

MODULE 1

INTRODUCTION TO ELECTRICAL SAFETY

Objectives

At the end of this module, participants will be able to:

- ⚡ Recognize key statistics relating to electrical injuries.
- ⚡ Recognize OSHA regulations and other standards relating to electrical safety.
- ⚡ Understand basic electrical terminology.
- ⚡ Identify the four types of injury relating to electrical incidents.
- ⚡ Understand key facts relating to electric shock.
- ⚡ Understand the basic facts of electricity.
- ⚡ Understand Ohm's Law and describe how the terms current, voltage and resistance relate to Ohm's Law.
- ⚡ Recognize the effects of electricity on the human body.

Time

80 minutes: 9:00 to 10:20 AM

Followed by a 10-minute break: 10:20-10:30 AM

Agenda

1. Introduction to Electrical Safety—Presentation (5 minutes)
2. OSHA and Other Standards Relating to Electricity—Presentation (5 minutes)
3. Terminology Relating to Electricity—Discussion (10 minutes)
4. Basic Facts of Electricity—Presentation and Activity (35 minutes)
5. Case Study—Activity (20 minutes)
6. Planning for Your Small Business—Activity (5 minutes)

RECOMMENDED PROCESS

1. Introduction to Electrical Safety—Presentation (5 minutes)

Cues	Content
PPT 1-1	<ul style="list-style-type: none">■ You will be covering Pages 1 and 2 in this segment.■ Show PPT 1-1 as you refer participants to Page 1 in Module 1 of their Participant Guides.■ Introduce the module by saying that before they learn the specifics of electrical safety, you want to make sure everyone has a common understanding of electrical basics. This module will cover the basics.
PPT 1-2 through PPT 1-4	<ul style="list-style-type: none">■ Show PPT 1-2 through PPT 1-4 as you introduce the objectives to this module.■ Refer participants to Page 2.
Question:	<ul style="list-style-type: none">■ Ask participants: Why do you need to be concerned about electrical safety?■ Get some responses, then say it is important to be concerned about electrical safety so they don't become a statistic.
PPT 1-5 through PPT 1-8	<ul style="list-style-type: none">■ Refer participants to the statistics on Page 2. Show PPT 1-5 through PPT 1-8 as you discuss the various statistics.■ Review the statistics quickly, but make sure you address any questions or comments participants have.■ Once you've reviewed the statistics, point out that they all are related to contact with a source.
Question:	<ul style="list-style-type: none">■ Ask participants: How can electrical workers avoid becoming one of these statistics?■ Get a few responses, then emphasize that the more an organization practices electrical safety, the more likely they will be able to avoid an electrical injury or fatality.

2. OSHA and Other Standards Relating To Electricity—Presentation (5 minutes)

Cues	Content
PPT 1-9	<ul style="list-style-type: none">■ You will be covering Pages 3 and 4 in this segment. Allocate about the same amount of time to each page.■ Begin this segment with the following points.<ul style="list-style-type: none">– There are some important regulations and standards relating to electrical safety.– The materials in this training program are based on these regulations and standards.– You should take the time to become familiar with them.■ Refer participants to Page 3. State that the OSHA regulations listed on this page will tell them all they need to know about establishing an electrically safe workplace.■ Show PPT 1-9 as you explain the various OSHA regulations.■ OSHA 29 CFR 1910, Subpart I<ul style="list-style-type: none">– This regulation is part of the Occupational Safety and Health Standards for general industry.– Subpart I addresses PPE.– Section 1910.137 specifically addresses electrical protective devices.■ OSHA 29 CFR 1910, Subpart P<ul style="list-style-type: none">– This regulation is also part of the Occupational Safety and Health Standards for general industry.– It addresses the safe operation of hand and portable powered tools and other hand-held equipment.■ OSHA 29 CFR 1910, Subpart S

Optional

- This regulation is also part of the Occupational Safety and Health Standards for general industry.
- It addresses electrical safety requirements for the practical safeguarding of employees in the workplace.

- If you have printed off Subpart S and have it in the classroom, pass it around for participants to see.

