


SCOR

SAFETY COMPLIANCE FOR OSHA REGULATIONS

A Cottingham & Butler Program

Electrical Safety

PRESENTER

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INTRODUCTION

- OSHA electrical standards are based on the National Electric Code (NEC) and reference NFPA 70E
- 1640 electrical injuries in 2016 (most recent BLS numbers)
- 154 workplace fatalities in 2016
- Electrical violations are always categorized as “serious” by OSHA
- All workplaces have electrical hazards, with voltages up to 4160 volts or higher

GENERAL REQUIREMENTS FOR ELECTRICAL EQUIPMENT

- Examination – free from recognized hazards
- Installation – in accordance with labeling
- Electric equipment shall be installed in a neat and workmanlike manner
- Marking – manufacturer's name, voltage, current, wattage
- Unused openings in boxes, raceways, auxiliary gutters, cabinets, equipment cases, or housings shall be effectively closed to afford protection substantially equivalent to the wall of the equipment

GENERAL REQUIREMENTS FOR ELECTRICAL EQUIPMENT

- Disconnect switches labeled to indicate the circuit's function
- Circuit breakers labeled as to function
- Working clearances around electrical equipment – 36 inches deep x 30 inches wide (minimum) x 78 inches high (minimum) 1910.303(g)(1)

GENERAL REQUIREMENTS FOR ELECTRICAL EQUIPMENT

Guarding of live parts operating at 50 volts or more

- Cabinets, secured rooms – eight feet above floor
- Must also protect from physical damage (forklifts)

QUALIFIED PERSON TRAINING 1910.332(B)(3)(I) – (III)

Qualified persons shall at a minimum be trained in the following areas:

- The skills to distinguish exposed live parts from other parts of electric equipment,
- The skills to determine the nominal voltage of exposed live parts, and
- The clearance distances specified in 1910.333(c) and the corresponding voltages to which the qualified person will be exposed

ELECTRICAL TERMINOLOGY

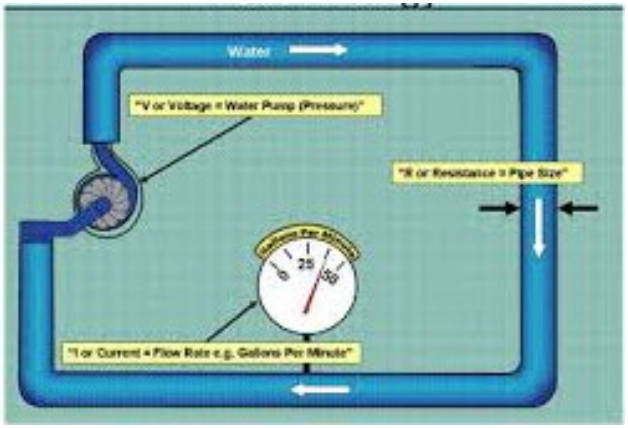
Current: the movement of electrical charge

Resistance: opposition to current flow

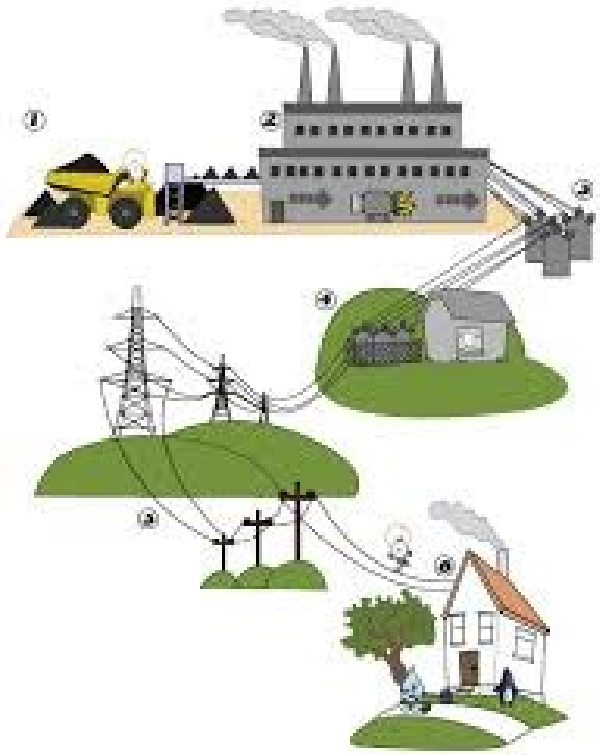
Voltage: a measure of electrical force

Conductors: substances, such as metals, that have little resistance to electricity

Insulators: substances (such as wood, rubber, glass, and bakelite) that have high resistance to electricity



HOW DOES ELECTRICITY WORK?



