

# **UNDERSTANDING NFPA 70E...** **ELECTRICAL HAZARDS AND** **SAFE PRACTICES IN** **INDUSTRIAL ENVIRONMENTS**

## **COURSE OUTLINE**

- **The NFPA 70E Standard addresses three main types of electrical hazards...**
  - Electric shock.
  - Arc flash.
  - Arc blast.
- **An “electric shock” happens when an electric current runs from the source of a voltage through your body or along the surface of your skin.**
  - Anyone can experience an electric shock... from a household appliance, frayed extension cord or a wall outlet.
  - These types of shocks typically result in minor injuries.
- **But when you’re shocked by a piece of industrial equipment, a live wire, or a power line, your injuries can be much more serious and include...**
  - Burns.
  - Seizures.
  - Loss of consciousness.
  - Internal organ damage.
- **But as serious as these injuries are, they are mild compared to what can happen during an “arc flash event”.**
  - This is an electrical explosion which occurs when air becomes the conductor of electricity, that can create a heated wave of plasma as hot as 35,000°F.
- **The light and heat from the explosion is called an “arc flash”, while the pressure wave that follows is called an “arc blast”.**
  - An arc blast can be powerful enough to knock you off your feet.

- **During an arc flash event, the clothes of anyone in the area can be ignited and burn their skin.**
  - The light, heat and pressure wave can also cause eye injuries and hearing loss.
  - Since arc flashes can burn metal, breathing in the surrounding air during or after the event can cause serious damage to your lungs.
- **If the arc flash and blast are powerful enough, the event can be fatal, even if it only lasts for a few microseconds.**
- **“Arc flashes” and “blasts” can be caused by a number of things, including...**
  - Voltage spikes.
  - Touching a test tube to an electrically “charged” surface.
  - Worn or loose connections in power cords.
  - Gaps in insulation in tools or equipment.
  - Improperly installed electrical parts.
  - Dust build-up and corrosion on electrical equipment.
- **So it is vital to use the safe work practices and procedures in the NFPA 70E Standard to help avoid these types of incidents.**
- **The keys to safe electrical work are planning and preparation.**
  - The better you can assess and plan for risks, the better you can avoid them.
- **That’s why the NFPA 70E Standard requires creating a “Job Safety Plan” before starting any work that involves exposure to electrical hazards.**
  - It should be written by a “qualified person”, who is most often the employee in charge of the job that is being done.
- **If it’s your responsibility to write a Job Safety Plan, you should include...**
  - A description of the job and the tasks it consists of.
  - The electrical hazards associated with each task.
  - An electric shock risk assessment.
  - An arc flash risk assessment.
  - The work procedures that are involved with the task.
  - An “Emergency Response Plan”, in case something goes wrong.

- **But even the most detailed and thought-out plans can go wrong if the equipment that you're using is damaged or defective.**
  - So you need to make sure that your equipment and test instruments are approved for the purpose you're using them for, and that you have read the manufacturer's instructions for their operation.
- **The NFPA 70E Standard also specifies that you should visually inspect all test instruments, equipment and accessories for defects and damage before each use.**
- **One way to verify that test instruments are working properly is through the "LIVE-DEAD-LIVE" test.**
  - This involves attaching the instrument to a known source of voltage before and after you use it to test for the absence of voltage on the machinery that you're working with.
- **When you have verified that all of your equipment is ready to use, you need to conduct risk assessments for electric shock and arc flash hazards.**
- **These assessments...**
  - Identify any potential hazards.
  - Estimate the likelihood of a potential injury or adverse health effect.
  - Determine what protective measures are needed to complete a task safely.
- **During the assessment, you need to determine the voltage of all the "conductors" in your vicinity and the voltage ratings of the tools you're going to use.**
  - You should also consider the design of the equipment that you're working on and how well it has been maintained.
- **These factors can help you calculate the "electric shock protection boundaries" you should set up using the table that the NFPA 70E Standard provides.**
  - These barriers should be marked using signs or other visual indicators.
- **There are two types of electric shock protection boundaries...**
  - The "limited approach boundary".
  - The "restricted approach boundary".

- The NFPA 70E defines the “limited approach boundary” as *“An approach limit at a distance from an exposed energized electrical conductor or circuit part within which an electric shock hazard exists”*.
- The “restricted approach boundary” is the *“Approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc-over combined with inadvertent movement.”*
- The main difference is that the area within a “limited approach boundary” poses less of a risk than the area within a “restricted approach boundary”.
- “Unqualified” personnel can enter the “limited approach boundary” with a “qualified” chaperone.
  - Only “qualified” personnel are allowed to enter a “restricted approach boundary”.
  - Specialized PPE that is not needed in a “limited approach boundary” may be required in a “restricted approach boundary”.
- NFPA 70E also stresses the importance of the “arc flash boundary”, stating, *“... the arc flash boundary separates an area in which a person is likely to be exposed to a second-degree burn from an area in which the potential for injury does not likely include a second-degree burn”*.
- The Standard uses  $1.2 \text{ cal/cm}^2$  to determine an arc flash boundary because it *“... is the distance at which there is a probability that the employee will not suffer a permanent physical injury”*.
- You can still experience an arc flash burn if you are outside the “arc flash boundary”.
  - But the burn is less likely to be as severe as a burn that occurs within the boundary.
  - Once you cross the boundary, you’re more likely to suffer second, third and even fourth degree burns in the event of an arc flash.
- So NFPA 70E states that any body part that crosses into the arc flash boundary *“... must be protected from the potential thermal effects of the hazard.”*

