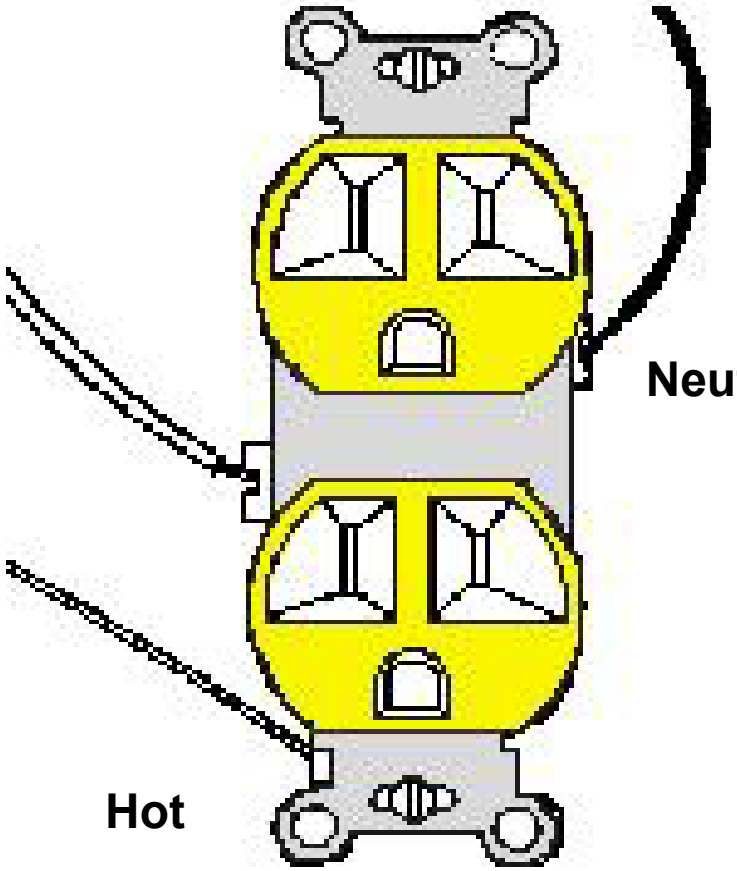
- Cabinets, boxes, switches, and circuit breakers in damp or wet locations must be protected from water.

- In wet locations, enclosures must be weatherproof.

Normal Wiring



Reverse Polarity



1910.304(a)(2)
NEC Article 200-11

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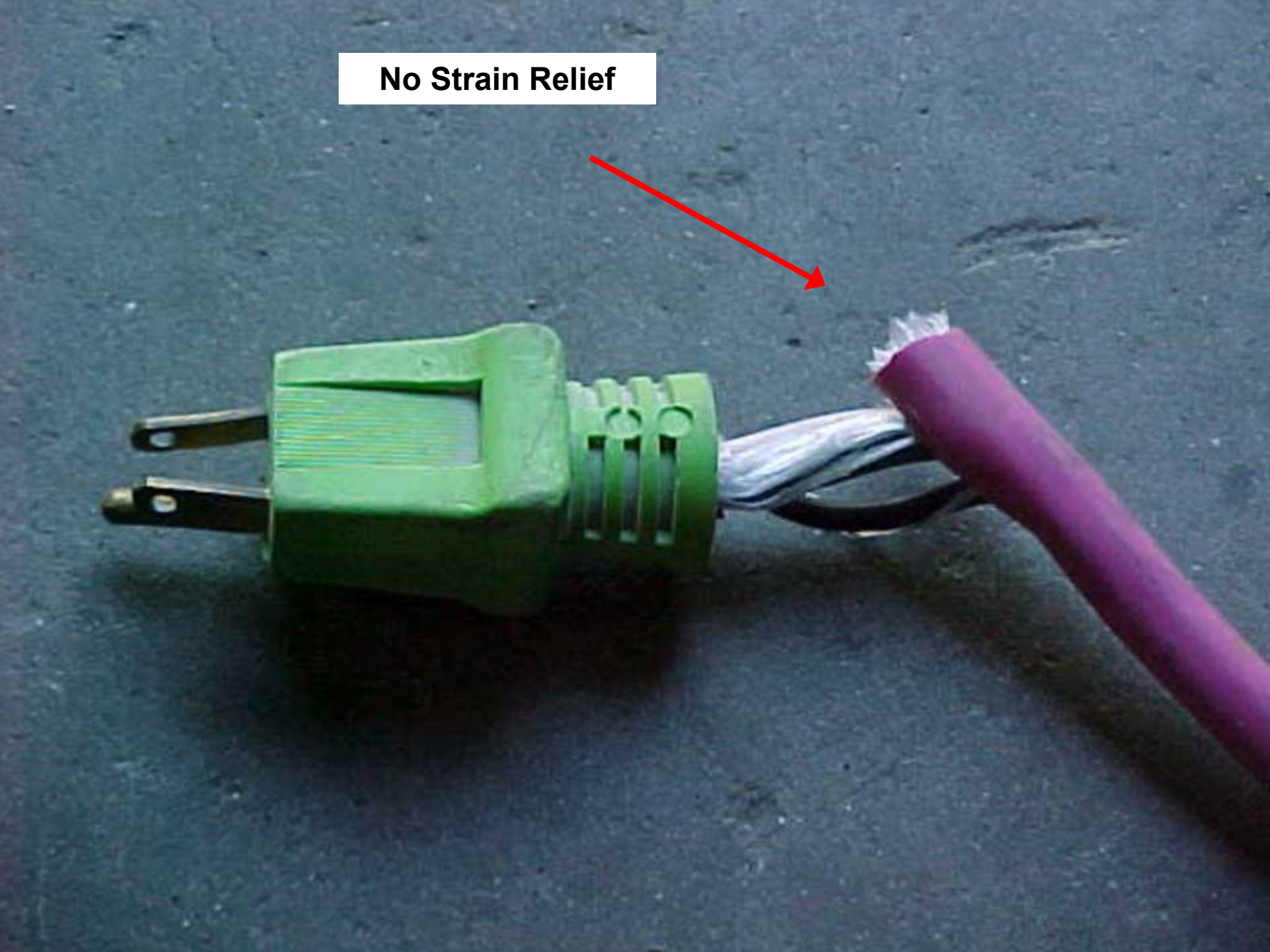
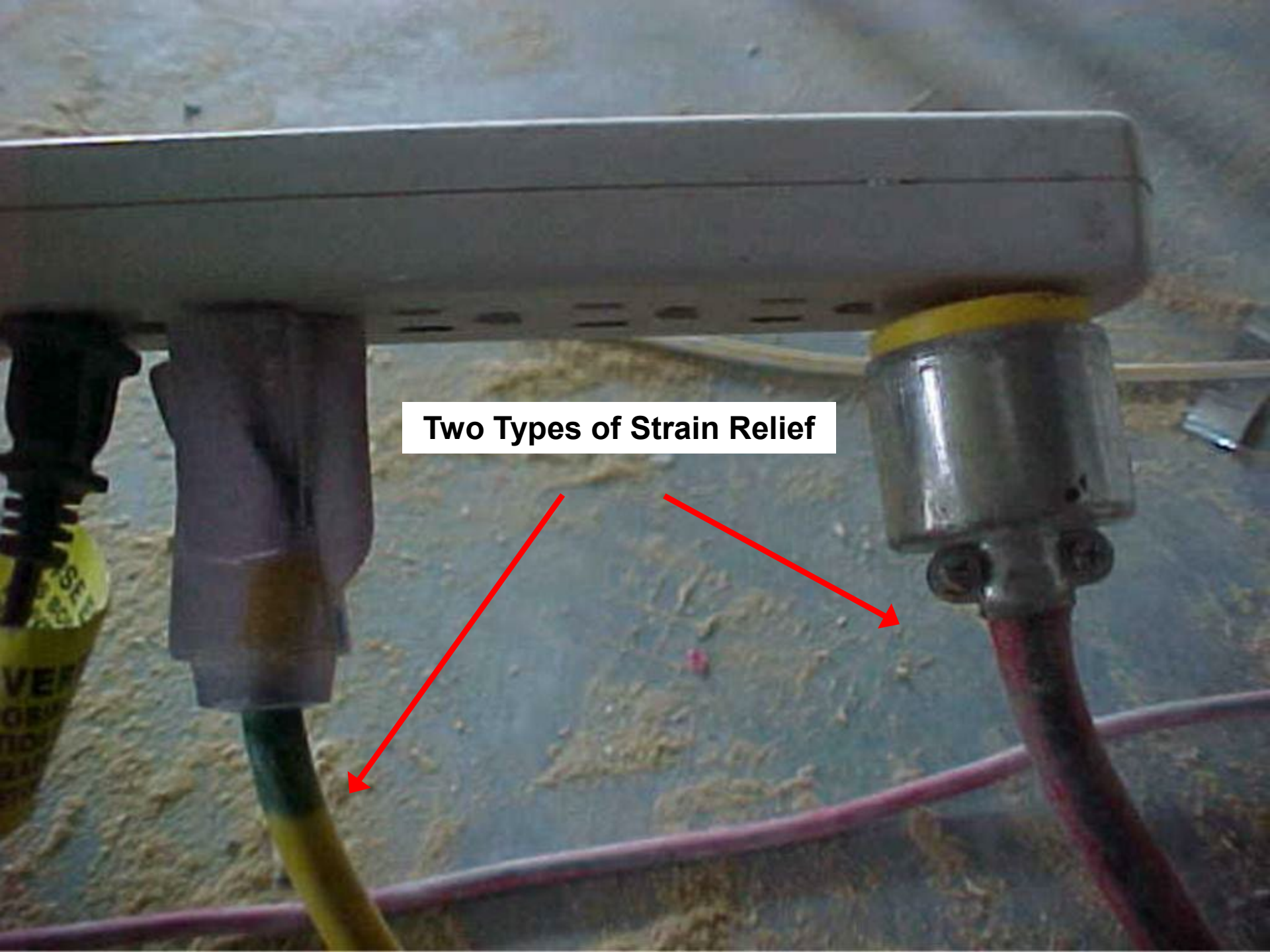
N.C. Department of Labor

Extension Cords

- All extension cords must be 3-wire type and hard or extra hard duty.
- Flexible cords and cables must be protected from damage.
- Cords may not run through pinch points.
- Extension cords may not be suspended by nails, staples, or wires.

Flat cords are NOT acceptable


No Strain Relief

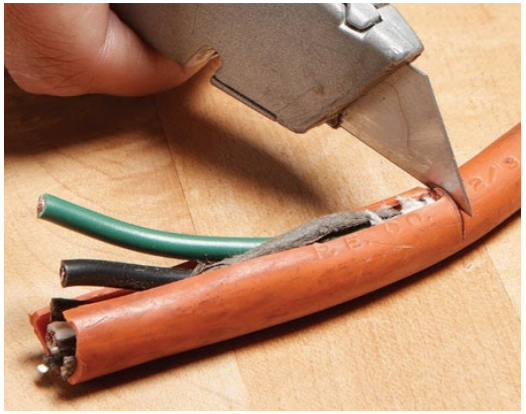

Two Types of Strain Relief

No strain relief


KEEP CLEAR
COMMANDER
SIZZOR
'87 3 3

Extension Cords - Repairs

- Repairs can only be made to 12 gauge or larger extension cords.
- Repairs (splices) must maintain outer sheath insulation properties (No electrical tape).
- Strain relief must be provided.