RELATED INJURIES

There are four main types of electrical injuries:

- Electrocution (death due to electrical shock)
- Electrical shock
- Burns
- Falls

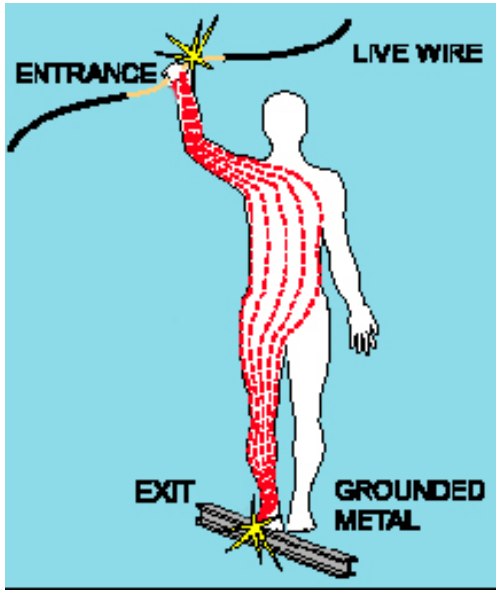
ELECTRICAL SHOCK

Received when current passes through the body

Severity of the shock depends on:

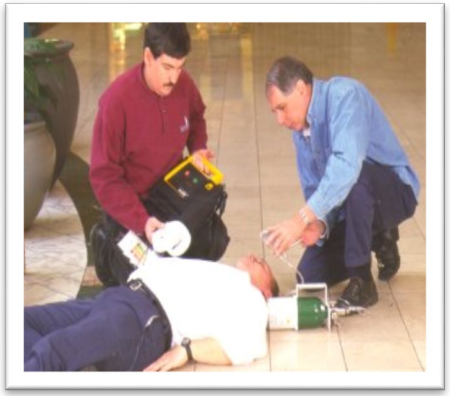
- **Path** of current through the body
- **Amount of current** flowing through the body
- **Length of time** the body is in the circuit

Low voltage does not mean low hazard



DANGERS OF ELECTRICAL SHOCK

- Currents greater than 75 mA* can cause ventricular fibrillation (rapid, ineffective heartbeat)
- Will cause death in a few minutes unless a defibrillator is used
- 75 mA is not much current – an average household outlet can supply 15 to 20 amps.



Defibrillator in use

ELECTRICAL BURNS

- Most common shock-related, nonfatal injury
- Occurs when you touch electrical wiring or equipment that is improperly used or maintained
- Typically occurs on the hands
- Very serious injury that needs immediate attention
- Burns may be internal

INADEQUATE WIRING HAZARDS

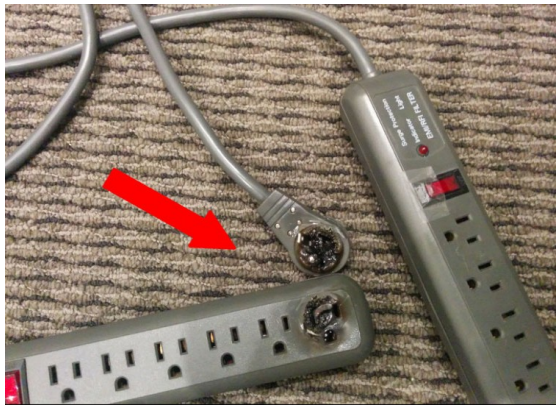
A hazard exists when a conductor is too small to safely carry the current

Example: using a portable tool with an extension cord that has a wire too small for the tool

- The tool will draw more current than the cord can handle, causing overheating and a possible fire without tripping the circuit breaker
- The circuit breaker could be the right size for the circuit but not for the smaller-wire extension cord
- Overheating cords/wiring suffer “line loss” which can also damage expensive electrical equipment or appliances.

OVERLOAD HAZARDS

- If too many devices are plugged into a circuit, the current will heat the wires to a very high temperature, which may cause a fire
- If the wire insulation melts, arcing may occur and cause a fire in the area where the overload exists, even inside a wall
- “Power strips” are not to be used for industrial applications.



GROUNDING

- 1910.304(g)(5) The path to ground from circuits, equipment, and enclosures shall be permanent, continuous, and effective
- Electricity can be considered “lazy,” as it will always take the path of least resistance

ELECTRICAL PROTECTIVE DEVICES

- These devices shut off electricity flow in the event of an overload or ground-fault in the circuit
- Include fuses, circuit breakers, and ground-fault circuit-interrupters (GFCIs)
- Fuses and circuit breakers are overcurrent devices
- Fuses and circuit breakers do not open quickly enough to prevent electrocution

What should you do when a circuit breaker trips or fuse blows?

