Course Binder Table of Contents

Train-the-Trainer Course 2018

OSHA Funding Disclaimer

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Acknowledgements

The State Building and Construction Trades Council of California, AFL-CIO (SBCTC) acknowledges the following organizations for providing information, training material, and technical support for this course:

- Cal/OSHA
- The Center for Construction Research and Training (CPWR)
- Commission on Health and Safety and Workers' Compensation, California, Department of Industrial Relations, Worker Occupational Safety and Health (WOSH) Specialist Training Program
- Federal OSHA
- International Brotherhood of Electrical Workers
- Labor Occupational Health Program (LOHP), University of California, Berkeley
- WorkSafe BC (Workers' Compensation Board, British Columbia, Canada)

For more information about this training program contact:

State Building & Construction Trades Council of CA (SBCTC)
Website: http://safety.sbctc.org

Course Presenters

Guest Speakers

Train-the-Trainer Course Objectives

After completing this course, participants will be able to:

1. Teach 4 modules of the SBCTC Electrical Hazards for Non-Electricians curriculum:
    - Electrical fatality trends in construction
        - Discuss electrocution numbers and rates for construction
        - Identify main causes of electrocution
        - Describe sources of electrocution
    - Understanding electricity basics
        - Explain basic concepts of electricity
        - Describe seven common electrical terms
        - Explain how electricity travels through a circuit
        - Explain the importance of grounding to worker safety
    - Effects of electricity on the human body
        - Describe main electrical-related injuries: shock, electrocution, burns, falls
        - Explain three factors that affect the severity of shock
        - Identify effects at different levels of amperage
    - Electrical hazards
        - Discuss five primary electrical hazards in construction
        - Apply a hazard assessment model to electrical hazards
        - Recognize hazards, evaluate risk, explain controls and best practices
        - Use teaching tools such as hazard mapping and case study activities

2. Practice best teaching methods and understand adult learning styles

3. Use resources provided through the training

4. Find additional training resources

5. Train a minimum of 20 non-electrical workers about electrical hazards

Train-the-Trainer Course Agenda

Day One:

8:00—8:45 a.m.	Introductions/Course Overview Pre-Test Introduction Section of PowerPoint Section 1—Electrical fatality trends in construction
8:45—9:45 a.m.	Section 2—Understanding electricity basics Hazard Mapping Activity
9:45—10:00 a.m.	Break
10:00—11:45 a.m.	Section 3— Effects of electricity on the human body Section 4—Electrical hazards (first half)
11:45—12:15	Hosted Lunch
12:15—1:15 p.m.	Section 4—Electrical hazards (second half)
1:15—2:30 p.m.	IBEW Guest Speaker
2:30—2:45 p.m.	Break
2:45—4:00 p.m.	Post-Test Choose Teach-back Teams and Topics Review
4:00 p.m.	Adjourn

Train-the-Trainer Course Agenda

Day Two:

8:00—8:45 a.m.	Welcome Back—Overview of Day Two Review Post-Test Results Cal/OSHA Quiz
8:45—9:30 a.m.	How Adults Learn Best Teaching Best Practices Elements of Good and Bad Training Interactive Training Methods Aim for the Bull's Eye
9:30—9:45 a.m.	Break
9:45—11:15 a.m.	Guest Speaker—Cal/OSHA Consultation
11:15—Noon	Teach-Back Preparation
Noon—12:30 p.m.	Hosted Lunch
12:30—1:30 p.m.	Teach-Back Preparation continued
1:30—3:15 p.m.	Practice Teaching—Student Team Presentations
3:15—4:00 p.m.	Wrap-Up Evaluations Next Steps Certificates
4:00 p.m.	Adjourn

How Training Materials Are Organized

The purpose of this training is to raise awareness of construction electrical hazards among non-electrical workers. It is intended to be delivered by trainers who have completed the SBCTC 2-day train-the-trainer course. This training program consists of this course binder, a flash drive and laminated slides. All electronic files needed to present this training are included on the flash drive. Hard copies of the Curriculum and handouts are included in the binder.

Curriculum and PowerPoint: The complete program consists of an introduction plus 4 sections designed for a multi-craft, worker audience. It can be presented at one time in its entirety in approximately 4.5 hours. An "At-A-Glance" page describing each section and approximate teaching times is included. The curriculum is formatted as a table with a left column that displays the PowerPoint slides and a right column with talking points, teaching notes, background information associated with each slide as well as instructions for activities. Each section begins with an overview of key points and what you will need to teach the section. The PowerPoint presentation includes a total of 106 slides.

Videos: 4 videos are embedded in the PowerPoint presentation. They will begin playing when you click on the slide. The video files are saved on the course flash drive in the "Video" folder. They also must be saved in the same file folder with the PowerPoint file in order for the embedded videos to play in your presentation. Additional videos, that are not in the PowerPoint, but that may be useful for your training are included in the Video folder.

The videos used in the presentation are:

- Slide 52 "Jacob's Ladder 500kVA Switch Opening" from YouTube. Demonstrates electricity arcing across high voltage power lines. Run time 10 seconds.
- Slide 54 "70E Electrical Arc Flash Demonstration." Shows what happens during arc flash/arc blast. Run time 1.25 minutes.
- Slide 63 "Power Line Hazard—Fatal Crane Truck Contact" WorkSafe BC video from YouTube. Dramatization of a job site accident resulting in electrocution from contact with overhead power lines. Used as a case study in our training activity. Run time 2 minutes.
- Slide 65 "A Bright Arc" WorkSafe BC video from YouTube. Describes what happens when equipment is energized by overhead power line. Run time 2 minutes.

Handouts: Certain modules of the curriculum use handouts to aid workers in retaining information or to guide activities. The curriculum notes prompt trainers when to use these materials. All required material is included in the "Handouts" tab of the binder and also on the flash drive. Additional factsheets and supplemental information from reputable sources are provided for training purposes only on the course flash drive. The SBCTC is not responsible for the accuracy of this material or for changes that may have occurred after the original publication date. Any reliance you place on such information is therefore strictly at your own risk. We suggest you contact OSHA or Cal/OSHA for current regulatory compliance information.

Training Tips: The binder includes information on training techniques and best practices that you may find helpful when presenting this program to others. These factsheets are from the Worker Occupational Safety and Health Training and Education Program (WOSHTEP) funded by the CA Commission on Health and Safety and Workers' Compensation.

Resources: There is a resource list provided in the binder. You can find useful references and website links related to electrical hazards in construction. This resource list is included as a Word file with active hyperlinks on the course flash drive.

SBCTC Training Forms: Train-the-trainer participants are expected to use this training material to train a minimum of 20 construction trades workers either on-the-job or through apprenticeship training programs. This is called "second-tier training" and must be accurately documented to be counted as part of this OSHA grant-funded program. Trainers will report training activity directly to the SBCTC Project Coordinator. We have provided training sign-in sheets, pre/post tests, evaluation forms, and instructions on how to report the training you accomplish. Second-tier training sessions must be at least 30 minutes in length and cover topics presented in this electrical hazards training material.

Training Post-Test

Name:____________________________ Date:_________________

Instructor:_________________________ Location:__________________________

1. More electricians are electrocuted than non-electricians.
   a. True
   b. False
   c. I don't know

2. Describe two types of injuries that may result from contact with electricity.

3. Workers risk injury or death from electric shock when they accidentally:
   a) Touch an insulated live conductor
   b) Become part of an energized circuit
   c) Use extension cords marked S, SJ, or STO
   d) None of the above

4. Match the four terms at left with their meanings at right. (Some terms will have multiple meanings)

_____ Resistance	A. The flow of electrons.
_____ Current	B. A material through which electricity flows easily.
_____ Conductor	C. Opposes electron flow.
_____ Insulator	D. A material through which electricity doesn't flow easily.
	E. Dry wood
	F. Copper wire
	G. A person

5. Which of these statements is true?
   a) Electricity flows only through the path of least resistance.
   b) A tool that works can't shock me.
   c) Electricity flows from the hot to the neutral.

(Continue on reverse side)

6. What is this device?
   a) Circuit breaker
   b) Circuit tester
   c) Ground fault circuit interrupter
   d) None of the above

7. What is the minimum safe clearance from overhead power lines carrying 50,000 Volts or less?
   a) 6 inches
   b) 100 feet
   c) 10 feet
   d) 5 feet

8. Answer the following questions "true" or "false"
   T F Workers are responsible for fixing faulted circuits or tools they use.
   T F If the tool or equipment continues to operate it does not have a fault condition.
   T F Qualified electricians should fix faulted circuits or tools.
   T F Workers should notify employers or supervisors about circuits that blow frequently

9. Which statement is true if a mobile crane hits a power line?
   a) It is okay to approach the crane if you do it slowly.
   b) The operator should leave as quickly as possible.
   c) Nearby workers may be in greater immediate danger than the operator.
   d) The operator should step down slowly and move away.

10. How should you assist a co-worker who contacts a power line while operating heavy equipment?
   a) Call 911 and the utility company
   b) Encourage her/him to stay on the equipment until utility company personnel say it is safe to get off
   c) If there is danger from fire or another hazard, tell her/him to jump clear of the equipment, keep both feet together, and land without touching the ground and equipment at the same time
   d) All of the above

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Training Pre-Test

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Instructor: _________________________ Location: __________________________

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Training Pre/Post-Test Answer Key

1. More electricians are electrocuted than non-electricians.
   a. True
   b. False
   c. I don't know

2. Describe two types of injuries that may result from contact with electricity.
   Possible answers: Electric shock; electrocution; burns; secondary injuries related to falls

3. Workers risk injury or death from electric shock when they accidentally:
   a) Touch an insulated live conductor
   b) Become part of an energized circuit
   c) Use extension cords marked S, SJ, or STO
   d) None of the above

4. Match the four terms at left with their meanings at right. (Some terms will have multiple meanings)

C	Resistance	A. The flow of electrons.
A	Current	B. A material through which electricity flows easily.
B,F,G	Conductor	C. Opposes electron flow.
D,E	Insulator	D. A material through which electricity doesn't flow easily.
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Train-the-Trainer Course Evaluation 2018

Training Date: __________________ **Your Name (optional):** ________________________________

Instructors: Laura Boatman (SBCTC) and Nazima El-Askari (LOHP)

Thank you for taking the time to complete this evaluation. Your feedback is important and will be used to improve the program.

OVERALL TRAINING EXPERIENCE

Please rate individual aspects of the training by circling the appropriate number below:

	Poor	Fair	Good	Excellent
Content of training	1	2	3	4
Organization of training	1	2	3	4
Quality of presenters	1	2	3	4
Relevance to your work	1	2	3	4
Opportunity for participation	1	2	3	4
Quality of materials/binder	1	2	3	4
Training venue	1	2	3	4
Overall course rating	1	2	3	4

Comments:

(Continue on reverse side)

INDIVIDUAL TRAINING ELEMENTS

Please <u>circle</u> the appropriate rating for each component of the ***Electrical Hazards for Non-Electricians*** training:

	Not useful	Useful	Very useful
Course binder	1	2	3
Curriculum	1	2	3
PowerPoint slides	1	2	3
Laminated slides	1	2	3
Videos:			
Arc flash demonstration	1	2	3
WorkSafe BC—Electrical Safety: Crane Truck Contact	1	2	3
WorkSafe BC—A Bright Arc	1	2	3
	1	2	3
Guest Speakers:			
DJ Siegman, IBEW 617 (Sacramento, San Leandro)	1	2	3
Laura Vergeront, IBEW—Inland Electrical Training Center (San Bernardino)	1	2	3
Gary McIver, Cal/OSHA	1	2	3
Training segments:			
Introduction	1	2	3
1. Electrical fatality trends in construction	1	2	3
2. Understanding electricity basics	1	2	3
3. Effects of electricity on the human body	1	2	3
4. Electrical hazards	1	2	3
Hazard Mapping team activity	1	2	3
"Hazard Challenge—You're the Expert" team activity	1	2	3
Effective training methods	1	2	3
Jeopardy Review Game	1	2	3
Practice Teaching	1	2	3

How confident are you teaching co-workers or students about electrical hazards in construction using the material from this course?

<u>Circle one</u>: **Not confident** **Somewhat confident** **Confident**

Comments:

1) What did you like most about the training?

2) How could the training be improved?

3) What was the most important thing you learned from this training?

4) How do you plan to use what you learned in this training?

5) What additional health & safety training would you like to receive?

Other comments:

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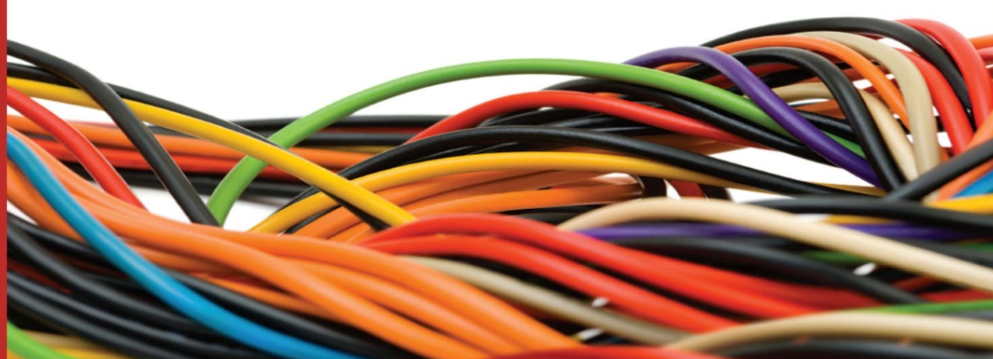
Electrical Hazards for Non-Electricians

2018 Training Curriculum

Presented by:
State Building and Construction
Trades Council of California, AFL-CIO



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Before presenting this training

This curriculum is designed for delivery by experienced instructors who have completed the State Building and Construction Trades Council of California 2018 Train-the-Trainer (TOT) course on Electrical Hazards for Non-Electricians. Instructors who have not completed this course should not attempt to deliver this training.

The curriculum is to be used in tandem with the accompanying PowerPoint presentation. It guides trainers through the entire presentation providing directions, key talking points, background information, activities, and prompting questions to engage the class.

Using this training package requires planning, preparation and practice.

Instructors should do the following before presenting:

- ✓ Study directions in the *Instructor's Guide* provided in the TOT course binder.
- ✓ Thoroughly review the curriculum and PowerPoint slides
- ✓ Assemble all necessary equipment, supplies, props, and handouts in advance
- ✓ Practice using the slides with the curriculum
- ✓ Test the PowerPoint presentation to assure all features are working properly (especially text animation and embedded videos)

Symbols and shaded blocks of text appear throughout the curriculum. Symbols cue trainers to take specific actions. The italicized text in shaded blocks provides optional background information that can be included at the instructor's discretion.

Key to Symbols:

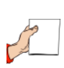
❖ Instructor teaching tips—best practices to improve your presentation

➢ Activity—alerts trainer where to insert organized activities


Class discussion—cue to use effective questioning to engage class


Key point—important information to emphasize


Video—prompt to play video


Handout—prompt to distribute handouts

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Introduction

(30 minutes)
Slides 1-11

Key points in this section:

- Acknowledge source and funding of training material
- How material may be used
- Introduce training topic
- Course objectives
- Hazards covered in this training

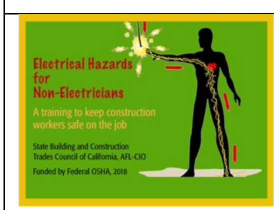
Handouts: Electrical Hazards Pre-Test

Activities:

- ❖ Participant introductions—Name one thing you want out of this training (create list)
- ❖ Participants take the electrical hazards pre-test
- ❖ Brainstorm: create list of questions/concerns regarding electricity at work
- ❖ Brainstorm: examples of unsafe conditions/equipment/acts found on-the-job related to electrical hazards

Materials:

- ✓ Flip chart pad and multicolor pens
- ✓ Easel
- ✓ Tape
- ✓ Timer

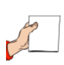


Slide 1—Title Slide

Before starting your training presentation:

Welcome the class:
Introduce yourself and explain that this training will cover Electrical Hazards for Non-Electricians.

Ask each participant to introduce themselves, and state one thing they would like to get out of the training session. Record responses on a flip chart and post in the classroom.

 Administer the pre-test to each participant. Allow 5 minutes for completion, then collect tests.

Slide 2—State Building and Construction Trades Council of CA, AFL-CIO

Identify that this training program was developed in 2017-18 by the State Building and Construction Trades Council of California, AFL-CIO (SBCTC).

Explain that the SBCTC is a statewide non-profit council of building trades unions representing union construction workers throughout California. In existence for more than a hundred years, the SBCTC has been a strong advocate for worker health and safety.

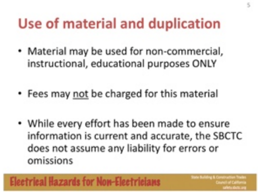
For more information about the SBCTC, visit our website at www.sbctc.org.

Slide 3—Safety and Health HUB

In addition to the SBCTC website, we have a separate online presence specifically for our health and safety training programs (like the one you're experiencing now). You can access materials, videos, resource links, and notifications of upcoming classes by visiting: safety.sbctc.org

Slide 4—Funded by OSHA

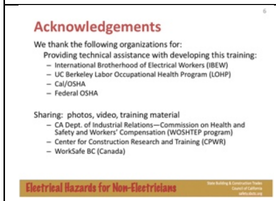
Explain that funding for this program was provided through a grant from federal OSHA. Through the grant program process, material is reviewed and approved by federal OSHA prior to distribution.



Slide 5—Use of Material/Duplication

Emphasize that this training was specifically designed to educate non-electrical workers about electrical hazards in construction. It cannot be used for commercial purposes.

We have made every effort to give proper credit to photo sources used in the PowerPoint presentation. These appear either on the slide or in the notes section below.

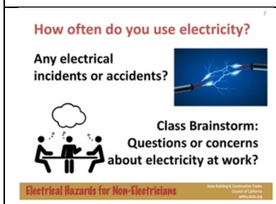


Slide 6—Acknowledgements

Whenever possible, we use existing sources of information to compile our training.

The SBCTC expresses thanks to the organizations listed on this slide for their cooperation in sharing their resources and expertise for the benefit of our training.

When using this training, acknowledge the SBCTC as the source of the material.



Slide 7—How often do you use electricity?

Initiate a class discussion about on-the-job experience with electricity.

Engage the class using prompts like these:

- How often do you use electricity?
- Does a day go by that you don't use it?
- In what ways do you use electricity to do your job?
- When do you become aware of electricity?

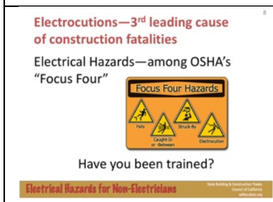
Ask: Has anyone experienced an incident or accident involving electricity, or known someone who has? Discuss what happened.

Class Brainstorm:
What questions or concerns come to mind about electricity at work? Write responses on flip chart.

It's easy to take electricity for granted because you usually don't see it, hear it, feel it, smell it, or taste it until something goes wrong.

It's all around us, overhead, underground, inside walls, floors, and ceilings.

It's easy to use without having much knowledge of how it works; we simply plug in a tool, turn on equipment, flip a switch. But contact with electricity puts you in danger of being hurt or even killed.



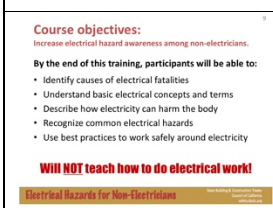
Slide 8—Electrocutions—3rd leading cause of construction fatalities

Electrocutions are the third leading cause of death among construction workers (CPWR). This is why electrical hazards are included in OSHA's "Focus Four" hazards.

Ask for a show of hands: How many of you are familiar with "Focus Four?"

Ask: In addition to electrical, what are the other three hazards?
Click on the slide to reveal answer.
Falls, struck-by, and caught-in-between.

Ask for a show of hands: Has anyone been trained about electrical hazards before now?



Slide 9—Course objectives: Increase electrical hazard awareness among non-electricians

The purpose of this training is to raise awareness of construction electrical hazards among non-electricians. It is not about teaching workers how to do electrical work.

Review the list of objectives on the slide. By the end of this training, participants will be able to:

- Identify causes of electrical fatalities
- Understand basic electrical concepts and terms
- Describe how electricity can harm the body
- Recognize common electrical hazards
- Use best practices to work safely around electricity

	The information presented in this training teaches workers to better understand electrical hazards and best work practices; it is not a compliance-based training. Any references to standards are made only to alert workers that regulations may apply. For help with specific compliance questions, contact your local Cal/OSHA (or OSHA) Consultation office.
	**Slide 10**—Electrical incidents caused by: Since we can't see electricity, we need to learn how to recognize signs of potential danger on the job site. Knowing some basics about how electricity works, how it can hurt you, what puts you at risk and the best practices to safely work around electricity, can save your life. Generally electrical incidents are caused by: ▪ Unsafe conditions; ▪ Unsafe equipment; ▪ Unsafe acts Ask: Have you experienced any of these on-the-job? What examples come to mind based on your work experience? Examples may include: Unsafe conditions—the combination of electricity and a wet work environment; uncovered electrical boxes/panels; using electrical systems that are not properly grounded; working in close proximity to energized high voltage lines. Unsafe equipment—power tools with cracked casings or damaged cords; broken electrical outlets; frayed or spliced extension cords. Unsafe acts—doing excavation without first locating power lines; working on electrical systems when you're not a qualified electrician; not reporting a recognized hazard to your supervisor; using a metal ladder when working near sources of electricity; altering equipment; not following manufacturers' instructions. We will discuss all of these in this training. Discuss: Who holds responsibility for each of these? Employers have the legal responsibility for providing a safe and healthful workplace and complying with OSHA and Cal/OSHA standards. Workers must be effectively trained to recognize hazards and understand proper policies and procedures for controlling or eliminating them.

<table>
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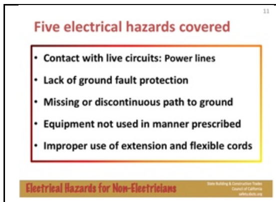

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Slide 11—Five electrical hazards covered

This class focuses on the five hazards that most frequently cause electrical injuries and fatalities in construction:
Click the slide to reveal hazards

– Contact with power lines (overhead/underground high voltage)
– Lack of ground fault protection
– Path to ground missing or discontinuous
– Equipment not used in manner prescribed
– Improper use of extension and flexible cords

You may not be familiar with some of the terms included here, but you will learn them in this training.

