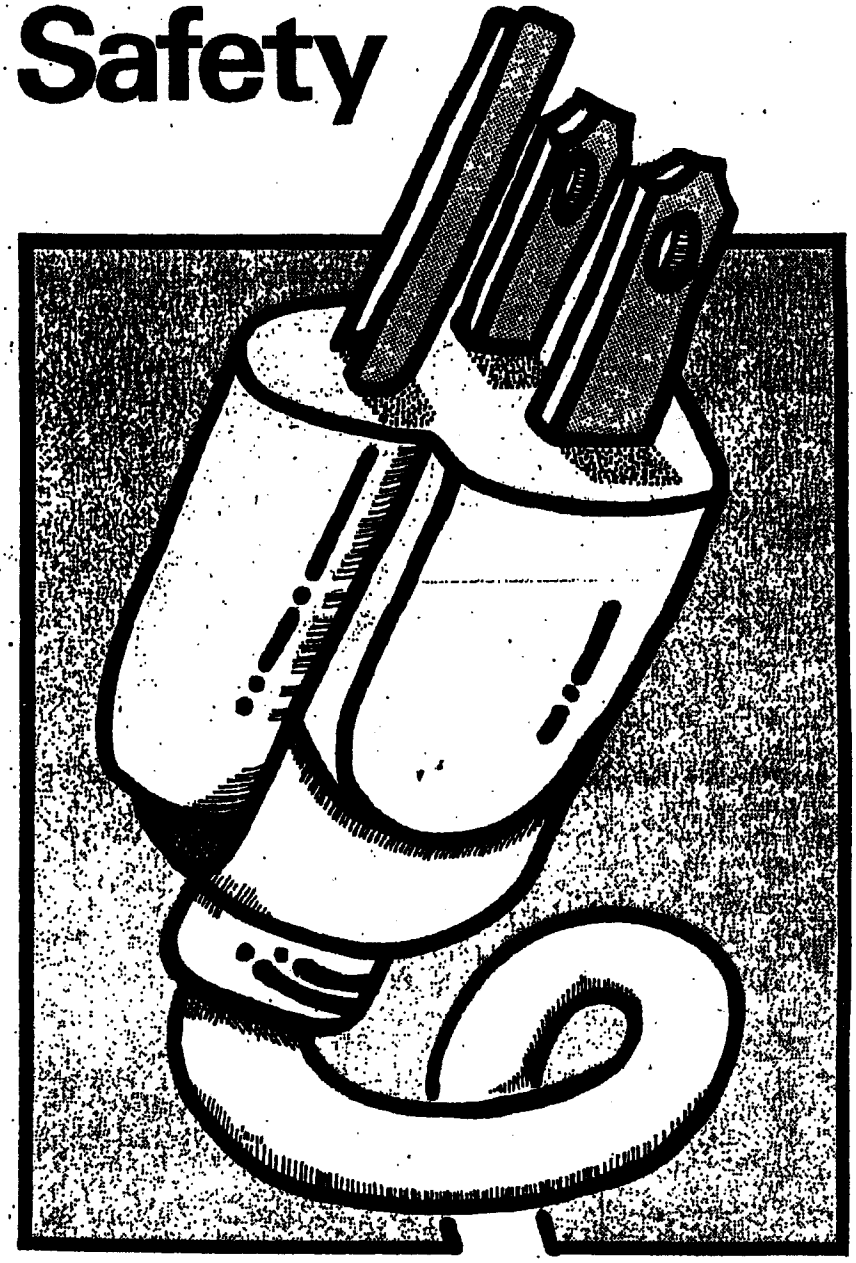
Electrical Safety



State of California
Gray Davis, Governor
Stephen J. Smith,
Director of
Industrial Relations

