SHOPWARE

Instructor's Guide

Safety and Technology Series
Electrical Safety

Introduction

This guide provides information to help you get the most out of the *Electrical Safety* program of the *Safety and Technology* series. *Electrical Safety* introduces the various dangers electricians and other trade professionals face when working with electrical apparatus and steps they can take to protect themselves from harm.

Learning Objectives

After viewing the program, students will be able to:

- Name the potential dangers at play when working with electricity.
- Explain the role of a circuit in the flow of electricity.
- Recognize the cause and impact of an electric shock.
- Identify the actions trade professionals must take to ensure safety when using or interacting with varied electrical devices and equipment.

Educational Standards

This program content correlates with the following Electrical Competency Objectives of the National Center for Construction Education and Research (NCCER).

Level One: MODULE 26102-08 – ELECTRICAL SAFETY
1. Recognize safe working practices in the construction environment.
2. Explain the purpose of OSHA and how it promotes safety on the job.
3. Identify electrical hazards and how to avoid or minimize them in the workplace.

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This program correlates with the National Science Education Standards National Committee on Science Education Standards and Assessment, National Research Council.

Science as Inquiry
Content Standard A: As a result of activities in grades 9-12, all students should develop:
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Sciences
Content Standard B: As a result of their activities in grades 9-12, all students should develop an understanding of:
- Structure of atoms
- Structure and properties of matter
- Chemical reactions
- Motions and forces
- Conservation of energy and increase in order
- Interactions of energy and matter

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The activities in this Teacher's Guide were created in compliance with the following National Standards for the English Language Arts from the National Council of Teachers of English.
- Standard 7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

- Standard 8: Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Standards for the English Language Arts, by the International Reading Association and the National Council of Teachers of English. Copyright 1996 by the International Reading Association and the National Council of Teachers of English. Reprinted with permission.

The activities in this Teacher's Guide were created in compliance with the following National Education Technology Standards from the National Education Technology Standards Project.

- Standard 3: Research and Information Fluency. Students apply digital tools to gather, evaluate, and use information.

- Standard 4: Critical Thinking, Problem-Solving & Decision-Making. Students use critical thinking skills to plan and conduct research, manage projects, solve problems and make informed decisions using appropriate digital tools and resources.

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Program Overview

Those who work with electricity continually run the risk of electric shock and electrical fires. This video details electricity-related safety procedures to follow for these hazards, as well as protection of electrical instruments and solid-state devices. This is an excellent overview for those who work with electricity and a useful general safety video for anyone else studying technology.

Main Topics

Chapter 1: Introduction
The opening segment underscores the importance of recognizing the invisible dangers trade professionals encounter when working with electricity. It also points out ways people can protect themselves from harm.

Chapter 2: Electricity
This section explains what electricity is and describes the makeup of a basic electric circuit through which electricity flows.

Chapter 3: Electric Shock
In this segment, viewers learn how electric shocks occur and what can be done to prevent electrocution. It discusses the potential electrical dangers gas-electric hybrid drive systems present, and precautions to take to avoid these dangers.

Chapter 4: Tool Safety
Introduced here are steps to take to prevent accidents and electrocution when working with electrical tools.

Chapter 5: Soldering Safety
This section describes several precautions to take while using soldering tools.

Chapter 6: Equipment Safety
Here, viewers learn the appropriate ways to use electrical power equipment and tools in order to avoid injury or even more serious consequences.

Chapter 7: Electronics Safety
This section lays out various precautionary measures that could prevent injury when trade professionals work with electronics and electrical apparatus.

Chapter 8: House Wiring Safety
In addition to explaining a circuit breaker's function and how wires are rigged to provide electricity, this segment describes how an electrical fire can occur and how to replace a fuse or circuit breaker to prevent overheating that could lead to a fire.

Fast Facts

- Electric shock results when current passes through the tissue of the human body.
- Thousands of people are killed every year because of electrocution.
- The amount of current entering the body primarily depends on the skin's wetness.
- At only 100 milliamps (1/10th of one full ampere of power), a shock can be fatal.
- A current flowing between two hands can be more dangerous than current flowing through one hand, down to your foot, and to ground.
- Current flowing between two hands might flow across your chest, causing heart stoppage.

- Touching high voltage current sources (120 — or even worse — 240 volts AC) causes a person's muscles to experience a reflex, contract, and tighten. And, even more current will then flow through the body, making it difficult for the victim to let go of the current conductor.
- Modern gas-electric hybrid drive systems have enough electrical energy to cause fatal electrocution almost instantly.
- Acid batteries can explode violently. Hydrogen gas inside and around the top of acid batteries is the same fuel powering the sun.
- Melted lead fumes and acid core flux fumes can be hazardous if inhaled.