GROUND-FAULT CIRCUIT INTERRUPTER

- This device protects you from dangerous shock
- The GFCI detects a difference in current between the black and white circuit wires
- (This could happen when electrical equipment is not working correctly, causing current “leakage” – known as a ground fault)

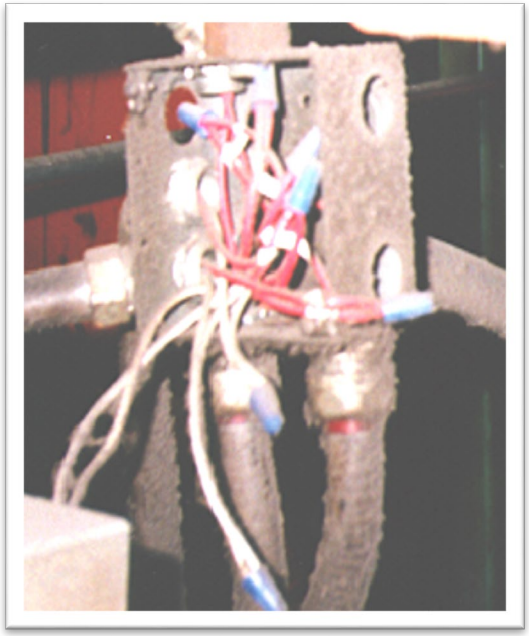
If a ground fault is detected, the GFCI can shut off electricity flow in as little as 1/40 of a second, protecting you from a dangerous shock

GROUND-FAULT CIRCUIT INTERRUPTER

- 15 to 20 amp outlets are required to be GFCI protected in bathrooms and kitchens and on roof tops. Outside and/or wet location outlets should be protected also
- Electrical cords used in construction activities should always be GFCI protected

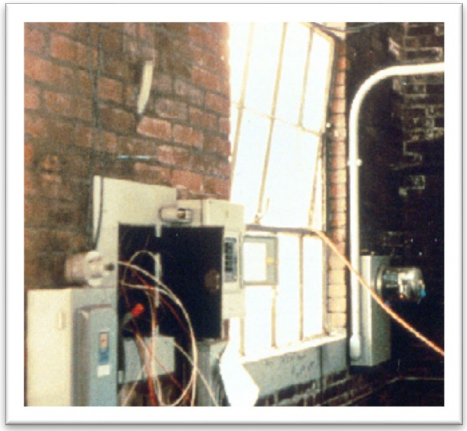
CABINETS, BOXES, AND FITTINGS

- Junction boxes, pull boxes, and fittings must have approved covers
- Unused openings in cabinets, boxes and fittings must be closed (no missing knockouts)
- Proper fittings must be used to secure wiring where it enters boxes/panels

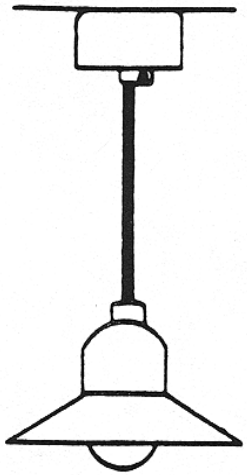


USE OF FLEXIBLE CORDS

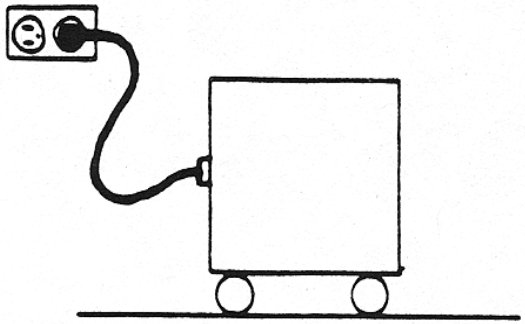
- Improper use of flexible cords is a common violation in general industry
- More vulnerable than fixed wiring
- Flexible cords can be damaged by:
  - Aging
  - Door or window edges
  - Staples or fastenings
  - Abrasion from adjacent materials
  - Activities in the area
  - Crushing
- Improper use of flexible cords can cause shocks, burns or fire



