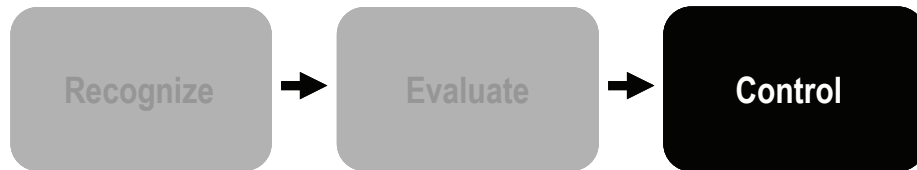


MODULE 4

METHODS OF CONTROL



At the end of this module, you will be able to...

- ⚡ Identify the three types of control that should be used to achieve electrical safety.
- ⚡ Identify the engineering, administrative and PPE electrical controls you use on your job as well as the controls you should be using.
- ⚡ Identify facts and procedures relating to lockout/tagout.
- ⚡ List the steps required to achieve an electrically safe condition.
- ⚡ Recognize when a work permit is required to work on energized electrical circuits.
- ⚡ Recognize the appropriate warning signs to alert employees to the danger of electricity.
- ⚡ Recognize the appropriate PPE to use based on the calculated energy value of an energy source.
- ⚡ Given a case study, determine the most appropriate method of control and necessary corrective action.

Controls for Electrical Hazards

Question: What is a control?

Answer:

Three Types of Control

Engineering—Engineering controls engineer the hazard out by initial design specifications or by applying substitution methods, isolation, enclosure, or ventilation. Of the three types of controls, engineering control methods should be considered first.

Examples:



Administrative—Administrative controls reduce employee exposures through methods such as education and training, work reduction, job rotation, maintenance/repairs, housekeeping, personal hygiene, and appropriate work practices. Administrative controls depend on constant human implementation or intervention.

Examples:

Personal Protective Equipment (PPE)—Personal Protective Equipment is worn by employees to protect them from the environment. PPE includes anything from gloves to full body suits with self-contained breathing apparatus and can be used with engineering and administrative controls.

Examples:



Activity: Engineering Controls for Electrical Safety

Directions: Below is a list of engineering controls. Check the appropriate box to indicate your organization's use of each control.

Control	In Use	Don't Know
1. Build overcurrent protection devices (fuses, circuit breakers, relays, GFCIs) into your electrical systems.	☐	☐
2. Isolate live electrical parts.	☐	☐
3. Insulate live electrical parts.	☐	☐
4. Put physical barriers (such as fences and insulators) around energy sources to prevent human contact.	☐	☐
5. Ground electrical systems and tools.	☐	☐
6. Bond components to equalize electrical potential.	☐	☐
7. Use the correct size and type of wiring.	☐	☐
8. Make sure that the thickness of an extension cord is at least as thick as the cord for the electrical tool.	☐	☐
9. Use switches with approved voltage and amperage.	☐	☐
10. De-energize the electrical system prior to doing electrical work.	☐	☐
11. Use lockout/tagout.	☐	☐
12. Provide proper equipment for the job.	☐	☐

-continued on next page-

Activity: Engineering Controls for Electrical Safety—continued

Control	In Use	Don't Know
13. Make sure all equipment and extension cords bear the mark of a Nationally Recognized Testing Laboratory.	☐	☐
14. Keep equipment up-to-date and in good working condition.	☐	☐
15. Provide adequate illumination where electrical work is being done.	☐	☐
16. Use insulated mats/barrier devices.	☐	☐
17. Use non-conductive tools whenever possible.	☐	☐
18. Provide only non-conductive ladders and scaffolds.	☐	☐
19. Install toe boards or use nets on work platforms so tools don't accidentally fall into the electrical system.	☐	☐
20. Use GFCI when there is moisture.	☐	☐

Note: This list is compiled based on the following regulations and standards.