Vocabulary Terms

AC (alternating current): An electrical current with a magnitude and direction that vary cyclically, as opposed to direct current with a direction that remains constant.

amperage: The rate of electrical current flow in a circuit.

ampere: The ampere (symbol: A) is the SI (International System of Units) unit of electric current.

battery: A device that uses chemicals to generate and store electricity.

charge: The amount of electricity carried by a body.

circuit: A path between two or more points along which an electrical current can be carried.

circuit breaker: An automatic switch that stops the flow of electric current in a suddenly overloaded or otherwise abnormally stressed electric circuit.

conductor: A material (like a metal) through which electricity and heat flow easily.

conduit: A passage through which electric wires can pass.

current: The flow of electricity, commonly measured in amperes.

electric charge: An electromagnetic property of matter that can be positive or negative and will cause either an attractive or repulsive force on another charge.

electric circuit: An electrical device that provides a path for electrical current to flow.

electricity: Energy made available by the flow of electric charge through a conductor.

electrolytic capacitor: A type of capacitor with a larger capacitance per unit volume than other types, making them valuable in relatively high-current and low-frequency electrical circuits.

electron: A negatively charged particle that is a small part of an atom.

ground fault circuit interrupter (GFCI): A specific type of circuit protection that helps safeguard against dangerous shocks.

grounding strap: A ground bracelet or grounding strap is a device that helps prevent the buildup of static electricity in a human body.

hybrid vehicle: A vehicle that uses two or more distinct power sources to move the vehicle.

integrated circuit: A thin chip consisting of at least two interconnected semiconductor devices, mainly transistors.

load: A device that consumes electrical power and is connected to a source of electricity.

milliamp: A rating for batteries. The higher the milliamp rating, the longer the cell can provide power.

multimeter: A portable test instrument that can be used to measure voltage, current, and resistance.

ohmmeter: A meter for measuring electrical resistance in ohms.

resistance: The characteristic of materials to oppose the flow of electricity in an electric circuit.

static electricity: Electric charge that has accumulated on an object. Static electricity is often created when two objects that are not good electrical conductors are rubbed together, and electrons from one of the objects rub off onto the other.

terminal: A connecting point in a circuit where a wire is attached to create an electrical connection.

Pre-Program Discussion Questions

1. What is electricity? What are some dangers associated with electricity?
2. What is the relationship between water and electricity?
3. What causes an electric shock?
4. How can people protect themselves against accidents that might happen when interacting with electrical devices or equipment?
5. What mistakes do you think people make when they are working with electrical apparatus?

Post-Program Discussion Questions

1. What dangers do gas-electric hybrid vehicles pose?
2. What does a circuit consist of and how does each component contribute to the flow of electricity?
3. What are some basic steps all trade professionals should take to protect themselves against electric shock (and electrocution)?
4. What precautions do you take when you are interacting with electrical devices and equipment?
5. How might you conduct an electrical safety training session for people new to the trade professions?

Student Projects

Electrical Safety Training
Students work in small groups to create a brief electrical safety training session based on one of the topics (one per group) highlighted in the film — electric shock, tool safety, soldering safety, equipment safety, electronics safety, and house wiring safety. Encourage students to use a variety of techniques (visuals, props, role plays, dramatization, etc.) to help their peers learn and practice electrical safety.

Shock Proof: The Electrical Safety Board Game
Students create a board game that reflects the various safety tips noted in the film. They can model it after popular board games they play.

Trade Professionals and Electricity
Instruct students to research a variety of trade professions that require contact with electrical devices and equipment. Each student selects one profession to research to learn in what ways their chosen trade professionals interact with electricity and the precautions they take to guard against accidents, electric shock, etc. Students write a one-page description which includes the name of the profession,

type of work involved, types of electrical work required, safety measures taken, etc. The class compiles the descriptions to create a vocational handbook on electrical safety, perhaps for use by people preparing for specific trades.

Face to Face
Students can interview various trade professionals in their community to learn about their work with electrical devices and equipment and how they guard against injuries, accidents, etc. Students share their interview findings with the class via mixed media, for example, using a visual presentation such as a PowerPoint slide, or an audio recording of the interviewees accompanied by "how to" charts.

The "Electric" Quiz
Instruct students to take several online electrical safety quizzes (links below) to see how much they know about the topic as presented in the film and from their general knowledge of electricity. Have them research any topics they are not familiar with.