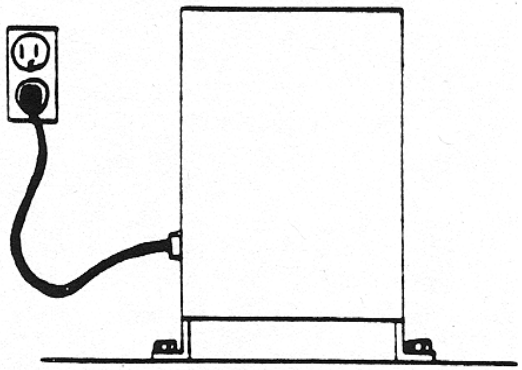
PERMISSIBLE USES OF FLEXIBLE CORDS - EXAMPLES



Pendant, or
Fixture Wiring

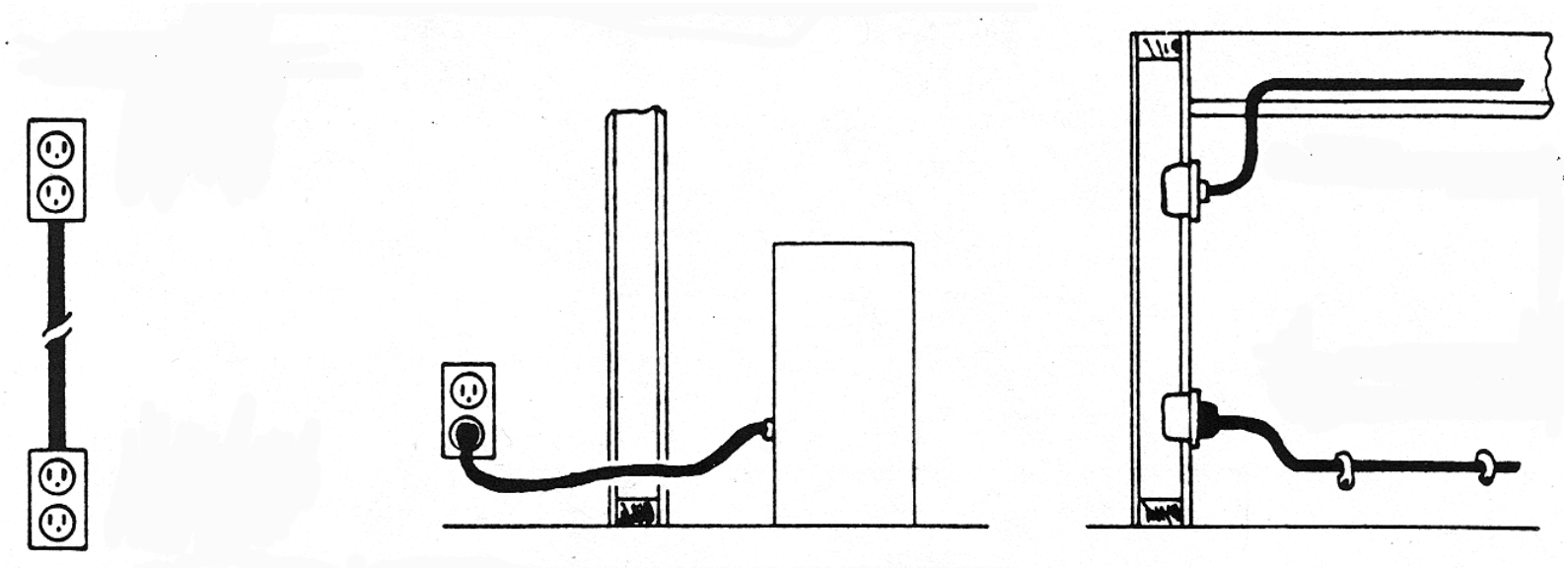


Portable lamps,
tools or appliances



Stationary equipment-
to facilitate interchange

PROHIBITED USES OF FLEXIBLE CORDS - EXAMPLES



Substitute for fixed wiring

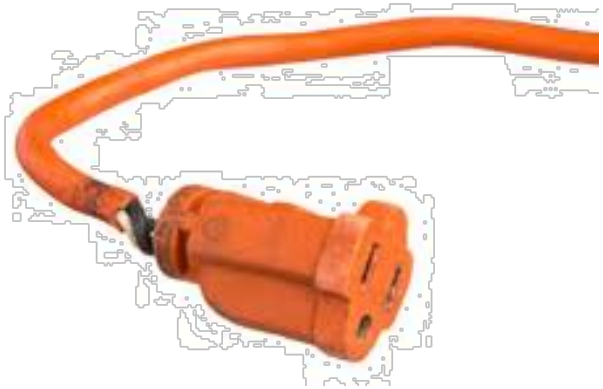
Run through walls, ceilings, floors, doors, or windows

Concealed behind or attached to building surfaces

PROCEDURES FOR USING PORTABLE ELECTRICAL EQUIPMENT

Proper handling of cords

- Don’t raise or lower equipment by its cord
- Don’t unplug the equipment by pulling on its cord
- Don’t staple or fasten the cord so as to damage the outer jacket



PROCEDURES FOR USING PORTABLE ELECTRICAL EQUIPMENT

Equipment Inspection

- Remove defective equipment from service
- Check the plug and receptacle mating configuration before connecting

