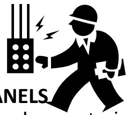
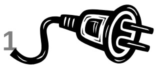


Toolbox Talks

Understanding Electricity Part 1



Understanding Electricity & Breaker Panels

The process of forcing electrons to move through a material creates electricity. A standard generator performs this process. The best material for carrying electricity is a "conductor." Most metals are excellent conductors, such as copper, which is the most common material used for electrical wiring. In order to provide protection from direct contact with the conductor, an "insulator" is used as a cover around the conductor. Electrons will not move easily through insulators such as most plastics & rubber. Insulators & proper grounding help to prevent electrical shocks.

Typically, electricity is provided to your building or facility by way of underground or overhead power lines originating from a nearby electrical power plant. The power lines feed into your electrical breaker panel(s). Each breaker in a panel represents a circuit supplying electricity to a designated area of your building. The majority of your electrical safety considerations begin at the breaker panel.

Basic Safety Considerations for all Panels:

° The breaker panel should be readily & easily accessible at all times. Do not store any items on the floor area directly in front of the panel. Maintain an aisle in front of the panel that is at least three feet wide.
° The panel should have a closed cover. The cover should not be locked unless work is in progress requiring that the cover be locked as part of the lock out procedure.
° The panel should have a directory index identifying each individual circuit breaker. It is usually found secured to the inside face of the cover. The directory should identify the various receptacles, general area, or equipment serviced by each circuit breaker.
° There should not be any missing breakers or other openings in the breaker face plate that would allow you to contact the "hot" electrical bus at the back of the panel. Openings could also allow dust or dirt to accumulate inside the panel box interior. This dust may damage the breakers to the point where they will not "trip" when needed.
° Breakers should never be taped or otherwise secured in the "closed" (on) position. Each circuit breaker & circuit are rated for a maximum amount of amperes. An ampere is the unit for measuring the rate of flow of electricity through the circuit. If the rate of flow in the circuit exceeds the designated maximum for the breaker, the breaker "trips" & stops the flow of electricity. If the breaker is not allowed to trip, insulators could melt from excessive conductor heat caused by electricity flowing too fast! Fires or increased exposure to shock may also occur.
° Lastly, breakers should not be taped in the "open" position as a means of de-energizing the circuit during repair or maintenance activity. Open breakers should be properly tagged or locked out.

Electircal Arcs & Blasts

Electrical arcs & blasts are a potential danger when working with most electrical devices. Depending on the voltage & the distance from the main power supply, arcs can cause severe injury, third-degree burns, & even death.

The Causes

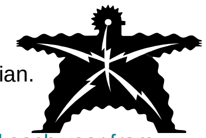
° An arc is created by a short-circuit, most often when non-insulated tools come in contact with a live electrical current.
° The heat of an electrical arc can exceed 10,000 °F -- which is 1,000 °F greater than the surface of the sun.
° The blast which accompanies an arc is created by the superheating of air in the vicinity. The force produced can equal the force of an exploding bomb...!!

Possible Outcomes

° Cardiac arrest
° Muscle, nerve, & tissue destruction
° Thermal burns
° Death

Safety Tips

° Make use of personal protective clothing, such as flash suits, face shields, & appropriately insulated gloves.
° Use insulated tools.
° Always work under the direct supervision of a trained electrician.

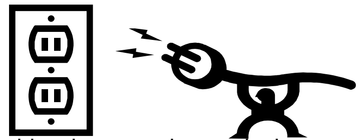


High Voltage Electrical Burns

More than 1000 employees are killed & another 30,000 injured each year from electrical shock. Hands are frequently involved in an electrical injury since they are the most common source of contact with the electrical current. However, damage to other parts of the body may be more extensive & life threatening. Severe electric shock can result in cardiac arrest due to ventricular fibrillation, massive fluid loss into swollen tissues, & kidney failure caused by an overload of muscle protein from damaged muscle & infections.
Electrical injuries are often more severe than they appear to be from the outside. Injury occurs not only at the contact site, but also along the path the electricity takes as well as at the exit location. Frequently, there is also extensive muscle damage that will not be evident from a visual examination of the skin. These deep tissue injuries cause severe swelling that require a deep incision extending from the hand to the shoulder to relieve the pressure. If this is not done, the mounting pressure from the swelling will shut off the blood supply by compressing the arteries, rapidly destroying any remaining healthy tissue. Extensive dead skin removal is often necessary to prevent massive infection. Deep burns result in unsightly scars that will often continue to enlarge for 12-18 months after the burn occurs. These scars are not only a cosmetic problem, but may seriously interfere with joint function as motion increases the tension across the wound, which tends to produce even more scar tissue.
More than 90% of fatalities occur when contact is made with a "hot" wire, or energized equipment housing, by a person who was well-grounded. Most of these injuries would probably have been prevented if a GFI -- ground fault interrupter -- had been installed on the circuit. A GFI is NOT an overcurrent device, but is placed across the line to continuously monitor the current flowing from the source & compare it to the current returning to the source. If the difference is 6 milliamperes or more, it opens the circuit almost instantly. This is important because it has been determined that 100 milliamperes flowing through the body for only 2 seconds can cause death by electrocution. 100 milliamperes is not much current when you consider that a portable electric drill draws 30 times that much. Incidentally, the "let go" threshold that causes freezing to the circuit is about 20 milliamperes. Make sure that the equipment you are working with has a GFI -- it could save your life.
To work on high voltage (over 600 volts), you must have a minimum of two years of training, experience with high voltage circuits, have demonstrated that you are familiar with the work to be performed, & know the hazards involved with high voltage work according to OSHA.
Other safety requirements that must be followed include: using insulated gloves for current over 300 volts, eye protection, & lockout/tagout if working on energized parts of equipment or systems. Conductive measuring tapes, ropes, or similar devices cannot be used around exposed conductors, & conductive fish tapes cannot be used if they will be entering enclosures with exposed conductors.