S-650
May 1999

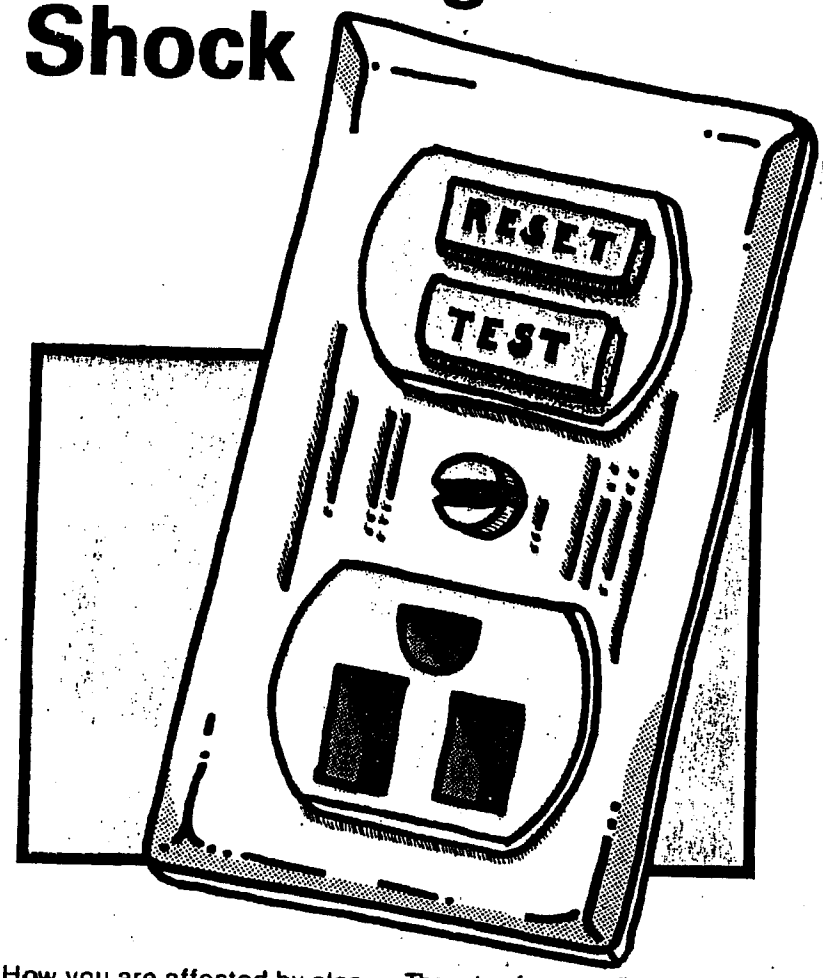
Electrical Safety

Industry runs on electricity. It is efficient, clean, relatively inexpensive, and safe to use when adequate precautions are taken. When precautions are not taken, however, electricity is a killer. A yearly average of 28 workers are killed and 559 disabled in California due to occupational accidents involving electric shock.

This pamphlet explains some of the most common electrical hazards, what you can do to protect yourself against them, and some of the steps the law requires employers to take to provide workers with a safe and healthful workplace.

Regulations referred to in this pamphlet are contained in Title 8 of the California Administrative Code. Most of the regulations can be found in Subchapter 5, the Electrical Safety Orders. This pamphlet is not a legal interpretation or a legal restatement of the Safety Orders. Refer to Title 8 for detailed and exact information, specifications, and exceptions.

Preventing Shock



How you are affected by electric shock depends on:

1. *The rate of flow of the current through your body*

The rate of current flow (measured in amperes) depends on how good a conductor of electricity your body is. If you have dry hands and are standing on a non-

conductive surface such as a rubber mat, you may not even feel a shock. If you are perspiring and are standing in water, you may be killed.

2. *The length of time the current flows through your body*

If the shock causes you to freeze to the conductor, you could receive severe internal injury. The longer the electrical contact the greater the current flow and the greater the shock.

3. *The path the current takes through your body*

The most dangerous paths through the body which the current can take are those in which the current passes through vital organs. Current which runs from hand to hand, from hand to head, or from foot to hand or head can cause severe internal damage especially to the heart and lungs.

It is the rate of current flow through the body, more than anything else, which determines how serious the shock will be. As the current increases, effects on the body range from a just noticeable shock to paralysis of the lungs and heart failure.