PROCEDURES FOR USING PORTABLE ELECTRICAL EQUIPMENT

Flexible Cords

- Flexible cords with grounding-type of equipment must have an equipment grounding conductor
- Never remove or alter the cord's grounding pin
- Never use an adapter with a missing grounding pin
- Cords must be rated for the amp draw of the equipment to be used

DETERMINING THE AMPERAGE DRAW OF EQUIPMENT

- Most electric equipment will come with a label- some list amperage draw- others list wattage
- Simply divide wattage by the voltage to determine amperage
  - P= Wattage
  - E= Voltage
  - I= Amperage
- P/E=I
- 2000 / 230 = 8.7 amps

CLUES THAT ELECTRICAL HAZARDS EXIST

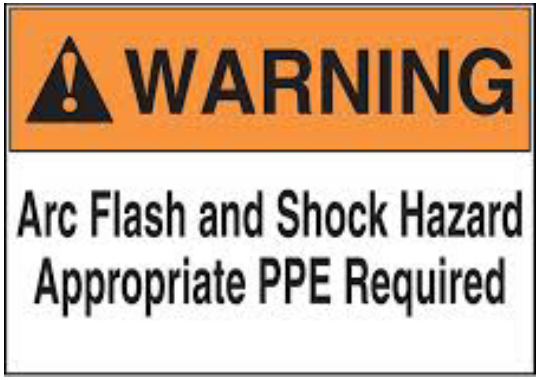
- Tripped circuit breakers or blown fuses
- Warm tools, wires, cords, connections, or junction boxes
- GFCI that shuts off a circuit
- Worn or frayed insulation around wire or connection
- Slow running tools/equipment
- “Hot” smell

WORKING ON OR NEAR EXPOSED ELECTRICAL PARTS

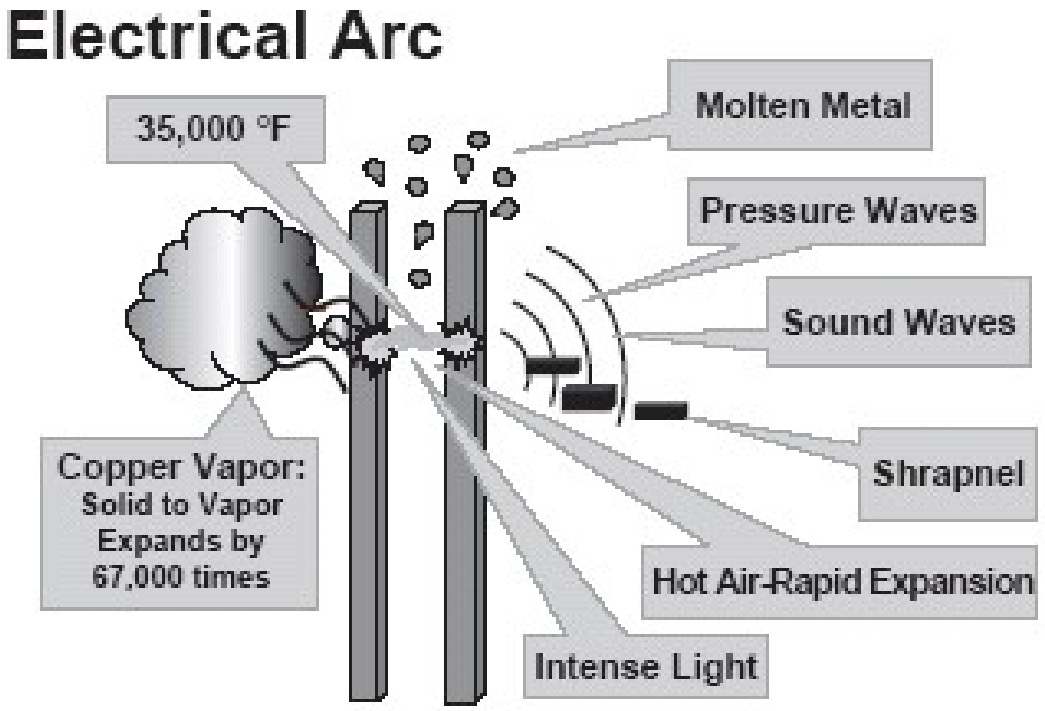
- Hazards of working on or near energized parts or conductors
- De-energize
- Lockout/tagout
- Test for energy

