

SHOCKS AND ARC FLASH

COURSE OUTLINE

- **Most of us have been “shocked” at one time or another from touching things like a...**
 - Doorknob.
 - Metal railing.
 - Sweater.
- **That quick “zap” is the result of static electricity.**
 - That’s the build-up of an electrical charge on the surface of an object.
- **This type of “shock” is typically harmless.**
 - But “electric shock” is a different story.
 - Imagine that “zap” you’ve felt from static electricity and multiply it by 100.
- **Electric shocks can be extremely painful, even life-threatening.**
 - So it’s important to know what can cause them.
- **“Shocks” occur when an electric current runs from a source of voltage, either through your body or on the surface of your skin.**
- **We all encounter situations that can result in shocks, whether it’s from a...**
 - Household appliance.
 - Frayed extension cord.
 - Wall outlet.
- **But when you’re shocked by a piece of high-powered equipment, a live wire, or a power line, your injuries can be extremely serious, including...**
 - Burns.
 - Seizures.
 - Loss of consciousness.
 - Internal organ damage.
- **Fortunately, there are safe work practices that you can follow to reduce your risk of being shocked in the workplace.**

- **It starts with keeping your eye out for hazards such as cracked wires and defective equipment.**
 - Inspect tools and extension cords before plugging them in.
 - If you see torn insulation or exposed wiring, don't use them.
- **This type of damage often results from "unsafe work practices" like...**
 - Picking up electric tools by their power cords.
 - “Unplugging” an extension by yanking on the cord instead of pulling the plug.
- **So it's important to treat tools and cords with care.**
- **Another way you can put yourself at risk is by removing the "ground" prong from a three-prong plug so you can use it in a "two-prong" outlet.**
 - The grounding prong is a safety measure designed to prevent an electrical current from flowing through you in case there is a “fault” in the equipment it is attached to.
 - If you remove it, it can't do its job.
- **If you find equipment with a plug that has been altered this way, don't use it.**
 - Inform your supervisor immediately so it can be repaired or replaced.
- **Water conducts electricity and promotes "shock".**
 - So whenever possible, avoid using power tools and equipment in wet conditions.
- **Don't touch any electrical equipment that's wet.**
 - Make sure your hands are dry when you're working with electricity as well.
- **A metal ladder behaves just like a lightning rod.**
 - So if you're working around a source of electricity, you should use nonconductive fiberglass or wooden ladders to avoid being “shocked”.
- **Metal tools can be dangerous for the same reason.**
 - So always choose non-conductive tools made of wood or plastic, or tools with insulated handles when you're working around electricity.
- **Have you ever seen a lightning bolt light up the sky during a thunderstorm?**
 - If so, you've witnessed an “arc flash”.

- **As lightning moves closer, you get a better idea of its violence and destructive power.**
 - If it gets too close you might not survive it.
- **While lightning occurs naturally, "man-made" arc flashes generally occur due to...**
 - 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 what exactly is an “arc flash”?**
 - An “arc flash event” is an electrical explosion that occurs when air becomes the conductor of electricity.
 - This causes a heated wave of plasma that can measure up to 35,000°F.
- **The “arc flash” is the light and heat from the explosion, while the pressure wave that follows is called an “arc blast”.**
 - An “arc blast” can be powerful enough to knock you off your feet.
- **The heat an arc flash gives off can be up to three and a half times hotter than the surface of the sun.**
 - So an arc flash will instantly superheat the air, and can vaporize nearby structures and equipment.
- **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.
- **Arc flash events send several thousand workers to burn units every year.**
 - They cause traumatic injuries... and they can kill.
- **So how does a man-made arc flash happen?**
 - Most of the time, energy moves safely through electrical systems, unless something occurs to divert the power.