Because of the danger of electric shock, CAL/OSHA regulations specify that only qualified workers work on electrical equipment or systems.

No work is to be done on exposed, energized parts of equipment or systems until:

- a responsible supervisor has determined that the work *must* be done while the part or system is energized
- workers have been trained in the techniques and hazards involved in the job
- personal protective equipment (including eye protection) has been issued
- necessary barriers, barricades, tags, or signs are in place

When the work has been completed, the supervisor is responsible to ensure that all permanent barriers and covers are reinstalled.

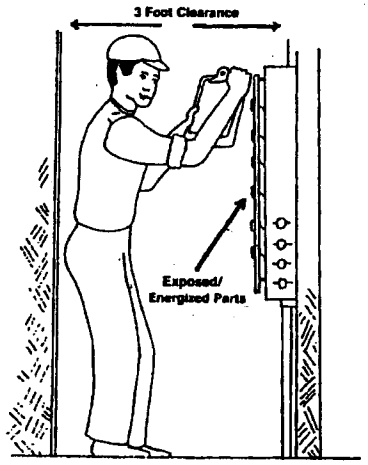
Clearances

Make sure there is sufficient clearance to operate and service electrical equipment safely. The chance that a worker may be shocked increases when he or she works on equipment with energized and exposed parts in a cramped space. Because of the danger posed to workers who work in cramped spaces, CAL/OSHA has established regulations setting minimum clear distances around electrical equipment rated at 600 volts or less. The minimum clear distances depend on :

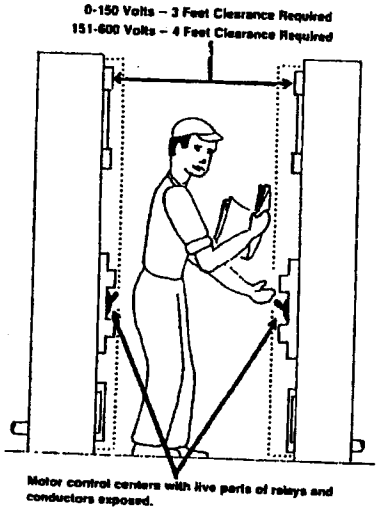
1. the voltage rating of the equipment

2. the nature of the work area

In this illustration the worker is working on a switchboard, parts of which are exposed and energized. However, because the wall to his back is well insulated, there is little danger of shock if he accidentally touches an energized part of the switchboard and the opposing wall. The minimum clearance under these conditions is 3 feet from the face of the switchboard to the opposing wall.

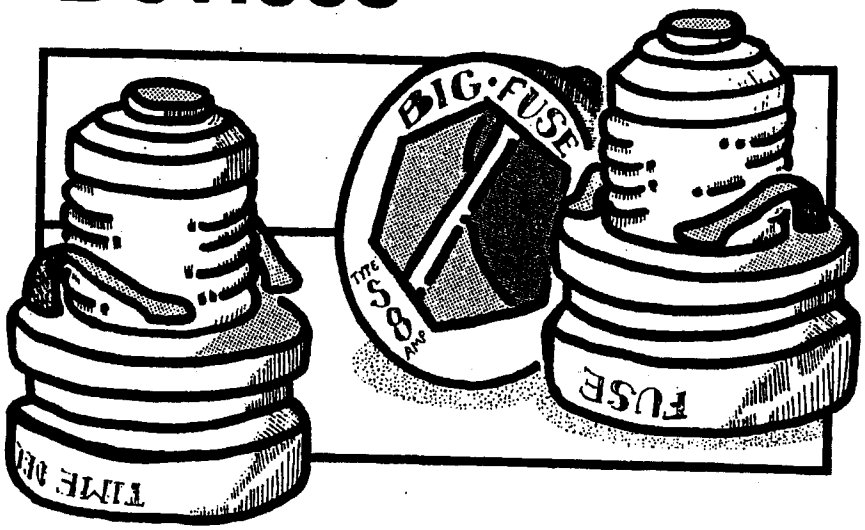


In this illustration the worker can touch both an energized part of the switchboard and the grounded wall. Current will flow through the worker to ground possibly causing a disabling injury or death. To prevent this from happening, minimum clearances between the face of the switchboard and the opposite wall are 3 feet for voltages up to 150 and 3½ feet for voltages between 151 and 600.



