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Electrical Safety

Protective Equipment and Procedures

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3 Ways to minimize shock risk

- Insulate
  - Insulate the conductors from accidental contact
- Elevate
  - Elevate the conductors so people cannot accidentality touch them
- Guard
  - Guard the conductors in a cabinet or enclosure to prevent accidental contact

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Insulate

- Insulate yourself and the conductors so there is no accidental contact with live electrical components
  - Use insulated tools (check the rating)
  - Use insulative PPE (boots and gloves)
  - Put down a rubber mat to stand on to prevent grounding
  - Make sure that the insulation on the cords you are using are in good working condition
    - No breaks or tears
    - Strain relief is in good condition
    - No electrical tape repair per OSHA 1926.403

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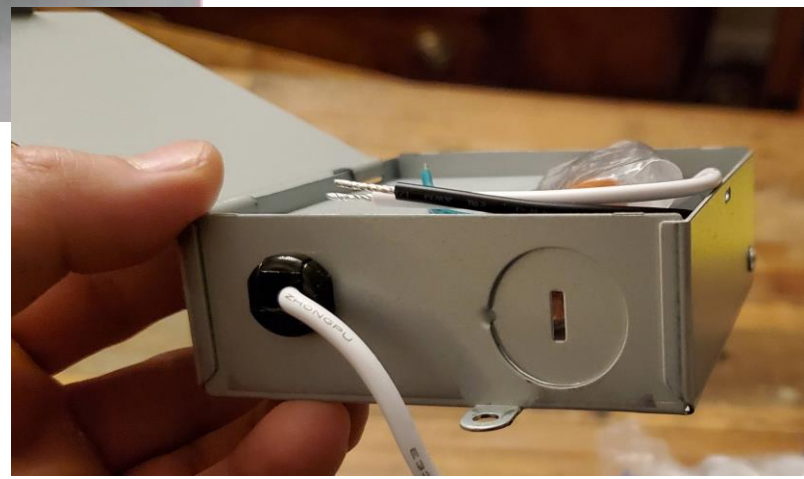
Proper Wire Insulation Care

- Do not try to fix with electrical tape (it is not an approved repair method for major damage).
- The insulation should be free of cracks, breaks or cuts
- Use wire strain relief on all tools to prevent breaking



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Knowledge Check 1

- Is electrical tape an approved repair method for electrical cabling?

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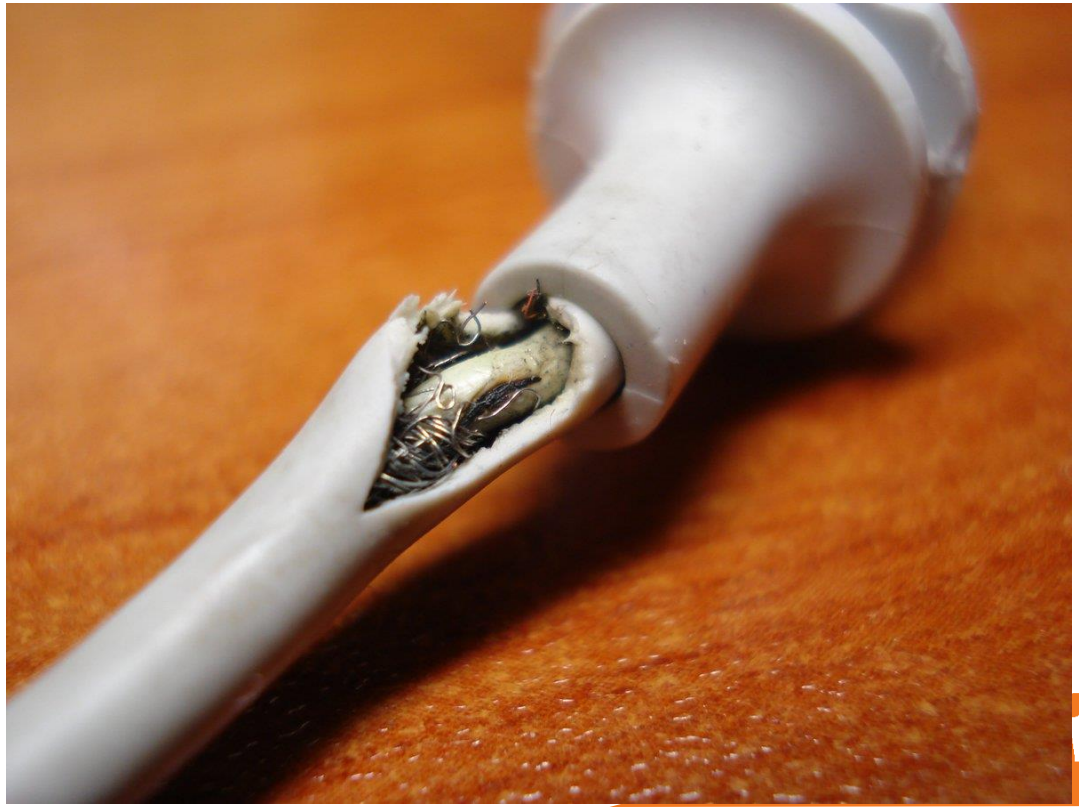
Knowledge Check 1

