# HIGH-IMPACT SAFETY TRAINING FOR QUALIFIED ELECTRICAL WORKERS

This easy-to-use Leader's Guide is provided to assist in conducting a successful presentation. Featured are:

**INTRODUCTION**: A brief description of the program and the subject that it addresses.

**PROGRAM OUTLINE:** Summarizes the program content. If the program outline is discussed before the video is presented, the entire program will be more meaningful and successful.

**PREPARING FOR AND CONDUCTING THE PRESENTATION:** These sections will help you set up the training environment, help you relate the program to site-specific incidents, and provide program objectives for focusing your presentation.

**REVIEW QUESTIONS AND ANSWERS:** Questions may be copied and given to participants to document how well they understood the information that was presented. Answers to the review questions are provided separately.

## INTRODUCTION

If you are potentially exposed to live electrical parts, you need to understand that electricity can cause severe injuries and death when safe work practices are not followed. While electricity is very powerful, it is not unpredictable. We can evaluate electrical hazards and then follow the safety precautions that will protect us from them. What is unpredictable is our willingness to faithfully follow these safety rules on every job task. As qualified electrical workers, we must treat each encounter with respect and caution so we can arrive home safely at the end of the day.

This video covers most of the training requirements and safe work practices for "qualified workers" outlined in OSHA 1910 Subpart (S). Featured are several incidents involving electricity in which unsafe acts by employees have resulted in serious injury or death.

Topics of the program include qualified worker status, electrical arcing and arc blasts, protective clothing requirements for qualified workers, limited approach and prohibited approach boundaries, use of voltage-rated gloves and other PPE, performing live work and de-energizing equipment.

## *PROGRAM OUTLINE*

### HAZARDS OF ELECTRICITY

- Most non-qualified workers don't realize that there are two hazards associated with electricity: electrical shock, which can shut down breathing and heart function even at very low levels; and, the risk of severe burns due to electrical arcing and arc blasts.

- As part of your training to be qualified to work on or near live parts, you will learn how to protect yourself from both shock and burn hazards through the use of safe electrical work practices.

### WHO IS "QUALIFIED"?

- The word "qualified" carries a great deal of weight when used in the context of electrical training. A worker is considered qualified when a) they possess the skills and techniques needed to distinguish live electrical parts from other parts; b) they have the skills needed to determine the nominal voltage of the exposed parts; and, c) they know and understand the proper clearance distances that must be maintained for the hazards present.

- Many people hear these requirements and think they are qualified to approach live parts simply because they know how to use a voltmeter. This is just <u>not</u> the case!

- The time to know the location of live parts and their voltage levels is before you start troubleshooting the circuit. This information is available from manufacturer's information, schematic diagrams, nameplate information and equipment-specific training; without this information, you are not qualified to service the equipment.

- You may be "qualified" in regard to certain pieces of equipment in your facility and "not qualified" with regard to others. Never exceed the limits of your training and knowledge when performing electrical work.

**PREVENTING UNQUALIFIED PERSONNEL FROM CONTACTING LIVE PARTS**

- While performing any electrical work, your number one goal is to avoid injury to both you and your co-workers.

- For every voltage level and circuit you work with, there is a minimum safe distance that unqualified workers must be kept away from any exposed live parts. This can be done with barricades and signs or by posting a designated person to stand watch.

- This safe distance, called the "limited approach boundary," is based on both shock and burn hazards. It not only applies to the workers, but also to any conductive object or extended reach tool they may be using.

**ELECTRICAL ARCING & ARC BLASTS**

- Electrical arcing is extremely hot and can ignite the air around the arc into a large fireball called an arc blast. Even a brief exposure to the intense heat of an arc blast can cause major burns, severe injury and death.

- The magnitude and duration of an arc blast depend on several factors, including the voltage level, the available fault current and the speed of any over-current protection devices.

- The risk of encountering an arc blast depends on what job task you are performing. Tasks that open, close or ground an electrical circuit increase the chance for an electrical arc or arc blast.

- You should always stand to the side when opening or closing any electrical disconnect. This puts your body outside the potential blast zone.

**PROTECTIVE CLOTHING FOR QUALIFIED ELECTRICAL WORKERS**

- To protect against burns due to arc blasts, the company has developed specific protective clothing requirements for qualified electrical workers.

- Certain fabrics and blends of fabrics such as rayon and polyester have been banned for use by electrical workers. These fabrics will continue to burn intensely once exposed to the initial heat of the blast and they can melt into the skin, turning a minor incident into a critical burn injury.