- **When diverted electricity jumps through the air from contact to contact, or from a contact to "ground", that's an arc flash.**
 - This can occur spontaneously when corrosion or conductive dust builds up in equipment.
 - But most arc flashes result from mistakes that are made when someone is working on or near an electrical system.
- **An arc flash can be caused by...**
 - Touching a probe to the wrong circuit.
 - Dropping a metal tool into an electrical system.
 - Digging into an underground cable.
- **Like lightning, these types of arc flashes happen very, very fast.**
 - They release huge amounts of light and heat energy as well.
- **In a matter of seconds, an “arc flash” event can permanently change, or even end, a worker’s life.**
 - But by examining how arc flashes occur, we can gain a better understanding of what we can do to protect ourselves from them.
- **For starters, you need to be familiar with your company’s Electrical Safety Program (ESP).**
 - Your workplace is required to have one under NFPA 70E, the consensus standard for electrical safety.
- **This program helps you stay safe when you’re working around sources of electricity by outlining...**
 - Safety policies.
 - Safe work procedures for specific tasks.
 - Risk assessment procedures.
 - How to report and investigate electrically related incidents.
- **It is your employer’s responsibility to create and establish this program.**
 - But it is up to you to familiarize yourself and comply with it.
- **The light released by an arc flash is literally blinding.**
 - And its heat can result in first, second and third-degree burns.

- **It can cause everyday clothing to burst into flames.**
 - This can result in some synthetic fibers actually melting into your skin.
 - So the use of personal protective equipment (PPE), when working in electrically hazardous environments is especially important.
- **This is why electrical workers always put on "arc-rated" protective clothing when they approach a potential arc flash source.**
 - Its "arc rating" describes how much heat the clothing can resist without damage.
- **To calculate the arc rating you need for a particular task, you should determine how many units of heat you would receive if an arc flash occurred in the equipment that you're working on.**
 - You can then choose clothing with an arc rating that meets or exceeds the protection level for that amount of heat.
- **When there is the danger of a head injury, you should wear an arc-rated...**
 - Hood.
 - Balaclava.
 - Face shield.
- **You can protect your arms and hands with rubber-insulated gloves and sleeves with built-in protectors.**
 - Don't forget about your feet!
 - Insulated or leather footwear can provide protection against electric shock and arc flash events.
- **But remember, PPE is the last line of defense.**
 - Without other protective measures, it cannot prevent every type of injury by itself.
 - So you need to adhere to "safe work practices", too.
- **For instance, you can become better informed about the equipment that you are working with by familiarizing yourself with its labels.**
 - So you need to be sure that the labels are legible.
 - If a label isn't durable enough to withstand the environment it is in, or you have trouble reading it, notify your supervisor.

- **All switchboards, panels, meter socket enclosures and motor control centers should be labeled with their...**
 - Nominal system voltage.
 - Arc flash boundary.
 - Minimum clothing arc rating.
 - Site-specific level of PPE that should be used when working with them.
- **The best way to reduce the risk of an arc flash is to create an "Electrically Safe Work Condition" (ESCW) before any electrical work begins.**
 - This starts with powering down or "de-energizing" the equipment you're going to be working on.
- **In recently updated guidance, OSHA emphasizes that simply "de-energizing" equipment does not eliminate shock and arc flash hazards.**
 - It's just one step toward establishing an "Electrically Safe Work Condition" (ESWC).
- **Another issue is that in many cases it can be all too easy for someone who cannot see the people who are working on a piece of equipment to turn the electricity back on again.**
 - So the power control system must be locked out and tagged after being turned off.
 - This physically prevents equipment from being re-energized.
- **Your company should have written procedures for this in its Electrical Safety Program.**
 - That includes up-to-date drawings and single-line diagrams for all electrically powered equipment that you can easily follow.
- **But even when it's locked and tagged, equipment still needs to be treated as if it is energized and a potential arc flash hazard.**
 - This is because you still have to test it to make sure the power is really off.
 - This means that the electrical workers who are servicing the equipment must continue to adhere to safe work practices and wear protective clothing and PPE.
- **Another important step in creating an "Electrically Safe Work Condition" is establishing an "Arc Flash Boundary".**

