PRESENTER'S GUIDE

"ELECTROCUTION HAZARDS IN CONSTRUCTION ENVIRONMENTS
PART I... TYPES OF HAZARDS AND HOW YOU CAN PROTECT YOURSELF"

Part of the "CONSTRUCTION SAFETY KIT" Series
OUTLINE OF MAJOR PROGRAM POINTS
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The following outline summarizes the major points of information presented in the program. The outline can be used to review the program before conducting a classroom session, as well as in preparing to lead a class discussion about the program.

- Construction sites can contain a number of potential electrical hazards.
  - So it's important to know what they are and how to protect yourself from them.

- OSHA defines four types of hazards that are associated with electricity, and three types of injuries that result from them.

- Direct contact with electricity, through a power source, cord or transmission line is the most common type of electrical hazard, and can occur in a number of ways.

- Fires are a common result of electrical problems.
  - Most often they occur as a result of faulty electrical outlets and old or damaged wiring.
  - Problems with power cords and extension cords, plugs, receptacles and switches can also cause electrical fires.

- Explosions are another potential result of an electrical malfunction.
  - An explosion can occur when electricity ignites an explosive mixture of material and air.
  - This can range from a liquid, such as gasoline, to something as common as dust.

- "Arc flash" is one of the most intense forms of electrical hazards.
  - It's the sudden release of electrical energy through the air when a high-voltage gap exists and there is a breakdown between conductors.
  - An arc flash gives of thermal radiation (heat) and bright, intense light, both of which can cause burns.

- Temperatures as high as 35,000 degrees Fahrenheit have been recorded from some arc flashes.
  - High-voltage arcs can also produce significant "pressure waves", by rapidly heating the air and creating a "blast".
• **Shock is the most common result of an electrical hazard.**
  — It occurs when the body becomes part of an electrical "circuit", as electricity enters the body at one point and leaves it at another point.

• **Burns are another electrical injury that occur frequently. Burns caused by electricity can be one of three types:**
  — Arc flash, the most serious, caused by an electric arc or explosion.
  — Thermal contact, intense radiated heat, this often occurs when the skin comes into contact with overheated equipment.
  — Electrical, resulting from the heat that is generated from the flow of electricity through the body.

• **Electrical burns occur when an electric current flows through tissue or bone, generating heat that causes tissue damage.**
  — The body cannot dissipate the heat generated by current flowing through the resistance of the tissue, and as a result, burns occur.
  — Electrical burns of any type are among the most serious types of burns, and always require immediate medical attention.

• **Electrocution is the most serious result of coming into contact with an electrical hazard.**
  — It occurs when someone is exposed to a lethal amount of electrical energy, and is by definition, fatal.
  — Typically, the electricity interrupts the rhythm of the heart and ultimately causes it to stop beating.

• **Over the years, electrocution has become the fourth leading cause of death in the construction industry.**
  — Contrary to common perception, it does not take a great deal of electricity to cause an electrocution.
  — Just the amount of current that it takes to light a common Christmas Tree bulb can stop the heart and result in death.

• **In 2005 electrocutions caused over 120 deaths in the construction industry. The construction occupations with the highest average number of deaths per year due to electrocutions were:**
  — Electricians…29 fatalities.
  — Laborers…19 fatalities.
  — Supervisors/managers…13 fatalities.
  — Electrical power installers and repairers…10 fatalities.
- **There are a number of causes of shock, electrical burns and electrocution.**
  - If the power to electrical equipment is not grounded, the grounding path has been broken, or there are live parts or bare wires, a fault current can travel through your body.
  - Even when the equipment or tool is properly grounded, it can instantly change from safe to hazardous because of extreme conditions or rough treatment.

- **There are three major types of electrocution hazards in construction:**
  - Contact with power lines.
  - Direct contact with other energized sources, such as live machine parts, damaged or bare wires, and defective equipment or tools.
  - The improper use of flexible power cords and extension cords.

