Science

The Dangers of Electricity

Working with electricity can be dangerous. Engineers, electricians, and other workers deal with electricity directly, including working on overhead lines, electrical installation and circuit assemblies. Others, such as office workers, farmers, and construction workers work with electricity indirectly and may also be exposed to electrical hazards.

How Electric Current affects the Body

Electric Current affects the body when it flows through. The basic unit of current is the amp. This is the current which flows through a resistance of 1 ohm (Ω) when a voltage of 1 volt is applied across it. However, currents as low as thousandths of amps (milliamps) can have an adverse effect on the body. The table below gives an illustration of the types of effects various levels of currents can have on the body.

Shock Physiological Effects

Electric Current (1 second contact)	Physiological Effect
1 mA	Threshold of feeling, tingling sensation.
5 mA	Accepted as maximum harmless current
10-20 mA	Beginning of sustained muscular contraction ("Can't let go" current.)
100-300 mA	Ventricular fibrillation, fatal if continued. Respiratory function continues.
6 A	Sustained ventricular contraction followed by normal heart rhythm. (defibrillation). Temporary respiratory paralysis and possibly burns.

30 mA can cause the onset of potentially fatal respiratory paralysis.
The adverse effect will be directly related to the level of current, the length of time that the body is exposed and the path the current takes through the body.

Most of us have experienced some form of electric "shock," where electricity causes our body to experience pain or trauma. If we are fortunate, the extent of that experience is limited to tingles or jolts of pain from static electricity build up, discharging through our bodies. When we are working around electric circuits, capable of delivering high power to loads, electric shock becomes a much more serious issue, and pain is the least significant result of shock.

As electric current is conducted through a material, any resistance (opposition to flow of electrons) results in a dissipation of energy, usually in the form of heat. This is the most basic and easy-to-understand effect of electricity on living tissue: current makes it heat up. If the amount of heat generated is sufficient, the tissue may be burnt. The effect is physiologically the same as damage caused by an open flame or other high-temperature source of heat, except that electricity has the ability to burn tissue well beneath the skin of a victim, even burning internal organs.

Another effect of electric current on the body, perhaps the most significant in terms of hazard, regards the nervous system. By "nervous system" we mean the network of special cells in the body called "nerve cells" or "neurons" which process and conduct the multitude of signals responsible for regulation of many body functions. The brain, spinal cord, and sensory/motor organs in the body function together to allow it to sense, move, respond, think, and remember.

Nerve cells communicate to each other through the transmission of electrical signals (very small voltages and currents). If electric current of sufficient magnitude is conducted through a living creature (human or otherwise), its effect will be to override the tiny electrical impulses normally generated by the neurons, overloading the nervous system and preventing internal signals from being able to actuate muscles. Muscles triggered by an external (shock) current will involuntarily contract, and there's nothing the victim can do about it.

This problem is especially dangerous if the victim contacts an energised conductor with his or her hands. The forearm muscles responsible for bending fingers tend to be better developed than those muscles responsible for extending fingers, and so if both sets of muscles try to contract because of an electric current conducted through the person's arm, the "bending" muscles will win, clenching the fingers into a fist. If the conductor delivering current to the victim faces the palm of his or her hand, this clenching action will force the hand to grasp the wire firmly, thus worsening the situation by securing excellent contact with the wire. The victim will be completely unable to let go of the wire. This effect can only be stopped by stopping the current through the victim.

Even when the current is stopped, the victim may not regain voluntary control over their muscles for a while, as the neurotransmitter chemistry has been thrown into disarray. Electric current is able to affect more than just skeletal muscles in a shock victim, however. The diaphragm muscle controlling the lungs, and the heart -- which is a muscle in itself -- can also be "frozen" by electric current. Even relatively low currents can often scramble nerve cell signals enough that the heart cannot beat properly, sending the heart into a condition known as fibrillation. A fibrillating heart flutters rather than beats, and is ineffective at pumping blood to vital organs in the body. In any case, death from asphyxiation and/or cardiac arrest will generally result from a strong enough electric current through the body.