Ask: Are there any questions about what we are going to cover in this safety class?
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Section 1: Electrical Fatality Trends in Construction

(15 minutes)
Slides 12-19

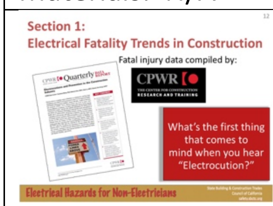
Key points in this section:

- Number of fatalities due to electrocution have decreased in construction
- Across all industries, construction has the highest amount of work-related electrocutions
- The highest percentage of construction electrocutions occurred among non-electrical trades workers
- Both low voltage and high voltage can cause electrocution
- Electric parts, ladders, and hand tools were the leading source of electrocution

Handouts: N/A

Activities: Interactive discussion (follow prompts)

Materials: N/A



Slide 12—Electrical fatality trends in construction

What do we know about electrical incidents on-the-job? To put electrical hazards in perspective, we're going to look at recent data trends and patterns of construction fatalities due to contact with electricity.

The data presented in the next few slides was compiled by CPWR—the Center for Construction Research and Training. The charts are from their online "Quarterly Data Report—Third Quarter 2017—Electrocutions and Prevention in the Construction Industry."
(The full report is available on their website at https://www.cpwr.com/publications/third-quarter-electrocutions-and-prevention-construction-industry.)

The source of the data is the U.S. Department of Labor Bureau of Labor Statistics (BLS). The BLS is a governmental statistical agency that collects, processes, analyzes, and disseminates essential statistical data to the public, Congress and other Federal agencies, State and local governments, business, and labor. It is the principal Federal agency responsible for measuring labor market activity and workplace injury and fatality statistics.

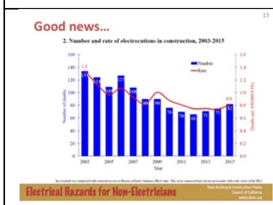
You'll notice that "current" data covers through 2015. Finalized, published data always lags a couple of years behind the current year.

The data we're discussing here focuses only on **fatal** injuries from **electrocution**.

What's the first thing that comes to mind when you hear the term electrocution?

Ask: What does it mean?
Answer: A fatal electric shock.

❖ *Someone may ask why non-fatal injuries are not included. In their report, CPWR explains that the number of non-fatal injuries caused by electrical hazards is small. According to the Electrical Safety Foundation International, about one fourth of 1% of all nonfatal injuries resulting in days away from work could be attributed to electricity during 2015. Although a significant source of fatalities, nonfatal electrical injuries remain relatively rare compared to many other injury types. Electrical shock and burns are the main non-fatal injuries due to contact with electricity.*

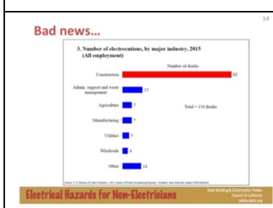


Slide 13—Good news…

As this chart illustrates, the good news is that both the rate and number of electrocution fatalities decreased between 2003-2015. Numbers in construction fell by 39%.

The lowest dip in numbers coincides with the economic recession that affected the construction industry.

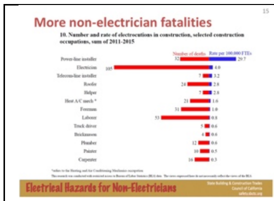
But a longer, declining trend in electrocutions, as compared to overall construction fatalities, suggests that electrical hazard interventions are effective.



Slide 14—Bad news…

The bad news is that 82 construction workers still died of electrocution in 2015. This means that, across all industries, construction claimed 61% of all the U.S. work-related electrocutions.

On average from 2003 to 2015, about 9% of construction fatalities were from electrocution.

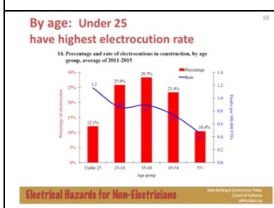


Slide 15—More non-electrician fatalities

Looking at this chart, we see that electricians had more electrocutions than any other single craft while power-line installers had the highest rate. This may not seem surprising since electricians and power line installers work directly with electricity all the time and have high exposure to electrical hazards.

What you might not realize, is that more than half (58%) of the construction workers electrocuted between 2011-15 worked in <u>non-electrical</u> trades. If you add up the number of deaths for all the other crafts listed, 190 workers from non-electrical trades died in this same period.

This is why it's critical for all workers to be aware of electrical hazards on-the-job.

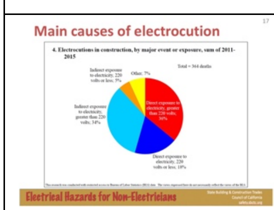


Slide 16—By age: Under 25 have highest electrocution rate

When looking at results for different age groups, this bar graph shows that middle-aged workers in the 35-44 year old group had the largest **proportion**, just under 29% of electrocutions.

But the blue line shows that workers under 25 years old had the highest **rate** of any age group at 1.2 fatalities per 100,000 FTE.

It is important that workers, regardless of experience level, receive effective training and regular reinforcement of best practices for working safely around electrical hazards. It's equally important that employers regularly review and implement policies, procedures and training programs to protect all workers.



Slide 17—Main causes of electrocution

This pie chart indicates the main causes of electrocutions in construction between 2011-15.

What stands out to you? Discuss feedback.

Ask: What do we mean by "direct and indirect exposures?"
Answer:
Direct exposure means a worker makes direct contact with a power source, such as touching a live wire or being struck by an electrical arc.

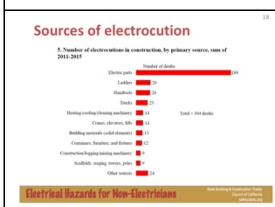
Indirect exposure means an object accidentally becomes electrified, such as a crane contacting a power line, or a pipe being held by a worker touches a power line, or electricity is transmitted to a worker through a wet surface.

Most deaths (two-thirds) were caused by direct and indirect exposure to more than 220 volts of electricity (the Red and Light Blue wedges).

Ask: Is 220 volts considered high voltage?
Answer: Cal/OSHA Electrical Safety Orders designates high voltage as above 600 volts.

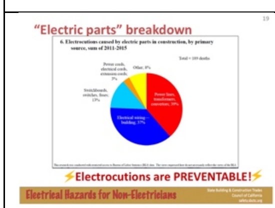
Electrocutions can occur from contact with both low and high voltage.

❖ *The "Other" category on this chart includes "unspecified cause or voltage" meaning that the data reported was non-specific.*



Slide 18—Sources of electrocution

This graph identifies primary sources of electrocution. While electric parts are the leading source, we also see that ladders and hand tools accounted for 57 worker deaths in this period.



Slide 19—"Electric parts" breakdown

This pie chart breaks down the electric parts category.
"Electric parts" are broken down as:

- Power lines, transformers, converters
- Electrical wiring
- Switchboards, switches, fuses
- Power cord, electrical cords and extension cords

❖ *The "Other" category on this chart includes " electric parts unspecified and not elsewhere classified" meaning that the data reported was non-specific.*

This information corresponds with the main hazards we'll be covering throughout this training.

Electrocutions are preventable if we implement proper solutions and assure workers understand the risks and best practices for working safely with electricity.

	Ask: Before we move to the next section, are there any questions about what we've covered so far? Discuss and review if necessary to clarify key points. ❖ *If you don't know, or are uncertain of answers, keep a list of questions to research and report back to the class. Often this list is called the "parking lot." You can set it up at the beginning of the class and explain what it is and how it will be used. It's more respectful to honestly tell the class "I don't know" than to offer a potentially incorrect answer.*

Section 2: Understanding Electricity Basics

(60 minutes) w/hazard mapping (30 minutes) w/o hazard mapping
Slides 20-36

NOTE: The material covered in this section provides only a general overview of basic electrical systems described in layman's terms. This information is included to help non-electricians better understand how electricity becomes hazardous to workers. Electrical work should <u>ONLY</u> be performed by qualified electricians.

Key points in this section:

- Basic concepts of electricity; what it is and how it works
- Explain seven common electrical terms
- How electricity travels through a circuit
- Why grounding of electrical circuits is important to worker safety

Handouts:

- ✓ "Name That Term" buzz group worksheet
- ✓ Hazard Mapping Directions

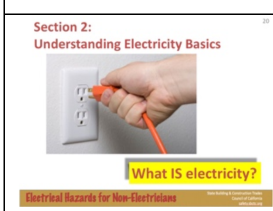
Activities:

- ❖ Buzz Group—Partners match seven electrical terms with appropriate meanings
- ❖ Hazard Mapping—Teams create visual overview of potential job site hazards

Materials:

- ✓ Flip chart pad
- ✓ 6 sets multicolor pens
- ✓ Easel
- ✓ Tape
- ✓ Timer

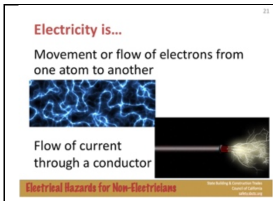
Optional Props: power tools; 3-prong receptacle; circuit breaker/fuse



Slide 20—Section 2: Understanding Electricity Basics

To better understand electrical hazards and controls, it is helpful to know some basics about electricity and the meanings of common terms used when discussing electrical systems and equipment.

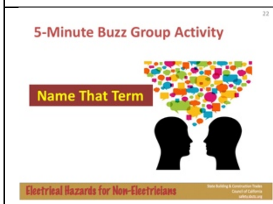
Ask: What is electricity?
answer appears on next slide>>>>>>



Slide 21—Electricity is…

Answer: Electricity is the movement or flow of electrons from one atom to another. Specifically, we're dealing with current electricity in this training. By this we mean a form of energy fueled by the flow of electrons through a conductor.

We will see later how electrical current is at the root of the five main hazards we will discuss.



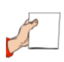
Slide 22—5-minute Buzz Group Activity

Some basic terms are important to know when discussing electrical safety. For example, we just used two terms, **current** and **conductor** in our definition of electricity.

Buzz Group Activity (5 minutes)
We're going to have you team-up with your neighbor for a quick activity to see if you can correctly match 7 terms with their appropriate meanings.

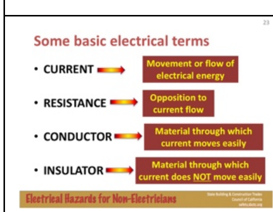
Refer to the prompts on the slide.

1. Ask participants to pair-up with the person next to them.

 Distribute a "Name That Term Buzz Group Worksheet" to each group.

❖ *(A blank worksheet is included in your binder for copying. It is also on your course flash drive for printing.)*

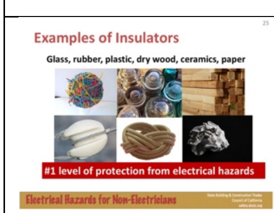
2. Explain: On the worksheet, you'll notice a list of terms in the left column, and a list of descriptions in the right column. Working together, you have 5 minutes to decide which description best matches each term and write its letter next to the term in the space provided.
3. Verify that all the groups understand the activity and have a worksheet.
4. Set a timer for 5 minutes and begin.
5. When time is over, tell the groups to hold on to their worksheets.



Slide 23— Some Basic Electrical Terms

Refer to the slide which shows 4 of the 7 terms (the remaining 3 terms will be covered on a later slide).

- Go through the list of terms on the slide <u>one at a time</u> and ask for different volunteer teams to share their answer for each of the terms.

	• CLICK on the slide to reveal answers one at a time. Each time you click on the slide, the correct description will appear next to the term in order. <u>Only click when you are ready to reveal the next answer</u>. • Continue until all terms are defined. Ask for feedback on the activity: How did everybody do? Did you find this easy or challenging? Discuss Review each term so that everyone is clear on the meaning. **Current** simply means the movement or flow of electrical energy. **Resistance** is simply the opposition to current flow. It is inversely proportional to current. That means that the higher the resistance, the lower the current and conversely, the lower the resistance the higher the current. **Conductor** refers to materials through which current moves easily. Good conductors have very low resistance. **Insulator** refers to materials through which current does <u>not</u> move easily. Insulators have higher resistance. Ask: What are some examples of conductors? *answer appears on next slide*>>>>>>
 	**Slide 24**—Examples of conductors Answer: Most metals (copper, silver and gold are excellent conductors). This often means wire intended for an electrical path, or any conductive metal that becomes part of the path unintentionally. Ask: What about us? Are humans good conductors? *<u>Click once</u> on the slide to reveal the answer* Answer: Yes! The human body is also a conductor. We'll discuss this more when we learn about how electricity affects the body in the next section.
 	**Slide 25**—Examples of insulators Ask: What are examples of insulators? *<u>Click once</u> on the slide to reveal photos of insulators.*

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Answer: Glass, rubber, plastic, dry wood, paper, ceramics and air.

Ask: Why might insulators be important in electrical systems?
Answer: Insulators are the number one level of protection associated with electrical hazards. Insulators provide protection from the dangerous effects of electricity flowing through conductors. Insulating materials, like the plastic or rubbery coating on wires and cords, shield us as well as other conductive materials from energized conductors inside.
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Slide 26—Conductor, insulator or both???

Ask: What about water? Do you think it is a conductor or an insulator?
Answer: It can be both, depending on whether it is "pure" or not. Distilled and de-ionized water may be pure enough to be insulators, but finding totally pure water in real life construction situations would be highly unlikely. Most water contains dissolved salts, ions, minerals, and dirty water could have a lot of materials in it that will make it an excellent conductor and potentially dangerous in combo with electricity on-the-job.

Ask: What about air?
Answer: Air can also be both an insulator and a conductor under the right conditions. When there is a big enough electrical charge, it can cause the air to act as a conductor.

Ask: Can you think of examples?
Lightning from a storm cloud to the earth; arcing when high voltages exist across a gap between conductors. We will talk more about arcing later in the presentation.
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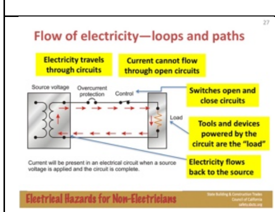

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Slide 27—Flow of electricity—loops and paths

Electricity travels through closed loops called **circuits**. This is like a racetrack of conductive material, usually made of insulated metal wires, that allows the electricity to flow in a specific, controlled way.

The diagram on the slide shows basic components of a circuit.

For electrical current to flow through a circuit, there must be a power source, conductors, and a complete, unbroken path back to the source. The flow of energy through these circuits powers our homes and work sites. Each device that is powered by the circuit (tools, equipment, lights, appliances) is called the "load."
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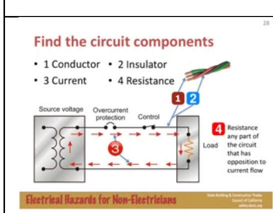
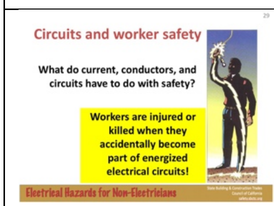
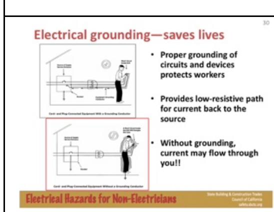
	Circuits can be AC—Alternating Current or, DC—Direct Current. Ask: Does anyone know sources of DC current we use every day? Answer: Batteries: the circuit flows from negative to positive. In this class, we are only talking about AC, which is the current used by most circuits on typical construction sites. In AC circuits, electricity flows out from a power source through the "hot" wire, through the load, and returns to the source on the "neutral" wire completing the circuit. The "neutral" wire is a current carrying conductor that is grounded at the main service. Injuries and fatalities can occur as a result of contact with a "neutral" wire. Electricity cannot flow if this circuit is open at any point. We open and close electrical circuits all the time without thinking much about it. Ask: What's one of the first things we do when we walk into our home at night? Answer: Flip a switch to turn on a light. On/off switches control the flow of electricity by either opening or closing the circuit. In the "off" position, a switch opens the circuit, stopping the flow of electricity. The "on" position closes the circuit, allowing electricity to flow through the circuit, power the light fixture, and return back to the source. When we plug-in power tools, equipment, lights, and extension cords to a normal live circuit, we create a loop from the hot wire, through the device, then back to the source through the neutral wire. The switch on the device starts or stops the flow of electricity to the tool. Ask: How do you think resistance affects circuits? Answer: Electricity will flow to any available path. The amount of resistance determines the amount of current flow in a circuit when voltage is held constant. Because they are inversely proportional, the more resistance a circuit has, the lower the amount of current flow. **When resistance is low, current flow is high.**
	**Slide 28**—Find the circuit components Ask for volunteers to identify where the four listed components would be found in a circuit. Discuss the responses. Are they correct? Click on the slide to reveal the correct answers.

	1. Conductor— represented by the solid black line. This would be the wire carrying current through the circuit 2. Insulator—also represented by the solid black line. This is the coating on the outside of the wire (conductor) that shields/protects from contact with the energized conductor. 3. Current—represented by the red arrows. This is the flow of electricity through the circuit. 4. Resistance—can be found anywhere in the circuit where there is opposition to current flow.
	**Slide 29**—Circuits and worker safety It's difficult to imagine our modern lifestyles or doing construction work without electricity! But, as we've already learned, electricity can be dangerous and even deadly for workers. Remember, construction leads all industries for fatalities due to electrical hazards. Ask: What is the root cause of workers being injured or killed by electricity? Answer: **Workers risk injury or death when they accidentally become part of an electrical circuit.** **The human body is a conductor. If electrical current travels through your body as a result of unsafe conditions, unsafe equipment, or unsafe acts, you may be severely injured or killed.** This is why properly installed electrical systems are equipped with built-in safety features to protect the circuits, equipment, and the people using them.
	**Slide 30**—Electrical grounding—saves lives **Grounding** of circuits and devices is the second most important protection for workers using electric tools and equipment. Remember, insulation is the first. Ask: Does anyone know what we mean by "grounding?" Answer: In addition to the hot and neutral wires, another wire conductor called a "**ground wire**" is added to circuits to create a

	physical electrical connection to the Earth. The ground that's all around you is a good conductor and makes for a safe return path for electrons. Conductors are usually identified by the color of their insulation. The grounding conductor is identified as a bare wire, or a wire with green insulation. Keep in mind, wire doesn't care what color it is, so you can't just assume green means ground. If a circuit has been wired improperly, the color coding may be off, creating a dangerous condition. Only qualified electricians should be wiring circuits. Ask: Does the ground wire have high or low resistance? Answer: The ground wire is the same as any other current carrying conductor. All conductors have a low resistance to current flow. It's the addition of this wire to the circuit that provides safety. Ask: Why do you think this grounding is so critical for worker safety? Answer: It provides a low resistive path back to the electrical panel thereby enabling the fuse to blow or breaker to trip and effectively shut off the current flow when a ground fault occurs. If a fault occurs in the circuit, current may leave the intended path, and "leak out" or "short circuit" causing conductive parts connected to the circuit such as a tool casing, metal cover, outlet cover, or switch plate, to become energized. This creates a very dangerous situation whereby workers can become part of the energized circuit, and complete a path for current to flow through their body. Ask: What might cause a fault in the system? Answers: • A loose or broken wire; • Poor connection; • Break in protective insulation; • Overloading the system A short circuit is any current flow that is outside of its normal path. It creates high current due to a very low resistance and will often blow the fuse or trip the breaker. A ground fault is a short circuit to ground. If the system is working properly, most of the dangerous current will be safely carried back to neutral or to the earth through the grounding wire, which is intentionally made of very low-resistance material. Proper grounding of circuits and tools provides a low resistive path for current that would be dangerous for humans and protects the worker from being shocked.

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Missing, disabled or altered grounding systems are a major safety hazard for workers. Later we'll see examples of common job site situations that expose workers to these hazards.

Ask: Before we move forward, are there any questions about what we've covered so far? Discuss
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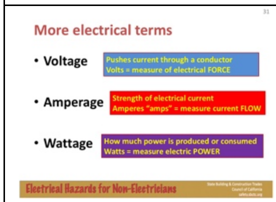

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Slide 31—More electrical terms

Have the class refer back to their Buzz Group worksheets and look at the remaining 3 terms shown on the slide.

• Go through the list of terms on the slide <u>one at a time</u> and ask for different volunteer teams to share their answer for each of the terms.
• Each time you click on the slide, the correct description will appear next to the term in order. <u>Only click when you are ready to reveal the next answer</u>.
• Continue until all terms are defined.

Ask for feedback on the activity: Were these terms more familiar than the first four? Discuss

Review each term so that everyone is clear on the meaning.

Voltage = is a measure of electrical force; the potential for energy to move. It is expressed in volts. You could think of it as pressure that powers the flow of electrons in a direction from higher to lower pressure, or higher to lower voltage. It's what pushes current through a conductor.

Amperage = is current flow; the strength of an electrical current measured in amperes or "amps."

Wattage = is a measurement of electric power expressed in watts. The watt measures the electrical power of a device, whether it is a motor, a machine or the heating capacity of a boiler.
You may also have heard words like kilowatt (kW) and megawatt (MW) used to express large amounts of power such as that generated by power plants. One kilowatt equals 1,000 watts.
One megawatt equals 1,000 kilowatts, or 1 million watts.
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Slide 32—Water comparison

Since we can't see volts, amps and watts, an easy way to understand them is to compare them to something more familiar, like a water system.

If we look at how a water system works, we find similarities to an electrical circuit. Both are closed systems, need a pressure source, flow in specific directions through conductors, are affected by resistance, can flow to more than one point at a time, and ultimately return to the source.

A water system needs pressure to push water through the pipes. This pressure might be created by a pump, and water flows from high to low pressure.

Ask: What would generate this pressure in our electrical circuit?
Answer: A power source

Ask: What do we call the pressure that creates the potential for electricity flow through a circuit?
Answer: Voltage

Current flowing along "hot" wires is pressurized. It flows from higher to lower voltage. Voltage pushes current. The higher the voltage, the harder it pushes the current.
Voltage can be compared to different water pressures illustrated on the slide. Contrast the amount of water flow through the low pressure squirt gun with the flow pushed through the high pressure fire hose. Visualize the difference between low and high voltage

In our water pipe, the rate at which water flows through the system is usually measured in gallons/minute.