- **Contact with both overhead and buried power lines is one of the biggest electrical problems in the construction industry.**
  - These lines are especially hazardous because they carry extremely high voltage.
  - Electrocution, which is fatal, is the main risk.
  - However, burns and falls can also result from being exposed to high voltage lines.

- **While one of the first thoughts that pops into your mind when you think about overhead power lines is often cranes, it’s important to remember that they aren’t the only equipment that can extend high enough to come into contact with power lines.**
  - Working on a ladder or in a "man-basket" suspended under or near power lines can also pose the risk of electrocution.

- **You can sometimes be lulled into a false sense of security when you’re working around overhead power lines that are covered with a protective material.**
  - Remember, these shields are there primarily to protect the lines against adverse weather.
  - Touching a power line, whether it is covered or bare, is extremely hazardous, and is usually fatal.
• Direct contact with "energized sources", such as a bare wire, is another serious problem in the construction industry.
  — The most common results of these types of contacts are electrical shock and burns.

• As we've discussed, shock occurs when the body becomes part of an electric circuit. This can occur when you come into contact with:
  — Both wires of an electrical circuit.
  — One wire of an energized circuit and the ground.
  — A metallic part in a machine or tool that has become energized through contact with an electrical source.

• The severity and effects of an electrical shock depend on a number of factors, including:
  — The pathway the electricity takes through the body.
  — The amount of current that's involved.
  — The length of time that you're exposed to the electrical current.
  — Whether your skin is wet or dry (water is a great conductor of electricity, and allows current to flow more easily through wet skin.).

• The results of direct contact with electrical current can include:
  — A mild tingling of the skin.
  — Extreme pain.
  — Respiratory arrest.
  — Severe muscular contractions.
  — Severe burns.
  — Cardiac arrest... and ultimately death.

• As we have discussed, it doesn't take a great deal of electricity to cause a shock.
  — Just the amount of current that is required to light a Christmas Tree bulb can cause shock, and even death.

• Using extension cords and flexible power cords improperly can also cause electrical problems on construction sites.
  — Even the normal wear and tear on these cords can loosen or expose wires, creating a hazardous condition.
  — Often dragged from place to place and exposed to materials with rough surfaces and sharp edges, these cords are more susceptible to damage than fixed wiring.
• Hazardous situations can also be created when cords, cord connectors, receptacles, and cord and plug-connected equipment are improperly used and maintained.
  — Cords that are not 3-wire type, not designed for hard use, or that have been modified, increase your risk of contracting electrical current even more.

• To reduce these hazards, flexible cords should be connected to devices and fittings so that there is no tension at joints and terminal screws.

• You also need to take care to keep cords dry, away from puddles and out of the rain.
  — If the plug or other connector of a cord gets wet, electrical current can leak to the equipment's grounding conductor as well as to anyone who picks up the connector, since they provide a path to ground.
  — This type of "current leakage" can occur not just on the face of the connector, but at any part of the connector that's wet.

• There are several ways to protect yourself from electrocution hazards. They include:
  — Keeping yourself a safe distance from overhead power lines.
  — Using ground-fault circuit interrupters (GFCI's).
  — Inspecting portable tools and extension cords thoroughly, before you use them.
  — Only using powered equipment and tools as they were designed to be used.
  — Following proper lock-out/tag-out procedures when you're working on electrically powered machinery and equipment.

• If you're working in an area that has overhead power lines, it's important to know at all times where they are in relation to the work you're doing.

• There are several things that you should do no matter where you are and what work you're performing.
  — Make sure that your equipment and the work that you're doing is positioned safely away from the lines.
  — OSHA has created a table showing what they believe to be safe power line clearance distance for various line voltages.
  — Clearance distances range from a minimum of 10 feet for power lines carrying up to 50 volts to more than 45 feet for power lines carrying 750 to 1000 volts.
• If at all possible you should either have the utility company de-energize and visibly ground the lines, or install insulated sleeves on the lines.
  — Flagged warning lines should be set up to mark both the horizontal and vertical power line clearance distances recommended by OSHA.

• Finally, you should make sure that the tools and materials that you’re using are non-conductive, when possible.