- No. Electrical tape is not an approved repair method for electrical cabling with severe damage to the jacket.



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Elevate

- Conductors can be elevated above the reach of most people and vehicles
- It is important that before you begin work you check your surroundings for overhead power
- Keep tools and equipment at least **10 feet** away from energized overhead power lines

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Guard

- Enclosures, guards and covers are all examples of guarding conductors from accidental contact

- Any electrical equipment over **50 V** must be guarded

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Knockouts

- Junction Boxes will have holes that can be removed to feed wire through them
- They are not allowed to have “missing knockouts” or holes that do not have conductors running through them
- You cannot just cover them with duct tape

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Knockouts and Cord Protection

- When running conductors through a knockout it is important to use cord protection to prevent damage to your cable

- The jacket should be inside the box with a clearance of ¼ inch minimum

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Grounding

- Grounding is the act of providing a low resistance connection to ground so that if there is an incident where current is not flowing normally, it will prefer that connection
- Grounding gives stray current somewhere to go and helps prevent you from becoming part of the circuit!
- Grounding only works if
  - Your tool and equipment has a ground pin
  - You are not working in excessively wet locations with no PPE
  - You are not touching a metal object

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An Effective Path to Ground

An effective path to ground must include the following

1. Shall be permanent and continuous
2. Shall have capacity to conduct safely any fault current that may run through it
3. Shall have sufficiently low impedance to limit the voltage to ground and to facilitate the operation of the circuit protection devices

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Grounding

- A ground connection must be present in
  - All non current carrying metal parts (case)
  - Portable and semi portable tools and equipment unless double insulated
  - All circuits and extension cords
    - If someone has removed the ground pin either repair the tool or throw it away