Ask: What does this flow correspond to in an electrical circuit?
Answer: Amperage (amps) or the rate at which electrical current flows through the conductors. In a water system, the size of the pipe determines the volume of water it can carry. Similarly, in electrical circuits, the size of the conductor affects the current-carrying capacity; larger diameter wires carry more current than small wires.

We use the flow of water by connecting devices like faucets, spigots, sprinklers and hoses to the system. Each device needs a certain amount of power to operate properly and valves to control the flow.

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For example, using a small diameter hose to power an impact lawn sprinkler may not allow enough flow to provide the power the sprinkler needs to function properly. The undersized hose has too much resistance, which restricts flow to the device.

Ask: What is the measurement of electric power?
Answer: Wattage

Ask: How do we connect to the electricity in our electrical circuit?
Answer: Through receptacles, switches, and fixtures. When we plug in a tool, the electrical current flows through the tool, powers the motor, then flows back to the source, completing the circuit.

Ask: What prevents water from leaking out of our system?
Answer: The pipe walls contain the flow of water within the system because they are made of material that has high resistance to water flow.

The thicker the pipe wall, the harder it is to damage. We all know what happens if a water pipe cracks or breaks; water leaks out and flows in all directions where there is the least resistance. The higher the pressure, the more forceful the flow. The pipe walls are similar to the insulation around an electrical conductor; it contains the electricity safely within the circuit and shields us from electrical current.

If water leaks out, you get wet; if electricity leaks out, it can kill you. This is why it's so important that electrical insulation is intact and heavy-duty enough to withstand construction wear and tear. All electrical conductors are rated for environmental usage and how much current they can carry safely. These ratings become very important, as we'll see later in the training. Only electric cords rated for "extra-hard" or "hard" use are allowed in construction.
You wouldn't want to use the squirt gun to put out a fire!
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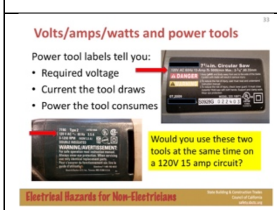

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Slide 33—Volts/amps/watts and power tools

Ask: Why are volts, amps, and watts important to non-electricians?
Answer: All electric power tools and equipment operate within certain specifications.

Voltage tells us how much power the tool needs to run properly.
Amps tell us how much current load the tool draws when running
Watts tell us how much power the tool consumes.
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It’s important that you know what voltage each of your electrical devices needs. If you supply a device with voltage that is too low, it may not run. If you supply voltage that is too high, you will damage your device.

Every power tool should be labeled with its electrical data so that you know the load that tool will put on the circuit.

Most tool specs give the voltage and amps. Here are some examples of tool loads at 120V:
Circular saw 15 amps
Demolition hammer 14 amps
Angle grinder 13 amps
Reciprocating saw 12 amps
Rotary hammer 10.5 amps
1/2" Hammer drill 9 amps
1/2" Drill 7 amps

The slide shows sample labels from a drill and a circular saw. According to manufacturer specifications, the drill draws 3.5 amps and the saw 13 amps. With this information you can determine what amperage circuit is required to operate the tools.

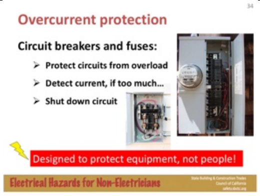
Ask: If these two power tools were being used at the same time, how much total amperage would they draw? Answer: 16.5 amps.

Ask: Would it be safe to run both of these on the same 15 amp circuit? Answer: No
A typical AC circuit on a construction site is 120 volts, 15- and 20-amp. The conductors are sized accordingly. Trying to draw too much current, for example running too many tools simultaneously, or using equipment that needs more power (watts) than the circuit can provide, can overload the circuit causing heat build-up and faults.

The more powerful a device is, the higher the number of watts. Trying to power devices or equipment that need more power than a circuit is built to deliver can have dangerous results.

An easy example: Putting a 100-watt light bulb in a fixture designed for 60-watts maximum could overload the circuit causing intense heat in the conductors that could melt the light socket and the insulation on the fixture's wires.

All switches, light fixtures and receptacles have a voltage and current rating. Light fixtures have a wattage rating as well. When you use these things outside of their rating, you create potential hazards.



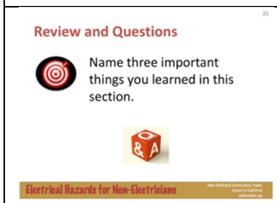
Slide 34—Overcurrent Protection

Ask: What are the devices pictured on the slide?
Answer: Circuit breaker and fuse.

Circuit breakers and fuses are overcurrent safety devices built into the system to protect it from overload, short circuit or ground fault. They are designed to detect electrical current and, if there is too much current, open or interrupt the circuit to shut it down before wires or equipment are damaged.

If circuit breakers trip and fuses keep blowing, something is wrong and you should not use the circuit until the system is inspected by a qualified electrician.

Keep in mind that circuit breakers and fuses are designed to protect equipment, not people. They don't shut down the circuit fast enough to protect workers from getting shocked. We're going to talk more about required devices and solutions that protect workers from circuit faults later in the training.

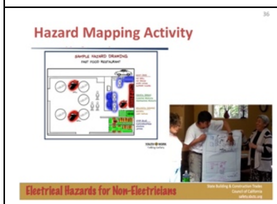


Slide 35— Review and questions

This concludes our basics about electricity and electrical circuits.

Ask the class to name three things they learned so far.

Ask: Do you have any questions before we move on?
Add any unanswered questions to the Parking Lot list.

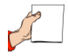


Slide 36—Hazard Mapping Activity

<u>Hazard Mapping Small Group Activity</u>
In this exercise, you'll be teaming-up in small groups to create a visual representation of a construction site where there are electrical hazards. Your final map will give an "at-a-glance" look at the hazards you identify. Work together as a team, pooling your knowledge and experience of construction worksites, to identify areas where workers are at risk for contact with electricity. Your task is only to identify potential hazards. In a later exercise, we'll work on risk factors and control strategies.

❖ *Refer to "Hazard Mapping Exercise Instructions and Setup" in the Instructor Guide to prepare for this activity.*

- Break the class into 6 groups. (These same groups will reconvene later in the training)



Distribute the following to each group:
Flip chart pages
Multi-colored marking pens

Tell each group to choose a team name and select a scribe and a spokesperson who will present their map to the class.

Review the directions on the handout and the ground rules.

Small Group Ground Rules:

- **Respect**—everyone has different skills, experiences and information to offer
- **Work collectively**—creatively pool your knowledge
- **Share the power**—involve everyone in the group equally

Explain each group will have 20 minutes to create their maps.

Things to consider when planning your map:
Which workers/trades are most likely to be exposed to the hazards?
Regarding the hazards, are they:

- Static/continuous, or changing/intermittent?
- Limited to one area, or spread out at multiple locations on the job site?
- Specific to one task or process?
- Differing levels of risk/severity? Low, medium, high, very high hazards?

When you've reviewed the instructions
Ask: Are there any questions/comments about the hazard mapping exercise?

❖ *Instructor directions:*

1. *Set a timer for 20 minutes—circulate among groups to keep them on task.*
2. *Reconvene class and ask for volunteers to present their maps and describe their group findings with the class.*
3. *When all groups have presented back to the class, discuss the exercise. Note key results and common threads. Were there any surprises? What were the positive aspects of doing this group exercise? Anything that could be changed/improved?*
4. *Save the maps for use later in the training.*

Section 3: Effects of Electricity on the Human Body

(45 minutes)
Slides 37-58

Key points in this section:

- Workers are injured or killed when they accidentally become part of a circuit.
- Main electrical-related injuries are: electric shock, electrocution, burns, falls.
- Three factors affect severity of shock: path through body; amount of current; amount of time in contact with circuit.
- Severe injury and death can occur at current levels less than 1 amp.
- Moisture lowers body's resistance to current flow.
- Three types of burns are: electrical; arc; thermal.
- Falls are a common secondary hazard related to electric shock.

Handouts:

- ✓ Effects of Electrical Current on the Body

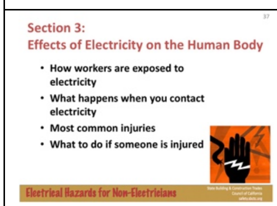
Videos: (embedded in PPT slides)

- Arcing power lines—slide 52
- Arc flash demonstration—slide 54

Activities: N/A

Materials:

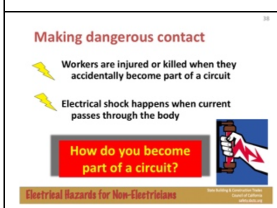
- ✓ Flip chart pad and multicolor pens
- ✓ Easel



Slide 37—Section 3: Effects of Electricity on the Human Body

In this section of the training we are going to learn:

- How workers are exposed to electricity
- What happens when you contact electricity
- Most common injuries that occur as a result of electrical hazards
- What you should do if someone is injured



Slide 38—Making Dangerous Contact

We learned about how electrical circuits work because workers are injured and killed when they accidentally become part of electrical circuits and are shocked by electrical current.

We discussed conductors and resistance. Humans are more conductive than the ground we stand on, which means our body is a low resistance path. An electric shock is received when current passes through the body back to the circuit or to the ground.

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Ask: How do you think workers accidentally become part of a circuit?

Answer is covered on the next slide.
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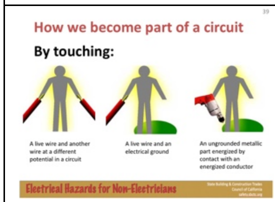

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Slide 39—How We Become Part of a Circuit

Answer: Current will pass through the body in a variety of situations. Electric shock occurs in one of three ways when an individual is in contact with the ground and does any of these:

1. Touches a live wire and another wire at a different potential in an electric circuit.
When you become part of the circuit and complete the path, you will receive an electric shock. Current will pass through your body.

2. Touches a live wire of an energized circuit and an electrical ground.
If you are in contact with a live wire or any live component of an energized electrical device—and also in contact with any grounded object—you will receive a shock. Plumbing is often grounded. Metal electrical boxes and conduit are grounded. Your risk of receiving a shock is greater if you stand in a puddle of water.

3. Touches an ungrounded metallic part that has become energized by contact with an energized conductor.
Metal parts of electric tools, machines, receptacles, cover plates, switches, may become energized if there is a loose or broken conductor that touches the tool housing, a break in the insulation, or damage to the power cord. A worker using these tools and machines is made less vulnerable to electric shock if the tool is grounded. Non-electrical metal tools and ladders that touch an energized conductor can also become energized.
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Slide 40—Four main electrical-related injuries

Electricity can cause a lot of damage to the human body.

There are four main types of electrical-related injuries, any of which can result in a fatality:

Electric shock
Electrocutions—fatal shock
Burns
Falls

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Electric shock is a sudden violent response to current flowing through any part of a person's body.

Electrocution is death caused by electric shock.

Tissue damage produced directly by electrical current or voltage is a primary electrical injury.

Falls are a common secondary hazard linked to electric shock.

We're going to discuss each of these individually.

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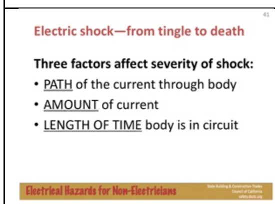

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Slide 41—Electric shock—from tingle to death

Ask: Has anybody been shocked? Describe the experience, what happened?

Effects of electric shock can range from a barely perceptible tingle to severe burns and immediate cardiac arrest.

Three factors affect the severity of shock:

- The <u>path</u> of the current through the body.
- The <u>amount of current</u> flowing through the body.
- The <u>length of time</u> the body is in the circuit.

These other factors can also affect shock:

- Voltage
- Presence of moisture in the environment
- Phase of the heart cycle when the shock occurs
- General health of the person prior to the shock

Let's look at why these factors are important.

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Slide 42—Path through the body

Ask: Why do you think the path the electrical current takes through the body is significant?
Answer: It can make the difference between an injury and a fatality depending on whether major organs are affected.

Explain to the class:

- Currents through the heart or nervous system are most dangerous. If the current goes through the chest, the person will almost surely be electrocuted.
- If you contact a live wire with your head, your brain and nervous system may be damaged.

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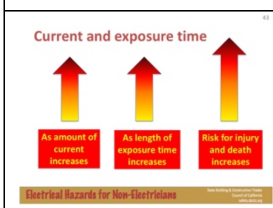
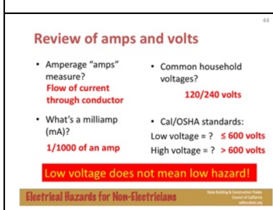
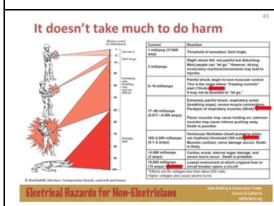
	• Contacting a live electrical part with one hand, while you are grounded at the other side of your body, will cause electrical current to pass across your chest, possibly injuring your heart and lungs. • A large number of serious electrical injuries involve current passing from the hands to the feet. Such a path involves both the heart and lungs, and this type of shock is often fatal. • There have been cases where an arm or leg is severely burned by high-voltage electrical current to the point of coming off, and the victim is not electrocuted. In these cases, the current passes through only a part of the limb before it goes out of the body and into another conductor. Therefore, the current does not go through the chest area and may not cause death, even though the victim is severely disfigured. • When electricity travels through the body, it "cooks" you from the inside out. The extent of the injury is not always apparent.
	**Slide 43**—Current and exposure time Two additional factors affect the severity of shock: • The amount of electrical current passing through the body • The amount of time the body is exposed to the current **As current and exposure time increases, so does the risk for injury and death.** For example, 1/10 of an amp (100 milliamps) of electricity going through the body (across the heart) for just 2 seconds is enough to cause death.
	**Slide 44**—Review of amps and volts Although we can't know the exact injuries that result from any given amperage, we do know what is likely to happen to the human body within certain ranges of electric current. (Review) Ask: Who remembers what amps measure? *Click on the slide to reveal the answer* Answer: The strength of electrical current flowing through a conductor. We're about to use a new term "milliamp" abbreviated as "mA." Ask: : What is a milliamp mA? *Click on the slide to reveal the answer* Answer: A milliamp is 1/1000 of an amp

Ask: What are typical household voltages?
Click on the slide to reveal the answer
Answer: 120/240 volts.

Ask: Who knows what is considered low voltage and high voltage according to Cal/OSHA safety orders?
Click on the slide to reveal the answer
Answer: Low voltage is less than or equal to 600 volts. High voltage is over 600 volts.

Low Voltage does not mean low hazard.
Even low voltages can be extremely dangerous because the degree of injury depends on current and how long the body is in contact with the circuit. Even at low voltages, the current can be strong enough to do serious harm.



Slide 45—It doesn't take much to do harm

Distribute the "Effects of Electrical Current on the Body" handout.

The table on the handout shows possible health effects for a range of amperages at an exposure lasting one second at typical household voltages.

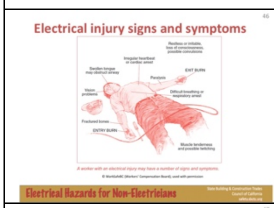
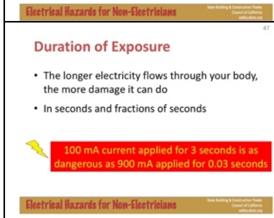
Ask: Is this table referring to low or high voltage?
Answer: Low, less than 600 volts.

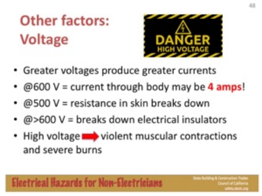
Ask: What stands out most to you about the information in this Table?

Key points to discuss about the information in the Table:

- Amperage ranges are shown in milliamps.
- At only 1 milliamp (1/1000 of an amp) of current, you begin to feel the electricity
- The amount of internal current a person can withstand and still be able to control the muscles of the arm and hand can be less than 10 milliamps (mA) or 10/1,000ths of an amp.
- "Freezing Current"
  Ask: According to the Table, at what amperage might "Freezing Current" start?
  Answer: Current above 10 mA.

	Ask: What does "freezing current" mean? Answer: Electric shock can paralyze or “freeze” muscles. When this “freezing” happens, a person is no longer able to release the electrified object. In fact, the electrified object may be held even more tightly, resulting in longer exposure to the shocking current. In the construction trades you may hear electricians call this "getting hung up." Ask: What construction equipment might become energized and expose workers to freezing current? Possible answers: Power tools; wires; cords; metal-handled non-power tools, metal ladders. Hand-held tools that give a shock can be very dangerous. If you can’t let go of the tool, current continues through your body for a longer time, which can lead to respiratory paralysis (the muscles that control breathing cannot move). You stop breathing for a period of time. What happens when you "get hung up" is that the current flow through your body is not enough to trip the circuit breaker. As long as you remain in the path, you will continue to receive current flow. • People have stopped breathing when shocked with currents from voltages as low as 49 volts. Ask: At what current does paralysis of respiratory muscles begin? Answer: 20 mA • Ask: What can happen at 100 mA of current? Answer: The heart is affected. This is considered the threshold for ventricular fibrillation (very rapid, ineffective heartbeat; uneven, uncoordinated pumping of the heart). This condition will cause death within a few minutes unless a special device called a defibrillator is used to save the victim. Ask: How many amps is 100 mA? Answer: 0.1 amps. This is not that much current! For example, a small power drill uses over 30 times that amount! A 100 watt light bulb at 120 Volts draws 0.833 amps of current, that's 833 mA. • Notice that at 2 amps and above, the heart stops pumping (cardiac arrest) and organ damage occurs.

	• A severe shock can cause much more damage to the body than is visible. A person may suffer internal bleeding and destruction of tissues, nerves, and muscles. Sometimes the hidden injuries caused by electrical shock result in a delayed death. Ask: Does anyone know the rating for typical household branch circuit breakers/fuses in the U.S.? Answer: 15, 20, 30, 40, 50 amp. Ask: Looking at the information in the table, do you think a circuit breaker is going to protect you from getting shocked if there is a problem in the circuit? No! Shock and electrocution can happen before a circuit breaker shuts down the current. Remember, circuit breakers are designed to protect equipment not people.
	**Slide 46**—Electrical injury signs and symptoms This illustration shows the variety of injuries that can occur.
	**Slide 47**—Duration of exposure The length of time of the shock greatly affects the amount of injury. The longer electricity flows through your body, the more damage it can do. Ask: How much time are we talking about? Minutes? Answer: No! Seconds and fractions of seconds. If the shock is short in duration, it may only be painful. A longer shock (lasting a few seconds) could be fatal depending on the level of current, as we just learned from the previous slides. For example, a current of 100 mA applied for 3 seconds is as dangerous as a current of 900 mA applied for a fraction of a second (0.03 seconds). At relatively high currents, death is certain if the shock is long enough.



Slide 48—Other factors: Voltage

Voltage is the force that pushes electric current through the body. Depending on the resistance, a certain amount of current will flow for any given voltage.

We've just discussed how the amount of current passing through the body affects the severity of an electrical shock.

While the amount of current determines the effect on the body, voltage does influence the outcome of an electric shock.

Greater voltages produce greater currents. At 600 volts, the current through the body may be as great as 4 amps. That's 4,000 milliamps! So, there is greater danger from higher voltages.

Higher voltages (500 V or more) can break down resistance in the outer layer of our skin. Areas of skin breakdown are sometimes pinhead-sized wounds that can be easily overlooked.

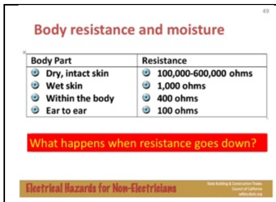
High voltage (>600 V) breaks down electrical insulators, including paint, skin, and most shoes and gloves. Special shoes, gloves, and tools are rated as being protective for certain voltage levels. These items must be tested periodically for (sometimes pinpoint sized) breaks in insulation. Insulation may not be effective if there is moisture or contamination on the surface of the item.

(Review) Ask: What happens when we lower resistance?
Answer: When resistance decreases, current increases.
If the body's resistance is lowered, the amount of current that flows with any given voltage will increase.

Inside the body, current can cause deep tissue injury to muscles, nerves, and other structures. Internal blood vessels may clot, nerves in the area of the contact point may be damaged, and muscle contractions may cause bone fractures. It is possible to have significant deep tissue injury, but little in the way of skin burns with high-voltage injuries.

High voltages can cause violent muscular contractions that may push you out of the circuit and cause you to fall, leading to secondary injuries, whereas the lower voltages cause you to get hung up.

Increasing the voltage greatly increases the heat energy delivered to tissues. High voltages can also cause severe burns.



Slide 49—Body resistance and moisture

This slide shows examples of different resistance levels by body part. The amount of electrical current, in amps, that flows through your body goes up when resistance goes down.

The Human Body Resistance Model
(source: National Safety Council PPT—OSHA Harwood Grant material 2008)

Body Part	**Resistance**
Dry, intact skin	**100,000-600,000 ohms**
Wet skin	**1,000 ohms**
Within the body	**400 ohms**
Ear to ear	**100 ohms**

Ask: What part of our body provides the most protection from electric current?
Answer: The skin. Under dry conditions, human skin is very resistant.

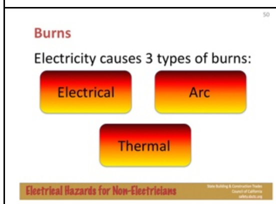
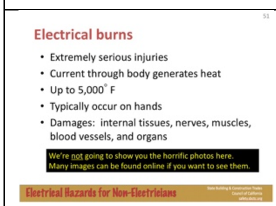
Ask: What is the resistance for dry skin shown on the table?
Answer: 100,000—600,000 ohms. (Ohms is the unit of measurement for resistance)

Ask: According to the table, what factors dramatically change the body's resistance? Answers:

- Moisture. If your skin is wet for any reason (rain, sweat, standing in a puddle of water), the skin's electrical resistance drops. The table shows that wet skin has a resistance of only 1,000 ohms. The low resistance of wet skin allows current to pass into the body more easily and give a greater shock.
- Resistance inside our body is even lower. This is why electric shock can be so damaging to internal organs and tissue.