- http://www.ehs.okstate.edu/modules/electric/quiz.htm
- http://www.twothirtyvolts.org.uk/education/revision-quiz/electrical-safety-11to14.html
- http://www.electriciansnetworks.com/info/electrical-safety-quiz

Assessment Questions

Q1: Which of the following is *not* a component of an electric circuit?
a) A conductor b) A milliamp c) A power source d) A load

Q2: The amount of current entering someone's body depends on the _____.

Q3: True or False? If someone is being electrocuted, use dry, bare hands to free them from the current.

Q4: When working on a gas-electric hybrid vehicle, which of the following should workers do?
a) Remove all jewelry.
b) Wear thick 1000-volt rated rubber gloves.
c) Recognize the extreme high voltage levels in these vehicles.
d) All of the above

Q5: An electrical tool's _____ prevents _____ from passing through the body.

Q6: What does a GCFI do?
a) It accelerates the speed of an electric current.
b) It detects the potential for electrocution.
c) It disables a circuit.
d) It is an alternative to an electrical power cord.

Q7: Which of the following statements is *not* correct?
a) An electrical spark can ignite hydrogen gas.
b) Melted lead fumes are hazardous when inhaled.
c) Hydrogen gas fuels the sun.
d) Acid batteries only explode when on a wet floor.

Q8: True or False? If an electrical cord is overloaded, it can heat up and burn.

Q9: What happens if a person does not wear a grounding strap when working with electronics or electrical items?
a) Static electricity stays on the body.
b) Static electricity flows to the ground.
c) Integrated circuits in the items generate static electricity.
d) The level of static electricity on the body doubles.

Q10: Which item regulates how much current can flow into a circuit?
a) Circuit wiring b) Conductive strap c) Circuit breaker d) Bus bar

Assessment Questions Answer Key

Q1: Which of the following is *not* a component of an electric circuit?

a) A conductor b) A milliamp c) A power source d) A load

A: b

Feedback: A milliamp is a rating for batteries.

Q2: The amount of current entering someone's body depends on the _____.

A: Skin's wetness

Feedback: Wet skin has less resistance to an electric current flow than dry skin.

Q3: True or False? If someone is being electrocuted, use dry, bare hands to free them from the current.

A: False

Feedback: If someone is being electrocuted, turn the power off quickly. If this is not possible, keep yourself insulated from the person by using wood, rubber, or plastic to try to free them. Don't grab the person with bare hands.

Q4: When working on a gas-electric hybrid vehicle, which of the following should workers do?

a) Remove all jewelry.
b) Wear thick 1000-volt rated rubber gloves.
c) Recognize the extreme high voltage levels in these vehicles.
d) All of the above

A. d

Feedback: Because modern gas-electric hybrid drive systems have enough electrical energy (they typically conduct a 3-phase AC at almost 600 volts and almost 300 volts DC at hundreds of amps) to cause fatal electrocution almost instantly, it is important for workers to take the precautions above to protect themselves from harm.

Q5: An electrical tool's _____ prevents _____ from passing through the body.

A: third prong; current

Feedback: Never use an electrical tool, unless it has a functional ground plug. The third prong prevents current from accidentally passing through your body in case of a short in the tool. A short in the tool will follow the path of least resistance, down through the third prong to ground. If this prong is cut off, it might find you to be the path of least resistance, a deadly path.

Q6: What does a GCFI do?

a) It accelerates the speed of an electric current.
b) It detects the potential for electrocution.
c) It disables a circuit.
d) It is an alternative to an electrical power cord.

A. c

Feedback: A ground fault circuit interrupter, also called a GFCI, is a fast acting circuit breaker. It detects small imbalances of about 5 milliamps in the circuit and in a fraction of a second opens to disable the circuit and prevent electrocution.

Q7: Which of the following statements is *not* correct?

a) An electrical spark can ignite hydrogen gas.
b) Melted lead fumes are hazardous when inhaled.
c) Hydrogen gas fuels the sun.
d) Acid batteries only explode when on a wet floor.

A: d

Feedback: No one should work with electricity on a wet floor. Acid batteries can explode violently. Hydrogen gas inside and around the top of these acid batteries is the same fuel powering the sun. Hydrogen gas is produced when the battery is being charged or discharged. The slightest spark or flame can ignite this gas and cause the battery to explode violently. Avoid breathing the fumes created when soldering. Melted lead fumes and acid core flux fumes can be hazardous if inhaled.

Q8: True or False? If an electrical cord is overloaded, it can heat up and burn.