There are exposed, energized parts on both sides of the work area. If the worker makes contact with both sets of switches, he can become part of a short circuit with potentially fatal amounts of current flowing through him. To avoid this, minimum clearances between the switches are 3 feet for voltages of between 0 and 150, and 4 feet for voltages between 151 and 600.

Protective Devices



Fuses and Circuit Breakers

Both fuses and circuit breakers are "overcurrent" devices used to prevent damage to wiring and equipment caused by an excessive flow of current. Their current ratings are so high (15 to 30 amperes for most residences) that they cannot protect against shock. When the current flow exceeds the rated levels, the fuse melts or the circuit breaker is tripped. In either case, the circuit is broken and current can no longer flow.

Grounding

There are two types of grounding:

1. *System grounding* in which one of the current carrying wires is connected to a grounded conductor

2. *Equipment grounding* in which the metal frame of the equipment is grounded or bonded to another piece of equipment which is grounded.

Systems are grounded to protect the wiring and equipment against excessive flow of current. The *equipment* is grounded to protect the operator against shock.

If the ungrounded frame of a hand tool becomes energized, the quickest and easiest path for the current to take to ground is through the worker. Depending on the conditions, the effects of the shock will range from slight to fatal.

If the frame of the tool is grounded, the connection to ground provides an easy pathway for the current to follow. This does not mean that the worker will not receive a shock. A certain amount of current will flow through the worker. But the chances of serious injury or death are reduced because most of the current will follow the grounding wire.

Ground Fault Circuit Interrupters (GFCI)

The ground fault circuit interrupter is an inexpensive device which measures the difference in current levels going to and returning from a piece of electrical equipment. How does this device protect against shock? If there is a ground fault in the equipment so that the metal frame becomes energized, a certain amount of current will flow through the operator to ground. The GFCI senses this leakage, trips, and breaks the circuit within 1/40th of a second. Instead of possible electrocution, the worst effect on the operator will be a painful shock before the circuit is broken. Workers who operate electrical equipment should be protected by GFCI's against the disabling and often fatal effects of ground faults.

CAL/OSHA regulations require the use of GFCI's on all 120 volt, AC, single phase, 15-20 ampere receptacles on construction sites when:

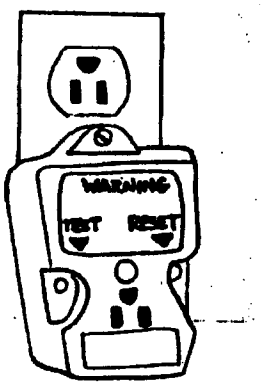
- the receptacles are used by workers
- the receptacles are not part of the permanent wiring of the structure

While GFCI's provide workers with the best protection from electric shock, employers may institute an Assured Equipment Grounding Conductor Program as an alternative to installing GFCI's.

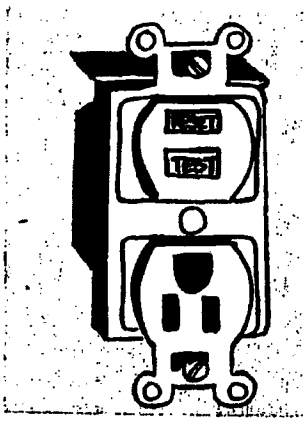
Ground Fault Circuit Interrupters

There are three basic types of ground fault circuit interrupters all of which have a test and reset button:

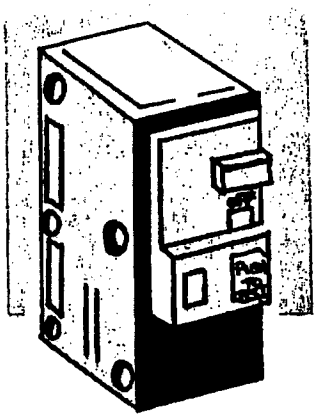
- Portable adapter for existing wall outlets (convenient because it requires no installation and can be used on 2 as well as 3 outlets.
- Replacement for wall outlets
- Circuit breaker type of GFCI



Portable Adapter

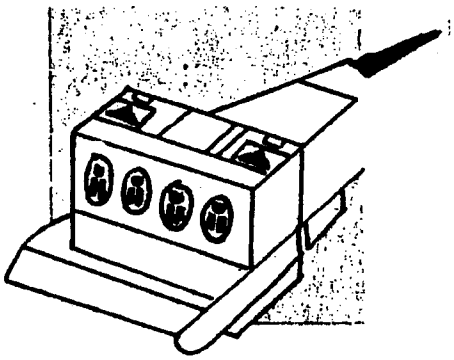


Replacement



Circuit Breaker Type

In addition, portable multiple outlet ground fault circuit interrupters are available for use on construction sites and industrial sites where heavy duty, multiple outlet GFCI's are required.



Heavy Duty GFCI

Lock Out

Many occupational injuries and deaths occur during the cleaning, adjusting, and servicing of machinery. Here's why:

A machine needs servicing. The worker disconnects the machine from the power source and begins to service the machine. Has the worker taken the necessary precautions to prevent an accident? No! In a few minutes another worker comes by and reconnects the machine to the power source. The servicing worker may be injured by electric shock or may be caught in the moving parts of the machine.

When you have to do maintenance work on a machine, take these four steps to protect yourself and your co-workers from injury:

1. De-energize the machine. Positively disconnect it from the power source. If there is more than one source of power, disconnect them all.

2. LOCK OUT the disconnect switches. You must be given a lock and key for each disconnect before you begin working on the machine.

3. Tag the disconnect switches. Get tags or accident prevention signs from your supervisor.

4. Keep the key with you or with your direct supervisor.

Each worker who works on the machine must lock out and tag the power disconnect. Never assume that the machine you are working on has been disconnected and locked out unless you have done it yourself.

Overhead Lines

Farm workers and construction workers in particular must be concerned with the hazards posed by high voltage overhead lines. Each year workers who accidentally make contact with these lines are killed and disabled.

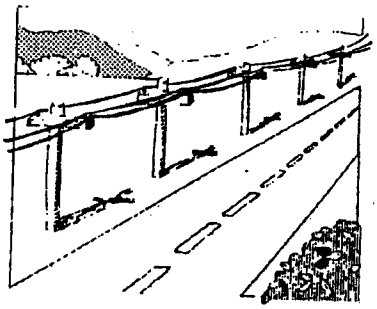
What precautions can you take to avoid this kind of accident?

CAL/OSHA Safety order 2946(b)(4) prohibits the storage of irrigation pipe or long metal poles near high voltage overhead lines if they are long enough to reach the lines. With some exceptions, work done *over* "live" overhead lines is against the law. The Safety Orders also forbid any work within 6 feet of lines carrying between 600 - 50,000 volts.

Do not store tools, machinery, or equipment near "live" high voltage overhead lines if it is possible for them to come within the minimum clearance distance (6 feet) when they are being moved or used.

When you are using boom-type lifting or hoisting equipment, the minimum clearance is 10 feet from overhead lines carrying between 600 - 50,000 volts except when the equipment is in transit with the boom lowered and no load attached when the minimum clearance must be 6 feet. Post a warning sign on the equipment in clear view of the operator which says:

UNLAWFUL TO OPERATE THIS EQUIPMENT WITHIN 10 FEET OF HIGH VOLTAGE LINES OF 50,000 VOLTS OR LESS



If you don't know if a line is "live", *assume that it is* until whoever owns or operates the line verifies that the power is not on. If you are working near a "dead" line, make sure that it is *clearly grounded* at the work site. (A grounded line has a grounding wire clamped to it with the other end clamped to the structure or to a grounding rod.)