- ⚡ OSHA 29 CFR 1910, Subpart I and Subpart S
- ⚡ NFPA 70E

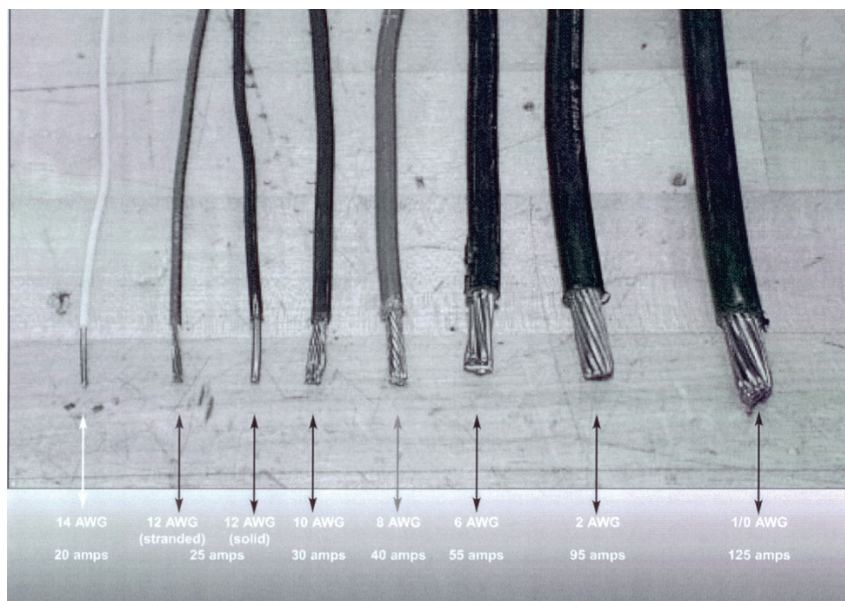
Note: This engineering control checklist is available on your *Tools and Resources* CD-ROM.

Safe Wiring

Electrical hazards result from using the wrong size or type of wire. It is up to you to make certain your workers use wiring safely. Following are some important tips.

- ⚡ Choose the correct size of wire for the amount of current in the circuit. The wire must be able to handle the current safely.
- ⚡ Make certain that the wire's insulation is appropriate for the voltage that will be running through it.
- ⚡ Make certain the wire is tough enough to stand up in the environment in which it will be used.
- ⚡ Make sure the connections are reliable.
- ⚡ Make sure the connections are protected.

Following is a photo showing which wire size to use for a variety of amperages. Note that the larger the wire is, the smaller its AWG (American Wire Gauge) number.



Wires come in different sizes. The maximum current each size can conduct safely is shown.

Activity: Administrative Controls for Electrical Safety

Directions: Below is a list of administrative controls. Check the appropriate box to indicate your organization's use of each control.

Control	In Use	Don't Know
1. Establish and adhere to a set of electrical safety principles.	☐	☐
2. Establish and adhere to consistent procedures for working around electricity.	☐	☐
3. Provide electrical safety training for workers.	☐	☐
4. Conduct job briefings for projects that involve electricity.	☐	☐
5. Have and use a documented housekeeping program.	☐	☐
6. Provide adequate work rest periods to prevent employees from taking costly shortcuts.	☐	☐
7. Consider every electrical conductor or circuit to be energized until proven otherwise.	☐	☐
8. Allow only qualified personnel to test electrical equipment.	☐	☐
9. Establish and observe approach boundaries.	☐	☐
10. Establish and use a system of warnings and signs.	☐	☐
11. Avoid working under overhead power lines.	☐	☐
12. Avoid working in wet conditions.	☐	☐
13. Verify location of all buried or embedded electrical circuits before digging or cutting.	☐	☐
14. Know where your overcurrent devices are (i.e. circuit breakers and fuses) so they can be easily and quickly reached in case of emergency.	☐	☐
15. Determine the reason a fuse operated or a circuit breaker tripped before replacing or resetting.	☐	☐

-continued on next page-

Activity: Administrative Controls for Electrical Safety—continued

Control	In Use	Don't Know
16. Read and follow all equipment operating instructions.	☐	☐
17. Ensure equipment repairs are made by authorized people.	☐	☐
18. Use electrical equipment for its intended purposes only.	☐	☐
19. Never modify tools.	☐	☐
20. Inspect electrical equipment before each shift.	☐	☐
21. Keep thorough records of inspections and maintenance.	☐	☐
22. Avoid carrying a tool by the cord.	☐	☐
23. Avoid yanking a cord to disconnect it from the receptacle.	☐	☐
24. Keep hands dry when plugging and unplugging equipment.	☐	☐
25. Keep cords and tools away from heat, oil and sharp edges.	☐	☐
26. Disconnect tools when changing bits, blades or accessories.	☐	☐
27. Avoid piggybacking power strips and extension cords.	☐	☐
28. When replacing lamps and bulbs, verify that the replacement matches fixture requirements.	☐	☐
29. Avoid wearing jewelry and other metal.	☐	☐
30. Secure and contain loose hair.	☐	☐

Note: This list is compiled based on the following regulations and standards.