- Electrical workers should wear 100 percent cotton fabric as a minimum level of protection. Cotton will also burn, but it will not melt into the skin.

- As arc hazards increase, additional levels of fire-retardant clothing are required. Fire-retardant clothing will not continue to burn once the heat source is removed and greatly reduces the degree and body percentage of the burn.

- The greater the hazard, the more protection may be required. For some jobs, this can mean a blast hood or an entire blast suit.

- Each additional layer of protection increases your ability to survive the extreme heat of an arc blast. Of course, like all forms of protective equipment, these devices are only effective when they are used.

- Remember that while this type of clothing offers protection from burns, it will not protect you from electric shock.

**THE PROHIBITED APPROACH BOUNDARY**

- Most electrical workers understand that to avoid shock, they must not directly contact live parts unless insulated by voltage-rated protective equipment, tools and barrier devices.

- At certain voltage levels, simply avoiding contact is not enough. Allowing your body or any other conductive object to get too close to a live part can have the same effect as making direct contact.

- During your training, the company will specify the distance from live parts a qualified worker is required to use voltage-rated protective equipment, tools and barrier devices. This distance is referred to as the "prohibited approach

boundary" and it may not be crossed unless the qualified worker has the proper equipment and training to perform live work on the exposed parts.

- As a qualified worker, you are responsible for knowing the prohibited approach boundary for the voltage levels and equipment to which you may be exposed.

**VOLTAGE-RATED ELECTRICAL GLOVES**

- Your hands can be electrically insulated by wearing voltage-rated electrical gloves. Many people think electrical gloves are only worn by high voltage workers and are too big and bulky for other applications, but that just isn't the case.

- Class 0 gloves allow an easy grip on tools and other objects and are rated up to 1,000 volts, making them a good choice for many applications.

- No matter what class glove or voltage level you are working with, always inspect your gloves before each use by capturing air into the glove and checking the glove for holes and leaks.

- Because electric current can find its way through even the smallest of holes, hold the glove near your cheek and feel for any air escaping from a hole that may be too small to see.

- Because of the importance of maintaining a glove free from holes and damage, never use an electrical glove by itself. Always use leather protectors over the glove to protect them from damage, which has the added benefit of offering some protection for your hands in the event of an arc flash.

- When not in use, your electric gloves should be stored in an approved storage device.

- Electric gloves that will be reused must be tested and recertified by an approved testing laboratory every six months.

**OTHER PROTECTIVE EQUIPMENT**

- When head protection is required, electrical workers must use the proper type. Head protection for electrical workers must be insulated to withstand 20,000 volts.

- A standard hardhat offers minimal electrical protection and is designed for non-qualified workers who are not exposed to live parts.

- To prevent making a solid connection to ground, electrical workers should wear safety shoes with non-conductive soles.

**USE OF INSULATING DEVICES & OTHER SAFE WORK PRACTICES**

- Where possible, insulating mats should be placed on the ground in front of work areas for additional protection.

- When working on insulated mats, be aware that allowing your toes to hang off the mat while kneeling greatly reduces the protection offered by the mat (especially when wearing worn out boots with exposed steel toes).

- Other types of insulating barrier devices can be used to avoid contact with exposed live parts. Use these devices anytime you work near live parts in tight spaces such as electrical vaults or manholes.

- When working with electrical equipment, make sure there is enough light for you to visually see the components with which you are working.

- Of course, electrical workers should never wear any conductive jewelry and never allow any conductive items such as keys or tools to dangle loosely while working near live parts.

**PERFORMING LIVE WORK**

- Qualified electricians who perform work on or near live parts receive training on safe work practices and techniques for live work.

- A variety of circumstances dictate the necessity for live work, such as testing and troubleshooting or performing maintenance on circuits that cannot safely be de-energized. These include life support systems, emergency response circuits and continuous process operations.

- Many situations don't require live work and the company has established procedures for de-energizing equipment before any work is performed.

**DE-ENERGIZING EQUIPMENT**

- Energy control procedures must be followed to create an electrically safe working condition, sometimes called a "zero energy state."

- As a qualified worker, you must understand that the process of creating an "electrically safe condition" can itself be dangerous and you need to know some key safety practices.

- Before de-energizing any equipment or circuit, review the procedure and any potential hazards with all involved workers prior to beginning any work.

- When removing power sources, never depend on control circuits such as push buttons, selector switches or interlocks as the sole means of interrupting power.

- Once all power has been removed, locked and tagged and the equipment has been confirmed inoperative by a qualified operator, you must verify a zero energy state.