We can calculate how wet and dry conditions impact the amount of current going through the body from a 120 volt circuit by using the resistance measurements from the Table and an electrical formula: Amps = Volts/Resistance

Dry Conditions: Amps = 120/100,000 = 0.0012 amps
Convert this to milliamps: 0.0012 x 1,000 = 1.2 mA
If we refer back to our Effects of Electrical Current table, we see that this level of current would have only a slight effect; be perceptible as a slight tingle.

	Wet Conditions: Amps = 120/1,000 = 0.12 amps **Convert this to milliamps: 0.12 x 1,000 = 120 mA** This level of current is extremely dangerous and can be deadly. It is sufficient to cause ventricular fibrillation and nerve damage. **Wet or broken skin greatly reduces the body's resistance to electrical current.** **Using electrical tools or equipment in wet areas puts you at greater risk for shock.**
	**Slide 50**—Burns There are three types of burns caused by electricity: • Electrical burns • Arc burns • Thermal contact burns
	**Slide 51**—Electrical Burns Electrical burns are one of the most serious injuries you can receive, and need immediate attention. The flow of electric current through the body generates heat that causes electrical burns. Typically these burns occur on the hands but, burns from being shocked can burn internal tissues while leaving only very small injuries on the outside of the skin. Extensive damage to nerves, blood vessels, muscles, and organs may take place as the current passes through the body and generates intense heat (up to 5,000 degrees Fahrenheit)
	**Slide 52**—Arc Burns—what is "arcing" Does anyone know what we mean by "arc burns?" Arc or flash burns result from a release of dangerous thermal energy and extreme high temperatures near the body produced by an electric arc or explosion. **Arcing** is a bright, sparking, luminous electrical discharge through the air that occurs when high voltages exist across a gap between conductors. High voltage can cause the air to act as a conductor.

	Click the slide to run a short video of high voltage power lines arcing. Ask: Most of us have seen this happen in nature when we've seen what during a storm? Answer: Lightning. A circuit is formed between a storm cloud and the Earth when lightning strikes. The air is acting as a conductor in the circuit.
	**Slide 53**—Arc flash and arc blast The same thing happens in an **arc flash**. An arcing fault on an electrical power system causes current to leave its intended path and travel through the air from one conductor to another, or to ground. An arc flash can occur while working on an energized circuit, or from electrical equipment failure. An arc flash gives off thermal radiation (heat) and bright, intense light that can cause burns. Temperatures have been recorded as high as <u>35,000˚F</u>. The results are often violent, and when a human is in close proximity to the arc flash, serious injury and even death can occur. **Arc flash temperatures can be three times hotter than the surface of the Sun!** High voltage arcs can also produce considerable pressure waves by rapidly heating the air and creating a blast or "**arc blast**." This pressure burst can hit a nearby worker with great force and send molten metal droplets from melted copper and aluminum electrical components great distances at extremely high velocities. Arc flash/arc blast injuries may require months of painful recovery, result in permanent disability, or even be fatal. Electricians receive extensive training about arc flash and arc blast because the work they do puts them at higher risk. They are required to use special PPE (Personal Protective Equipment).

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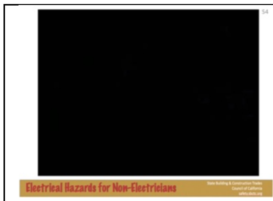
<td>
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<td>Slide 54—Demonstration of arc flash/arc blast

Click the slide to play a video of a simulated arc flash/arc blast.

Discuss the class reaction to the video.</td>
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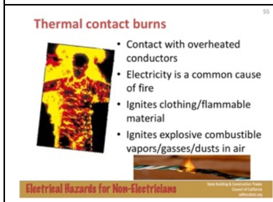
<td>
</td>
<td>Slide 55—Thermal contact burns

Thermal contact burns occur when skin comes in contact with hot surfaces of overheated electrical conductors or other equipment, or when clothing is ignited in an electrical incident.

Electricity is one of the most common causes of fire and thermal burns in homes and workplaces.

Flame burns caused by the ignition of clothing or other flammable materials are common, particularly with high-voltage exposure.

Thermal burns may also result from electricity igniting an explosive buildup of combustible vapors, gasses, or dusts in the air.

Ask: What electrical faults might cause these situations:
Possible Answers:
• Bad insulation on faulty or old wiring;
• Defective or misused tools and equipment;
• Poor splices can make short circuits possible;
• Short circuits can generate a lot of heat and also cause arcing;
• Loose connections or partially broken conductors increase resistance which can generate enough heat to reach ignition temperatures, especially at switches and outlets.</td>
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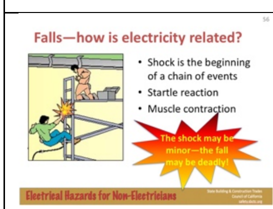
<td>
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<td>Slide 56—Falls—how is electricity related?

Ask: From what we discussed earlier, how do you think electricity is related to falls?
Answer: Violent muscle contractions, or a startle reaction, can cause workers to fall from ladders, scaffolds, aerial lifts and aerial buckets or inadvertently strike other objects resulting in injury (bruising, broken bones) or even death.

Shock is often only the beginning of a chain of events. Even if the electrical current is too small to cause injury, your reaction to the shock may cause you to fall.</td>
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<td>Normal muscle contraction is caused by very small amounts of electricity that are created within our bodies. Muscles violently contract when stimulated by excessive amounts of electricity.</td>
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<td>Slide 57—What to do if someone gets shocked?

Review the points on the slide:

Don't touch the injured person if he/she is still in contact with the electrical current. Don't put yourself at risk of becoming a victim too!
Call 911
If you can do so safety, shut off the circuit.
If the circuit can't be turned off, use a non-conductive object to push the person away from the source of the current. Don't try this if you have any doubt about what to use. You may be shocked too. <u>This does not apply to high voltage lines.</u>
Don't move a person with an electrical injury unless he/she is in immediate danger. Moving an injured person can make injuries worse.
Once the person is away from the source of electricity, check the person's airway, breathing, and pulse. If the victim is not breathing, rescue breathing from trained personnel should begin immediately. Begin CPR if the person shows no signs of a pulse.
Cal/OSHA says there must be people trained in CPR and first aid on the site. An automatic defibrillator (AED) can help if a severe shock causes heart problems. It can save lives!

A person who has been injured by contact with electricity should be seen by a doctor, even if they "feel fine."</td>
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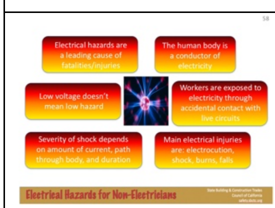
<td>
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<td>Slide 58—no title

QUICK REVIEW—So far we've learned the following:

Electrical hazards are a leading cause of construction worker fatalities and injuries.
The human body is a conductor of electricity.
Workers can be seriously injured or killed when they accidentally become part of a live electrical circuit.
Typically, shock occurs when a person contacts: both wires of an energized circuit; one wire of an energized circuit and the ground; a metallic part in contact with an energized wire while person is also in contact with the ground.
The severity of electrical shock depends upon the path and
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	amount of current flowing through the body and the length of time the body is in the circuit. • The four main types of electrical injuries are: Electrocutions (fatal shock); Electric shock; Burns; Falls. Ask: Do you have any questions or comments about anything we've covered so far before we move to the next part of the training? Review information as needed; use the "Parking Lot" for questions that need further research.

Section 4: Electrical Hazards

(120 minutes) w/Hazard Challenge activity (75 minutes) w/o Hazard Challenge activity
Slides 59-106

Key points in this section:

- Contact with overhead power lines are the primary source of electrocutions.
- Ground fault protection is required on construction sites.
- Missing or discontinuous grounding paths are a serious hazard.
- Electrical equipment that is not used as intended by the manufacturer can injure or kill workers.
- Damaged or misused extension cords can be deadly for workers.
- Following safe practices and controls will prevent electrical injuries and fatalities.

Handouts:

- ✓ Hazard Assessment Model
- ✓ Team Hazard Maps (from earlier activity if used)
- ✓ Case studies (optional)
- ✓ "Electrical Hazard Risk Factors and Safe Practices" summarizes key points for each hazard covered in the training
- ✓ CPWR Hazard Alert "Electrical Hazards—Non-Electricians"
- ✓ Electrical Hazards Post-Test
- ✓ Electrical Hazards Pre/Post Test Answer Key
- ✓ Training Evaluation Form

Videos:
WorkSafe BC—Power Line-Fatal Crane Truck Contact (for case study)—slide 63
WorkSafe BC "A Bright Arc" power line contact—slide 65

Activities:

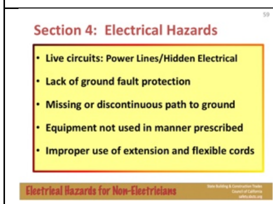
- ❖ "Hazard Challenge—You're the Expert" Small Group Activity. Six teams analyze case studies and scenarios and report back to the class.

Materials:

- ✓ Flip chart pad
- ✓ 6 sets of multicolor pens
- ✓ Easel
- ✓ Tape
- ✓ Team numbers (1-6) to draw, for Hazard Challenge activity
- ✓ Bag to draw numbers from
- ✓ Laptop for station 1 case study video
- ✓ Timer

Optional Props:

- Examples of damaged: tools; extension cords; electrical parts;
- Examples of approved, undamaged extension cords
- GFCI samples of different varieties
- Ladders (non-conductive vs. conductive)
- Double-insulated tools
- Lock out/Tag out devices
- Cord strain relief samples

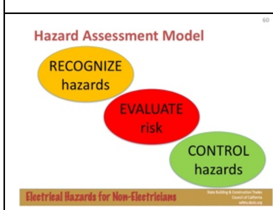


Slide 59—Section 4: Electrical hazards

For the remainder of the training, we're going to identify specific hazards and situations that most frequently cause electrical injuries and fatalities on construction sites and discuss solutions and best practices that protect workers from these hazards.

Explain to the class:
The electrical hazards shown here on the slide most commonly cause worker injuries and fatalities on construction job sites.

Our goal is to alert you to common situations on-the-job that put you at risk for electrocution, electric shock, burns or falls due to contact with electricity. We will also learn how these fatalities and injuries can be prevented.



Slide 60—Hazard Assessment Model

Distribute the "Hazard Assessment Model" handout to participants.

Ask the class to refer to the handout.

Explain: We'll be breaking-down each hazard, using these three steps shown on the slide and on the handout.

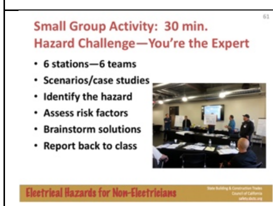
The prompts given for each step identify the kind of information we will focus on for each hazard.

Ask: Based on your construction experience, is there anything you would add to our assessment model? Discuss responses and decide if you want to add anything.

- *Notice the curriculum teaching notes for each hazard are organized to match this model. Corresponding PowerPoint slides provide visual prompts and summarize key points.*

Shorter training sessions:
If you are presenting a shorter training on one specific hazard, all key points and discussion prompts are summarized in the notes and can be used as a stand-alone training module. Case study scenarios are also included in your training binder. If it's not feasible to use PowerPoint, consider adapting the teaching points to hands-on props and equipment you have available.

Impromptu On-The-Job Training or Tailgate Meetings:
For each hazard, we have provided laminated cards (with images from the PowerPoint slides) that you can use along with the curriculum teaching notes. The advantage of job site training is that you have live construction hazards to identify and discuss. You can also use this training model to debrief actual incidents, or turn a near-miss or "good catch" into a training opportunity. Additionally, for some topics, we have included our "Walkaround Safety Checklist/Tailgate Training Guides" as well as some CPWR Tool-Box Talk guides in the training binder.



Slide 61— Small Group Activity: Hazard Challenge—You're the Expert

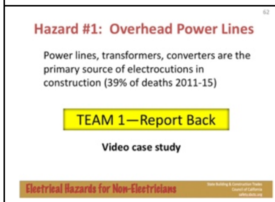
- *This activity requires advance planning and classroom set-up. Instructions for setting-up the activity are included in the Instructor's Guide. Six teams visit pre-arranged stations to evaluate assigned hazards. At their station, each team reviews a case study (and any additional props or sample equipment you include) related to their assigned hazard. Teams then use the "Hazard Assessment Model" guidelines to identify elements of the hazard, risk factors, and control strategies/safe work practices. Each team then presents their findings back to the class.*

  After each team presentation, the instructor shows the PowerPoint slides that correspond to that hazard and assures the information in the curriculum is covered.

- *If you elect not to do this small group activity, you can read the case studies for each hazard aloud to the class and discuss them as a group using the Hazard Assessment Model as a guide. Then continue with the PowerPoint and curriculum.*

	Prepare the class: We're going to ask for your expertise in this section of the training because you are most knowledgeable about your job sites and your craft. We're now going to break back into our 6 Hazard Mapping teams for a new activity. Find your teammates and regroup for: "Hazard Challenge—You're the Expert" Tell the class: In this activity, your team will explore specific electrical hazards through analyzing actual case study scenarios. **Goal:** Practice hazard identification and risk assessment; reinforce safe work practices using the Hazard Assessment Model. Have each team randomly draw a number from 1-6. ❖ *You can use numbered pieces of paper, playing cards, or even electrical parts…be creative and fun!* Point out the six stations you have set-up around the room and explain the following: Each numbered station has a scenario (based on an actual case study) that illustrates the dangers associated with a specific electrical hazard. Some stations may have a video to watch or actual props/tools/equipment to inspect. Each team goes to the station matching the number they picked. Teams will have 20 minutes to review the facts of the scenario, identify the hazard, assess risk factors, and brainstorm possible control strategies/solutions using the prompts from the "Hazard Assessment Model" handout. Include examples from your work in construction. A blank worksheet version of the handout will be available for keeping notes while brainstorming. When their assessment is done, each team prepares to report back to the class: 1. Fill-in their information on the flipchart page provided; 2. Select a team spokesperson to present their findings back to the class. After 20 minutes, teams return to the class (the Instructor will check-in with teams at the 15 minute mark to determine if additional time is needed to complete the exercise). Tell the class: As you listen to the presentations, be thinking about how this information ties back to your hazard map. At the end of the training, you'll be going back with your teams to update your map.

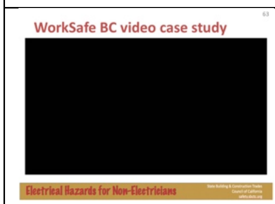
The Instructor returns to the PowerPoint presentation and follows the prompts in the curriculum. Each team, in turn, will be asked to report back on the hazard they studied.



Slide 62—Hazard #1: Overhead Power Lines

Power lines, transformers, converters are the primary source of electrocutions caused by electric parts in construction, causing 39% of deaths between 2011-15.

Call up Team 1. Play the video on the next slide before they present their findings.



Slide 63—WorkSafe BC video case study

Click the slide to play the case study video for overhead power lines.

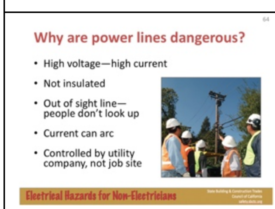
WorkSafeBC—Power Line-Fatal Crane Truck Contact

The Team 1 spokesperson shares the team's hazard assessment with the group. When they are finished, continue with the PowerPoint presentation.

Recognize the Hazard

Ask: Has anyone experienced an incident where a person or equipment contacted overhead or underground power lines? Tell us what happened. Discuss.

Ask: What makes overhead power lines so dangerous?



Slide 64—Why are power lines so dangerous?

Overhead power lines are dangerous because:

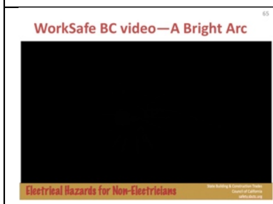
- They carry high voltage—high current
- Are typically not insulated
- Can arc
- Out of sight-line; people don't look up
- Controlled by utility company, not the job site

Overhead power lines are used in electric power transmission and distribution to transmit large quantities (tens of thousands of volts) of electrical energy along large distances. They are usually not insulated; most of the insulation is provided by air.

You must assume all overhead power lines are energized and potentially dangerous, including service drops running between poles and buildings. These wires may look insulated, but any coating you see is designed to protect the lines from weather, not to protect you from shock. Contact can still be deadly.

High voltage power lines can **arc** through the air over distances; strong current can jump gaps in a circuit. Getting too close to high voltage lines puts you at risk even if you do not actually touch the conductor.

Ask: What happens if you make contact with overhead power lines?



Slide 65—WorkSafe BC video—A Bright Arc

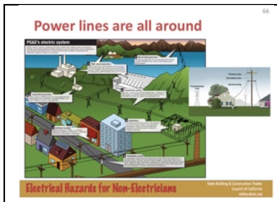
Click on the slide to play the video

Ask: What did you learn from this video? Discuss

Key points:

- Electricity seeks all paths to ground.
- If part of the equipment or tool you are using contacts a live power line, it becomes an energized conductor and anything that comes in contact with your equipment or tool, including you, will also become energized.
- Even the earth itself can become energized for some distance around the equipment.
- When the current reaches the ground, it spreads out in concentric circles, like ripples in a pool of water.
- The voltage is very high where electrical contact is made with the ground, and gradually drops off the farther away it gets from this point.
- Wet ground will extend the distance and the danger (remember, wet conditions lower resistance).

It's possible that the operator inside the energized equipment is relatively safe (because the equipment is grounded) providing they don't touch or step on anything outside the equipment. But workers outside the equipment may be electrocuted by touching the equipment or from stepping across the energized ground around the equipment.



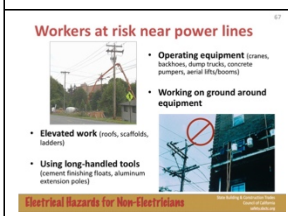
Slide 66—Power lines are all around

This PG&E graphic shows a simple overview of a power grid.

Ask: What stands out to you? Discuss responses.
Point out that there are a lot of places for potential contact with lines.

Optional info to share:

- Wires on tall transmission towers carry high-voltage from power plants to substations where the voltage is reduced.
- From substations, electricity travels on smaller wires that branch out down streets, either overhead or underground.
- Overhead and underground power lines carry electricity to transformers on poles or on the ground, where the voltage is reduced again to a level that is safe for typical use.
- From transformers, electricity travels into buildings through service drop wires. These connect to the meter and to all the wires that run inside walls to outlets and switches.



Slide 67—Workers at risk near power lines

<u>Evaluate Risk</u>
What construction activities put workers at risk for contacting overhead power lines?

- Operating equipment such as cranes, backhoes, front-end loaders, dump trucks, concrete pumpers, aerial lifts/booms, hoisting equipment under or adjacent to overhead power lines.
- Working on the ground around equipment being used near power lines. In the event of power line contact, workers on the ground are in the greatest danger of shock. If a crane or other piece of equipment you are guiding hits an overhead power line, electricity can travel down the tag line that you are holding and through you.
- Performing work at elevations that may put workers too close to power lines.
    - Scaffolding—Erecting, relocating, or working on the platform
    - Ladders—Extend the reach of workers into potential danger zone; ladders are potential conductors of electricity (especially metal ladders)
    - Working on roofs
    - Using long-handled tools, extension poles—examples: cement finishing floats; aluminum extension pole for paint rollers

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Handling/carrying long, conductive building materials—pipe; rebar, solar panel brackets, rain gutters
What injuries might occur?

Electrocution—usually shocks are fatal because of high-voltage
Burns—high current means high heat; potential for arc flash
Falls

❖ Optional Case Studies are included in your course binder:

Scaffold too close to power line (OSHA)
Crane boom too close to power line (OSHA)
Crane boom swung into power line (OSHA)
Laborer Electrocuted by energized crane (SBCTC Focus Four)

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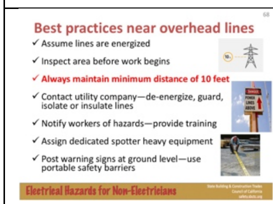

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Slide 68—Best practices near overhead lines
<u>Control Strategies/Safe Work Practices</u>
Review the points on the slide:
✓ Assume <u>all</u> overhead power lines are energized and potentially dangerous.
✓ Inspect area before any work begins. Locate and identify all power lines, poles, and support wires. Look for lines that may be blocked from view by trees or buildings.
✓ Always maintain a <u>minimum distance of 10 feet</u> from power lines. Workers should <u>never</u> get themselves or any tools or equipment within 10 feet of lines carrying between 600-50,000 volts.
As voltages increase, clearance distances also increase. And cranes and derricks used in construction require different safety precautions than other equipment. Consult Cal/OSHA Consultation for current standards and requirements.
✓ Contact the utility company/owner/operator well in advance of work to determine if they can de-energize, guard, isolate or insulate the lines, or make other safety arrangements that will prevent workers from contacting lines either directly or indirectly.
✓ Make all workers who must enter the area aware of overhead line hazards and review proper safety procedures before beginning work. Provide proper training.
✓ Post warning signs at ground level.
✓ Make a portable safety barrier to keep workers and equipment a safe distance from overhead lines.
✓ If heavy equipment if being used, assign a <u>dedicated</u> spotter who is in continuous contact with the equipment operator. The spotter should <u>not</u> be performing other jobs while helping the operator maintain safe clearance.
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Slide 69—Ladders near electrical circuits

- ✓ Always make sure ladders and tools used near energized electrical circuits are **non-conductive and are clean and dry.**

  Ask: How do you know which ladders are non-conductive?
  Answer: Non-conductive ladders are made of fiberglass or wood.

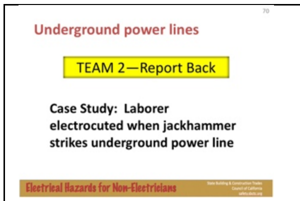
- ✓ Use of portable metal or conductive ladders for electrical work or in locations where they may contact electrical conductors is prohibited.

- ✓ Ladders should be labeled by the manufacturer to indicate if they are non-conductive and safe to use around electricity. If you're not sure if you have a non-conductive ladder, talk to your foreman or safety manager before you use a ladder near sources of electricity.

  Cal/OSHA General Industry Safety Orders §3276 Portable Ladders (e)(18) states:
  Electrical Hazards. Non-conductive ladders shall be used in locations where the ladder or user may contact unprotected energized electrical conductors or equipment. Conductive ladders shall be legibly marked with signs reading "CAUTION - Do Not Use Around Electrical Equipment," or equivalent wording.