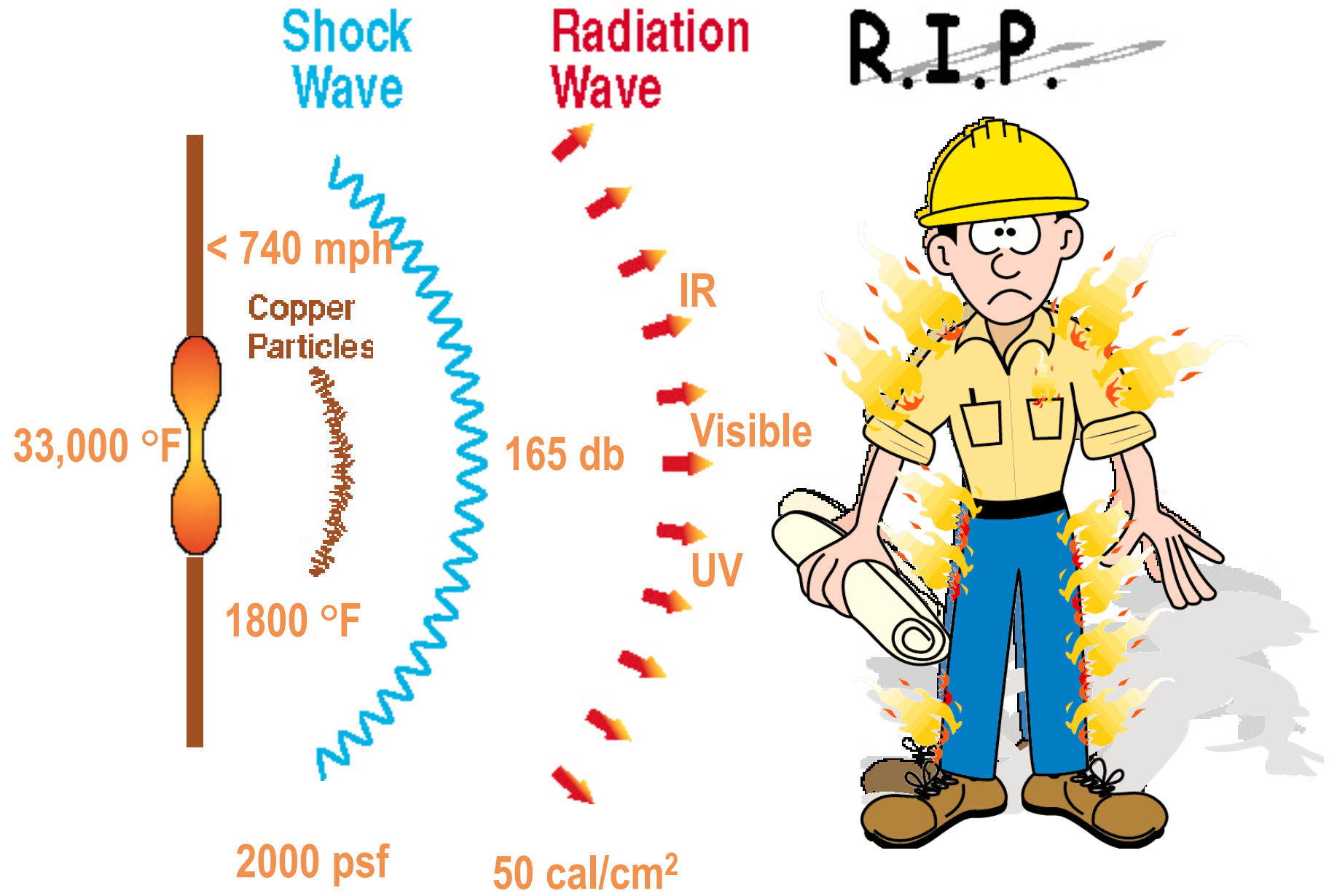
ARC FLASH

- What is it?
- Arc Flash – release of tremendous thermal energy
- Arc Blast – release of tremendous pressure



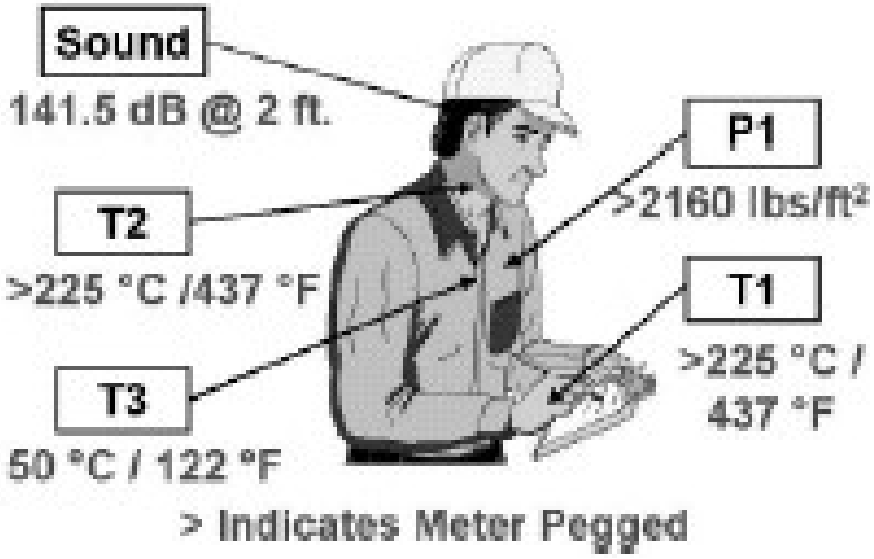
ELECTRIC ARC




Shock Wave
Radiation Wave
R.I.P.
< 740 mph
Copper Particles
33,000 °F
1800 °F
165 db
IR
Visible
UV
2000 psf
50 cal/cm²

