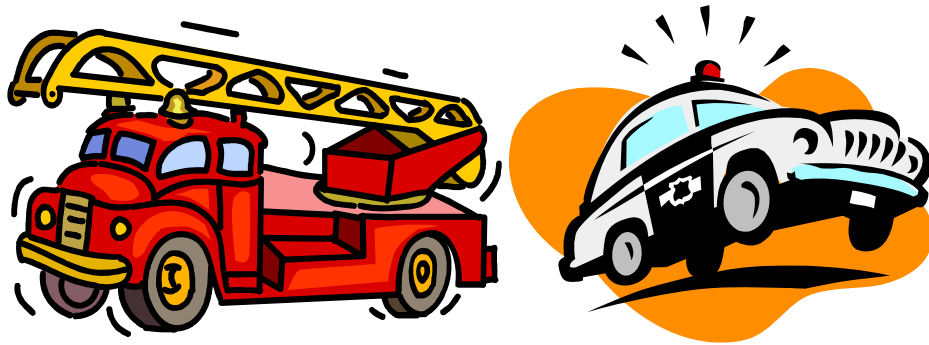


Georgia Public Safety

911 Emergency

First Responder Training



Identifying and Avoiding Electrical Hazards

Student Guide

Purpose

**Terminal Performance
Objective**

Enabling Objectives

Lesson

Purpose

The purpose of this training is to give the student an understanding of electric facilities and how to identify and avoid electrical hazards from a first responder's point of view.

Terminal Performance Objective

Given the need to respond to an electrical fire or wire, the first responder will identify and avoid potential electrical hazards according to the guidelines provided by Georgia Power.

Enabling Objectives

1. Define the goal of the first responder.
2. Identify the basic characteristics of electricity.
3. List the three basic parts of an electrical system.
4. List the levels and thresholds of electrical shock on the human body.
5. List and describe the two types of shock injuries.
6. List the protective gear a first responder shall wear when treating an electrical shock victim.
7. Define the term energized.
8. Describe safety procedures for the first responder and vehicle occupant when a vehicle accident involves an energized power line.
9. Identify the safest matter of water spray when combating an electrical fire.
10. List the do's and don'ts of entering a burning building.
11. Describe the hazards associated with substation, plant, and transmission fires.

Student Guide

Video Introduction

The goal of the responder is to “*protect life and property*”.

Segment One

Electricity The Basics

The video uses water to illustrate the characteristics of voltage, amps and resistance. He talks about insulators and conductors.

- Voltage is the measurement of electrical force or pressure.
- Amperage is the measurement of electrical current.
- Resistance is the property of a material to inhibit current flow.

Segment Two

The Electrical System

Generation, Transmission and Distribution are the three basic parts of an electrical system.

- Fossil fuel, hydro, and nuclear are common types of generation facilities.
- Towers, poles, 50,000 volts to 500,000 volts and transformers are common characteristics of a transmission system.
- 120 volts, meters and transformers are common characteristics of a distribution system.
- Energized is the term that describes anything with an electric current running through it.

Student Guide

Segments Three and Four Anatomy of a Shock and Responding to Injuries

When living things unintentionally become part of an electric circuit, bad things happen.

Generally, skin has limited resistance to electrical shock.

Dry, unbroken skin has about 50,000 ohms

Ohms law: Voltage X Resistance = Amperes (amps)

A milliamp is one, one thousands of an amp (1/1000).

The effects of electrical shock on the human body threshold in milliamps:

- 1 milliamp slight tingling sensation
- 10 milliamp mild shock
- 25 milliamps painful shock and muscle contraction
- >25 milliamps severe muscle spasms
- 50 milliamps ventricular fibrillation (irregular heartbeat)
- 200 milliamps severe burning

As voltage increases, the skins ability to resist it decreases.

Severity Factors:

- Duration
- Path through the body
- Skin moisture
- Current strength

Two types of shock injuries:

- Cardiac Arrest
- Electrical Burns

Prior to treating a shock victim, protect yourself by making sure there is not any electrical contact with the victim or in reach of the victim.

Student Guide

When treating a shock victim, protect yourself by wearing:

- Safety glasses
- Gloves
- Mask

When treating an electrical burn victim in regard to where the burn occurred, you should be looking for an:

- Entrance wound
- Exit wound

Segment Five Approaching Energized Areas

When an electrical hazard has been reported and or identified, such as an electrical wire down, it requires a coordinated response. The electrical hazard must be reported to the electrical utility company as soon as possible.

Warning!