Toolbox Talks

Understanding Electricity Part 2



ABC's of Electrical Safety

Let's review some of the most common workplace hazards & controls related to electrical safety.

Tips for working around electricity safely:

° Know how to power up & power down the equipment before starting any work. Properly lock out & tag out any systems that are to be worked on. Identify the location of emergency stops, outlets, & power sources.

° Inspect electrical cords of all types for exposed or frayed wiring. Extension cords should only be used for temporary purposes & should not be permanently installed.

° Ensure electrical plugs are grounded (3-prong) & they are completely encased in the shroud.

° Dissipate electrical energy accordingly before starting repair work, conducting a change-over of any sort or performing routine maintenance. Never assume energy is dissipated unless you have verified it personally. Once the energy is dissipated, use test equipment to verify, if applicable.

° If performing work in or around electrical panels & generators, wear E-rated PPE, including E-rated rubber soled shoes & mats, shirts, & protective helmets. Be sure to wear PPE that is matched to the hazard classification of your work area. To mitigate risk from arc flash, stand behind the cabinet door when opening, & then check the condition of protective panels inside the cabinet, if applicable.

° Keep ladders, poles, & similar objects that could serve as grounding devices at least 10' away from overhead power lines. Electricity is always looking to ground itself…do not become a conductor of electricity.

° Verify signage, labeling, & any applicable color-coding is visible & legible.

° Keep all sources of water away from electricity. Do not stand in water while operating electrical equipment.

° Do not dig or excavate underground without first knowing where power lines may exist. Consult with the local electrical company to verify these locations or call DigSafe at 811.

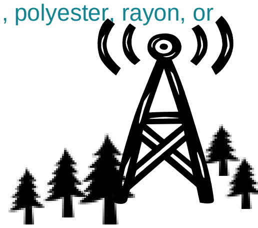
Safety Precautions for Work Around High Voltage:

Clothing

° Always wear safety shoes with nonconductive soles
° Always wear headgear insulated to withstand 20,000 volts
° Wear voltage-rated insulated gloves covered by leather gloves to protect against piercing
° Wear clothing that is NOT made of synthetic materials (e.g., polyester, rayon, or nylon); these can melt and cause severe burns
° Always remove any jewelry that can be conductive

Safety Preparations

° Never exceed your limits of knowledge and training
° Set up barricades to keep non-qualified personnel away from the work site
° Use only properly rated tools
° Always be sure you have adequate light



Safe Work Practices

° Always stand to the side when opening or closing any electrical disconnect
° Check blue prints and naming configurations to determine voltage levels & places of live wires
° Always be sure to de-energize a unit if possible
° Always use a test meter to confirm that there is no power
° Always install grounding conductors, where applicable

Proper Repair of Electrical Cords

It shouldn't happen, but it does. Even heavy duty extension cords become damaged. Because they can be expensive, you may be asked to make a repair, rather than get a new cord. But merely re-attaching & wrapping the wires doesn't mean the repair is proper or safe.

The correct way to repair electrical cords:

° The first *obvious* step is often overlooked; unplug the cord & take control of both ends.

° **Splices:** Cut back only enough of the outer & inner insulation to make the repair. Keep in mind that the color-coded wires on one side need to be connected to the like-colored wires on the other. In other words, black-to-black, white-to-white, green-to-green. Stagger the lengths of the inner wire so that, even if the insulation goes bad, the conductors will not come in contact with each other. If the black wire is long on one side, it should be short on the other. Make good mechanical connections. Twist the conductors together & solder, using electrical solder. The splices now need to be insulated. Electrical tape is not very reliable. Shrink tubing works well. This is a sleeve of plastic put over one of the wires before it is connected to the other. When the joint is completed, the sleeve is slipped over the joint & heated with a small heat source; a hair dryer, match, or lighter will do. When heat is applied, the tubing shrinks around the conductor, forming tight insulation. We now need to pay attention to the outer jacket. This is important, because the outer jacket protects the inner wires from additional damage. Shrink tubing could again be used, although, for additional strength & protection, it could also be wrapped with electrical tape, duct tape, or other durable, non-conductive material. NOTE: See NFPA-70 for restrictions on splicing flexible cords.

° **Plugs:** Remove only as much outer jacket as is needed to make the repair. The outer jacket must be long enough to go into the plug or cap & be gripped by the strain relief clamp. After the jacket & wires are cut to length, we again must pay attention to the color coding. *The black (or sometimes red) wire is "hot". It goes to the smaller prong on the plug, which has a brass screw for attachment. The white wire is neutral. It goes to the larger prong, which is attached with a chrome screw. The green wire is "ground." This goes to the half-round or curved prong & is attached with a green colored screw.* Make a good connection. All screws must be tight. Reassemble the plug & tighten the clamp until it is snug on the cord. Do not over-tighten the clamp.

° **Testing:** The repair is not done until the cord has been tested. The easiest way to check for continuity & correct wiring is to use a simple, inexpensive test light. This device plugs into the end of the cord, & by way of three lights, indicates if you have continuity & proper polarity. If you do *not*, you must redo the repair. You have created a dangerous situation. Good repairs take simple skills--but you cannot take shortcuts.

Incomplete or improper repairs create fire & shock hazards. Do the job right!