STAGED ARC FLASH TEST #1

- T1 and T2 temp. at bare hand and neck
- T3 temp. at chest under cotton shirt
- P1 pressure on chest
- Sound level at ear



NFPA 70E

National Fire Protection Association (NFPA) standard that covers arc flash is NFPA 70E.

NFPA 70E is considered by OSHA to be a nationally recognized industry best practice which employers must comply with and are subject to citation for non-compliance.

NFPA 70E - WHAT YOU NEED

Electrical hazard assessment

- Line drawing type/ incident energy analysis
- Tables in 130.7

Panel/equipment labelling

PPE

Training

- Unqualified
- Qualified

KNOW YOUR BOUNDARIES

Flash Protection Boundary

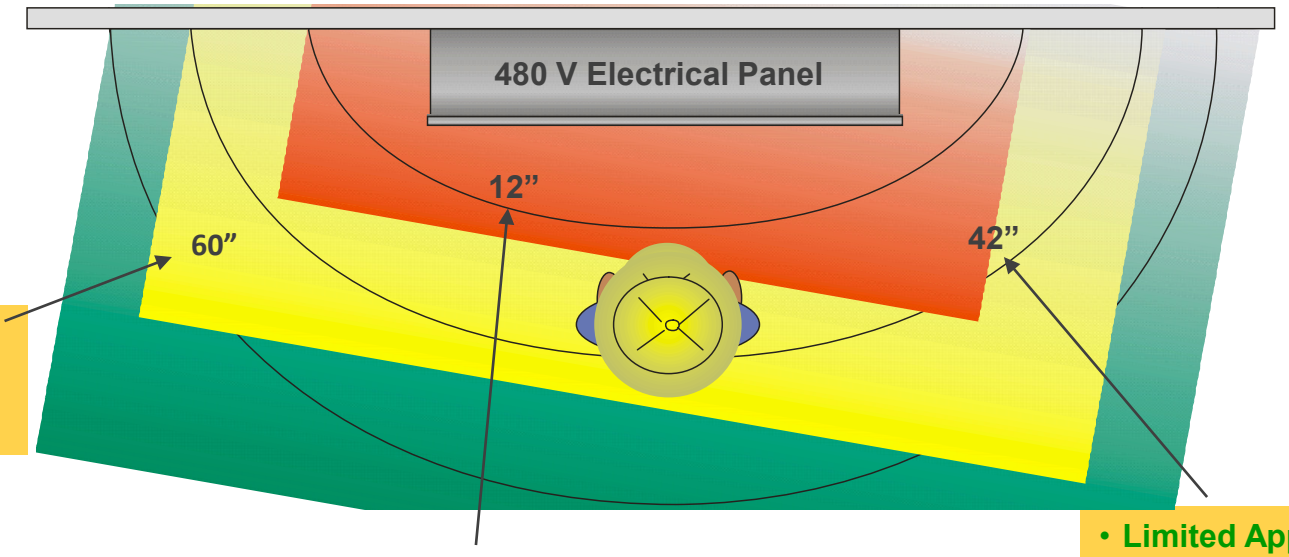
Linear distance to prevent any more than 2nd degree burns from a potential arc-flash (typically 5 feet)

Limited Approach Boundary (Shock Protection)

Entered only by qualified persons or unqualified persons that have been advised and are escorted by a qualified person

Restricted Approach Boundary (Shock Protection)

Entered only by qualified persons required to use shock protection techniques and PPE



- Arc Flash Boundary
- PPE required

- Restricted Approach Boundary
- Qualified Persons ONLY
- PPE required

- Limited Approach Boundary
- Qualified persons
- Unqualified person ONLY if supervised/escorted by Qualified person
- PPE required

600-volt class motor control centers (MCCs) 2 1.5 m
Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)

NFPA 70E - BOUNDARY TABLES

Table 130.7(C)(15)(a) Arc-Flash PPE Categories for Alternating Current (ac) Systems