When approaching a downed electrical wire:

- Always consider the lines as energized.
- There are no reliable indications that a downed wire is energized.
- Caution begins when approaching the accident site.
- Vehicle tires do not insulate against shock.
- Rubber boots do not insulate against shock.
- When possible, park two spans away on the opposite side of the road.
- Do not touch any power lines whether it appears energized or not.
- When approaching any possible high voltage conductor, the ground may be energized, so leave a 30 foot circle of safety between you and where the wire contacts the ground.
- For downed transmission lines, the minimum safety zone is 100 feet.

Student Guide

Vehicles using an extension device, such as boom and ladder trucks with the ability to reach overhead power lines, shall not be closer than ten feet from the electrical conductors.

Segment Six Vehicle Rescue From Downed Power Lines

Scenario

❖ Response

* Warning

1. Wire down on vehicle, occupant(s) conscious and not impaired, vehicle drivable.
 - ❖ Instruct the occupant to stay in the vehicle and drive away from the conductor, no less than 30 feet.
 - This requires the responder to use good judgment.
 - Do not create a greater hazard by moving the vehicle.
 - Be aware of the conductor recoiling back to the point of attachment. Stay in the clear!
2. Wire down on vehicle, occupant(s) conscious and not impaired, vehicle not drivable.
 - ❖ Instruct the occupant to stay in the vehicle until the utility company has de-energized the down conductor.
 - The responder must notify the utility company and request the conductor be de-energized.
 - The responder **must** know the location.
3. Wire down on vehicle, occupant(s) not conscious and or impaired.
 - ❖ Notify the utility company and request the conductor to be de-energized.
 - The responder **must** know the location.
4. Wire down on vehicle, occupant(s) conscious and not impaired, vehicle on fire.
 - ❖ Instruct the occupant to exit vehicle by jumping from the vehicle without touching any part of the vehicle and once on the ground, keeping feet together, hopping away from the vehicle for no less than 30 feet.

Student Guide

5. Wire down on vehicle, occupant(s) not conscious and or impaired, vehicle on fire.
 - ❖ Use dry chemical to extinguish the fire.
 - This is a very dangerous situation.
 - The dry chemical may not reach the fire.
 - Must maintain 30 feet safety distance
 - Do not use water or fog agents
 - The utility company must be contacted as soon as possible.
6. Wire down creating step potential
 - ❖ Must eliminate difference in voltage between feet by keeping feet together and hopping away from energized conductor.
7. Construction equipment / vehicles working close to overhead wires.
 - ❖ The equipment operator and everyone working in the work area must identify all energized conductors in the work area and maintain a 10 feet safety distance from any and all conductors.
8. Construction equipment / vehicles making contact with overhead wires and the operator is not impaired and equipment is still operative.
 - ❖ Instruct the operator to stay on the equipment / vehicle and move equipment no less than 10 feet from the wire.
9. Construction equipment / vehicles making contact with overhead wires and the operator is impaired and or equipment is not operative.
 - ❖ Keep everyone away from the equipment and if the operator is conscious, instruct the operator to stay on the vehicle and wait for the utility company to de-energize the wire.
10. Construction equipment / vehicles making contact with overhead wires, the operator is not impaired and the situation is such that the operator must leave the equipment.
 - ❖ Instruct the operator to jump clear of the equipment and with both feet together, hop away from the equipment for no less than 30 feet.

Student Guide

Segment Seven Emergencies Involving Electrical Equipment and Facilities

The most common type of electrical equipment outside the substation is the distribution transformer. There are two different types and applications for a distribution transformer:

- ❖ Overhead, pole mounted transformer
- ❖ Underground, pad mounted transformer
 - (The term “underground” refers to the type of system; in that the high voltage and secondary conductors are installed in the ground to a depth determined by the voltage of the conductor. The transformer itself, is generally above ground positioned on a pad.

Both types of transformers contain oil which can create additional hazards. If the oil is burning, never use water or foam. Water and foam are both conductive and could create a path to ground. Always use dry chemical to extinguish the fire.

For overhead transformers that are burning, it is not practical to try to extinguish the fire, let the equipment burn and contain the threat by protecting exposures.

More and more electrical conductors and equipment are underground. Fire and smoke associated with underground equipment are usually found in vaults and manholes. Dealing with these situations are extremely hazardous.

- ❖ If there are no personnel and or equipment at the scene of the fire, stay a safe distance away and call the utility company.
 - **Do not** enter the vault or manhole.
- ❖ If there are personnel present, request the circuits be de-energized. Then test the vault and or manhole for hazardous gases and ventilate if necessary before entering.
 - **Do not** enter the vault or manhole until all electrical and or environmental hazards have been eliminated.

Student Guide

Segment Eight

Electric Hazards in Building Fires

Most electrical fires are caused by excessive heat from wires, machines and appliances, which have been overloaded or poorly insulated. Most dwellings and buildings have energized conductors. Voltages range from 120/240 to over 10,000 volts.

