The Shocking Truth about Electrical Safety

There are very few of us that have never experienced the sensation of receiving an electrical shock. From the “zap” of static electricity to the significant potential for burns, neurological damage or even death, electricity is more often than not taken far too lightly in our daily activities. Without a long and technical dissertation on the nomenclature and identification of advanced electrical theory, this article will show, in layman’s terms, that the everyday potential worker exposure to electrical shock is much greater than commonly understood or acted upon.

THE EFFECTS OF ELECTRICITY

Shock: Almost all of us have received an electrical shock and therein lies the problem. We survived and learned a very dangerous lesson. Electricity does not always kill. The problem is that the most common amount of electricity we were exposed to, such as 110 to 120 volts/15 amps, is more than enough to deliver a fatal shock. In reality it takes as little as 7 milliamps (mA) to stop the human heart.

Any electrical shock has the potential to cause injury to humans. It doesn’t matter if it’s 120 volts AC or 12 volts DC, both can cause injury or even a fatality. The amount and kind of injury depends on six elements—voltage, amperage, resistance, type of current, path of current, and duration of exposure.

It has been found that as little as 20 mA can be fatal based on the duration of exposure. Anything above 60 mA can be fatal in just a few seconds.

One to 5 mA is the range at which we can feel the shock current but you still can let go of a live wire with 5 mA of current.

In the 5 to 20 mA range, you are no longer able to control your muscles and often can’t let go of the live wire and if enough time passes (before the power is shut off or someone knocks you clear). This shock can do extensive damage and could very well be fatal.

Twenty to 60 mA can be fatal within a few seconds and can cause fibrillation (where the heart pumps little or no blood) or can completely stop the heart.

Anything from 60 mA on up is generally considered fatal and will stop the heart of even the most healthy people.

Burns: The resultant arc from a fault (dead short) typically from the hot wire to ground generates an inordinate amount of heat (11,000 degrees Fahrenheit or 6,000 degrees Celsius). This is roughly the same temperature as the sun’s photosphere or outer visible layer.

This is hot enough to ignite the surrounding air forming a plasma arc. Of course, any material involved in the arc is immediately vaporized or explodes.

Blast: This is the result of rapidly expanding materials, such as plastic or metal, which are expelled from the point of the arc and can cause additional burns or impact related injuries.

SOURCES OF POTENTIAL EXPOSURES TO ELECTRICAL SHOCK

The construction industry is filled with opportunities to receive an electrical shock involving things like careless care of electrical devices to weather related exposures; shocks are just waiting to happen:

Illegal Applications: NFPA 70E, NEC & OSHA state that an electrical device must be listed and rated for its intended use. A four square box is intended for in-wall installation, not a splitter box on the end of an extension cord. This could be a very costly short cut.

Damaged or cut cords: In event of a fault or electrical leakage from a tool in conjunction with a missing ground prong is a combination that often leads to an electrical shock. The designated path for errant current to take is missing and if the worker is grounded, the current will travel through them. This holds true with cords that have been exposed to vehicle traffic, pinched in doorways or any other form of abrasion that result in exposed energized conductors.

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.

Wet conditions: The construction process is seldom slowed down just because of the weather. This creates an opportunity to discover any potential problems with an electrical circuit first hand. Receiving an electrical shock is an indicator that the current is not following its designated path and must be addressed. Many times though a shock is perceived as just a tingle and considered as a nuisance instead of a significant problem. Major inroads have been made in worker protection with the advent of the Ground Fault Circuit Interrupter.

Overhead Power Lines: Workers are often exposed to overhead hazards in the form of power lines carrying enough voltage/amperage to be fatal. Whether using tools that reach into the power lines like extension poles or scaffold work that places workers close to power lines workers need to be made aware of the Minimum Safe Approach Distances. These are the approach boundaries allowed for specific voltages. For the most part, 10 feet is as close as you want to be from overhead conductors. This distance expands as the voltage increases.

GFCI vs. AEGP

Ground Fault Circuit Interrupter vs. Assured Equipment Grounding Conductor Program

In the workplace, employees are at greater risk of exposure to faulty wiring, inadequately protected electrical sources, and coming into contact with energized electrical parts. CFR 1926.404 is the basis of OSHA's interpretations regarding construction ground-fault circuit protection:

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.

It must be understood that an Assured Equipment Grounding Conductor Program has very little to do with protecting an employee from receiving an electrical shock. In reality, the obverse is true: If the electrical cord is in perfect working condition, it is guaranteed to deliver electricity along all conductors regardless of what or who is in the circuit unless it/they cause a fault (short circuit) whereas a Ground Fault Circuit Interrupter would break the circuit when an abnormality is sensed. The circuit protection device (i.e. fusible link or breaker style) needs a current increase past a pre-designed maximum to melt the link or operate the latching mechanism, thus turning the circuit breaker off. Since a very large and rapid increase in current past the design rating of the fuse or breaker is usually associated with a serious problem this method of blowing a fuse or tripping a breaker adds an extra element of safety but only protects the wiring, not the person.

In reality the GFCI should have been named the Differential in Potential Sensing Switch since that is what it really does. More often than not, an electrical shock is received when an individual becomes part of an electrical circuit and that usually involves bridging from one phase (hot or neutral) to ground. Of course bridging from hot to neutral will have the same effect. So just how does a GFCI Work? It works by comparing the amount of current going to and returning from equipment along the circuit conductors. When the amount going differs from the amount returning by approximately 5 milliamperes, the GFCI interrupts the flow:

1926.404(b)(1)(ii)

Ground-fault circuit interrupters: All 120-volt, single-phase 15- and 20-ampere (NFPA 70E All 125-volt, single phase, 15- and 20- and 30-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.

When it is all said and done, electrical shock is no laughing matter and can be easily prevented by using a GFCI and planning work activities so as not to expose workers to energized electrical parts. W&C

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