- ⚡ OSHA 29 CFR 1910, Subpart I and Subpart S
- ⚡ NFPA 70E

Note: This administrative control checklist is available on your *Tools and Resources* CD-ROM.

Activity: PPE Controls for Electrical Safety

Directions: Below is a list of PPE controls. Check the appropriate box to indicate your organization's use of each control.

Control	In Use	Don't Know
1. Establish procedures to ensure employees wear their PPE.	☐	☐
2. Establish routine checks to ensure employees wear PPE.	☐	☐
3. Apply consequences for employees not wearing PPE.	☐	☐
4. Wear insulated gloves to protect hands and arms.	☐	☐
5. Wear insulated shoes or boots to protect feet.	☐	☐
6. Use face shields.	☐	☐
7. Use safety glasses to protect eyes.	☐	☐
8. Use hard hats.	☐	☐
9. Use flame resistant clothing that does not impair mobility.	☐	☐
10. Wear hearing protection.	☐	☐
11. Adjust helmets to proper size.	☐	☐
12. Avoid drilling or punching holes in helmets.	☐	☐
13. Avoid wearing helmets backwards.	☐	☐
14. Store PPE properly.	☐	☐
15. Check dates for integrity of flame resistant clothing.	☐	☐

Note: This list is compiled based on the following regulations and standards.

- ⚡ OSHA 29 CFR 1910, Subpart I and Subpart S
- ⚡ NFPA 70E

Note: This PPE control checklist is available on your *Tools and Resources* CD-ROM.

Activity: Controls for Electrical Hazards

Directions: We've discussed how to recognize and evaluate electrical hazards. Now let's look at how to control them. Work with your group and, using Pages 3 through 8, identify important controls that you can use for electrical hazards.



Photo courtesy of Schneider Electric

Engineering Controls

Administrative Controls

PPE Controls

Facts About Lockout/Tagout

Lockout:

Tagout:



When to Use Lockout/Tagout

- ⚡ When repairing electrical equipment and machinery
- ⚡ When maintaining electrical equipment and machinery

People Involved in Lockout/Tagout (1910.147)

<i>Authorized employee</i>	The person (or people) authorized to perform a lockout/tagout. This person locks out and tags out machines and equipment in order to perform servicing and maintenance.
<i>Affected employee</i>	An employee whose job requires him or her to operate or use a machine or equipment on which servicing or maintenance is being performed under lockout/tagout, or whose job requires him or her to work in an area in which such servicing or maintenance is being performed.
<i>Other Employees</i>	Per OSHA, employees within a workplace who are not involved in operating or servicing the affected equipment, but who must know about the lockout/tagout program.

People Involved in Lockout/Tagout (1910.333)

<i>Qualified Person</i>	A person who has received training in and has demonstrated skills and knowledge in the construction and operation of electrical equipment and installations and the hazards involved.
<i>Unqualified Person</i>	A person with some electrical knowledge/experience, but who must limit work to de-energized parts. The person has little or no training on identifying and preventing the electrical hazards associated with working on or near exposed energized parts.

Which OSHA Lockout/Tagout Standard to Use

When you study the OSHA standards for lockout/tagout, you will find there is more than one standard covering the procedure that applies to the operation. As you just saw on Page 10, one standard is OSHA 29 CFR 1910.147(d). But there is also OSHA 29 CFR 1910.333. How will you know which standard to use? Following is a comparison to guide you.

OSHA 29 CFR 1910 147(d)

When to Use:

When servicing or maintaining machines or equipment in which the **unexpected** energization or start up of the equipment, or release of stored energy, could cause injury to employees.

Who Performs the Procedure:

An authorized person, who is an employee trained to do lockout/tagout.

Verification Process:

Prior to starting work on machines or equipment that have been locked out or tagged out, the authorized employee shall verify that isolation and de-energization of the machine or equipment have been accomplished.