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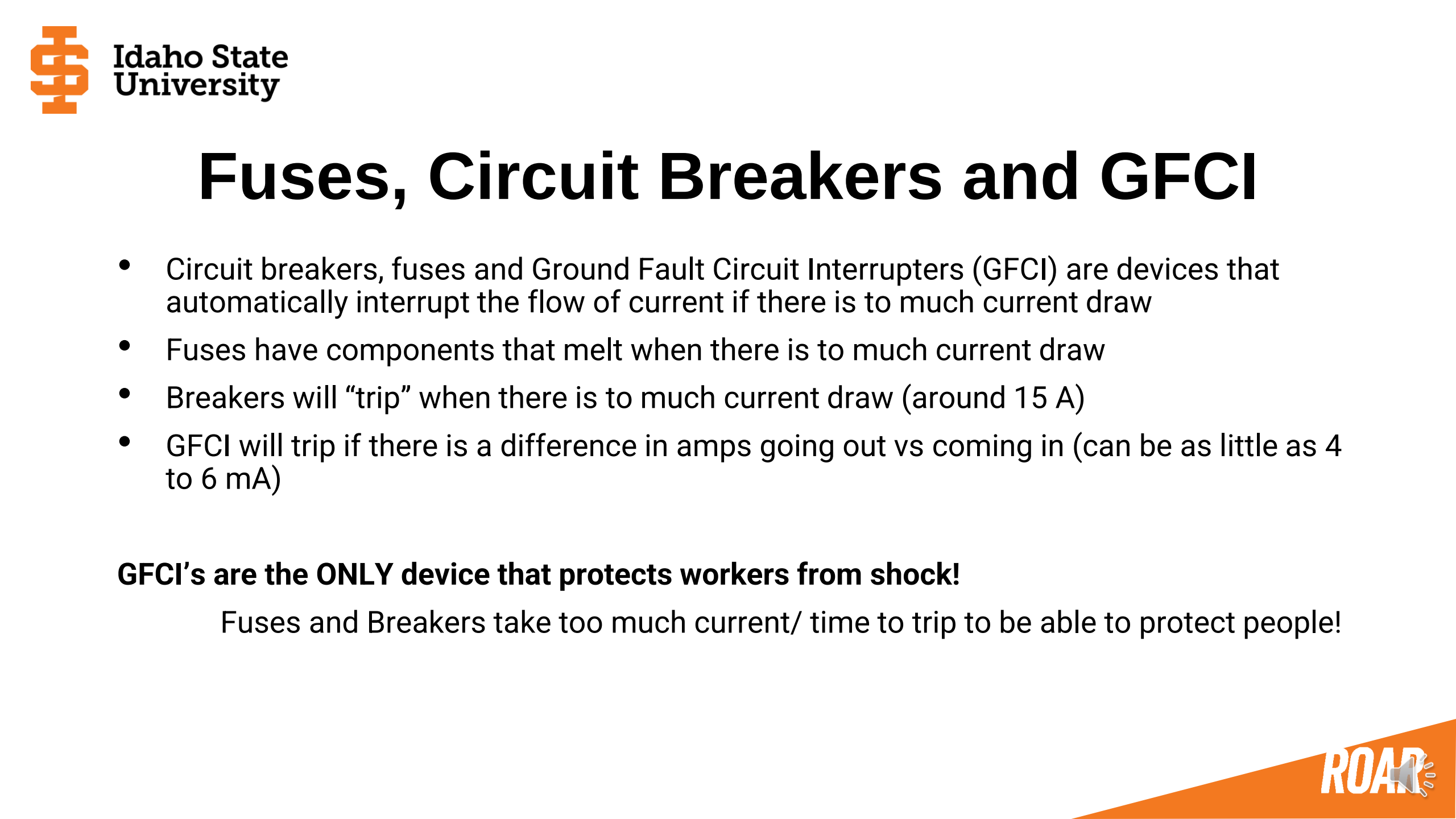
Fuses, Circuit Breakers and GFCI

- Circuit breakers, fuses and Ground Fault Circuit Interrupters (GFCI) are devices that automatically interrupt the flow of current if there is to much current draw
- Fuses have components that melt when there is to much current draw
- Breakers will “trip” when there is to much current draw (around 15 A)
- GFCI will trip if there is a difference in amps going out vs coming in (can be as little as 4 to 6 mA)

GFCI’s are the ONLY device that protects workers from shock!

Fuses and Breakers take too much current/ time to trip to be able to protect people!