**VERIFYING A ZERO ENERGY STATE**

- When confirming a zero energy state, remember the circuit is still live until it is confirmed otherwise. Testing live parts requires proper voltage-rated PPE and any required arc flash protections.

- Before using your meter to verify zero energy, test it on a known power source to make sure it is functioning properly. Once zero energy is verified on the circuit in question, recheck the meter's operation again on the known source.

- Remember, a zero voltage reading alone does not confirm zero energy because a broken meter will always read zero.

- When work is being performed on a system where voltage could be induced or back feed could occur, grounding conductors must be installed on each phase before the system can be considered in an electrically safe condition.

- Installing or removing these grounds is considered live work. Voltage-raged tools and equipment must be used and safe live work practices must be followed.

**CONCLUSION**

- Electricity is a powerful force that can cause serious injury and death. While electricity is powerful, it is not unpredictable.

- We know exactly how electricity will react at various voltage levels and under certain conditions. We also know it seeks all available paths to ground and we can insulate ourselves from it.

- The duration and magnitude of arc hazards can be calculated and protective clothing has been developed to protect us from this powerful force.

• The hazards of electricity are well-documented and predictable, but what is unpredictable is our own willingness to follow safe electrical work practices on each and every task we perform.

• As a qualified electrical worker, treating each encounter with electricity with respect and caution helps make sure you arrive home safely at the end of each day.

## INCIDENTS AND THEIR SAFETY LESSONS

### Incident 1: Voltage Meter Blows Up In Maintenance Worker's Face

Jerry, who was filling in for the regular maintenance worker in the department, was troubleshooting some door-mounted control circuits on a motor starter. Having worked with 600-volt starters in his own department, Jerry assumed the control power transformer had the same voltage. He had no idea that the transformer actually had a primary side voltage of 2,300 volts. He proceeded to verify its power with a voltage meter rated for 1,000 volts. When he placed the leads across the terminals, the voltage meter exploded and Jerry suffered severe burns to his face.

**Safety Lessons:**

• ***You must know the location of live parts and their voltage levels before you start troubleshooting a circuit. This information is available from manufacturer's information, schematic diagrams, nameplate information and equipment-specific training.***

• ***Never exceed the limits of your training and knowledge when performing electrical work. While you may be qualified to work on certain equipment at your facility, you may not be qualified to work on others.***

### Incident 2: Unqualified Employee Shocked And Killed After Contacting Exposed Live Parts

Jeff, a qualified electrical worker, decided that since he was only going to be working inside a cabinet a short time, he didn't need set up a boundary around the work. When Donnie, an unqualified co-worker, came to update him about a problem, Jeff didn't think about him inside the limited approach boundary. While they were talking, a forklift in the area caused Donnie to lose his balance and contact the live parts. He was shocked and killed.

**Safety Lessons:**

• ***As a qualified employee, you have the responsibility to keep unqualified persons a safe distance from exposed live parts. This safe distance is referred to as the "limited approach boundary."***

• ***You must be able to determine the limited approach boundary for the voltage levels and equipment you are working on.***

• ***Use barricades and signs or post a designated person to stand watch to keep unqualified personnel from entering.***

### Incident 3: Arc Blast Results In Traumatic Head And Neck Burns To Unprotected Employee

Because it was late and nobody else was in the area, Larry decided not to wear the required blast helmet when he racked out a 480-volt circuit breaker. After all, the helmet was hot and bulky, sometimes fogged up and Larry didn't like being told by the company to wear it. As he racked out the breaker, he could hear an arcing noise. He hastily tried to rack it back in, but couldn't before an arc blast blew him away from the front of the cabinet. His fire-retardant switching jacket likely saved his life, but his head and neck were unprotected and received severe burns.

**Safety Lessons:**

• ***Always wear the protective clothing and use the proper equipment required for each job task you do. These devices are only effective when they are used.***

• ***Don't let a poor attitude about safety trick you into making excuses for not following safe work practices.***

### Incident 4: Failure To Wear Electrical Gloves Leads To Worker's Electrocution

Jerome was troubleshooting a circuit when he had to reach deep into a cabinet to test the output of a special relay. He never wore his electrical gloves, since he only worked on low voltages and gloves kept him from getting a "feel" for what he was doing. As a co-worker held the voltage meter, Jerome got the leads on the relay terminal block but they got no reading on the meter. When he tried to check the main terminal lug to see if it was getting power, his hand inadvertently came into contact with a loose wire powering the control circuit. His co-worker quickly shut off the power and performed CPR, but Jerome died as a result of the shock.