OSHA 29 CFR 1910.333

When to Use:

When servicing or maintaining equipment or circuits which are or may be energized.

Who Performs the Procedure:

A qualified person, who is someone who must be trained in and who has demonstrated skills and knowledge in the construction and operation of electrical equipment and installations and the hazards involved.

Verification Process:

A qualified person shall test the circuit elements and electrical parts of equipment to which employees will be exposed and verify that the circuit elements and equipment parts are de-energized. The test will determine if any energized condition exists as a result of inadvertently induced voltage or unrelated voltage backfeed. If the circuit is over 600 volts nominal, the test equipment shall be checked for proper operation immediately after this test.

It is important to distinguish between these two procedures because it takes different training and experience to perform lockout/tagout under the two standards. An authorized person who has had the training to perform lockout/tagout under OSHA 29 CFR 1910.147(d) **is not automatically qualified** to perform lockout/tagout under OSHA 29 CFR 1910.333.

Performing Lockout/Tagout

Here are the procedures for performing a lockout/tagout under OSHA 29 CFR 1910.147 (d).

Step 1—Prepare for Shutdown

Before equipment or a machine is turned off, the person shutting it down must have knowledge of the type and magnitude of the energy, the hazards of the energy to be controlled and the method or means to control the energy.

Step 2—Perform the Shutdown

The machine must be turned off or shut down using the procedures established for the machine or equipment. An orderly shutdown must be used to avoid any additional or increased hazard(s) to employees as a result of equipment stoppage.

Step 3—Isolate the Machine or Equipment.

All energy isolating devices that are needed to control the energy to the machine or equipment shall be physically located and operated in such a manner as to isolate the machine or equipment from the energy source(s).

Step 4—Apply the Lockout or Tagout Device

Lockout or tagout devices must be applied by an authorized employee. The locks and tags must be affixed so that they hold the energy isolating devices in a “safe” or “off” position. Tagout devices must clearly indicate that the operation or movement of energy isolating devices is prohibited.

Step 5—Release Stored Energy

All potentially hazardous stored or residual energy shall be released, disconnected, restrained and otherwise rendered safe. The authorized person must verify that there is no stored energy. If there is a possibility of reaccumulation of stored energy to a hazardous level, verification of isolation must be continued until the servicing or maintenance is completed, or until the possibility of such accumulation no longer exists.

Step 6—Verify Energy Isolation

Before starting work on the machine or equipment, the authorized employee must verify that isolation and de-energization of the machine or equipment have been accomplished.

Achieving an Electrically Safe Condition

Here are the procedures for performing a lockout/tagout under OSHA 29 CFR 1910.331-1910.333, which will create an electrically safe condition.

1. Complete and communicate a detailed job plan.
2. Identify all potential sources of energy from a one-line drawing or other reliable source.
3. Calculate the incident energy potential for the job.
4. Select the proper PPE.
5. Wear the PPE before performing any task.
6. Interrupt the load circuit.
7. Open the disconnecting device for each source.
8. Perform lockout/tagout.
9. Verify that the circuit is de-energized.
10. Apply ground connecting devices.



Photo courtesy of Schneider Electric

Energized Electrical Work Permit

Under NFPA 70E, there are only two instances in which an employee can work on live parts. In these situations, a work permit must be completed and approved by an authorized person.

1. When de-energizing would interrupt essential life support, emergency alarms or ventilation systems.
2. When the organization can demonstrate that de-energizing the system would introduce additional or increased hazards or that it is infeasible due to equipment design or operational limitations.

PART I TO BE COMPLETED BY THE REQUESTER Job/Work Order Number _____	
1. Description of circuit/equipment/job location: _____ 2. Description of work to be done: _____ 3. Justification of what the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage: _____	
PART II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED PERSONS DONG THE WORK	
1. Detailed job description procedure to be used in performing the above detailed work: _____ 2. Description of the safe work practices to be employed: _____ 3. Results of the shock hazard analysis: _____ 4. Determination of shock protection boundaries: _____ 5. Results of the flash hazard analysis: _____ 6. Determination of the flash protection boundary: _____ 7. Necessary personal protective equipment to safely perform the assigned task : _____ 8. Means employed to restrict the access of unqualified persons from the work area: _____ 9. Evidence of completion of job briefing including discussion of any job-related hazards: _____	Check when Complete ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
10. Do you agree the above described work can be done safely? ☐ Yes ☐ No (if no, return to requester)	
Electrically Qualified Person(s) _____	Date _____
PART III: APPROVAL(S) TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED	
Manufacturing Manager _____	Maintenance/Engineering Manager _____
Safety Manager _____	Electrically Knowledgeably Person _____
General Manager _____	Date _____
Note: Once the work is complete, forward this form to the site Safety Department for review and retention.	