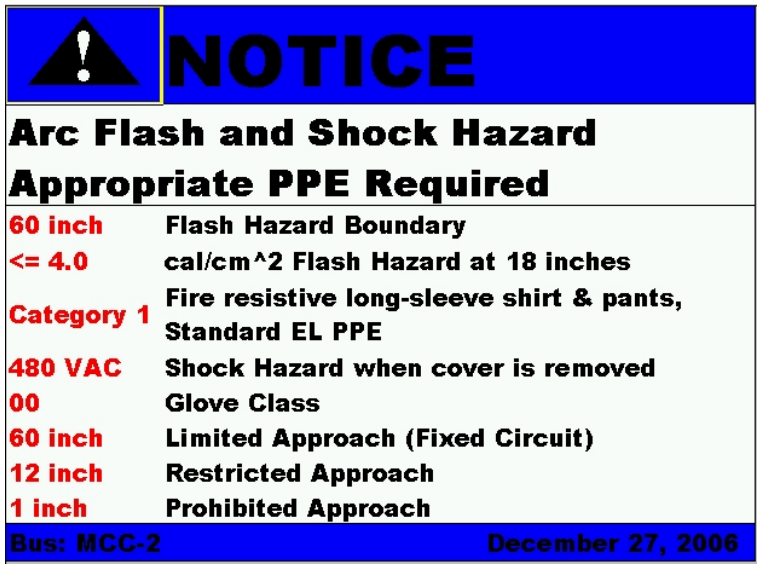
Equipment	Arc-Flash PPE Category	Arc-Flash Boundary
Panelboards or other equipment rated 240 volts and below Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	1	485 mm (19 in.)
Panelboards or other equipment rated greater than 240 volts and up to 600 volts Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	900 mm (3 ft)
600-volt class motor control centers (MCCs) Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	1.5 m (5 ft)
600-volt class motor control centers (MCCs) Parameters: Maximum of 42 kA available fault current; maximum of 0.33 sec (20 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	4	4.3 m (14 ft)
600-volt class switchgear (with power circuit breakers or fused switches) and 600-volt class switchboards Parameters: Maximum of 35 kA available fault current; maximum of up to 0.5 sec (30 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	4	6 m (20 ft)
Other 600-volt class (277 volts through 600 volts, nominal) equipment Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	1.5 m (5 ft)

NFPA 70E – PPE MATRIX

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

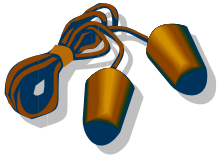
Arc-Flash PPE Category	PPE
1	**Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)[a]** Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated face shield[b] or arc flash suit hood Arc-rated jacket, parka, rainwear, or hard hat liner (AN) **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts)[c] Heavy-duty leather gloves[d] Leather footwear (AN)
2	**Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)[a]** Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated flash suit hood or arc-rated face shield[b] and arc-rated balaclava Arc-rated jacket, parka, rainwear, or hard hat liner (AN) **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts)[c] Heavy-duty leather gloves[d] Leather footwear

UNDERSTANDING YOUR LABEL



PROTECTIVE EQUIPMENT (PPE) REQUIREMENTS

PPE Category 1



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NOTICE

Arc Flash and Shock Hazard
Appropriate PPE Required

60 inch	Flash Hazard Boundary
<= 4.0	cal/cm^2 Flash Hazard at 18 inches
Category 1	Fire resistive long-sleeve shirt & pants, Standard EL PPE
480 VAC	Shock Hazard when cover is removed
00	Glove Class
60 inch	Limited Approach (Fixed Circuit)
12 inch	Restricted Approach
1 inch	Prohibited Approach

Bus: MCC-2 December 27, 2006

PPE CATEGORY 2

Covers most electrical equipment in plant

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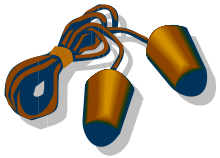
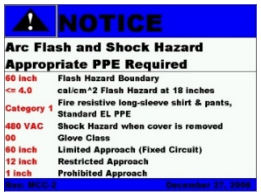
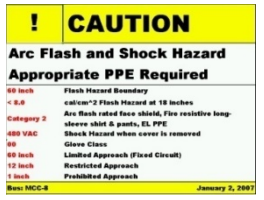
OR







SUMMARY AND RECOMMENDATIONS

Hazards

- Inadequate wiring
- Exposed electrical parts
- Ungrounded electrical systems and tools
- Overloaded circuits
- Damaged power tools and equipment
- Arc flash
- Electrocution

Protective Measures

- Proper grounding
- Using GFCIs
- Using fuses and circuit breakers
- Guarding live parts
- Proper use of flexible cords
- Training
- PPE

Recommendations

- Assess workplace for electrical hazards
- Provide training
- Provide electrical safety policy
- Provide PPE
- Regular inspections

THANK YOU!

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