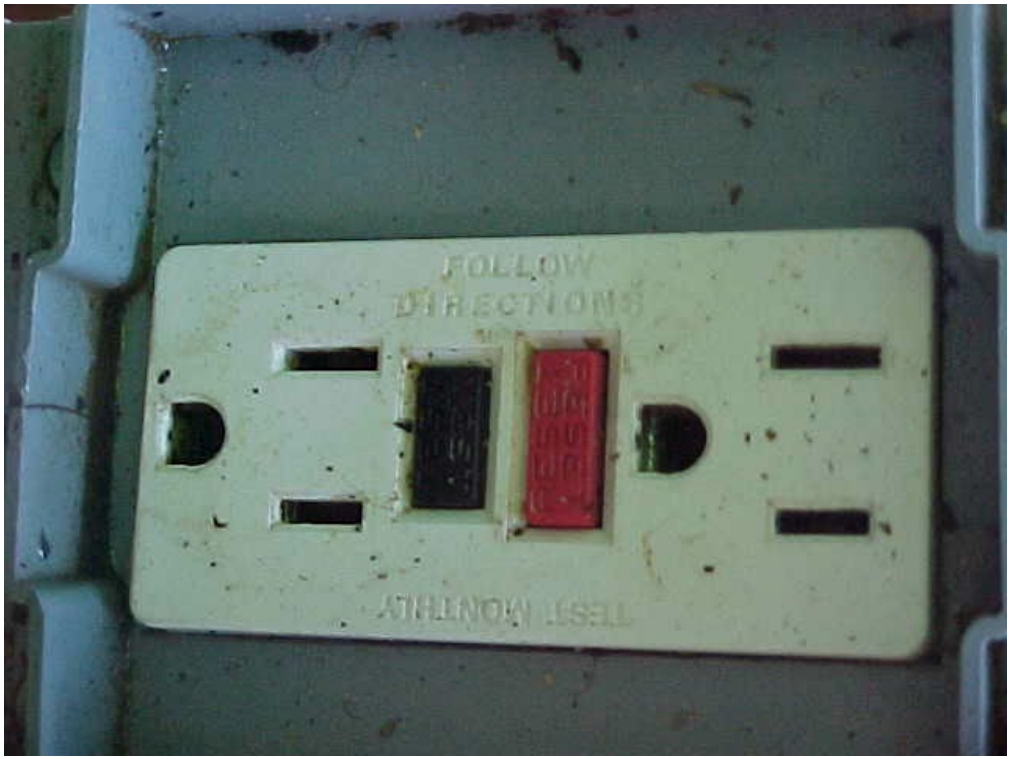

RIDGID
100ft
12 GAUGE
STRIPES

CSA (-40C) FT


Rated for 600 volts
Heat Shrinkable Tubing
1/4" x 4"
P/N: 73803
Qty 6

Equipment for General Use

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



Electrical

Hazardous Locations

Hazardous Locations

Electrical installations

- Equipment, wiring, and installations of equipment in hazardous (classified) locations must be intrinsically safe, approved for the location, or safe for the location.

Class I Locations

- Locations in which flammable gasses or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

Class I, Division 1

Location in which hazardous concentrations of flammable gases or vapors may exist:

- Under normal operating conditions
- Because of repair or maintenance operations or leakage
- Because of breakdown or faulty operation

Class I, Division 2

Location in which flammable gases or vapors are:

- Normally confined within closed containers or systems
- Normally kept below hazardous concentrations by ventilation
- Normally kept below hazardous concentrations by positive-pressure ventilation (adjacent to Division 1)

Class II Locations

- Locations which are hazardous because of the presence of combustible dust.

Class II, Division 1

Location where combustible dust may be present due to:

- Normal operations
- Mechanical failure or abnormal operation of machinery or equipment
- Presence of combustible dust of an electrically conductive nature

Class II, Division 2

Location where:

- Combustible dust will not normally be in suspension in ignitable quantities
- Dusts may be in suspension as a result of an infrequent malfunction of handling or processing equipment.

Class III Locations

- Locations that are hazardous because of the presence of easily ignitable fibers but in which such fibers are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures.

Class III, Division 1

- Locations in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured or used.

Electrical

The Control of Hazardous Energy Lockout Tagout

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Lockout/Tagout

- Controls on equipment being serviced/repaired must be tagged out of service & clearly identified.

- Circuits or equipment that are deenergized must be locked & tagged to prevent unauthorized re-energizing at any point.

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For Public Official's Use Only


DANGER
EQUIPMENT
LOCKED OUT BY
DANGER
LOCKED
OUT
DO NOT OPERATE
This lock / tag may
only be removed by:
Name:
Dept.:
Expected Completion:
DANGER
THIS TAG & LOCK
TO BE REMOVED
ONLY BY PERSON
SHOWN ON THE
OTHER SIDE

Single Lock

Multi Lock Hasp

Electrical

Overhead Power Lines & Underground Hazards

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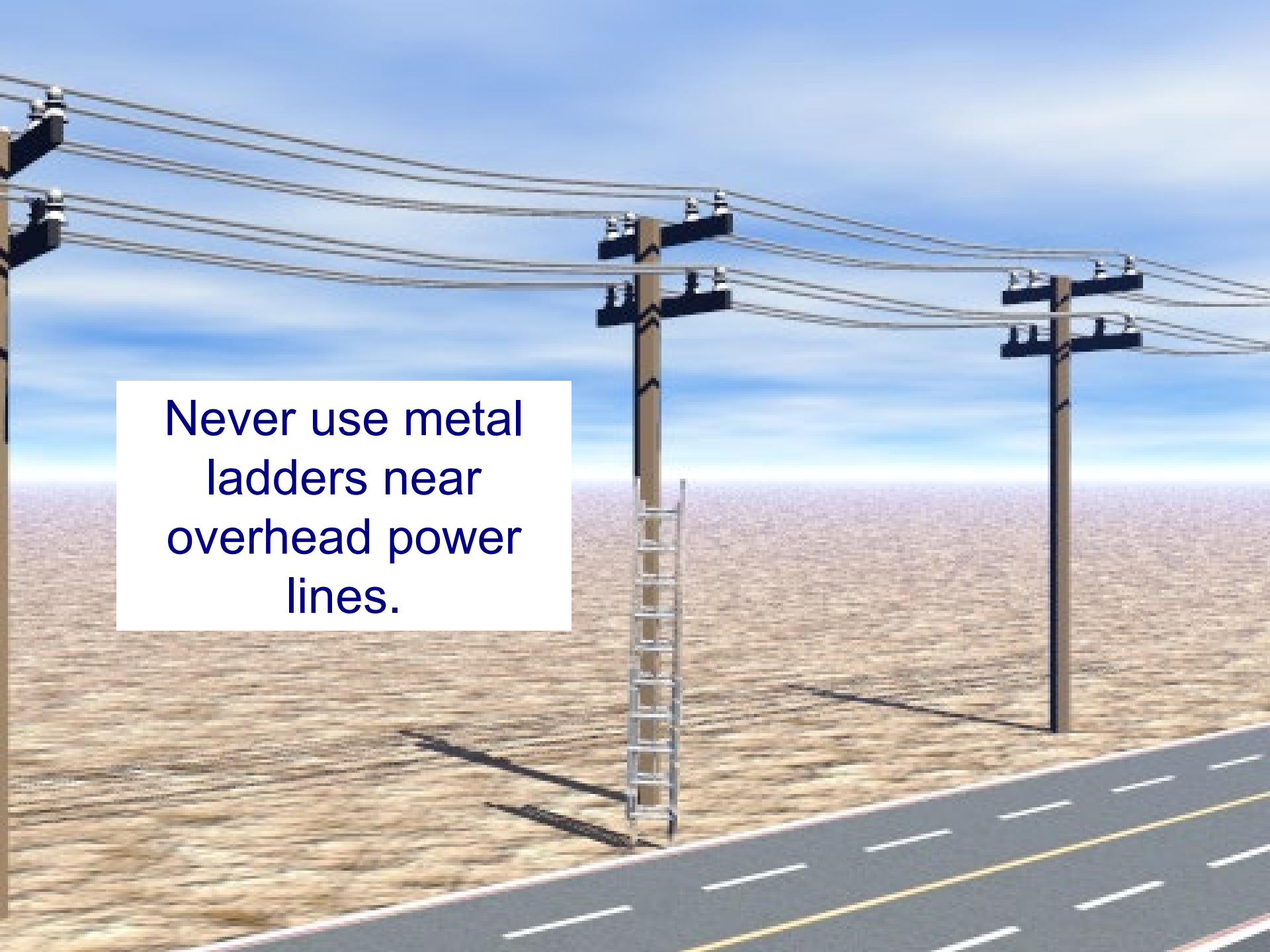
Overhead Power Lines

- Lines to be de-energized and grounded by power provider if possible.
- Lines may be guarded or insulated.
- 10 ft. minimum distance must be maintained (50KV).

Overhead Power Lines

- Insulated PPE must be used.
- De-energized lines shall be locked/tagged out.


Never use metal ladders near overhead power lines.

Digging Near Buried Power Lines

- Always call for utility locates prior to digging near any buried power lines.
- All lines must be located, marked, & de-energized if possible prior to digging.
- If obvious signs of utilities (power boxes, poles etc.) exist but are not marked, call for the locator to re-mark before working.

Electrical

Training

Training Requirements

- Employees must be trained:
  - To understand the specific hazards associated with electrical energy
  - In safety-related work practices and procedural requirements
  - To identify and understand the relationship between hazards and injury

Training Requirements

- Emergency Procedures

  Those working near exposed energized conductors or parts must be:

  - Trained in methods of release of victims from contact
  - Instructed in methods of first aid and emergency procedures such as resuscitation if warranted

Training Requirements

Qualified Persons permitted in Limited Approach Boundary must, at a minimum, be additionally trained:

- To distinguish exposed energized parts from other parts
- To distinguish the voltage of live parts
- To use the approach distances specified in Table 130.2(C)
- In the decision-making process to:
  - Determine the degree and extent of the hazard and…
  - Use personal protective equipment and job planning necessary to perform the job safely

Training Requirements

- Unqualified Persons shall be trained in and familiar with…
  - Any of the electrical safety-related practices that might not be addressed specifically by Chapter 1, but are necessary for their safety

Electrical

Review of Letters of Interpretation in Handouts

What's the Impact?

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Electrical

Examples of Citable Hazards and Solutions

How Would This Citation be Classified?

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Electrical

Back to Search **Photo ID:** 1426
(Click photo to view original size.)

Category:

Electrical

Hazard:

electrocution

Related Standard:

1926.403(b)(1)

Corrective Action:

Replace cord with approved fully insulated cord.

Description:

Electrical euipment, the cord, was not free from a recognized hazard, the flexible cord's outer insulation was damaged exposing the inner cords.

Inspection #:306748245

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N.C. Department of Labor

How Would This Citation be Classified?

NCDOL
N.C. Department of Labor

Electrical

Back to Search **Photo ID:** 1814
(Click photo to view original size.)

Category:

Electrical

Hazard:

Employees installing corrugated metal wall panels on an engineered building with a DeWalt 257 sn 64295 electric drill were exposed to electric shock hazards.

Related Standard:

1926.403(b)(2) 1926.403(e)

Corrective Action:

Electirc drill removed from service

Description:

Electric drill flexible cord was spliced to a non-flexible conductor with damaged insulation

Inspection #:309139996

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N.C. Department of Labor

How Would This Citation be Classified?