Source: National Fire Protection Association, © 2004

Note: This work permit form is available on your *Tools and Resources* CD-ROM.

Warnings and Signs

An important administrative control for electrical safety is to have warnings and signs when there is work on electrical circuits. Although the sign can be a simple warning of electrical danger, the best warnings contain as much information as possible about the electrical hazard.

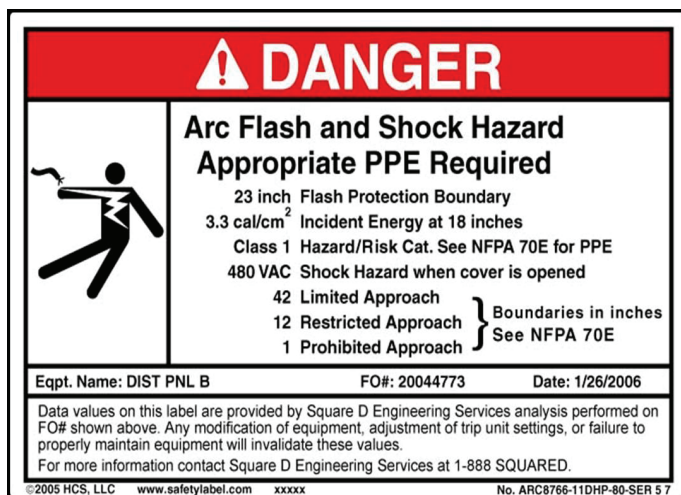
Adequate Warning Sign

This sign illustrates the minimum warning requirement. It is an example, not a recommendation.

- ✦ It's visible
- ✦ It shows the universal sign for electricity
- ✦ It warns of arc flash and shock hazard
- ✦ It advises safe work practices and PPE



Sign courtesy of Schneider Electric



Sign courtesy of Schneider Electric

Preferable Warning Sign

This sign is preferable because it contains the following additional information.

- ✦ The flash protection boundary requirements
- ✦ The energy intensity
- ✦ The hazard category
- ✦ The approach limits

Selecting Protective Clothing

The NFPA 70E standard has developed guidelines for using PPE based on the calculated value of incident energy. Once a qualified person performs a Shock Hazard Analysis, PPE can be determined based on the following.

Output Category	Calculated Incident Energy Value (Cal/cm ²)	PPE
0	N/A	☐ Untreated cotton
1	4	☐ Fire resistant (FR) shirt ☐ FR pants
2	8	☐ Cotton underwear ☐ FR shirt ☐ FR pants
3	25	☐ Cotton underwear ☐ FR shirt ☐ FR pants ☐ FR coverall
4	40	☐ Cotton underwear ☐ FR shirt ☐ FR pants ☐ Double layer switching coat ☐ Double layer switching pants
NOTE THAT MELTABLE FABRICS AND OTHER SIMILAR SYNTHETICS ARE <u>NEVER PERMITTED</u>		

Table Source: NFPA 70E, Table 130.7(C)(11)

The above is a sample of the information provided in the NFPA 70E tables. Please note that this is an excerpt from the tables and only a sample. This particular table addresses only clothing and does not address head, eye, hearing and face protection, which are covered in NFPA 70E, Table 130.7(C)(10).

Activity: Can You Identify the Appropriate Controls?

Directions: Look at the slides your facilitator shows you. Identify the appropriate controls for the hazards in each slide. Write them in the space below.

Case #1



Case #2



Case #3



Case #4



Planning for Your Small Business

Directions: Based on what you've learned in this module, what will you do back on the job?

1. Identify two or three actions you will take when you return to your worksite.
2. In addition, identify the potential barriers you might encounter in taking these actions.
3. Next, list ideas for overcoming the barriers identified.

Action Plan

Action	Potential Barriers	Overcoming the Barriers