- **To find out where this boundary should be, you need to know the distance from the equipment where the "incident energy" of an arc flash would equal 1.2 calories of heat per square centimeter.**
 - Fortunately, this information is typically shown on the equipment's label.
- **This distance is where the Arc Flash Boundary should be set up.**
 - The boundary must be clearly labeled and physically restrict access to the area.
- **You can still experience an arc flash burn from outside of the "Arc Flash Boundary".**
 - But the burn is less likely to be a second-degree burn or worse.
- **So unqualified electrical service personnel and other workers should never cross an Arc Flash Boundary line.**
 - Even qualified electrical workers shouldn't cross the boundary unless they are wearing appropriate protective clothing and PPE with the right arc-rating.
- **When you are testing equipment to verify an ESWC, you should use a known source of voltage to ensure that the test instrument is working correctly before and after you use it on each circuit part.**
 - This is called the "LIVE-DEAD-LIVE" test.
 - It will help to make sure that your results are accurate.
- **Only when it is verified that the power is off, does an "Electrically Safe Work Condition" exist.**
- **In rare cases, you might need to do work where an "Electrically Safe Work Condition" does not exist.**
 - This is called "Justified Energized Work".
- **For instance, it might not be feasible to de-energize equipment when it could interrupt the power in a hospital.**
 - In these cases, OSHA emphasizes that you must still use strict safety measures to minimize workers' exposure to electrical hazards.
- **Preventing arc flash situations in your workplace largely depends on the practices of the "qualified" electrical workers who are servicing the equipment.**
 - But there are things that other employees can do to help keep themselves safe when electrical work is being done.

- **First, if you're not qualified and authorized to operate or work on electrical equipment, you shouldn't try.**
 - Even small mistakes with high voltage equipment can have big consequences.
- **That's why it's also a good habit to stay clear of electrical equipment and potential arc flash sources under any circumstances.**
 - Warning labels make arc flash sources easy to recognize so you can keep your distance.
 - If an electrical worker has set up an Arc Flash Boundary, don't cross it!
- **If you are a “qualified” electrical worker, you still need to use caution.**
 - For example, you must stay alert and aware throughout the entire job.
 - If you’re feeling tired, sick or distracted, alert your supervisor immediately.
 - You should look for safety signs and barricades that have been put up to keep you safe as well.
- **You will also need to make sure that the area you will be working in has 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 areas that could contain exposed electrical conductors or circuits.**
- **You should also avoid wearing anything that could be conductive, such as...**
 - Jewelry.
 - Watches.
 - Key chains.
 - Metal-framed glasses.
- **Any doors or hinged panels must be secured.**
 - If not, they could swing into you, exposing you to the active electricity inside.
- **If your work area is cluttered or messy, this could also pose an electrical hazard.**
 - So before you start any job, always make sure the surrounding area is neat and clean.

*** * * SUMMARY * * ***

- **An “electric shock” occurs when a current runs from a source of electrical voltage through your body or on the surface of your skin.**
- **An “arc flash event” involves an “arc flash” itself (the light and heat) and an “arc blast”, (the pressure wave that follows).**
- **Before you undertake any electrical work, you should be familiar with your company’s Electrical Safety Plan, read the labels of the equipment you will be servicing, and put on the proper PPE.**
- **You should always establish an “Electrically Safe Work Condition” by de-energizing the equipment you will be working on, locking and tagging it out, and testing it to verify there is no active voltage.**
- **If you aren’t “qualified” to work with electricity, you should never try to. Always adhere to safety boundaries and look for warning signs regarding potential electrical hazards.**
- **When you are doing electrical work, it’s important to stay alert and aware, and keep your work area clear of clutter at all times.**
- **Now that you know what “electric shock” and “arc flash” are, and how you can avoid them, you can help to keep yourself, your coworkers and your workplace safe... every day!**