NCDOL
N.C. Department of Labor

Electrical

Back to Search **Photo ID:** 2134
(Click photo to view original size.)

Category:

Electrical

Hazard:

Exposure to live electrical parts

Related Standard:

1926.404(b)(1)(ii) - No GFCI; 1926.404(f)(1)(iv)(A)- System not grounded; 1926.405(b)(1)-Openings where conductors entered were not closed;1926.405(b)(2)-Boxes not provided with covers; 1926.405(d) - Panelboards were not dead front.

Corrective Action:

Employer took Temporay power pole out of service until electrical contractor could correct hazards.

Description:

Temporary power pole at a construction worksite used by HVAC contractor.

Inspection #:311031355

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How Would This Citation be Classified?

NCDOL
N.C. Department of Labor

Electrical

Back to Search **Photo ID:** 3079
(Click photo to view original size.)

Category:

Electrical

Hazard:

Electrical panel was being back fed from a temporary receptacle outlet to provide lighting. This created exposed live energized parts that employees could contact.

Related Standard:

1926. 403(b)(1)(i)

Corrective Action:

Wires from recepatacle were disconnected from the electrical panel

Description:

The photo shows wires coming from the breaker panel with a male plug attached, plugged into an extension cord.

Inspection #:310992326

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How Would This Citation be Classified?

Electrical

Back to Search **Photo ID:** 3055
(Click photo to view original size.)

Category:

Electrical

Hazard:

electrical shock/burns.

Related Standard:

1926.403(b)(2) 1926.404(b)(1)(ii) 1926.405(b)(2) 1926.405(j)(2)(ii)

Corrective Action:

--Install receptacle box with faceplate, designed for outdoor use. --Remove Romex cable (rigid cable underrated, not supported, not for outdoor use). --Connect each duplex outlex separately to each 240 live wire. --Connect independent ground. --Install GFCIs.

Description:

Four 120 V outlets fed from a 250 V outlet via NEMA 10-50 R 125/250 V receptacle and NEMA 10-50 P 125/250 V plug - NEMA plug and receptacle (50 A) underrated when feeding four receptacle outlets of 15 A each) - Romex cable not designed for outdoor use and/or temporary use - The 3-wired 250 V line has ground to neutral - duplex receptacle box not grounded - duplex receptacle box not protected by GFCIs - receptacle box does not have a cover - receptacle box not designed for outdoor use - joint ground and neutral may prevent a GFCI from functioning properly - CSHO should be cautious before plugging a ground/polarity tester.

Inspection #:310990544

Electrical

Citing Electrical Hazards Case Study

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N.C. Department of Labor

Electrical

- **Team Assignments**

- **Case Study Exercise:**
  - Each Team Will Review Each Photographic or Video Case Study and…
  - Identify the Hazard, if a Hazard
  - List the Citation for the Identified Hazard

Electrical

- Case Study Exercise:
  - Once all hazards are listed and citations identified…
  - As a Team, author a Citation Letter to issue to the company
  - Each Team will present their results to the class

Electrical

Case Study Information:

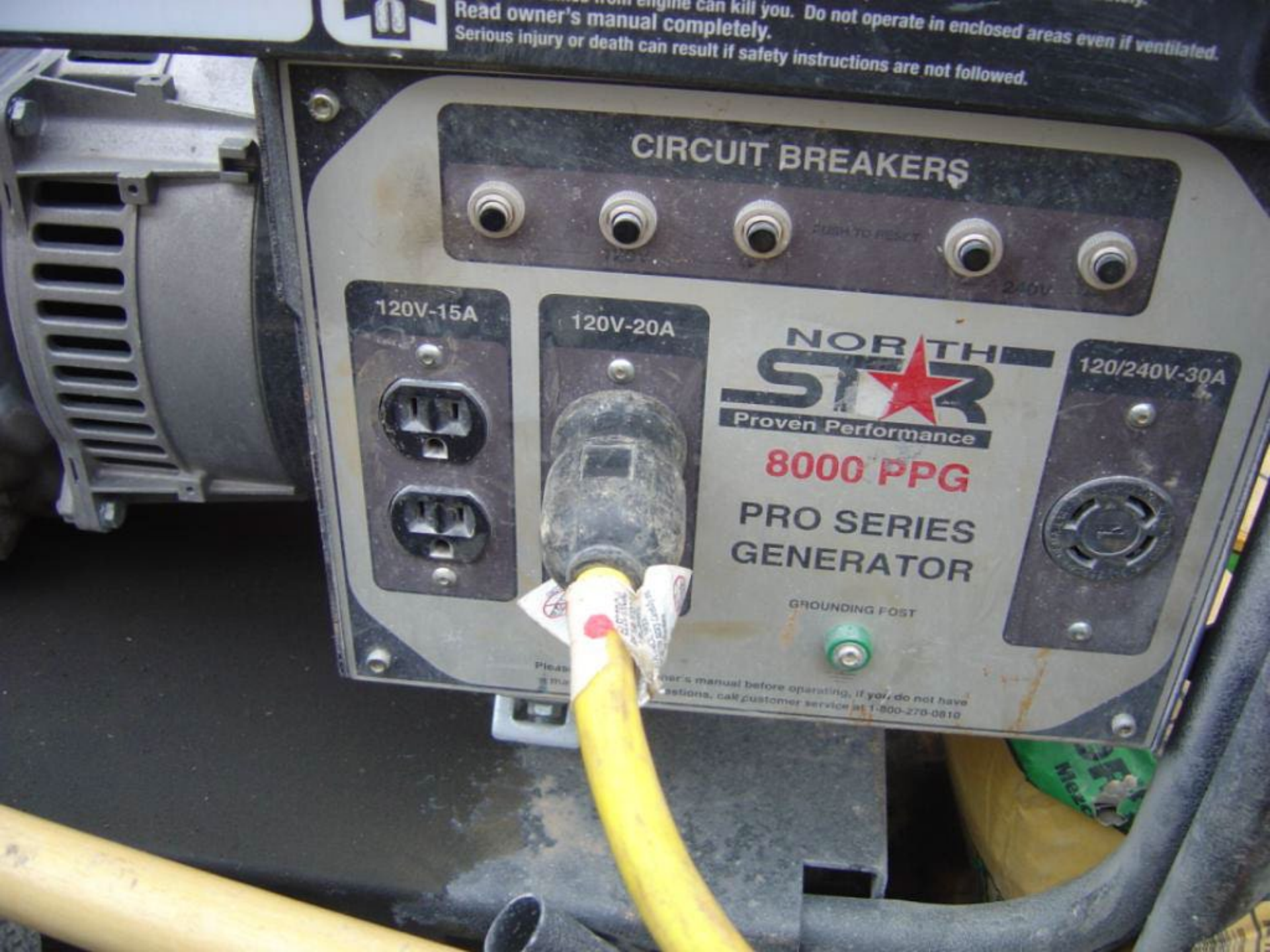
Project:	NC Power Plant JBR Project
GC:	Johnson Construction 459 Smith Road Raleigh, NC 27609
Electrical Sub:	Watts Electrical 232 Raleigh Durham Pkwy Raleigh, NC 27609