- ✓ Water is an excellent conductor, so no matter what the ladder is made of, wet ladders should always be kept away from sources of electricity.
- ✓ **Be careful carrying/using ladders and long handheld tools.** Carry ladders, paint rollers, rain gutters, and other long objects so they are parallel to the ground. When it's time to use them, raise and lower them carefully to avoid power lines.
- ✓ **Adjust ladders and tools cautiously.** Before adjusting extension ladders, paint rollers, or other long tools, add your own height and make sure the total height will remain a safe distance of ***at least*** **10 feet away** from overhead lines of 50,000 volts or less.

Ask: Do you have anything to add or any questions before we move on?
Discuss



Slide 70—Underground power lines

Call up Team 2 to report back their case study findings.

Read case study aloud: **Laborer electrocuted when jackhammer strikes underground power line (Washington FACE report)**

A 38-year-old laborer was electrocuted when the jackhammer he was using struck an underground power line. The incident happened at a hospital parking lot where his employer was a subcontractor hired to install a storm water drainage system. His employer was a site preparation contractor. The victim was an experienced laborer and a member of the Laborers' International Union of North America. His job duties for this project included digging trenches and laying and connecting storm drain pipe.

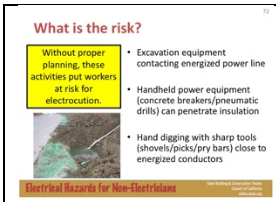
On the day of the incident, the victim and two other employees were digging trenches and installing storm drains. At the location they were working, there was a buried duct bank which was in the way and conflicted with the plans for installing the storm drain. This duct bank contained three lines of PVC electrical conduit piping encased in concrete. Each line of conduit piping contained four power line cables carrying 7,200 volts each. In order to install the storm drain pipes to the necessary grade, the employees were using an excavator, breaker bar, and a rivet-buster-type jackhammer to chip away at the duct bank concrete. The victim was in the trench chipping the duct bank's concrete when his rivet buster punctured the conduit and contacted the power line cable. He was electrocuted and died at the scene.

Slide 71—Underground line hazards

High-voltage power lines are not only overhead, they may also be buried underground.

<u>Recognize the Hazard</u>
What makes underground power lines dangerous?

- May be high-voltage
- Can't see them; may be almost anywhere under a construction site; could be close to the surface, in unexpected locations, and poorly protected.
- May have been put in at different times, by different companies
- Actual "as-built" locations may not match plans
- Private underground lines may not belong to a utility, may not be marked by locator

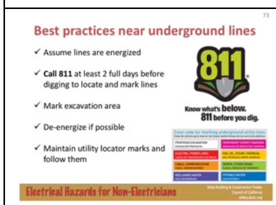


Slide 72—What is the risk?

<u>Evaluate Risk</u>
Brainstorm:
What construction activities put workers at risk for contacting underground power lines?

- Excavation/trenching work using heavy equipment
- Using handheld power equipment such as concrete breakers and pneumatic drills that can easily penetrate insulation
- Hand digging with shovels/picks/pry bars close to energized conductors

❖ *Optional Case study included in your course binder:*
"Worker electrocuted when backhoe strikes underground electrical transmission line" (New Jersey FACE report)



Slide 73—Best practices near underground lines

<u>Control Strategies/Safe Work Practices</u>
Strategies are similar to those we just discussed for overhead lines.

✓ Always assume lines are energized.
✓ **Call 811** Do advance planning—locate lines before doing any digging. Contact Underground Service Alert (USA); call 811 at least two full days before you dig or move earth in any way. USA will arrange to mark buried utilities. Before calling, delineate the excavation area with white paint, flags or stakes so locators can easily identify and mark affected utilities.
There is a standardized color code for locator marks.

Ask: Who knows what color indicates electric power lines?
Answer: Red. The chart on the slide shows the color codes.

✓ If working on private property, there may be buried electrical lines that are not marked by USA. The property owners should be contacted before any work begins to identify where these are located. Or a private locating service may be needed.
✓ De-energize if possible—notify and coordinate with the local utility companies before work begins.
✓ Maintain utility locator marks and follow them when digging.
✓ Look for pipeline markers in the vicinity.
✓ If you damage a conduit, do not attempt to repair—notify a qualified electrician to assess the damage and repair the conduit.

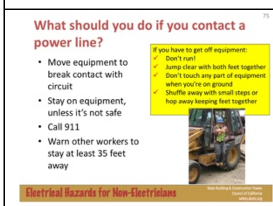
Slide 74—Dig with care—hand digging

Dig with care. The law requires hand digging within a certain distance of marked lines.
Ask: Does anyone know what that distance is?
Answer: Within 24 inches of each side of marked utility lines.

Follow safe practices when hand digging:

- ✓ Use a rounded or blunt-edged, fiberglass handled shovel.
- ✓ Don't use sharp tools that can damage lines.
- ✓ Never pry against a utility line to remove soil, stab at the soil, or stomp on the shovel with both feet. Even a slight gouge, scrape, or dent to a utility line conduit or its coating can cause a hazard.
- ✓ You must see the line with your own eyes before working close to an underground utility line with power digging equipment.
- ✓ If you damage a conduit, do not attempt to repair—notify a qualified electrician to assess the damage and repair the conduit.

Ask: Does anyone have anything to add to our best practices list?



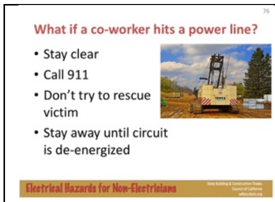
Slide 75—What should you do if you contact a power line?

What should you do if your equipment contacts a power line?

- ✓ Move the equipment to break contact with the power line if possible.
- ✓ Stay on the equipment, unless other hazards (e.g. fire) are present.
- ✓ Call 911 and warn other workers to stay a distance away (at least 35 feet)
  Electricity flows through the equipment to ground and travels in all directions. Voltage decreases as it travels out from the center where the energized equipment is touching the ground.
- ✓ Wait on the equipment until emergency responders or utility employees tell you it is safe to exit.

If you **must** leave the equipment:

- ✓ **Don't run!** If you run or take large steps, you increase the chance that electricity could come up one leg and go out the other, and you could be shocked.
- ✓ Jump clear and land with your feet together; do not touch any part of the equipment once you are in contact with the ground.
- ✓ Shuffle away with small steps, or hop away on two feet, keeping both feet together until you are a safe distance away.

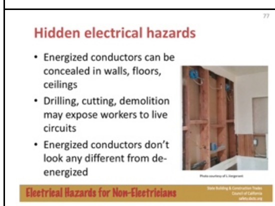


Slide 76—What if a co-worker hits a power line?

Ask: What should you do if a co-worker hits a power line?
Review the info on the slide.

Explain:
If you touch someone who is in contact with electricity, you could be shocked too. You can also be shocked if you touch the vehicle or equipment that person is in, or the tool they are holding. The best thing to do is to stay far away and call for help.

Ask: Do you have anything to add or any questions before we move on to the next hazard?
Discuss



Slide 77—Hidden electrical hazards

(This is not covered in the team activity)

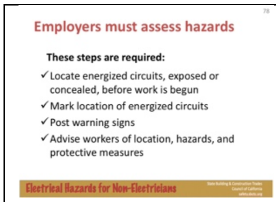
Energized electrical conductors may be concealed in ceilings, walls, or under floors.

<u>Recognize the Hazard</u>
What makes hidden electrical conductors dangerous?

- Conductors are not visible; their location is not obvious.
- If they are visible, energized "live" conductors do not appear any different from de-energized conductors.
- Workers may be shocked or electrocuted by accidentally cutting or breaking insulation and contacting energized conductors.
- Low voltage electricity (600 volts or less) can potentially injure and electrocute workers, or start fires.

<u>Evaluate Risk</u>
What job tasks might expose workers to hidden live electrical conductors?

- Demolition
- Drilling or cutting into walls, ceilings, floors



Slide 78—Employers must assess hazards

<u>Control Strategies/Safe Work Practices</u>
What do you think is the best way to avoid contact with hidden live conductors?

- ✓ Assess the job site before work begins; have a qualified electrician locate/identify potential live circuits, de-energize and lock out the circuits before work begins
- ✓ Pre-task planning; prepare for training workers
- ✓ Mark potential hazards; warning signs to alert workers
- ✓ Notify workers of location of potential electrical hazards and review policies and procedures
- ✓ Train workers about the dangers of contacting energized electrical conductors and tell them to verify that circuits are de-energized before beginning work.

Here are the Cal/OSHA standards:
CSO §1518. Protection from Electric Shock.
(d) Before work is begun, the employer shall ascertain by inquiry, direct observation, or by instruments, whether any part of an energized electric power circuit, ***exposed or concealed****, is so located that the performance of the work may bring any person, tool or machine into physical or electrical contact with the electric power circuit.*

(1) Where such circuits exist, a legible marking shall be made indicating the presence and location of the energized circuit(s), or warning signs shall be posted in accordance with Section 3340 of the General Industry Safety Orders.

(2) The employer shall advise the employee of the location of such energized circuits, the hazards involved, and the protective measures to be taken in accordance with Section 1509 of these Orders.
Note: Section 1518(d) applies to electrical installations present on the jobsite which do not involve excavations. For electrical installations involving excavations as defined in Section 1540, see Section 1541.

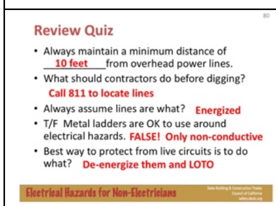
CSO §1735(a) Demolition states
Utility companies shall be notified and all utility service shut off, capped, or otherwise controlled, at the building or curb line before starting demolition, unless it is necessary to use electricity or water lines during demolition. If use is necessary, the utility services shall be relocated or rearranged as necessary and protected from physical damage.

Slide 79—Best practice—de-energize circuits

Ask: Who knows what this slide is showing?
Click the slide to reveal the answer
Answer: Lock Out/Tag Out (LOTO)

De-energizing Electrical Equipment
The accidental or unexpected sudden starting of electrical equipment can cause severe injury or death. Before ANY inspections or repairs are made, the current must be turned off at the switch box and the switch padlocked in the OFF position. At the same time, the switch or controls of the machine or other equipment being locked out of service must be securely tagged to show which equipment or circuits are being worked on.

The law provides protection to you from the unexpected start or sudden release of hazardous energy by requiring your employer to put into place a Lockout/Tagout (LOTO) Program. (Required by the California Code of Regulations Title 8, Section 3314).



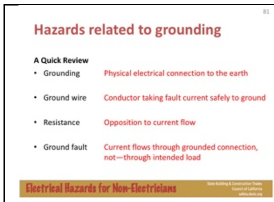
Slide 80—Review Quiz

Ask participants to raise their hand if they know the answer. Call on different people to answer each quiz question.
Click on the slide to reveal answers one-at-a-time

Review main takeaway messages about power line and hidden electrical hazards.

- ✓ Look for overhead power lines and buried power line indicators. Post warning signs.
- ✓ Stay <u>at least</u> 10 feet away from overhead power lines.
- ✓ Contact utilities: call 811 USA to mark buried power line locations.
- ✓ Unless you know otherwise, assume that lines are energized.
- ✓ Have a qualified electrician de-energize and ground lines when working near them. Other protective measures include guarding or insulating the lines.
- ✓ Use only clean, dry, non-conductive wood or fiberglass ladders when working near power lines.
- ✓ Identify and mark any potential concealed electrical conductors and de-energize (and lock out) before drilling/cutting into walls, ceilings or floors.

Ask: Do you have any questions/comments about these hazards before we move on?



Slide 81—Hazards related to grounding

Properly grounding electrical systems, equipment and tools protects workers from electric shock. The next two hazards result from grounding issues.

Review the electrical terms on the slide before Team 3 presents their case study.

Ask the class to raise their hands if they know the meaning of the terms.
Click on the slide to reveal the answers one-at-a-time

The terms "grounding" and "ground wire" mean:

- A physical electrical connection to the earth.
- A conductor that takes fault current (any current that is not in its intended path) safely to the ground.
- A separate, low-resistance pathway for electricity when it does not follow normal flow from hot to neutral.
- A wire used in an electrical circuit/tool/cord to conduct current to the earth in the event of a short circuit.

Two kinds of grounding are required by construction standards: system or service ground (neutral conductor is grounded—protects machines, tools) and equipment ground (protects workers).

Ask: What does a ground wire do to protect us?
Answer: The ground wire provides a path that is less resistant than the human body for electricity to flow back to its source or to the earth. In the event of a fault, most of the electrical current will flow through the ground wire instead of flowing through you.

Resistance is the opposition to current flow.
Ask: Who remembers what conditions lower our body's electrical resistance? Possible answers:

- Wet skin/perspiration
- Standing in water
- Working in a damp environment

Ask: What is meant by a "ground fault?"
Answer: A loss of current from a circuit to a ground connection.
Ask for examples of what might cause this to happen. Possible Answers:

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- Contact between an energized wire and a ground wire
- A broken hot wire
- Insulation failure

Ground faults can happen in any part of an energized electrical circuit where grounding exists—including devices connected to the circuit. For example: portable power tools; light fixtures; receptacles and switches; flexible cords; connectors, etc.

Explain: We'll be assessing two hazards related to grounding. As we go through the information, note if you've experienced any of these on-the-job.

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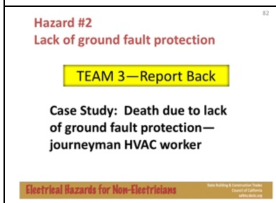

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Slide 82—Hazard #2 Lack of ground fault protection

Call up Team 3 to report back their case study findings.

Read case study aloud:
Death Due to Lack of Ground-Fault Protection
A journeyman HVAC worker was installing metal duct work using a double-insulated drill connected to a drop light cord. Power was supplied through two extension cords from a nearby residence. The individual's perspiration-soaked clothing/body contacted bare exposed conductors on one of the cords, causing an electrocution. No GFCI's were used. Additionally, the ground prongs were missing from the two cords.

When Team 3 is finished with their presentation, continue with the PowerPoint

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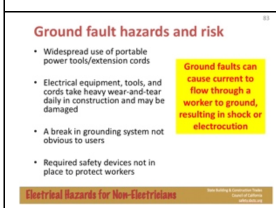

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Slide 83—Ground fault hazards and risk

<u>Recognize the Hazard</u>
Widespread use of portable power tools and flexible extension cords on construction sites creates the potential for electric shock and even death.

A break in the grounding system may occur without the user's knowledge.
Ground faults most often occur when equipment is damaged or defective, such that live electrical parts are no longer adequately protected from unintended contact.

Cords, cord connectors, receptacles, and cord and plug-connected

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equipment are vulnerable to damage by daily job activities. Wear-and-tear and heavy use can damage insulation, exposing energized wires. Insulation is damaged by misuse or excessive current.

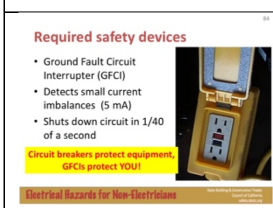
Wiring and insulation inside tools and cords can also be damaged with heavy use or overheating, creating a potential for ground faults. This damage may not be visible to the worker using the tool.

<u>Evaluate Risk</u>

- Workers using electric tools, cords and equipment, at jobsites that are not equipped with proper ground fault safety devices to protect them, are at risk for electric shock, burns, and electrocution.
- Even at low voltage/low current, electric shock can cause respiratory paralysis and ventricular fibrillation (heart loses ability to pump properly).
- Receiving an electric shock while working at height may cause a worker to fall.
- Without proper training, workers may not be aware that they are at risk for electrical hazards.

Discussion Prompts:

- Is this a static or a changeable hazard at construction sites?
- Are these incidents a result of unsafe conditions, equipment, or acts?



Slide 84—Required safety devices

<u>Control Strategies/Safe Work Practices</u>

Refer to the photo on the slide:
Ask: Who knows what this is?
Answer: GFCI (Ground Fault Circuit Interrupter) GFCIs are life-saving devices that protect workers from electric shock and electrocution. They are an effective, relatively inexpensive control strategy for ground fault protection and are **<u>required</u>** by OSHA and Cal/OSHA at construction sites.

❖ *Consider having GFCI samples to pass around the class.*

Ask: Does anybody know what GFCIs do?
Answer: A GFCI constantly monitors current flowing through a circuit and senses small imbalances in the circuit caused by current leakage to ground (a ground fault).

If the current flowing into the circuit through the hot wire differs by a very small amount (most GFCIs are set at about 5 milliamps) from the returning current through the neutral wire, the GFCI shuts off the electricity faster than a blink of an eye to prevent a lethal dose of electricity.
GFCIs are designed to operate in a fraction of a second before the electricity can affect your heartbeat.

Here's an example: A bare wire inside a tool touches its metal case. The case is then charged with electricity. If you touch the tool with one hand while another part of your body is touching a grounded object, you will get shocked. If the tool is plugged into an outlet protected by a GFCI, the power to the tool will be shut off in 1/40th of a second before a fatal shock can occur.

Ask: What are the buttons on the GFCI?
Answer: GFCIs are equipped with "test" and "reset" buttons to test that they are working properly. Pressing the "test" button on the device ensures that it trips, breaking the circuit. Pushing the "reset" button should restore the circuit to normal operation. If it does not trip, there is no protection and it will function as a normal outlet. GFCIs must be tested in accordance with manufacturers recommendations.

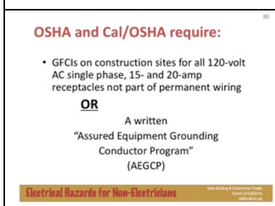
Slide 85—Have you seen these on-the-job?

Discuss the different GFCIs pictured on the slide.
Ask: Has anyone used/seen these on the job? Discuss
Ask: Has anyone had a GFCI shut down a circuit while you were using it? What did you do? Discuss

Different GFCI types are available for a variety of situations. GFCI protection may be anywhere on the circuit as long as it works effectively to protect the worker. Protection may be for the entire circuit, the outlet receptacle, or the extension cord.

Common GFCIs available are:

- Circuit Breaker Type—Located at the power supply or in a circuit breaker panel controlling all outlets in a circuit.
- Receptacle Type—Used in place of a standard duplex receptacle. Fits into a standard outlet box and protects against ground faults whenever an electrical tool is plugged into the outlet. These can be installed so that they also protect other electrical outlets in the branch circuit.

	– <u>Portable Type</u>—Used where permanent GFCIs are not practical. Portable GFCIs are convenient on construction sites because they allow ease of movement for workers going from one location to another. One type contains GFCI circuitry in a plastic enclosure with plug/receptacle slots in front; it is plugged into a standard receptacle, then the electrical tool is plugged into the GFCI. Another type is an extension cord combined with a GFCI that plugs into a non-GFCI-protected receptacle. A Spider box is a multi-receptacle portable power outlet unit used with temporary wiring installations. Spider boxes are typically manufactured with built-in GFCI protection for these receptacles. This will help ensure that no one becomes injured should electrical cords become damaged or the system compromised. Portable GFCI devices should only be used on a temporary basis and should be tested according to manufacturers recommendations and stored properly each day.
	**Slide 86**—OSHA and Cal/OSHA require: OSHA and Cal/OSHA standards <u>**require**</u> employers to use GFCIs on construction sites for all 120-volt, AC, single-phase, 15- and 20-amp receptacle outlets that are not part of the permanent wiring of the building or structure <u>**OR**</u> they must maintain an "Assured Equipment Grounding Conductor Program (AEGCP)." Ask: Does anyone work under an AEGCP? If yes, ask them to tell the class about their experience. Ask: Do you also use GFCIs with your AEGCP? AEGCP must meet these <u>minimum</u> requirements: 1. Written plan must be on file at the job site; 2. Designate one or more qualified persons to implement the program; 3. Conduct daily equipment inspections (all cord sets, attachment caps, plugs/receptacles, and cords); 4. Regularly scheduled testing for continuity of all equipment grounding conductors, and each receptacle and attachment cap or plug shall be tested for correct attachment of the equipment grounding conductor. Tests will be scheduled as follows: • Before first use for newly acquired equipment; • Before equipment is returned to service following any repairs;

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- Before equipment is used after any incident that can be reasonably suspected to have caused damage (for example, when a cord set is run over); and
- At intervals not to exceed three (3) months, except for cord sets and receptacles that are fixed and not exposed to damage shall be tested at intervals not exceeding 6 months.
- Records of the testing must be kept.

Because it may be impractical to meet all these requirements of an assured grounding program, GFCI protection is often considered easier and better.

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Slide 87—Safe practices: ground fault hazards

Control Strategies/Best Work Practices:

✓ Employers should inform workers which form of ground fault protection is being used on the job site; GFCI, AEGCP, or both.
✓ Identify the designated qualified persons on the job site;
✓ If GFCIs are being used, visually inspect and test before each day's use, follow manufacturers recommendations.
The GFCI must trip when you press the “Test” button. It must also energize the circuit when you press “Reset.” If either test fails, you must replace the GFCI in order to be protected. This should only be done by a qualified electrician;

Ask: What is the policy on your job sites for testing GFCIs? Who does it, and how often?   Discuss

✓ Train workers about proper use of GFCIs;
✓ Workers should ask their employer if GFCIs, tools and cords have been tested to make sure they are safe before use.
✓ Train workers to look for clues that ground fault problems may exist.
What are some clues? Possible answers:

- Warm tools, wires, cords, connections, or junction boxes;
- Worn or frayed insulation around wires or connections;
- GFCI trips to shut off circuit

✓ Operate only one power tool on each GFCI.
✓ Store power tools and extension cords in a dry location.
✓ Use extreme caution if working in wet environments.
✓ Remove defective/damaged tools and cords from service immediately.