- **OSHA 29 CFR 1910.147**

- This regulation addresses lockout/tagout procedures.
- It describes how to service or maintain equipment that might unexpectedly energize.

- **OSHA 29 CFR 1910.333**

- This regulation also addresses lockout/tagout procedures.
- In this instance, it describes how to service or maintain energized circuits.
- You will learn more about how to distinguish these two lockout/tagout procedures in Module 4.

- Refer participants to Page 4.

PPT 1-10

- Show PPT 1-10 as you explain that the National Fire Protection Association (NFPA) addresses electrical safety in the workplace with its NFPA 70E standard.

- It applies to all employees who work on or near exposed energized electrical conductors or circuit parts.

- It also applies to employees who face a risk from electrical shock.

- It addresses the following.

- Safety related work practices
- Safety related maintenance requirements

- Safety requirements for special equipment
 - Installation safety requirements
- Optional
- If you have a copy of the NFPA 70E standard in the classroom, pass it around for participants to see.
- PPT 1-11
- Show PPT 1-11 and point out that NFPA publishes a supplementary handbook to its 70E standard.
 - This handbook provides step-by-step instructions for how to implement the NFPA 70E standard.
 - It also provides the thought process and rationale for the standards.
- Optional
- If you have a copy of the NFPA 70E handbook in the classroom, pass it around for participants to see.
- Question:**
- Ask participants: There are so many regulations and standards. How can a person know which ones to use?
- PPT 1-12
- Get a few responses, then show PPT 1-12 to illustrate the differences in OSHA and the two NFPA publications.
 - Tell participants that it is critical for them to become familiar with these regulations and standards.
 - Let them know that there are links to the OSHA website on their *Tools and Resources* CD-ROM.
 - Also, the entire Subpart S is on their *Tools and Resources* CD-ROM.
 - If their organization doesn't already own a copy of the NFPA 70E, they should get one. Information on where to order the book is on their *Tools and Resources* CD-ROM.
 - Encourage participants to learn more about the OSHA and NFPA standards by continually referring to them and integrating them into their work practices.

3. Terminology Relating to Electricity—Discussion (10 minutes)

Cues	Content
	<ul style="list-style-type: none">■ You will be covering Pages 5 and 6 in this segment. Split the time evenly between the two pages.■ Refer participants to Page 5. Make the following points.<ul style="list-style-type: none">– As we go through the class today, we will be using terminology relating to electricity.– Let’s take some time to review this terminology now.– Two terms we will use a lot today are “Qualified Person” and “Unqualified Person.”
Question:	<ul style="list-style-type: none">■ Ask participants: Without looking at the definitions on Page 5, can anyone tell me what a qualified person is?■ Get some responses.
Question:	<ul style="list-style-type: none">■ Ask participants: As it relates to electricity, what is an unqualified person.
PPT 1-13	<ul style="list-style-type: none">■ Show PPT 1-13 to review the definition of a qualified person.■ Quickly review the requirements of a qualified person on Page 5.■ Address participant questions.
Question:	<ul style="list-style-type: none">■ Ask participants: How many of you are a qualified person for your organization?■ If one or more people raise their hands, ask them about the training they had to undergo to achieve their designation.
PPT 1-14	<ul style="list-style-type: none">■ Show PPT 1-14 as you emphasize that this class does not meet the requirements for a qualified person.■ This class is for people who work on less than 600 volts and who have a qualified person (either within their organization or as an outside contractor) to consult.

Question:

PPT 1-15, Media
Clip

- Ask participants: How many of you know who your organization's qualified person is?
- If someone doesn't know who their qualified person is, strongly encourage them to find out.
- Refer participants to Page 6 and make the following points.
 - Now let's look at some other terminology relating to electricity.
 - Because you guys work on and around electricity in your jobs, you are probably familiar with most of these terms.
 - However, to refresh your memory, and to ensure that we all have the same definitions, let's quickly review them.
- Allow participants a few minutes to review the list of terms on Page 6.
- Once participants have reviewed the list, ask them if they have any questions about the terms.
- After answering their questions, refer them back to the term "arc flash." Show PPT 1-15, which is a media clip illustrating an arc flash.
- Get a few participant responses to the video clip.
- Refer participants to the term "voltage". Emphasize that the term can be designated with either a "V" or an "E".
- The materials in this class will always use the "V" designation.
- If you have time, answer participant questions.

