Electricity Training

Aims Community College

Facilities and Operations

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- Electricity is a ubiquitous energy agent to which many workers in different occupations and industries are exposed daily in the performance of their duties. Many workers know that the principal danger from electricity is that of electrocution, but few really understand just how minute a quantity of electrical energy is required for electrocution.
- In reality, the current drawn by a tiny 7.5 watt, 120-volt lamp, passed from hand to hand or hand to foot across the chest is sufficient to cause electrocution.1 The number of people who believe that normal household current is not lethal or that powerlines are insulated and do not pose a hazard is alarming. Electrocutions may result from contact with an object as seemingly innocuous as a broken light bulb or as lethal as an overhead powerline, and have affected workers since the first electrical fatality was recorded in France in 1879 when a stage carpenter was killed by an alternating current of 250 volts.

- *Electricity is the flow of an atom's electrons through a conductor. Electrons, the outer particles of* an atom, contain a negative charge. If electrons collect on an object, that object is *negatively charged. If the electrons flow from an object through a conductor, the flow is called electric current.*
- Four primary terms are used in discussing electricity: voltage, resistance, current, and ground

- *Voltage is the fundamental force or pressure that causes electricity to flow through a conductor and* is measured in volts. *Resistance is anything that impedes the flow of electricity through a conductor* and is measured in Ohms.
- *Current is the flow of electrons from a source of voltage through a* conductor and is measured in amperes (Amps). If the current flows back and forth (a cycle) through a conductor, it is called *alternating current (AC). In each cycle the electrons flow first in one* direction, then the other. In the United States, the normal rate is 60 cycles per second [or 60 Hertz (Hz)]. If current flows in one direction only (as in a car battery), it is called *direct current (DC).*
- AC is most widely used because it is possible to step up or step down (i.e., increase or decrease) the current through a transformer. For example, when current from an overhead powerline is run through a pole-mounted transformer, it can be stepped down to normal household current.

- ***Ohm's Law (Current=Voltage/Resistance) can be used to relate these three elements mathematically.***
- **A *ground is a conducting connection, whether or not unintentional, between an electrical circuit or* equipment and the earth, or to some conducting body that serves in place of the earth.**

- Electrical injuries consist of four main types: electrocution (fatal), electric shock, burns, and falls caused as a result of contact with electrical energy.
- Electrocution results when a human is exposed to a lethal amount of electrical energy. To determine how contact with an electrical source occurs, characteristics of the electrical source before the time of the incident must be evaluated (pre-event). For death to occur, the human body must become part of an active electrical circuit having a current capable of overstimulating the nervous system or causing damage to internal organs. The extent of injuries received depends on the current's magnitude (measured in Amps), the pathway of the current through the body, and the duration of current flow through the body (event). The resulting damage to the human body and the emergency medical treatment ultimately determine the outcome of the energy exchange (post-event)

- Electrical injuries may occur in various ways: direct contact with electrical energy, injuries that occur when electricity arcs (an arc is a flow of electrons through a gas, such as air) to a victim at ground potential (supplying an alternative path to ground), flash burns from the heat generated by an electrical arc, and flame burns from the ignition of clothing or other combustible, nonelectrical materials.
- Direct contact and arcing injuries produce similar effects. Burns at the point of contact with electrical energy can be caused by arcing to the skin, heating at the point of contact by a highresistance contact, or higher voltage currents. Contact with a source of electrical energy can cause external as well as internal burns.
- Exposure to higher voltages will normally result in burns at the sites where the electrical current enters and exits the human body. High voltage contact burns may display only small superficial injury; however, the danger of these deep burns destroying tissue subcutaneously exists.8 Additionally, internal blood vessels may clot, nerves in the area of the contact point may be damaged, and muscle contractions may cause skeletal fractures either directly or in association with falls from elevation. It is also possible to have a low-voltage electrocution without visible marks to the body of the victim.

- Flash burns and flame burns are actually thermal burns. In these situations, electrical current does not flow through the victim and injuries are often confined to the skin.
- Contact with electrical current could cause a muscular contraction or a startle reaction that could be hazardous if it leads to a fall from elevation (ladder, aerial bucket, etc.) or contact with dangerous equipment.

- The NEC describes high voltage as greater than 600 volts AC.5 Most utilization circuits and equipment operate at voltages lower than 600 volts, including common household circuits (110/120 volts); most overhead lighting systems used in industry or office buildings and department stores; and much of the electrical machinery used in industry, such as conveyor systems, and manufacturing machinery such as weaving machines, paper rolling machines or industrial pumps.

- A total of 5,348 workers were electrocuted in 5,180 incidents from 1980 through 1992. One-hundred fifty-three (3%) of the fatal incidents resulted in multiple fatalities: 140 incidents involved 2 victims each, 11 incidents involved 3 victims each, and 2 incidents involved 4 victims each.
- An average of 411 workers were electrocuted each year, with an average annual rate of 0.4 per 100,000 workers. Figure 1 provides the frequency and rate per 100,000 workers of electrocutions by year of death. The substantial decrease is noteworthy, but it varies by industry. While total workrelated fatalities decreased 23% from 1980 to 1989,24 the number of electrocution deaths have decreased by more than 50% from 1980 to 1992.

- At least one of the following five factors was present in all 224 incidents evaluated by the FACE program: (1) established safe work procedures were either not implemented or not followed; (2) adequate or required personal protective equipment was not provided or worn; (3) lockout/tagout procedures were either not implemented or not followed; (4) compliance with existing OSHA, NEC, and NESC regulations were not implemented; and (5) worker and supervisor training in electrical safety was not adequate.

- Most of the 224 occupational electrocution incidents investigated as part of the FACE program could have been prevented through compliance with existing OSHA, NEC, and NESC regulations; and/or the use of adequate personal protective equipment (PPE). All workers should receive hazard awareness training so that they will be able to identify existing and potential hazards present in their workplaces and relate the potential seriousness of the injuries associated with each hazard. Once these hazards are identified, employers should develop measures that would allow for their immediate control

- A strong commitment to safety by both management and workers is essential in the prevention of severe occupational injuries and death due to contact with electrical energy.

- **BE SAFE**