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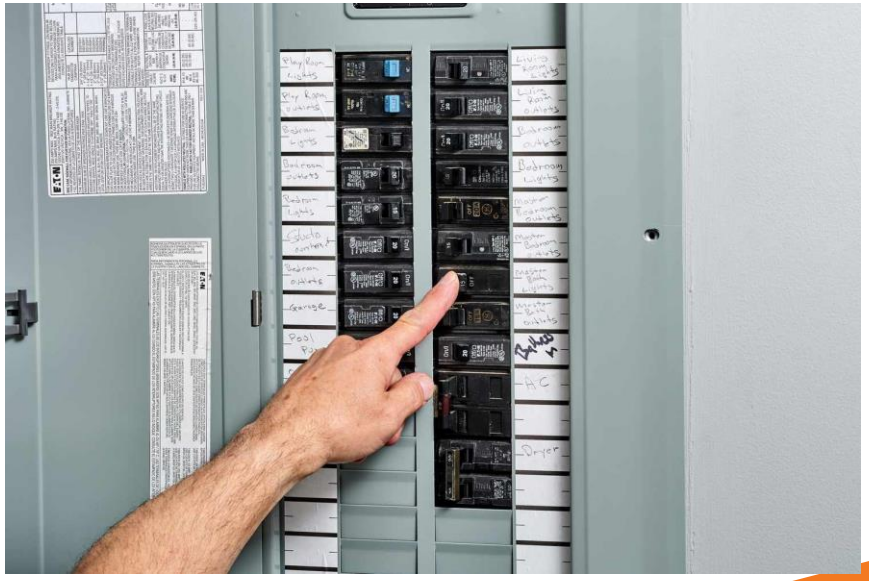
Fuses and Breakers

- Designed to only protect tools, equipment and the building – NOT YOU
- Most breakers will trip around 15 A which is more than a lethal amount of current
- they take time to “trip”



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Ground Fault Circuit Interrupters (GFCI)

- ***Designed to protect you!***
- Will trip if there is a current difference as little as 4 to 6 mA in 1/40th of a second
- All temporary circuits are required to have GFCI (or must be part of an Assured Equipment Grounding Program

- Can come in different types
  - Receptacle (outlet)
  - Breaker
  - Portable

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GFCI use

- The National Electric Code requires GFCI's to be used in the following locations that have single phase 120 V to 250 V supplies:
  - Bathrooms
  - Garages
  - Crawl Spaces
  - Basements
  - Kitchens
  - Laundry Rooms
  - Outdoor receptacles
  - Where water may be present

They also should be tested regularly to ensure they are working properly

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Knowledge Check 2

- Which one of these protection devices will protect the worker?

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Knowledge Check 2

- A GFCI is the only device designed to protect workers. Fuses and breakers trip with too much current to be safe for humans. They are only designed to protect equipment

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Head Protection

Non conductive hard hats must be worn when there is a potential danger of coming into contact with overhead shock hazards

Balaclavas and hoods are made for the entire head 360 degrees

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Eye Protection

1. Eye protection should be worn whenever there is a risk of electric arcs, flashes or a risk of flying material if there were an explosion
2. Face shields with the appropriate arc flash rating (cal/cm^2) shall be used for electrical work but safety glasses must be worn under eye shields
3. The eye wear worn should be non conductive

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Torso and Limb Protection

Electrical workers shall wear arc rated natural fiber apparel (overalls, long sleeve shirts, long pants) and must be rated at or above the incident energy or category level of the equipment being worked on

It is important to note that wearing synthetic fibers when an arc flash or blast occurs can cause the fibers to melt into your skin and these fibers are not flame retardant

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Hand Protection

- Insulated rubber gloves are used as hand protection for live electrical work
- It is mandatory that they have leather protectors on top to prevent small pinhole leaks and tears
- If even the smallest hole exists in these gloves, electricity can get through