- **You're ready to begin the job when you have...**
  - Written your Job Safety Plan.
  - Inspected your tools and equipment.
  - Determined what the “boundaries” are for the equipment that you're working on.
- **Working with and around electrical equipment comes with a lot of hazards.**
  - That's why the NFPA 70E Standard sets out various ways you can protect yourself in these situations.
- **One thing you can do is simply inform yourself about the equipment that you are working with by looking at its labels.**
- **All switchboards, panels, meter socket enclosures and motor control centers should be labeled with their...**
  - Nominal system voltage.
  - Arc flash boundary.
  - Minimum arc rating for clothing.
  - The level of PPE that should be worn when working on the equipment.
- **So it's important that the labels are legible.**
  - If a label isn't durable enough to withstand the environment it's in, or you have trouble reading it, notify your supervisor.
- **Another thing that NFPA 70E discusses is the use of personal protective equipment (PPE).**
  - Remember, PPE is the last line of defense.
  - Without other protection measures it can't protect you from all of the potential injuries that could occur on its own.
- **However, it can minimize the severity of injuries... as long as it is maintained in a safe, clean and reliable condition.**
- **When there is the possibility of head injury, NFPA 70E requires you to wear head, face, neck and chin protection. This can include an arc-rated...**
  - Hood.
  - Balaclava.
  - Face shield.

- **If you wear a face shield, it needs to provide “wrap-around” guarding to protect your face, chin, forehead, ears, and neck area.**
  - You should also wear safety glasses or goggles, and ear canal inserts to protect your eyes and ears.
- **To avoid an electric shock to your arms and hands, you need to wear rubber insulating gloves as well as sleeves with protectors.**
  - To guard against an arc flash, heavy-duty, “arc-rated” leather gloves are best.
- **Don’t forget about your feet!**
  - Insulated or leather footwear can provide protection against electric shock and arc flash events as well.
- **You should also wear “arc-rated” clothing such as an arc flash suit to protect yourself against thermal burns when you are within the “arc flash boundary” of the equipment you’re working on or using.**
- **Regardless of the type of PPE you wear, it is very important that it has a loose fit to provide additional thermal insulation and it fully covers your body.**
- **But even with all these precautions, you are not done yet.**
  - It’s also important to use the right tools and equipment when you are working around electrical hazards.
- **Any tools that you work with within a “restricted approach boundary” area should be insulated.**
  - They should also be rated for the voltages they are being used with.
- **Additionally the NFPA 70E Standard lists physical or mechanical barriers that can be used as a protective measure when you’re working around exposed energized electrical conductors that operate at 50 volts or more.**
  - This prevents any accidental contact.
- **It’s also essential to understand the “procedural” precautions you should take while you’re working around electrical equipment that can help to keep you safe.**

- **For example, the NFPA 70E Standard stresses that you must be “alert and aware” while you’re working with or near electricity or with electrically powered equipment.**
  - So if you are feeling tired, sick or distracted, alert your supervisor immediately.
- **You should also look for safety signs as well as barricades that have been positioned in or around the equipment you are working with to keep you informed and away from potential hazards.**
- **To be fully aware of everything in your work area, you need proper lighting.**
  - If you can’t see what you’re doing, you can’t safely perform a task.
- **Similarly, you should never blindly reach into spaces that could contain exposed electrical conductors or circuit parts.**
- **NFPA 70E also warns against wearing anything that could be “conductive”, such as...**
  - Jewelry.
  - Watches.
  - Key chains.
  - Metal-framed glasses.
- **Any doors or hinged panels on equipment that you are working with must be secured.**
  - Otherwise, they could swing open, exposing you to energized electrical conductors or circuits.
- **If your work area is overcrowded or messy, it could prevent you from having clear access to the equipment or to escape passages.**
  - So before you start any job, always make sure the surrounding area is neat and clean.
- **But in some cases, despite all of these precautions, the equipment that you are working on could fail on its own.**
  - So NFPA 70E advises that if there is any indication that electric equipment could fail, it should be “de-energized” immediately.
- **If this does happen, you should not re-energize the equipment until the cause of the failure has been identified and repaired.**

**\* \* \* SUMMARY \* \* \***

- **The three main types of electrical hazards are electric shock, arc flash, and arc blast. They can lead to burns, organ damage, loss of hearing or eyesight... even death.**
- **You should develop a “Job Safety Plan” that includes your risk assessments for electrical shock and arc flash for all electrical work that you do.**
- **Before beginning any electrical work, you should always establish the “electric shock safety boundary” and the “arc flash boundary” for the equipment you’re working on.**
- **One way you can become familiar with the electrical equipment at your facility is by thoroughly reading its labels.**
- **You should wear PPE such as insulated gloves, leather footwear, and head and face protection when you’re doing electrical work or working around electrical equipment.**
- **Now that you know what type of electrical hazards you may encounter, and how complying with the NFPA 70E Standard can help you protect yourself from them, you can keep yourself, your coworkers and your facility safer... every day!**