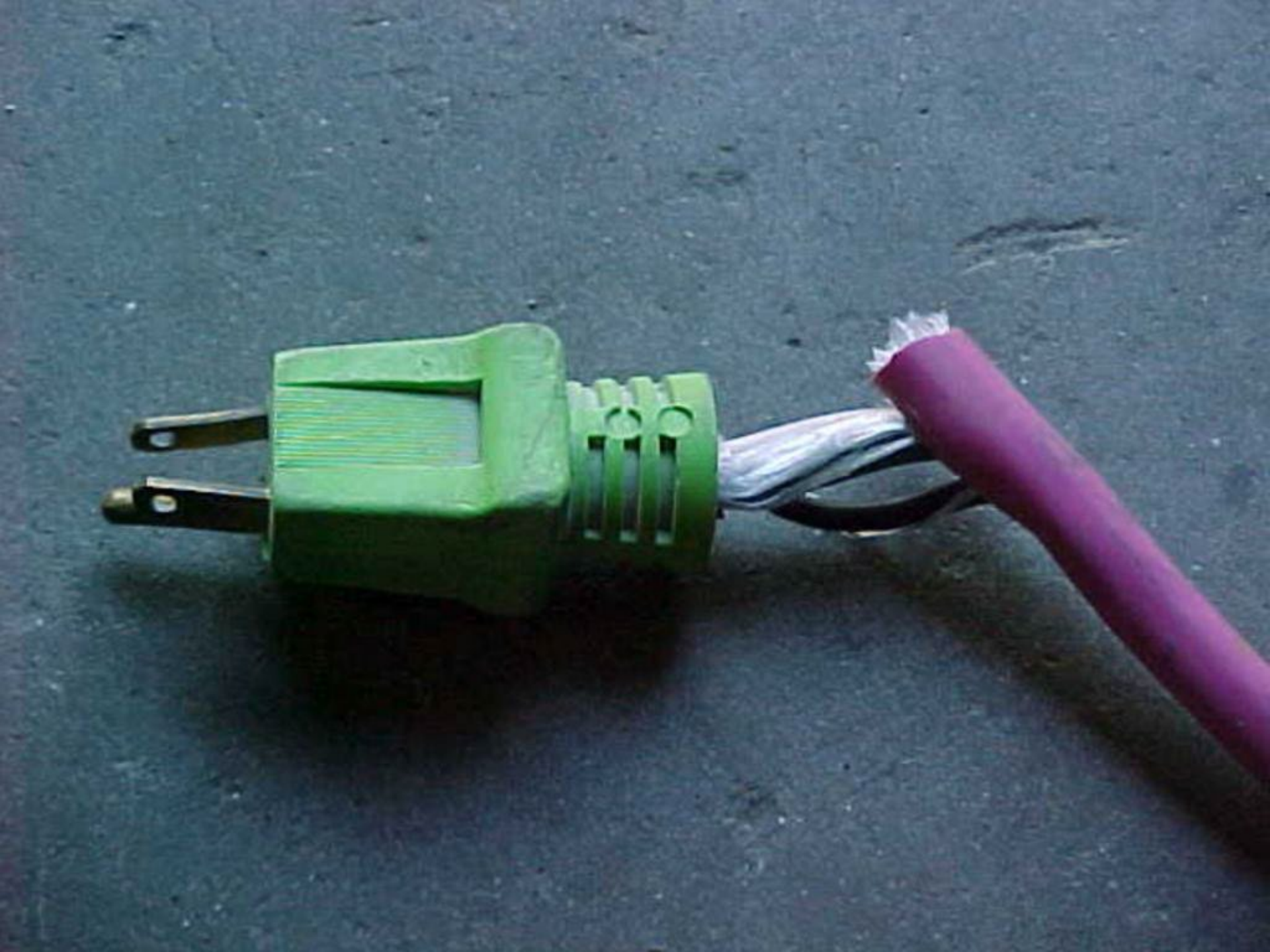
Electrical

Inspection Photographs & Videos

Note: Not all Photographs & Videos Depict a Citable Hazard

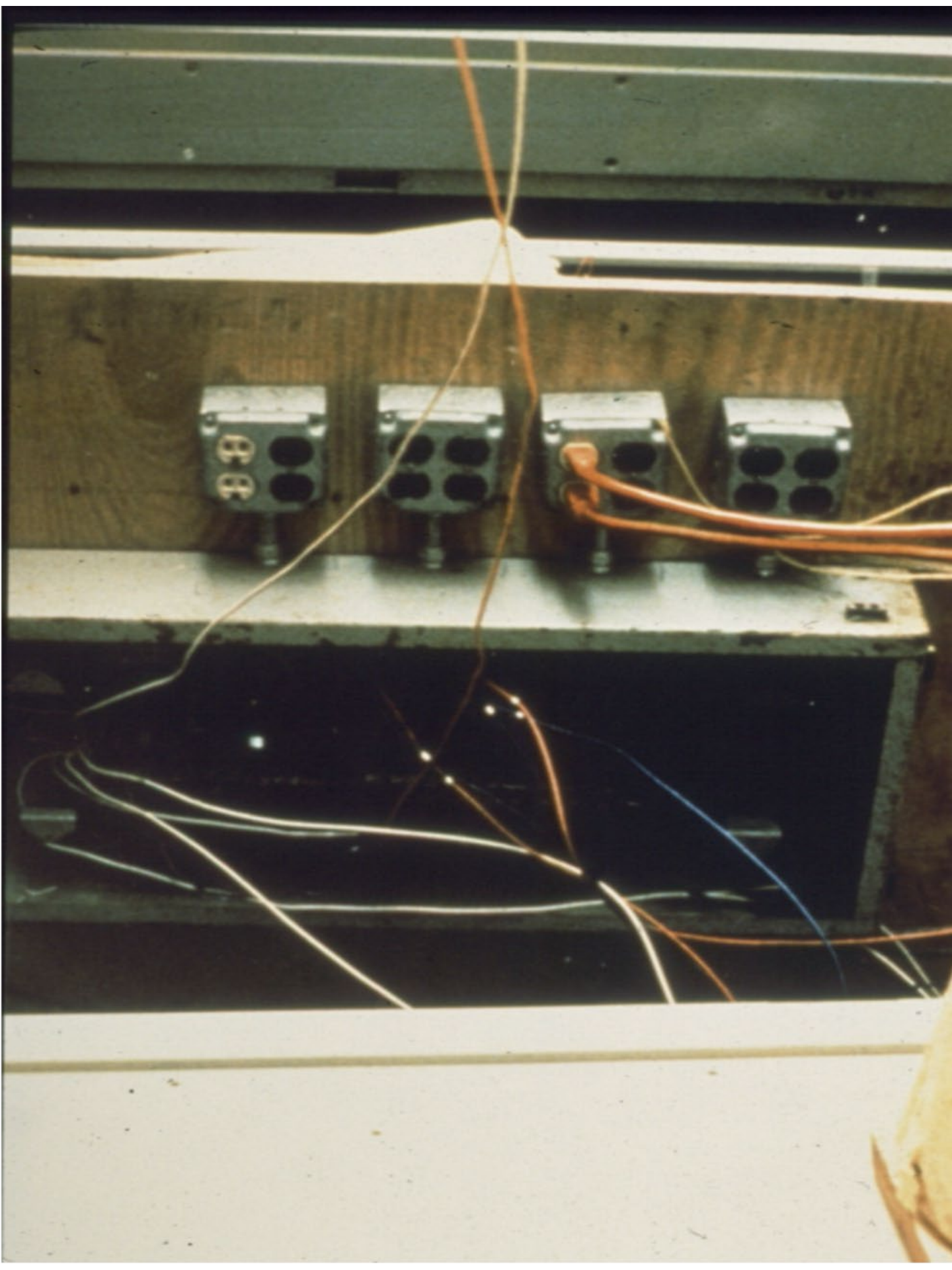

PORTABLE GFCI

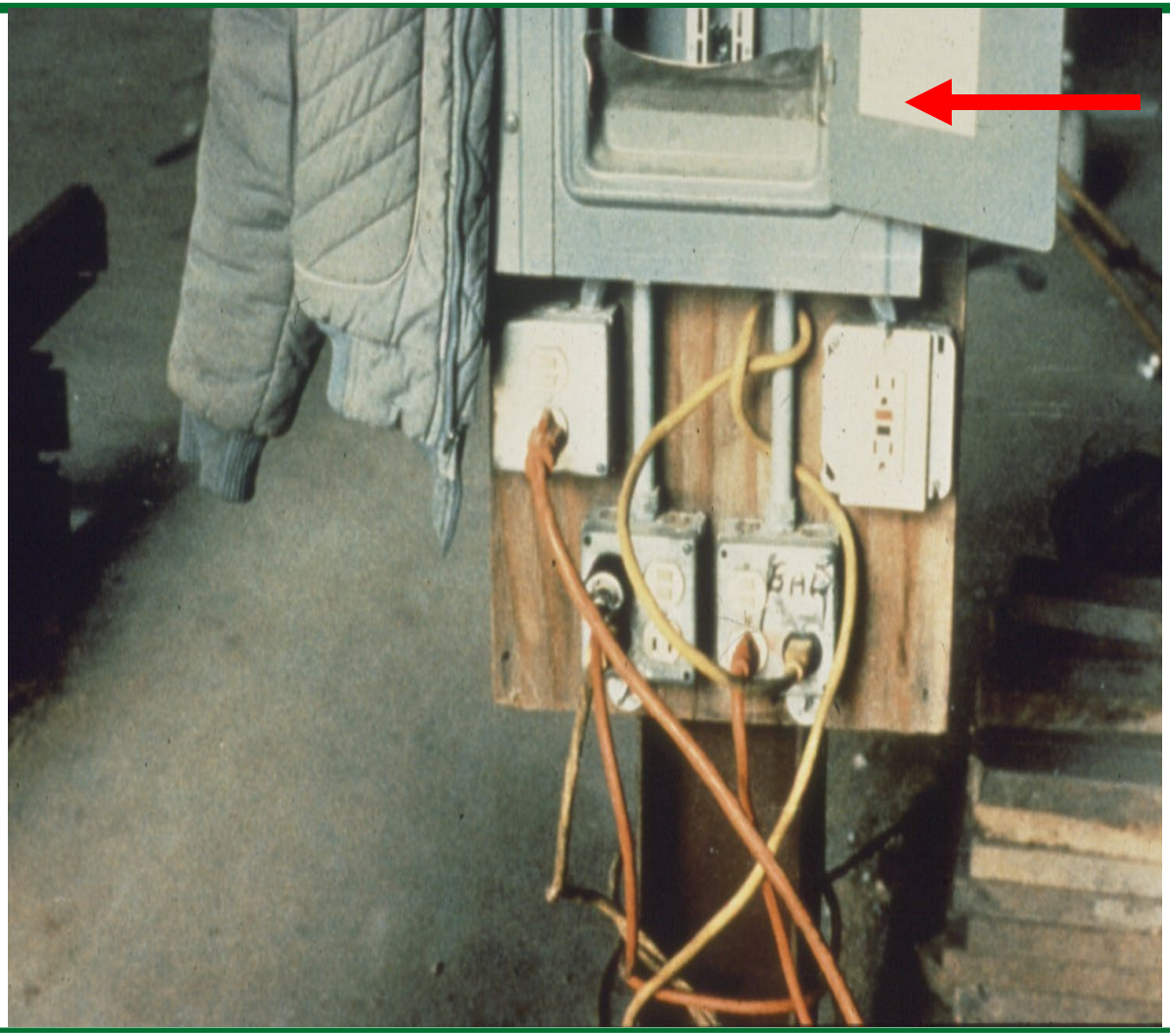

Read owner's manual completely.
Serious injury or death can result if safety instructions are not followed.
CIRCUIT BREAKERS
120V-15A
120V-20A
NORTH STAR
Proven Performance
8000 PPG
PRO SERIES GENERATOR
120/240V-30A
GROUNDING POST

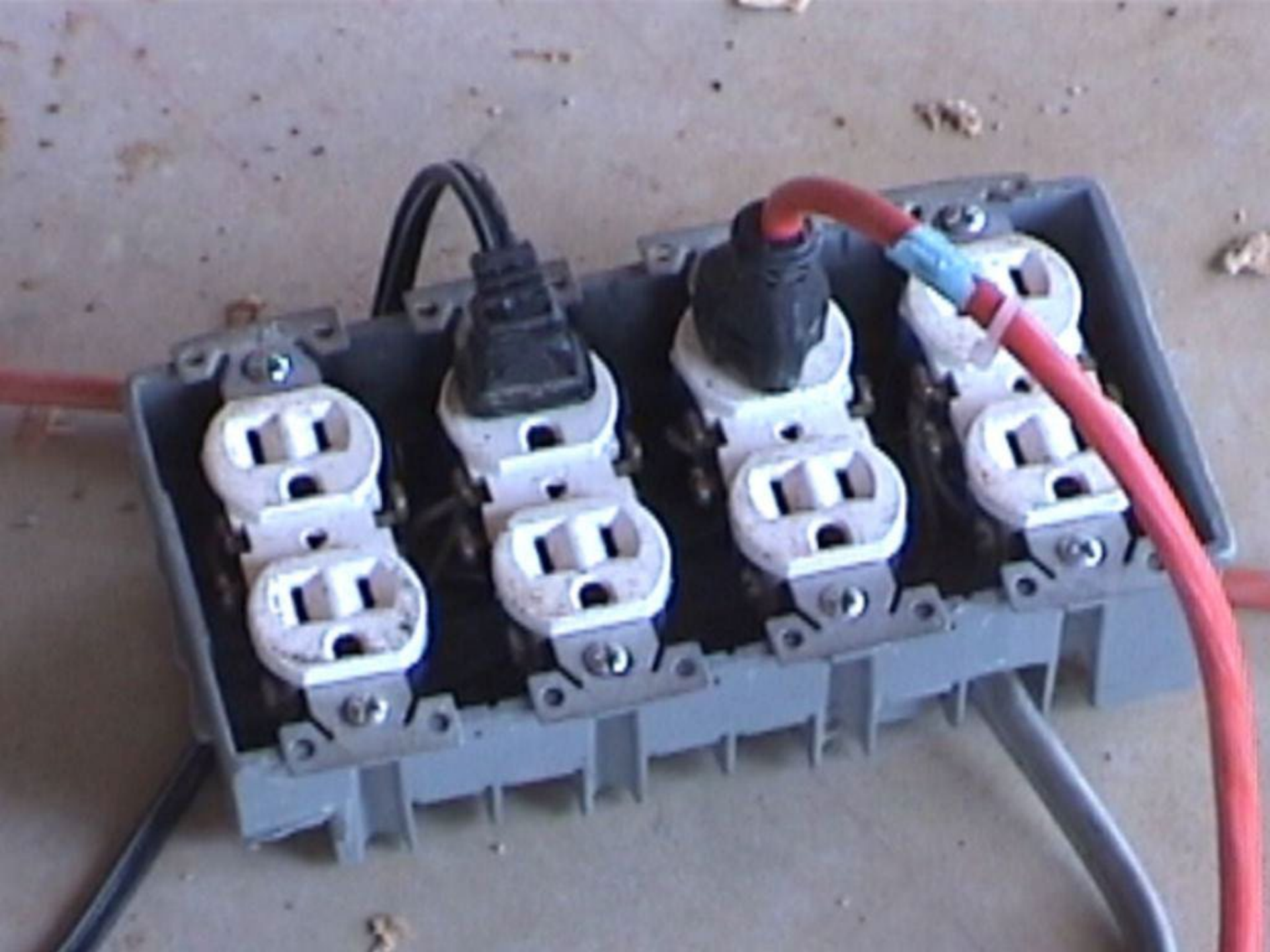


NCDOL
N.C. Department of Labor

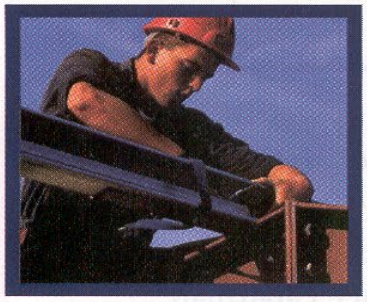
For Public Official's Use Only

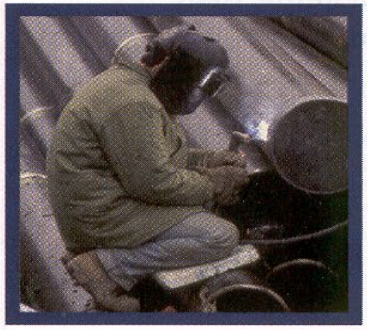


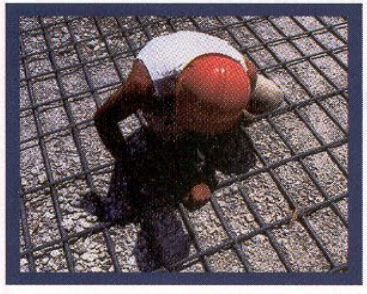





Fire Pro
Fire







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ANGER


LOCK - OU
ACCUPRIL


MCC 251 – B2
1000 GAL. S.P.
SURGE TANK AGIT.
50-0810
1000 GAL SP
DANGER
DEPARTMENT
TAG
DO NOT
OPERATE
OPERATIONS ONLY
SEE OTHER SIDE
Master
MCC 251 – B3
50-0803
NO. 3 LD PINE
CHEST AGIT.
MCC 251 – A2