4. Basic Facts of Electricity—Presentation and Activity (35 minutes)

Cues	Content
	<ul style="list-style-type: none">■ You will be covering Pages 7 through 12 in this segment. Allocate time as follows.<ul style="list-style-type: none">– 5 minutes on Pages 7 and 8, with equal amounts of time on each page– 5 minutes on Page 9– 10 minutes on Page 10– 10 minutes on Pages 11– 5 minutes on Page 12■ Refer participants to Page 7. Introduce this page by pointing out that there are four primary types of electrical injury.
PPT 1-16	<ul style="list-style-type: none">■ Show PPT 1-16 as you introduce the four types of injury.■ Refer participants to Page 8. Spend an equal amount of time on all three sections of this page.
PPT 1-17	<ul style="list-style-type: none">■ Use PPT 1-17 as you review the rules of electrical action.
PPT 1-18	<ul style="list-style-type: none">■ Use PPT 1-18 as you review how electric shock occurs.
PPT 1-19	<ul style="list-style-type: none">■ Use PPT 1-19 as you review the three factors that influence the severity of shock.■ Refer participants to Page 9. Introduce the page by stating that electricity is the most versatile form of energy when used properly.■ Before dealing with electrical equipment, workers should know basic electrical facts and the importance of learning and following safe work practices.
PPT 1-20	<ul style="list-style-type: none">■ Use PPT 1-20 as you make the following points.<ul style="list-style-type: none">– Electricity is electrons in motion.

PPT 1-21

- These electrons can be measured in current, force and resistance.
 - Since it's not possible to actually see electrons, it may be hard to picture electrical current, force and resistance.
 - However, it becomes easier to picture if we compare the flow of electricity to the flow of water.
 - Picture a garden hose.
- Show PPT 1-21 as you make the following points about current.
- Think of current as “flow”. Water flows through a hose, electricity flows through a circuit.
 - The flow (or current) of water through a hose is measured in gallons per minute.
 - The flow (or current) of electricity (or electrons) through a circuit is measured in amps.

PPT 1-22

- Show PPT 1-22 as you make the following points about force.
- Think of force as the pressure of the current.
 - When someone turns off the water spigot, the water flow (or current) stops. This is because there is no longer any force (or pressure) to move the water out of the hose.
 - When the spigot is turned on again, the water is again forced through the hose.
 - We measure the force of water in terms of pounds per square inch.
 - Similarly, in order for electrons to flow in a circuit, there has to be a force pushing the free electrons.
 - This force is measured in volts.

PPT 1-23

- Most homes are supplied with 110-120 volts or 220-240 volts.
- Show PPT 1-23 as you make the following points about resistance.
 - Now let's think of the garden hose once more to understand resistance.
 - As we discussed, water will only flow through a hose if there is a force pushing the water forward.
 - But the flow through the hose will also be impacted by things like kinks in the hose, frayed interior lining and the size of the hose.
 - These are examples of factors within the hose that may create resistance to the water flow.
 - Similarly, in an electric circuit, things like the diameter of the wire or the type of metal used to conduct the current can impact the electric current flow.
 - This resistance is measured in a term called ohms.
 - Appliances within the home will have different levels of resistance.

PPT 1-24

- Refer participants to Page 10.
- Use PPT 1-24 to introduce Ohm's Law. Make the following points.
 - Ohm's Law is a mathematical formula that enables the measurement of electric current moving through a conductive body.
 - It states that one volt will cause a current of one ampere to flow through a conductor having the resistance of one ohm.

PPT 1-24

- Review the formula for Ohm's Law on PPT 1-24.
- Emphasize that resistance is measured in ohms.