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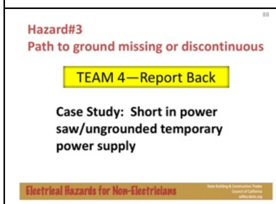
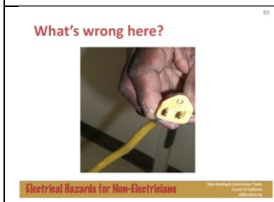
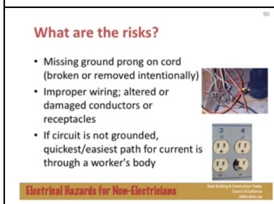
	Ask: Does anyone have anything to add to our best practices list? **A GFCI can save your life!** Ask: Are there any questions about ground fault protection before we go to the next Team?
	**Slide 88**—Hazard #3 Path to ground missing or discontinuous Call up Team 4 to report back their case study findings. Read case study aloud: **Short In Power Saw/Ungrounded Temporary Power Supply:** A 22-year-old carpenter was working at the construction site of a large apartment complex using a portable electric saw to construct the wooden framework of a laundry building. Electricity to operate portable power tools was supplied by a temporary service pole 50 feet away. The pole had not been inspected by the city and was not in compliance with code requirements (it was not grounded). The victim used two extension cords to supply power: a home-made cord plugged into an ungrounded receptacle on the pole, and a UL-approved cord extending from the homemade cord to the saw. The accident site was wet; also, humidity was high and the victim was sweating. Reportedly, he was shocked throughout the morning, and he had replaced one of the extension cords in an effort to eliminate the shocks. The source of the shocks—the saw—was not replaced. As the victim climbed down a makeshift ladder, he shifted the saw from his right hand to his left, and was shocked. This caused him to fall from the ladder and land in a puddle of water, still holding the saw. Apparently, his hand contracted and he was "locked" to the saw. A co-worker disconnected the power cord to the saw, too late to save the victim. After Team 4 completes their presentation, resume the PowerPoint. Explain to the class: If the power supply to the electrical equipment is not properly grounded, or the path has been broken, a hazard exists because unwanted voltage cannot be safely eliminated. Even when the power system is properly grounded, electrical equipment can instantly change from safe to hazardous because of extreme conditions and rough treatment.

	Without proper grounding, metal parts (switch plates, ceiling light fixtures, conduit, etc.) of electrical systems, tools, and cords that we touch can become energized. Discussion Prompts: Has anyone encountered this hazard personally? What happened?
 	**Slide 89**—What's wrong here? Discuss the photo: The ground prong is missing from the plug. What type of changes to equipment, either intentional or unintentional, would cause a ground conductor to lose its connectivity? Answers: • Broken ground prong on an electric cord plug • Removing the ground prong from a plug to fit an ungrounded outlet • Disconnected, broken or damaged grounding wires • Improperly wired, altered or damaged receptacles • Cracked casings on power tools • Mishandling and improper storage of tools and extension cords • Frayed, cut, spliced, damaged or improperly repaired cords • Vehicle/equipment traffic running over cords Discuss—Are these incidents a result of unsafe conditions, equipment, or acts? Ask: Have you observed any of these on-the-job? What did you do? Discuss
 	**Slide 90**—What are the risks? <u>Evaluate Risk</u> • Without proper grounding, the quickest and easiest path for the current to take to ground is through the worker's body. • Workers can be shocked, burned or electrocuted. • This hazard is known to be widespread on construction sites. • Electrical equipment—receptacles, connectors, cords damaged by everyday use or abuse (e.g. being thrown down on and dragged across concrete floors; run over by construction equipment, etc.) can still be energized. • Just because a 3-prong receptacle is present, this does not mean

it's properly grounded. Receptacles must be wired correctly to be properly grounded. This should only be done by a qualified electrician.

Optional Case studies included in your course binder:
Deaths Due to Missing or Discontinuous Path to Ground

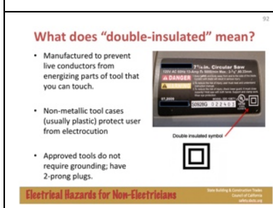
- *Adapter For 3-Prong Cord Not Grounded To Outlet*
- *Ground Wire Not Attached*

Slide 91—Safe practices and solutions

<u>Control Strategies/Safe Work Practices</u>

✓ Ground all power supply systems, electrical circuits, and electrical equipment.
✓ Frequently inspect electrical systems to insure that the path to ground is continuous.
✓ Visually inspect all electrical equipment before use. Take any defective equipment out of service.
✓ Do not remove ground prongs from cord- and plug-connected equipment or extension cords.
✓ Use double-insulated tools and equipment, distinctively marked.
✓ Use cordless tools
✓ Ground all exposed metal parts of equipment.
✓ Train workers on the importance of proper grounding to protect their safety.

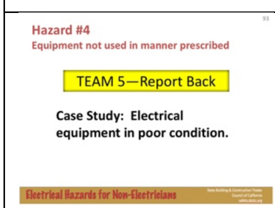
Ask: What do we mean by "double-insulated" tools?
Answer on next slide



Slide 92—What does "double-insulated" mean?

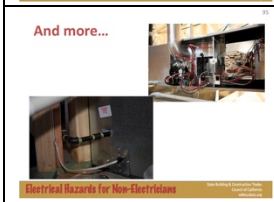
Answer: Double insulated tools are hand-held tools manufactured with non-metallic cases (usually plastic) that will prevent the user from electrocution if the tool develops a short circuit. A second insulation barrier (in addition to the insulation on individual wires in the tool and cord, and the cord itself) prevents an energized conductor ("hot" wire), that may come loose inside the tool, from energizing parts of the tool that you can touch.

If approved, they do <u>not</u> require grounding under the National Electrical Code. These tools will have a <u>two-prong plug with no ground pin</u> and one prong will be wider than the other. The wider pin is the neutral conductor while the thinner pin is the hot. This is important because if plugged into a properly wired circuit, the tool’s

	switch will control the hot conductor and the internal wiring of the tool cannot become energized. Although this design method reduces the risk of grounding deficiencies, a shock hazard can still exist. Cal/OSHA regulations (2395.45) state: Power-operated tools must be grounded <u>or</u> of the double-insulated type. If double-insulated types of tools are used, the equipment <u>shall be distinctively marked</u>. Double insulated tools are marked with the symbol shown here (see slide) that looks like a box within a box. Ask: Does anyone have anything to add to our best practices list? Ask: Are there any questions about missing or improper grounding before we go to the next Team?
	**Slide 93**—Hazard #4 Equipment not used in manner prescribed Call up Team 5 to report back their case study findings. Read case study aloud: **Electrical Equipment In Poor Condition:** An 18-year-old worker at a construction site was electrocuted when he touched a light fixture while descending from a scaffold for his afternoon break. The source of the electricity was apparently a short in a receptacle, but examination revealed that the electrical equipment used by the contractor was in such poor condition that it was impossible to make a certain determination of the source of the short. Extension cords had poor splices, no grounds, and reversed polarity. One hand drill was not grounded, and the other had no safety plate. Out of several possible scenarios, the most likely was contact between the exposed wires of an extension cord and a screw that protruded from the receptacle, which had its face plate removed. The light fixture, which served as a ground, was known to be faulty for at least 5 months before the incident. After Team 5 completes their presentation, resume the PowerPoint

Slide 94—Examples of misused equipment

Discuss the photos on the slide.
Ask: What's wrong with how this equipment is being used?



Slide 95—And more…

Discuss the photos.

Ask: Have you seen electrical equipment and tools misused on-the-job? What have you noticed? Create a list of responses.

<u>Recognize the Hazard</u>
Ask: How might misuse of electrical equipment create a hazard? Discuss

If electrical equipment is used in ways for which it is not designed, you can no longer depend on safety features built in by the manufacturer. This may damage your equipment and put workers at risk for injuries.

<u>Common Examples of Misused Equipment</u>

- Using multi-receptacle boxes designed to be *mounted* by fitting them with a power cord and placing them on the floor.
- Fabricating extension cords with ROMEX® wire.
- Using equipment outdoors that is labeled for use only in dry, indoor locations.
- Attaching ungrounded, two-prong adapter plugs to three-prong cords and tools.
- Using circuit breakers or fuses with the wrong rating for over-current protection, e.g. using a 30-amp breaker in a system with 15- or 20-amp receptacles. Protection is lost because it will not trip when the system's load has been exceeded.
- Using modified cords or tools, e.g., removing ground prongs, face plates, insulation, etc.
- Using cords or tools with worn insulation or exposed wires.

Can you think of any other examples?

- Removing covers from electrical panels and boxes allows free access to energized electrical parts.

Ask: Has anyone seen ROMEX® wire used to make cords on the job? Why is this not allowed?
Short answer: It is neither manufactured nor approved in the National Electrical Code to be used as a flexible cord.

Longer Answer:

Romex, or technically NM cable, is UL listed to be part of a building electrical system and the National Electrical Code (NFPA 70) Article 334 limits its use to residential structures and a few other uses. It is for use concealed inside walls and ceilings and, subject to detailed requirements, exposed in garages, ceilings and unfinished basements run along floor joists. According to Title 9 2500.7 all cords must be approved (i.e. UL listed) for that use. ROMEX® *seems tough but, used improperly, would be easily damaged on a construction site. The outer sheath has poor cut and abrasion resistance and it has solid wire that is not as flexible as the stranded wire in cords. Repeated flexing would lead to cracking and eventually breaking of the solid wire. It is designed to be installed and left static. Similarly, electrical boxes are UL listed to be part of a building structure and should not be used as part of an extension cord.*

Slide 96—Activities that put you at risk

Evaluate Risk

Doing any of the following puts you and your co-workers at increased risk for injury and death:

- Disregarding manufacturer specifications for using tools and equipment
- Altering equipment/disabling grounding
- Ignoring clues that point to electrical problems: overheating tools; frayed/damaged cords; tripped circuit breakers and GFCIs; loose or exposed wires; burned insulation; uncovered electrical boxes/panels.
- Failing to remove damaged tools/cords/equipment from service immediately
- Not speaking-up when you recognize a potential hazard

❖ *Optional Case studies included in your course binder:*

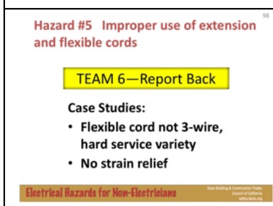
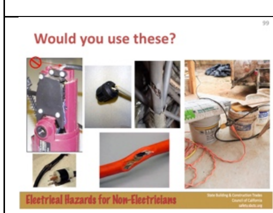
Deaths Due to Equipment Not Used in Manner Prescribed

- *Handling Damaged Extension Cord When Energized*
- *Improper Modification of Plugs*
- *Damaged Extension Cord Leaves Arc Welder Ungrounded*

Slide 97—Best practices

Control Strategies/Safe Work Practices

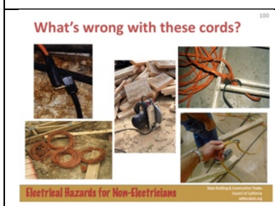
✓ Use only equipment that is approved to meet OSHA standards. [29 CFR 1926.403(a)]

	✓ Use all equipment according to the manufacturer's instructions. [29 CFR 1926.403(b)(2)] ✓ Do not modify cords or use them incorrectly. ✓ Be sure equipment that has been shop fabricated or altered is in compliance. ✓ Junction boxes, pull boxes and fittings must have approved covers. ✓ Unused openings in cabinets, boxes, and fittings must be closed (no missing knockouts). Ask: Does anyone have anything to add to our best practices list? Ask: Are there any questions about "equipment not used in manner prescribed" before we go to the next Team?
	**Slide 98**—Hazard #5 Improper use of extension and flexible cords Call up Team 6 to report back their case study findings. Read the two case studies aloud: **Deaths Due to Improper Use of Extension and Flexible Cords** **Flexible Cord Not 3-Wire, Hard Service Variety:** A worker received a fatal shock when he was cutting drywall with a metal casing router. The router's 3-wire power cord was spliced to a 2-wire cord and plug set which was not rated for hard service. A fault occurred, and with no grounding and no GFCI protection, the worker was electrocuted. **No Strain Relief:** A worker was operating a ¾" electric chisel when an electrical fault occurred in the casing of the tool, causing him to be electrocuted. An OSHA inspection revealed that the tool's original power cord had been replaced with a flat cord, which was not designated for hard service, and that strain relief was not provided at the point where the cord entered the tool. Additionally, the ground prong was missing and there was no GFCI protection. After Team 6 completes their presentation, resume the PowerPoint
	**Slide 99**—Would you use these? Discuss the photos with the class.

Recognize the Hazard

Extension cords can deliver electrical power almost anywhere on construction job sites. Because they are exposed, flexible, unsecured, heavily used and handled frequently they are susceptible to damage. Normal wear and tear can expose or loosen wires and weaken connections. They are repeatedly connected and disconnected, moved, stressed and stretched, coiled, run over, and exposed to dirt, oils, solvents, and other chemicals. Knowing what to look for and using best practices when working with flexible cords will help you avoid electrical hazards.

Ask: Do any of the cords in the photos look familiar?
What have you noticed about use of extension cords on the job?
Have you experienced a shock from a cord?



Slide 100—What's wrong with these cords?

Discuss the photos.

Evaluate Risk

How can using extension cords put you at risk?

- Workers have been shocked, burned or electrocuted as a result of contact with damaged extension cords.
- Extension and flexible cords are the link between the outlet and the worker and may be the point in an electrical circuit with the greatest risk of shock.
- Using extension and flexible cords as a substitute for permanent wiring.
- Running cords through walls, ceilings, floors, doorways or windows can damage cords and make frequent inspection difficult.
- Working outdoors or in wet or damp locations can increase your risk
- Tripped circuit breakers/GFCIs and blown fuses should alert you to potential tool/equipment malfunctions, electrical conductor/circuit, or grounding problems.
- Using a cord that is not designed for heavy construction is not safe.
- An extension cord or connection that feels warm may indicate too much current for the wire size of the cord.
- A burning odor may indicate overheated insulation.
- Using cords that are worn, frayed or have damaged insulation puts yourself and others at risk for shock, electrocution, and may start a fire.

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- Using cords when the plug has separated from the wire puts you at risk for shock
- Cords that are not 3-wire type, not designed for hard-usage, or that have been modified, increase your risk of contacting electrical current.

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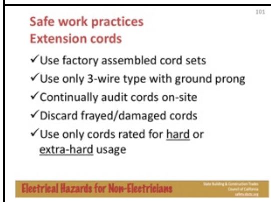

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Slide 101—Safe work practices—extension cords

<u>Control Strategies/Safe Work Practices</u>

- Use factory-assembled cord sets. *(While standards/codes may not specifically prohibit "made" cords on job sites, these cords would have to meet all the requirements of manufactured cords, including cord and fittings that are UL listed).*
- Use only extension cords that are 3-wire type <u>with ground plugs in place</u>.
- Continually audit cords on-site.
- Discard frayed cords
- Use only extension cords that are marked with a designation code indicating they are manufactured for hard or extra-hard usage. Any cords found not to be marked for hard or extra-hard use, or that have been modified, must be taken out of service immediately.

Ask: Has anyone ever looked at the markings on extension cords?

- *Provide samples of differently rated cords to pass around the class. Have trainees find the designation code.*

Ask: Where do you find this marking?
Answer on next slide

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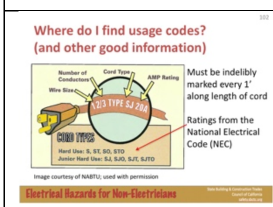

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Slide 102—Where do I find usage codes? (and other good information)

Answer: Usage codes are <u>required</u> to be indelibly marked approximately every foot along the length of the cord.

Ask: What codes should be on the cords I use?
Answer: Examples include: S, ST, SO, and STO are rated for <u>extra-hard</u> usage (also referenced by trade name "hard service"), and SJ, SJO, SJT, and SJTO are rated for <u>hard</u> usage (also referenced by trade name "junior hard service").

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<td>These ratings are derived from the National Electrical Code (NEC). A full listing of these codes with their specifications and approved usage can be found in the NEC Article 400, "Table 400.4 Flexible Cords and Cables"

Here's what OSHA says:
1926.405(a)(2)(ii)(J)
"Extension cord sets used with portable electric tools and appliances shall be of three-wire type and shall be designed for hard or extra-hard usage. Flexible cords used with temporary and portable lights shall be designed for hard or extra-hard usage.
NOTE: The National Electrical Code, ANSI/NFPA 70, in Article 400, Table 400-4, lists various types of flexible cords, some of which are noted as being designed for hard or extra-hard usage. Examples of these types of flexible cords include hard service cord (types S, ST, SO, STO) and junior hard service cord (types SJ, SJO, SJT, SJTO)."</td>
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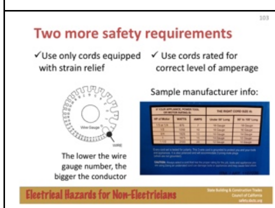
<td>
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<td>Slide 103—Two more safety requirements

Use only cords, connection devices, and fittings that are equipped with <u>strain relief</u>.

Ask: What does this mean?
Answer: Strain relief protects plugs, prongs, connectors that are plugged into an outlet from sideways or up and down pressure. To reduce hazards, flexible cords must connect to devices and to fittings in ways that prevent tension at joints and terminal screws. Flexible cords are finely stranded for flexibility, so straining a cord can cause the strands of one conductor to loosen from under terminal screws and touch another conductor.

Several different types of strain relief devices are commercially available.
• Have samples to pass around the class.
Looping two plugged devices together can keep plugs firmly connected.

OSHA standard says:
1926.405(g)(2)(iv)
Strain relief. Flexible cords <u>shall</u> be connected to devices and fittings so that strain relief is provided which will prevent pull from being directly transmitted to joints or terminal screws.</td>
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Slide 104—Don't abuse your power cords! Things you should NEVER do:

Demonstrate bad/good practices using props

- Remove cord from receptacle by pulling on the plug NOT jerking on the cord.
- Don't pull or put strain on cords
- Never carry a tool by the cord
- Keep cords away from heat, water, and oil.
- NEVER break off the ground prong
- Do NOT tie cords in tight knots
- Always use extension cords that are rated for the level of amperage or wattage you are using
- Do not allow vehicles to pass over unprotected extension cords

Ask: Does anyone have anything to add to our best practices list?

Ask: Are there any questions about "improper use of extension and flexible cords" before we move forward?

➢ Update Hazard Maps with solutions.
The goal is to apply what we just learned in the last section to participants' work settings.
Option A: Break back into teams, review original maps, list solutions for hazards identified on map, report back to large group.
Option B: Post all hazard maps on the wall and conduct this as a large group activity.

Slide 105—Do the right thing!

This training has provided you with information to help you stay safe on-the-job around electrical hazards.

Now it's up to you to put this training into action.

Distribute Electrical Hazards Post-Test

Post-Test (5 minutes): Participants retake the same test they took at the beginning of the class and return tests to their instructor.

Distribute Electrical Hazards Pre/Post Test Answer Key

Review the correct answers with the class.
Discuss any questions, review information as needed.

Slide 106—Work safely around electricity and enjoy a healthy career in the trades

We've reached the end of our training!

Ask: Are there any questions about what we've covered today? Discuss

Call attention to the flipchart with the "What Do You Want to Get Out of This Class" list that you created at the beginning of the training.

Review the list and ask if the class met participants' expectations.

If there were expectations that weren't met, ask for suggestions for how the class could be improved and record them on a flip chart.

Thank everyone for attending!

Distribute Training Evaluation Form
Ask participants to complete the class evaluation and return it to their instructor.

Hazard Challenge—You're the Expert (case study activity)

Equipment:
- ✓ Extra laptop with sound (only if using video case study)
- ✓ Timer

Materials:
- ✓ Painter's Tape

(6 sets of each)
- ✓ Flip chart prepared as shown
- ✓ Multi-color flip chart pens
- ✓ Hazard Assessment Worksheet

Set-Up:
Designate 6 spaces where you will set-up individual stations.
Supply each station as described.

Flip chart:

TEAM NAME:		
HAZARD:		
RECOGNIZE HAZARD	EVALUATE RISK	CONTROL HAZARD

Station 1: (Overhead power lines)
Case Study
- WorkSafe video "Power Line Hazard—Fatal Crane Truck Contact" (on flash drive) –OR—
- Written case study "Laborer Electrocuted by Energized Crane"

Set of materials

Station 2: (Underground power lines)
Case Study—Laborer electrocuted when jackhammer strikes underground power line.
Set of materials

Station 3: (Lack of ground fault protection)
Case Study—HVAC worker electrocuted while installing duct work.
Set of Materials
Props: GFCI samples

Station 4: (Path to ground missing/discontinuous)
Case Study—Carpenter electrocuted while using portable electric saw
Set of Materials
"Effects of Electrical Current on the Body" handout

Station 5: (Equipment not used in manner prescribed)
Case Study—Worker electrocuted while descending scaffold
Set of Materials
Props: Samples of damaged electrical parts, tools and cords.

Station 6: (Improper use of extension and flexible cords)
Case Studies:
- Worker electrocuted while cutting drywall
- Worker electrocuted while operating electric chisel

Set of Materials
Props: Samples of bad cords, damaged insulation, frayed, loose connections, damaged plugs

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Instructions for Setting-Up Activities

Hazard Mapping Teams	
<u>Equipment:</u> ✓ Timer <u>Materials</u>: (For each team) ✓ Flip chart sheet (2) ✓ Black and Red flip chart marker pens ✓ Painters tape ✓ Hazard Mapping Directions handout ✓ Notepad & Pens	<u>Set-Up</u>: ➢ Prepare to discuss risk factors for each hazard. ➢ Decide how many teams you will have. ➢ Assure there's enough space for teams to work and wall space to post completed maps. ➢ Follow notes in Curriculum for leading this activity.

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Hazard Challenge—You're the Expert (case study activity)

<u>Equipment</u>:

- ✓ Extra laptop with sound (only if using video case study)
- ✓ Timer

<u>Materials</u>:

- ✓ Painter's Tape

(6 sets of each)

- ✓ Flip chart prepared as shown
- ✓ Multi-color flip chart pens
- ✓ Hazard Assessment Worksheet

<u>Set-Up</u>:

Designate 6 spaces where you will set-up individual stations.
Supply each station as described.