• If you’re working with a crane or other high reaching equipment and the power lines are active, you should:
  — Be sure that the utility company has confirmed the voltage in the lines, and determine what the safe working distance is on the OSHA clearance charts.
  — If possible use an onsite observer, insulated links, boom cage guard or proximity device when they’re applicable.

• If you’re using other mobile, heavy equipment you should use installed rider posts when you are working under power lines, to avoid getting too close to the lines.

• If the work you’re doing calls for ladders, be sure that they are non-conductive and that you retract them before you move from one location to another.

• Make sure that none of the materials you are working with are stored under power lines, so there will be no need to position equipment under the lines to retrieve them.
  — Use caution tape and signs to cordon off the space under the power lines, so everyone knows where the restricted areas are located.

• Working around underground power lines calls for a different set of precautions.
  — Always call your local underground line locator service before you start any project that involves digging into the ground.
  — Make sure that you’ve documented the instructions they give you for determining where any underground lines may be.
  — If the service has put markers into the ground themselves, know what type of markers you should be looking for, and make sure you find them before you start to work.
• **Always hand dig within 3 feet of an underground power line location.**
  — Remember, more than one underground cable can be buried in the vicinity of a marker.

• **Working with power tools and other electrical equipment on construction sites can create hazards as well.**
  — One way to protect yourself is to use ground-fault circuit interrupters (GFCI's).
  — A GFCI is designed to protect workers from severe and sometimes fatal electrical shocks.
  — It detects when a circuit or tool's grounding system is not working, and interrupts the flow of electric current when this happens.
  — In this way it eliminates the potential for an electrical shock, or if one occurs, limits the duration of the shock you experience.

• **There are three types of GFCI's.**
  — The first is a "receptacle GFCI".
  — These are often found on construction sites and other locations where damp conditions exist. Receptacle GFCI's fit into standard outlet boxes and protect users against ground faults when something is plugged into the outlet.

• **Receptacle GFCI's should be tested after they are installed and at least once a month thereafter. To conduct a test:**
  — Plug in a test light or power tool and turn it "on".
  — Push the test button on the receptacle.
  — It should pop up and the power to the light or tool should go off.
  — Push the "Reset" button on the receptacle to restore power to the outlet.
  — If the GFCI fails this test, it should be removed from service immediately.

• **The second type of GFCI is a "temporary" or "portable" GFCI.**
  — This is an extension cord combined with a GFCI.
  — It allows you to use receptacles that are not themselves protected by GFCI's.
  — These types of cords, with built-in GFCI protection, should be used whenever outlets with their own GFCI's are not available.
  — Cords should be run through the same test that is used for GFCI receptacles prior to each use.
• The third type of GFCI is a "circuit breaker" GFCl.
  — These are installed instead of normal circuit breakers in a main circuit board or panel box.
  — A "circuit breaker" GFCl controls an entire circuit, so there is no need for GFCIs at individual outlets.

• Being careful and knowing how to use the portable tools and extension cords that you work with is another way to protect yourself against electrical hazards and electrocution.
  — Cords from power tools as well as extension cords should be inspected each time they're used.
  — Either of these types of cords can have damaged insulation that is difficult to detect.

• If a cord's insulation is damaged, exposed metal parts can become energized if a live wire inside the cord touches them.
  — This can often be a problem with electric hand tools that are old, have been damaged in other ways or have been misused.

• Flexible cords that are used with temporary and portable lights need to be designed for hard or extra-hard use.
  — They should be marked with usage-type designations regarding their size and number of conductors.

• It's also important to use power tools and equipment as they were designed to be used.

• OSHA has created a list of Tool Safety Tips that can help you keep your power tools and equipment in good shape. They include:
  — Never carry a tool by its cord.
  — Never yank a power cord to disconnect it from an outlet.
  — Keep all power cords away from heat, oil and sharp edges.
  — Always disconnect a power tool when it's not in use, as well as when you're changing accessories, blades or bits.
  — Keep your fingers away from "On/Off" buttons and switches when you are not using a tool, such as when you're carrying it.
**Additional tips from the list include:**
- Always wear gloves and appropriate footwear when working with power tools and equipment.
- Store your equipment in a dry place.
- Keep the areas that you're working in well lit.
- Arrange power and extension cords so that they don't create trip hazards.
- Immediately remove any damaged tool from use.
- Use double-insulated tools whenever possible.