PPT 1-25

- Point out that as long as they know any two of the values in the Ohm's Law equation, they can calculate the third.
- Use PPT 1-25 to show participants a visual way to remember these formulas.
 - If they look at the quadrant containing amps (I), they can visually see that they can determine amps by dividing volts (V) by resistance (R).
 - In a similar manner, if they look at the quadrant containing ohms, which represent resistance (R), they can visually see that they determine resistance by dividing volts (V) by amps (I).
 - Finally, to determine volts (V), they can visually see that they would multiply amps (I) by resistance (R).

Question:

- Address participant questions or comments.
- Refer participants to the bottom on Page 10. Tell them to use Ohm's Law to solve this problem. Let them know that they can work on this problem with one or two other people.
- Allow about two minutes for participants to work on the problem, then call the large group back together.

PPT 1-26 and
PPT-27,
Animated

- Ask participants: What answer did you get?
- Get some responses and congratulate people who got it correct. The correct answer is 0.12 amps or 120 milliamps.
- Use PPT 1-26 and PPT 1-27 to work through the problem with the large group. **Note** that these two slides are animated so that you can bring in the steps and answers individually, as you see fit.
- Answer participant questions and take any comments they have.
- Refer participants to Page 11. Make the following points.
 - As we have seen from the problem we have just solved, the human body conducts electricity.

PPT 1-28

- But it also has some resistance to electricity.

- Show PPT 1-28 to illustrate the resistance of the human body depending on the current and upon the moisture of the skin.

- Point out the difference in resistance between wet and dry skin.

Question:

- Ask participants: Why would resistance of wet skin be so much lower than the resistance of dry skin?

- Get some responses, then share the following.

- Wet skin is caused by sweat or water that contain small amounts of dissolved minerals like sodium or calcium.

- Although distilled water is a poor conductor, minerals dissolved in water are very effective conductors.

Question:

- Ask participants: What happens to resistance when the skin has cuts or scabs?

- Get some responses, then share the following.

- Cuts and scabs lessen skin resistance.

- They provide electrical current a point of entrance.

Question:

- Ask participants: What practical implication does an understanding of the low resistance within a human body have to a safety professional?

- Get some responses, then share the following.

- If an electric current penetrates the skin; the human body has no defense against the current.

- Once a person becomes part of a circuit, the current will normally follow either the nervous system or the circulatory system to the ground.

- The electron flow can often have a devastating impact on any organs that it encounters within the body.

PPT 1-29

Question:

PPT 1-30 through
PPT-32

- This is why lockout/tagout, electrical safety programs, and inspections are all very important practices.
- They are designed to prevent an employee from becoming part of a circuit.
- Refer participants to Page 12 and tell them that they are now going to look further at the effects of electricity on the human body.
- Explain that the effects of electricity depend on a number of factors.
- Use PPT 1-29 to review these factors.
- Refer participants to the chart in the middle of Page 12. Make the following points.
 - This chart shows how electricity affects the human body.
 - Think of the exercise we just did on Page 10. This worker was shocked by 120 milliamps.
- Ask participants: Using the chart on Page 12, what is the likely injury to this worker?
- Get participant responses, then point out that at the very least the employee would experience extreme pain and at the worst he would die.
- Point out that even something as ordinary as an electric drill can be deadly.
- Use PPT 1-30 through PPT 1-32 to demonstrate the damage electric shock has on the body.
- Close the discussion by emphasizing the importance of practicing electrical safety.

5. Case Study—Activity (20 minutes)

Cues	Content
	<ul style="list-style-type: none">■ Participants will now solve a case study. You will cover Pages 13 and 14 in this case study.■ Allocate 10 minutes to each page.■ Refer participants to Page 13. Tell them they will be working on a case study.■ Take a couple of minutes to read the case study out loud to the group.
Question:	<ul style="list-style-type: none">■ Ask participants: What were the volts present in the drill?■ Get some responses, then point out that a common voltage for this type of drill is 120 volts.■ Encourage participants to write this voltage in the space provided on Page 13.
Question:	<ul style="list-style-type: none">■ Ask participants: What are some of the potential differences between the work environment of the apprentice and that of the project manager?■ Get some responses. Participants will likely identify the following items.<ul style="list-style-type: none">– The apprentice was working outdoors in a hot environment.– His hands were likely sweaty and covered with dirt and minerals.– The project manager was working in a cool, controlled environment.– His hands were likely clean and dry.■ Encourage participants to write these responses in the space provided on Page 13.

