General Rules for Construction Electrical Safety

MAJOR PROTECTIVE METHODS FROM ELECTRICAL HAZARDS

Protection from electrical hazards generally includes the following methods:

1. **DISTANCE:** Commonly used with regard to power lines.
2. **ISOLATION AND GUARDING:** Restricting access, commonly used with high voltage power distribution equipment.
3. **ENCLOSURE OF ELECTRICAL PARTS:** A major concept of electrical wiring in general, e.g., all connections are made in a box.
4. **GROUNDING:** Required for all non-current carrying exposed metal parts, unless isolated or guarded as above. (However, corded tools may be either *grounded* **OR** be *double-insulated*.)
5. **INSULATION:** Intact insulation allows safe handling of everyday electrical equipment, including corded tools. Category also includes insulated mats and sleeves.
6. **DE-ENERGIZING AND GROUNDING:** Protective method used by electrical utilities and also in conjunction with electrical lockout/tagout.
7. **PERSONAL PROTECTIVE EQUIPMENT (PPE):** Using insulated gloves and other apparel to work on energized equipment, limited to qualified and trained personnel working under very limited circumstances.

Effects of Electric Current in the Human Body

Current / Reaction *(1,000 milliamperes = 1 amp; therefore, 15,000 milliamperes = 15 amp circuit)*
Below 1 milliampere Generally not perceptible
1 milliampere Faint tingle
5 milliampere Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6-25 milliamperes (women) Painful shock, loss of muscular control
9-30 milliamperes (men) The freezing current or " let-go" range. Individual cannot let go, but can be thrown away from the circuit if extensor muscles are stimulated.
50 150 milliamperes Extreme pain, respiratory arrest, severe muscular contractions. Death is possible.
1,000 - 4,300 milliamperes Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely.
10,000 milliamperes Cardiac arrest, severe burns; death probable

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Safety Tips for Workers

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Electrical Safety Overview

1. **CORD AND PLUG OPERATED** electric tools with exposed metal parts must have a *three-prong grounding plug* – **AND** *be grounded* – or else be *double-insulated.*

2. **EQUIPMENT GROUNDING** *only works when there is a permanent and continuous electrical connection between the metal shell of a tool and the earth.*

3. **PROPER POLARITY IN ELECTRICAL WIRING IS IMPORTANT:** *hot to hot, neutral to neutral, equipment ground to equipment ground. Polarized plugs have a wider neutral blade to maintain correct polarity.* ***Reversed polarity can kill.***

4. **CIRCUITS MUST BE EQUIPPED WITH FUSES OR CIRCUIT BREAKERS** *to protect against dangerous overloads. Fuses melt, while circuit breakers trip to turn off current like a switch.* ***Overcurrent protection devices protect wiring and equipment from overheating and fires.*** *They may, or may not, protect you.*

5. **MOST 120 VOLT CIRCUITS** *are wired to deliver up to 15 or 20 amps of current. Currents of* ***50 – 100 milliamperes*** *can kill you. (1 mA = 1/1,000 of 1 Amp.)*

6. **WET CONDITIONS LOWER SKIN RESISTANCE,** *allowing more current to flow through your body. Currents* ***above 75 milliamps*** *can cause* ***ventricular fibrillation,*** *which may be fatal. Severity of a shock depends on: path of current, amount of current, duration of current,* voltage level, moisture and your general health.

7. **A GROUND FAULT CIRCUIT INTERRUPTER (GFCI)** protects from a ground-fault, the most common electrical hazard. GFCIs detect differences in current flow between hot and neutral. They trip when there is current leakage – such as through a person – of about 5 milliamperes and they act within 1/40 of a second. Test a GFCI every time you use it. It must "Trip" and it must "Reset."

8. **EXTENSION CORD WIRES MUST BE HEAVY ENOUGH** for the amount of current they will carry. For construction, they must be UL approved, have strain relief and a 3-prong grounding plug, be durable, and be rated for hard or extra-hard usage.

9. **OVERHEAD POWER LINES CAN KILL.** The three major methods of protection are: maintaining a *safe distance, de-energizing AND grounding lines,* having the power company install *insulating sleeves.* Have a power company rep on the site.