A. True

Feedback: When electrical cords are overloaded, they can heat up and burn. If a cord feels warm, it is overloaded and carrying too much current.

Q9: What happens if a person does not wear a grounding strap when working with electronics or electrical items?

a) Static electricity stays on the body.
b) Static electricity flows to the ground.
c) Integrated circuits in the items generate static electricity.
d) The level of static electricity on the body doubles.

A. a

Feedback: To protect integrated circuits from damage, always ground your body before working. This will allow any static electricity on your body to flow to ground. Even a tiny electric arc from static electricity can ruin delicate integrated circuits. Grounding straps are available for this purpose. The conductive strap fits over your wrist and to chassis ground. This assures that there is not a static buildup that could damage ICs.

Q10: Which item regulates how much current can flow into a circuit?

a) Circuit wiring
b) Conductive strap
c) Circuit breaker
d) Bus bar

A: c

Feedback: Circuit breakers snap over the two hot bars to regulate how much current can flow into the circuit. If current accidentally starts to flow near or above the circuit breaker amp or current rating, the circuit breaker overheats and quickly snaps the circuit open to cut power to the malfunctioning or overloaded circuit.

Additional Resources

American Electric Power: Teaching Electrical Safety
www.aepnationalaccounts.com/safety/TeachingElectricalSafety.aspx

Centers for Disease Control and Prevention
Workplace Safety & Health Topics: Electrical Safety
www.cdc.gov/niosh/topics/electrical

OSHA Academy: Electrical Safety Basics
www.oshatrain.org/courses/pages/715Ae.html

Electrical Safety Foundation International
www.esfi.org

Electricians' Toolbox Etc...
Electrical Safety
www.elec-toolbox.com/Safety/safety.htm

Oklahoma State University: EHS Safety Training
Electrical Safety
http://ehs.okstate.edu/modules/electric/index.htm

United States Department of Labor: Safety and Health Topics
Electrical Safety
www.osha.gov/SLTC/electrical/index.html

Additional Video Programs from Films Media Group

Available from Films Media Group • www.films.com • 1-800-322-8755

Circuits
This program presents both the theory of electric circuits and basic practical methods of managing circuits safely. The benefits and dangers of ground circuits are investigated, together with safety devices such as fuses and ground fault interrupters. The concept of electric resistance is introduced. Specific modules include Completing a Circuit, Fuses, Circuit Breakers, Ground Circuits, Ground Faults, Ground Fault Interrupters, Resistance, and Electrical Resistance. A viewable/printable instructor's guide is available online. A Shopware Production. (27 minutes) ©2008. Order # 38709

Electrical Components Part II: Capacitors, Fuses, Flashers, and Coils
Capacitors, fuses, fuse links, circuit breakers, flashers, coils, and other devices are discussed in this training video. Computer animation, component cutaways, and lab experiments are used to demonstrate how these basic components are constructed and how they operate. This is a must-see for all students of electricity-electronics, technology courses, auto mechanics, and many other subject areas that involve electricity and electronics. A viewable/printable instructor's guide is available online. A Shopware Production. (14 minutes) ©2006. Order # 35396

Electrical: Rough-in and Final
In this video, students will learn how to install cables, wires, boxes, and devices to control current flow, such as switches, outlets, and circuit breakers. Particular attention is paid to safety and the standards of the National Electrical Code. A viewable/printable instructor's guide is available online. A Shopware Production. (15 minutes) ©2004. Order # 31964

GFCIs and AFCIs
Ground-fault and arc-fault circuit interrupters offer the peace of mind that homeowners want—and the life-saving protection that building codes require. After explaining where GFCIs and AFCIs must be used, this video illustrates how to wire GFCI receptacles, GFCI circuit breakers, and AFCIs and then how to test them. A viewable/printable instructor's guide is available online. A Shopware Production. (17 minutes) ©2004. Order # 32074

Grounding
What exactly needs to be grounded in a house, and how is it done? That's what this video explains as it demonstrates how to install a low-resistance panel-to-earth grounding system. Other surge and lightning protection devices are also discussed, and tips on testing systems for functionality and safety are included. A viewable/printable instructor's guide is available online. A Shopware Production. (16 minutes) ©2004. Order # 32073

Wiring for Appliances
Hardwiring doesn't have to be hard. This video looks at some of the most frequently encountered appliances that get wired right into a house's electrical system: electric wall heaters, electric stoves, garbage disposals, dishwashers, thermostats, garage door openers, water heaters, and electric dryers. A viewable/printable instructor's guide is available online. A Shopware Production. (21 minutes) ©2004. Order # 32077