**There are several other common problem-causing situations that occur frequently in construction environments that you should look out for. For instance:**
- Multi-receptacle boxes that are designed to be mounted on a stud or other surface are frequently fitted with power cords, then placed on the floor or ground and misused as portable receptacles.
- On some sites, makeshift extension cords are created using Romex wire.

**Attaching ungrounded, 2-prong adapter plugs to three-prong extension cords and tools is something that happens frequently as well.**
- Workers will also sometimes modify cords and tools by removing the ground prongs from plugs, or not installing faceplates on outlets.

**Another problem that is common is that equipment that is designed and labeled for use only in dry, in-door locations is often used outdoors.**

**Using circuit breakers or fuses with the wrong rating for the panels or boxes they're in is something else that often times occurs on construction sites.**
- For example, on some construction sites you'll see a 30-amp breaker being used in a system that's designed to support 15 or 20-amp receptacles.
- Workers assume that this will provide more protection from electrical current.
- In fact, this removes all of the protection against the electricity that flows through the circuit, because the higher rated breaker or fuse will not trip when the system’s load has been exceeded.
• One of the most important things that you can do to guard against injury and electrocution when you're working with electrically powered equipment is to follow proper lock-out/tag-out procedures.
  — Lock-out/tag-out prevents you from coming into contact with moving parts, such as blades, gears and shafts, while you're working on powered equipment.
  — It also prevents the unexpected release of hazardous gases, fluids or other material in areas where people are working.

• The basic premise behind lock-out/tag-out is that equipment and machinery needs to be "de-energized" before it is worked on. OSHA has created a checklist of steps to follow to accomplish this. Initially you should:
  — Notify all personnel that the equipment and circuitry must be shut off, locked out and tagged (simply turning a switch off is not enough).
  — Identify all sources of electrical energy for the equipment or the circuits you're working on.
  — Disable any back-up energy sources such as generators and batteries.
  — Identify all "shut-offs" for each energy source (such as "On/Off" switches and circuit-breaker boxes).
  — Shut off all energy sources and apply appropriate locks and tags (if multiple workers are going to be involved in servicing the equipment, they should apply their individual locks to the power source, and keep the keys to the locks with them at all times).

• Once these steps have been taken the equipment and circuitry should be tested to ensure that everything has been de-energized (this must be done by an OSHA-defined "qualified person).
  — Stored energy should be depleted by bleeding, blocking, grounding or other appropriate measures.

• When work on the equipment has been completed, all workers should be accounted for and moved away from the equipment before the locks are removed, the circuits reactivated and the equipment is turned back on.
  — Remember, only a "qualified person" can determine when it's safe to re-energize circuits.
• In the rare cases where a machine cannot be de-energized to be serviced, only "qualified persons" can work on the electrical circuit or equipment itself.
  — These people must be capable of working safely on energized circuits, and must be familiar with the special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools that should be used in these situations.

*** SUMMARY ***

• As you can see, there's a lot to remember about how to work safely with electricity.

• It doesn't take much electricity to cause a serious injury. Just the current used to light a Christmas Tree bulb can be fatal.

• There are three major types of electrocution hazards in construction environments:
  — Contact with power lines.
  — Contact with other energized sources, such as bare wires and defective power tools.
  — Using power cords and extension cords improperly.

• You should know where all power lines are located on your job site, and how far you need to be from them to work safely.

• GFCI's provide important protection from shocks, and should be installed wherever needed.

• Power and extension cords should be treated with "respect", and inspected for any damage.

• Always wear appropriate personal protective equipment when you're working with power tools and machinery.

• And use "lock-out/tag-out procedures when you are servicing or repairing electrical equipment.

• Electricity can be dangerous! But by taking the proper precautions, and knowing how to work safely, you can go home injury-free every day!