DANGER


123456
Miller
XMT 350 MPa
Miller
LEASCO
EQUIPMENT SERVICES, INC.
Miller
XMT 350 MPa
Miller
XMT 350 MPa
Miller
XMT 350 MPa


480 VOLTS
480V
PB1


KEEP CLEAR
COMMANDER
SIZZOR
'87 3 3


BOSCH


UP ON
I-T-E
HEAVY DUTY
RAINPROOF
Vacu-Break
SAFETY SWITCH
Clampatic
CONTACTS
CAT. NO. NFR352
AMPS. 60
VOLTS A.C. 600
3 PHASE H.P. 240 V 480 V 15 30
SEE ADDITIONAL RATING INFORMATION INSIDE
DOWN OFF
UP ON
I-T-E
HEAVY DUTY
RAINPROOF
Vacu-Break
SAFETY SWITCH
Clampatic
CONTACTS
CAT. NO. NFR352
AMPS. 60
VOLTS A.C. 600
3 PHASE H.P. 240 V 480 V 15 30
SEE ADDITIONAL RATING INFORMATION INSIDE
DOWN OFF


W-155
TANK CO.
PRODUCTS
LINCOLN
ELECTRIC
DC-600
VOLTS
DC
AMPERES
DC


BOSCH

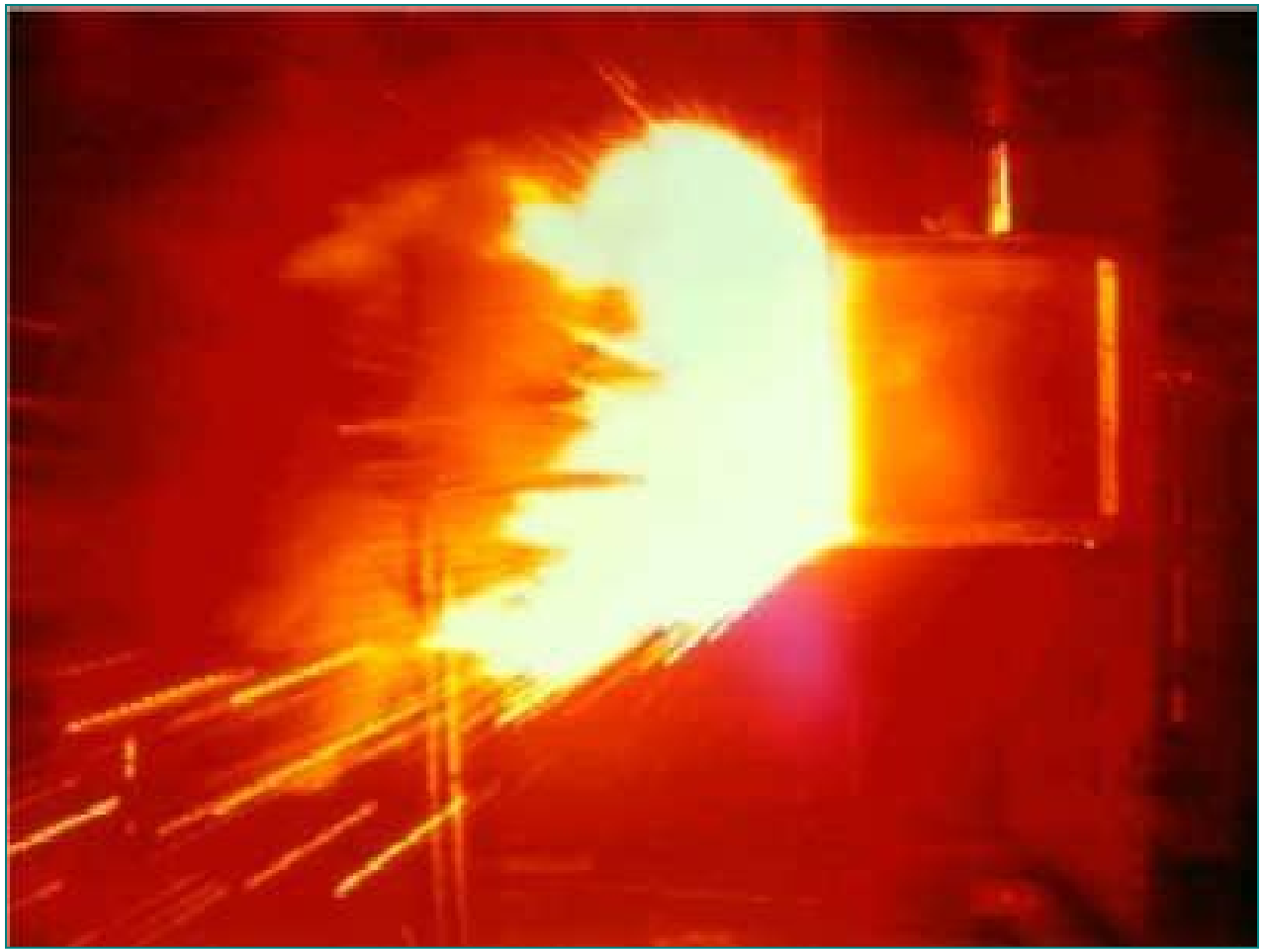

HATTANOOGA
BOILER & TANK CO.
FABRICATED PRODUCTS
#3
LINCOLN ELECTRIC
IDEALARC DC-600
CONSTANT VOLTAGE/CONSTANT CURRENT DC ARC WELDER
#4


PEED
MIT
MPH
DANGER
OVERHEAD POWER LINES
7.2 KV

Electrical

- Case Study Exercise:
  - List the Citations and Hazards
  - As a Team, author a Citation Letter to issue to the company
  - Each Team will present their results to the class

Why Electrical Safety & Arc Flash Protection



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Arc Flash Injuries

- Electric shock
- Severe burns
- Blindness
- Blast injuries
  - Shrapnel wounds
  - Lung blast injuries
  - Ruptured eardrums
  - Pressure wave injuries

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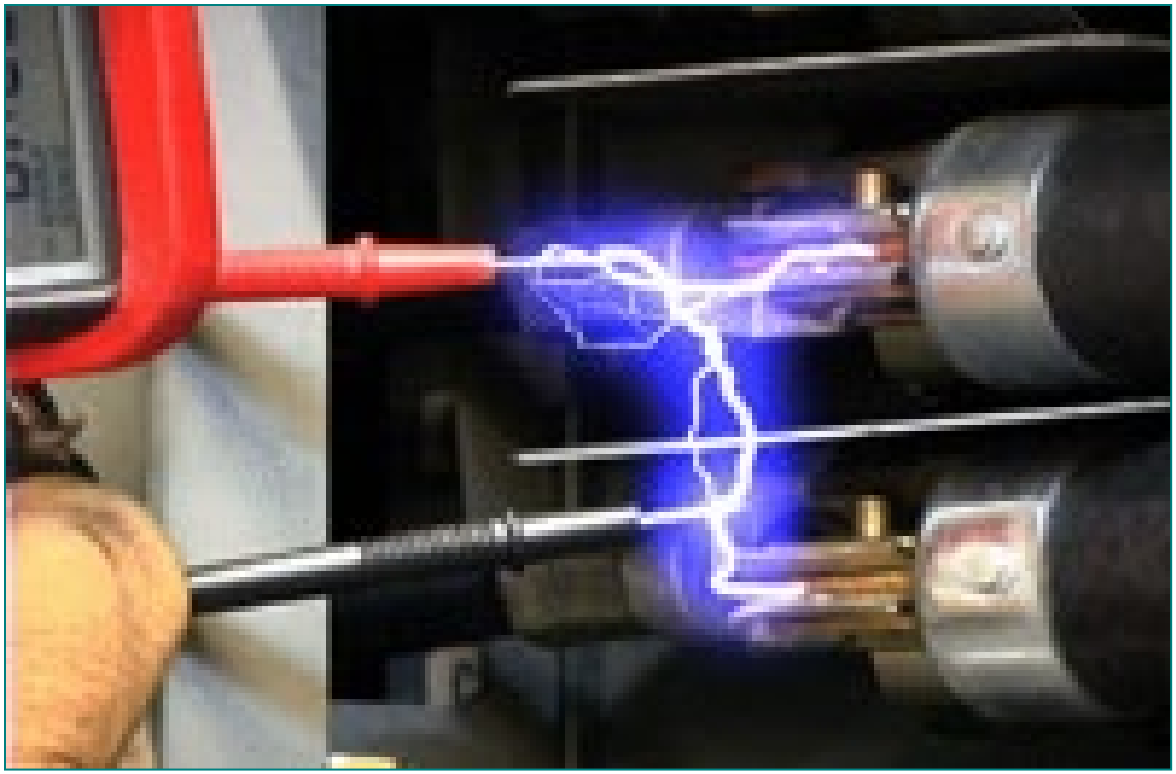
What is an Electric Arc?

An electric arc is a short circuit through the air.