Question:

- Ask participants: Given these factors, what is the likely resistance of the project manager's skin? Feel free to look at the chart on Page 11.
- Get some responses, which will be a range of 100,000 to 600,000 ohms.
- Encourage participants to write 100,000 ohms in the space provided on Page 13.

Question:

- Ask participants: What is the likely resistance of the apprentice's skin?
- Get some responses, which should be 1,000 ohms.
- Encourage participants to write this response in the space provided on Page 13.
- Tell participants the following.
 - Now that you have all the information you need, use Ohm's Law to calculate the flow of current experienced by both the project manager and the apprentice.
 - Work together with a couple of classmates to perform these calculations.
- Allow a few minutes for participants to work on the calculations, then call the large group back together.

Question:

- Ask participants: What answers did you get?
- Get some responses.
 - The correct answer for the project manager is .0012 amps or 1.2 milliamps.
 - The correct answer for the apprentice 0.12 amps or 120 milliamps.
- Use PPT 1-33 and PPT 1-34 to work through the problems with the large group. **Note** that these two slides are animated so that you can bring in the steps and answers as you see fit.

PPT 1-33 and
PPT-34,
Animated

Question:

- Answer participant questions and take any comments.
- Refer participants back to the chart on Page 12.
- Ask participants: What is the difference in effect of 1.2 milliamps versus 120 milliamps on the human body?
- Get some responses, then point out that the project manager probably felt a faint tingle, if anything at all.
- On the other hand, the apprentice's shock level was enough to be extremely painful or, in his case, fatal.

Question:

- Ask participants: Why do you think the manager dismissed the employee's concern so readily?
- Get some responses, then point out that at times the mindset of a manager is jaded and cynical. However, when it comes to electricity, the manager should always give the employee the benefit of the doubt and get the tool out of service.
- Refer participants to Page 14. You will be leading a discussion of the two questions on this page.

PPT 1-35

- Ask Question 1: Are lower amperage/voltage circuits a threat to humans?
- Get some participant responses, then use PPT 1-35 to review facts about lower amperage.

PPT 1-36

- To further emphasize the dangers of low voltage, show PPT 1-36 and make the following points.
 - If you're still not convinced of the dangers of lower voltages, consider this chart.
 - NIOSH conducted an analysis of all the electrocutions in its FACE program from 1982-1994.
 - Note that the largest percentage of electrocutions come from electrocution at 120 volts or less.
 - That's more than one in three deaths at 120 volts or less!

Facilitator Note

- If you would like to view the NIOSH report referenced on PPT 1-36, go to <http://www.cdc.gov/niosh/docs/98-131/>.
- The publication, called *Worker Deaths by Electrocution*, is also listed in the *Resources* section on your *Tools and Resources* CD-ROM.
- Ask Question 2: Does your organization have emergency response procedures for working on exposed electrical parts?
- Get some participant responses, then make the following points if they haven't already been made.
 - If your organization does not have emergency response procedures for working around electricity, you should consider developing some.
 - If you do have them, you should have a program for providing training and review.

6. Planning for Your Small Business—Activity (5 minutes)

Cues	Content
PPT 1-37	<ul style="list-style-type: none">■ You will be covering Page 15 in this segment. Allow 5 minutes.■ Refer participants to Page 15. Show PPT 1-37 as you point out that this is a planning page.■ They should think about how they can apply on-the-job some of the things they've learned in this module.■ Allow participants a couple of minutes to write their ideas on Page 15.
Question:	<ul style="list-style-type: none">■ Ask participants: What are some of the things you will try back at your worksite?■ As time permits, have participants share some of their ideas, barriers and ways to overcome the barriers.
10 Minute Break	Take a 10 minute break.