Flip chart:

TEAM NAME:		
HAZARD:		
RECOGNIZE HAZARD	EVALUATE RISK	CONTROL HAZARD

Station 1: (Overhead power lines)
Case Study

- WorkSafe video "Power Line Hazard—Fatal Crane Truck Contact" (on flash drive) –OR—
- Written case study "Laborer Electrocuted by Energized Crane"

Set of materials

Station 2: (Underground power lines)
Case Study—Laborer electrocuted when jackhammer strikes underground power line.
Set of materials

Station 3: (Lack of ground fault protection)
Case Study—HVAC worker electrocuted while installing duct work.
Set of Materials
Props: GFCI samples

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Case Study—Carpenter electrocuted while using portable electric saw
Set of Materials
"Effects of Electrical Current on the Body" handout

Station 5: (Equipment not used in manner prescribed)
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Set of Materials
Props: Samples of damaged electrical parts, tools and cords.

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Props: Samples of bad cords, damaged insulation, frayed, loose connections, damaged plugs

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INSTRUCTOR'S GUIDE

Teaching materials for this training include the following:

- Instructor preparation tools (in course binder Tab 2)
    - ✓ Overall training objectives
    - ✓ At-A-Glance
    - ✓ Preparing to teach this training
    - ✓ What you need to present this training
    - ✓ Instructions for setting up activities

- Curriculum (in course binder Tab 2 and on flash drive)
  Includes all teaching notes and background information to teach the course. Pairs with Electrical Hazards for Non-Electricians PowerPoint presentation and Laminated slides

- PowerPoint presentations (on flash drive)
    - ✓ Electrical Hazards for Non-Electricians (106 slides) matches Curriculum
    - ✓ Electrical Hazards Jeopardy Review Game (42 slides)

- PowerPoint slides reference hardcopy
    - ✓ Electrical Hazards for Non-Electricians handout with space for notes (in course binder Tab 2)
    - ✓ Electrical Hazards Jeopardy Answer Key and Game Board (back pocket of course binder)

- Videos (on flash drive)
    - ✓ Slide 52 "Jacob's Ladder 500kVA Switch Opening" Run time 10 seconds.
    - ✓ Slide 54 "70E Electrical Arc Flash Demonstration." Run time 1.25 minutes.
    - ✓ Slide 63 "Power Line Hazard—Fatal Crane Truck Contact" WorkSafe BC. Run time 2 minutes.
    - ✓ Slide 65 "A Bright Arc" WorkSafe BC. Run time 2 minutes

- 5 Laminated Slides (front pocket of course binder)

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OVERALL TRAINING OBJECTIVES

By the end of this training, participants will be able to:

1. Identify causes of electrical fatalities
2. Understand basic electrical concepts and terms
3. Describe how electricity can harm the body
4. Recognize common electrical hazards
5. Use best practices to work safely around electricity

AT-A-GLANCE

Module	Slide #s	Time	Training Goal
Introduction	1-11	30 min	-Acknowledge source -Introduce topic -Course objectives -Hazards covered in the training -Take Electrical Hazards pre-test
1. Electrical Fatality Trends in Construction	12-19	15 min	-Review construction fatality data - Identify causes of electrocution - Describe sources of electrocution
2. Understanding Electricity Basics Hazard Mapping activity	20-36	60 min	-Explain basic electrical concepts -Describe seven common electrical terms -Learn about an electrical circuit -Explain relevance of grounding to worker safety -Work in teams to identify potential job site hazards
3. Effects of Electricity on the Human Body	37-58	45 min	- Describe electrical-related injuries: shock, electrocution, burns, falls -Explain three factors that affect the severity of shock -Identify health effects at different levels of current
4. Electrical Hazards	59-106	120 min	-Discuss five primary electrical hazards in construction -Apply hazard assessment model to electrical hazards -Recognize hazards, evaluate risk factors -Learn controls and safe practices -Work in teams to practice applying this training to case studies of actual fatalities in construction

Total time: Approximately 4.5 hours

Preparing to Teach This Training

The curriculum is designed to guide you through the entire training with key talking points, background information, activities, and prompting questions to engage the class. The goal of the training is to educate non-electrical workers about electrical hazards. It is important that workers know how to recognize hazardous situations; that contact with electricity can cause severe injury and death; what to do if a co-worker is shocked; and the safe practices and controls that keep them safe on-the-job.

Specialized technical knowledge is not necessary to teach this course. With proper preparation, foremen, union staff, apprenticeship instructors, and others can present the material. The Train-the-Trainer (TOT) class is designed to prepare participants to teach the curriculum by experiencing the training first-hand as well as receiving supplemental technical information from expert guest speakers and teaching tips and adult learning information.

The course is flexible and can be presented in different ways. Feel free to adapt it to your own situation. The minimum recommended training session is 30 minutes. You can use specific modules that are most relevant to your training needs, or present the entire course in 4.5 hours.

Laminated Slides: We have provided 5 laminated double-sided slides that can be useful for presenting training at a job site where it is not feasible to use PowerPoint or video. We condensed material from the course curriculum and PowerPoint that cover essential information from each training module. Use the curriculum talking points with these slides to present a shorter, basic training or refresher class. They also work well in conjunction with a tailgate training or toolbox talk.

PRACTICE! However you decide to present this training, it is always essential to study the curriculum and rehearse your presentation before holding a class. The curriculum provides a level of detail designed to provide the information you need to competently teach the material. Some of this information is intended to enhance the trainer's understanding of the concepts. You may choose to target only key points in your training as outlined at the beginning of each section and as shown on the PowerPoint slides.

If you have any questions or need help using this material, please contact the SBCTC Project Coordinator whose contact information is listed in the front of your binder.

What you need to present this training:

- Flash drive provided at the TOT class—(PowerPoint files with video files)
- Computer and LCD projector for PowerPoint presentation
- Audio system or portable speakers for videos
- Extension cord and power strip
- Course curriculum
- Class sign-in sheet
- Pre/Post tests
- Class evaluation forms
- Copies of handouts
- Flip chart pads and easel or white board
- Multi-colored markers (7 sets)
- Painter's tape for posting flip charts
- (Optional) Samples of electrical system parts (conductors, conduit, receptacles, circuit breakers, fuses, different types of GFCIs, etc.)
- (Optional) Samples of corded power tools used in your trade, including double-insulated tools. Both good and damaged tools for comparison.
- Samples of damaged equipment (frayed cords, plugs missing ground prong, abused extension cords with damaged insulation, power tools with cracked casings and damaged cords, etc.)
- Examples of non-conductive fiberglass and conductive metal ladders
- (Optional) Prizes for playing Jeopardy Review Game
- Master question list for Jeopardy Review Game

ANSWER KEY

Name That Term Buzz Group Exercise

Below is a list of common electrical terms. Match the descriptions in the right column to the terms they best fit with on the left. Some terms will have more than one description. All the letters are used.

Amperage ___M_____	A. Power produced or consumed B. Opposes electron flow C. A person D. Electrical force
Conductor _G, I, L, C_	E. A material through which electricity doesn't flow easily F. Dry wood
Current ____H_____	G. Copper wire H. The flow of electrons
Insulator _E, F, J___	I. A material through which electricity flows easily
Resistance _____B_____	J. Glass
Voltage __D, K___	K. Pushes electron flow L. Aluminum ladder
Wattage ___A_____	M. Strength of current

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Hazard Challenge Activity
Station #1 Scenario/Case Study

Option A: Video—WorkSafe BC
"Power line hazard—Fatal crane truck contact"

Option B:
Laborer Electrocuted by Energized Crane
(CA FACE report)

A 26 year-old construction laborer was electrocuted when he tripped and came into contact with a crane. The crane had become energized through accidental contact with a high voltage line overhead.

The crane was in an area with both telephone and high voltage lines, and the crane operator was aware of them. Earlier in the day, the crane had brushed against telephone lines and had to be repositioned. However, at this time in the late afternoon, the operator's vision of the high voltage lines was obstructed because of the Sun's position. The auxiliary line of the crane made contact with the high voltage line. The auxiliary line burned in two and the ball/hook assembly fell to the ground. Voltage was 16,000 volts.

The laborer was carrying a wire rope over to be used to attach a pile of plywood to the crane's hook. The crane operator and laborer were both startled by the fall of the ball/hook assembly. The boom of the crane momentarily drifted, contacting the high voltage line directly.

At the same moment, the laborer tripped and brushed against the corner of the energized crane. Cardiopulmonary resuscitation was immediately administered by co-workers until paramedics arrived. However, the laborer was pronounced dead.

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Hazard Challenge Activity
Station #2 Scenario/Case Study

Laborer electrocuted when jackhammer strikes underground power line
(Washington FACE report)

A 38-year-old laborer was electrocuted when the jackhammer he was using struck an underground power line. The incident happened at a hospital parking lot where his employer was a subcontractor hired to install a storm water drainage system. His employer was a site preparation contractor. The victim was an experienced laborer and a member of the Laborers' International Union of North America. His job duties for this project included digging trenches and laying and connecting storm drain pipe.

On the day of the incident, the victim and two other employees were digging trenches and installing storm drains. At the location they were working there was a buried duct bank which was in the way and conflicted with the plans for installing the storm drain. This duct bank contained three lines of PVC electrical conduit piping encased in concrete. Each line of conduit piping contained four power line cables carrying 7,200 volts each. In order to install the storm drain pipes to the necessary grade, the employees were using an excavator, breaker bar, and a rivet-buster-type jackhammer to chip away at the duct bank concrete. The victim was in the trench chipping the duct bank's concrete when his rivet buster punctured the conduit and contacted the power line cable. He was electrocuted and died at the scene.



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Hazard Challenge Activity
Station #3 Scenario/Case Study

HVAC worker electrocuted while installing duct work
(OSHA eTool)

A journeyman HVAC worker was installing metal duct work using a double-insulated drill connected to a drop light cord. Power was supplied through two extension cords from a nearby residence.

The individual's perspiration-soaked clothing/body contacted bare exposed conductors on one of the cords, causing an electrocution. No GFCI's were used. Additionally, the ground prongs were missing from the two cords.

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Hazard Challenge Activity
Station #4 Scenario/Case Study

Carpenter electrocuted while using portable electric saw
(OSHA eTool)

A 22-year-old carpenter was working at the construction site of a large apartment complex, using a portable electric saw to construct the wooden framework of a laundry building. Electricity to operate portable power tools was supplied by a temporary service pole 50 feet away. The pole had not been inspected by the city and was not in compliance with code requirements (it was not grounded).

The victim used two extension cords to supply power: a home-made cord plugged into an ungrounded receptacle on the pole, and a UL-approved cord extending from the homemade cord to the saw. The accident site was wet; also, humidity was high and the victim was sweating.

Reportedly, he was shocked throughout the morning, and he had replaced one of the extension cords in an effort to eliminate the shocks. The source of the shocks, the saw, was not replaced.

As the victim climbed down a makeshift ladder, he shifted the saw from his right hand to his left, and was shocked. This caused him to fall from the ladder and land in a puddle of water, still holding the saw.

Apparently, his hand contracted and he was "locked" to the saw. A co-worker disconnected the power cord to the saw, too late to save the victim.

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Hazard Challenge Activity
Station #5 Scenario/Case Study

Worker electrocuted while descending scaffold
(OSHA eTool)

An 18-year-old worker at a construction site was electrocuted when he touched a light fixture while descending from a scaffold for his afternoon break.

The source of the electricity was apparently a short in a receptacle, but examination revealed that the electrical equipment used by the contractor was in such poor condition that it was impossible to make a certain determination of the source of the short.

Extension cords had poor splices, no grounds, and reversed polarity. One hand drill was not grounded, and the other had no safety plate.

Out of several possible scenarios, the most likely was contact between the exposed wires of an extension cord and a screw that protruded from the receptacle, which had its face plate removed.

The light fixture, which served as a ground, was known to be faulty for at least 5 months before the incident.

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Hazard Challenge Activity
Station #6 Scenario/Case Studies

Worker electrocuted while cutting drywall
(OSHA eTool)

A worker received a fatal shock when he was cutting drywall with a metal casing router. The router's 3-wire power cord was spliced to a 2-wire cord and plug set which was not rated for hard service. A fault occurred, and with no grounding and no GFCI protection, the worker was electrocuted.

Worker electrocuted while operating electric chisel
(OSHA eTool)

A worker was operating a ¾" electric chisel when an electrical fault occurred in the casing of the tool, causing him to be electrocuted. An OSHA inspection revealed that the tool's original power cord had been replaced with a flat cord, which was not designated for hard service, and that strain relief was not provided at the point where the cord entered the tool. Additionally, the ground prong was missing and there was no GFCI protection.

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Additional Case Studies (from OSHA Construction eTool)

Hazard: Overhead power lines

Scaffold Too Close To Power Line:
Seven employees of a masonry company were erecting a brick wall from a tubular, welded-frame scaffold approximately 24 feet high. The scaffold had been constructed only 21 horizontal inches across from a 7,620-volt power line. A laborer carried a piece of wire reinforcement (10 feet long by 8 inches wide) along the top section of the scaffold and contacted the power line with it. The laborer, who was wearing leather gloves, received an electric shock and dropped the wire reinforcement, which fell across the power line and simultaneously contacted the metal rail of the scaffold, energizing the entire scaffold. A 20-year-old bricklayer standing on the work platform in contact with the main scaffold was electrocuted.

Crane Boom Too Close To Power Line:
A 56-year-old construction laborer was removing forms from a concrete wall poured several days earlier. As he removed the forms, he wrapped them with a length of cable called a choker, which was to be attached to a crane. The victim signaled the operator of the crane to extend the boom and lower the hoist cable. Both the operator and the victim failed to notice that the boom had contacted a 2,400-volt overhead power line. When the victim reached down to connect the choker to the hoist cable, he suddenly collapsed. Co-workers provided CPR, but were unable to revive the victim. Only after a rescue squad arrived about 4 minutes later did anyone realize that the crane was in contact with a power line -- all those present had assumed that the victim had suffered a heart attack.

Crane Boom Swung Into Power Line:
A 29-year-old worker was electrocuted when he pushed a crane cable into a 7,200-volt power line. The victim was part of a crew that was constructing a concrete wall. Before work began, the company safety director made sure that insulated line hoses were placed over sections of the the power line near the jobsite and that a safety clearance zone was marked off for arriving cement trucks. After the wall was poured, one driver cleaned the loading chute of his cement truck with a water hose mounted on the truck. As he began to pull away, the crew supervisor yelled to him, asking if the crew could use his water hose to wash out their cement bucket suspended from the crane. The driver stopped the truck under the power line, and the victim, not realizing that the truck had moved, swung the boom to position the bucket behind the truck. When he grasped the handle of the bucket to pull it down, the crane cable came into contact with the overhead line. The victim provided a path to ground and was electrocuted.

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Hazard: Path to ground missing or discontinuous

Ground Wire Not Attached:
A fan connected to a 120-volt electrical system via an extension cord provided ventilation for a worker performing a chipping operation from an aluminum stepladder. The insulation on the extension cord was cut through and exposed bare, energized conductors which made contact with the ladder. The ground wire was not attached on the male end of the cord's plug. When the energized conductor made contact with the ladder, the path to ground included the worker's body, resulting in death.

Adapter For 3-Prong Cord Not Grounded To Outlet:
On May 27, 1986, two workers were using a 110-volt auger to install tie-down rods for a manufactured home. The auger has a one-quarter horsepower motor encased in a metal housing with two handles. One handle has a deadman's switch. Electricity to the auger was supplied by a series of 50-foot extension cords running to an adjacent property. Since the outlet at the adjacent property had no socket for a ground prong, the extension cords were plugged into the outlet using an adapter, but the ground wire of the adapter was not grounded. Two of the extension cords had no ground prongs, and some of them were repaired with electrical tape. The workers had removed their shirts and were sweating. One worker, holding the deadman's switch, received a shock from a ground fault in the auger and was knocked back from the machine. The auger then fell across the other worker, the 24-year-old victim. The first worker knocked the auger off the victim, but saw that the electric cord was wrapped around the victim's thigh. He yelled for his co-workers to disconnect the power, which they did. The workers administered CPR to the victim, but to no avail.

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Hazard: Equipment used in manner not prescribed

Damaged Extension Cord Leaves Arc Welder Ungrounded:
A 29-year-old welder attempted to connect a portable arc welder to an electrical outlet using an extension cord. The power switch on the welder was already in the "on" position, and the female end of the extension cord, which was spring loaded, had apparently been dropped and broken. As a result, the ground prong of the welder plug did not insert into the ground terminal of the cord, so that as soon as a connection was made, the outside metal case of the welder became energized, electrocuting the victim. An examination revealed that the spring, cover plate, and part of the melamine casing were missing from the face of the female connector (the spring and some melamine fragments were found at the accident site). The victim was totally deaf in one ear and suffered diminished hearing in the other. He may have dropped the extension cord at the site and not heard the connector break.

Handling Damaged Extension Cord When Energized:
A 19-year-old construction laborer was working with his foreman and another laborer to construct a waterfront bulkhead for a lakeside residence. Electricity for power tools was supplied from an exterior 120-volt, grounded AC receptacle located at the back of the residence. On the day of the incident, the victim plugged in a damaged extension cord and laid it out towards the bulkhead. There were no eyewitnesses to the accident, but evidence suggests that while the victim was handling the damaged and energized extension cord, he provided a "path to ground" and was electrocuted. The victim collapsed into the lake and sank 4-1/2 feet to the bottom.

Improper Modification of Plugs:
An employee was texturing a wall using an air compressor. The plug of the compressor and an extension cord had been modified to fit a wall outlet for a common household clothes dryer (220 V). While attempting to unplug the compressor from the extension cord, the employee was fatally shocked. The modification of the plug was not an intended use or prescribed by the manufacturer.

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Effects of Electrical Current on the Body

1 milliamp (mA) = 1/1000th of an amp

Current	Reaction
1 milliamp (0.001 amps)	Threshold of sensation; faint tingle.
5 milliamps (0.005 amps)	• Slight shock felt; not painful but disturbing. • Most people can "let go." • However, strong involuntary reactions/movements may lead to injuries.
6–16 milliamps (0.006—0.016 amps)	• Painful shock, begin to lose muscular control. • This is the range where "freezing currents" start (10mA) • It may not be possible to "let go."
17–99 milliamps (0.017—0.099 amps)	• Extremely painful shock • Respiratory arrest (breathing stops), severe muscle contractions. • Paralysis of respiratory muscles (20mA) • Flexor muscles may cause holding on. • Extensor muscles may cause intense pushing away. • **Death is possible.**
100–2,000 milliamps (0.10–2 amps)	• Ventricular fibrillation (heart pumping action not rhythmic) threshold (100 mA). • Muscles contract; nerve damage occurs. • **Death is likely.**
>2,000 milliamps (2 amps)	• Cardiac arrest, internal organ damage, and severe burns occur. • **Death is probable.**
15,000 milliamps (15 amps)	Lowest overcurrent at which a typical fuse or circuit breaker opens a circuit!
*Effects are for voltages less than about 600 volts. Higher voltages also cause severe burns.	

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Hazard Assessment Model

RECOGNIZE HAZARDS → EVALUATE RISK → CONTROL HAZARDS

RECOGNIZE HAZARDS

- Think about the job and plan ahead; identify hazards before work starts.
- What is the nature of the electrical hazard?
- Where are electrical hazards located on the job site?
- What situations might expose workers to danger?
- Identify clues workers should be looking for that indicate electrical hazards.

EVALUATE RISK

- How can exposure to the hazard harm workers?
- Which workers/crafts are most at risk?
- What job tasks expose workers to electrical hazards?
- What conditions, specific to construction, can increase risk?

Examples:

– Dynamic, frequently changing conditions
– Multi-craft; many workers performing different tasks simultaneously
– Multi-employer
– Exposure to harsh elements
– Pace of production

CONTROL HAZARDS

- Develop control plan and best practices for each hazard.
- Are the control strategies addressing:
  - Unsafe conditions;
  - Unsafe equipment;
  - Unsafe acts
- Can the hazard be eliminated?
- Who is responsible for controlling the hazard?
- Breakdown job into separate tasks/steps. Evaluate hazard and risk factors of each step.
- Are the controls engineering, administrative, or PPE?

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Hazard Assessment Worksheet

RECOGNIZE HAZARDS	EVALUATE RISK	CONTROL HAZARDS

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Hazard Mapping Directions

In your teams, choose a scribe and a spokesperson who will present the team's findings back to the larger group. Working together, list the electrical hazards commonly associated with construction, or specifically with your trade. Be prepared to explain how each item constitutes a hazard at job sites where you've worked.

Have there been any accidents at your job site from the hazards you identified?

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Step 1: Using the black pen, make a drawing on the flip chart that shows the basic layout of your job site. (Your team can choose whether to go large scale (an entire construction site) or small scale (focusing on one specific area of a construction site).

Step 2: Using the red pen, identify the electrical hazards in each area of the site with a red circle on the map.

Step 3: Rate each hazard on a scale of 1 to 4:

1= Low hazard
2 = Medium hazard
3= High hazard
4= Very high hazard

Step 4: Label each hazard with a name or brief description.

Step 5: Based on your map, make a list of the hazards that concern you the most and be ready to tell us why these hazards are a concern for your team.

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Name That Term Buzz Group Exercise

Below is a list of common electrical terms. Match the descriptions in the right column to the terms they best fit with on the left. Some terms will have more than one description. All the letters are used.

Amperage __________ Conductor __________ Current __________ Insulator __________ Resistance __________ Voltage _________ Wattage _________	A. Power produced or consumed B. Opposes electron flow C. A person D. Electrical force E. A material through which electricity doesn't flow easily F. Dry wood G. Copper wire H. The flow of electrons I. A material through which electricity flows easily J. Glass K. Pushes electron flow L. Aluminum ladder M. Strength of current

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Electrical Safety Resource Guide
For Construction Workers Who Are Not Electricians

ORGANIZATIONS

Cal/OSHA – *California Occupational Safety and Health Association*
http://www.dir.ca.gov/dos

Cal/OSHA is a division of California's Department of Industrial Relations whose mission is to protect the health and safety of California's workers. It is divided into three main parts: The Division of Occupational Safety and Health (DOSH) enforces the state's regulations and provides technical assistance to employers and employees to help employers comply with the regulations; the California Occupational Safety and Health Standards Board, establishes regulations to help keep workers safe and healthy; and the Occupational Safety and Health Appeals Board hears appeals from employers who have received a citation from a DOSH inspector. Cal/OSHA Consultation, the part of DOSH that provides technical assistance, has created many helpful guides to workplace hazards which you can find for free on this website under the Publications link at http://www.dir.ca.gov/dosh/PubOrder.asp

CPWR – The Center for Construction Research and Training

https://www.cpwr.com/

CPWR is the NIOSH-funded National Construction Center. You'll find toolbox talks, factsheets, videos, and handouts as well as studies, data, and research reports for more in-depth information.