**Safety Lessons:**

• ***No matter what the voltage, electrical gloves are often all that separate you from becoming part of the circuit. Failing to wear them can be a fatal mistake.***

• ***Recognize the danger presented by low voltages; it only takes a few milliamps to stop your heart.***

**Incident 5: Arc Blast From Ungrounded Conductor Kills Maintenance Technician**

Jerry and a co-worker were working on the power system to the process facility. They had isolated the power and locked and tagged the unit. Because he was hot, Jerry removed all of his protective equipment before connecting the grounding conductors. While connecting the second grounding conductor, an arc blast occurred that severely burned Jerry. Because he was wearing no protection, most of Jerry's body was badly burned and he died several days later.

**Safety Lessons:**

- ***Because installing or removing grounding conductors is considered live work, voltage-rated tools and equipment must be used and safe live work practices must be followed.***
- ***In a system where voltage could be induced or back feed could occur, it must be grounded before an electrically safe condition exists.***

**PREPARE FOR THE SAFETY MEETING OR TRAINING SESSION**
Review each section of this Leader's Guide as well as the videotape. Here are a few suggestions for using the program:

Make everyone aware of the importance the company places on health and safety and how each person must be an active member of the safety team.

Introduce the videotape program. Play the videotape without interruption. Review the program content by presenting the information in the program outline.

Copy the review questions included in this Leader's Guide and ask each participant to complete them.

Make an attendance record as needed and have each participant sign the form. Maintain the attendance record and each participant's test paper as written documentation of the training performed.

**Here are some suggestions for preparing your videotape equipment and the room or area you use:**

Check the room or area for quietness, adequate ventilation and temperature, lighting and unobstructed access.

Check the seating arrangement and the audiovisual equipment to ensure that all participants will be able to see and hear the videotape program.

Place or secure extension cords to prevent them from becoming a tripping hazard.

**CONDUCTING THE PRESENTATION**
Begin the meeting by welcoming the participants. Introduce yourself and give each person the opportunity to become acquainted if there are new people joining the training session.

Explain that the primary purpose of the program is to explain safe work practices for qualified electrical workers, to stress the importance of always following these practices and to show the tragic consequences of not following these practices and committing other unsafe acts.

Introduce the videotape program. Play the videotape without interruption. Review the program content by presenting the information in the program outline.

Lead discussions about specific job assignments and equipment at your facility that have electrical hazards and the work practices your employees must follow to prevent these hazards from causing injury or death.

After watching the videotape program, the viewer will be able to explain the following:

- The importance of recognizing when you are qualified or not qualified to perform a task;

- The “limited approach boundary” for unqualified personnel and the “prohibited approach boundary” for qualified workers;

- The significance of using voltage-related electrical gloves;

- Protective clothing and equipment that qualified workers must wear and use;

- The procedures for de-energizing equipment and verifying a zero energy state.

**HIGH-IMPACT SAFETY TRAINING FOR QUALIFIED ELECTRICAL WORKERS**
***REVIEW QUIZ***

**Name_____Date_____**

***The following questions are provided to check how well you understand the information presented during this program.***

1. An electrical worker may be "qualified" in regard to certain equipment and "not qualified" with regard to other equipment.

a. true
b. false

2. The minimum safe distance that unqualified employees must be kept away from exposed live parts is known as the _____.

a. prohibited approach boundary
b. limited approach boundary
c. designated approach boundary

3. Which fabric will not melt into the skin when burning and should be worn by electrical workers?

a. cotton
b. polyester
c. rayon

4. Flame retardant clothing is effective in protecting against burns and electrical shock.

a. true
b. false

5. Which of the following statements about electrical gloves is ***not*** true?

a. they should be inspected before each use
b. they should never be worn without additional protection
c. they must be tested and recertified every twelve months
d. they should be kept in an approved storage device when not in use

6. Head protection for electrical workers must be able to withstand _____ volts.

a. 8,000
b. 12,000
c. 20,000

7. An electrically safe working condition is also known as a _____.

a. continuous process operation
b. zero energy state
c. minimized electrical condition

8. You should test your voltage meter for proper function _____ using it to verify a system as de-energized.

a. before
b. after
c. both a and b
d. neither a or b

9. Installing and removing grounding conductors is considered live work.

a. true
b. false

## *ANSWERS TO THE REVIEW QUESTIONS*

1. a
2. b
3. a
4. b
5. c
6. c
7. b
8. c
9. a