See the attached video in Moodle for testing your rubber gloves

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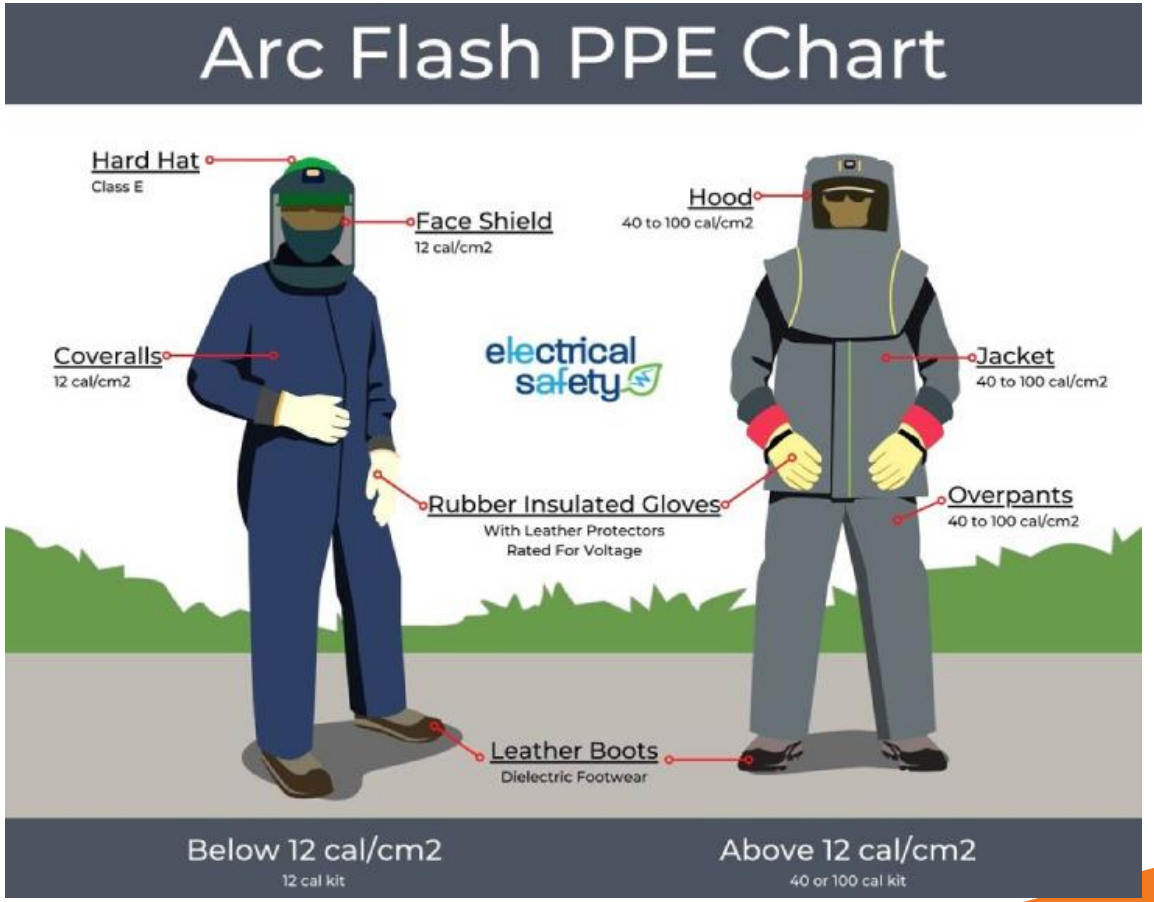
Arc Flash PPE

- The arc potential can be determined using the NFPA 70E Table 130.7(C)(15)(a)
- CAT 1 (4 cal/cm^2)
  - Lowest level
  - Workers need long sleeves, pants, face shields and safety glasses, heavy duty leather gloves, hard hat, leather safety shoes
- CAT 2 (8 cal/cm^2)
  - Workers need long sleeves, pants, Arc rated hood and safety glasses, heavy duty leather gloves, hard hat, leather safety shoes