Severity Factors

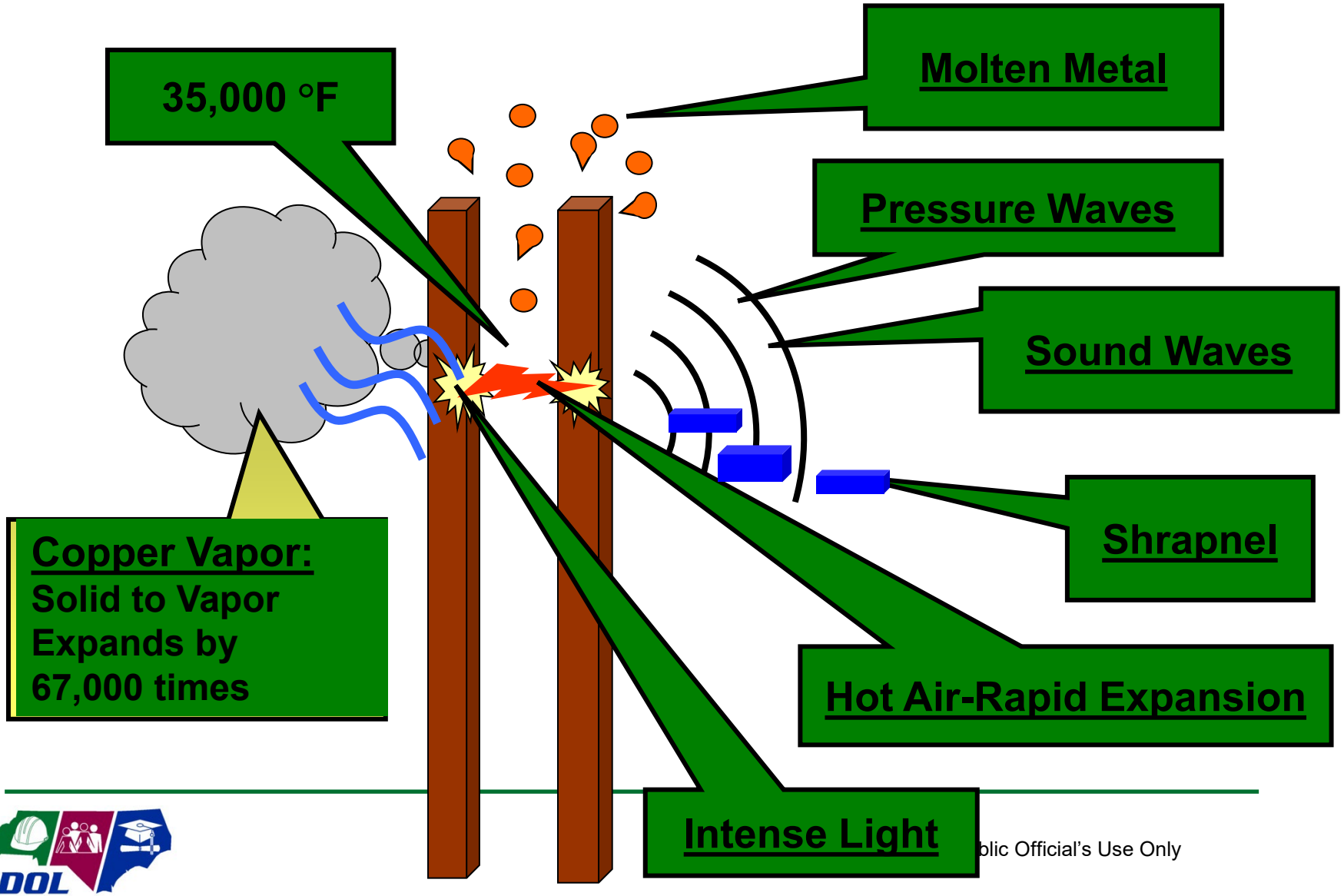
Power – amount of energy at the arc

Distance – of the worker to the arc

Time – duration of the arc exposure

Arc Flash

Electrical Arc



Electric Shock Injury – Burn

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Electric Shock Injury – Burn

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Severe Burns from Arc Flash

Arc flash	up to 35,000°F
Sun	9,900°F

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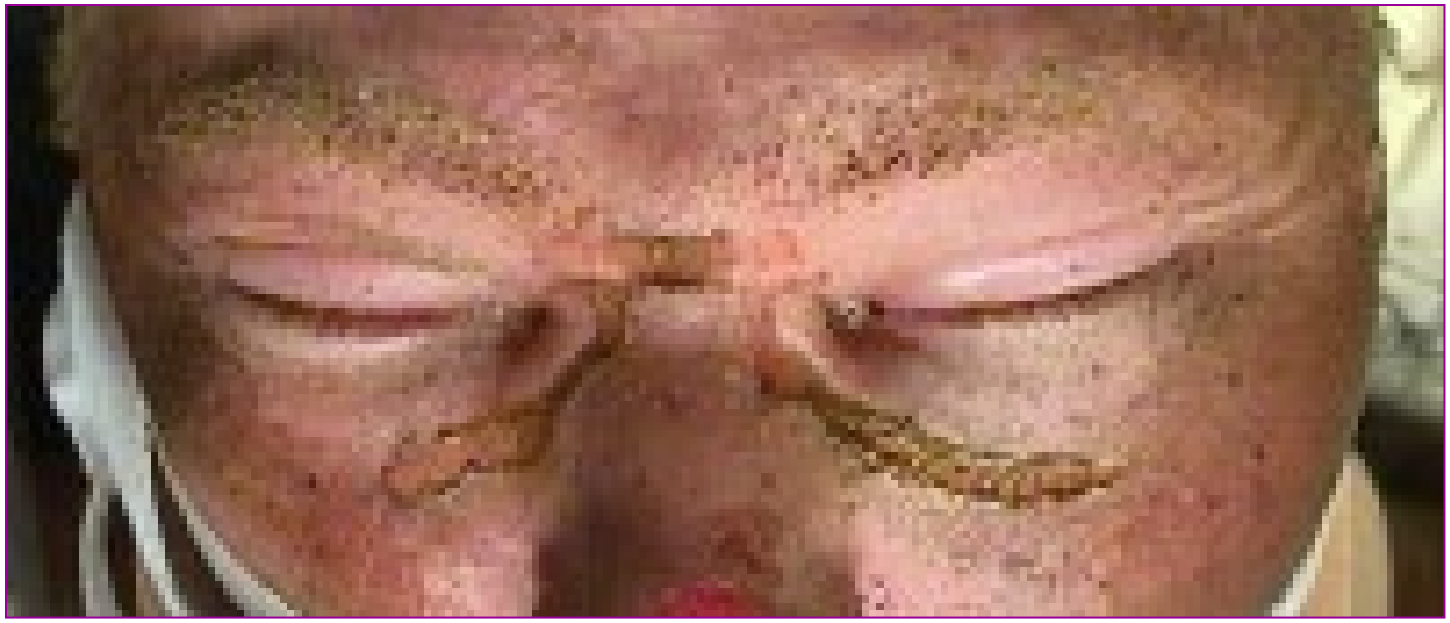
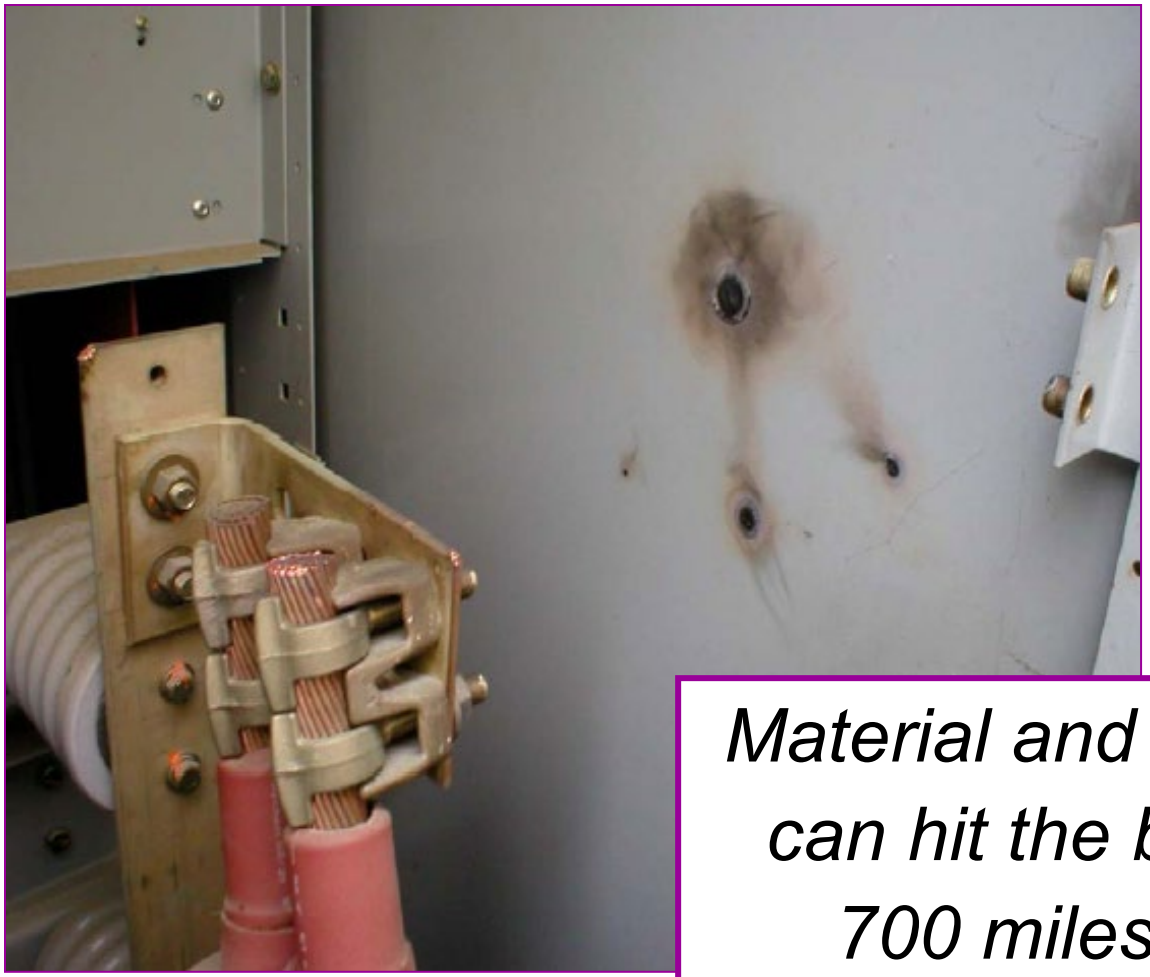
Blindness

- Flash of light is so intense it can damage vision.



Shrapnel Wounds



Material and molten metal can hit the body at over 700 miles per hour.

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Blast Lung Injury (BLI)

- Arc blast can cause inhalation injuries.
  For example:
  - Inhaling high temperature copper vapor
  - More than 100 toxic substances can be found in the fumes.

BLI + Burns = Greater chance of death

Hearing Damage

Arc blast at 2 feet	145 decibels
Jet engine at 200 feet	132 decibels
Pain threshold	130 decibels

Pressure Wave Injuries

- Arc blast can throw a worker:
  - Off a ladder
  - Into nearby walls or equipment
- 2000 lbs/ft^2 pressure on the body can cause:
  - Concussion
  - Collapsed lungs
  - Other internal injuries

What Does Electrical Safety Look Like?