CPWR has created a database of solutions to construction hazards. The solutions for some electrical hazards is available at http://www.cpwrconstructionsolutions.org/hazard_solutions/303/electrical-shocks--burns-and-or-electrocution/. Be sure to click the Expand Solution button at the bottom of the page for each solution for more details on it.

CPWR also writes and publishes the Construction Chart Book, which contains information on all facets of the U.S. construction industry – economics, demographics, employment/income, education/training, and safety and health issues. The numerous detailed charts and graphs are accompanied by text for more detail on each topic. https://www.cpwr.com/publications/construction-chart-book

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LOHP – *Labor Occupational Health Program at UC Berkeley*
http://www.lohp.org/

LOHP is a public service program at the University of California, Berkeley, affiliated with the Center for Occupational and Environmental Health at the School of Public Health. We seek to reduce occupational injury, illness and death by protecting the health and safety of workers worldwide. In addition to hands-on training, LOHP provides technical assistance, develops educational materials, conducts participatory research, and consults on the development of workplace standards and policies.

Read about LOHP's projects
http://lohp.org/our-work/

NIOSH – *National Institute for Occupational Safety and Health*
http://www.cdc.gov/NIOSH/

The National Institute for Occupational Safety and Health (NIOSH) is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. It was created by the OSH Act of `970 and has headquarters in Washington, DC and Atlanta, GA.

- Electrical Safety
  https://www.cdc.gov/niosh/topics/electrical/
  includes links to many NIOSH publications
- Other NIOSH publications
  http://www.cdc.gov/niosh/pubs/

OHB – *Occupational Health Branch at California Department of Public Health (CDPH)*
http://www.cdph.ca.gov/programs/ohb/Pages/Programs.aspx

OHB is the program in CDPH which is dedicated to preventing worker injuries through prevention programs. Its publications are available at
http://www.cdph.ca.gov/programs/ohb/Pages/Publications.aspx

OSHA – *Occupational Safety and Health Administration*
http://www.osha.gov/

The Occupational Safety and Health Administration (OSHA) is the federal agency responsible for ensuring safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education and assistance. It was also created by the OSH Act of 1970 and has headquarters in Washington, DC. OSHA has a lot of information available for construction workers, such as topical pages with lots of information, publications, and factsheets. Some of these are below.

- Alphabetical listing of safety and health topics
  https://www.osha.gov/SLTC/text_index.html
- Electrical 10-Hour General Industry Outreach Trainer Presentations

https://www.osha.gov/dte/outreach/construction_generalindustry/Electrical_PPT_v-03-01-17.pptx

- Electrical (General Industry)
  https://www.osha.gov/SLTC/electrical/hazards.html

- Electrical (Construction Industry)
  https://www.osha.gov/SLTC/electrical/construction.html
- eTools, eMatrix, Expert Advisors and v-Tools
  https://www.osha.gov/dts/osta/oshasoft/index.html
- Harwood Training Grant – Grantee Produced Training Materials
  https://www.osha.gov/dte/grant_materials/material_listing_topic.html#e

State Building and Construction Trades Council of California, AFL-CIO (SBCTC)
Safety and Health HUB website safety.sbctc.org

Access training materials and other resources from SBCTC train-the-trainer programs. Topics: Electrical Hazards for Non-Electricians; Silica in Construction; Fall Prevention and Rescue Planning; Toxics in Construction; Noise and Hearing Loss Prevention; Ergonomics.

FACTSHEETS

Electric Power: Toolbox Talk
CPWR
English
https://www.cpwr.com/sites/default/files/publications/CPWR_Electric_Power_1.pdf
Spanish
https://www.cpwr.com/sites/default/files/publications/spanish/15%20energja%20elctrica.pdf

Electric Wiring: Toolbox Talk
CPWR
English
https://www.cpwr.com/sites/default/files/publications/CPWR_Electric_Wiring_1.pdf
Spanish
https://www.cpwr.com/sites/default/files/publications/spanish/16%20cableados%20el%2Bctricos.pdf

Electrical burns: First aid
Mayo Clinic
English
https://www.mayoclinic.org/first-aid/first-aid-electrical-burns/basics/ART-20056687?p=1
Spanish
https://www.mayoclinic.org/es-es/first-aid/first-aid-electrical-burns/basics/art-20056687?p=1

Electrical Hazards
OSHA
https://www.osha.gov/dte/grant_materials/fy09/sh-18796-09/electricalhazards.pdf
7 page factsheet includes info on double insulated and a list of safe work practices

Electrical Injury
Medline Plus
English
https://medlineplus.gov/ency/article/000053.htm
Spanish
https://medlineplus.gov/spanish/ency/article/000053.htm

Electric Safety (for Non-Electricians)
New England Laborers' Health and Safety Fund
http://nelhsf.com/nelhsf-library/safety/electric-safety-for-non-electricians/

Electrical Shock: First Aid
Mayo Clinic
English
https://www.mayoclinic.org/first-aid/first-aid-electrical-shock/basics/art-20056695
Spanish
https://www.mayoclinic.org/es-es/first-aid/first-aid-electrical-shock/basics/art-20056695?p=1

Extension Cord Safety: Toolbox Talk
CPWR
English
https://www.cpwr.com/sites/default/files/publications/16-Extension-Cord-Safety-CPWR.pdf
Spanish
https://www.cpwr.com/sites/default/files/publications/spanish/16-cableados-el%C3%A9ctricos.pdf

Hazard Alert - Electric Safety in Construction for Non-Electricians. 2016.
CPWR
English
https://www.cpwr.com/sites/default/files/publications/Electrical_Safety_WebHazardAlert_122016_3.pdf
Spanish
https://www.cpwr.com/sites/default/files/publications/spanish/Electrical_Safety_Web_HazAlert_November2016.pdf

Lockout/Tagout
CPWR
English
https://www.cpwr.com/sites/default/files/publications/Lockout_Tagout_web_3.pdf
Spanish
https://www.cpwr.com/sites/default/files/publications/spanish/Lockout_Tagout_Spanish_2.pdf

Overhead Power Lines: Toolbox Talk
CPWR
English
https://www.cpwr.com/sites/default/files/publications/CPWR_Overhead_Power_Lines_0.pdf
Spanish
https://www.cpwr.com/sites/default/files/publications/spanish/41%20cables%20de%20tendido%20electrico.pdf

OSHA Quick Card
English/Spanish
https://www.osha.gov/OshDoc/data_Hurricane_Facts/electrical_safety.pdf

SAFETY CHECKLISTS

Electrical Safety Checklist for Small Construction Sites
WorkSafe New Zealand
https://worksafe.govt.nz/dmsdocument/92-electrical-safety-checklist-for-small-construction-sites

Portable Power Tools – Safety Walkaround Checklist
Labor Occupational Health Program, UC Berkeley
http://www.elcosh.org/record/document/1461/d000242.pdf

Pre-Use Inspection Checklist
Havard – Environmental Health and Safety
https://www.ehs.harvard.edu/sites/ehs.harvard.edu/files/hand_and_portable_power_tools_pre_use_inspection_checklist.pdf

Work Area Safety Checklist
Texas Department of Insurance. 8/05
http://losscontrol.bldrs.com/losscontrol2/resources/en/Construction/General+Safety+%26+Health/Work+Area+Safety+Checklist.pdf
See pages 6-7 for Electrical Wiring, Fixtures, and Controls checklist

OSHA Checklist for the Construction Industry
South Carolina Office of OSHA Voluntary PRograms
http://www.scosha.llronline.com/PDFS/construction%20check%20list.pdf
electrical hazards checklist on page 13

SOLUTIONS

Construction Solutions for "electrical shocks, burns, and/or electrocution"
CPWR Construction Solutions database
http://www.cpwrconstructionsolutions.org/hazard_solutions/303/electrical-shocks--burns-and-or-electrocution/
17 different solutions here, from Using Live-Line Tools to Safe Work Practices when Using Portable Generators

Electrical Work Hazards – Possible Solutions
OSHA
https://www.osha.gov/SLTC/electrical/solutions.html

Ergonomics eTool: Solutions for Electrical Contractors
OSHA
https://www.osha.gov/SLTC/etools/electricalcontractors/index.html

POWER TOOLS

Counterfeit Tools
Power Tool Institute
http://www.powertoolinstitute.com/pti-pages/it-counterfeit-tools.asp

Electrical Incidents – Power Tools
OSHA
English
https://www.osha.gov/SLTC/etools/construction/electrical_incidents/powertools.html
Spanish
https://www.osha.gov/SLTC/etools/construction_sp/electrical_incidents/powertools.html

Hand and Portable Power Tools
Havard – Environmental Health and Safety
https://www.ehs.harvard.edu/programs/hand-portable-power-tools

Power Cord Safety
Tools In Action
http://toolsinaction.com/power-tool-information/power-cord-safety/

Power Tool Amps, Horsepower and Volts
Tools In Action
http://toolsinaction.com/power-tool-information/power-tool-amps-horsepower-and-volts/
Explains amps, torque, horsepower, volts, and efficiency and what these have to do with power tools for non-professionals

Power Tool Safety
Tools In Actioin
http://toolsinaction.com/power-tool-information/power-tool-safety/

Power Tool Safety Rules
Power Tool Institute
http://www.powertoolinstitute.com/pti_pdfs/Power-Tool-Safety-Rules-06-2016.pdf

Power Tool Safety Terms
Power Tool Institute
http://www.powertoolinstitute.com/pti-pages/ed-glossary-terms.asp

Power Tools and Cords: Toolbox Meeting Guide
WorkSafe BC
https://www.worksafebc.com/en/resources/health-safety/toolbox-meeting-guides/power-tools-and-cords?lang=en&direct

Related Industry Links
Power Tool Institute
http://www.powertoolinstitute.com/pti-pages/il-industrial-links.asp

Student Activities
Power Tool Institute
http://www.powertoolinstitute.com/pti_pdfs/Student-Activities-and-Quizzes-06-2016.pdf
Games for students: word search, always/never, icon match, term match – all with answers

Teaching General Power Tool Safety
Power Tool Institute
http://www.powertoolinstitute.com/pti_pdfs/Teaching-General-Power-Tool-Safety-06-2016.pdf
Factsheet with tips for teachers

Tool-Specific Safety Information
Power Tool Institute
http://www.powertoolinstitute.com/pti-pages/ed-tool-specific.asp
Safety sheet, manufacturer sponsored video in English and Spanish, for 24 tools

CURRICULUM & SAFETY PRESENTATIONS

Big Four Construction Hazards
https://www.osha.gov/dte/grant_materials/fy08/sh-17792-08/electrical_english_r6.pdf
First section devoted to electrical hazards.

CAF Construction Site Safety Certificate Program – Class 4 – Electricity
OSHA grant number SH-22224-11-60-F-18
https://www.osha.gov/dte/grant_materials/fy11/sh-22224-11/5_Electricity.pptx

Electrical Industry Construction Training Criteria for the Commercial/Industrial Segment
https://www.dir.ca.gov/dlse/ecu/ECP_Curriculum_Committee/ECP_ElectricalIndustryConstructionTrainingCriteria.pdf
This guide provides an outline of recommended topics to be taught and covers safety, tools, math, and electrical theory, etc.

Electrical Safety – Construction
OSHA Office of Training and Education
http://www.mwua.org/wp-content/uploads/2010/09/electrical_c.pdf
Lots of pictures.

Electrical Safety Lesson Plan
Military Public Safety & Security, A Division of Florida State College at Jacksonville
https://www.osha.gov/dte/grant_materials/fy11/sh-22297-11/ElectricalSafetyLessonPlan.pdf

The Electrical Safety Model
OSHAcademy Occupational Safety and Health Training
https://www.oshatrain.org/courses/mods/715m4.html
Includes a couple of 10+ minute videos and a short quiz

Focus Four Construction Hazards. 2009.
Compacion Foundation in collaboration with the Hispanic Contractors Association de Tejas
https://www.osha.gov/dte/grant_materials/fy08/sh-17792-08/hcat_englishbook_v4_5.pdf
One section devoted to electrical hazards.

Focus 4: Construction Health and Safety
Electrical Safety: Participants Guide
https://www.osha.gov/dte/grant_materials/fy07/sh-16586-07/4_electrical_safety_participant_guide.pdf

NFPA 70E Electrical Safety Presentation
Updated 2012
Independent Electrical Contractors, Inc. (IEC)
http://www.ieci.org/media/media/download/861
While some of this is specifically for electricians, other parts are very general and good information for non-electricians

Sample Lesson Plan – Electrical
OSHA Harwood Training Grant – Grantee Produced Training Material
https://www.osha.gov/dte/grant_materials/fy11/sh-22224-11/5_Electricty_Lesson_Plan.pdf

Train-the-Trainers Guide to Electrical Safety for General Industry. 2007.
Workplace Safety Awareness Council
https://www.osha.gov/dte/grant_materials/fy07/sh-16615-07/train-the-trainer_manual2.pdf
While for general industry, there are many things here that you can use in your trainings

VIDEOS

Are You Training Your Construction Employees on Jobsite Electrical Safety?
Forconstructionpros.com
https://www.forconstructionpros.com/blogs/construction-toolbox/blog/12212566/are-you-training-your-construction-employees-on-jobsite-electrical-safety
Short article with links to several electrical safety videos for construction workers

Electrical Safety Awareness for Non-Electrical Workers
Forconstructionpros.com
https://www.forconstructionpros.com/business/construction-safety/video/12212561/video-electrical-safety-awareness-for-nonelectrical-workers

Electrical Safety Awareness for Non-electrical Workers
ACSASafety
https://www.youtube.com/watch?v=wal2KP1bbIY
Lots of pictures of faulty equipment. About 9 minutes.

How Electricity Affects the Body
WorkSafe BC
https://www.worksafebc.com/en/resources/health-safety/videos/a-bright-arc/how-electricity-affects-the-body?lang=en

Quarterly Data Report: Electrocutions and Prevention in the Construction Industry
CPWR
https://youtu.be/Gle9cTLjAz8
During this 30 minute webinar, you will hear from the authors of the report about their findings and updated information for electrocution prevention.
slides:
https://www.cpwr.com/sites/default/files/Webinar_Electrocution_11.15.pdf

ARTICLES/REPORTS/GUIDES

Cal/OSHA Guide to Electrical Safety. 2016.
CALOSHA
http://www.dir.ca.gov/dosh/dosh_publications/Electrical_Safety.pdf

Creating a Safer Industry. Electrical Transmission & Distribution Partnership (ET&D). 2016.
OSHA and the Electrical Transmission and Distribution Construction Contractors, The IBEW And Trade Associations Strategic Partnership
https://www.osha.gov/dcsp/ETD_Whitepaper_FINAL.PDF

Electrical Safety Laboratory Curriculum for the Safety Sciences Undergraduate: Theory to Application. Journal of SH&E Research, Vol. 2, Num. 1. Spring 2005.
http://www.asse.org/assets/1/7/05spring_Rhodes.pdf

Electrical Safety: Safety and Health for Electrical Trades
NIOSH
https://www.cdc.gov/niosh/docs/2009-113/
Part of a safety and health curriculum for secondary and post-secondary electrical trades courses. A good guide to get information and pictures from.

Electrocutions and Prevention in the Construction Industry
CPWR Quarterly Data Report, Third Quarter 2017
https://www.cpwr.com/sites/default/files/publications/Quarter3-QDR-2017.pdf

Fatal electrocutions 'unacceptably high' in construction industry despite decline: CPWR.
Nov 7, 2017
Safety + Health. National Safety Council
http://www.safetyandhealthmagazine.com/articles/16351-fatal-electrocutions-unacceptably-high-in-construction-industry-despite-decline

OTHER ORGANIZATIONS

WorkSafe BC (Workers' Compensation Board, British Columbia, Canada)
Electricity
https://www.worksafebc.com/en/health-safety/hazards-exposures/electricity

Independent Electrical Contractors, Inc. (IEC)
OSHA National Alliances
https://www.osha.gov/dcsp/alliances/iec/iec.html

National Fire Protection Association (NFPA)
Electric
https://www.nfpa.org/Public-Education/By-topic/Top-causes-of-fire/Electrical
You'll find safety tip sheets, an electrical safety message in American Sign Language, and more here.

PG&E

Safety Education Websites
http://www.pgesafetyeducation.com
Electrical Grid
https://www.pge.com/includes/docs/pdfs/shared/edusafety/systemworks/electric/pge_electric_system.pdf

Oregon OSHA

Electrical
http://osha.oregon.gov/Pages/topics/electrical.aspx

Southern California Edison

Tips: Working Safely Around Electricity
https://www.sce.com/safetyonthejob
Free materials order form
http://www.culverco.com/sce_safety/contractor.php

http://www.culverco.com/sce_safety/contractor.php

Electrical Hazards for Non-Electricians

Guidelines for 2018 Second-Tier Training

TRAIN → EVALUATE → REPORT

After completing your Train-the-Trainer class, here's what we ask you to do:

1. Train a minimum of 20 people, train more if you can. This is referred to as "2nd-tier training."
2. Document your training sessions with sign-in sheets (blank form is in your course binder).
3. Send your sign-in sheets to :

    Via Email to:
    Via Fax to:
    Via Mail to:

    Address here

4. EVALUATE—OSHA requires 2 levels of training evaluation to be documented. Levels 1 and 2 are done at the training session.
    - Level 1—Training Reaction Assessment: This is done at the end of your training session to assess trainees' perception of quality and usefulness of the training. You can use a written or oral training satisfaction survey.
    - Level 2—Learning Assessment: Measures the skills, knowledge, or attitude that the trainee retains because of the training. This can be accomplished through pre/post tests, or asking the trainee to demonstrate a new task that was taught at the training.

Report evaluation results to the Project Coordinator: Forward copies of written forms/surveys; summarize results of verbal evaluations; report back on success stories and changes that resulted from the training you delivered.

5. Training Observation: We are looking for opportunities to attend 2nd-tier trainings and observe our trainers in action. This is to help us evaluate first-hand how our materials are being used in the field. These visits will be arranged with the Project Coordinator individually on a voluntary basis.

(Continued on other side)

FAQs:

- **Who can I train?**
  Anyone covered by OSHA (e.g. journeymen, apprentices, employers).

- **What kind of training can I do?**
  Whatever best fits your needs. It can be classroom, on-the-job, safety meetings, journeyman upgrade, union meeting, workshops, etc. Select parts of our curriculum or materials to use in your training to count it toward our grant goals.

- **How long does my training need to be?**
  Minimum time is 30 minutes, maximum is unlimited.

- **How do I document my training?**
  We provided a sample sign-in sheet in your binder (last page) you can copy and use that -OR- use your own sign-in sheet providing it has **ALL** the information that's on our sample. You need to validate each training roster by signing it at the bottom as the trainer.

- **What if I misplace or forget a sign-in sheet, can I still count my training?**
  Yes, you can recreate a list of participants or describe the number of people trained and include all the other required information about the training on letterhead and sign it.

- **What if I can't train 20 people?**
  Do your best to do 2nd tier training any way you can. If you train 1 person, report it. If you train 200 people, report it. All training is important for us to document. If everyone trains at least 20 people, we will meet our projected goals.

- **What if I do multiple trainings?**
  Report all training you accomplish. Individual trainees can only be counted once.
  Scenario 1: you train 10 workers for 30 minutes on how electricity affects the body; you train the same individuals for 30 minutes the next week on electrical hazards. Submit 2 sign-in sheets for a total of 10 workers trained for 1 hour. Scenario 2: you train 10 workers for 30 minutes on health effects and a different 10 workers for 30 minutes on electrical hazards. Submit 2 sign-in sheets for a total of 20 workers trained for 30 minutes. We track total number of individual workers trained in our reports to OSHA. If you do a series of trainings on electrical hazards in construction over a span of time for the same group of workers, wait until the final segment is completed and submit documentation (multiple sign-in sheets are OK) for the total training those workers received.

- **When do I need to send in my numbers?**
  Don't save up sign-in sheets! Send them ongoingly as you complete training.
  Follow this schedule:

Training Completed in:	Submit No Later Than
April, May, June	July 15
July, August, September	October 15

  If you report late after the deadlines, we are required to submit revised reports to OSHA.

- **What should I do if I'm not sure whether something counts?**

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State Building and Construction Trades Council of CA

<u>Training Evaluation Form</u>

Type of Training: ____

Topic Covered Today: ____

Instructors: ____

Date: _________ **Time:**_________ **Location:** ____________________________

Name: (optional) __________________________

1. What is one thing you will remember from this training?

2. How useful will this information be to you on-the-job? (Check one)

   ☐ Very Useful ☐ Useful ☐ Not Useful ☐ I don't know

3. How would you rate this safety training? (Check one)

   ☐ Excellent ☐ Good ☐ Just OK ☐ Boring ☐ Waste of time

4. Will having this training change how you will work with/around electrical hazards in the future?

   ☐ Yes ☐ Not likely ☐ I'm not sure

   If yes, what will you change? ______________________________________

5. Additional comments?

____

Thank you for taking the time to complete this evaluation. Your input will be used to improve this program. **<u>Please hand this form back to your Instructor.</u>**

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Electrical Hazards for Non-Electricians

TRAINING ATTENDANCE SHEET

Grantee: SBCTC
Grant#: SH31244SH7
Grant Topic: Electrical Hazards for Non-Electricians

Training Date: ________________ **Time:** _____ **to** _____

Location: ______________________________ **Instructor:** ________________________ **Translator:** ____________________

Training modules/activities/topics covered in this session: ____

	Print Name	Signature	Company where you work	✓ if Manager	✓ if Worker	Contact Info: Phone/Email or mailing address
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						

I certify that the information on this page is accurate. ____

(Signature of trainer)

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	Print Name	Signature	Company where you work	✓ if Manager	✓ if Worker	Contact Info: Phone/Email or mailing address
10.						
11.						
12.						
13.						
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15.						
16.						
17.						
18.						
19.						
20.						

I certify that the information on this page is accurate. ____
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