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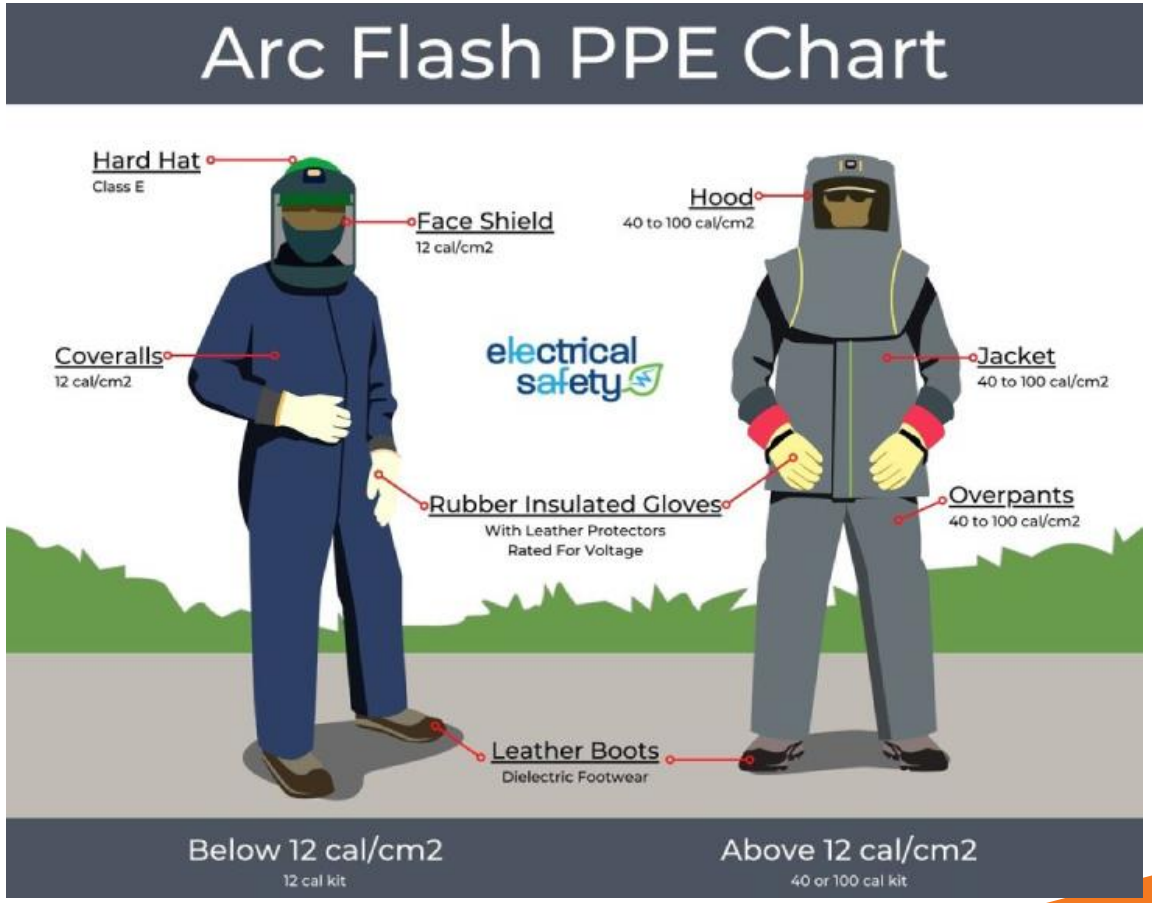
Arc Flash PPE

- The arc potential can be determined using the NFPA 70E Table 130.7(C)(15)(a)
- CAT 3 (25 cal/cm^2)
  - Workers need Arc rated suit (pants and shirt or coveralls), Arc rated hood with safety glasses, rubber insulating gloves with leather protectors, hearing protection, leather safety shoes, hard hat
- CAT 4 (40 cal/cm^2)
  - Workers need Arc rated suit (pants and shirt or coveralls), Arc rated hood with safety glasses, rubber insulating gloves with leather protectors, hearing protection, leather safety shoes, hard hat



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