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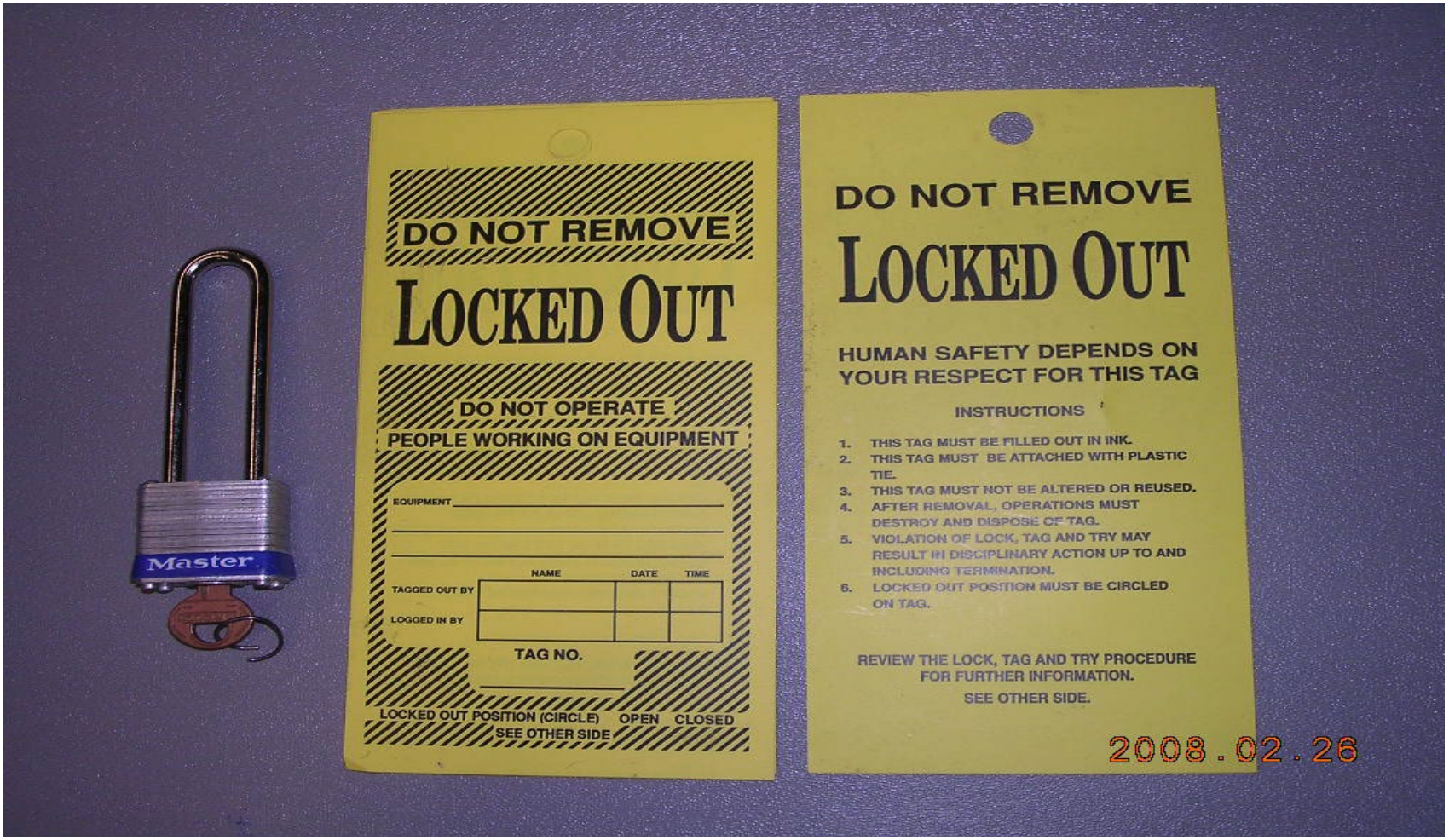
Lockout Tagout



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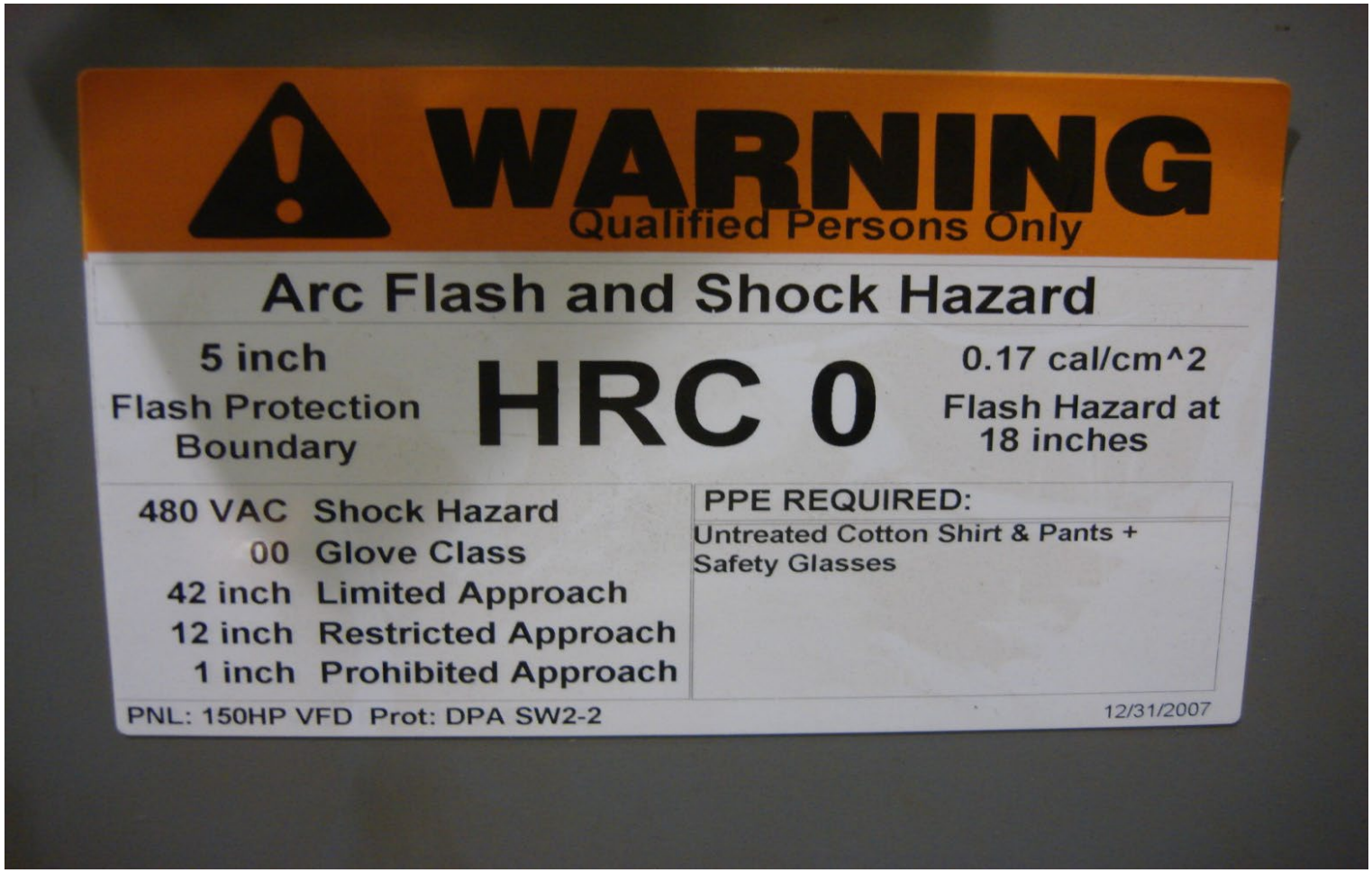
Gloves


MAX. USE VOLTAGE
500V AC, RMS
KUNZ-CHICAGO
9
WEAR OVER SIZE
PROTECTOR
CLASS "00"
10 "O.A.L.
910
2008.02.26

Label Electrical Systems



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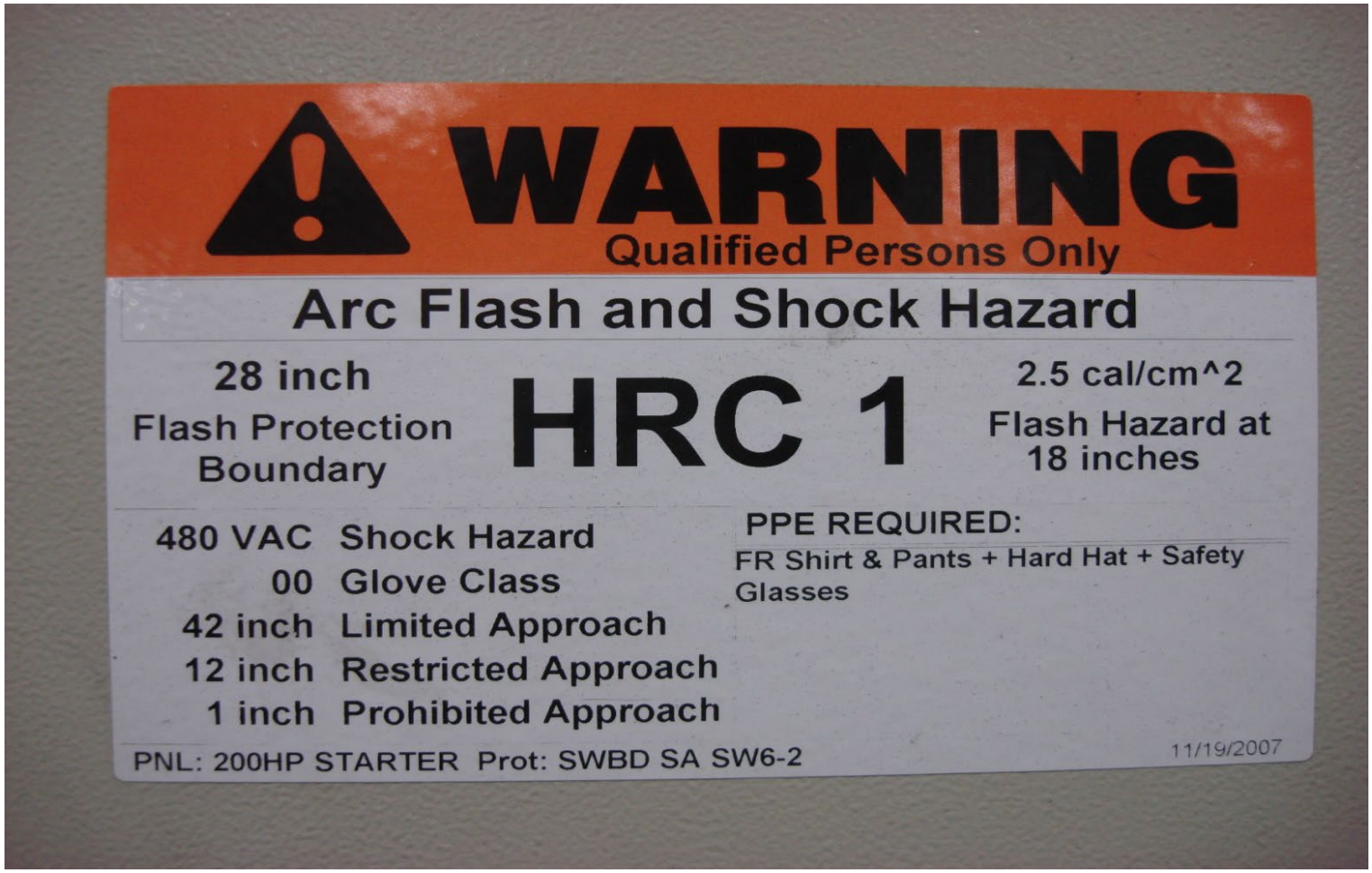
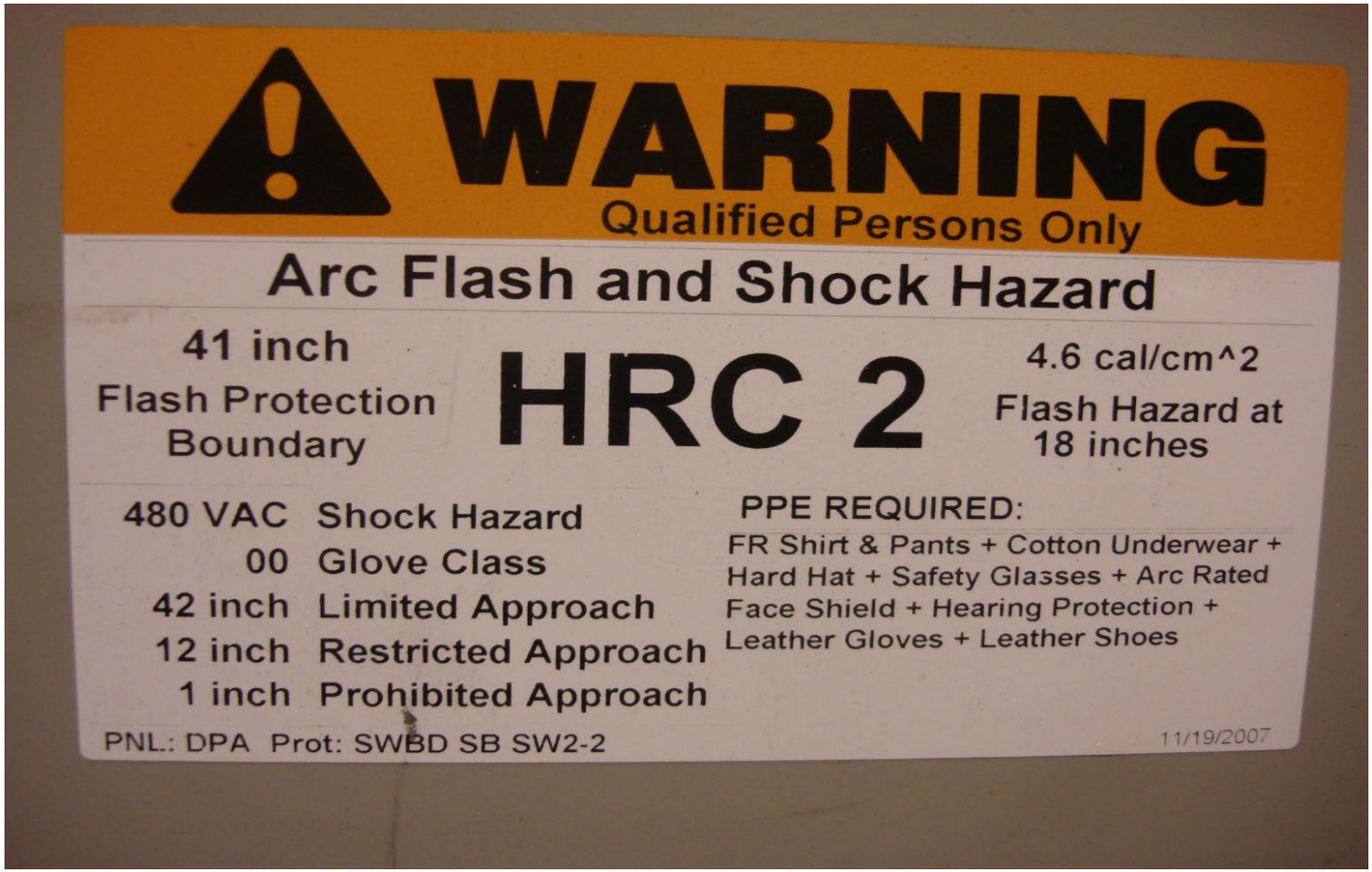
Label Electrical Systems