10. **UNDERGROUND POWER LINES CAN KILL.** Call before you dig to locate all underground cables. Hand dig within three feet of cable location!

General Rules for Electrical Work

- ***Non-conductive PPE is essential for electricians. NO METAL PPE! Class B hard hats provide the highest level of protection against electrical hazards, with high-voltage shock and burn protection (up to 20,000 volts). Electrical hazard, safety-toe shoes are nonconductive and will prevent the wearers' feet from completing an electrical circuit to the ground.***
- ***Be alert to electrical hazards,*** especially when working with *ladders, scaffolds and other platforms.*
- ***Never bypass electrical protective*** systems or devices.
- ***Disconnect cord tools*** when not in use and when changing blades, bits or other accessories.
- ***Inspect all tools*** before use.
- ***Use only grounded extension cords.***
- ***Remove damaged*** tools and damaged extension cords from use.
- ***Keep working spaces and walkways clear*** of electrical cords.

RULES FOR TEMPORARY WIRING AND LIGHTING

- ***Use Ground Fault Circuit Interrupters (GFCIs)*** on all 15-Amp and 20-Amp temporary wiring circuits.
- ***Protect temporary lights*** from contact and damage.
- ***Don't suspend temporary lights by cords,*** unless the temporary light is so designed.

Condensed Electrical Glossary

AMPERE OR AMP: The unit of electrical *current* (flow of electrons). • One *milliamp (mA)* = 1/1,000 of 1 Amp.

CONDUCTORS: Materials, such as metals, in which electrical current can flow.

ELECTRICAL HAZARDS can result in various effects on the body, including: • SHOCK – The physical effects caused by electric current flowing in the body. • ELECTROCUTION – Electrical shock or related electrical effects resulting in death. • BURNS – Often occurring on the hands, thermal damage to tissue can be caused by the *flow of current* in the body, by *overheating* of improper or damaged *electrical components,* or by an *arc flash.* • FALLS – A common effect, sometimes caused by the body's reaction to an electrical current. A non-fatal shock may sometimes result in a fatal fall when a person is working on an elevated surface.

EXPOSED LIVE PARTS: Energized electrical components not properly enclosed in a box or otherwise isolated, such that workers can touch them and be shocked or killed. Some of the common hazards include: missing knockouts, unused openings in cabinets and missing covers. Covers must not be removed from wiring or breaker boxes. Any missing covers must be replaced with approved covers.

INSULATORS: Materials with high electrical resistance, so electrical current can't flow.

LOCKOUT/TAGOUT: The common name for an OSHA standard, *"The control of hazardous energy (lockout /tagout)."* ***Lockout*** is a means of controlling energy during repairs and maintenance of equipment, whereby energy sources are *de-energized, isolated,* and then *locked out* to prevent unsafe start-up of equipment which would endanger workers. *Lockout* includes – but is not limited to – the control of electrical energy. ***Tagout*** means the placing of warning tags to alert other workers to the presence of equipment that has been locked out. Tags alone DO NOT LOCK OUT equipment. ***Tagout is most effective when done in addition to lockout.***

OHM or Ω: The unit of *electrical resistance* (opposition to current flow).

OHM'S LAW: A mathematical expression of the relationship among *voltage* (volts), *current* (amps) and *resistance* (ohms). This is often expressed as: $E = I \times R$. In this case, E = volts, I = amps and R = ohms. (The equation, Amps = Volts/Ohms, as used in this curriculum, is one form of Ohm's Law.)

VOLT: The unit of *electromotive force (emf)* caused by a *difference in electrical charge or electrical potential* between one point and another point. **The presence of voltage is necessary before current can flow in a** *circuit* (in which *current* flows from a *source* to a *load* – the equipment using the electricity – and then back to its source).

WET CONDITIONS: Rain, sweat, standing in a puddle – all will decrease the skin's electrical resistance and increase current flow through the body in the event of a shock. **Have a qualified electrician inspect any electrical equipment that has gotten wet before energizing it.**