Guidelines For Entry

When entering a building consider leaving the power/lights on to aid in investigating the fire. If smoke limits your visibility, avoid being electrically “tied up” by keeping your palms turned inward to minimize the effect of accidental electrical contact. (When electrical contact is made, arms and hands will pull toward the body and away from the electrical source.)

Warning: Do not remove the electrical meter!

Pulling certain kinds of meters may not disconnect the electrical service to the structure. This is particularly true for apartments, commercial buildings, industrial structures and even some large residences. Many of the structures have current transformer rated metering systems, and pulling the meter will only disconnect the meter circuit while the main circuit remains energized.

If there is a heavy load or a short-circuit condition, pulling meters may short out causing an electrical arc and explosion due to very high fault currents.

Arcs

Other than a laser, electric arcs are the hottest heat source on the planet. Electric arcs are capable of producing up to 10,000 degrees F. A relatively small arc that develops by a short between an energized component and a grounded surface can grow into an arc that consumes the entire work area by superheating the air and following the now-conductive paths to other conductive system components. Heat of this intensity can kill at distances up to 8 feet and burn at distances up to 20 feet. These uncontrolled arcs will continue to burn until either a protective device (such as a transformer fuse) opens or the conductors supplying the circuit burn in the clear.

Student Guide

Explosions

An explosion is the rapid release of energy, gas or heat. Factors that determine how much damage is caused by an explosion include the intensity of the energy source and the distance from the explosive device. Electric fault current is the energy source for an electrical explosion. The intense heat caused by an electric arc causes the surrounding air to expand rapidly. For example, the forces exerted by expanding gases surrounding electric arcs can approach 1,000 psi. These forces could cause structural damage to confined spaces and harm anyone in the work area.

An additional hazard associated with electric explosions is energy produced by an electric blast. An electric blast can make projectiles of anything. The heat caused by an arc can easily melt any metal component and molten metal is often spewed outward during an arc. Similarly, pieces of broken insulators and or unmelted metal parts can be projected outward with enough force to be driven through a firefighter in the work area.

Alternative

Alternative to pulling an electric meter is to locate the main disconnect or fuse box and shut off the power from there.

Additional Key Points:

- ❖ Firefighters gloves are not designed to handle electric wires.
- ❖ Treat all downed wires as energized
- ❖ Do not cut/disconnect wires
- ❖ Even after the power has been turned off, avoid contact with equipment and appliances because of the possibility of alternate or emergency power source.
- ❖ Look up, identify all overhead lines when positioning or using firefighting equipment and or tools
- ❖ When fighting fires around overhead electric lines, keep equipment and tools a safe distance (10 feet) from the power lines.

Have an action plan to identify all electrical hazards

Student Guide

Segment Nine

Fires Involving Electric Substations, Transmission Lines and Generating Plants

Substations

An electric substation has transmission and distribution lines coming in and out.

The purpose of a substation is to:

- ❖ Change the value of voltage and current (step the voltage up or down by changing the current inversely)
- ❖ Protect the lines and equipment coming in and going out as well as, lines and equipment inside the station.
- ❖ To be used as a switching point to manage load and to isolate trouble on the system either automatically or manually.

Substation Components

- ❖ Structures to elevate the lines
- ❖ Battery banks (combustible and toxic gases)
- ❖ Power Transformers (oil filled)
- ❖ Circuit breakers (oil filled)
- ❖ Regulators (oil filled)
- ❖ Capacitors (oil filled)
- ❖ Switches
- ❖ Control buildings

Transformers, regulators, capacitors and circuit breakers all have large amounts of oil that insulates and helps to cool the internal components.

Substations are under the control of the utility control centers and have the ability to dispatch personnel where and when needed.

Do not enter substation before the utility personnel are on site.

Because of the high voltage and possibility of explosions, the safe zone is extended to 300 feet.

Do not use a metal ladder in a substation.

Student Guide

When inside a substation do not have equipment above shoulder height.

Oil fires inside of a de-energized substation, protein foam spray and water fog stream can be use to extinguish the fire.

Never use solid streams of water on oil or pools of oil.

Beware that oil vapors are capable of exploding.

Glass and ceramic insulator exposed to high heat may explode when exposed to water.

Substations have large banks of batteries which are highly combustible and give off toxic gases.

Transmission

Transmission lines are mostly limited to right-of-ways.

Particles of smoke can cause a transmission line to arc.

Maintain a minimum of 100 feet between you and the fire that's next to an energized transmission line.

If a tree is making contact with a transmission line, maintain a minimum of 100 feet between you and where the tree is making contact with the energized transmission line.

Generation Plants

Identify generation plants in your area.

Meet with and create an action plan to deal with the hazards specific to the individual plants.

Apply the same rules for generating plants as it relates to entering and fighting fires for a substation