Label Electrical Systems



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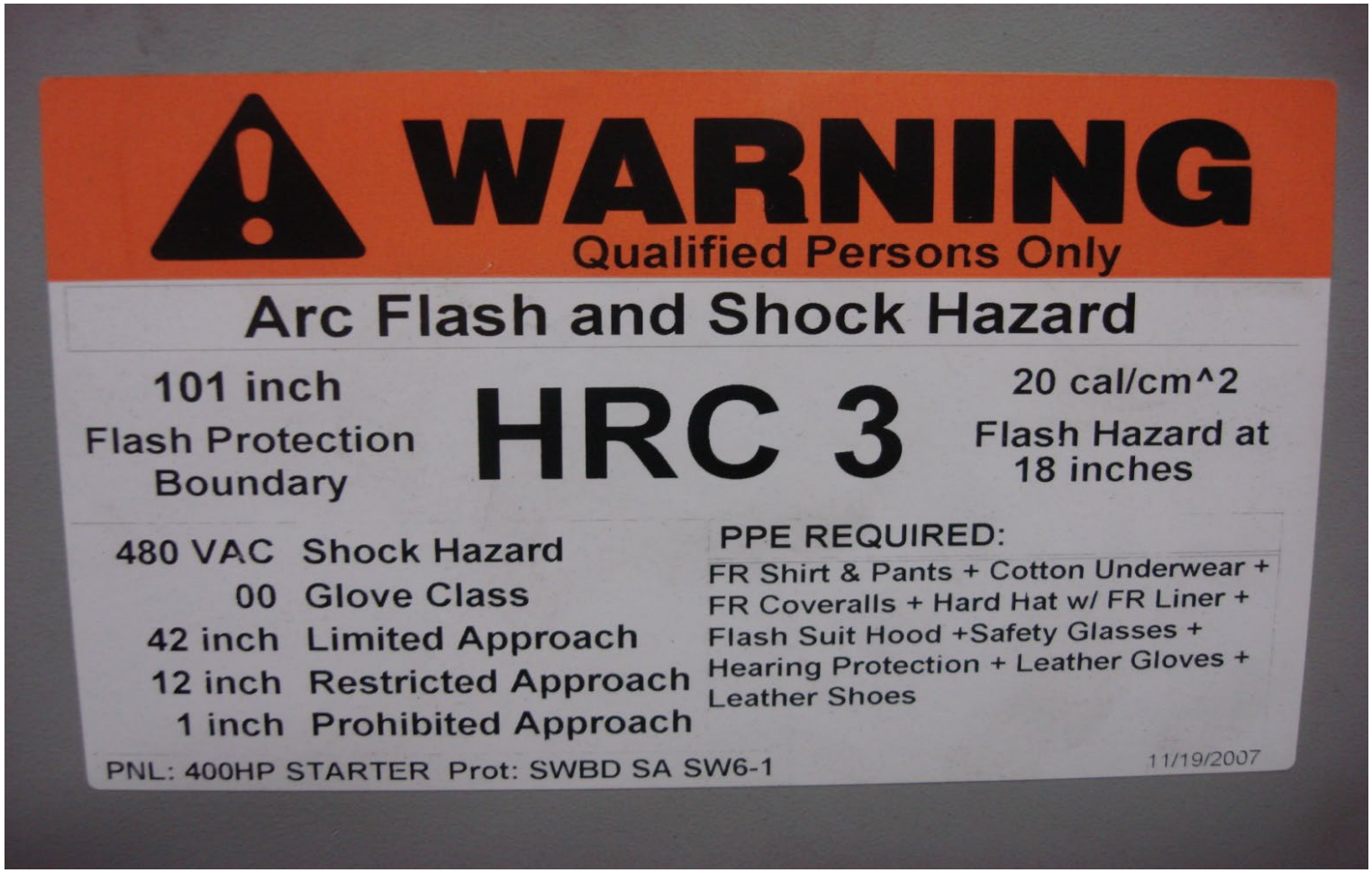
Label Electrical Systems



Dated Insulated Gloves

Leather Gloves

Voltage Rated Gloves

CLASS	PROOF VOLTAGE	COLOR	MAX USE Volts
OO	1,000	BEIGE	500
O	5,000	RED	1,000
1	10,000	WHITE	7,500
2	20,000	YELLOW	17,000
3	30,000	GREEN	26,500
4	40,000	ORANGE	36,000

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Article 130 - Working On or Near Live Parts

130.7 Personal and Other Protective Equipment

- (C) Personal Protective Equipment.
- (13) Arc Flash Protective Equipment.
- (c) Hand Protection. Leather or FR gloves shall be worn where required for arc flash protection. Where insulating rubber gloves are used for shock protection, leather protectors shall be worn over rubber gloves.

Voltage Rated Gloves & Tool Testing

- MSHA Requires testing yearly
- OSHA Requires testing every 6 months
- Tested date is marked on gloves, equipment and hot sticks
- Must be inspected and field tested before each use (visual and roll-up test)

Does not meet requirements of 120.1(5) – NFPA 70E

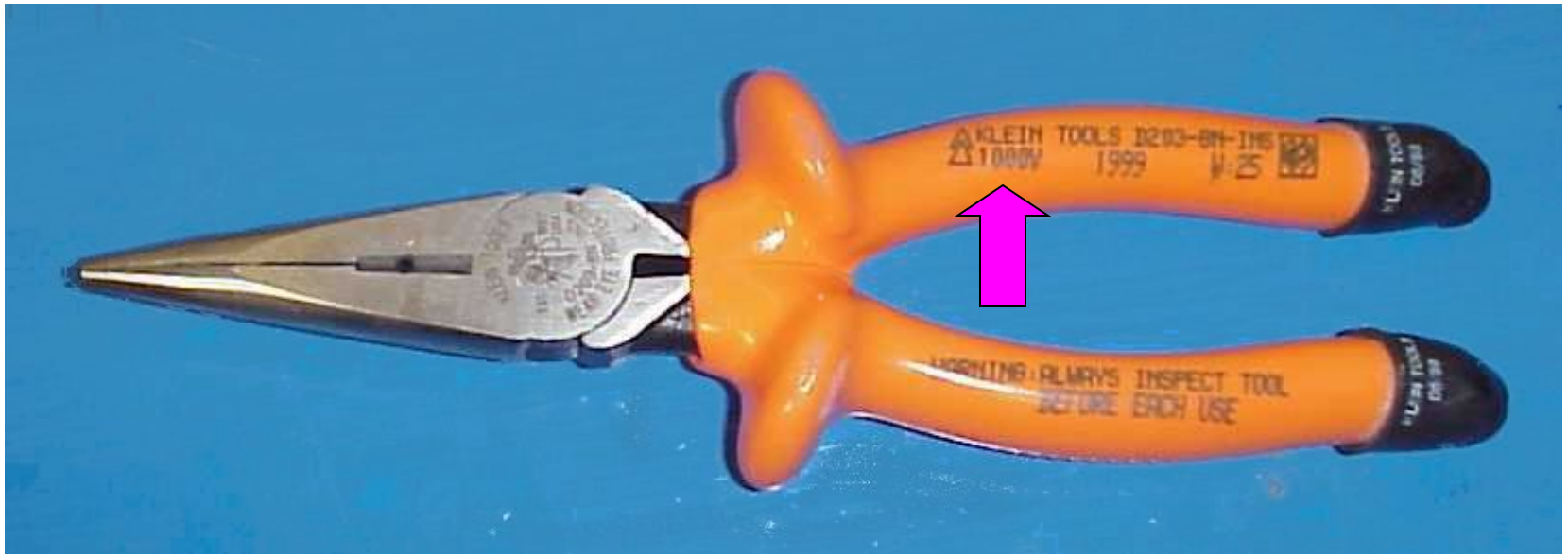
Meter Safety-Does meet requirements of 120.1(5) – NFPA 70E

CAT III-1000 V
CAT IV -600V

CAT IV-600 V
CAT III-1000 V

CAT III-
600 V

Voltage Rated Tools



Electrical

Post Test

Electrical

Resources

www.oshainfo.gatech.edu
www.arcflashtrainer.com
www.nfpa.org

Thank You For Attending!

Questions?

1-800-NC-LABOR

(1-800-625-2267)

www.nclabor.com

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